



4456 Series Digital Phosphor Oscilloscope

User Manual



Ceyear Technologies Co., Ltd

Foreword

Thank you for choosing the 4456 series digital phosphor oscilloscope developed and manufactured by Ceyear Technologies Co., Ltd (CETI). This product embraces complete functions, advanced technical specifications, rich options and configuration, and breakthrough and innovative technology, which allow you to experience more and better oscilloscope performance. Please read this manual carefully to understand and use this oscilloscope.

We are devoted to providing for you high-quality products and first-class after-sales service with your most concerns and demands in mind. Following the consistent tenet of “High Quality and Considerable Service”, we are committed to provide our customers with satisfactory products and service. For any questions, please contact us:

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This manual describes the applications, menu structure, operation method, precautions for use, basic working principle, etc. of the 4456 series digital phosphor oscilloscope to help you familiarize yourself with and master the operation methods and essentials as soon as possible. Please carefully read this manual, and operate correctly according to the corresponding instructions.

However, due to time constraints and limitations of the author, the manual may be subject to errors or deficiencies. We sincerely welcome your corrections! We apologize for the inconvenience caused by errors of our work!



Instructions:

This manual is the first version of the 4456 Series Digital Phosphor Oscilloscope User Manual, with the version number of V2.0.

This manual is subject to change without notice. Ceyear Technologies Co., Ltd reserves right of final interpretation of the content and the terms of this manual.

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Author
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Chapter I Operation Guide

Thank you for choosing the 4456 series digital phosphor oscilloscope developed and manufactured by Ceyear Technologies Co., Ltd! The 4456 series oscilloscope has 6 product models, including standard types 4456C/D/E and economical types 4456CM/DM/EM. This product is integrated with the digital oscilloscope, logic analyzer, waveform generator, protocol analyzer and digital voltmeter, embraces functions including waveform autoset, automatic measurement of waveform parameter, cursor measurement, histograms measurement, arithmetic operation and advanced mathematics, FFT analysis, serial protocol trigger and analysis, limit/mask test, power measurement and analysis, internal test signal output, waveform record & play, analog-digital signal analysis, and arbitrary function generator, and supports Ethernet SPC, thus bringing convenience to your integrated development.

This chapter introduces the precautions including unpacking inspection, safety instructions and after-sales maintenance. Please read this chapter carefully before use, so as to avoid damage to oscilloscope or accident caused by improper operation. If there is any problem, please contact us timely, and we will give solution as soon as possible.

1.1 Unpacking inspection

When you receive this instrument, please check its package and packing list through the following steps:

- 1) Check whether the packaging box and pad are extruded or torn. If yes, please unpack the instrument and check whether its appearance is damaged.
- 2) Carefully take out the items in the packaging box, and check the attached accessories and documents according to the packing list. The necessary accessories and documents in the packaging box include:

Main unit of the 4456 series oscilloscope (4456C/CM/D/DM/E/EM) * 1

Power cord * 1

Passive voltage probe * 4

Certificate of Conformity * 1

*User Manual of 4456 Series Digital Phosphor Oscilloscope * 1*

*Programming Manual of 4456 Series Digital Phosphor Oscilloscope * 1*

Packing List * 1

After ensuring that instruments, accessories and documents in the box are complete and intact, the electric performance test of the oscilloscope can be carried out.

- 3) If you have any questions about the product or you need relevant consultation service, please contact us via the contact information in the Foreword or section 1.3, and we will make answers, repairs and replacements rapidly based on your requests.



Instructions: **The packaging and transportation materials of the oscilloscope are recyclable. When the transportation materials can't be reused due to damages, they can be processed as recyclable wastes.**

1.2 Safety instructions

The safety of the 4456 series digital phosphor oscilloscope satisfies the requirements of GJB3947A-2009. There is no part for the user's operation inside this instrument. Please do not open the enclosure of the instrument without permission, so as to avoid unnecessary personal injury. To ensure your safety and correct use of the instrument, please read the following safety instructions carefully before use.

1.2.1 Environment requirements

In order to ensure the service life of the 4456 series digital phosphor oscilloscope and the measurement validity and accuracy, please test and store data under the following temperature conditions. Storage temperature range: $-40^{\circ}\text{C} \sim +70^{\circ}\text{C}$, working temperature range: $0^{\circ}\text{C} \sim +50^{\circ}\text{C}$.

1.2.2 Selection of power cord

The 4456 series digital phosphor oscilloscope uses a 3-core power cord that complies with the international safety standard. During use, insert the power cord into the appropriate power socket with a protective ground to ensure that the enclosure can be grounded by the power cord. The power cord provided together with the instrument is

recommended. If the power cord shall be replaced, it is recommended to use the same type of 250 V/ 2.5 A power cord.

1.2.3 Power supply requirements

The 4456 series digital phosphor oscilloscope adopts AC power supply, with the output of 100 ~ 240 V and 50 ~ 60 Hz AC power supply and max. power of 150 W. In order to prevent or decrease mutual interference due to multiple devices by the power supply, especially internal hardware damage of the oscilloscope due to peak pulse interference of the high power equipment, it is recommended to use AC regulated power supply for the oscilloscope to ensure that the supply voltage is within the range specified in 0.

Table 1.1 Power requirement

Power Supply Parameter	Applicable Scope
Input voltage	100 V ~ 240 V _{AC}
Rated input current	1.5A
Working frequency	50 Hz ~ 60 Hz

1.2.4 Electrostatic protection (ESD)

The electrostatic protection is often neglected. The accumulated electrostatic discharge of human body is easy to damage the sensitive circuit components of the instrument, greatly reduce the test reliability of the instrument, and even small electrostatic discharge that can't be directly observed may cause permanent damage to the sensitive device. Therefore, the following electrostatic protection measures shall be taken as much as possible when conditions allow:

- 1) Ensure that all instruments are correctly grounded to prevent electrostatic generation.
- 2) The staff shall wear anti-static wrist straps or adopt other anti-static measures before contacting joints and core wires or carrying out any assembly operation.

1.3 After-sales maintenance

Ceyear Technologies Co., Ltd has nationwide outlets and offices, and the technical support personnel in each outlet and office can quickly reach the user's premise for technical exchanges, training and maintenance service, and provide you with comprehensive and convenient technical support and after-sales service. In addition, you can log in www.ceyear.com website, and get online consulting help through QQ online customer service.



All the instruments supplied by us have passed the inspection by the quality department, and we make following commitments: The instrument will have an 18-month warranty period after its delivery and have a long-term maintenance, and the probe will have a 3-month warranty period. If the instrument has any fault not due to man-made fault within the warranty period, we will provide repair free of charge; we will solve your problems by telephone or door-to-door maintenance according to different faults of the instrument.

In addition, if the instrument has any fault, please contact us timely, and we will provide you with the necessary help and return it to the factory for repair if necessary. The user is not allowed to disassemble the machine without permission to avoid the damage of internal circuit and device due to wrong operation.

1.4 Identification in the Manual

During the compilation of the User Manual, some additional instructions, warnings and precautions are given in form of identifications. Try to operate and use the instrument according to the warnings and attentions, so as to avoid permanent damage to the oscilloscope due to improper behavior. The main identification is as shown in 0:

Table 1.2 Identification in the Manual

Identification in the Manual	Explanation
	It is intended to explain the operation, precautions and safety instructions of the instrument, and remind the user of general operation information or instructions.
	It is a kind of hazard warning, which is intended to remind the user of important precautions. The incorrect operation may cause damage to the instrument or lead to personal injury.



Some key precautions during use of the instrument.

Chapter II About the 4456 Series Digital Phosphor Oscilloscope

This chapter describes the 4456 series digital phosphor oscilloscope generally. You can get more familiar with the instrument structure and its basic test functions by reading this chapter. In addition, Chapter III is about use of oscilloscope vertical system; Chapter IV is about use of oscilloscope horizontal system; Chapter V is about use of oscilloscope trigger system; Chapter VI is about use of oscilloscope measurement system; Chapter VII is about mathematic operation function of oscilloscope; Chapter VIII is about use of oscilloscope display system; Chapter IX is about storage, recall and reference of oscilloscope; Chapter X is about oscilloscope system setup; Chapter XI is about use of protocol trigger and analysis options; Chapter XII is about use of limit/mask test options; Chapter XIII is about use of power measurement and analysis options; Chapter XIV is about use of logic analyzer options; Chapter XV is about use of waveform generator options; Chapter XVI is about use of oscilloscope probe; Chapter XVII is about function of digital voltmeter; Chapter XVIII is about basic principles of digital phosphor oscilloscope; Chapter XIX is about application examples of digital phosphor oscilloscope, and Chapter XX is about fault detection and troubleshooting of digital phosphor oscilloscope.

2.1 Power on

Before powering on the 4456 series digital phosphor oscilloscope, please check the power supply unit according to the “Power supply requirements” in Chapter I. Power on the digital oscilloscope after confirming that power supply is correct.



Instructions:

The safety of digital oscilloscope conforms to the requirements of GJB3947A-2009: The effective AC rating is 1.5k v, 1 min, 10 mA, with no flashover or breakdown; input voltage AC is 242 V, and leakage current is ≤ 3.5 mA. Therefore, the operation and maintenance of the oscilloscope according to the specified operation regulations will not cause personal hazard or injury or cause any damage to the DUTs.


Press down the power button on the rear panel of the 4456 series digital phosphor oscilloscope, and the poweron indicator lamp on the front panel of the oscilloscope will turn yellow. Press down the power button  on the bottom left of the front panel of the 4456 series digital phosphor oscilloscope for about 2 s, and the poweron indicator lamp on the front panel of the oscilloscope will turn green, and the oscilloscope will enter the poweron login interface, as shown in 0.




Fig. 2.1 Poweron Interface of the 4456 Series Digital Phosphor Oscilloscope

The 4456 series oscilloscope will take about 40 s to start the system and perform a series of self-check programs, and then enter the main program initialization interface, displaying “Initializing..., please wait”, as shown in 0. After the main program starts, it will enter the oscilloscope interface automatically. Press down **【Bus】** key to enable the protocol analyzer function, and press down **【Meter】** key to enable functions of the digital voltmeter and hardware frequency meter. Press down **【Digital】** key to enable the logic analyzer function. Press down **【WaveGen】** key to enable the waveform generator function.



Fig. 2.2 Software Login Interface of the 4456 Series Digital Phosphor Oscilloscope

Press down green power button  on the bottom left of the front panel for 2 s again, and the oscilloscope will automatically exit the measurement application, and turn off the power supply.



Instructions: In this manual, the buttons on the front panel are represented in the form of **[XXX]** , and XXX denotes the name of the key. The menu items corresponding to the menu keys (hereinafter referred to as the menu) on the display screen are represented in the form of **[XXX]** , and XXX denotes the name of the menu.

2.2 Overview of front panel

This section will give a detailed description of the front panel of the 4456 series oscilloscope. You can become familiar with the basic use of the instrument panel keyboard by reading this section. Ois the front panel of the 4456 series digital phosphor oscilloscope.

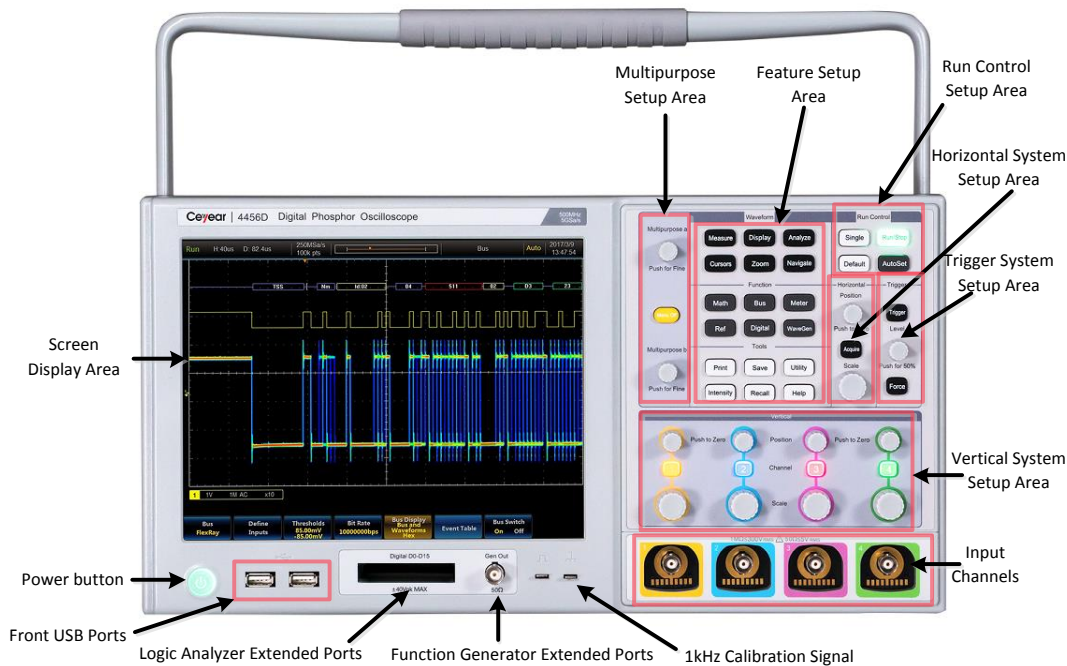


Fig. 2.3 Front Panel of the 4456 Series Digital Phosphor Oscilloscope


The front panel of the 4456 series digital phosphor oscilloscope is composed of the Power Button, Front USB Ports, Logic Analyzer Extended Ports, Waveform Generator Extended Ports, 1kHz Calibration Signal, Screen Display Area, Multipurpose Setup Area, Feature Setup Area, Run Control Setup Area, Horizontal System Setup

Area, Trigger System Setup Area, Vertical System Setup Area, Input Channels Area, etc.

2.2.1 Power button



Fig. 2.4 Power button

 : For instrument power on and power off.

2.2.2 Front USB Ports



Fig. 2.5 Front USB Ports

2 front USB2.0 HOST ports for insertion of mouse, keyboard and USB storage devices.

2.2.3 Logic analyzer extended ports



Fig. 2.6 Logic Analyzer Ports

The logic analyzer extended ports are used for signal input of 16 digital channels, which will be opened when the 4456-H01 option is selected.

2.2.4 Waveform generator extended ports



Fig. 2.7 Waveform Generator Ports

The waveform generator extended ports are used for the waveform output of 1 channel, with 50Ω output impedance. The extended ports will be opened when the 4456-H02 option is selected.

2.2.5 1 kHz Calibration Signal



Fig. 2.8 1kHz Calibration Signal

The output probe square wave calibration signal, with about 1 kHz frequency and 3 V_{pp} amplitude, which is mainly used for probe calibration and keeping flat amplitude-frequency characteristics of the oscilloscope by adjusting the adjustable capacitance of the probe.

2.2.6 Screen Display Area

The Screen Display Area is an interaction window between the oscilloscope and the user, and information including waveform and measurement result will be provided through it. The Screen Display Area of the oscilloscope is mainly composed of the Horizontal Status Display Area, Running Status Display Area, Waveform Display Area, Measurement Result Display Area, Vertical Status Display Area, Trigger Status Display Area, System Time Display Area, Level1 Menu, Level2 Menu and Level3 Menu.



Fig. 2.9 Screen Display Area

2.2.7 Multipurpose Setup Area



Fig. 2.10 Multipurpose Setup Area

The Multipurpose a is mainly used for selection of Level1 Menu and Level2 Menu. Turn it left or right to change the selection, and press it down for confirmation.

The Multipurpose b is mainly used for selection of Level3 Menu. Turn it left or right to change the selection and press it down for confirmation. It can also be used to adjust the value in Level2 Menu, specifically speaking, turn it to increase or decrease the corresponding value.

【Menu Off】 : It can be used to close the open menu. Press it down to close the Level3 Menu, Level2 Menu and Level1 Menu in turn.

2.2.8 Feature Setup Area



Fig. 2.11 Feature Setup Area

The Feature Setup Area is composed of the Waveform, Function and Tools Areas. The Waveform Area is composed of Measure, Display, Analyze, Cursors, Zoom and Navigate keys. The Function Area is composed of Math, Bus, Meter, Ref, Digital and WaveGen keys. The Tools Area is composed of Print, Save, Utility, Intensity, Recall and Help keys.

- 1) **【Measure】** : It is used for the setting of the oscilloscope measurement system, including the addition of measurement parameters, deletion of measurement parameters, histogram measurement and statistical functions.
- 2) **【Display】** : It is used for the setting of the oscilloscope display system.
- 3) **【Analyze】** : It is used for the advanced analysis function setting of the oscilloscope, including limit/mask test option and power measurement and analysis option.
- 4) **【Cursors】** : It is used for the cursor measurement function of the oscilloscope, which can realize the cursor measurement of voltage and time of 4 channels and operation waveform as well as the amplitude and frequency of the FFT waveform.
- 5) **【Zoom】** : It is used for the multi-window display and double time base measurement function of the oscilloscope, which observes details of the waveform mainly through different windows.
- 6) **【Navigate】** : It is used for trigger search and waveform recording and playback of the oscilloscope.
- 7) **【Math】** : It is used for the mathematic operation function of the oscilloscope, including basic arithmetic operation, FFT analysis and advanced mathematics operation.
- 8) **【Bus】** : It is used for protocol trigger and analysis function setting, including analysis functions of 9 serial buses including I2C, CAN, LIN, RS232, FlexRay, USB, SPI, AUDIO and 1553B.
- 9) **【Meter】** : It is used for function setting of the digital voltmeter, including 4-bit digital voltmeter and 6-bit hardware frequency meter.
- 10) **【Ref】** : It is used for function setting of the oscilloscope reference waveform.
- 11) **【Digital】** : It is used for function setting of logic analyzer options of 16 channels.
- 12) **【WaveGen】** : It is used for function setting of waveform generator option of 1 channel.
- 13) **【Print】** : It is used for image printing on screen.
- 14) **【Intensity】** : It is used for adjusting screen intensity, division intensity and waveform intensity.
- 15) **【Save】** : It is used for function setting of the oscilloscope waveform saving.
- 16) **【Recall】** : It is used for function setting of the storage setting and recall and waveform playback of the oscilloscope.
- 17) **【Utility】** : It is used for system menu setting of the oscilloscope, including calibration, configuration and network setting.

- 18) **【Help】** : It is used for recall of the help file of the oscilloscope, and the help file can be recalled with this key.

2.2.9 Run Control Setup Area



Fig. 2.12 Run Control Setup Area

The Feature Setup Area is composed of the Run/Stop, Single, Default and AutoSet keys.

- 1) **【Run/Stop】** : It is used for the continuous acquire function of the oscilloscope, including Run/Stop. Under the running status, it can realize the continuous acquire of signals dynamically display a screen of data captured each time; under the stop status, it can statically display the last captured screen of data, and you can view and analyze the waveform.
- 2) **【Single】** : It is used for the single acquire function of the oscilloscope. When the corresponding trigger channel is triggered normally, press it down to capture the acquired data of the set storage depth.
- 3) **【AutoSet】**: It is used for the automatic waveform setting of the oscilloscope. The vertical system, horizontal system and trigger system are automatically set to get a more appropriate waveform display.
- 4) **【Default】** : It is used for the setting function of the initial status of the oscilloscope. When the machine has an abnormal status, press down the default setting key to reset the system.

2.2.10 Horizontal System Setup Area



Fig. 2.13 Horizontal System Setup Area

The Horizontal System Setup Area is composed of the Horizontal Position Knob, Time Base Scope Knob and Acquire Key.

- 1) **【Position】** : It is used to set the horizontal delay of the oscilloscope. Rotate it, and the trigger point of the channel will move to the left or right by one pixel; press it down, and it will be set to 0.
- 2) **【Scale】** : It is used to set the horizontal time base of the oscilloscope. Rotate it, and the time base of the oscilloscope will increase or decrease by one gear.
- 3) **【Acquire】** : It is used to set the acquire mode and record depth of the oscilloscope.

2.2.11 Trigger System Setup Area



Fig. 2.14 Trigger System Setup Area

The Trigger System Setup Area is composed of the Trigger Key, Level Key and Force Key.

- 1) **【Trigger】** : It is used to set the trigger system of the oscilloscope, including functions covering the trigger type, trigger source, trigger polarity, trigger mode, trigger sensitivity and trigger holdoff.
- 2) **【Level】** : It is used to set the level of the oscilloscope. Rotate the knob to make the level of the trigger channel to move up or down; press it down to set the level to 50%.
- 3) **【Force】** : It is a kind of software trigger mode. When the channel signal is not normally triggered and the Force key is pressed down, the waveform will be triggered once.

2.2.12 Vertical System Setup Area



Fig. 2.15 Vertical System Setup Area

The Vertical System Setup Area is composed of the Channel Keys, Position Knob and Scale Knob, and setup methods of 4 channels are the same.

- 1) **【1】** : It is used to set the vertical system of the Channel1 of the oscilloscope, including the channel switch, input impedance, bandwidth limit, channel delay and probe setting.
- 2) **【2】** : It is used to set the vertical system of the Channel2 of the oscilloscope, including the channel switch, input impedance, bandwidth limit, channel delay and probe setting.
- 3) **【3】** : It is used to set the vertical system of the Channel3 of the oscilloscope, including the channel switch, input impedance, bandwidth limit, channel delay and probe setting.
- 4) **【4】** : It is used to set the vertical system of the Channel4 of the oscilloscope, including the channel switch, input impedance, bandwidth limit, channel delay and probe setting.
- 5) **【Position】** : It is used to set the vertical offset of the CH1 ~ CH4 of the oscilloscope. Rotate it, and the vertical offset of the CH1 ~ CH4 will move up or down; press it down, and the position will be set to 0.
- 6) **【Scale】** : It is used to set the vertical scope of the CH1 ~ CH4 of the oscilloscope. Rotate it, and the vertical sensitivity of the CH1 ~ CH4 will be increased or decreased by one gear according to the step.

2.2.13 Input Channels Area



Fig. 2.16 Input Channels Area

2.3 Overview of rear panel

The rear panel of the 4456 series digital phosphor oscilloscope is as shown in 0, including the AUX IN, AUX OUT, 10 MHz IN/OUT, LAN, VIDEO OUT, USB DEVICE, USB HOST and POWER INPUT Ports.

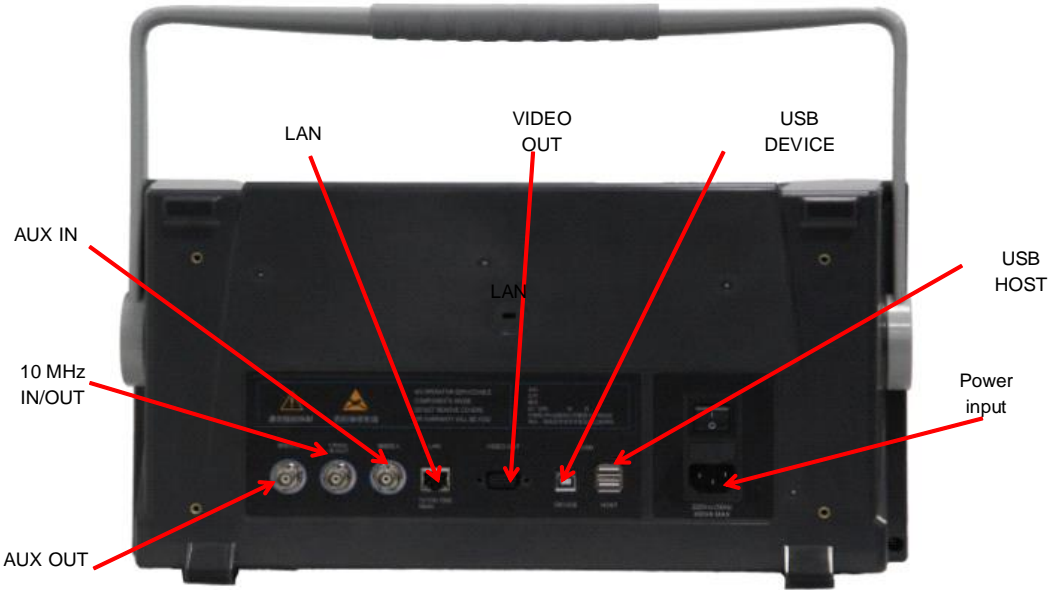


Fig. 2.17 Schematic Diagram of Rear Panel

Chapter III Vertical System

This oscilloscope provides 4 analog input channels CH1 ~ CH4, and each channel can be separately controlled. The vertical system is mainly used to decrease the large signal and increase the small signal, so as to satisfy the requirements of the ADC input scope.



Fig. 3.1 Vertical Operation Area of the Oscilloscope

When any channel key CH1 ~ CH4 is pressed down, the menu of the corresponding channel will pop up at the bottom of the screen:



Fig. 3.2 Channel Menu

3.1 Description of Keys/Buttons

Table 3.1 Description of Keys/Buttons

Keys/Buttons	Description
1 ~ 4	It is used to open the menu of the corresponding analog channel for channel setting
Scale	It is used to set the corresponding vertical scale of each analog channel Setting scope: 50Ω: 1 mV/div ~1 V/div, 1MΩ: 1 mV/div~10 V/div
Position	It is used to adjust the corresponding vertical offset of each analog channel, which has "Push to Zero" function. Adjustment scope: 1 mV/div~100 mV/div: ±1 V 200 mV/div~1 V/div: ±10 V 2V/div~10V/div: ±100V

3.2 Probe

3.2.1 Probe port

There are 4 analog channels on the front panel of the 4456 series digital oscilloscope, which have 4 BNC input connectors. To ensure reliable connection, ensure that your probe or cable connector is pushed in and locked.

This oscilloscope supports passive voltage probe, high voltage single end probe, high voltage differential probe, current probe and active voltage probe. When the passive voltage probe, high voltage single end probe, high voltage differential probe and current probe are used, the input impedance of the oscilloscope shall be set to 1 MΩ and the probe attenuation coefficient shall be consistent with that of the selected probe. When the active voltage probe is used, the input impedance of the oscilloscope shall be set to 50Ω and the probe attenuation coefficient shall be consistent with that of the selected probe.



Fig. 3.3 Schematic Diagram of the Probe Port

3.2.2 Calibration of the standard passive voltage probe

In order to avoid the error caused by the probe connection, the probe shall be connected to a probe calibration square wave signal on the front panel, with about 1 kHz frequency and 3 V_{pp} amplitude, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the adjustable capacitance of the probe.

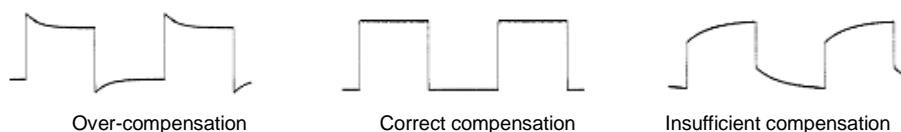


Fig. 3.4 Schematic Diagram of Probe Compensation



Warning: The max. measured voltage of the passive voltage probe is 300 V CATII. Never exceed this voltage during use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

3.3 Channel status

When any channel key CH1-CH4 is pressed down, open the channel menu for on/off status setting.

When the channel is to be closed, press down the channel key to automatically open the corresponding channel and channel menu. When the channel menu is opened, press down the channel key to automatically close the corresponding channel.

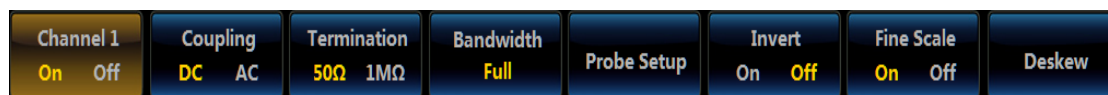


Fig. 3.5 Channel Status Setup Menu

Click [Channel1] menu key, and the channel can be switched between on/off status to realize the on/off function of the channel.

When the channel is opened, the corresponding channel key indicator lamp will light up, and the corresponding channel information, including the vertical scale, termination, coupling status, invert status and probe attenuation coefficient will be displayed at the bottom status bar of the screen. When the channel is closed, the indicator lamp will go out, and no channel information will be displayed in the status bar.



Fig. 3.6 Channel status indication column

3.4 Coupling

Set the coupling mode to filter out unnecessary signals. For example, the measured signal is a signal with a DC offset.

When the coupling mode is “DC”: Both the DC component and the AC component of the measured signal can pass through.

When the coupling mode is “AC”: Only the AC component of the measured signal can pass through.

When any channel key CH1 ~ CH4 is pressed down, open the channel menu for coupling setting of the channel.

Click [Coupling] menu key, and the channel can be switched between DC and AC coupling. In addition, the corresponding channel status bar will be displayed as DC or AC.

3.5 Termination

The oscilloscope provides two input impedances: 1 MΩ and 50Ω.

1 MΩ: In this case, the input impedance of the oscilloscope is very high, and the current flowing into the oscilloscope from the measured circuit can be ignored.

50Ω: Make the oscilloscope match with the equipment with an output impedance of 50Ω.

When any channel key CH1 ~ CH4 is pressed down, open the channel menu for input impedance setting of the channel.

Click [Termination] menu key, and the channel input impedance can be switched between 1 M Ω and 50 Ω . In addition, 1 M Ω or 50 Ω is displayed in the corresponding channel status bar.

Attention: The input impedance will also be automatically identified after the probe is automatically identified, so no input impedance setting is required.

3.6 Bandwidth

Set the bandwidth limit to reduce the display noise. For example, the measured signal is a signal with a HF component.

If selecting [Full], the HF component of the measured signal can pass through.

If [20M] or [250M] is selected, the HF component larger than 20 MHz or 250 MHz of the measured signal will be blocked.

When any channel key CH1 ~ CH4 is pressed down, open the channel menu for bandwidth limit setting of the channel.

Click [Bandwidth] menu key, and the Bandwidth option will be displayed on the right side of the screen:

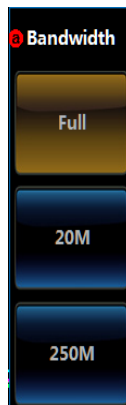


Fig. 3.7 Bandwidth Menu

Click the corresponding key, and the corresponding Bandwidth option can be set.

3.7 Probe Setup

It can be used for the probe attenuation coefficient and probe type setup as well as probe zero.

When any channel key CH1 ~ CH4 is pressed down, open the channel menu for probe setup.

Click [Probe Setup] menu key, and the Probe Setup option will be displayed on the right side of the screen:

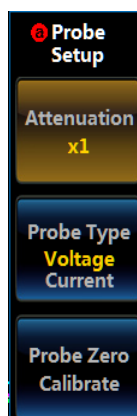


Fig. 3.8 Probe Setup Menu

3.7.1 Attenuation

Click [Attenuation] menu key, and the Attenuation option at the left side of the button will pop up.

The Attenuation option of the voltage and current probe is:

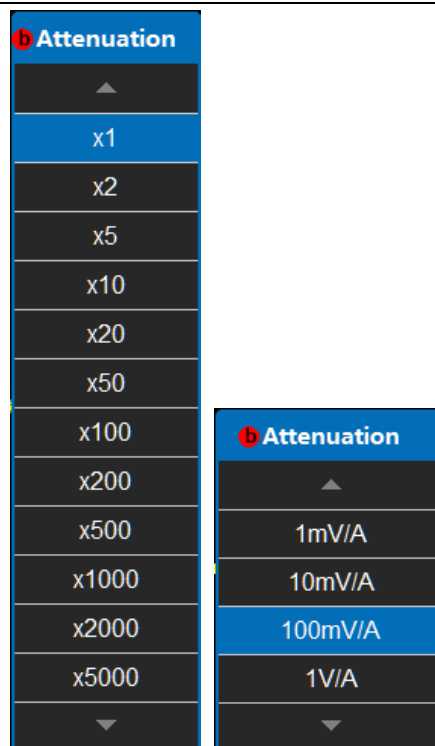


Fig. 3.9 Attenuation Menu

If [Voltage] is selected, select the corresponding attenuation option according to the attenuation multiplier of the current probe, and the corresponding channel status will display x1 ~ x5000. If [Current] is selected, select the corresponding attenuation coefficient according to the voltage and current conversion ratio 1 mV/A ~ 1 V/A of the current probe.

3.7.2 Probe Type

Click [Probe Type] of the menu to set the voltage and current probe type according to the measurement type of the currently connected probe.

3.7.3 Probe Zero Calibrate

When the connected probe is an active voltage probe, click [Probe Zero Calibrate] menu key to automatically zero and calibrate the probe to make the probe zero baseline located in the center of the screen.

3.8 Invert

When any channel key CH1 ~ CH4 is pressed down, open the channel menu for invert on/off setting.

Click [Invert] menu key to enable and disable the invert function of the channel. When the Invert is opened, the waveform display will be rotated by 180° relative to the ground level.

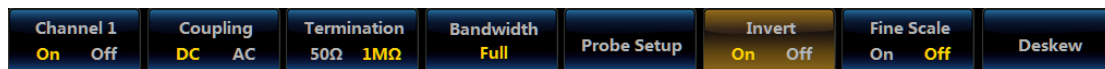


Fig. 3.10 Invert Setup Menu



Fig. 3.11 Invert Example

3.9 Fine Scale

When any channel key CH1 ~ CH4 is pressed down, open the channel menu for Fine Scale on/off setting.

Click [Fine Scale] menu key to enable and disable the fine scale function of the channel. When Fine Scale is disabled, operate the Scale knob of the channel, and the vertical range gear of the channel will be stepped according to 1, 2 and 5. When Fine Scale is enabled, the vertical range gear of the channel will be added with some fine tuning gears on the basis of steps 1, 2 and 5. The specific gears include:

The vertical range gears in case of 50 Ω input impedance: 1 mV/div, 2 mV/div, 5 mV/div, 10 mV/div, 20 mV/div, 30 mV/div, 40 mV/div, 50 mV/div, 60 mV/div, 70 mV/div, 80 mV/div, 90 mV/div, 100 mV/div, 200 mV/div, 300 mV/div, 400 mV/div, 500 mV/div, 600 mV/div, 700 mV/div, 800 mV/div, 900 mV/div and 1 V/div.

The vertical range gears in case of 1 M Ω input impedance: 1 mV/div, 2 mV/div, 5 mV/div, 10 mV/div, 20 mV/div, 30 mV/div, 40 mV/div, 50 mV/div, 60 mV/div, 70 mV/div, 80 mV/div, 90 mV/div, 100 mV/div, 200 mV/div, 300 mV/div, 400 mV/div, 500 mV/div, 600 mV/div, 700 mV/div, 800 mV/div, 900 mV/div, 1 V/div, 2 V/div, 3 V/div, 4 V/div, 5 V/div, 6 V/div, 7 V/div, 8 V/div, 9 V/div and 10 V/div.

3.10 Vertical range

Operate the Scale knob of any channel to set the vertical range gear of the corresponding channel. When Fine Scale is disabled, the gear will be increased and decreased according to steps 1, 2 and 5 in case of clockwise rotation and counterclockwise rotation respectively. When Fine Scale is enabled, the gear will be increased and decreased according to fine tuning range in case of clockwise rotation and counterclockwise rotation respectively.

When the input impedance of the oscilloscope is 1 M Ω , the adjustment range of the vertical range gear is: 1 mV/div~10 V/div; When the input impedance is 50 Ω , the adjustment range of the vertical range gear is: 1 mV/div~1 V/div.

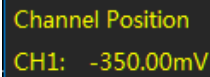
When adjusting the vertical range gear, the range information in the corresponding channel status bar will change in real time, and the current gear will be displayed. You can quickly realize the vertical zoom of the waveform through the multi-touch function of the capacitor screen.

3.11 Vertical offset

Operate the Position knob of any channel to set the vertical offset position of the corresponding channel. In case of clockwise rotation, the waveform will move up; in case of counterclockwise rotation, it will move down.

When adjusting vertical position, the vertical position movement window will pop up on the left side of the screen, and the current vertical offset will be displayed. You can quickly realize the vertical movement of the waveform

through the multi-touch function of the capacitor screen.



Channel Position
CH1: -350.00mV

Fig. 3.12 Channel Position display window

3.12 Deskew

In case of actual measurement with the oscilloscope, the probe or cable transmission delay may lead to larger zero offset. The 4456 series oscilloscope supports setting a delay time to correct the delay calibration between the channels, with an adjustment range of ± 150 ns and a step of 400 ps for standard types 4456C/D/E, and with an adjustment range of ± 150.4 ns and a step of 800 ps for economical types 4456CM/DM/EM.

When any channel key CH1 ~ CH4 is pressed down, open the channel menu for delay setting of the channel.

Click [Deskew] menu key, and the Deskew setup menu will be displayed on the right side of the screen:

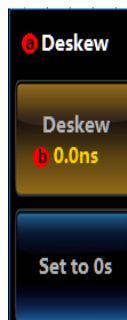


Fig. 3.13 Deskew Setup Menu

Click [Deskew] key, and the delay time can be adjusted through the Multipurpose b. Click [Set to 0s] key, and the delay time will be set to 0.



Fig. 3.14 Deskew Calibration Example

Chapter IV Horizontal System

The 4456 series has a sample rate up to 5 GSa/s, and you can change it by adjusting the Scale knob. The sample rate of the oscilloscope will directly affect the authenticity of waveform construction, and the low sample rate will bring following impacts on the waveform.

Distorted Waveform: Due to low sample rate, some waveform details will be lost, so there will be larger difference between the displayed sampling waveform of the oscilloscope and the actual signal.

Confused Waveform: As the sample rate is smaller than twice of the actual signal frequency (Nyquist Frequency), the waveform frequency during the sampling data reconstruction is smaller than the actual signal frequency. The most common Confused Waveform will jitter on the edge of the fast transition.

Missing Waveform: As the sample rate is too low, the waveform during the sampling data reconstruction doesn't reflect all actual signals.

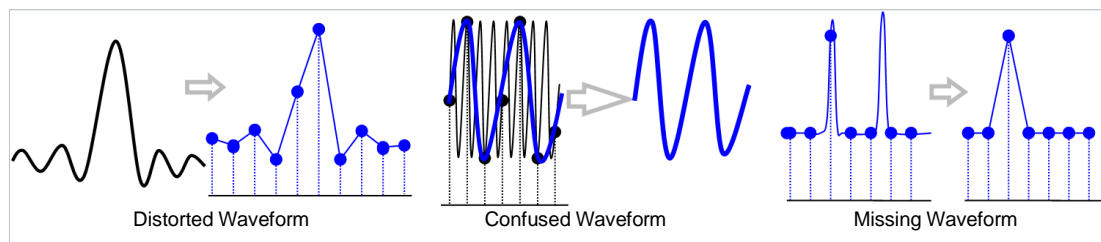


Fig. 4.1 Impact on Waveform due to Too Low Sampling Rate

The adjustment of the horizontal system mainly includes setting of parameters including time base, delay time, acquire mode and window extension.



Fig. 4.2 Horizontal System Operation Area

4.1 Description of Keys/Buttons

Table 4.1 Description of Keys/Buttons

Keys/Buttons	Description
Acquire	It is used to open the Acquire setup menu of the oscilloscope and set the acquire mode and memory depth.
Scale	It is used to set the horizontal time base of the oscilloscope.
Position	It is used to set the horizontal delay of the oscilloscope, which has a "Push to Zero" function.

4.2 Time base

Operate the Scale knob of the horizontal system, which can set the corresponding time base gear. The gear will be reduced in case of clockwise rotation, and it will be increased in case of counterclockwise rotation.

The time base adjustment range of this oscilloscope is 200 ps/div ~1,000 s/div for standard types 4456C/D/E, and 400 ps/div ~1,000 s/div for economical types 4456CM/DM/EM

When adjusting the time base gear, the time base information in the top status bar will change in real time, **H:1us** and the current time base setting will be displayed, and then you can quickly realize horizontal zoom of the waveform through multi-touch of the touch screen.

Attention: When the trigger is in an automatic mode and the time base is 100 ms/div ~ 1,000 s/div, the waveform will scroll from right to left on the screen. If the logic analyzer is enabled, it will be automatically disabled.

4.3 Horizontal delay

Operate the Position knob of the horizontal system, which can set the horizontal delay time. The pretrigger delay time will be increased in case of clockwise rotation, and it will be increased in case of counterclockwise rotation.

If Delay is set to on, the horizontal delay adjustment range of this oscilloscope is -10 divisions ~ 5,000 s. If Delay is set to off, the horizontal delay adjustment range is 0% ~ 100% of current screen's sampling time.

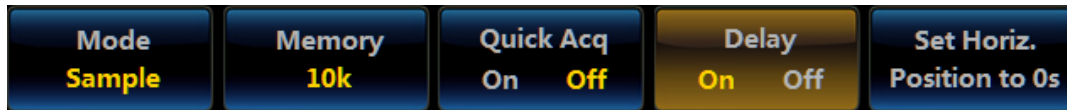


Fig. 4.3 Delay Menu

When adjusting the horizontal delay, the delay information in the top status bar will change in real time, and the current delay time will be displayed, and then you can quickly realize horizontal movement of the waveform through multi-touch of the touch screen.

4.4 Zoom

The Zoom function can be used to zoom in a segment of waveform to check the details of the signal.

Press down **【Zoom】** key on the front panel to open the corresponding menu:

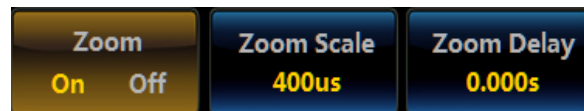


Fig. 4.4 Zoom Menu

Click [Zoom] menu key to enable and disable the Zoom.

Attention: When the Zoom window is opened, the XY display mode of the oscilloscope will be disabled automatically. If the logic analyzer is enabled, it will be automatically disabled.

When opening the Zoom window, the waveform area of the screen will be divided into two display areas, the top small window corresponds to the waveform display of the main time base, and the bottom large window below corresponds to the waveform display of the extended time base.

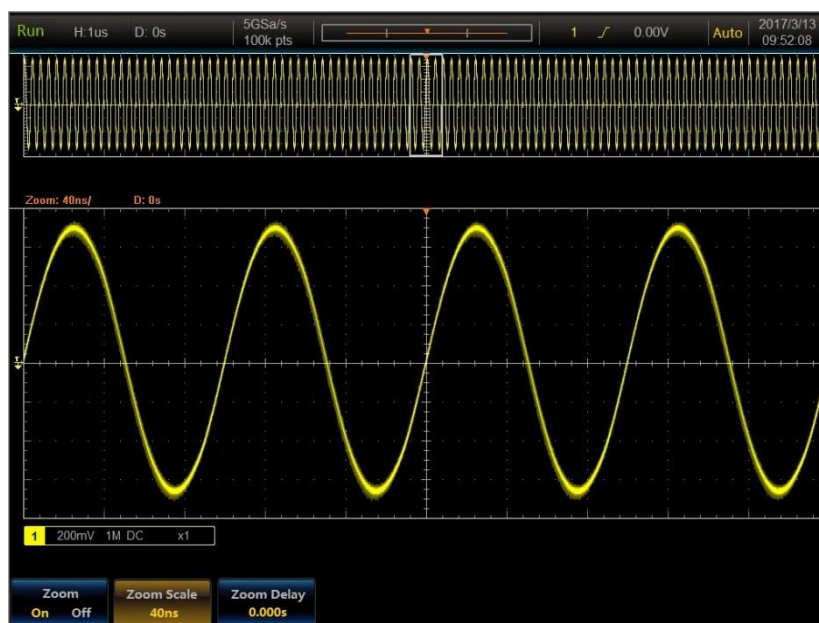


Fig. 4.5 Zoom Example

Click [Zoom Scale] menu key to turn, press down the Zoom Scale Adjustment menu key, and adjust the Zoom time base gear through the Multipurpose b. The time base range of the Zoom is the same as that of the main time base, but shall not be greater than the main time base.

Click [Zoom Delay] menu key to turn Zoom Delay Adjustment menu key, and adjust the Zoom delay time through the Multipurpose b. The delay time range of the Zoom is the same as that of the main time base but shall not be greater than acquired time range of the main time base.

4.5 Mode

Press down 【Acquire】 key on the front panel and open the Acquire menu:

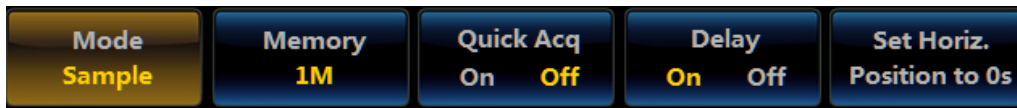


Fig. 4.6 Acquire Menu

Click [Mode] menu key, and open the Mode setup menu:

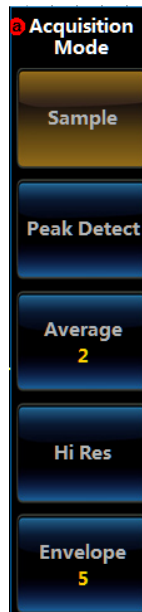


Fig. 4.7 Mode Setup Menu

Click the corresponding key of the required acquire mode to set the acquire mode.

Sample: This is the simplest capture mode. For each waveform interval, the oscilloscope will save the value of a sampling point as a point of the waveform.

Peak Detect: Select the min. and max. values of the sampling points collected within the waveform interval, and make these sample values as two relevant waveform points. The Peak Detect mode can obtain the envelope of the signal or the narrow pulse that may be lost to avoid the signal confusion, but the display noise is louder.

Average: For each waveform interval, the oscilloscope will save a sampling point, and this point is consistent with the sample mode. Calculate the average of the obtained waveform points after multiple captures, and then generate the final display waveform. The Average mode is intended to reduce random noise on input signals and improve vertical resolution. The higher average frequency will bring the lower noise, the higher vertical resolution, but the slower display refresh of the waveform. The number of averages will be stepped by a multiple of 2, which will be set from 2 to 512.

High Res: Collect multiple sampling values in a waveform point interval, and then calculate the average and obtain a waveform. The resolution of the low speed signal will be increased to 11, which can effectively reduce the noise.

Envelope: The min. and max. waveform points of multiple waveforms which have been captured for several times will be recombined into a new waveform, indicating the min./max. changes of waveform with time. The Peak Detect mode is often used to capture the records. In case of the envelope waveform, it is necessary to set the envelope times, with the envelope times setting scope of 1 ~1,000 and infinity.

4.6 Memory depth

The memory depth refers to the number of waveform points that can be recorded in an oscilloscope during a trigger acquire, which reflects the memory capacity of the acquire memory. The 4456C/D/E provides a memory

depth up to 500M points, and the 4456CM/DM/EM provides a memory depth up to 200M points. The deep memory means that it can keep high sample rate when capturing records for longer time, which can rebuild signal waveform more accurately, bring better resolution between sampling points, and capture glitch or abnormal events more probably. With the segment memory, you can selectively capture and save important signal activities and avoid capturing invalid signal silence time.

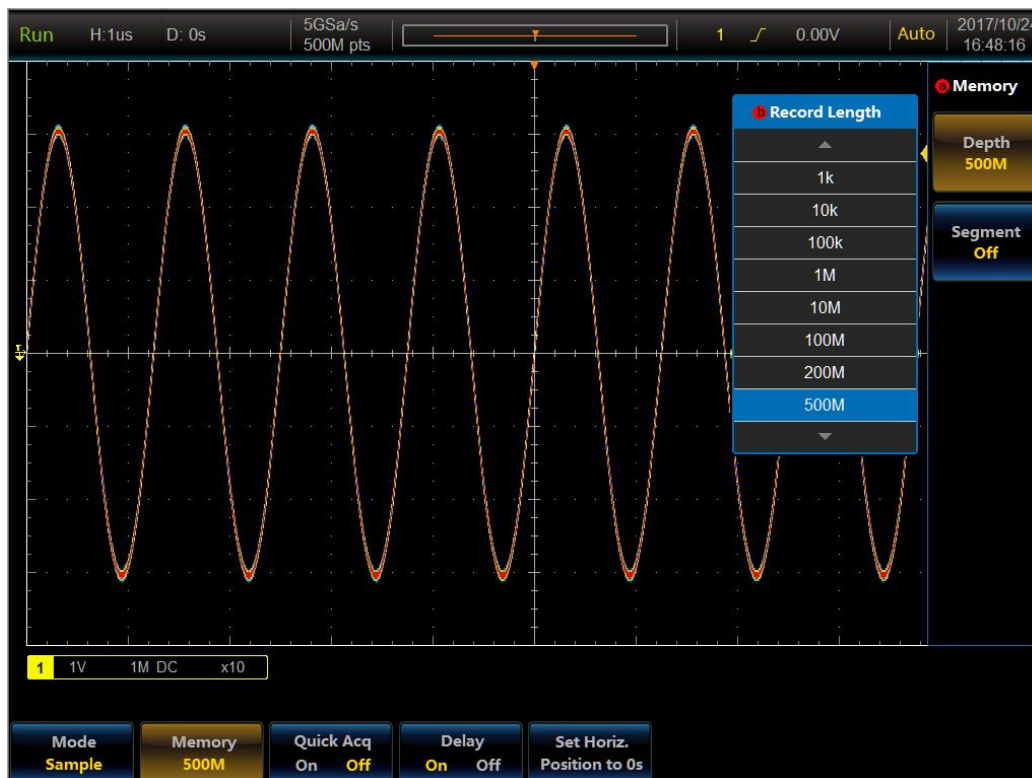


Fig. 4.8 500 Mpts Length Memory Example

Press down **【Acquire】** key on the front panel and open the Acquire setup menu.

Click **[Memory]** menu key, and open the Memory setup menu:

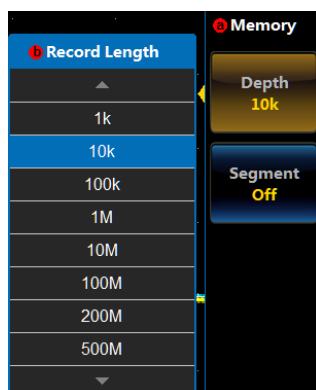


Fig. 4.9 Memory Menu

Click the corresponding key of the required memory depth to set the memory depth.

Attention: When the 4456C/D/E is in a Sample mode, the max.memory depth can be set to 500M, and when it is in other acquire mode, the max.memory depth can be set to 200M. When the 4456CM/DM/EM is in a Sample mode, the max.memory depth can be set to 200M, and when it is in other acquire mode, the max.memory depth can be set to 100M.

Click **[Segment]** menu key to open or close the segment mode. When the segment mode is switched on, the memory will be divided into different segments according to different memory depths; when memory depth is set to 1k, the memory can be divided into 131,072 segments maximally, which can be selected through the Multipurpose b.

Attention: When the logic analyzer or bus is enabled, both the segment function and the **[Segment]** menu key will

become ineffective. When the logic analyzer and bus is disabled, both the segment function and the [Segment] menu key will be effective.



Fig. 4.10 Segment Memory Setup Menu

4.7 Quick Acq

In the Quick Acq mode, the waveform collected will be saved by 1k depth memory in the FPGA. In this mode, the waveform capture rate is up to 1 million waveforms/s, which can significantly reduce the dead zone collection time.

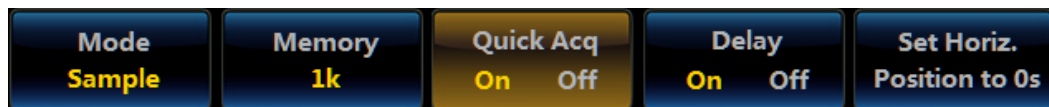


Fig. 4.11 Quick Acq Setup Menu

Chapter V Trigger System

The trigger system of the oscilloscope has two main applications:

1. Ensure stable display

The invention of trigger function is a breakthrough for the oscilloscope as an electric and electronic signal measurement and debugging tool, and it can display repeated periodical signal stably.

2. Display signals with specific characteristics

The trigger can respond to specific waveform events. This facilitates the isolation and display of specific signal characteristics, such as logic level failing to reach the pulse height, signal interference caused by crosstalk, low edge triggering, or invalid timing between channels.

The precision and flexibility of the trigger system determine whether the oscilloscope can accurately display and analyze the measured signal. The trigger system of the oscilloscope mainly includes the Trigger key, Level knob and Force key.



Fig. 5.1 Trigger System Operation Area

5.1 Description of Keys/Buttons

Table 5.1 Description of Keys/Buttons

Keys/Buttons	Description
Trigger	It is used to open the trigger menu of the oscilloscope and set the trigger type and trigger mode.
Force	Press it down to forcedly trigger the oscilloscope once.
Level	It is used to adjust trigger level and has the "Push for 50%" function.

5.2 Trigger source

Press down **【Trigger】** key of the trigger control area on the front panel, open the trigger menu, click [Source] key, open the Source selection menu on the right side of the screen, and click the corresponding options to set the source.

In case of the Edge type, besides the analog channel CH1 ~CH4, the external channel, digital channels D0 ~ D15 and utility power supply (AC Line) can also be used as the source. In case of other trigger type, only the analog channel CH1 ~CH4 or the digital channels D0 ~ D15 can be used as the source.

Analog channel

The input signal of the analog channels CH1 ~CH4 can be made as the source, and the selected channel can work normally regardless of whether its input is displayed.

External channel

The external channel source can be used to trigger on the fifth channel while other four simulation channels are acquiring data. The trigger signal will be accessed through the "AUX IN" BNC connector on the rear panel.

Digital channel

The input signal of the digital channels D0 ~ D15 can be made as the source, and the selected channel can work normally regardless of whether its input is displayed.

Utility

The trigger signal is taken from the AC power input of the oscilloscope. This source can be used to display the relationship between a signal (such as a lighting device) and a power supply (power supply device). For example, the waveform of the transformer output of a stable trigger substation is mainly used in relevant measurement of the power industry.

5.3 Trigger type

The 4456 series oscilloscope supplies users with rich trigger functions, including Edge, Pulse Width, Video, Runt, Logic, Sequence, Setup&Hold, Rise/Fall Time, HD Video, RS232 Trigger, I2C Trigger, SPI Trigger, CAN Trigger, LIN Trigger, I2S Trigger, USB Trigger, FlexRay Trigger, 1553 Trigger and Visual Trigger (Area Trigger), which help users locate events in which they have interest out of complicated sample information.

Edge trigger

Trigger on the Rise or Fall edge of any channel or AUX IN

Trigger type

Press down **【Trigger】** key of the trigger control area on the front panel, and open the trigger menu.




Fig. 5.2 Edge Trigger Menu

Click [Type] menu key, and the Type menu will pop up on the right side of the screen.



Fig. 5.3 Trigger Type Menu

Click [Edge] key to select the slope trigger type. The relevant edge trigger information  will be displayed on the top right corner of the screen, including the source, edge type and trigger level.

Trigger source

Click [Source] menu key, and the Source menu will pop up on the right side of the screen:



Fig. 5.4 Source Menu

The CH1 ~CH4, digital channel, external channel or utility power supply can be selected as the source.

Edge type

Click [Edge] menu key to trigger at the Rise or Fall edge of the input signal when the voltage satisfies the set trigger level.

Trigger level

Press down **【Level】** key on the front panel to modify the trigger level; in addition, the corresponding mark and trigger level line of the source channel will be displayed on the left side of the screen and the waveform area; the display position will be changed along with changes of the trigger level, and trigger level value of the trigger information area on the top right corner of the screen will also change. The trigger level line in the waveform area will disappear within about 3 s after the knob operation stops.

Attention: When the source is [Aux] or [AC], or digital channel, no trigger mark and trigger level line will be displayed. Also, when the source is "AC", no trigger level value will be displayed.

Coupling

The trigger coupling will determine which component of the signal will be transmitted to the trigger circuit. It refers to the trigger signal coupling, please note the difference between the "Channel Coupling".

DC: It allows that DC and AC components can pass through the trigger circuit.

AC: It allows that only AC component can pass through the trigger circuit.

HF Reject: Reject HF components in signals

Attention: The trigger coupling can only be set when the source selects the "Auxiliary Channel".

Click [Coupling] key of the trigger menu, and the Trigger Coupling selection menu will be opened on the right side of the screen:

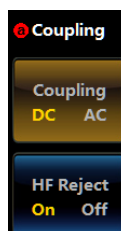


Fig. 5.5 Trigger Coupling Menu

Click the corresponding option button to set the trigger coupling mode.

Auxiliary channel

When the “Auxiliary Channel” is selected as the trigger source, click [Configure Aux Channel] key of the trigger menu, and the Configure Aux Channel menu will pop up on the right side of the screen.

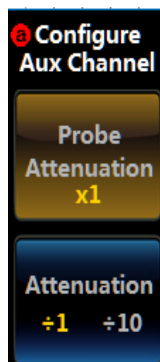


Fig. 5.6 Configure Aux Channel Menu

The corresponding probe attenuation coefficient can be set according to the attenuation multiplier of the probe of the connected auxiliary channel signal. The settable probe coefficient is the same as the probe coefficient in the channel, which is $x1 \sim x5000$.

The attenuation multiplier of the connected auxiliary channel signal can be selected according to the size of the connected external channel signal. Settable options: $\div 1$, $\div 10$.

Pulse trigger

Trigger on a positive or negative pulse of the specified width of the input signal.

Trigger type

Press down 【Trigger】 key of the trigger control area on the front panel, and open the trigger menu.

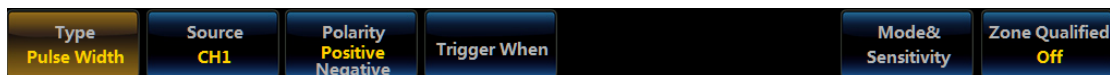


Fig. 5.7 Pulse Trigger Menu

Click [Type] menu key and click [Pulse Width] key in the popup Type menu to select the pulse width trigger. The relevant pulse width trigger information $1 \mu 0.00V$ will be displayed on the top right corner of the screen, including the source, polarity and trigger level.

Trigger source

Click [Source] menu key, and the Source menu will pop up on the right side of the screen. The CH1 ~CH4 can be made as the source.

Polarity

Click [Polarity] menu key, and trigger on a positive or negative pulse of the specified width of the input signal.

Trigger When

Click [Trigger When] menu key, and the Trigger When setup menu will pop up on the right side of the screen:

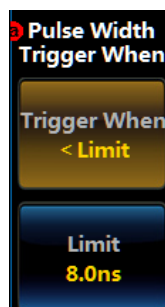


Fig. 5.8 Pulse Trigger When Setup Menu

Click [Trigger When] menu key, and the Trigger When option menu will pop up:

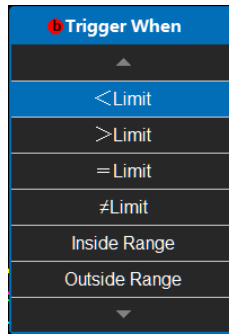


Fig. 5.9 Pulse Trigger When Option Menu

The relative Trigger When can be selected by directly clicking the Trigger When option or by pressing down the Multipurpose b.

If “Inside Range” or “Outside Range” is selected, the corresponding “<Limit” and “>Limit” can be set in the Trigger When setup menu.

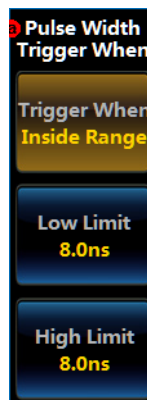


Fig. 5.10 Pulse Trigger When Setup Menu

Click [Width] menu key to set the pulse width through the Multipurpose b or numeric keypad. Pulse width adjustment range: 0.8 ns ~10 s.

Trigger level

Press down **【Level】** key on the front panel to modify the trigger level; in addition, the corresponding mark and trigger level line of the source channel will be displayed on the left side of the screen and the waveform area; the display position will be changed along with changes of the trigger level, and trigger level value of the trigger information area on the top right corner of the screen will also change. The trigger level line in the waveform area will disappear within about 3 s after the knob operation stops.

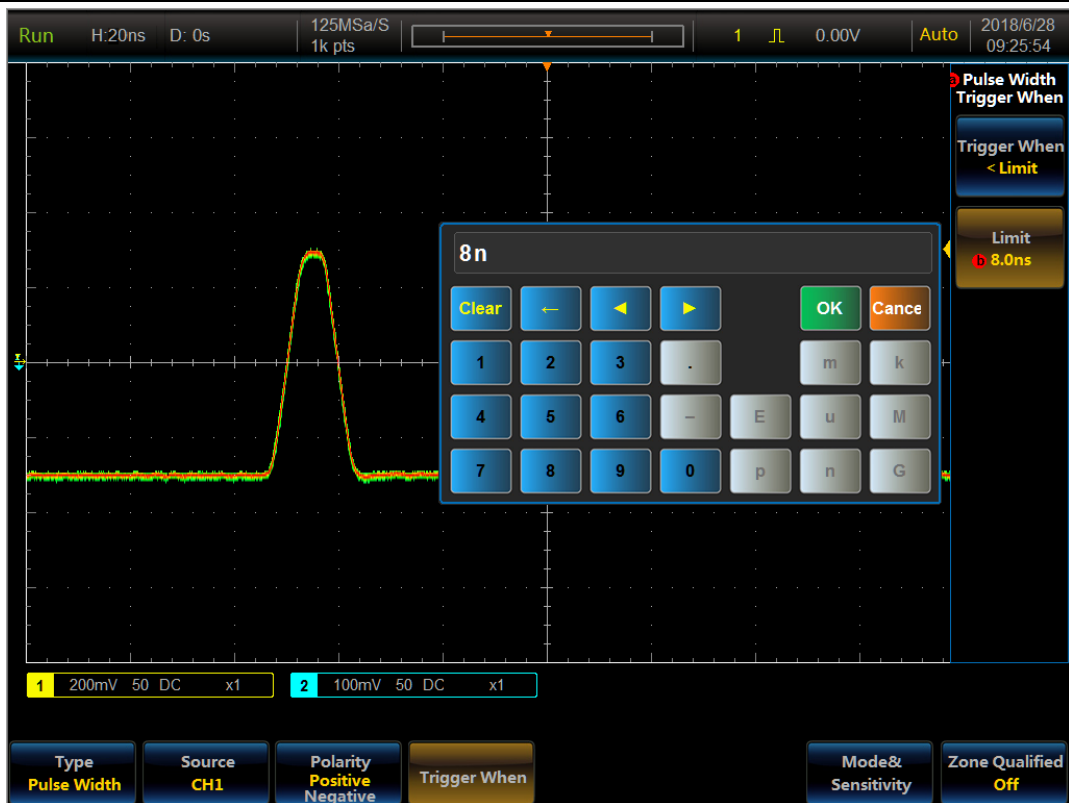


Fig. 5.11 Pulse Trigger Example

Runt trigger

It will be triggered when the input signal crosses through a threshold but fails to cross through the second threshold before crossing through the first threshold again.

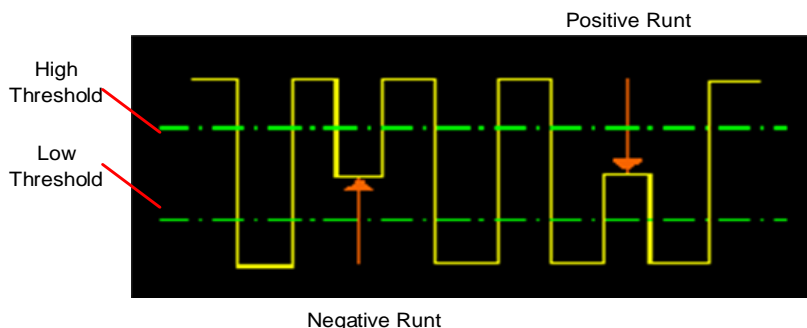


Fig. 5.12 Schematic Diagram of Runt Pulse

Trigger type

Press down **【Trigger】** key of the trigger control area on the front panel, and open the trigger menu. Click [Type] menu key and click [Runt] key in the popup Type menu to select the Runt trigger.

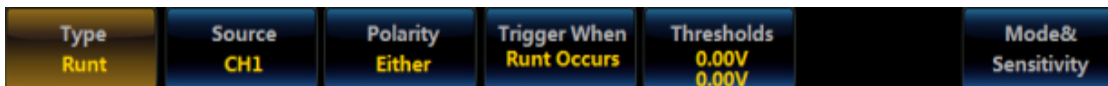


Fig. 5.13 Runt Trigger Menu

The relevant Runt trigger information  will be displayed on the top right corner of the screen, including the source and polarity.

Source:

Click [Source] menu key, and the Source selection menu will pop up on the right side of the screen. The CH1 ~ CH4 can be made as the source.

Polar:

Click [Polarity] menu key, and the Polarity setup menu will pop up on the right side of the screen:

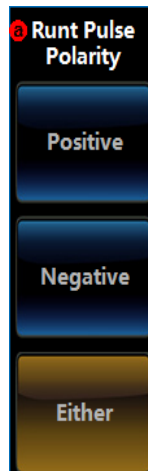


Fig. 5.14 Runt Trigger Polarity Setup Menu

Click [Positive] , [Negative] and [Either] buttons to select the corresponding polarity setting.

Trigger When

Click [Trigger When] menu key, and the Trigger When setup menu will pop up on the right side of the screen:

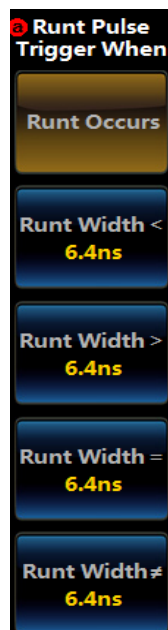


Fig. 5.15 Runt Trigger When Setup Menu

Click [Runt Occurs] key to set the trigger time to be Trigger When to Runt Occurs;

Click [Runt Width<], and set the trigger time to be smaller than a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Runt Width>], and set the trigger time to be larger than a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Runt Width=], and set the trigger time to be equal to a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Runt Width≠], and set the trigger time to be not equal to a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s.

Runt Pulse Thresholds

Click the menu key, and the Runt Pulse Thresholds setup menu will pop up on the right side of the screen:

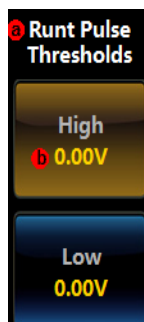


Fig. 5.16 Runt Pulse Thresholds Setup Menu

Click High menu option or Low menu option, and then rotate the Multipurpose b to set the threshold. The threshold level line in the waveform area will disappear within about 3 s after the knob operation stops.

Sequence Trigger

Prepare on the selected edge, and wait for the specified time or another selected edge of the event for triggering.

Trigger type

Press down **【Trigger】** key of the trigger control area on the front panel, and open the trigger menu.

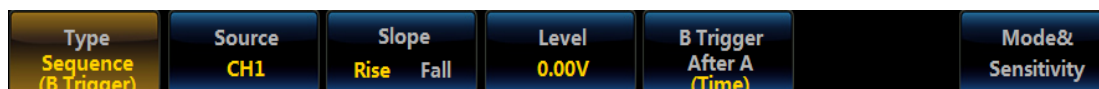


Fig. 5.17 Sequence Trigger Menu

Click [Type] menu key and click [Sequence] key in the popup Type menu to select the sequence trigger, and display relevant sequence trigger information on the top right corner of the screen.

Trigger source

Click [Source] menu key, and the Source selection menu will pop up on the right side of the screen. The CH1 ~CH4 can be made as the source.

Slope

Click [Slope] menu key to trigger at the specified Rise or Fall edge of the input signal.

Level

Click [Level] menu key, and the Trigger Level setup menu will pop up on the right side of the screen:

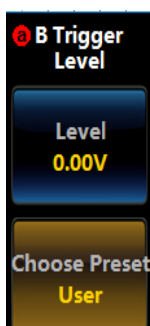


Fig. 5.18 Sequence Trigger Level Setup Menu

Click [Level] menu key, and then rotate the Multipurpose b to set the trigger level.

Click [Choose Preset] menu key, and the trigger level Choose Preset Level3 Menu will pop up on the left side of the menu. The User option can be set through the Level menu key by the user, and other option will be set according to corresponding common value of different signal types. Rotate the Multipurpose b to select one option or press it down for confirmation, or directly click one option.

Family	Value
User	0.00V
TTL	1.4V
5.0V CMOS	2.5V
3.3V CMOS	1.65V
2.5V CMOS	1.25V
ECL	-1.3V
PECL	3.7V
0V	0V

Fig. 5.19 Sequence Trigger Level Choose Preset Menu

Trigger mode

Click [Trigger Mode] menu key, and the Sequence Trigger Mode setup menu will pop up on the right side of the screen:

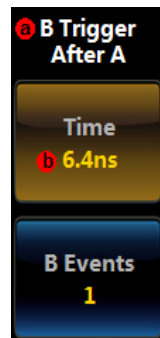


Fig. 5.20 Sequence Trigger Mode Setup Menu

Click [Time] menu key, and set the sequence trigger mode to the time, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Events] menu key, and set the sequence trigger mode to the event, which can be set by rotating the Multipurpose b, with a range from 1 to 10,000.

Logic trigger

It will be triggered when any logic code pattern of the channel becomes false or remains true in the specified time, and any input can be used as a clock to find the code pattern on the clock slope. The specified code patterns (AND, OR, NAND, NOR) of four input channels are defines as High (H), Low (L) or Don't Care.

Trigger type:

Press down 【Trigger】 key of the trigger control area on the front panel, and open the trigger menu.



Fig. 5.21 Logic Trigger Menu

Click [Type] menu key and click [Logic] key in the popup Type menu to select the logic trigger. The relevant logic trigger information AND X X X X will be displayed on the top right corner of the screen.

Define inputs

Click [Define Inputs] menu key, and the Define Inputs setup menu will pop up on the right side of the screen:

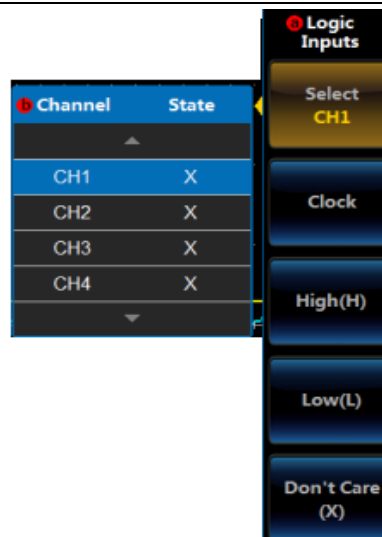


Fig. 5.22 Define Logic Input Menu

Click [Select] menu key, and the Select and State Level3 Menu will pop up on the left side of the menu. Rotate the Multipurpose b to select the channel or press it down for confirmation, or directly click one Select setting option to set Select;

Click [Clock] menu key, and the current channel can be set to clock, but only one channel can be set to clock;

Click [High (H)] menu key, and the current channel can be set to High (H);

Click [Low (L)] menu key, and the current channel can be set to Low (L);

Click [X (Don't Care)] menu key, and the current channel can be set to X (Don't Care).

Define logic

Click [Define Logic] menu key, and the Logic Function setup menu will pop up on the right side of the screen:

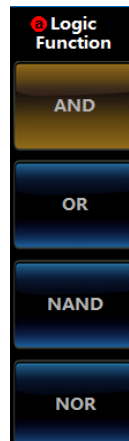


Fig. 5.23 Define Logic Function Menu

Click[AND] menu key, and set the logic function to AND;

Click[OR] menu key, and set the logic function to OR;

Click[NAND] menu key, and set the logic function to NAND;

Click [NOR] menu key, and set the logic function to NOR.

Trigger When

When defining an input and setting a channel to the clock, this menu key will be invalid, but it will be valid in other conditions.

Click [Trigger When] menu key, and the Trigger When setup menu will pop up on the right side of the screen:

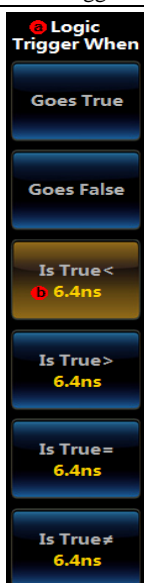


Fig. 5.24 Logic Trigger When Setup Menu

When clicking [Goes True] menu key to set Trigger When to True;

When clicking [Goes False] menu key to set Trigger When to False;

Click [Is True<], and set the Trigger When to be true and smaller than a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Is True>], and set the Trigger When to be true and greater than a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Is True=], and set the Trigger When to be true and equal to a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Is True≠], and set the Trigger When to be true and not equal to a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s.

Logic Thresholds

Click [Level] menu key, and the Logic Thresholds setup menu will pop up on the right side of the screen:

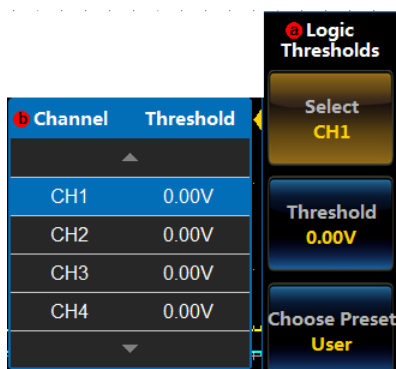


Fig. 5.25 Logic Thresholds Setup Menu

Click [Select] menu key, and the Select and Thresholds Level3 Menu will pop up on the left side of the menu. Rotate the Multipurpose b to select the channel or press it down for confirmation, or directly click the Select setting option to select Select;

Click [Level] menu key, and then rotate the Multipurpose b to set the threshold of the current channel.

Click [Choose Preset] menu key, and the trigger level Choose Preset Level3 Menu will pop up on the left side of the menu. The User option can be set through the Level menu key by the user, and other option will be set according to corresponding common value of different signal types. Rotate the Multipurpose b to select one option or press it down for confirmation, or directly click one option.

Clock slope

When defining an input and setting a channel to the clock, this menu key will be valid, but it will be invalid in other conditions.

Click [Clock Slope] menu key, and the Clock Slope setup menu will pop up on the right side of the screen:

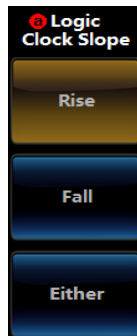


Fig. 5.26 Logic Clock Slope Setup Menu

Click [Rise] menu key to set the clock slope to Rise;

Click [Fall] menu key to set the clock slope to Fall;

Click [Either] menu key to set the clock slope to Either.

Setup&Hold Times trigger

It will be triggered when the input signal changes the state relative to setup or hold time of the clock slope. The setup time is the length of time that the input signal is stable and unchanged before the appearance of clock slope, and the hold time is the length of time that the input signal is stable and unchanged after the appearance of clock slope.

Trigger type

Press down 【Trigger】 key of the trigger control area on the front panel, and open the trigger menu.

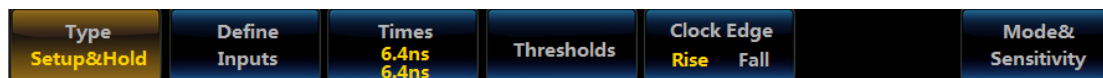


Fig. 5.27 Setup&Hold Trigger Menu

Click [Setup&Hold] menu key and click [Setup&Hold] key in the popup Type menu to select the Setup&Hold trigger. The relevant Setup&Hold trigger information **Setup&Hold** will be displayed on the top right corner of the screen.

Define inputs

Click [Define Inputs] menu key, and the Setup&Hold Inputs menu will pop up on the right side of the screen:



Fig. 5.28 Setup&Hold Inputs Menu

Click [Select] key, and the Select Level3 Menu will pop up on the left side of the menu. Rotate the Multipurpose b to select the corresponding channel, and then rotate it to confirm Select, or directly click the Select option to select Select. The selected channel will be displayed on the channel Select menu item on the right side;

Click [Clock] menu item, and the current channel can be set to Clock function;

Click [Data] menu item, and the current channel can be set to Data function;

Click [Not Used] menu item, and the current channel can be set to Not Used;

Time

Click [Time] menu key, and the Setup Time setup menu will pop up on the right side of the screen:

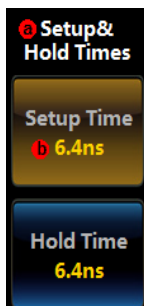


Fig. 5.29 Setup&Hold Times Setup Menu

Click [Setup Time] menu key, and set the setup time by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Hold Time] menu key, and set the hold time by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s.

Thresholds

Click [Thresholds] menu key, and the Thresholds setup menu will pop up on the right side of the screen:

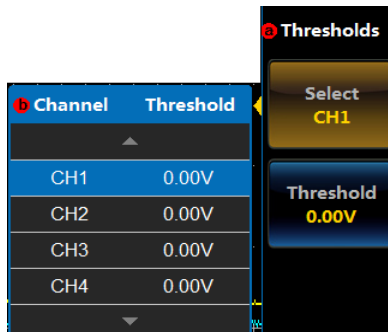


Fig. 5.30 Setup&Hold Thresholds Setup Menu

Click [Select] key, and the Select Level3 Menu will pop up on the left side of the menu. Rotate the Multipurpose b to select the corresponding channel, and then press it down to confirm Select, or directly click the Select option to select Select. The selected channel will be displayed on the channel Select menu item on the right side;

Click [Thresholds] menu key, and then rotate the Multipurpose b to set the threshold of the current channel.

Clock slope

Click [Clock Slope] menu key to trigger at the Rise or Fall edge of the clock signal.

Rise/Fall Time trigger

It will be triggered when the pulse edge rate is faster or slower than the specified value.

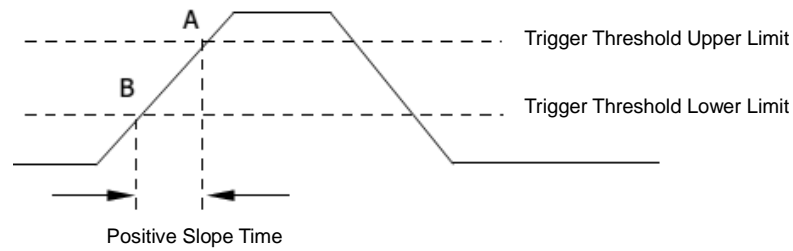


Fig. 5.31 Schematic Diagram of Rise/Fall Time

Trigger type

Press down **【Trigger】** key of the trigger control area on the front panel, and open the trigger menu.



Fig. 5.32 Rise/Fall Time Trigger Menu

Click [Type] menu key and click [Rise/Fall Time] key in the popup Type menu to select the rise/fall time trigger.

The relevant rise/fall time trigger information **1** will be displayed on the top right corner of the screen.

Trigger source

Click [Source] menu key, and the Source selection menu will pop up on the right side of the screen. The CH1 ~CH4 can be made as the source.

Slope

Click [Slope] menu key, and the Slope setup menu will pop up on the right side of the screen:

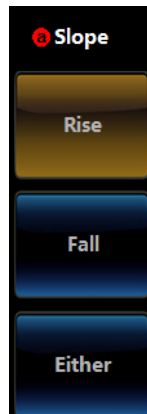


Fig. 5.33 Rise/Fall Time Slope Setup Menu

Click [Rise] menu key to set the slope to Rise;

Click [Fall] menu key to set the slope to Fall;

Click [Rise/Fall] menu key to set the slope to Rise/Fall.

Trigger When

Click [Trigger When] menu key, and the Trigger When setup menu will pop up on the right side of the screen:

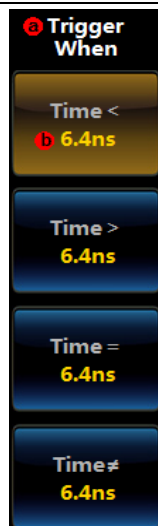


Fig. 5.34 Rise/Fall Time Trigger When Setup Menu

Click [Time<] menu key, and set the Trigger When to be smaller than a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Time>] menu key, and set the Trigger When to be larger than a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Time=] menu key, and set the Trigger When to be equal to a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s;

Click [Time≠] menu key, and set the Trigger When to be not equal to a certain time value, which can be set by rotating the Multipurpose b, with a range from 6.4 ns to 12.8 s.

Runt Pulse Thresholds

Click [Thresholds] menu key, and the Thresholds setup menu will pop up on the right side of the screen:

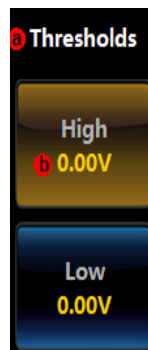


Fig. 5.35 Rise/Fall Time Thresholds Setup Menu

Click [High] menu key, and then rotate the Multipurpose b to set it to High;

Click [Low] menu key, and then rotate the Multipurpose b to set it to Low.

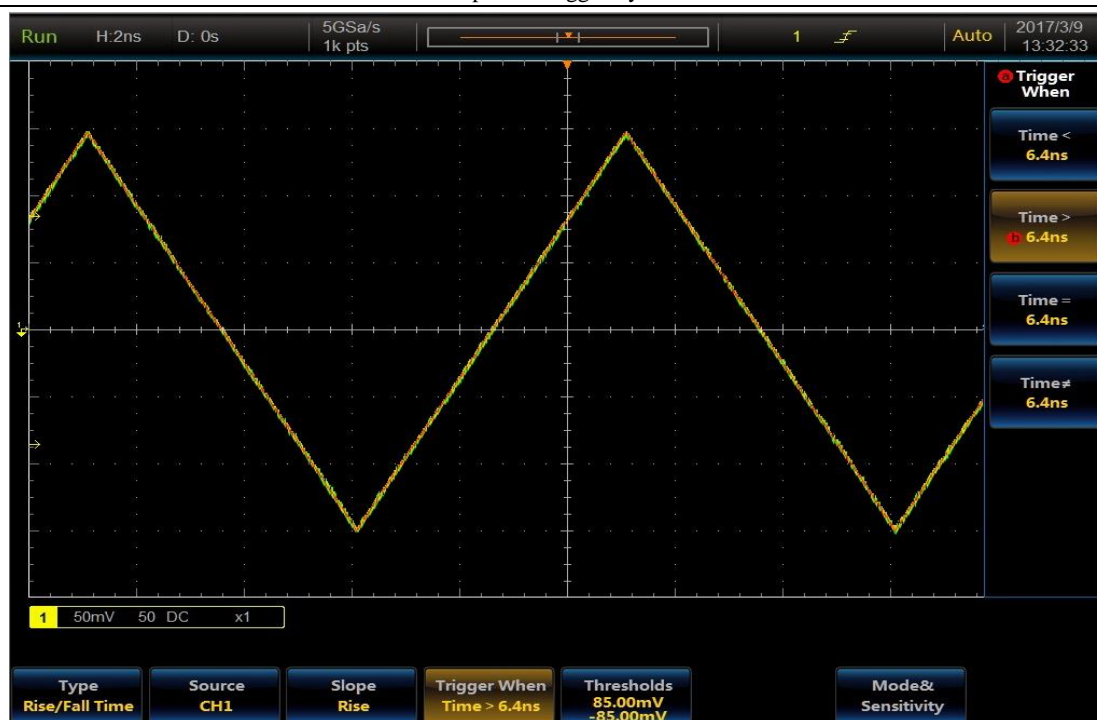


Fig. 5.36 Rise/Fall Time Trigger Example

Video and HD video trigger

It will be triggered on video signals including NTSC, PAL, SECAM, 480p/60, 576p/50, 720p/50, 720p/60, 1080i/50, 1080i/60, 1080p/24, 1080p/25 and 1080p/30.

Trigger type

Press down **【Trigger】** key of the trigger control area on the front panel, and open the trigger menu.

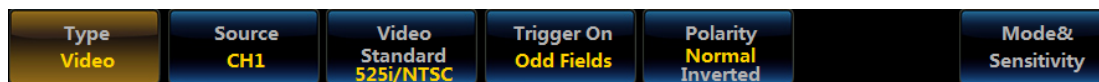


Fig. 5.37 Video Trigger Menu

Click [Type] menu key and click [Page Down] key in the popup Type menu, and the Page Down Type selection menu will pop up. Click [Video] key to select the Video Trigger. The relevant video trigger information

1 Video will be displayed on the top right corner of the screen.

Trigger source

Click [Source] menu key, and the Source selection menu will pop up on the right side of the screen. The CH1 ~CH4 can be made as the source.

Video Standard

Click [Video Standard] menu key, and the Video Standard selection menu will pop up:

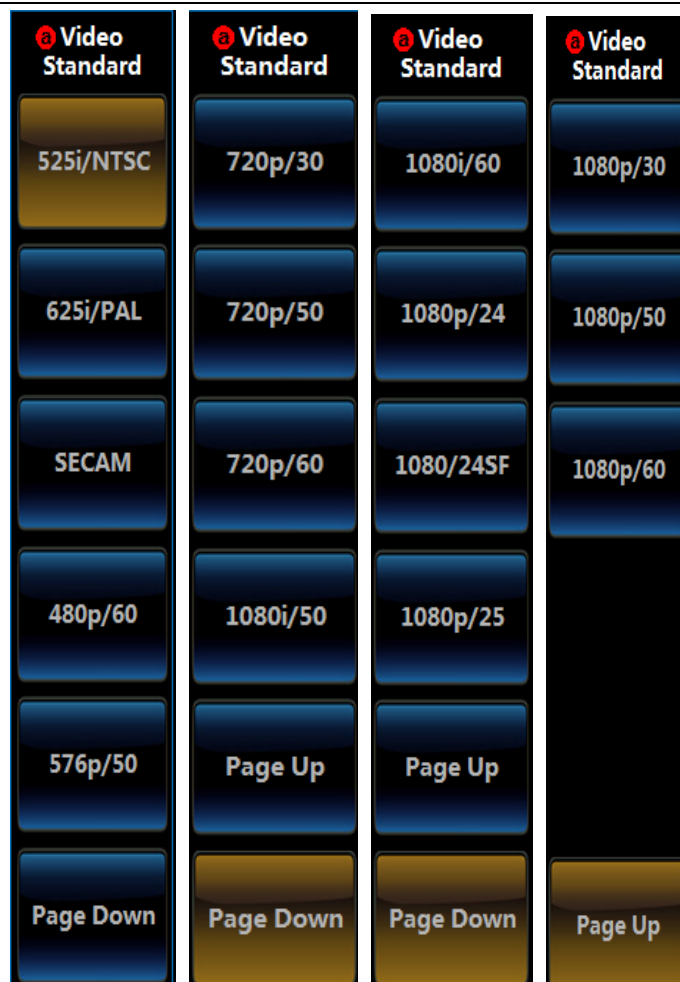


Fig. 5.38 Video Standard Setup Menu

The Video Standard includes NTSC, PAL, SECAM and HDTV. The HD video trigger (option S03) can be displayed after being separately purchased by the customer.

NTSC: The field frequency is 60 fields/s, with 30 frames/s. The number of the TV scan line is 525, with the even field in front of the odd field.

PAL: The frame frequency is 25 frames/s and the number of the TV scan line is 625, with the odd field in front of the even field.

SECAM: The field frequency is 25 fields/s and the number of the scan line is 625, with interlaced scanning.

HDTV: The HDTV has five systems including 480p, 576p, 720p, 1080p and 1080i.

Trigger On

Click [Trigger On] menu key, and the Trigger On setup menu will pop up on the right side of the screen:

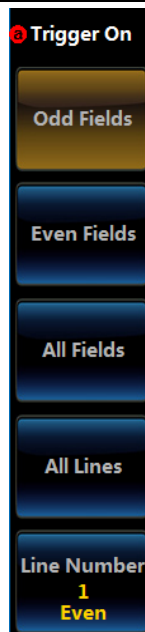


Fig. 5.39 Video Trigger On Setup Menu

Click [Odd Fields] menu key to set the Trigger On to Odd Fields;

Click [Even Fields] menu key to set the Trigger On to Even Fields;

Click [All Fields] menu key to set the Trigger On to All Fields;

Click [All Lines] menu key to set the Trigger On to All Lines;

Click [Line Number] menu key, and set the Trigger On to one line. Rotate the Multipurpose b to set the line number;

Polarity

Click [Polarity] menu key, and set the trigger to Normal or Inverted:



Fig. 5.40 Video Trigger Example

Serial protocol trigger (options S04 ~ S12)

The serial protocol trigger includes RS232 Trigger, I2C Trigger, SPI Trigger, CAN Trigger, LIN Trigger, AUDIO Trigger, USB Trigger, FlexRay Trigger and 1553 Trigger. For details, see Chapter XI *Protocol Analyzer*.

Visual trigger (zone trigger)

The 4456 series is adopted with the brand-new visible trigger technology, so that the oscilloscope can scan all waveform acquisitions, compare them with the waveform area on the screen, and quickly and easily identify target trigger events by simply observing interested signals on the screen and drawing a zone around it.

Click [Zone&Qualified] menu key during the edge or pulse width trigger, and open the Zone setup menu.



Fig. 5.41 Zone Menu

Source: Select the waveform of the corresponding channel as the Zone source.

Zone: The In and Out can be selected for judgment.

On/Off: When the ZoneQualified is on, it can be drawn by touching and dragging in the waveform area and made as the trigger judgment zone.

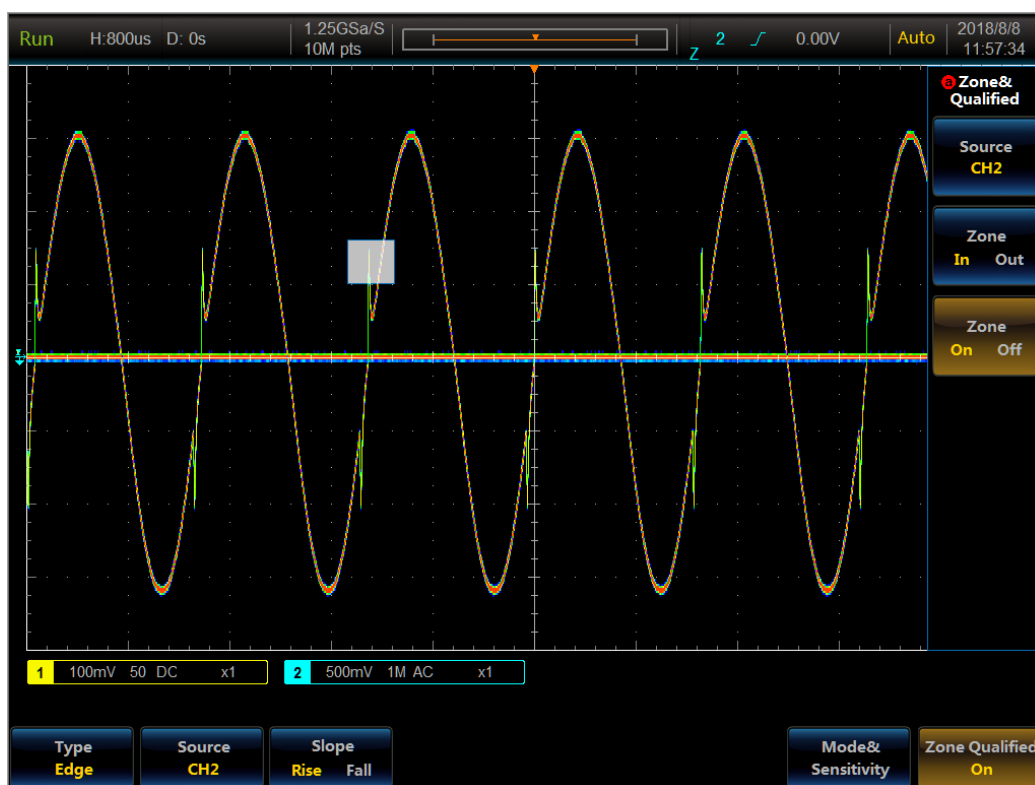


Fig. 5.42 Schematic Diagram of Visual Trigger

5.4 Trigger holdoff

The trigger holdoff is used to stably trigger the complex waveforms, such as pulse burst signals. The holdoff time refers to the time that the oscilloscope waits to restart the trigger circuit. During holdoff, the oscilloscope will not be triggered until the end of the holdoff time.

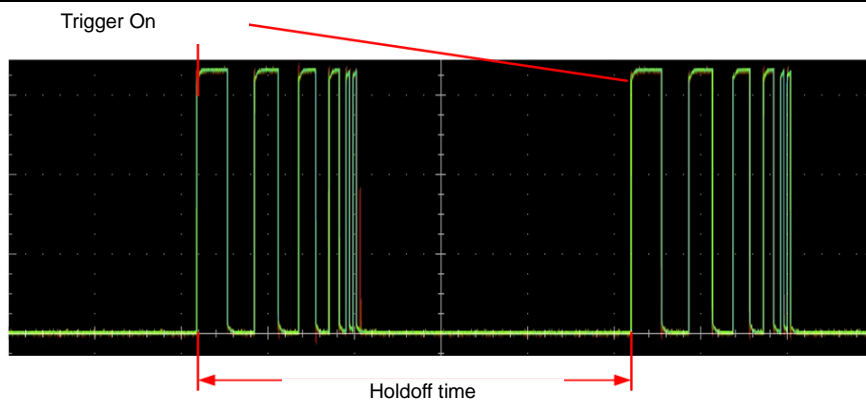


Fig. 5.43 Schematic Diagram of Trigger Holdoff

Click [Mode&Sensitivity] menu key, and open the Trigger Mode setup menu:

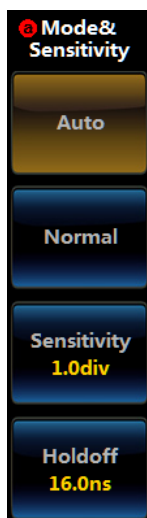


Fig. 5.44 Mode Menu

Click [Holdoff] key to set the trigger holdoff time through the Multipurpose b, or directly input the trigger holdoff time through the numeric keypad. The adjustment range of the holdoff time is 6.4 ns ~ 12.8 s.

5.5 Trigger mode

The 4456 series oscilloscope includes three trigger modes: Auto, Normal, and Single, and the currently selected trigger mode will be displayed in the top status indication column.



Fig. 5.45 Trigger Mode System Indication

Auto: The waveform display will be refreshed no matter whether the trigger condition is satisfied. The baseline will be displayed when there is no signal input.

Normal: The waveform display will be refreshed when the trigger condition is satisfied. When the trigger condition is not satisfied, it will keep the original waveform display and wait for the next trigger. Attention: Press down **【Force】** key in this mode to generate one trigger signal.

Single: When this mode is selected, the oscilloscope will be in a waiting for trigger state. When the trigger condition is satisfied, the waveform display will be refreshed, and then the oscilloscope will switch to the stop state.

Press down **【Single】** key on the front panel to select the single trigger mode. The Auto and Normal can be selected in [Mode] menu.

Attention: When the trigger is in an automatic mode and the time base is 100 ms/div ~ 1,000 s/div, the waveform will scroll from right to left on the screen. If the logic analyzer is enabled, it will be automatically disabled.

5.6 Trigger sensitivity

Click [Mode&Sensitivity] menu key in the Mode menu, and then rotate the Multipurpose b to adjust the trigger sensitivity. The trigger sensitivity range is 0.1 ~8 divisions, with a step of 0.1 divisions. The continuous adjustment of trigger sensitivity can ensure HF Reject and LF Reject more flexibly and can accurately display and analyze the measurement signal.

The trigger sensitivity is related to the trigger hysteresis of the digital comparator. If the signal is pure, the trigger sensitivity can be set to 0.5 divisions or smaller, so as to ensure that small signal can be stably triggered. If the signal contains noise, the trigger sensitivity can be set to 2 divisions or larger to ensure that the signal with large noise can be stably triggered.

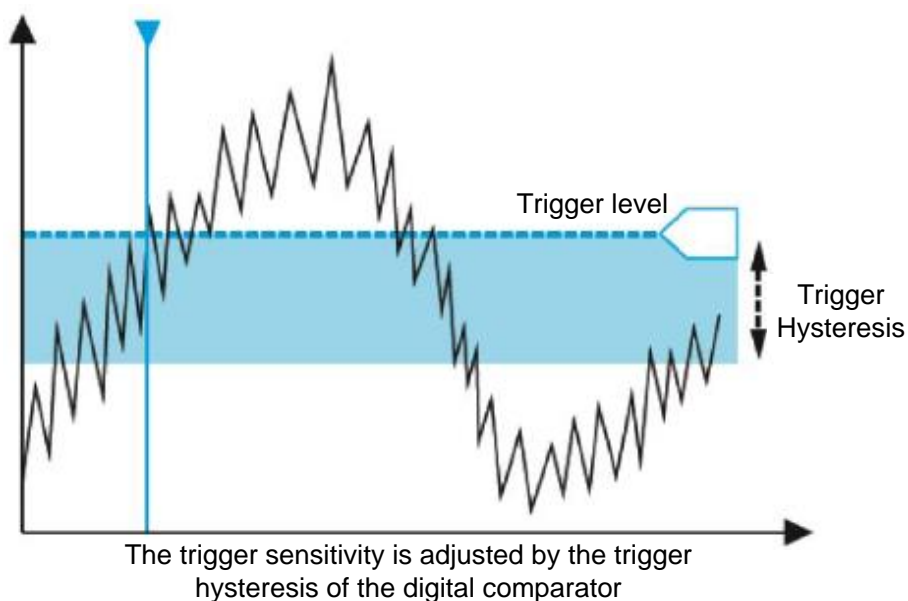


Fig. 5.46 Schematic Diagram of Trigger Hysteresis

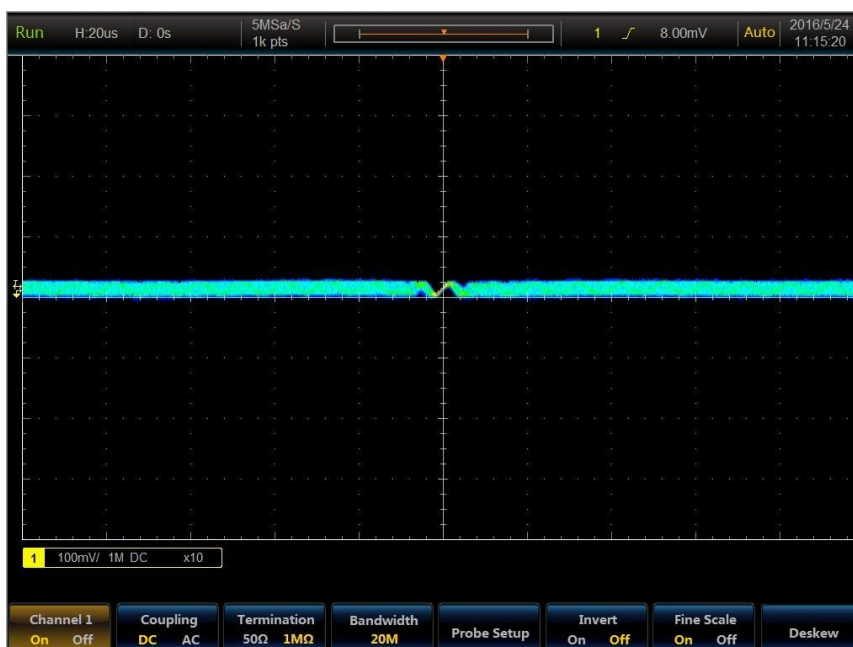


Fig. 5.47 High Trigger Sensitivity Example

5.7 Trigger level

Press down 【Level】 key on the front panel to modify the trigger level; in addition, the corresponding mark and trigger level line of the source channel will be displayed on the left side of the screen and the waveform area; the display position will be changed along with changes of the trigger level, and trigger level value of the trigger

information area on the top right corner of the screen will also change. The trigger level line in the waveform area will disappear within about 3 s after the knob operation stops.

Attention: In case of advanced trigger of protocol trigger sequence, logic and rise/fall time, the trigger level can be changed by the Multipurpose b.



Fig. 5.48 Trigger Level System Indication

5.8 AUX OUT

The AUX OUT is used to trigger pulse signal output, event output of limit/mask test, or built-in test signal output.

The AUX OUT is the signal output of trigger pulse by default, which can be used for trigger synchronization function of multiple instruments and waveform capture rate test of the 4456 series oscilloscope. Press down

【Utility】 key to pop up Level1 Menu of the system,

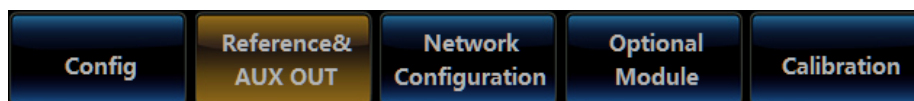


Fig. 5.49 Level1 Menu of the System

Click [Reference&AUX OUT] menu key, and open the Reference&AUX OUT setup menu:

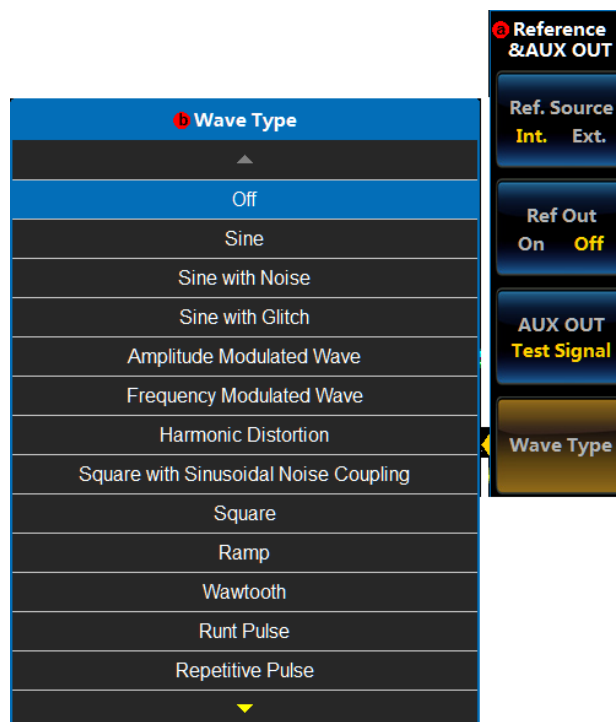


Fig. 5.50 AUX OUT Setup Menu

Select trigger pulse output, limit/mask test event output, or test signal output by touching or clicking the Multipurpose b. If the test signal is output, click the popup [Waveform Type] menu, and 25 test signals will pop up. Selection can be made by clicking the touch screen or rotating the Multipurpose b.



Fig. 5.51 RF Test Signal Example

Chapter VI Measurement System

After the oscilloscope acquires, triggers and displays the waveform, the measurement can be carried out. It can select functions including cursor, automatic measurement, statistics and histogram.

6.1 Parameter measurement

This oscilloscope provides automatic measurement of 30 kinds of waveform parameters and 12 kinds of histogram parameters, as well as statistics and analysis of the measurement result. The time and voltage are the two most basic measurements, and other measurement is based on one of the two basic measurements.

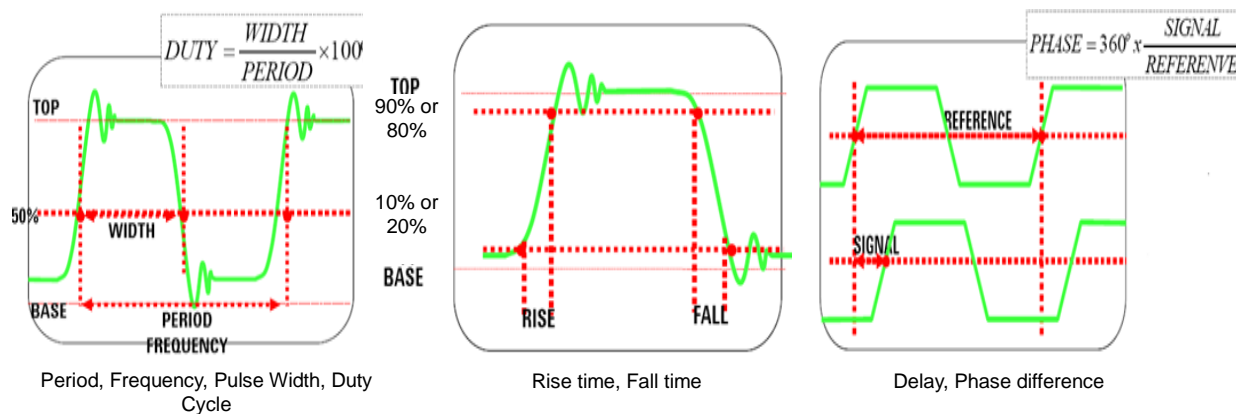


Fig. 6.1 Time Parameter

The time parameters mainly include frequency, period, positive pulse width, negative pulse width, rise time, fall time, duty cycle, delay and phase difference.

Period: The time between the intermediate threshold intersections of two consecutive homogeneous edges with like polarity.

Frequency: The inverse of a period.

Positive pulse width: The time difference between the 50% threshold of the pulse Rise Edge and the 50% threshold of the next Fall Edge.

Negative pulse width: The time difference between the 50% threshold of the pulse Fall Edge and the 50% threshold of the next Rise Edge.

Positive duty cycle: The ratio between positive pulse width and period.

Negative duty cycle: The ratio between negative pulse width and period.

Rise time: The time taking for the signal amplitude to increase to a high reference level (90% by default) from a low reference level (10% by default).

Fall time: The time taking for the signal amplitude to decrease to a low reference level (10% by default) from a high reference level (90% by default).

Delay: The time difference between edges of two channels. If the source is CH1 and the delay source is CH2, it means the time difference between CH1 and CH2.

Phase difference: The phase difference between the first Rise Edge of two channels. If the source is CH1 and the phase is CH2, it means the phase difference between CH1 and CH2.

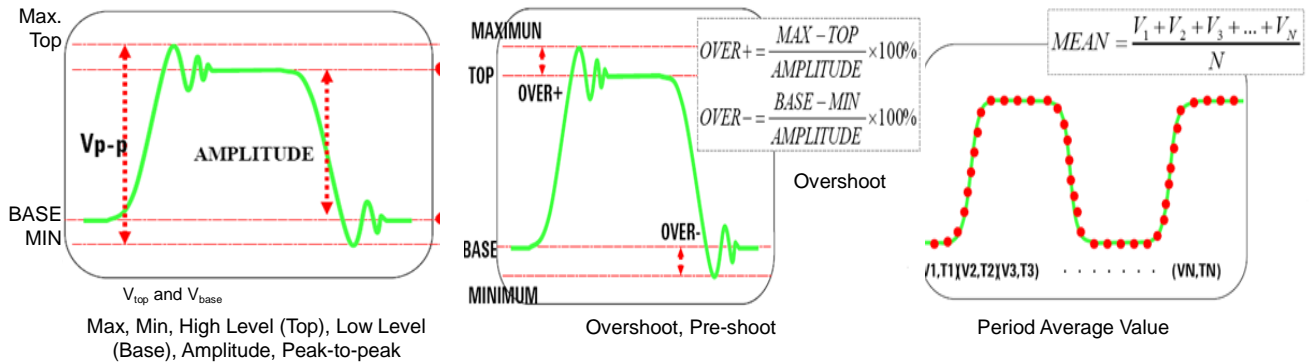


Fig. 6.2 Voltage Parameter

Voltage parameter: Max, Min, High Level (Top), Low Level (Base), Amplitude, Peak-to-peak, Pre-shoot, Overshoot, Top Fall, Effective Value and Period Average Value.

Amplitude: The voltage value from top to bottom of waveform.

Peak-to-peak: The voltage value from the highest point to the lowest point of waveform.

MAX: The voltage value from the highest point of waveform to ground.

MIN: The voltage value from the lowest point of waveform to ground.

High Level (Top): The voltage value from the flat top of waveform to ground.

Low Level (Base): The voltage value from the flat top of waveform to ground.

Pre-shoot: The ratio between the difference between the max.value and the top value of the waveform and the amplitude.

Overshoot: The ratio between the difference between the min.value and the base value of the waveform and the amplitude.

Top Fall: The ratio between the difference between the max.value and the top value of the waveform and the peak-to-peak.

Period RMS: the effective value; the root mean square value of the waveform within a period according to the DC voltage corresponding to the equivalent energy generated by the AC signal within a period.

Period Average Value: The average amplitude of the signal within a period.

Click **【Measure】** key on the front panel to pop up the main menu.



Fig. 6.3 Measurement Menu

6.1.1 Add Measurement

Click [Add Measurement] menu key, and the Add Measurement setup menu will pop up on the right side of the screen:

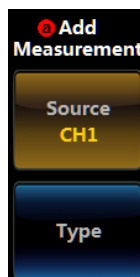


Fig. 6.4 Add Measurement Menu

Source

Click [Source] menu key, and the Source option menu will pop up:

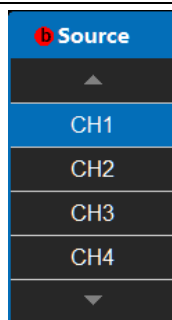


Fig. 6.5 Source Option Menu

The corresponding Source can be selected by directly clicking the option or by pressing down the Multipurpose b. Besides the open analog channels CH1 ~CH4, if the reference waveform and mathematical operation waveform are switched on, or the histogram is switched on, the source can also select the reference waveform, mathematical operation waveform or histogram waveform.

Measurement Type

Click [Type] menu key, and the Type option menu will pop up:

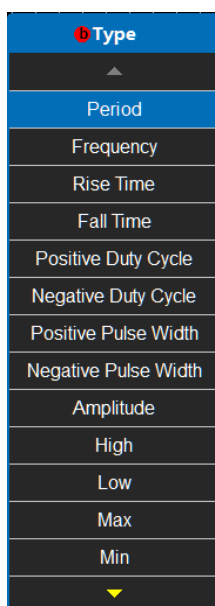


Fig. 6.6 Measurement Type Option Menu

The selected measurement type can be added by directly clicking the option or by pressing down the Multipurpose b.

The analog channel waveform, reference waveform and mathematical operation waveform mainly include the period, frequency, rise time, fall time, positive duty cycle, negative duty cycle, positive pulse width, negative pulse width, amplitude, high level, low level, max., min., peak-to-peak, positive overshoot, negative overshoot, pulse top fluctuation, average, average period value, root mean square, period root mean square, burst width, positive pulse number, negative pulse number, rise edge number, fall edge number, area, period area, delay and phase.

For histogram waveform, the oscilloscope will provide 12 measurement types, including the wave count, box hit number, peak hit number, mid-value, peak-to-peak, max., min., average, standard difference, Sigma1, Sigma2 and Sigma3.

When the measurement type is set to “Delay”, press down [Configure Delay] in the menu for the next delay setting:



Fig. 6.7 Configure Delay Menu

Source: It is used to select the first source.

Delay To: It is used to select the second source.

Source Edge: It is used to select the edge type of the first source.

Delay Edge: It is used to select the edge type of the second source.

Delay Edge Occurrence: Is used to set the delay measurement of the edge of the second source.

When the measurement type is set to “Phase”, press down [Phase To] in the menu to set the second source of the phase measurement.

6.1.2 Remove Measurement

Click [Remove Measurement] menu key, and the Remove Measurement menu will pop up on the right side of the screen:

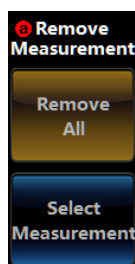


Fig. 6.8 Remove Measurement Menu

Remove All: Remove all the currently added measurement options after the click.

Select Measurement: The currently added measurement option list will pop up after the key is clicked:

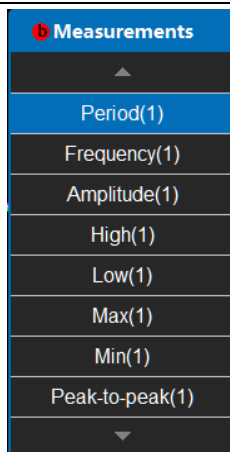


Fig. 6.9 Remove Measurement Option List Menu

The corresponding measurement option can be removed by clicking the measurement option to be removed or by pressing down the Multipurpose b.

6.1.3 Histogram

Click [Waveform Histograms] menu key, and the Waveform Histograms setup menu will pop up on the right side of the screen:

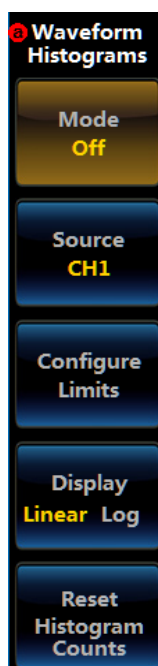


Fig. 6.10 Waveform Histograms Menu

Mode

Off: No histogram will be displayed.

Vertical: The vertical histogram will be displayed.

Horizontal: The horizontal histogram will be displayed.

Source

It can select the histogram measurement source: waveform of the analog channels CH1 ~CH4, and reference waveform and mathematical operation waveform.

Configure Limits

Set the waveform scope for the histogram measurement. Click the menu key, and the setup menu will pop up:

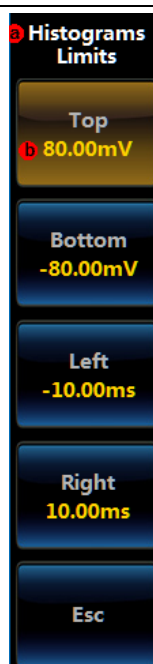


Fig. 6.11 Histograms Limits Setup Menu

The Top and Bottom Limits are the corresponding top and bottom voltage in the vertical direction of waveform in the screen.

The Left and Right Limits are the corresponding left and right time in the horizontal direction of waveform in the screen.

Display

Linearity: The histogram statistics are displayed in a linear relationship.

Log: The histogram statistics are displayed in a log relationship.

Reset Histogram Counts

Clear the current statistics of the histograms, and carry out statistics and count again.

6.1.4 Statistics

Click [Statistics] menu key, and the Statistics setup menu will pop up on the right side of the screen:

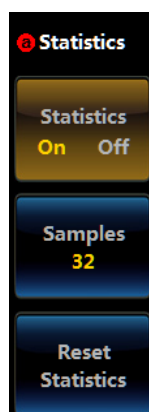


Fig. 6.12 Statistics Setup Menu

When the statistics are disabled, the measurement result window will only display the current measurement value. When the statistics are enabled, besides the current measurement value, it will also display the average, min., max. and standard difference.

Samples: It is used to set samples for statistics and count of average and standard difference. The adjustment range is 2 ~1,000.

Reset Statistics: Clear the current statistics, and carry out statistics, count and calculation again.

6.1.5 Gating

It is used to limit measurements in specific parts of the waveform.

Click [Gating] menu key, and the Gating will be switched between the screen and cursor. The data in the waveform area of the screen or between the cursors can be selected for measurement and calculation.

6.1.6 Reference Levels

The [Reference Levels] is used to determine how to carry out time-related measurement.

Click [Reference Levels] menu key, and the Reference Levels setup menu will pop up on the right side of the screen:

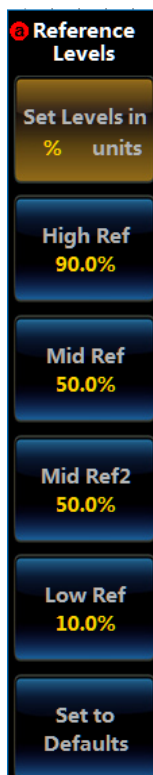


Fig. 6.13 Reference Levels Setup Menu

The Set Levels in can be set to % or units. When “%” is selected, the corresponding value of signal amplitude percentage will be used for calculation. When “units” is selected, the set level value will be used for calculation.

The High Ref and Low Ref are mainly used to calculate rise and fall time.

The Mid Ref is mainly used to calculate edge-related measurement, and judge mid position of the edge.

The Mid Ref2 corresponds to the Mid Ref of the second source during the delay and phase measurement.

The Set to Defaults is set to %, the High Ref is set to 90%, the Mid Ref is set to 50%, and the Low Ref is set to 10%.

6.1.7 Hardware AUX On Off

When the AUX On Off is enabled, the period, frequency, duty cycle, pulse width, pulse number, edge number and delay will be measured with Hardware AUX.

6.1.8 Window

When zoom is on, Window menu is displayed.

If the Window is set to Main, the measurement is calculated with main window’s data, if the window is set to zoom, the measurement is calculated with zoom window’s data.

6.2 Cursor measurement

The cursor is a mark for positioning the waveform on the screen, which is used for manual measurement of the acquired data. The cursor is composed of horizontal and vertical lines.

Click **【Cursors】** key on the front panel to open the cursors menu:

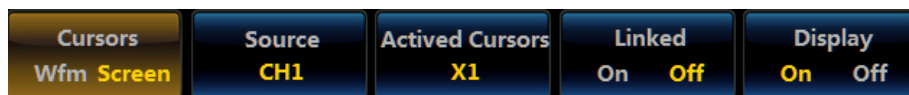


Fig. 6.14 Cursors Menu

Cursor

When the cursor measurement is set to Wfm, only the vertical line cursor, measurement time of the corresponding position and waveform amplitude of the corresponding time will be displayed on the screen. When the cursor measurement is set to Screen, the horizontal and vertical line cursor, amplitude of the corresponding position of the horizontal line measurement and corresponding time of the vertical line measurement will be displayed on the screen.

Source

Select the source for cursor measurement: analog channels CH1~ CH4, mathematical operation waveform and FFT waveform.

Activated Cursors

The cursor line which moves during operation with the Multipurpose b can be X1, X2, Y1, or Y2. X1 and X2 are vertical line cursors for measuring time; Y1 and Y2 are horizontal line cursors for measuring amplitude. The color of the activated cursors is the same as that of the source channel.

Linked

When Linked is set On and the Multipurpose b is operated, two cursor lines related to the current activated cursors will move simultaneously. When Linked is set Off and the Multipurpose b is operated, only the current activated cursors will move.

Measurement Result

When the cursor is switched on, the cursor line will be displayed on the screen, and the corresponding measurement results of the cursor line will be displayed. The dX is the time difference between two vertical line cursors, and the dY is the amplitude difference between two horizontal line cursors.

X1:-760.00ns	X2:1.24us	dX:2.00us
Y1:722.22mV	Y2:-687.50mV	dY:1.41V

Fig. 6.15 Cursor Measurement Result

Chapter VII Mathematical Operation

The 4456 series oscilloscope can realize multiple operations of channel waveform, including mathematical operation, FFT and advanced mathematical operation.

Press down **【Math】** key on the front panel, and open the menu:



Fig. 7.1 Math Menu

7.1 Dual Wfm Math

Click [Dual Wfm Math] menu key, and open the Dual Wfm Math setup menu:

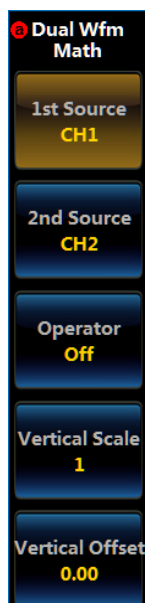


Fig. 7.2 Dual Wfm Math Menu

1st source and 2nd source: It is used to set 2 sources for mathematical operation, and the analog channels CH1 ~CH4 can be selected.

Operator: It can be used to set the mathematical operation type, including off, +, −, ×, ÷. If the Operator is not set to off, the mathematical operation status bar will be displayed at the bottom of the screen, displaying the vertical scale and operation expression of the operation waveform:



Fig. 7.3 Dual Wfm Math Status Bar

Vertical Scale: After clicking the menu key, rotate the Multipurpose b to set the vertical scale of the operation waveform.

Vertical Offset: After clicking the menu key, rotate the Multipurpose b to set the vertical offset of the operation waveform.

7.2 FFT

The FFT can convert time domain signals into frequency domain signals. The FFT operation can be used to facilitate the following operations:

- 1) Measure the harmonic component and distortion in the system.
- 2) Measure noise characteristics in DC power supply.
- 3) Analyze the vibration.



Instructions: The signal with DC component or offset may cause an error or offset in the FFT waveform component. The “AC” coupling mode can be selected to reduce

DC component.

In order to reduce the random noise and aliasing frequency components of repeated or single pulse events, the oscilloscope can be set to “Average” acquire mode.

Click [FFT] menu key, and open the FFT menu:



Fig. 7.4 FFT Menu

Source: It is used to set the source for the FFT operation, and the analog channels CH1 ~CH4 can be selected.

Window: It can be used to set Window type for the FFT operation, and the Window can be set to Rectangular, Hamming, Hanning or Blackman-Harris. The Window can be used to reduce the spectrum leakage effect, which shall be selected properly according to the characteristics of the measured signal.

Peak Mark: When it is set On, the corresponding amplitude and frequency can be displayed at the FFT waveform peak.

SubPeak Mark: When it is set On, the corresponding amplitude and frequency can be displayed at the FFT waveform subpeak.

Table 7.1 Introduction to Window

Window	Characteristics	Applicable Waveforms
Rectangle	Best frequency resolution; worst amplitude resolution; similar to conditions without Window.	Transient or short pulse with signal level approximately equals all the time; equiamplitude sine wave with very similar frequency; broadband random noise with slow-changing spectrum.
Hanning	Better frequency resolution; worse amplitude resolution	Sinusoidal, periodic and narrow-band random noise.
Hamming	Better frequency resolution	Short pulse with quite different signal level
Blackman	Best amplitude resolution Worst frequency resolution	Single frequency signal, searching for higher harmonics

Configure: Click the menu key to open the Configure FFT menu:

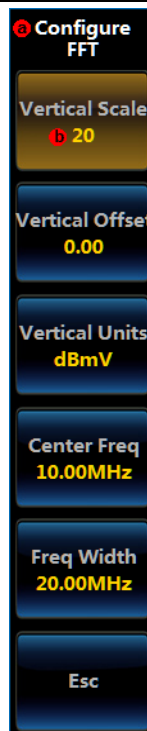


Fig. 7.5 Configure FFT Menu

Vertical Scale: After clicking the menu key, rotate the Multipurpose b to set the vertical scale of the FFT waveform.

Vertical Offset: After clicking the menu key, rotate the Multipurpose b to set the vertical offset of the FFT waveform. Attention: The FFT waveform zero position is at the top of the screen waveform area.

Vertical Units: Select the FFT operation unit, including V, dBV, dBmV, mV.

Center Freq: Set the corresponding frequency of the center of the screen, which can be input by Multipurpose b or digital keyboard.

Freq Width: Set the frequency width of a screen, which can be input by Multipurpose b or digital keyboard. In this case, the frequency of the left-most position of the screen is: Center Freq - Freq Width/2, and the frequency of the right-most position of the screen is: Center Freq + Freq Width/2.

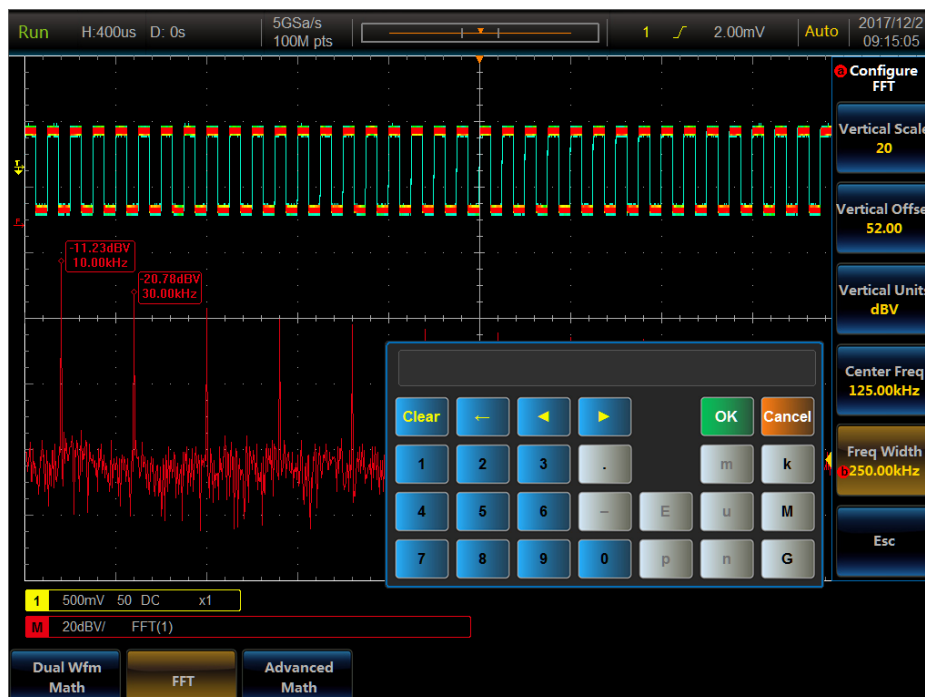


Fig. 7.6 FFT Example

7.3 Advanced Math

Click [Advanced Math] menu key, and open the Advanced Math setup menu:

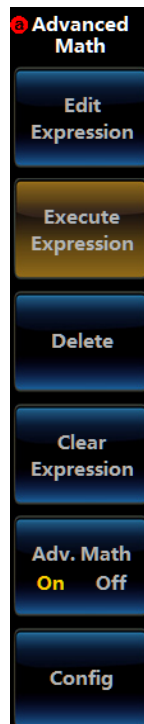


Fig. 7.7 Advanced Math Menu

Edit Expression

Click [Edit Expression] menu key, and the Expression Edit window will pop up on the screen:

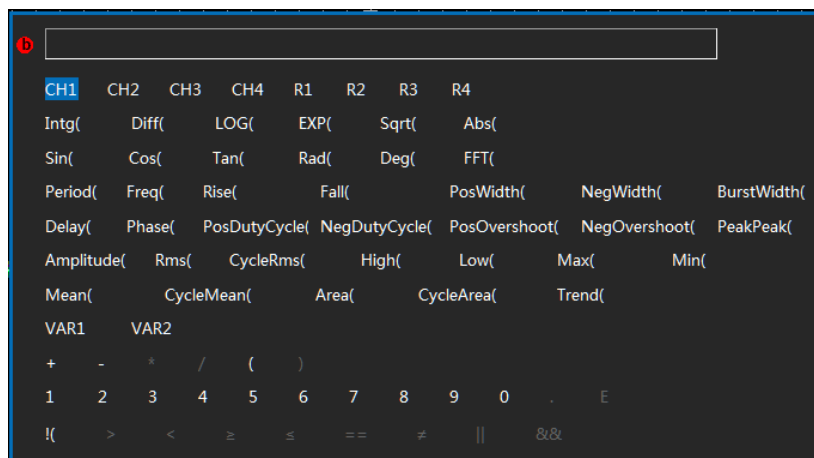


Fig. 7.8 Advanced Math Expression Edit Window

The required Source and Operator can be selected by pressing down the Multipurpose b or by directly clicking the option, and the selected option will be input to the expression.

Delete: The finally entered option will be removed.

Clear Expression: The expression will be cleared.

Execute Expression: The currently edited expression will be used for operation.

The Operators are defined as follows:

Intg: Carry out integral operation of data.

Diff: Carry out differential operation of data.

LOG: Carry out log operation of data.

EXP: Carry out exponent operation of data.

Sqrt: Carry out square root operation of data.

Abs: Carry out absolute value operation of data.

Sin: Carry out sine operation of data.

Cos: Carry out cosine operation of data.

Tan: Carry out tangent operation of data.

Rad: Carry out radian operation of data.

Deg: Carry out degree operation of data.

FFT: Carry out FFT operation of data.

Period, Freq,CycleArea: Parameter measurement results.

VAR 1, VAR 2: The user-defined variables can be set by setting the menu.

E: The values are expressed with scientific notation.

Example: Carry out integral operation of signals of Channel1.

1. Select“Intg (”
2. Select“CH1”
3. Select“(”
4. Click“Execute Expression”

Configuration

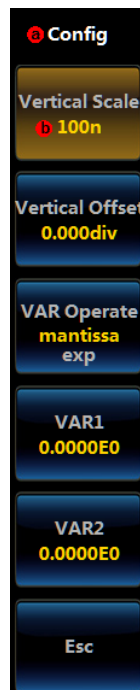


Fig. 7.9 Config Menu of Advanced Math

Vertical Scale: Set the vertical scale of the advanced math operation waveform through the Multipurpose b.

Vertical Offset: Set the vertical offset of the advanced math operation waveform through the Multipurpose b.

VAR Operate: Set partial data of 2 variables with scientific notation. The mantissa and exp can be selected.

VAR1, VAR2: Set mantissa and exp of the variable through the Multipurpose b, or set values of VAR1 and VAR2 through the numeric keypad.



Fig. 7.10 Advanced Math Example

Chapter VIII Display System

This oscilloscope can set the waveform display type, color, persist time, intensity, graticule type and intensity.

8.1 Waveform display setup

Press down **【Display】** key on the front panel, and open the display menu:



Fig. 8.1 Display Menu

Click [Wfm Display] menu key, and open the Wfm Display setup menu:

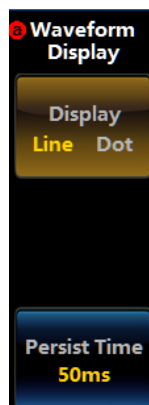


Fig. 8.2 Wfm Display Menu

Display: When it is switched Line, the sample points will be displayed by line. When it is switched Dot, the sampling point will be displayed directly.

8.2 Wfm Palette setting

The 4456 series oscilloscope implements digital phosphor three-dimensional display technique, to tell probability of event occurrence through lightness of color (256-grade gray scale) or temperature change (color grade), and to provide 4 types of waveform palettes including normal, inverted, temperature and spectral, which enhances the capability of contingency view for superior visual experience.

Normal: indicates event probability by default channel color and gray scale. Bright color indicates events of high occurrence probability;

Inverted: indicates probability of event occurrence by default channel color and gray scale. Dark color indicates events of high occurrence probability;

Temperature: uses color grade to indicate event occurrence probability. Warm color (red or yellow) indicates events of high occurrence probability;

Spectral: uses color grade to indicate event occurrence probability. Cold color (blue or green) indicates events of high occurrence probability.

Click [Wfm Palette] menu key, and open the Wfm Palette setup menu:

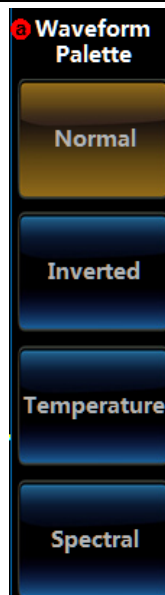


Fig. 8.3 Wfm Palette Menu



Fig. 8.4 Normal Palette



Fig. 8.5 Inverted Palette



Fig. 8.6 Temperature Palette



Fig. 8.7 Spectral Palette

8.3 Persist setup

Click [Persist Time] of the Waveform setup menu, and set the persist time through the Multipurpose b. The adjustment range is 0 s~12.5 s or infinite.

8.4 Graticule setup

Click [Graticule] key of the display menu, and open the Graticule menu:

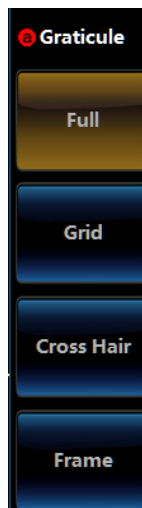


Fig. 8.8 Graticule Menu

Click the menu key to set the graticule to the corresponding type.

Full: Display the background grid and coordinates.

Grid: Display the background grid instead of coordinates.

Cross Hair: Display coordinates instead of the background grid.

Frame: No display of the background grid and coordinates.

8.5 Intensity setup

Operate **【Intensity】** menu on the front panel, and open the Intensity setup menu:

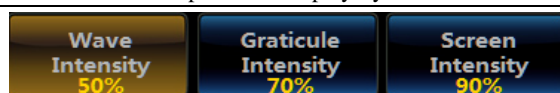


Fig. 8.9 Intensity Menu

This oscilloscope can be used to set the Wave Intensity, Graticule Intensity and Screen Intensity.

After clicking the menu key, the corresponding Intensity setup menu will pop up, and then rotate the Multipurpose b to adjust the intensity.

8.6 XY Display

In XY mode, the oscilloscope will convert two input channels to voltage-voltage display from voltage-time display. The X axis and Y axis will track the voltage of CH1 and CH2 respectively. The phase difference between two signals with the same frequency can be easily displayed and measured with Lissajous method. The following figure gives the principle diagram of measurement phase difference.

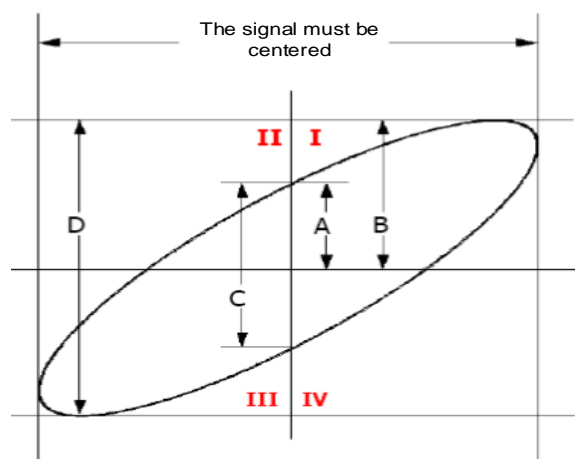


Fig. 8.10 Principle Diagram of Phase Difference Measurement

According to $\sin\theta=A/B$ or C/D , where θ is the phase difference angle between the channels, and definitions of A, B, C, D are as shown in the above figure. Therefore, the phase difference angle can be obtained: $\theta = \pm\arcsin(A/B)$ or $\pm\arcsin(C/D)$. If the main axis of the ellipse is in quadrants I and III, the obtained phase difference angle shall be in quadrants I and IV, namely in $(0 \sim \pi/2)$ or $(3\pi/2 \sim 2\pi)$. If the main axis of the ellipse is in quadrants II and IV, the obtained phase difference angle shall be in quadrants II and III, namely in $(\pi/2 \sim \pi)$ or $(\pi \sim 3\pi/2)$.

Click [XY Display] key of the display menu to turn on/off XY display.

Attention: When the XY display mode is enabled, if the logic analyzer is enabled, it will automatically disable the logic analyzer.



Fig. 8.11 Display Menu

When the XY mode is enabled, the Channel1 and Channel2 are a group, while the Channel3 and Channel4 are a group. The Channel1 and Channel3 correspond to the data of X axis and the Channel2 and Channel4 correspond to the data of Y axis.

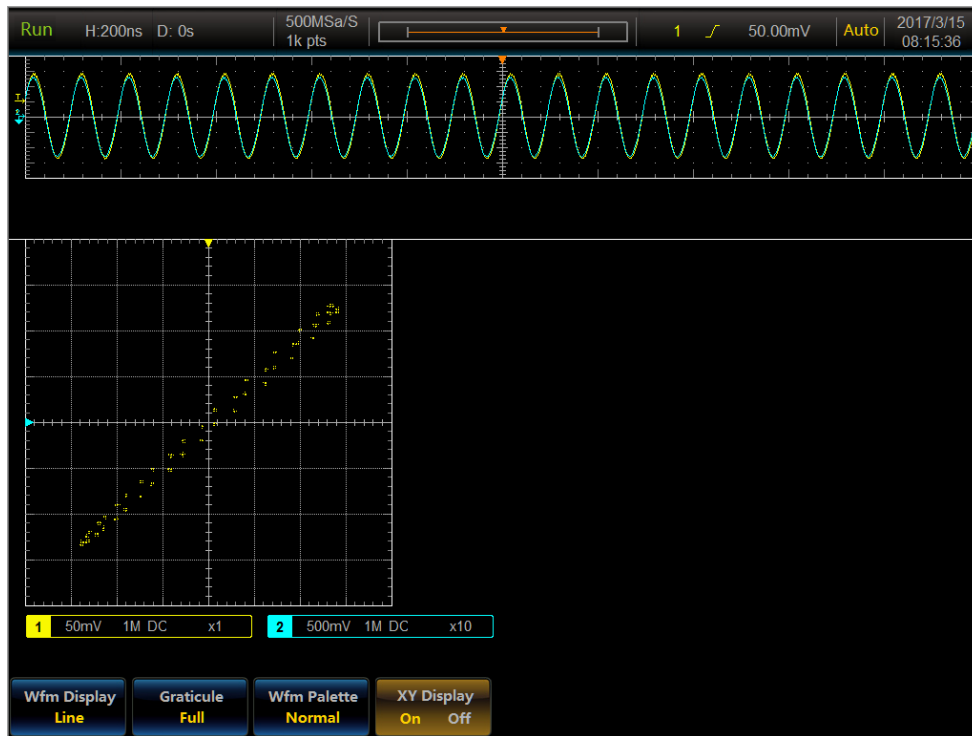


Fig. 8.12 XY Display Example

Chapter IX Save, Recall and Reference

This oscilloscope can save waveform, setup and screen image, and can recall waveform and setup.

9.1 Save

Press down **【Save】** key on the front panel, and open the Save menu:



Fig. 9.1 Save Menu

9.1.1 Save Waveform:

Click [Save Waveform] menu key, and open the Save Waveform menu:

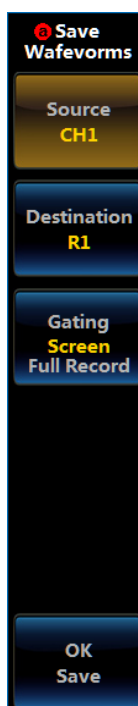


Fig. 9.2 Save Waveform Menu

Source: It is used to set the source of the Save Waveform, and the analog channels CH1 ~CH4 can be selected.

Destination: Set the destination of the Save Waveform, and internal references R1 ~R4 can be selected. If want to save to disk, "Save to file" can be selected, and files can be made in CSV or bin format.

If "Save to file" is selected, the all opened channel can be selected with source.

The default file name is "4456_YYYYMMDD_HHMM_CHx". The YYYYMMDD is the year, month and day information of the current date, HHMM is the hour and minute information, CHx is the channel information, and CH1 represents the Channel1. The file suffix name is the same as the selected file saving type.

You can also enter the file name through the keyboard in the popup file save dialog box. The save structure of the bin format data is:

Table 9.1 Save Data Structure

Position	Content
Data Head	
0	Model: 4456
0x0E	Firewave Version: 1.4.0
0x27	Acquire mode, 32-bit integer 0: Normal; 1: Peak; 2: Average; 3: High resolution; 4: Envelope

0x2B	Memory depth, 32-bit integer
0x2F	Source, 32-bit integer 0 ~3: Corresponding to Channel1 ~Channel4
0x33	Horizontal scale, 64-bit double precision number
0x3B	Horizontal delay, 64-bit double precision number
0x43	Waveform data length, 32-bit integer
0x47	Waveform sampling data point time interval , 64-bit double precision number
0x4F	Probe type, 32-bit integer 0: Voltage probe; 1: Current probe
0x53	Attenuation, 32-bit integer When the probe type is voltage probe, it represents the attenuation When the probe type is current probe, it represents the voltage-current conversion ratio of the probe
0x57	Source channel vertical scale , 64-bit double precision number
0x5F	Source channel vertical offset , 64-bit double precision number
0x67	Corresponding acquire time of the first data , 64-bit double precision number
0x6F	Null data 0, 8-bit char
Waveform Data	
0x70	Data waveform starting address Normal/Average acquire mode: each sampling points contains one 8-bit char. High resolution acquire mode: each sampling points contains one 16-bit short integer. Peak/Envelope acquire mode: each sampling point contains one 16-bit short integer, the low 8-bit char is the min, and that of the high 8-bit char is the max.

Note:**The time of each sampling data :**

Acquire time of the first data + sequence number of the data * waveform sampling data point time interval

The amplitude of signal:

Normal: $\text{sampling data} * (\text{vertical scale} * 8 / 0xFF) + (-4 * \text{vertical scale} + \text{vertical offset})$

High resolution: $\text{sampling data} * (\text{vertical scale} * 8 / 0x7FF) + (-4 * \text{vertical scale} + \text{vertical offset})$

Gating: It is used to set the memory depth of the Save Waveform, and the corresponding acquired data of the screen or whole memory depth data can be selected.

Save: It is used to complete waveform save according to above settings.

9.1.2 Save Setup

This oscilloscope can save up to 8 groups of setup data.

Click [Save Setup] menu key, and open the Save Setup menu:

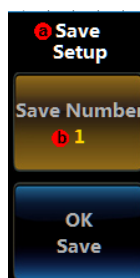


Fig. 9.3 Memory Menu

Set the Save Numbers 1 ~8 through the Multipurpose b.

After clicking [Save] key, carry out save setup. The saved setting information includes the current vertical, horizontal, and trigger information.

9.1.3 Recall Waveform

Click [Recall Waveform] menu key, and open the Recall Waveform menu:

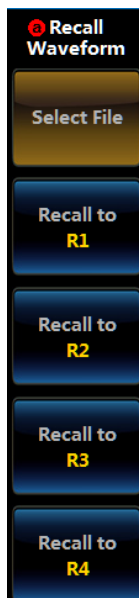


Fig. 9.4 Recall Waveform Menu

Click [Select File] menu key to select the waveform file saved in disk, with the file format including CSV or bin. It can recall the selected file to R1 ~R4 of the internal reference.

9.1.4 Save Screen Image

Click the menu key, and the current screen image will be saved to files of the disk.

The file format can be 16-bit bmp, 24-bit bmp and 32-bit bmp or tif.

The default file name is: 4456_YYYYMMDD_HHMM. The YYYYMMDD is the year, month and day information of the current date, and HHMM is the hour and minute information. The file suffix name will be bmp or tif according to the selected save file type. You can also enter the file name through the keyboard in the popup File Save dialog.

9.2 Recall

Press down **【Recall】** key on the front panel, and open the Recall menu:



Fig. 9.5 Recall Menu

If the saved setting data is detected, the menu key will display the recall setting, otherwise the button will display "----".

Click Recall Setup1 ~8 buttons of the menu to recall the saved settings to the system.

9.3 Reference

This oscilloscope can save 4 groups of Ref Wfm data.

Press down **【Reference】** key on the front panel, and open the Ref Wfm menu:



Fig. 9.6 Ref Wfm Menu

If the saved Ref Wfm data is detected, the menu key will display the corresponding Ref Wfm on/of state, otherwise the key will display “----”.

Click [Ref Wfm] menu key to turn on/off the Ref Wfm display. When the Ref Wfm display is turned on, the Ref Wfm setup menu will be displayed on the right side of the screen.

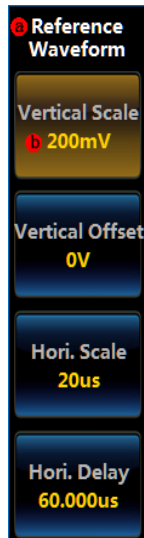


Fig. 9.7 Ref Wfm Setup Menu

Rotate the Multipurpose b to adjust the Vertical Scale, Vertical Offset, Hori. Scale and Hori. Delay of the Ref Wfm.

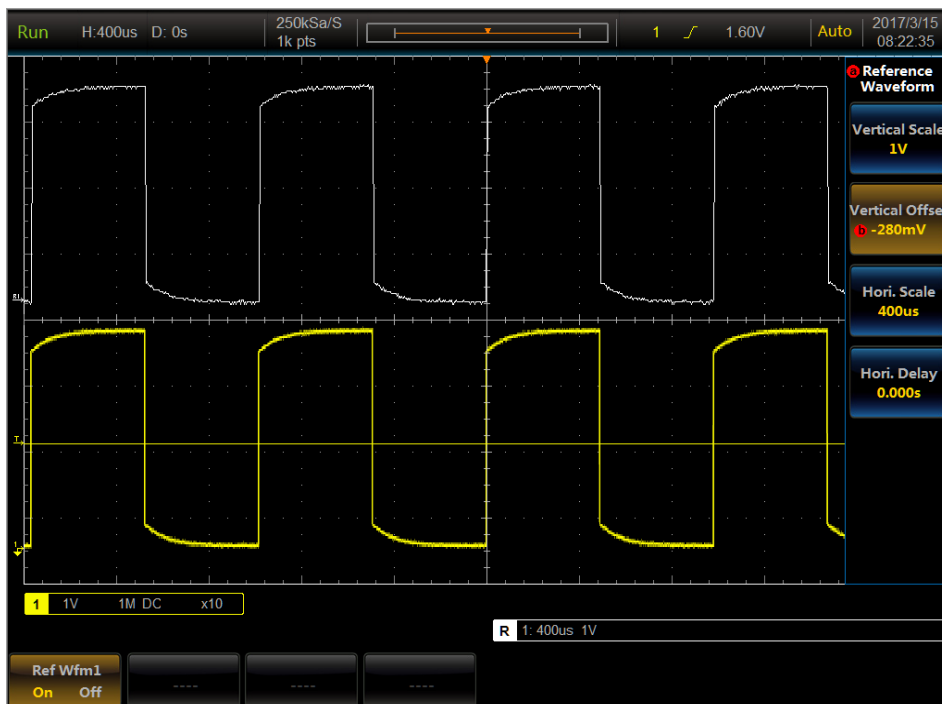


Fig. 9.8 Ref Wfm Example

9.4 Record&Play

This oscilloscope can be used for waveform record & play.

Press down **【Navigate】** key on the front panel, and open the menu:

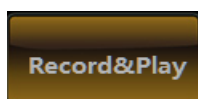


Fig. 9.9 Navigate Menu

Click [Record&Play] menu key, and open the menu:

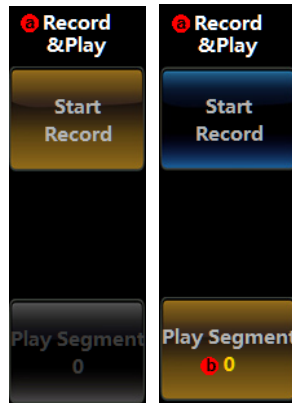


Fig. 9.10 Record&Play Menu

Start Record: Click this key in the running state to begin waveform record. When all data segments are recorded, the instrument will stop automatically.

Note: The number of recorded data segment is consistent with the number of saved setting segment in the acquire menu.

Play Segment: This key becomes effective when the record is completed, and corresponding waveform of the data segment number to be played can be selected through the Multipurpose b.

Chapter X System Configuration

This oscilloscope can be used for setting of Touch Panel, Print Mode, Reference & AUX OUT, Network, Optional Module, etc., as well as calibration of channel, etc.

Press down 【Utility】 key on the front panel, and open the System Config menu:

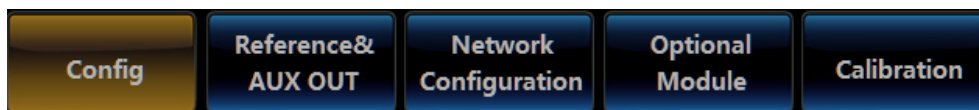


Fig. 10.1 System Config Menu

10.1 Config

Click [Config] menu key, and open the Config menu:

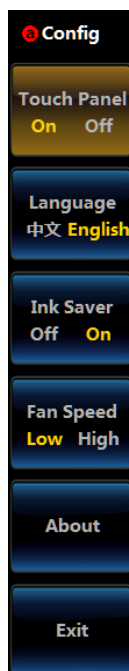


Fig. 10.2 Config Menu

Touch Panel On/Off: Enable and disable the touch panel function. When the Touch Panel is turned on, the waveform control can be realized by gesture.

Table 10.1 Description of Gestures

Gesture	Control
Slide to the left	The trigger point and waveform horizontally move to the left
Slide to the right	The trigger point and waveform horizontally move to the right
Slide up	The vertical zero point and waveform vertically move up
Slide down	The vertical zero point and waveform vertically move down
Zoom in horizontally by two fingers	Zoom out the time base, and horizontally zoom in the waveform
Zoom out horizontally by two fingers	Zoom in the time base, and horizontally zoom out the waveform
Zoom in vertically by two fingers	Zoom out the vertical range, and vertically zoom in the waveform
Zoom out vertically by two fingers	Zoom in the vertical range, and vertically zoom out the waveform

Language: The Chinese and English operation interface can be selected.

Ink Saver: The Ink Saver can be set on or off. With Ink Saver Off, the color of the printed screen image is the same as the currently displayed color. With Ink Saver On, the screen image will be inverted before printing.

Fan Speed: Fan Speed can be set low or high. It can be selected low or high speed based current temperature.

About: Click this button, the information of this production can be showed.

Exit: Click this button, and exit the application.

10.2 Reference&AUX OUT

Click [Reference&AUX OUT] menu key, and open the setup menu:

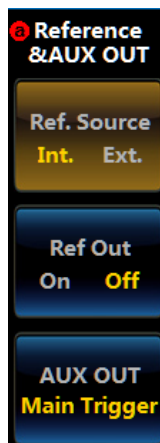


Fig. 10.3 Reference&AUX OUT Menu

Ref. Source: The 10M Ref. Source clock source can be selected. The Int. and Ext. clock source can be selected.

Ref OUT: When the Int. is selected for the 10M Ref. Source, the Ref OUT can be enabled.

AUX OUT: When the AUX OUT is selected, it can be set to test signal, trigger output and limit/mask output.

Main Trigger: One pulse will be output when there is a trigger during the internal acquire.

Limit/mask output: The pulse will be output when the limit/mask test fails or when it is completed.

Test signal: The required signal output can be selected through [Waveform Type] menu key. The optional analog signal waveforms include sine wave, sine wave with noise, sine wave with glitch, modulation signal with 10 kHz fundamental frequency, uniform frequency modulation wave, harmonic distortion signal, 1 kHz square wave with sinusoidal noise coupling, ramp wave, sawtooth wave, runt pulse, non-monotonic edge pulse, RF signal, and analog and digital signal. The optional digital signal waveform includes square wave, repetitive pulse, single-shot pulse, clock with infrequent glitch, edge transition & setup&hold signal, digital burst signal, digital burst signal with rare glitch, DC motor, RS232, CAN, LIN and FlexRay.

Note: When selecting “Single-shot Pulse”, one pulse will be output every time after [Send Pulse] menu key is clicked.

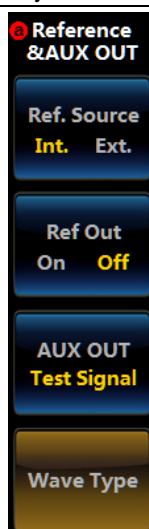


Fig. 10.4 Test Signal Waveform Type Menu

10.3 Network Configuration

It is used to set the network parameter of the oscilloscope. It includes IP address and port.

Click [Network Configuration] menu key, and open the Network Configuration menu:

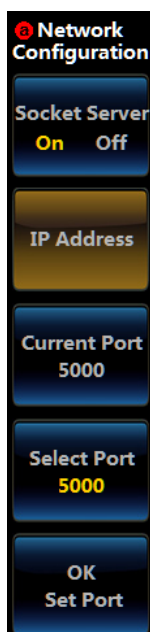


Fig. 10.5 Network Configuration Menu

Click [Socket Server] menu key to turn on or turn off the Socket Server.

Click [IP Address] menu key, and the IP setting dialog box will pop up on the left side of the menu:

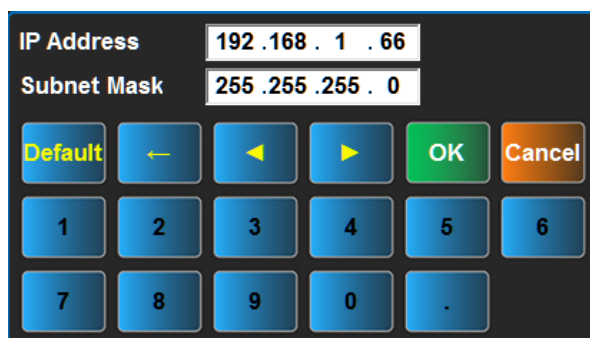


Fig. 10.6 Network Configuration Dialog

The [Current Port] option of the menu will display the current port. Click [Select Port] menu key and then rotate the Multipurpose to change the port value. When it is set to the required port, click [OK/Set Port] menu key and set the system port, and it will be displayed on [Current Port] option of the menu after the setup succeeds.

10.4 Options

The software optional module of this oscilloscope includes the limit/mask test, power measurement and analysis, HD video trigger, I2C trigger and analysis, RS232 trigger and analysis, SPI trigger and analysis, CAN trigger and analysis, LIN trigger and analysis, FlexRay trigger and analysis, Audio trigger and analysis, USB trigger and analysis and 1553 trigger and analysis.

Click [Optional Module] menu key to open the Optional Module menu:

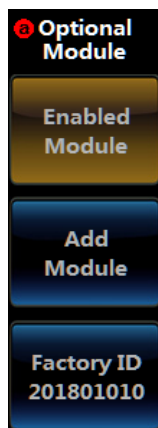


Fig. 10.7 Optional Module Menu

Click [Enabled Module] menu key, and the list of the enabled module in the oscilloscope will be displayed.

Click [Add Module] menu key, and the list of the add module will be displayed. Click the option to be added, and then enter the registration code in the popup registration window.

[Factory ID] menu key shows the factory ID of this instrument.

10.5 Calibration

This oscilloscope can automatically complete the channel calibration.

Click [Calibration] menu key, and open the menu:

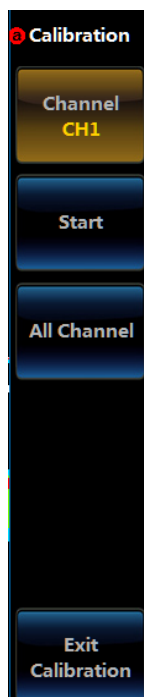


Fig. 10.8 Calibration Menu

In case of channel calibration, the channel input shall be kept in a suspended state and no probe or input signal can be connected. Click [Channel] to select the channel number to be calibrated, and then click [Start] or [All Channel], and wait for completion of calibration.

During calibration, click [Exit Calibration] to stop calibration, and this calibration is invalid.

10.6 System write-protection

The disc C has been subject to write protection during delivery, and any changes of the disc C will be removed automatically when the instrument is restarted, so as to ensure the safety of the instrument system. If you need to change the data of disc C or install drivers such as printer, carry out following operations.

Press down **【Utility】** key to pop up the System Config menu. Click [Config] menu to pop up the Level2 Menu, and click [Exit] to make the instrument exit to the desktop from the running software.

Click “My Computer” on the desktop to enter the disc C root directory, and then click “Turn Off System Write Protection”. When the computer is restarted, you can make any changes to the disc C of the instrument.

After the disc C is changed, be sure to click “My Computer” on the desktop to enter the disc C root directory, and then click “Turn On System Write Protection”. When the computer is restarted, the system will be in a write protection state.

Chapter XI Protocol Analyzer (Option)

The 4456 series oscilloscope supplies a powerful set of serial protocol analysis tools, which support auto trigger and analysis of many buses like I2C, SPI, CAN, LIN, FlexRay, RS232, USB, Audio and 1553, provide serial bus test solutions of embedded, auto, computer, audio and other serial protocols. Based on FPGA hardware decoding technique, the 4456 series oscilloscope improves the acquisition probability of random serial communication error codes.

Table 11.1 Protocol Analysis

Protocol Analysis	Decode channel	1
	Display format	Binary, hexadecimal
	Display	Bus, digital, event list with time scale information.
	I2C (option S04)	Signal rate: ≤ 10 Mbps Protocol type: 7 digits/10 digits address
	RS232 (option S05)	Signal rate: 50bps~2Mbps
	SPI (option S06)	Signal rate: ≤ 10 Mbps
	CAN (option S07)	Signal rate: 10kbps~1Mbps
	LIN (option S08)	Signal rate: 800bps~100kbps Protocol standard: 1.x, 2.x
	FlexRay (option S09)	Signal rate: 2.5Mbps、 5Mbps、 10Mbps
	Audio (option S10)	Signal rate: ≤ 10 Mbps Protocol standard: I2S, LJ, RJ, TDM
	USB (option S11)	Signal rate: Low speed 1.5 Mbps, full speed 12 Mbps
	1553 (option S12)	Signal rate: 1Mbps

11.1 I2C trigger and analysis

The I2C bus includes SCLK (clock) and SDA (data) lines. The I2C bus frame structure is composed of start, address, data, ACK and stop, which can be triggered on start, repeat start, stop, ACK loss, address, data, address and data.

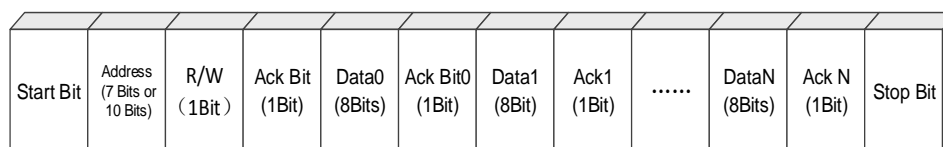


Fig. 11.1 I2C Frame Format

11.1.1 I2C bus setting

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen:

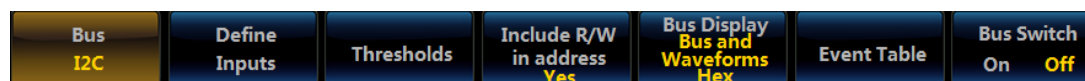


Fig. 11.2 Bus Setup Menu

Click [Bus] menu key, and the Bus Type selection menu will pop up on the right side of the screen:

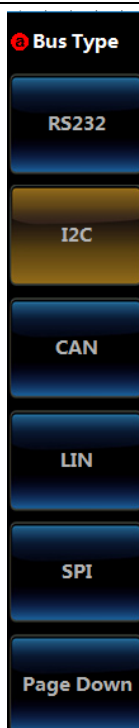


Fig. 11.3 Bus Type Setup Menu

Click [I2C] menu key and select the I2C bus type, and it will be switched to the I2C Bus setup menu at the bottom of the screen:

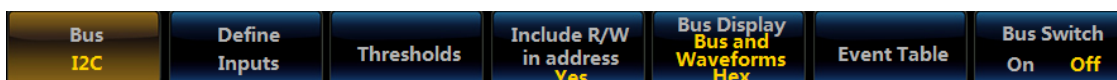


Fig. 11.4 I2C Bus Setup Menu

Define inputs setup

Click [Define Inputs] menu key, and the I2C Inputs setup menu will pop up on the right side of the screen:



Fig. 11.5 I2C Define Inputs Setup Menu

Click [SCLK Input] menu key, and the SCLK Input Selection Level3 Menu will pop up on the left side of the menu:

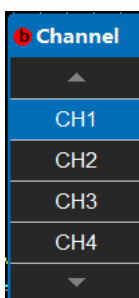


Fig. 11.6 I2C Define SCLK Input Setup Menu

Rotate the Multipurpose b to select the channel, and then press it down to confirm Select, or directly click the corresponding channel to select Select. The selected channel will be displayed on the menu item on the right side.

Click [SDA Input] menu key, and the SDA Input Selection Level3 Menu will pop up on the left side of the menu:

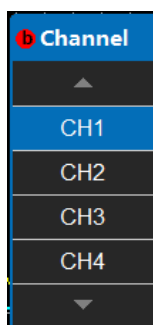


Fig. 11.7 I2C Define SDA Input Setup Menu

Rotate the Multipurpose b to select the channel, and then press it down to confirm Select, or directly click the corresponding channel to select Select. The selected channel will be displayed on the menu item on the right side.

Threshold setup

Click [Thresholds] menu key, and the I2C Channel Threshold setup menu will pop up on the right side of the screen:

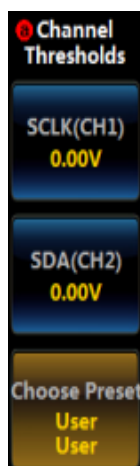


Fig. 11.8 I2C Threshold Setup Menu

Click [SCLK] menu key, and then rotate the Multipurpose b to set the threshold of the SCLK input channel;

Click [SDA] menu key, and then rotate the Multipurpose b to set the threshold of the SDA input channel;

Click [Choose Preset] menu key, and the Choose Preset Type Selection Level3 Menu will pop up on the left side of the menu:

Family	SCLK	SDA
User	0.00V	0.00V
TTL	1.4V	1.4V
5.0V CMOS	2.5V	2.5V
3.3V CMOS	1.65V	1.65V
2.5V CMOS	1.25V	1.25V
ECL	-1.3V	-1.3V
PECL	3.7V	3.7V
0V	0V	0V

Fig. 11.9 I2C Choose Preset Type Selection Level3 Menu

Rotate the Multipurpose b to select the preset threshold, and then press it down to confirm or directly click the corresponding type on the screen to select it.

Attention: When the channel threshold preset type is set to the User, click [Thresholds] menu key, and then rotate the Multipurpose b to change the threshold. When selecting other preset type, the corresponding threshold will be displayed on the menu key. If the type of threshold is greater/smaller than the max./min. threshold under this range, the max./min. threshold will be displayed. If the preset type is not set to the User, click [Thresholds] menu key. When rotating the Multipurpose b to change the threshold, the preset type will be changed to the User.

Include R/W in address

Click [Include R/W in address] menu key, and the Include R/W in address setup menu will pop up on the right side of the screen:

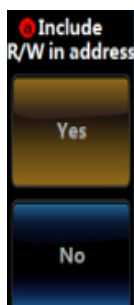


Fig. 11.10 Include R/W in address Menu

Click [Yes] or [No] menu key to set Whether R/W is Included in I2C Address.

Bus display setup

Click [Bus Display] menu key, and the I2C Bus Display selection menu will pop up on the right side of the screen:



Fig. 11.11 I2C Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up on the left side of the menu:

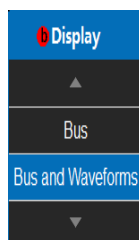


Fig. 11.12 I2C Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] menu key, and the Number Format Setup Level3 Menu will pop up on the left side of the menu:

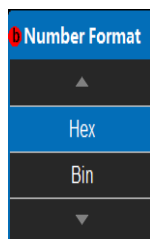


Fig. 11.13 I2C Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] menu key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] menu key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area;

Attention: The Waveforms Offset button will be displayed when the display mode is Bus and Waveforms.

Event table setup

Click [Event Table] menu key at the bottom of the screen, and the Event Table setup menu will pop up on the right side of the screen:

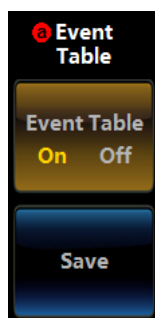


Fig. 11.14 I2C Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] menu key, and save the event table information.

Bus switch setting

Click [Bus Switch] menu key at the bottom of the screen, and enable or disable the bus decoding function.

11.1.2 I2C trigger setup

Press down 【Trigger】 key in the Function Area on the front panel, and the Trigger setup menu will pop up on the lower screen:



Fig. 11.15 Trigger Setup Menu

Click [Type] menu key, and the Type selection menu will pop up on the right side of the screen:



Fig. 11.16 Trigger Type Selection Menu

Click [Bus] menu key and select the protocol trigger type, and the protocol trigger setup menu will be displayed at the bottom of the screen:



Fig. 11.17 Trigger Type Setup Menu

Attention: When the bus decoding type is I2C and it is switched to protocol trigger, the protocol trigger menu will automatically switch to the I2C trigger setup menu.

I2C trigger type setup

Click [Trigger On] menu key at the bottom of the screen, and the I2C Trigger Type setup menu will pop up on the right side of the screen:

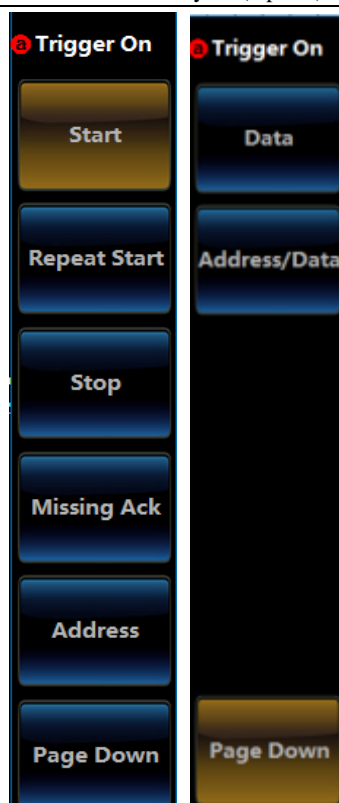


Fig. 11.18 I2C Trigger Type Setup Menu

Click [Start] menu key, and the I2C trigger type will be set to Start;

Click [Repeat Start] menu key, and the I2C trigger type will be set to Repeat Start;

Click [Stop] menu key, and the I2C trigger type will be set to Stop;

Click [Missing Ack] menu key, and the I2C trigger type will be set to Missing Ack;

Click [Address] menu key and set the I2C trigger type to Address, and the menu at the bottom of the screen will be switched to the Trigger Address setup menu:

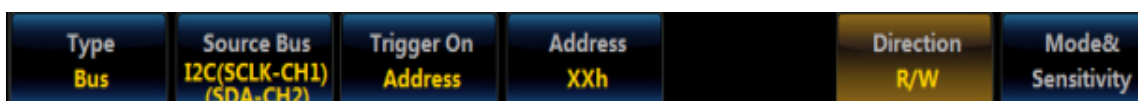


Fig. 11.19 Trigger Address Setup Menu

Click [Address] menu key, and the Address setup menu will pop up on the right side of the screen:

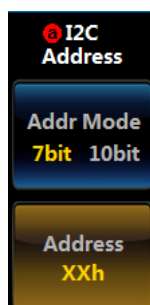


Fig. 11.20 Trigger Address Setup Menu

Click [Addr Mode] menu key, and switch the Addr Mode to 7bit or 10bit;

Click [Address] menu key, and the Address setting numeric keypad will pop up on the left side of the menu:



Fig. 11.21 Numeric Keypad

Set the address value through buttons on the soft keyboard or Multipurpose a and Multipurpose b.

Click [Direction] menu key, and the I2C Direction setup menu will pop up on the right side of the screen:



Fig. 11.22 I2C Input Direction Setup Menu

Click [Read], [Write] or [R/W] menu key to set the I2C direction to Read, Write or R/W.

Click [Data] menu key and set the I2C trigger type to Data, and the menu at the bottom of the screen will be switched to the Data Trigger Type setup menu:



Fig. 11.23 Trigger Type Setup Menu

Click [Data] menu key, and the Data setup menu will pop up on the right side of the screen:

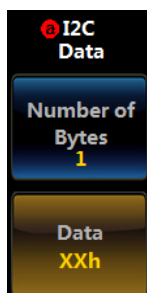


Fig. 11.24 Data Trigger Setup Menu

Click [Number of Bytes] menu key, and then rotate the Multipurpose b to set the triggered Number of Bytes.

Click [Data] menu key, and the numeric keypad will pop up on the left side of the menu for trigger data setup:



Fig. 11.25 Numeric Keypad

Set the data value through keys on the soft keyboard or Multipurpose a and Multipurpose b.

Click [Address/Data] menu key and set the I2C trigger type to Address/Data, and the menu at the bottom of the screen will be switched to the Address/Data Trigger Type setup menu:

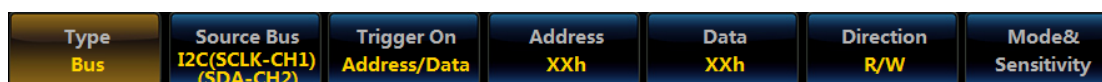


Fig. 11.26 Address/Data Trigger Setup Menu

For specific operations, refer to address trigger type and data trigger type respectively.



Fig. 11.27 I2C Trigger and Analysis Example

11.2 RS232/RS422/RS485/UART trigger and analysis

The RS232 protocol analyzer option can analyze the RS232, RS422, RS485 and UART buses. When the user selects RS232 bus, the input polarity will be set to Normal. When the user selects RS422 bus, RS485 bus or UART bus, the input polarity will be set to Inverted. The RS232 bus is made as an example to introduce the bus option hereinafter.

The RS232 bus is composed of sending data line (Tx) and receiving data line (Rx). Each frame of data is composed of Start Bit, Data Bit, Check Bit and Stop Bit, which will be triggered on Tx start bit, Rx start bit, Tx end of packet, Rx end of packet, Tx data, Rx data, Tx parity error, and Rx parity error.

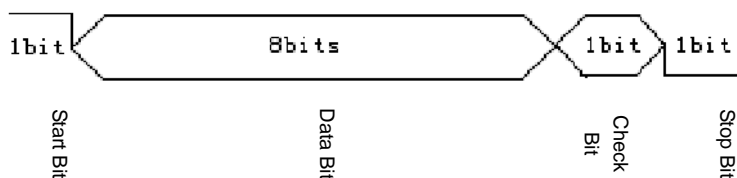


Fig. 11.28 RS232 Frame Format

11.2.1 RS232 bus setting

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen:



Fig. 11.29 Bus Setup Menu

Click [Bus] menu key, and the Bus Type selection menu will pop up on the right side of the screen:

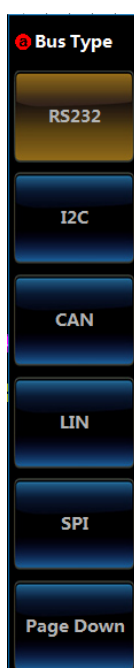


Fig. 11.30 Bus Type Setup Menu

Click [RS232] key and select the RS232 bus type, and the RS232 Bus setup menu will be displayed at the bottom of the screen:



Fig. 11.31 RS232 Level1 Setup Menu

Define inputs

Click [Define Inputs] key, and the RS232 Input Level2 Menu will pop up, and then set the Tx input and Rx input channel as well as polarity.

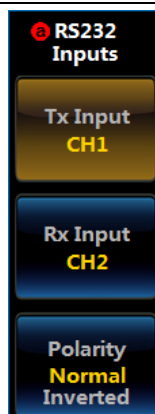


Fig. 11.32 RS232 Level2 Setup Menu

Click [Tx Input] key, select any channel (CH1 ~ CH4) in the popup Level3 Menu as the Tx channel. If “Off” is selected, it means that no Tx channel will be set.

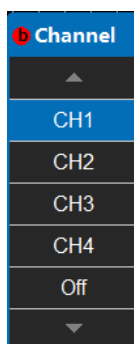


Fig. 11.33 RS232 Channel Setup Menu

Click [Rx Input] key, select any channel (CH1 ~ CH4) in the popup Level3 Menu as the receiving channel. If “Off” is selected, it means that no Rx channel will be set.

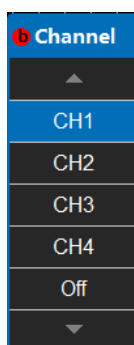


Fig. 11.34 RS232 Channel Setup Menu

Click [Polarity] key, and select Normal or Inverted. Normal means that the high level is logic “0” and the low level is logic “1”; Inverted means that the high level is logic “1” and the low level is logic “0”.

Thresholds

Click [Thresholds] key to pop up the Channel Threshold Level2 Menu, set the Tx and Rx thresholds, rotate the Multipurpose b to change the threshold, or select the preset threshold through the preset button.

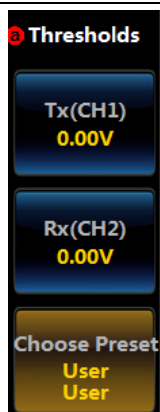


Fig. 11.35 Thresholds Setup Menu

Click [Tx] key, rotate the Multipurpose b, and adjust thresholds of the Tx channel.

Click [Rx] key, rotate the Multipurpose b, and adjust thresholds of the Rx channel.

Click [Choose Preset] key, select the preset thresholds in the popup Level3 Menu, and adjust thresholds of the Tx and Rx channels.

Family	Tx	Rx
▲		
User	0.00V	0.00V
TTL	1.4v	1.4v
5.0VCMOS	2.5v	2.5v
3.3VCMOS	1.65v	1.65v
2.5VCMOS	1.25v	1.25v
ECL	-1.3v	-1.3v
PECL	3.7v	3.7v
0v	0v	0v
▼		

Fig. 11.36 Choose Preset Setup Menu

Config

Click [Configure] menu to pop up the Level2 Configuration Menu of the RS232.

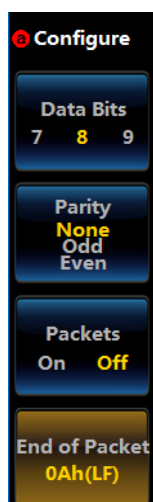


Fig. 11.37 Configure Setup Menu

Click [Data Bits] key and select the Data Bits. It can be set to 7, 8, 9, which is set to 8 by default. The Data Bit

width represents the number of actual data bits of each frame of data.

Click [Parity] key to select Parity. It is set to None by default. Odd: The number of “1” in Data Bits and Check Bits and bit odd. Even: The number of “1” in Data Bits and Check Bits and bit even. None: There is no Check Bit during transmission.

Click [Packets] key to turn on or turn off the End of Packet character during data transmission. When the End of Packet is turned on, several data blocks will be combined accordingly.

Click [End of Packet] key, and set the End of Packet character during data transmission, which can be set to 00 (NULL), 0A (LF), 0D (CR), 20 (SP), FF.

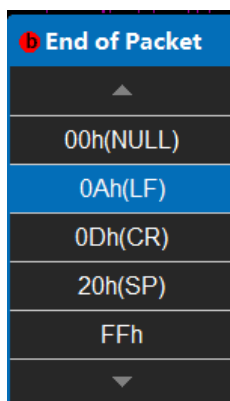


Fig. 11.38 End of Packet Character Setup Menu

Bit Rate

Click [Bit Rate] menu to pop up the Level2 Bit Rate Menu of the RS232.

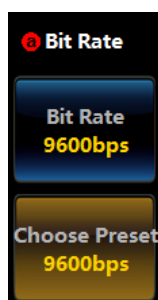


Fig. 11.39 Bit Rate Setup Menu

Click [Bit Rate] key, and the digital keyboard will pop up. Enter the Bit Rate directly, or rotate the Multipurpose b to set the RS232 Bit Rate.



Fig. 11.40 Numeric Keypad

Click [Choose Preset] key, and the Level3 Bit Rate Choose Preset Menu will pop up.

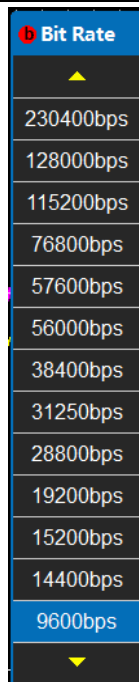


Fig. 11.41 Bit Rate Setup Menu

Rotate the Multipurpose b to select the corresponding Bit Rate, and then press it down to confirm Select, or directly click the corresponding option to select the Bit Rate.

Bus display setup

Click [Bus Display] key, and the Bus Display menu will pop up on the right side of the screen.



Fig. 11.42 Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up:

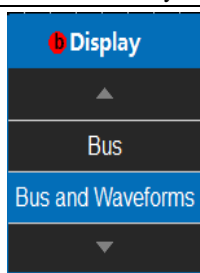


Fig. 11.43 Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] key, and the Number Format Setup Level3 Menu will pop up:

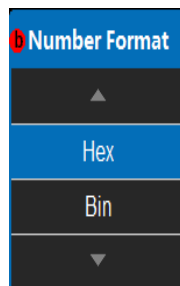


Fig. 11.44 Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area;

Event table setup

Click [Event Table] key, and the Event Table setup menu will pop up on the right side of the screen:

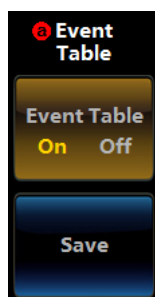


Fig. 11.45 Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] key, and save the event table information.

Bus switch setting

Click [Bus Switch] key, and enable or disable the bus decoding function.

11.2.2 RS232 trigger setup

The RS232 can be triggered according to the Start Bit, End of Packet, Data and Check Error.

Press down **【Trigger】** key on the front panel to pop up the Trigger Level1 Menu; click [Type] key to pop up the Trigger Level2 Menu, and click [Bus] key to pop up the RS232 Trigger Level1 Menu. Click [Trigger On] key, pop up the Trigger Level2 Menu, and select the type.



Fig. 11.46 Trigger Setup Menu

Tx/Rx Start Bit

Click [Tx Start Bit] key or [Rx Start Bit] key, and select the Tx or Rx Start Bit trigger.

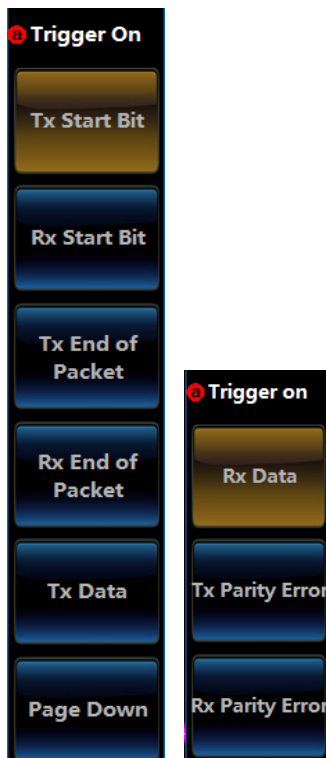


Fig. 11.47 Trigger When Setup Menu

Tx/Rx End of Packet

Click [Tx End of Packet] key or [Rx End of Packet] key, and select the Tx/Rx End of Packet trigger.

Tx/Rx Data

Click [Tx Data] key or [Rx Data] key, and select the Tx/Rx Data trigger.



Fig. 11.48 Data Setup Menu

Click [Data] key, pop up the Tx or Rx Data Input Level2 Menu, and set the number of bytes and data of the input data.



Fig. 11.49 Data Input Setup Menu

Click [Number of Bytes] key, and rotate the Multipurpose b to select number of bytes of the input data. The selection scope is 1 ~ 8, and it can be set to 1 by default.

Click [Tx Data] key or [Rx Data] key, pop up the data input keyboard, and input data.



Fig. 11.50 Numeric Keypad

Tx/Rx Parity Error

Click [Tx Parity Error] key or [Rx Parity Error] key, and select the Tx/Rx Parity Error trigger.

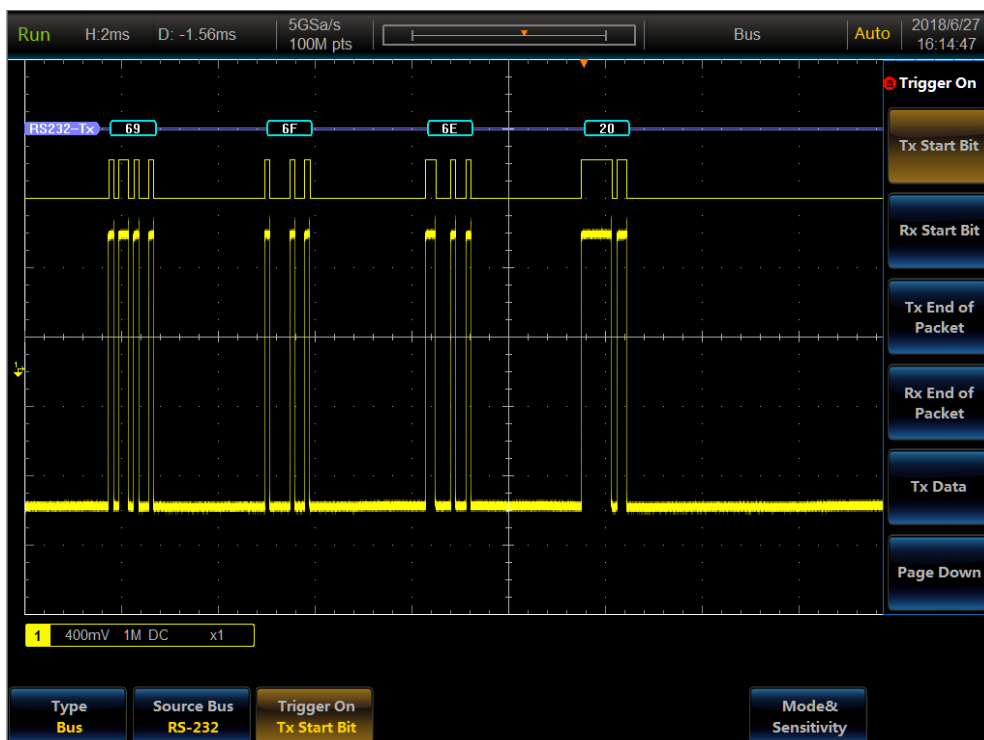


Fig. 11.51 RS232 Trigger and Analysis Example

11.3 SPI protocol trigger and analysis

The SPI bus is composed of the SS (chip select line), SCLK (clock line), MOSI (slave input/host output data line) and MISO (host input/slave output data line), which can be triggered on SS Active, MOSI, MISO, MOSI and MISO.

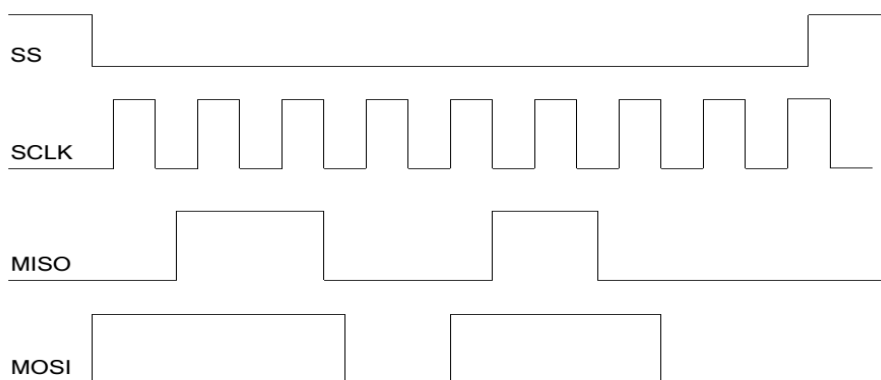


Fig. 11.52 SPI Bus Sequence Chart

11.3.1 SPI bus setting

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen:

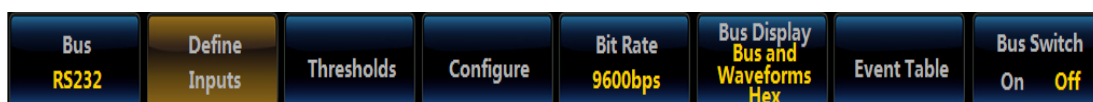


Fig. 11.53 Bus Setup Menu

Click [Bus] menu key, and the Bus Type selection menu will pop up on the right side of the screen:

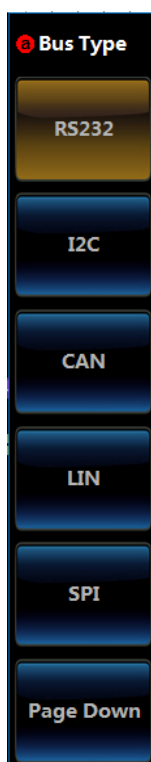


Fig. 11.54 Bus Type Setup Menu

Click [SPI] key and select the SPI bus type, and it will be switched to the SPI Bus setup menu at the bottom of the screen:



Fig. 11.55 SPI Bus Level1 Menu

Define inputs

Click [Define Inputs] key of the SPI Bus Setup Level1 Menu, and the SPI Input Level2 Menu will pop up, and then set SCLK, SS, MOSI, MISO channels.

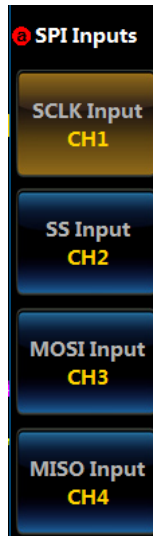


Fig. 11.56 SPI Define Inputs Menu

Click [SCLK Input] key, and select any channel (CH1 ~ CH4) in the popup Level3 Menu as the SCLK channel.

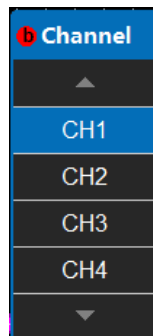


Fig. 11.57 SPI Channel Setup Menu

Click [SS Input] key, and select any channel (CH1 ~ CH4) in the popup Level3 Menu as the SS channel.

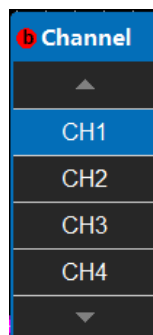


Fig. 11.58 SPI Channel Setup Menu

Click [MOSI Input] key, select any channel (CH1 ~ CH4) in the popup Level3 Menu as the MOSI channel. If “Off” is selected, it means that no MOSI channel will be set.

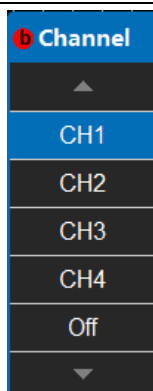


Fig. 11.59 SPI Channel Setup Menu

Click [MISO Input] key, select any channel (CH1 ~ CH4) in the popup Level3 Menu as the MOSI channel. If “Off” is selected, it means that no MISO channel will be set.



Fig. 11.60 SPI Channel Setup Menu

Thresholds

Click [Thresholds] key to pop up the Channel Threshold Level2 Menu, set the SCLK, SS, MOSI and MISO thresholds. Firstly, select the channel, rotate the Multipurpose b on the front panel to change the threshold of the corresponding channel, or select the preset threshold through the preset button.

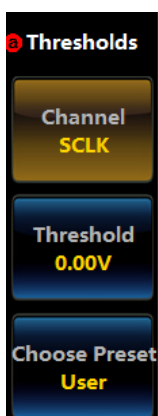


Fig. 11.61 SPI Define Inputs Menu

Click [Channel] key, select SCLK in the popup Level2 Menu, click [Thresholds] key, rotate the Multipurpose b, and adjust thresholds of the SCLK channel.

Channel	Threshold
SCLK	0.00V
SS	0.00V
MOSI	0.00V
MISO	0.00V

Fig. 11.62 SPI Channel Setup Menu

Click [Channel] key, select SS in the popup Level2 Menu, click [Thresholds] key, rotate the Multipurpose b, and adjust thresholds of the SS channel.

Click [Channel] key, select MOSI in the popup Level2 Menu, click [Thresholds] key, rotate the Multipurpose b, and adjust thresholds of the MOSI channel.

Click [Channel] key, select MISO in the popup Level2 Menu, click [Thresholds] key, rotate the Multipurpose b, and adjust thresholds of the MISO channel.

Click [Choose Preset] key, select the proper thresholds in the popup Level3 Menu, and adjust thresholds of the SCLK, SS, MOSI and MISO channels.

Family	Value
User	0.00V
TLL	1.4V
5.0V CMOS	2.5V
3.3V CMOS	1.65V
2.5V CMOS	1.25V
ECL	-1.3V
PECL	3.7V
0V	0V

Fig. 11.63 SPI Choose Preset Setup Menu

Config

Click [Configure] menu to pop up the SPI Configuration Level2 Menu for bus configuration.

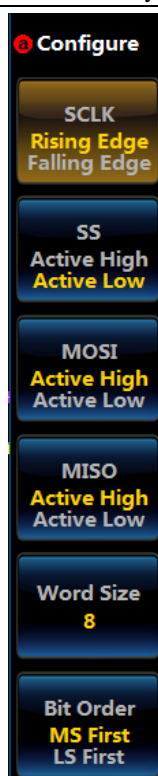


Fig. 11.64 SPI Config Menu

Click [SCLK] key, select the rise or fall edge from the SCLK edge type, and set MOSI and MISO sampling on the SCLK rise or fall edge.

Click [SS Level] key to select Active High or Active Low, and set SS to be valid at Active High or Active Low.

Click [MOSI Level] key to select Active High or Active Low, and set the MOSI data line polarity bit to Active High (Active High is 1) or Active Low (Active Low is 1).

Click [MISO Level] key to select Active High or Active Low, and set the MISO data line polarity bit to Active High (Active High is 1) or Active Low (Active Low is 1).

Click [Word Size] key, and rotate the Multipurpose b to set the word size. The value range is 4 ~ 32, and it can be set to 8 by default. The Word Size represents the bit number of each frame of data.

Click [Bit Order] key, set the transmission sequence to LS First (the low data bit will be transmitted first) or MS First (the high data bit will be transmitted first), which will be set to LS First by default.

Bus display setup

Click [Bus Display] key, and the Bus Display menu will pop up on the right side of the screen.



Fig. 11.65 Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up:

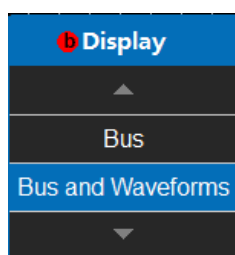


Fig. 11.66 Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] key, and the Number Format Setup Level3 Menu will pop up:

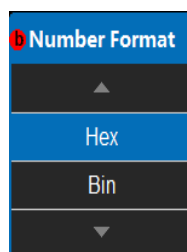


Fig. 11.67 Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area.

Event table setup

Click [Event Table] key, and the Event Table setup menu will pop up on the right side of the screen:

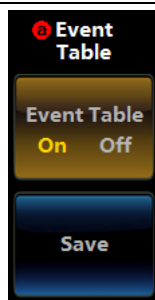


Fig. 11.68 Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] key, and save the event table information.

Bus switch setting

Click [Bus Switch] key, and enable or disable the bus decoding function.

11.3.2 SPI trigger setup

The SPI can be triggered according to the SS Active, MOSI, MISO, MOSI and MISO.

Press down **【Trigger】** key on the front panel to pop up the Trigger Level1 Menu; click [Type] key to pop up the Trigger Level2 Menu, and click [Bus] key to pop up the SPI Trigger Level1 Menu. Click [Trigger On] key, pop up the Trigger Level2 Menu, and select the type.

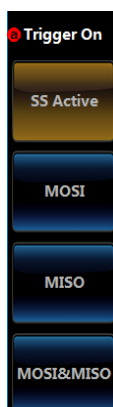


Fig. 11.69 SPI Trigger When Setup Menu

SS Active

Click [SS Active] key, and select SS Active trigger.

MOSI

Click [MOSI] key, and select MOSIData trigger.

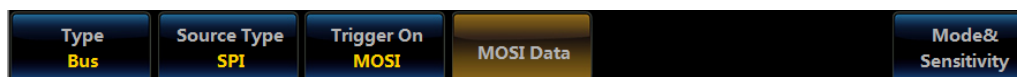


Fig. 11.70 SPI Trigger Menu

Click [MOSI Data] key, pop up the SPI Data Level2 Menu, and set the number of bytes and data of the input data.

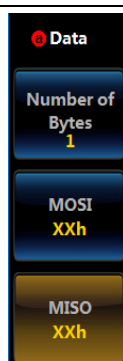


Fig. 11.71 SPI Data Trigger When Setup Menu

Click [Number of Bytes] key, and rotate the Multipurpose b to select number of bytes of the input data. It will be set to 1 by default.

Click [MOSI Data] key, and input data by opening the data input keyboard.

MISO

Click [MISO] key, and select MISO data trigger. Click [MISO Data] key, open the SPI Data Level2 Menu, and set the number of bytes and data of the input data.

Click [Number of Bytes] key, and rotate the Multipurpose b to select number of bytes of the input data. It will be set to 1 by default.

Click [MISO Data] key, and input data by opening the data input keyboard.

MOSI&MISO

Click [MOSI&MISO] key, and select MOSI&MISO data trigger. Click [Data] key, open the SPI Data Level2 Menu, and set the number of bytes and data of the input data.

Click [Number of Bytes] key, and rotate the Multipurpose b to select number of bytes of the input data. It will be set to 1 by default.

Click [MISO Data] key, and input data by opening the MISO data input keyboard.

Click [MOSI Data] key, and input data by opening the MOSI data input keyboard.

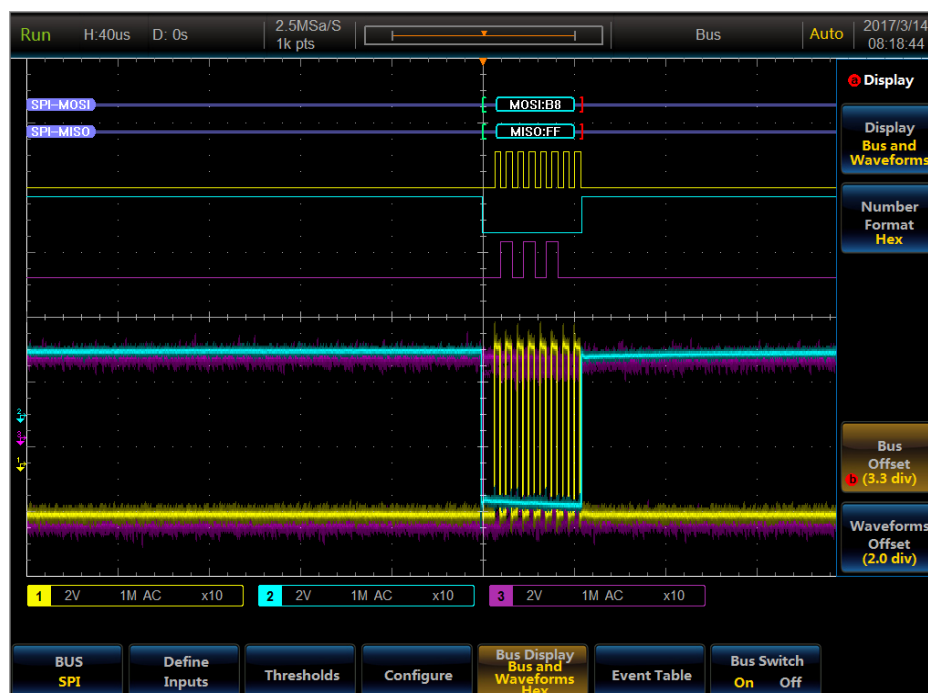


Fig. 11.72 SPI Trigger and Analysis Example

11.4 CAN trigger and analysis

The CAN bus Tx frame structure includes the SOF, arbitration field, control field, data field, CRC field, ACK, EOF and INT, which can be triggered on start of frame, frame type, identifier, data, identifier and data, end of frame, missing ACK, or bit stuffing error.

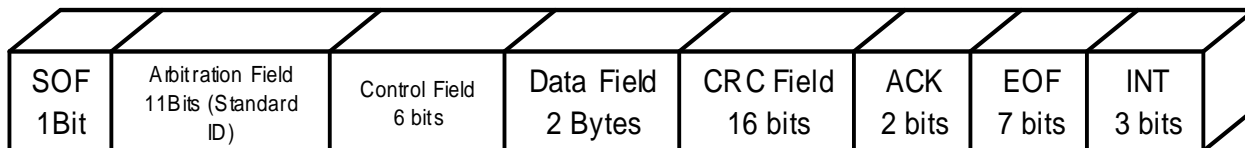


Fig. 11.73 CAN Bus Frame Format

11.4.1 CAN bus setup

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen. (Refer to the I2C bus) As shown in the figure, click [Bus] menu key, and the Type selection menu will pop up on the right side of the screen. (Refer to the I2C bus) As shown in the figure, click [CAN] menu key and select the CAN bus type, and the CAN Bus setup menu will be displayed at the bottom of the screen:

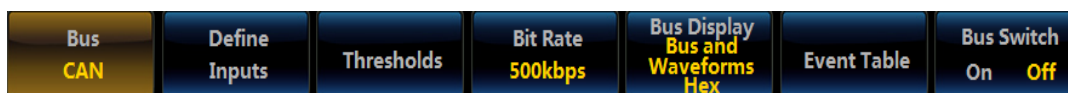


Fig. 11.74 CAN Level1 Setup Menu

Define inputs setup

Click [Define Inputs] menu key, and the CAN Input setup menu will pop up on the right side of the screen:

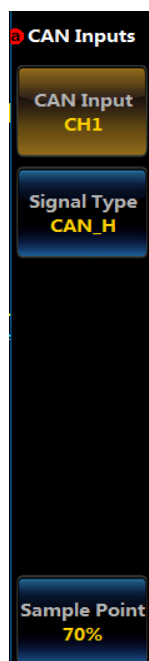


Fig. 11.75 CAN Define Inputs Setup Menu

Click [CAN Input] menu key, and the CAN Input Selection Level3 Menu will pop up on the left side of the menu:

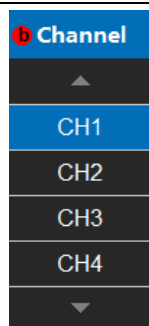


Fig. 11.76 CAN Input Setup Menu

Rotate the Multipurpose b to select the channel, and then press it down to confirm Select, or directly click the corresponding channel to select Select.

The selected channel will be displayed on the menu item on the right side.

Click [Signal Type] menu key, and the Signal Type Selection Level3 Menu will pop up on the left side of the menu:

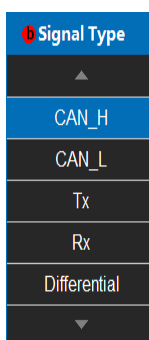


Fig. 11.77 CAN Signal Type Setup Menu

Rotate the Multipurpose b to select the channel, and then press it down to confirm Select, or directly click the corresponding signal type on the screen to select Select. The selected signal type will be displayed on the menu item on the right side.

The CAN bus signal type includes types including the CAN_L, CAN_H, Tx, Rx and differential. When the differential signal is connected, the positive pole and negative pole of the differential probe will be connected to CAN_H bus signal and CAN_L bus signal respectively.

Click [Sample Point] menu key, and then rotate the Multipurpose b to change position of the Sample Point. The settable scope of the Sample Point is 15% ~ 85%.

Threshold setup

Click [Thresholds] menu key, and the CAN Channel Threshold setup menu will pop up on the right side of the screen:

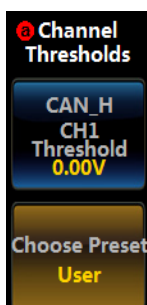


Fig. 11.78 CAN Threshold Setup Menu

Click [Thresholds] menu key, and then rotate the Multipurpose b to set the threshold of the CAN input channel;

Click [Choose Preset] menu key, and the Choose Preset Type Selection Level3 Menu will pop up on the left side of the menu:

Family	Value
User	0.00V
CAN_L	1.4V
CAN_H	2.8V
Tx	1.65V
Rx	1.65V
Differential	1.0V
0V	0V

Fig. 11.79 CAN Threshold Setup Menu

Rotate the Multipurpose b to select the preset threshold, and then press it down to confirm or directly click the corresponding type on the screen to select it.

Attention: When the channel threshold preset type is set to the User, click [Thresholds] menu key, and then rotate the Multipurpose b to change the threshold. When selecting other preset type, the corresponding threshold will be displayed on [Thresholds] menu key. If the type of threshold is greater/smaller than the max./min. threshold under this range, the max./min. threshold will be displayed. If the preset type is not set to the User, click [Thresholds] menu key. When rotating the Multipurpose b to change the threshold, the preset type will be changed to the User.

Bit Rate setup

Click [Bit Rate] menu key, and the CAN Bit Rate setup menu will pop up on the right side of the screen:

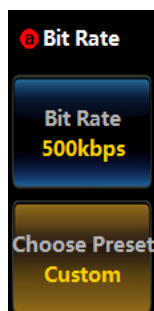


Fig. 11.80 CAN Bit Rate Setup Menu

Click [Bit Rate] menu key, and then rotate the Multipurpose b to set the Bit Rate of the CAN bus, or set it by entering the necessary Bit Rate in the popup Bit Rate setup dialog box on the left side;

Click [Choose Preset] menu key, and the Bit Rate Type selection menu will pop up on the left side of the menu:

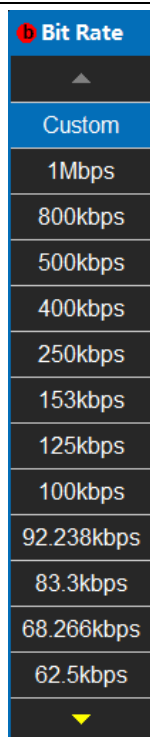


Fig. 11.81 CAN Bit Rate Setup Menu

Rotate the Multipurpose b to select the corresponding type, and then press it down to confirm Select, or directly click the corresponding type on the screen to select the preset type.

Attention: When selecting the custom Bit Rate, click [Bit Rate] menu key, and then rotate the Multipurpose b to change it. When selecting other Bit Rate preset type, the corresponding Bit Rate will be displayed on [Bit Rate] menu key. If the preset type is not custom, click [Bit Rate] menu key, and then rotate the Multipurpose b to change the Bit Rate and change the preset type to custom.

Bus display setup

Click [Bus Display] menu key, and the CAN Bus Display setup menu will pop up on the right side of the screen:



Fig. 11.82 CAN Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up on the left side of the menu:

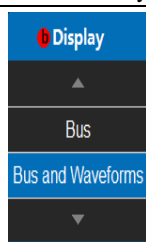


Fig. 11.83 CAN Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] menu key, and the Number Format Setup Level3 Menu will pop up on the left side of the menu:

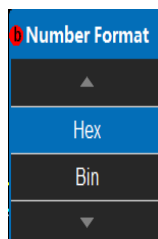


Fig. 11.84 CAN Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] menu key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] menu key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area;

Attention: The Waveforms Offset button will be displayed when the display mode is Bus and Waveforms.

Event table setup

Click [Event Table] menu key at the bottom of the screen, and the Event Table setup menu will pop up on the right side of the screen:

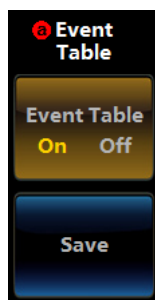


Fig. 11.85 CAN Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] menu key, and save the event table information.

Bus switch setting

Click [Bus Switch] menu key at the bottom of the screen, and enable or disable the bus decoding function.

11.4.2 CAN trigger setup

Press down **【Trigger】** key in the Function Area on the front panel, and the Trigger setup menu will pop up on the lower screen (the menu will be triggered by referring to the I2C). Click [Type] menu key, and the Type selection menu will pop up on the right side of the screen (the menu will be triggered by referring to the I2C). Click [Bus] menu key and select the protocol trigger type, and it will be switched to the Protocol Trigger setup menu at the bottom of the screen:



Fig. 11.86 CAN Level1 Trigger Menu

Attention: When the bus decoding type is CAN and it is switched to protocol trigger, the protocol trigger menu will automatically switch to the CAN Trigger setup menu.

CAN Trigger When setting

Click [Trigger On] menu key at the bottom of the screen, and the CAN Trigger Type setup menu will pop up on the right side of the screen:

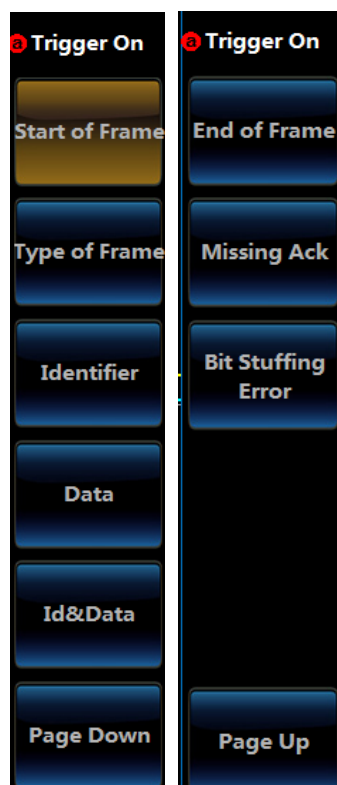


Fig. 11.87 CAN Trigger Type Setup Menu

Click [Start of Frame] menu key, and the CAN trigger type will be set to Start of Frame;

Click [Type of Frame] menu key and set the CAN trigger type to Type of Frame, and the menu at the bottom of the screen will be switched to the Type of Frame setup menu:

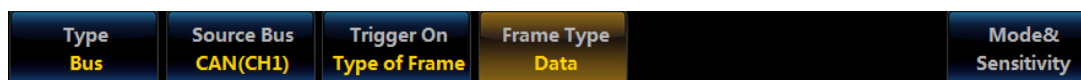


Fig. 11.88 CAN Frame Type Trigger Level1 Menu

Click [Frame Type] menu key, and the Frame Type selection menu will pop up on the right side of the screen:

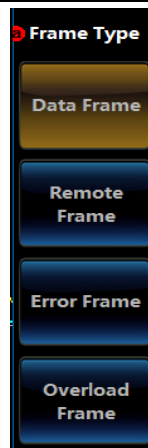


Fig. 11.89 CAN Frame Type Trigger Level2 Menu

Click [Data Frame], [Remote Frame], [Error Frame] and [Overload Frame] keys of the menu to set the Frame Type to Data Frame, Remote Frame, Error Frame and Overload Frame respectively.

Click [Identifier] menu key and set the CAN Trigger type to Identifier, and the menu at the bottom of the screen will be switched to the Identifier setup menu:

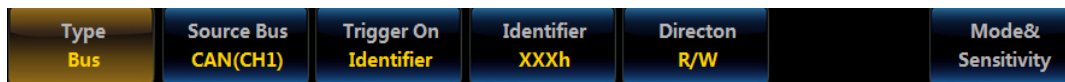


Fig. 11.90 CAN Identifier Trigger Level1 Menu

Click [Identifier] menu key at the bottom of the screen, and the CAN Identifier setup menu will pop up on the right side of the screen:

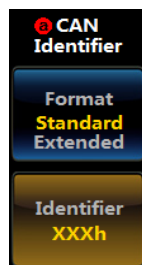


Fig. 11.91 CAN Identifier Trigger Level2 Menu

Click [Format] menu key and set the identifier format to Standard or Extended;

Click [Identifier] menu key, and the Identifier setting numeric keypad will pop up on the left side of the menu:



Fig. 11.92 Numeric Keypad

Set the Identifier through buttons on the soft keyboard or Multipurpose a and Multipurpose b.

Click [Direction] menu key at the bottom of the screen, and the CAN Direction setup menu will pop up on the right side of the screen:



Fig. 11.93 CAN Read-Write Direction Setup Menu

Click [Read], [Write] and [R/W] keys of the menu to set the direction to Read, Write or R/W.

Click [Data] menu key and set the CAN trigger type to Data, and the menu at the bottom of the screen will be switched to the Data Trigger Type setup menu:



Fig. 11.94 CAN Data Trigger Level1 Menu

Click [Data] menu key, and the Data setup menu will pop up on the right side of the screen:

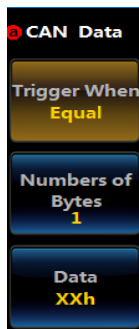


Fig. 11.95 CAN Data Trigger Level2 Menu

Click [Trigger When] menu key, and the Trigger When Setup Level3 Menu will pop up on the left side of the screen:

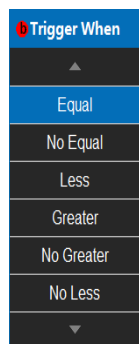


Fig. 11.96 CAN Data Trigger Comparison Condition Menu

Rotate the Multipurpose b to select the corresponding Trigger When, and then press it down to confirm Select, or directly click the corresponding Trigger When setting on the screen.

Click [Number of Bytes] menu key, and then rotate the Multipurpose b to set the triggered Number of Bytes;

Click [Data] menu key, and the Trigger Data numeric keypad will pop up on the left side of the menu:



Fig. 11.97 Numeric Keypad

Set the data value through buttons on the soft keyboard or Multipurpose a and Multipurpose b.

Click [ID/Data] menu key and set the CAN Trigger type to ID/Data, and the menu at the bottom of the screen will be switched to the ID/Data Trigger Type setup menu:

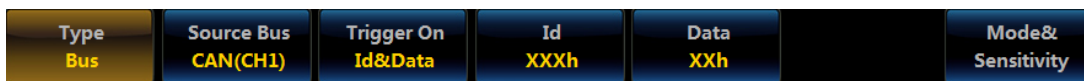


Fig. 11.98 CAN Data Setup Keypad

For specific operations, refer to ID trigger type and data trigger type respectively.

Click [End of Frame] menu key, and the CAN Trigger type will be set to End of Frame;

Click [Missing Ack] menu key, and the CAN Trigger type will be set to Missing Ack;

Click [Bit Stuffing Error] menu key, and the CAN Trigger type will be set to Bit Stuffing Error.



Fig. 11.99 CAN Trigger and Analysis Example

11.5 LIN trigger and analysis

The LIN bus frame is composed of Header, Response space and Response. The Header includes Brake Field, Sync Byte Field and Identifier, and the Response includes Data and Checksum Fields, which can be triggered on synchronization, identifier, data, identifier and data, wakeup frame, sleep frame and error.

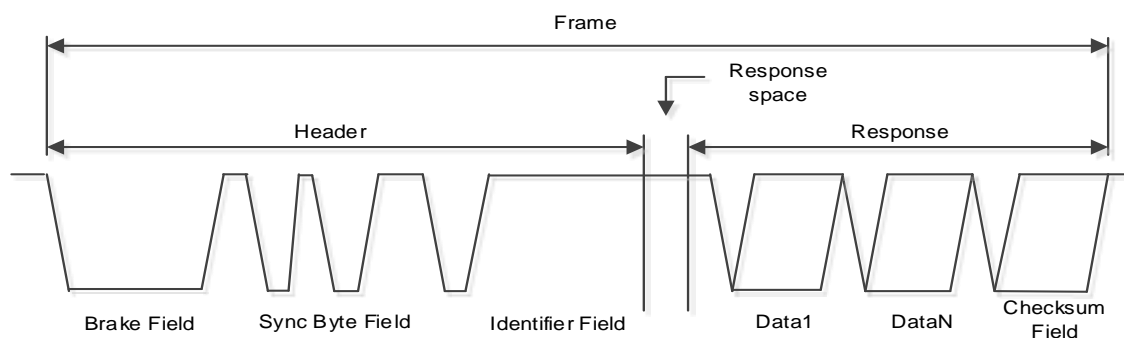


Fig. 11.100 LIN Frame Format

11.5.1 LIN bus setup

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen (the menu will be based on the I2C bus). Click [Bus] menu key, and the Type selection menu will pop up on the right side of the screen (the menu will be based on the I2C bus). Click [LIN] menu key and select the LIN bus type, and it will be switched to the LIN Bus setup menu at the bottom of the screen:

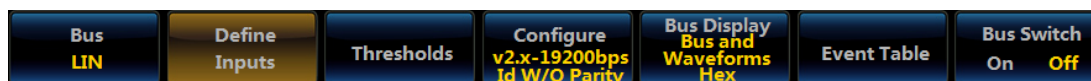


Fig. 11.101 LIN Bus Setup Level1 Menu

Define inputs setup

Click [Define Inputs] menu key, and the LIN Input setup menu will pop up on the right side of the screen:

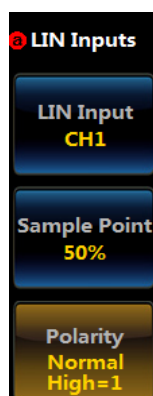


Fig. 11.102 LIN Input Setup Menu

Click [LIN Input] menu key, and the LIN Input Selection Level3 Menu will pop up on the left side of the menu:

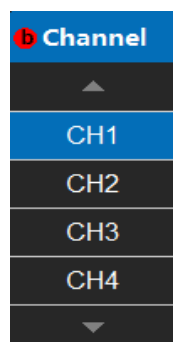


Fig. 11.103 LIN Input Channel Setup Menu

Rotate the Multipurpose b to select the channel, and then press it down to confirm Select, or directly click the corresponding channel on the screen to select Select. The selected channel will be displayed on the menu item on the right side.

Click [Sample Point] menu key, and then rotate the Multipurpose b to change position of the Sample Point. The settable scope of the Sample Point is 5% ~ 95%;

Click [Polarity] menu key, and the Polarity Setup Level3 Menu will pop up on the left side of the menu:

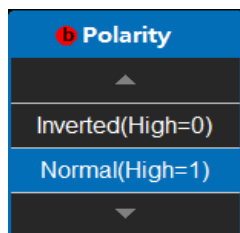


Fig. 11.104 LIN Input Polarity Setup Menu

Rotate the Multipurpose b to select the polarity, and then press it down to confirm Select, or directly click the corresponding polarity on the screen to select Select. The selected polarity will be displayed on the menu item on the right side.

Threshold setup

Click [Thresholds] menu key, and the LIN Channel Threshold setup menu will pop up on the right side of the screen:

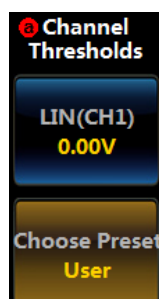


Fig. 11.105 LIN Thresholds Setup Menu

Click [LIN (Channel)] menu key, and then rotate the Multipurpose b to set the threshold of the LIN input channel;
Click [Choose Preset] menu key, and the Choose Preset Type Selection Level3 Menu will pop up on the left side of the menu:

Channel Thresholds	
User	0.00V
TTL	1.4V
5V CMOS	2.5V
7V	3.5V
10V	5.0V
14V	7.0V
0V	0V

Fig. 11.106 LIN Channel Thresholds Choose Preset Menu

Rotate the Multipurpose b to select the preset threshold, and then press it down to confirm or directly click the corresponding type on the screen to select it.

Attention: When the channel threshold preset type is set to the User, click [Thresholds] menu key, and then rotate the Multipurpose b to change the threshold. When selecting other preset type, the corresponding threshold will be displayed on [Thresholds] menu key. If the type of threshold is greater/smaller than the max./min. threshold under this range, the max./min. threshold will be displayed. If the preset type is not set to the User, click [Thresholds] menu key. When rotating the Multipurpose b to change the threshold, the preset type will be changed to the User.

Configure setup

Click [Configure] menu key, and the LIN Configure setup menu will pop up on the right side of the screen:

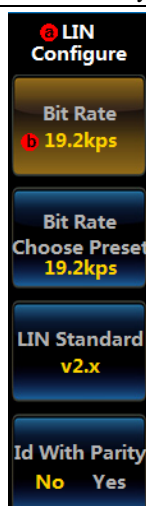


Fig. 11.107 LIN Configure Setup Level2 Menu

Click [Bit Rate] menu key, and then rotate the Multipurpose b to set the LIN bus bit rate;

Click [Choose Preset] menu key, and the Bit Rate Choose Preset menu will pop up on the left side of the menu:

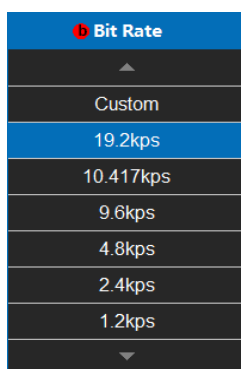


Fig. 11.108 LIN Bit Rate Setup Menu

Rotate the Multipurpose b to select the corresponding type, and then press it down to confirm Select, or directly click the corresponding type on the screen to select the preset type.

Attention: When selecting the custom Bit Rate, click [Bit Rate] menu key, and then rotate the Multipurpose b to change it. When selecting other Bit Rate preset type, the corresponding Bit Rate will be displayed on [Bit Rate] menu key. If the preset type is not custom, click [Bit Rate] menu key, and then rotate the Multipurpose b to change the Bit Rate and change the preset type to custom.

Click [LIN Standard] menu key, and the LIN Standard Setup Menu will pop up on the left side of the menu:

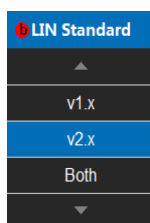


Fig. 11.109 LIN Standard Setup Menu

Rotate the Multipurpose b to select the corresponding type, and then press it down to confirm Select, or directly click the corresponding type on the screen to select the standard type.

Click [Id with Parity] menu key, and the switch it to Yes or No.

Bus display setup

Click [Bus Display] menu key, and the LIN Bus Display setup menu will pop up on the right side of the screen:



Fig. 11.110 LIN Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up on the left side of the menu:

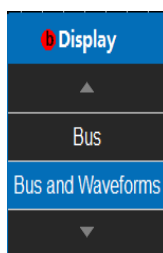


Fig. 11.111 LIN Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] menu key, and the Number Format Setup Level3 Menu will pop up on the left side of the menu:

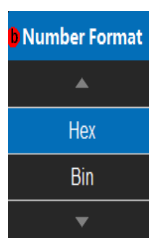


Fig. 11.112 LIN Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] menu key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] menu key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area;

Attention: The Waveforms Offset button will be displayed when the display mode is Bus and Waveforms.

Event table setup

Click [Event Table] menu key at the bottom of the screen, and the Event Table setup menu will pop up on the right side of the screen:

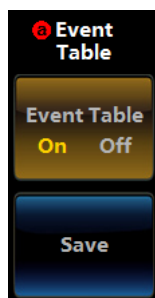


Fig. 11.113 LIN Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] menu key, and save the event table information.

Bus switch setting

Click [Bus Switch] menu key at the bottom of the screen, and enable or disable the bus decoding function.

11.5.2 LIN trigger setup

Press down **【Trigger】** key in the Function Area on the front panel, and the Trigger setup menu will pop up on the lower screen (the menu will be triggered by referring to the I2C). Click [Type] menu key, and the Type selection menu will pop up on the right side of the screen (the menu will be triggered by referring to the I2C). Click [Bus] menu key and select the bus trigger type, and it will be switched to the Bus Trigger setup menu at the bottom of the screen:



Fig. 11.114 LIN Trigger Level1 Menu

Attention: When the bus decoding type is LIN and it is switched to protocol trigger, the protocol trigger menu will automatically switch to the LIN Trigger setup menu.

LIN trigger type setup

Click [Trigger On] menu key at the bottom of the screen, and the LIN Trigger Type setup menu will pop up on the right side of the screen:



Fig. 11.115 LIN Trigger Type Selection Menu

Click [Sync] menu key, and the LIN Trigger type will be set to Sync;

Click [Identifier] menu key and set the LIN Trigger type to Identifier, and the menu at the bottom of the screen will be switched to the Identifier setup menu:



Fig. 11.116 LIN Identifier Trigger Level1 Menu

Click [Identifier] menu key at the bottom of the screen, and the LIN Identifier setup menu will pop up on the right side of the screen:



Fig. 11.117 LIN Identifier Setup Menu

Click [Identifier] menu key, and the Identifier setting numeric keypad will pop up on the left side of the menu:



Fig. 11.118 Numeric Keypad

Set the Identifier through buttons on the numeric keypad or Multipurpose a and Multipurpose b.

Click [Data] menu key and set the LIN Trigger type to Data, and the menu at the bottom of the screen will be

switched to the Data Trigger Type setup menu:



Fig. 11.119 LIN Data Trigger Level1 Menu

Click [Data] menu key, and the Data setup menu will pop up on the right side of the screen:

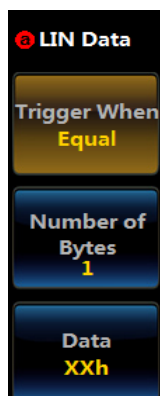


Fig. 11.120 LIN Data Trigger Level2 Menu

Click [Trigger When] menu key, and the Trigger When Setup Level3 Menu will pop up on the left side of the screen:

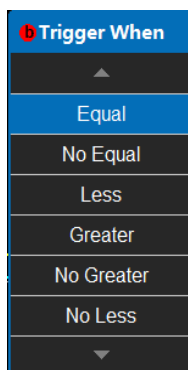


Fig. 11.121 LIN Data Trigger When Setup Menu

Rotate the Multipurpose b to select the corresponding Trigger When, and then press it down to confirm Select, or directly click the corresponding Trigger When setting on the screen.

Click [Number of Bytes] menu key, and then rotate the Multipurpose b to set the triggered Number of Bytes;

Click [Data] menu key, and the numeric keypad will pop up on the left side of the menu for trigger data setup:



Fig. 11.122 Numeric Keypad

Set the data value through buttons on the numeric keypad or Multipurpose a and Multipurpose b.

Click [ID/Data] menu key and set the LIN Trigger type to ID/Data, and the menu at the bottom of the screen will

be switched to the ID/Data Trigger Type setup menu:

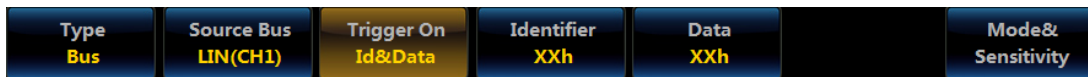


Fig. 11.123 Trigger Type Setup Menu

For specific operations, refer to ID trigger type and data trigger type respectively.

Click [Wakeup Frame] menu key, and the LIN Trigger type will be set to Wakeup Frame;

Click [Sleep Frame] menu key, and the LIN Trigger type will be set to Sleep Frame;

Click [Error] menu key and set the LIN Trigger type to Error, and the menu at the bottom of the screen will be switched to the Error Trigger Type setup menu:

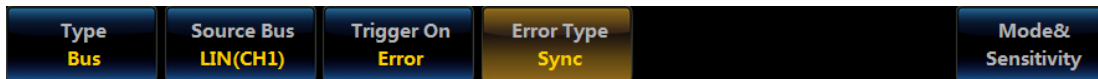


Fig. 11.124 LIN Error Trigger Level1 Menu

Click [Error Type] menu key, and the Error Type selection menu will pop up on the right side of the screen:

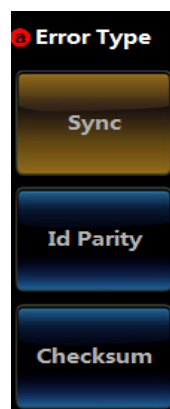


Fig. 11.125 LIN Error Trigger Type Setup Menu

Click [Sync], [Id Parity] and [Checksum] to set the error type to Sync Error, Id Parity Error and Checksum Error respectively.



Fig. 11.126 LIN Trigger and Analysis Example

11.6 FlexRay protocol trigger and analysis

The FlexRay bus frame is composed of the Header Segment, Payload Segment and Trailer Segment, as shown in the following figure. The Header Segment is composed of the indicator bit, frame ID, payload length and header CRC and cycle count; the Payload Segment is composed of number of bytes between 0 and 254; the Trailer Segment is composed of 3-byte CRC, which can be triggered on the header, frame type, identifier, cycle count, complete header field, data, identifier and data, frame end and error.

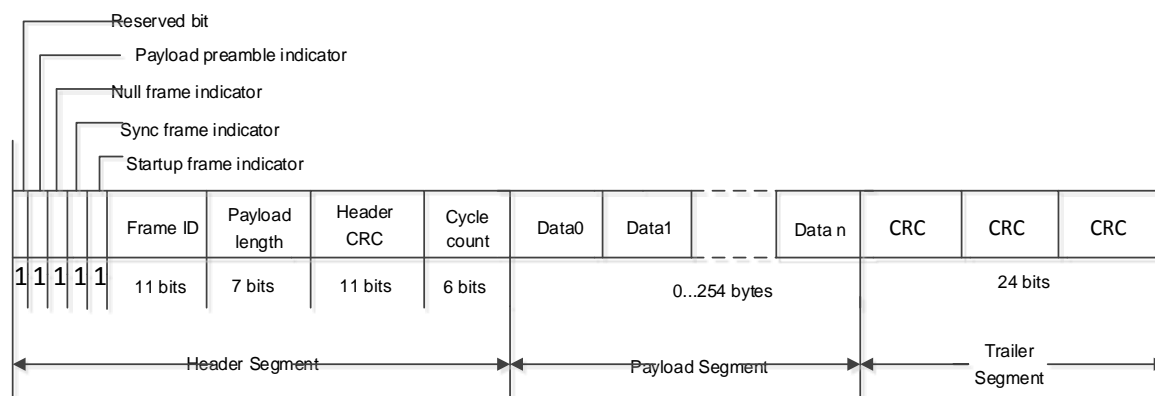


Fig. 11.127 FlexRay Frame Format

The FlexRay frame includes static and dynamic frames. The decoding/coding sequences of static and dynamic frames are as shown in Fig. 2. The TSS is a transmission start sequence, which is a period of low level. The FSS is a frame start sequence, which is a period of high level and after the TSS. The BSS is a byte start sequence, which provides timing information for a period of high level and low level. The FES is a frame end sequence, which is a low level and a high level, after the effective data bit. If it is a dynamic frame, there is also a DTS sequence after the FES, and the DTS is a dynamic tail sequence to prevent premature judgment of idle bus.

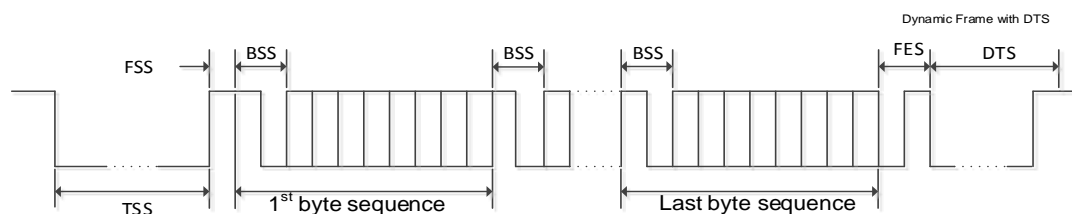


Fig. 11.128 FlexRay Frame Sequence

11.6.1 FlexRay bus setting

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen (the menu will be based on the I2C bus). Click [Bus] menu key, and the Type selection menu will pop up on the right side of the screen (the menu will be based on the I2C bus). Click [FlexRay] menu key and select the FlexRay bus type, and it will be switched to the FlexRay Bus setup menu at the bottom of the screen:

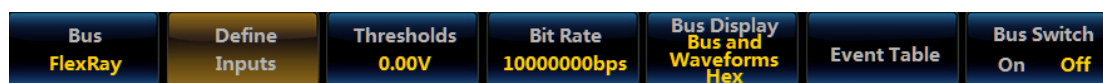


Fig. 11.129 FlexRay Bus Setup Level 1 Menu

Define inputs setup

Click [Define Inputs] menu key, and the FlexRay Input setup menu will pop up on the right side of the screen:



Fig. 11.130 FlexRay Input Setup Menu

Click [FlexRay Input] menu key, and the FlexRay Input Selection Level3 Menu will pop up on the left side of the menu:

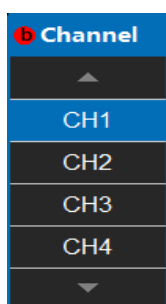


Fig. 11.131 FlexRay Input Channel Menu

Rotate the Multipurpose b to select the channel, and then press it down to confirm Select, or directly click the corresponding channel to select Select. The selected channel will be displayed on the menu item on the right side.

Click [Type] menu key and switch the input channel type of the FlexRay bus to A or B;

Click [Signal Type] menu key, and the Signal Type Setup Level3 Menu will pop up on the left side of the menu:

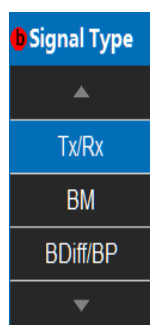


Fig. 11.132 FlexRay Input Signal Type Menu

Rotate the Multipurpose b to select the signal type, and then press it down to confirm Select, or directly click the corresponding signal type on the screen to select Select. The selected signal type will be displayed on the menu item on the right side.

Threshold setup

Click [Thresholds] menu key, and the FlexRay Channel Threshold setup menu will pop up on the right side of the screen,

When the signal type is Tx or Rx, the FlexRay Channel Thresholds Setup Menu is as follows:



Fig. 11.133 FlexRay Input Channel Single Threshold Menu

Click [Thresholds] menu key, and then rotate the Multipurpose b to set the threshold of the FlexRay input channel;

Click [Choose Preset] menu key, and the Choose Preset Type Selection Level3 Menu will pop up on the left side of the menu:

Family	Value
User	0.00V
TTL	1.4V
5.0V CMOS	2.5V
7V	3.5V
10V	5.0V
14V	7.0V
0V	0V

Fig. 11.134 FlexRay Input Channel Single Threshold Choose Preset Menu

Rotate the Multipurpose b to select the preset threshold, and then press it down to confirm or directly click the corresponding type on the screen to select it.

Attention: When the channel threshold preset type is set to the User, click [Thresholds] menu key, and then rotate the Multipurpose b to change the threshold. When selecting other preset type, the corresponding threshold will be displayed on [Thresholds] menu key. If the type of threshold is greater/smaller than the max./min. threshold under this range, the max./min. threshold will be displayed. If the preset type is not set to the User, click [Thresholds] menu key. When rotating the Multipurpose b to change the threshold, the preset type will be changed to the User.

When the signal type is BDiff/BP and BM, the FlexRay Channel Thresholds Setup Menu is as follows:



Fig. 11.135 FlexRay Input Channel Dual-Threshold Choose Preset Menu

Click [Threshold High] menu key, and then rotate the Multipurpose b to set the high threshold of the FlexRay input channel;

Click [Threshold Low] menu key, and then rotate the Multipurpose b to set the low threshold of the FlexRay input channel;

Click [Choose Preset] menu key, and the Choose Preset Type Selection Level3 Menu will pop up on the left side of the menu:

Family	High	Low
▲		
User	0.00V	0.00V
TTL	2.0V	800mV
5.0V CMOS	5.00V	800mV
7 V	5.25V	1.75V
10V	7.5V	2.5V
14V	10.5V	3.5V
0V	0V	0V
▼		

Fig. 11.136 FlexRay Input Channel Dual-Threshold Choose Preset Menu

Rotate the Multipurpose b to select the preset threshold, and then press it down to confirm or directly click the corresponding type on the screen to select it.

Attention: When the channel threshold preset type is set to the User, click [Threshold High] or [Threshold Low] menu key, and then rotate the Multipurpose b to change the threshold. When selecting other preset type, the corresponding threshold will be displayed on [Threshold High] or [Threshold Low] menu key. If the type of threshold is greater/smaller than the max./min. threshold under this range, the max./min. threshold will be displayed. If the preset type is not set to the User, click [Threshold High] or [Threshold Low] menu key. When rotating the Multipurpose b to change the threshold, the preset type will be changed to the User.

Bit Rate setup

Click [Bit Rate] menu key, and the FlexRay Bit Rate setup menu will pop up on the right side of the screen:

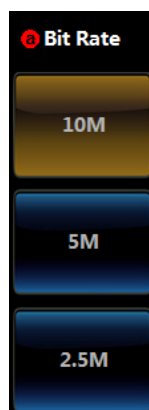


Fig. 11.137 FlexRay Bit Rate Setup Menu

Click [10M] menu key, and set the FlexRay Bit Rate to 10 Mbps;

Click [5M] menu key, and set the FlexRay Bit Rate to 5 Mbps;

Click [2.5M] menu key, and set the FlexRay Bit Rate to 2.5 Mbps.

Bus display setup

Click [Bus Display] menu key, and the FlexRay Bus Display setup menu will pop up on the right side of the screen:



Fig. 11.138 FlexRay Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up on the left side of the menu:

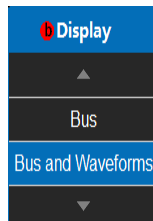


Fig. 11.139 FlexRay Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] menu key, and the Number Format Setup Level3 Menu will pop up on the left side of the menu:

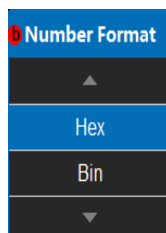


Fig. 11.140 FlexRay Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] menu key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] menu key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area;

Attention: The Waveforms Offset button will be displayed when the display mode is Bus and Waveforms.

Event table setup

Click [Event Table] menu key at the bottom of the screen, and the Event Table setup menu will pop up on the right side of the screen:

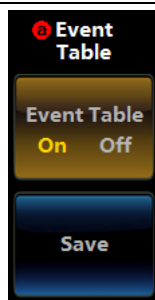


Fig. 11.141 FlexRay Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] menu key, and save the event table information.

Bus switch setting

Click [Bus Switch] menu key at the bottom of the screen, and enable or disable the bus decoding function.

11.6.2 FlexRay trigger setting

Press down **【Trigger】** key in the Function Area on the front panel, and the Trigger setup menu will pop up on the lower screen (the menu will be triggered by referring to the I2C). Click [Type] menu key, and the Type selection menu will pop up on the right side of the screen (the menu will be triggered by referring to the I2C). Click [Bus] menu key and select the bus trigger type, and it will be switched to the Bus Trigger setup menu at the bottom of the screen:



Fig. 11.142 FlexRay Protocol Trigger Level1 Menu

Attention: When the bus decoding type is FlexRay and it is switched to protocol trigger, the protocol trigger menu will automatically switch to the FlexRay trigger setup menu.

FlexRay trigger type setup

Click [Trigger On] menu key at the bottom of the screen, and the FlexRay Trigger Type setup menu will pop up on the right side of the screen:

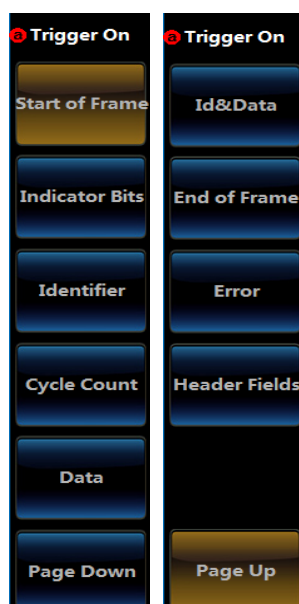


Fig. 11.143 FlexRay Trigger Type Setup Menu

Click [Start of Frame] menu key, and the FlexRay protocol trigger type will be set to Start of Frame;

Click [Indicator Bits] menu key and set the FlexRay trigger type to Indicator Bits, and the menu at the bottom of the screen will be switched to the Indicator Bits setup menu:

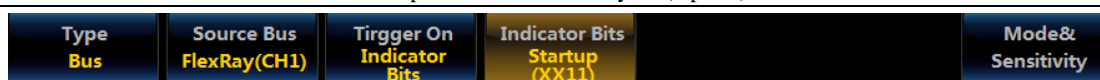


Fig. 11.144 FlexRay Indicator Bits Trigger Level1 Menu

Click [Indicator Bits] menu key at the bottom of the screen, and the FlexRay Indicator Bits setup menu will pop up on the right side of the screen:

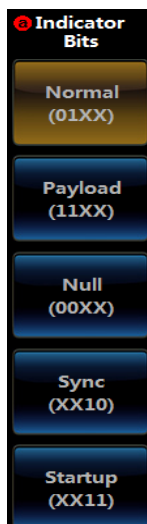


Fig. 11.145 FlexRay Indicator Bits Trigger Type Setup Menu

Click [Normal], [Payload], [Null], [Sync] and [Startup] keys of the menu to set the Indicator Bits to Normal, Payload, Null, Sync and Startup respectively.

Click [Identifier] menu key and set the FlexRay trigger type to Identifier, and the menu at the bottom of the screen will be switched to the Identifier setup menu:

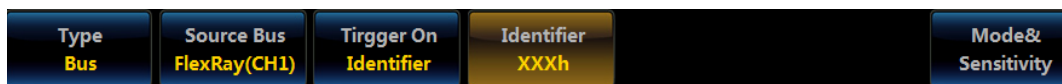


Fig. 11.146 FlexRay Identifier Trigger Level1 Menu

Click [Identifier] menu key at the bottom of the screen, and the FlexRay Identifier setup menu will pop up on the right side of the screen:



Fig. 11.147 FlexRay Identifier Trigger Level2 Menu

When the "Identifier Trigger When" is set to Equal, No Equal, Less, Greater, No Less and No Greater, there will be [Trigger When] and [Identifier] keys of the menu. When the "Trigger When" is set to Inside Range and Outside Range, there will be [Trigger When], [Identifier Low] and [Identifier High] keys of the menu.

Click [Trigger When] menu key, and the Trigger When Setup Level3 Menu will pop up on the left side of the

screen:

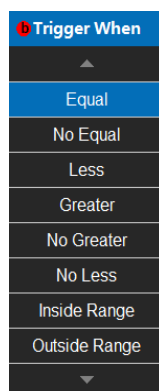


Fig. 11.148 FlexRay Identifier Trigger When Menu

Rotate the Multipurpose b to select the corresponding Trigger When, and then press it down to confirm Select, or directly click the corresponding Trigger When setting on the screen.

Click [Identifier] menu key, and the Identifier setting numeric keypad will pop up on the left side of the menu:



Fig. 11.149 Numeric Keypad

Set the Identifier through keys on the numeric keypad or Multipurpose a and Multipurpose b.

Click [Identifier Low] or [Identifier High] menu key, and the numeric keypad same as the [Identifier] menu key setting as shown in the above figure will pop up on the left side of the menu, and the setting method is the same.

Click [Cycle Count] menu key and set the FlexRay trigger type to Cycle Count, and the menu at the bottom of the screen will be switched to the Cycle Count Trigger Type setup menu:



Fig. 11.150 FlexRay Cycle Count Trigger Level1 Menu

Click [Cycle Count] menu key, and the Cycle Count setup menu will pop up on the right side of the screen:



Fig. 11.151 FlexRay Cycle Count Trigger Level2 Menu

When the "Cycle Count Trigger When" is set to Equal, No Equal, Less, Greater, No Less and No Greater, there will be [Trigger When] and [Identifier] keys of the menu. When the "Trigger When" is set to Inside Range and Outside Range, there will be [Trigger When], [Identifier Low] and [Identifier High] keys of the menu.

Click [Trigger When] menu key, and the Trigger When Setup Level3 Menu will pop up on the left side of the screen:

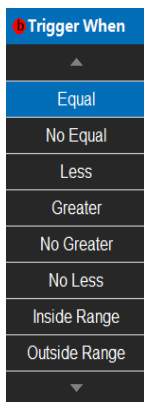


Fig. 11.152 FlexRay Cycle Count Trigger When Setup Menu

Rotate the Multipurpose b to select the corresponding Trigger When, and then press it down to confirm Select, or directly click the corresponding Trigger When setting on the screen.

Click [Cycle Count] menu key, and the Cycle Count setting numeric keypad will pop up on the left side of the menu:



Fig. 11.153 Numeric Keypad

Set the cycle count through keys on the soft keyboard or Multipurpose a and Multipurpose b.

Click [Cycle Count Low] or [Cycle Count High] menu key, and the numeric keypad same as the [Cycle Count] menu key setting as shown in the above figure will pop up on the left side of the menu, and the setting method is the same.

Click [Data] menu key and set the FlexRay trigger type to Data, and the menu at the bottom of the screen will be switched to the Data Trigger Type setup menu:



Fig. 11.154 FlexRay Data Trigger Level1 Menu

Click [Data] menu key, and the FlexRay Data setup menu will pop up on the right side of the screen:

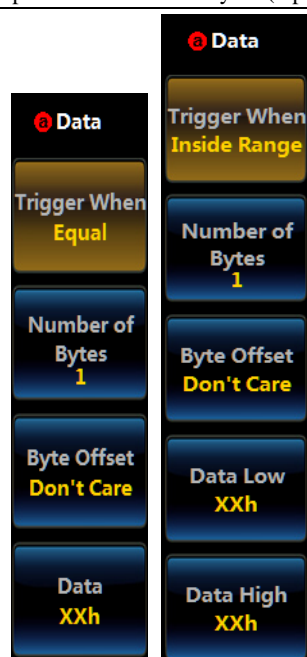


Fig. 11.155 FlexRay Data Trigger Level2 Menu

When the "Data Trigger When" is set to Equal, No Equal, Less, Greater, No Less and No Greater, there will be [Trigger When], [Number of Bytes] and [Data] keys of the menu. When the "Trigger When" is set to Inside Range and Outside Range, there will be [Trigger When], [Number of Bytes], [Data Low] and [Data High] keys of the menu.

Click [Trigger When] menu key, and the Trigger When Setup Level3 Menu will pop up on the left side of the screen:

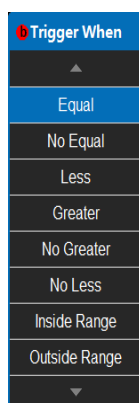


Fig. 11.156 FlexRay Data Trigger When Menu

Rotate the Multipurpose b to select the corresponding Trigger When, and then press it down to confirm Select, or directly click the corresponding Trigger When setting on the screen.

Click [Number of Bytes] menu key, and then rotate the Multipurpose b to set the data trigger Number of Bytes;

Click [Data] menu key, and the Data setting numeric keypad will pop up on the left side of the menu:

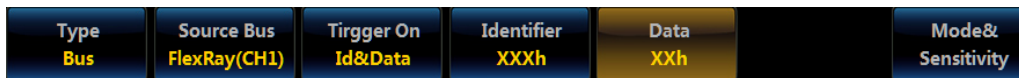


Fig. 11.157 Numeric Keypad

Set the data value through keys on the numeric keypad or Multipurpose a and Multipurpose b.

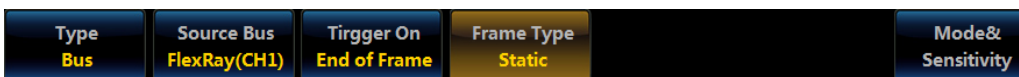
Click [Data Low] or [Data High] menu key, and the numeric keypad same as the [Data] menu key setting as shown in the above figure will pop up on the left side of the menu, and the setting method is the same.

Click [ID/Data] menu key and set the FlexRay trigger type to ID/Data, and the menu at the bottom of the screen will be switched to the ID/Data Trigger Type setup menu:

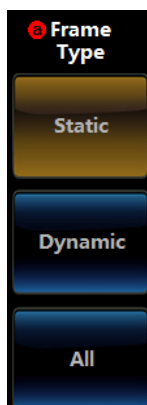
**Fig. 11.158 FlexRay ID and Data Trigger Level1 Menu**

For specific operations, refer to identifier trigger type and data trigger type respectively.

Click [End of Frame] menu key and set the FlexRay trigger type to End of Frame, and the menu at the bottom of the screen will be switched to the End of Frame Trigger Type setup menu:

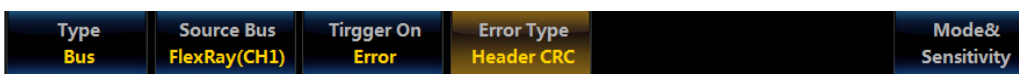
**Fig. 11.159 FlexRay End of Frame Trigger Level1 Menu**

Click [End of Frame] menu key, and the Error Type selection menu will pop up on the right side of the screen:

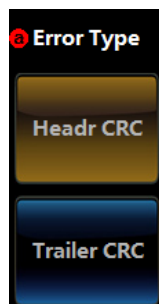
**Fig. 11.160 FlexRay End of Frame Trigger Level2 Menu**

Click [Static], [Dynamic] and [Full] keys of the menu to set the End of Frame to Static, Dynamic and Full.

Click [Error] menu key and set the FlexRay protocol trigger type to Error, and the menu at the bottom of the screen will be switched to the Error Trigger Type setup menu:

**Fig. 11.161 FlexRay Error Trigger Level1 Menu**

Click [Error Type] menu key, and the Error Type selection menu will pop up on the right side of the screen:

**Fig. 11.162 FlexRay Error Trigger Level2 Menu**

Click [Header CRC] and [Trailer CRC] to set the error type to Header CRC Error and Trailer CRC Error respectively.

Click [Header Field] menu key and set the FlexRay protocol trigger type to Header Field, and the menu at the bottom of the screen will be switched to the Header Field Trigger Type setup menu:



Fig. 11.163 FlexRay Header Field Trigger Level1 Menu

Click [Header Field] menu key, and the Header Field setup menu will pop up on the right side of the screen:

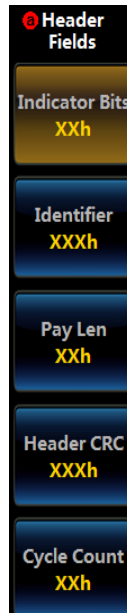


Fig. 11.164 FlexRay Header Field Trigger Level2 Menu

Click [Indicator Bits], [Identifier], [Payload Length], [Header CRC] and [Cycle Count] keys of the menu, and the Indicator Bits, Identifier, Payload Length, Header CRC and Cycle Count setup keypad will pop up respectively. As the setting method is the same as above, it will be omitted here.



Fig. 11.165 FlexRay Trigger and Analysis Example

11.7 AUDIO trigger and analysis

The Audio bus is composed of the bit clock, bit select and data, which can be triggered on word select, frame sync,

or data. The Audio bus has I2S, LJ, RJ and TDM formats.

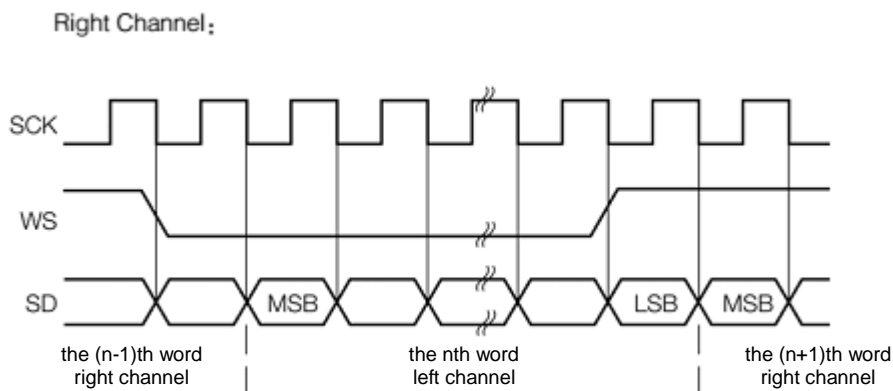


Fig. 11.166 I2S Sequence Chart

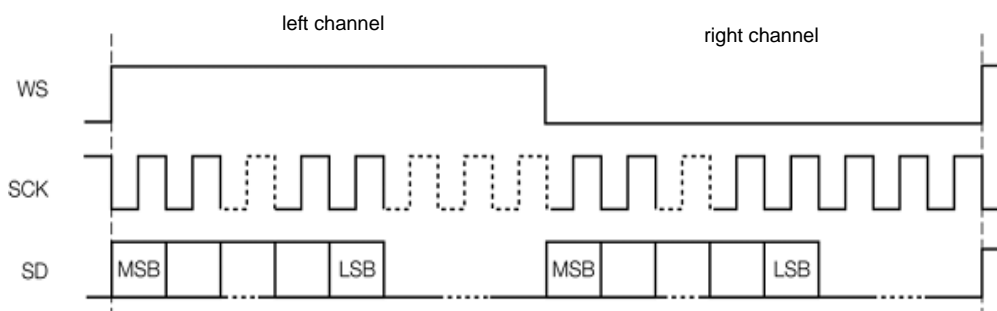


Fig. 11.167 LJ Sequence Chart

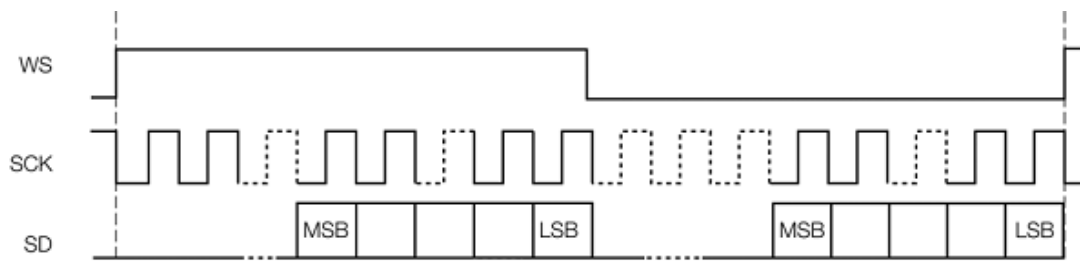


Fig. 11.168 RJ Sequence Chart

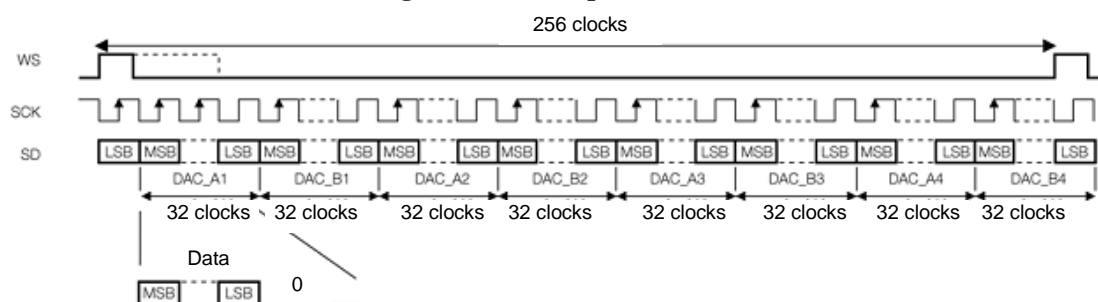


Fig. 11.169 TDM Sequence Chart

11.7.1 Audio bus setup

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen:

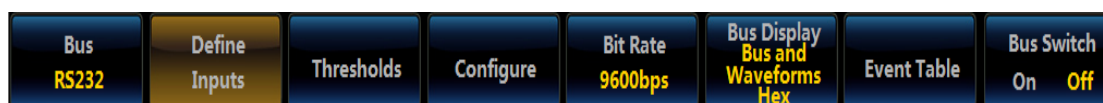


Fig. 11.170 Bus Setup Menu

Click [Bus] menu key, and the Bus Type selection menu will pop up on the right side of the screen:

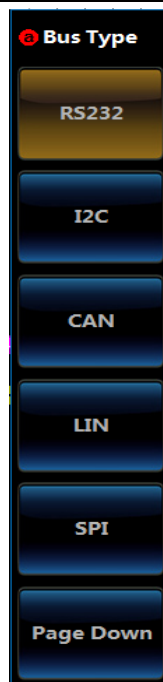


Fig. 11.171 Bus Type Setup Menu

Click [Audio] key and select the Audio bus type, and it will be switched to the Audio Bus setup menu at the bottom of the screen:

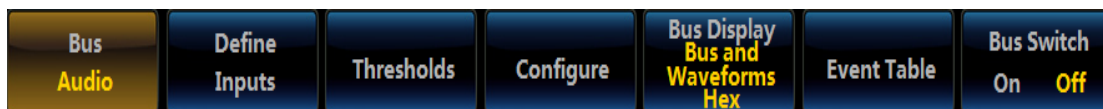


Fig. 11.172 Bus Setup Menu

Define inputs

Click [Define Inputs] key, and the Audio Input Level2 Menu will pop up, and then set the Audio type and bit clock, bit select and data channel.

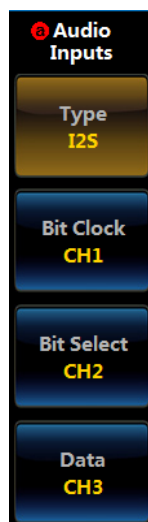


Fig. 11.173 Input Setup Menu

Click[Type] key, and select the Type in the popup Level3 Menu.

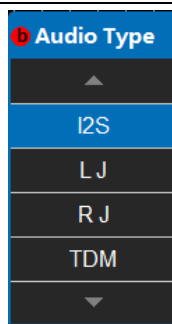


Fig. 11.174 Type Setup Menu

Click [Bit Clock] key, and select any channel (CH1 ~ CH4) in the popup Level3 Menu as the Bit Clock channel.

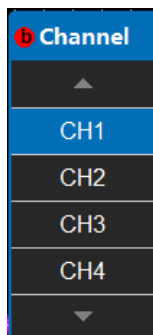


Fig. 11.175 Channel Setup Menu

Click [Bit Select] key, and select any channel (CH1 ~ CH4) in the popup Level3 Menu as the Bit Select channel.

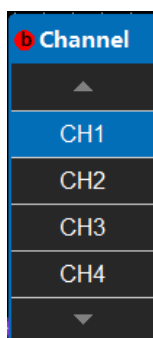


Fig. 11.176 Channel Setup Menu

Click [Data] key, and select any channel (CH1 ~ CH4) in the popup Level3 Menu as the Data channel.

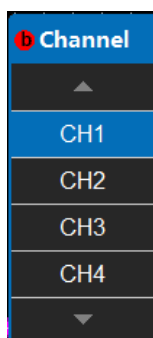


Fig. 11.177 Channel Setup Menu

Thresholds

Click [Thresholds] key to pop up the Channel Threshold Level2 Menu, set the bit clock, bit selection and data thresholds. Firstly, select the channel, rotate the Multipurpose b on the front panel to change the threshold of the corresponding channel, or select the preset threshold through the preset button.

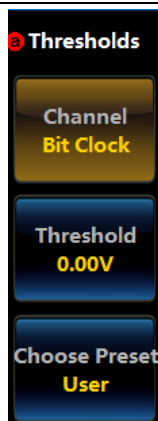


Fig. 11.178 Threshold Setup Menu

Click [Channel] key, select Bit Clock in the popup Level2 Menu, click [Thresholds] key, rotate the Multipurpose b, and adjust thresholds of the Bit Block channel.

b Channel	Threshold
Bit Clock	0.00V
Bit Select	0.00V
Data	0.00V

Fig. 11.179 Channel Setup Menu

Click [Channel] key, select Bit Select in the popup Level2 Menu, click [Thresholds] key, rotate the Multipurpose b, and adjust thresholds of the Bit Select channel.

Click [Channel] key, select MISO in the popup Level2 Menu, click [Thresholds] key, rotate the Multipurpose b, and adjust thresholds of the Data channel.

Click [Choose Preset] key, select the proper thresholds in the popup Level3 Menu, and adjust thresholds of the Bit Clock, Bit Select and Data channels.

b Family	Value
User	0.00V
TLL	1.4V
5.0V CMOS	2.5V
3.3V CMOS	1.65V
2.5V CMOS	1.25V
ECL	-1.3V
PECL	3.7V
0V	0V

Fig. 11.180 Choose Preset Setup Menu

Config

Click [Configure] menu to pop up the Audio Configuration Level2 Menu for bus configuration.



Fig. 11.181 I2S/LJ/RJ Configuration Menu

Click [Word Size] key, and rotate the Multipurpose b to set the word size. The value range is 4 ~ 32, and it can be set to 4 by default. The Word Size represents the bit number of each frame of data.

Click [Bit Clock] key, set the clock edge type to Rising Edge or Falling Edge, and set Data sampling on the Bit Clock Rising Edge or Falling Edge.

Click [WS Polarity] key, and select Normal or Inverted.

Click [Data] key, and select High=1 or High=0.

Click [Bit Order] key, set the transmission sequence to LS First (the low data bit will be transmitted first) or MS First (the high data bit will be transmitted first), which will be set to LS First by default.

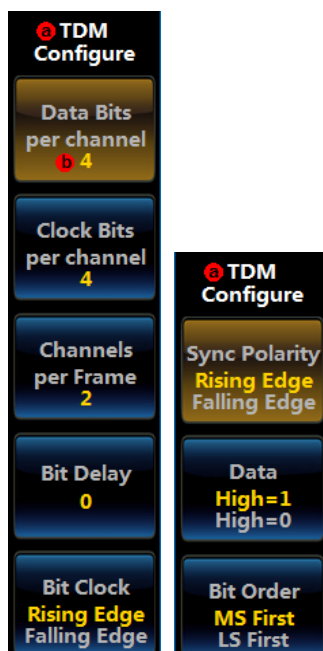


Fig. 11.182 TDM Configure Menu

Click [Data Bits per channel] key, and rotate the Multipurpose b to set the Data Bits per channel. The value range is 4 ~ 32, and it can be set to 4 by default.

Click [Clock Bits per channel] key, and rotate the Multipurpose b to set the Clock Bits per channel. The value range is 4 ~ 32, and it can be set to 4 by default.

Click [Channels per Frame] key, and rotate the Multipurpose b to set the Channels per Frame. The value range is 2

~ 64, and it can be set to 2 by default.

Click [Bit Delay] key, and rotate the Multipurpose b to set the Bit Delay. The value range is 0 ~ 31, and it can be set to 0 by default.

Click [Bit Clock] key, set the clock edge type to Rising Edge or Falling Edge, and set Data sampling on the Bit Clock Rising Edge or Falling Edge.

Click [Sync Polarity] key, and select the Rising Edge or Falling Edge.

Click [Data] key, and select High=1 or High=0.

Click [Bit Order] key, set the transmission sequence to LS First (the low data bit will be transmitted first) or MS First (the high data bit will be transmitted first), which will be set to LS First by default.

Bus display setup

Click [Bus Display] key, and the Bus Display menu will pop up on the right side of the screen.



Fig. 11.183 Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up:

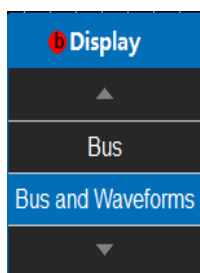


Fig. 11.184 Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] key, and the Number Format Setup Level3 Menu will pop up:

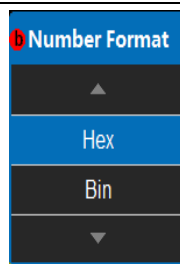


Fig. 11.185 Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area;

Event table setup

Click [Event Table] key, and the Event Table setup menu will pop up on the right side of the screen:

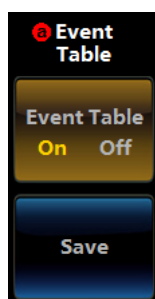


Fig. 11.186 Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] key, and save the event table information.

Bus switch setting

Click [Bus Switch] key, and enable or disable the bus decoding function.

11.7.2 Audio trigger setup

When the Audio type is I2S, LJ or RJ, it can be triggered according to Word Select and Data. When the Audio type is TDM, it can be triggered according to Frame Sync and Data.

Press down **【Trigger】** key on the front panel to pop up the Trigger Level1 Menu; click [Type] key to pop up the Trigger Level2 Menu, and click [Bus] key to pop up the Audio Trigger Level1 Menu. Click [Trigger On] key, pop up the Trigger Level2 Menu, and select the type.

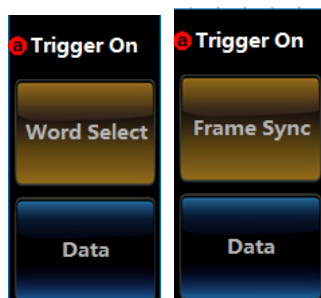


Fig. 11.187 Trigger When Setup Menu

Word Select

Click [Word Select] key, and select Word Select trigger.

Frame Sync

Click [Frame Sync] key, and select Frame Sync trigger.

Data

Click [Data] key, and select Data trigger.

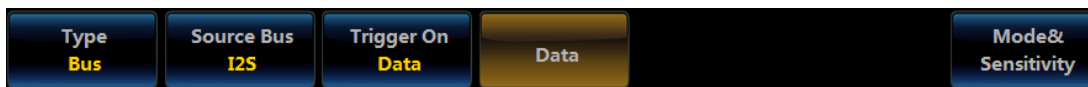


Fig. 11.188 Trigger Setup Menu

When the Audio type is I2S, LJ, RJ, click [Data] key, pop up the Audio Data Level2 Menu, and set the Trigger When, Trigger On and Data.

When the Audio type is TDM, click [Data] key, pop up the Audio Data Level2 Menu, and set the Trigger When, TDM Trigger Channel and Data.

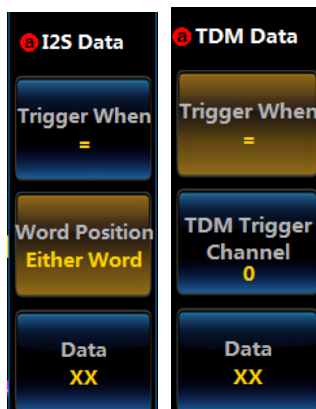


Fig. 11.189 Audio Data Level2 Menu

Click [Trigger When] key, and select the required Trigger When in the popup Level3 Menu.

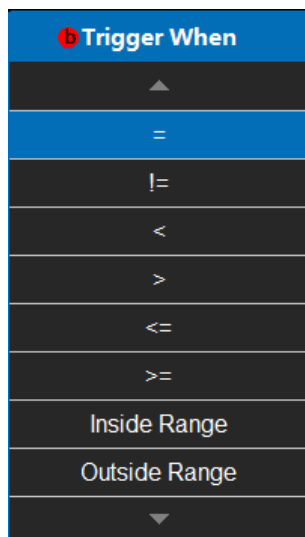


Fig. 11.190 Trigger When Setup Menu

Press down [Either Word] key, and select Either Word circularly: Left Word and Right Word.

Click [TDM Trigger Channel] key, and rotate the Multipurpose b to select the TDM Trigger Channel. It will be set to 0 by default.

Click [Data] key, and input data by opening the data input keyboard.



Fig. 11.191 Audio Trigger and Analysis Example

11.8 USB trigger and analysis

The USB bus is composed of differential data lines D+ and D-, which can be triggered on sync active, reset, suspend, resume, end of packet, token packet, data packet, handshake packet, special packet, error.



Fig. 11.192 USB Frame Format

11.8.1 USB bus setting

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen:

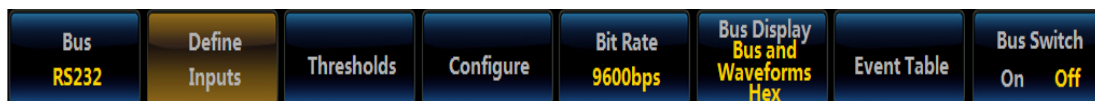


Fig. 11.193 Bus Setup Menu

Click [Bus] menu key, and the Bus Type selection menu will pop up on the right side of the screen:

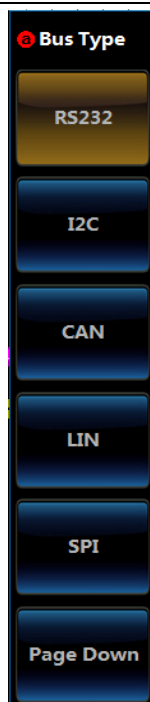


Fig. 11.194 Bus Type Setup Menu

Click [USB] key and select the USB bus type, and it will be switched to the USB Bus setup menu at the bottom of the screen:



Fig. 11.195 USB Bus Level1 Menu

Define inputs

Click [Define Inputs] key, and the USB Input Level2 Menu will pop up, and then set the signal speed, signal type and input channel.

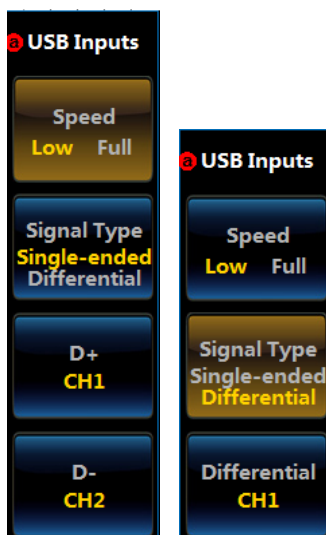


Fig. 11.196 Define Inputs Setup Menu

Click [Speed] key, and select Low (1.5 Mbps) or Full (12 Mbps).

Click [Signal Type] key, and set the Signal Type to Single-ended or Differential. If Single-ended is selected, the input channel will be D+ channel and D- channel; if Differential is selected, the input channel will be differential channel.

Click [D+] key, and select any channel (CH1 ~ CH4) as the D+.

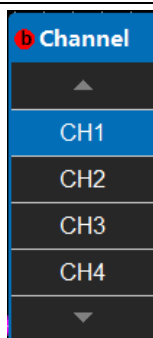


Fig. 11.197 Channel Setup Menu

Click [D-] key, and select any channel (CH1 ~ CH4) as the D-.

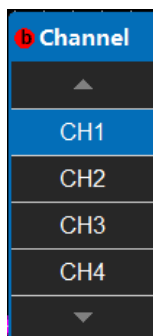


Fig. 11.198 Channel Setup Menu

Click [Differential] key, and select any channel (CH1 ~ CH4) as the Differential.

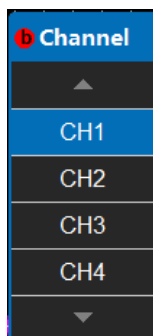


Fig. 11.199 Channel Setup Menu

Thresholds

Click [Thresholds] key to pop up the Channel Threshold Level2 Menu, set the D+, D- (Single-ended) or Diff High and Diff Low (Differential), rotate the Multipurpose b to change the threshold, or select the preset threshold through the preset button.

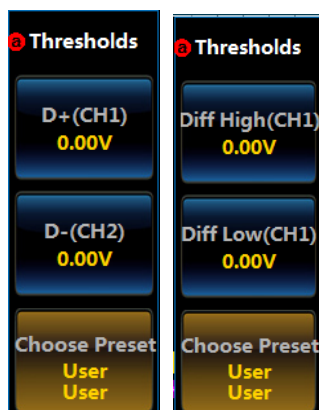


Fig. 11.200 Thresholds Setup Menu

Single-ended:

Click [D+] key, rotate the Multipurpose b, and adjust thresholds of the D+ channel.

Click [D-] key, rotate the Multipurpose b, and adjust thresholds of the D- channel.

Click [Choose Preset] key, select the proper thresholds in the popup Level3 Menu, and adjust thresholds of the D+ and D- channels.

Family	D+	D-
	▲	
User	0.00V	0.00V
Low/Full Speed	1.4v	1.4v
0v	0v	0v
	▼	

Fig. 11.201 Choose Preset Setup Menu

Differential:

Click [Diff High] key, rotate the Multipurpose b on the front panel, and adjust high thresholds of the differential channel.

Click [Diff Low] key, rotate the Multipurpose b on the front panel, and adjust low thresholds of the differential channel.

Click [Choose Preset] key, select the proper thresholds in the popup Level3 Menu, and adjust thresholds of the differential channel.

Family	High	Low
	▲	
User	0.00V	0.00V
Low/Full Speed	1.4v	-1.4v
0v	0v	0v
	▼	

Fig. 11.202 Choose Preset Setup Menu

Bus display setup

Click [Bus Display] key, and the Bus Display menu will pop up on the right side of the screen.



Fig. 11.203 Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up:

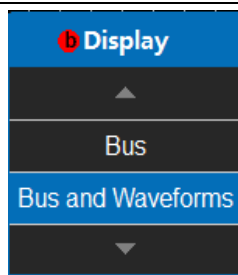


Fig. 11.204 Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] key, and the Number Format Setup Level3 Menu will pop up:

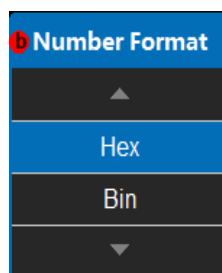


Fig. 11.205 Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area;

Event table setup

Click [Event Table] key, and the Event Table setup menu will pop up on the right side of the screen:

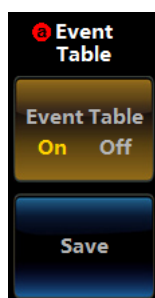


Fig. 11.206 Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] key, and save the event table information.

Bus switch setting

Click [Bus Switch] key, and enable or disable the bus decoding function.

11.8.2 USB trigger setup

The USB bus can be triggered on sync active, reset, suspend, resume, end of packet, token packet, data packet, handshake packet, special packet and error.

Press down **【Trigger】** key on the front panel to pop up the Trigger Level1 Menu; click [Type] key to pop up the Trigger Level2 Menu, and click [Bus] key to pop up the USB Trigger Level1 Menu. Click [Trigger On] key, pop up the Trigger Level2 Menu, and select the type.

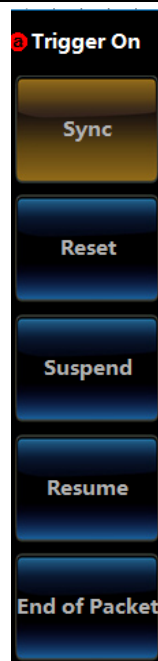


Fig. 11.207 Trigger When Setup Menu

(1) Sync

Click [Sync] key, and select Sync trigger.

(2) Reset

Click [Reset] key, and select Resume trigger.

(3) Suspend

Click [Suspend] key, and select Suspend trigger.

(4) Resume

Click [Resume] key, and select Resume trigger.

(5) End of Packet

Click [End of Packet] key, and select End of Packet trigger.

(6) Token Packet

Click [Token Packet] key, and select Token Packet trigger. The Token Type, Address and endpoint shall be set.

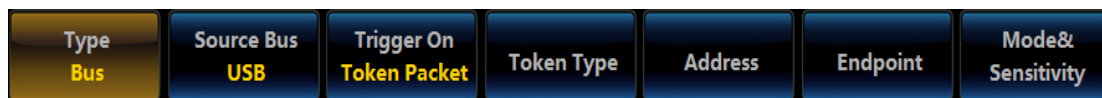


Fig. 11.208 Token Trigger Setup Menu

Click [Token Type] key, and select the Token Type in the popup Token Type Level2 Menu.

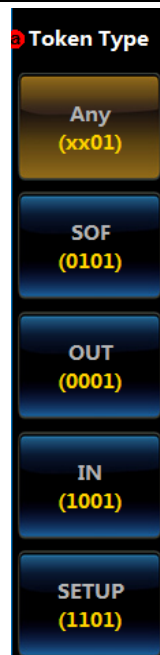


Fig. 11.209 Token Type Setup Menu

Click [Address] key, and set the required Trigger When and Address in the popup Address Level2 Menu.

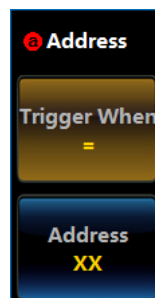


Fig. 11.210 Trigger When and Address Setup Menu

Click [Endpoint] key, and set the Endpoint in the popup Endpoint Level2 Menu.

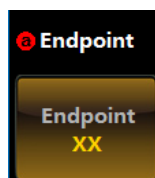


Fig. 11.211 Endpoint Setup Menu

(7) Data Packet

Click [Data Packet] key, and select Data Packet trigger. The Data Type and Data shall be set.

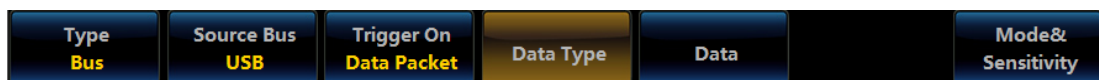


Fig. 11.212 Data Packet Trigger Setup

Click [Data Type] key, and select the Data Type in the popup Data Type Level2 Menu.

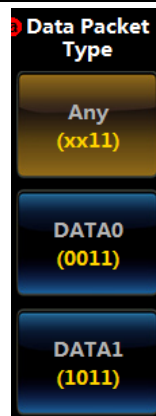


Fig. 11.213 Data Type Setup Menu

Click [Data] key, and set the Trigger When, Number of Bytes and Data in the popup Data Level2 Menu.

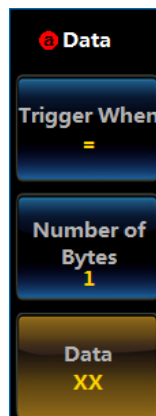


Fig. 11.214 Trigger When, Number of Bytes and Data Setup Menu

(8) Handshake Packet

Click [Handshake Packet] key, and select Handshake Packet trigger. The Handshake Packet Type shall be set.

Click [Handshake Packet Type] key, and select the Handshake Packet Type in the popup Handshake Packet Type Level2 Menu.

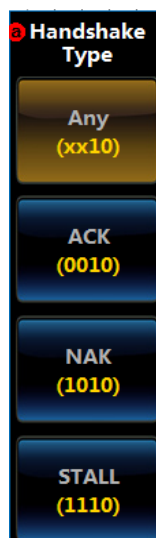


Fig. 11.215 Handshake Type Setup Menu

(9) Special Packet

Click [Special Packet] key, and select Special Packet trigger. The Special Packet Type shall be set.

Click [Special Packet Type] key, and select the Special Packet Type in the popup Special Packet Type Level2 Menu.

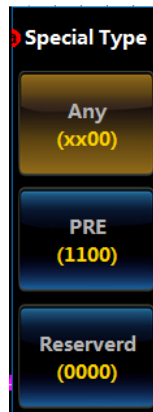


Fig. 11.216 Special Type Setup Menu

(10) Error

Click [Error] key, and select the Error trigger. The Error Type shall be set.

Click [Error Type] key, and select the Error Type in the popup Error Type Level2 Menu.

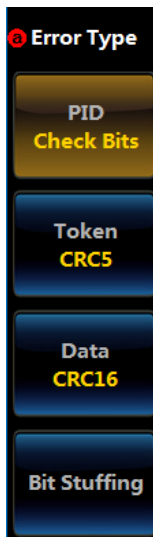


Fig. 11.217 Error Type Setup Menu

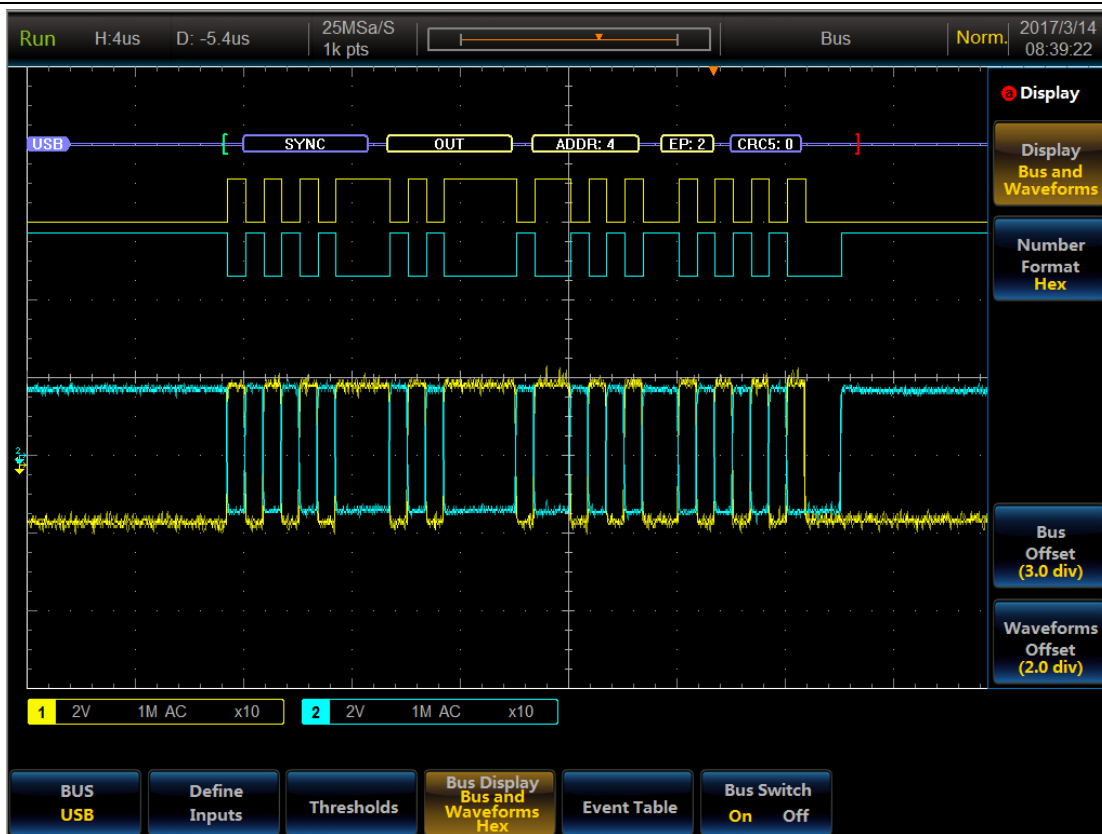


Fig. 11.218 USB Trigger and Analysis Example

11.9 MIL-STD-1553 trigger and analysis

The MIL-STD-1553 bus, fully known as the AircraftInternalTime Division Command/ResponseMultiplexData Bus, is a serial multiplexing data bus standard published by the United States in the 1970s. The 1553 bus has three terminal types: Bus controller (BC), remote terminal (RT) and bus monitor (BM).The information format includes BC to RT, RT to BC, RT to RT, and broadcast and system control mode. The transmission medium is shielded twisted pair, and the 1553 bus coupling mode includes direct coupling and transformer coupling. The 1553 bus has a multi-redundancy bus topology structure, with two-way transmission, transmission speed of 1 Mbps, half duplex transmission mode and the Manchester II code for coding and transmission.

11.9.1 MIL-STD-1553 setup

Press down **【Bus】** key in the Function Area on the front panel, and the Bus setup menu will pop up on the lower screen:



Fig. 11.219 Bus Setup Menu

Click [Bus] menu key, and the Bus Type selection menu will pop up on the right side of the screen:

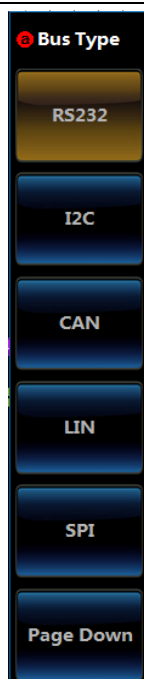


Fig. 11.220 Bus Type Setup Menu

Click [1553] key and select the 1553 bus type, and it will be switched to the 1553 Bus setup menu at the bottom of the screen:

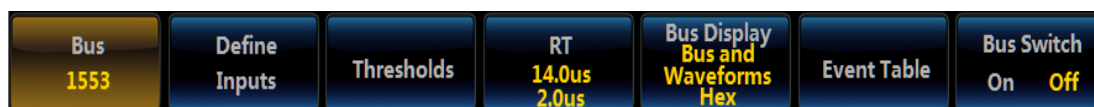


Fig. 11.221 1553 Level1 Menu

Define inputs

Click [Define Inputs] key of the 1553 Bus Setup Level1 Menu, and the 1553 Input Level2 Menu will pop up, and then set channel and select polarity.

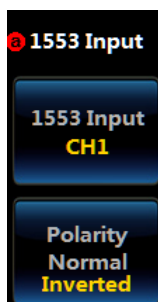


Fig. 11.222 1553 Define Inputs Menu

Click [1553 Input] key, and select any channel (CH1 ~ CH4) in the popup Level3 Menu as the 1553 input channel.

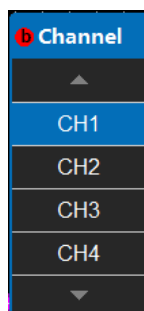


Fig. 11.223 1553 Channel Setup Menu

Click [Polarity] key, and select Normal or Inverted.

Thresholds

Click [Thresholds] key to pop up the Channel Threshold Level2 Menu, set the high and low thresholds. Rotate the Multipurpose b on the front panel to change the threshold of the corresponding channel, or select the preset threshold through the preset button.

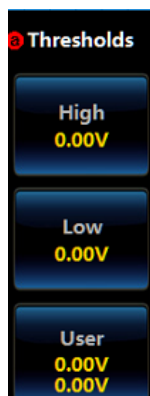


Fig. 11.224 1553 Threshold Setup Menu

Click [Choose Preset] key, select the proper thresholds in the popup Level3 Menu, and adjust thresholds of the 1553 channel.

Family	High	Low
	▲	
User	0.00V	0.00V
1553	500mv	500mv
0v	0v	0v
	▼	

Fig. 11.225 1553 Choose Preset Setup Menu

RT time

Click [RT] menu to pop up the 1553RT Setup Level2 Menu for RT time configuration.



Fig. 11.226 1553 RT Setup Menu

Click [Response Time Maximum] key, and rotate the Multipurpose b on the front panel to set the max. response time.

Click [Response Time Minimum] key, and rotate the Multipurpose b on the front panel to set the min. response time.

Bus display setup

Click [Bus Display] key, and the Bus Display menu will pop up on the right side of the screen.



Fig. 11.227 Display Setup Menu

Click [Display] menu key, and the Bus Display Setup Level3 Menu will pop up:

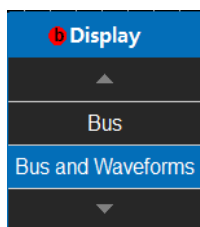


Fig. 11.228 Display Setup Menu

Rotate the Multipurpose b to select the corresponding display, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Number Format] key, and the Number Format Setup Level3 Menu will pop up:

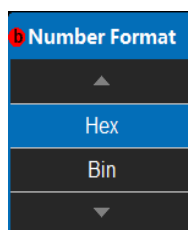


Fig. 11.229 Number Format Setup Menu

Rotate the Multipurpose b to select the corresponding number format, and then press it down to confirm Select, or directly click the corresponding option of the Level3 Menu for direct settings;

Click [Bus Offset] key, and then rotate the Multipurpose b to change the bus position in the vertical direction of the display area;

Click [Waveforms Offset] key, and then rotate the Multipurpose b to change the waveform position in the vertical direction of the display area.

Event table setup

Click [Event Table] key, and the Event Table setup menu will pop up on the right side of the screen:

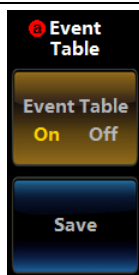


Fig. 11.230 Event Table Setup Menu

Click [Event Table] key to close or open the event table;

Click [Save] key, and save the event table information.

Bus switch setting

Click [Bus Switch] key, and enable or disable the bus decoding function.

11.9.2 MIL-STD-1553 trigger setup

The 1553 can be triggered on SS Active, Sync, Command, Status, Data, Time and Error.

Press down **【Trigger】** key on the front panel to pop up the Trigger Level1 Menu; click [Type] key to pop up the Trigger Level2 Menu, and click [Bus] key to pop up the 1553 Trigger Level1 Menu. Click [Trigger On] key, pop up the Trigger Level2 Menu, and select the type.

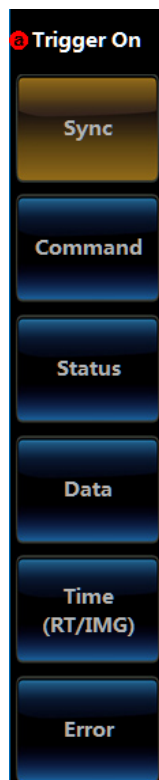


Fig. 11.231 1553 Trigger When Setup Menu

Sync

Click [Sync] key, and select Sync trigger.

Command

Click [Command] key, and select Command trigger.



Fig. 11.232 1553 Command Trigger Menu

Click [RT Address] key, pop up the RT Address Level2 Menu, and set the Trigger When and Address.

Click [Command Word Details] key, pop up the Command Word Level2 Menu, and set T/R bit, Subaddress, Word Count and Parity.

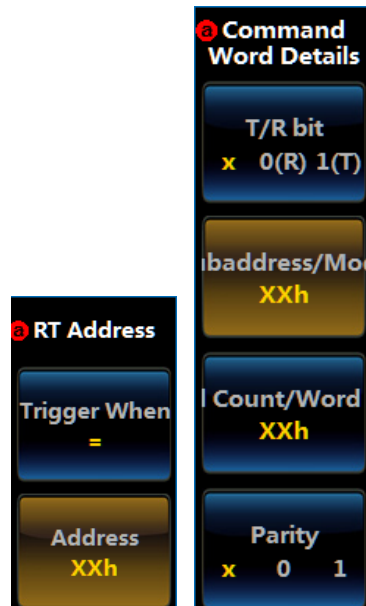


Fig. 11.233 1553 Command Trigger Setup Menu

Status

Click [Status] key, and select Status trigger.



Fig. 11.234 1553 Status Trigger Menu

Click [RT Address] key, pop up the RT Address Level2 Menu, and set the Trigger When and Address.

Click [Status Word Bits] key, pop up the Command Word Level2 Menu, and set Message Error, Instr., Service Req, BCR, Busy, Subsystem Flag, DBCA, Terminal Flag and Parity.

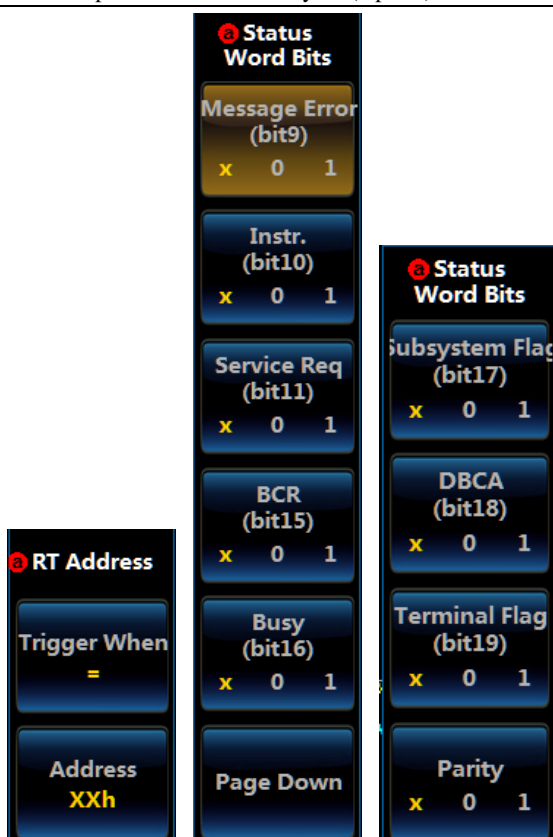


Fig. 11.235 1553 Status Trigger Setup Menu

Data

Click [Data] key, and select Data trigger.

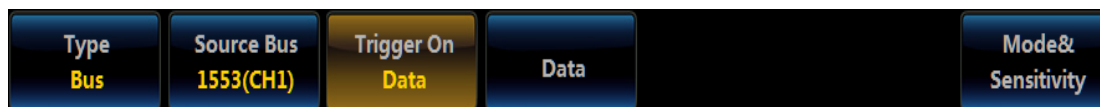


Fig. 11.236 1553 Data Trigger Menu

Click [Data] key, pop up the Data Trigger Level2 Menu, and set the input data and parity.

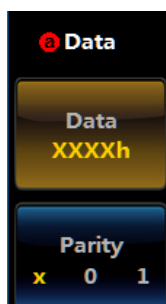


Fig. 11.237 1553 Data Trigger Setup Menu

Time

Click [Time] key, and select Time trigger.

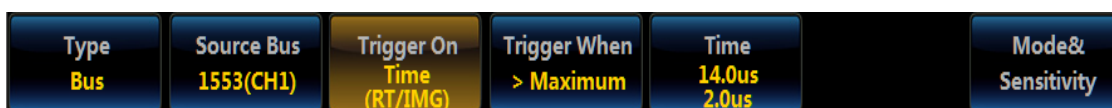


Fig. 11.238 1553 Time Trigger Menu

Click [Trigger When] key, pop up the Time Trigger When Level2 Menu, and set the Trigger When.

Click [Time] key, pop up the Time Setup Level2 Menu, and set the max. time and min. time.

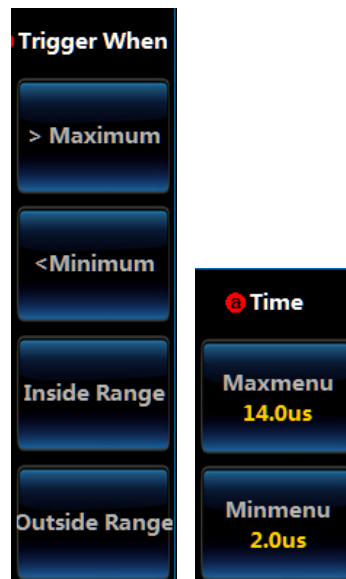


Fig. 11.239 1553 Time Trigger Setup Menu

Error

Click [Error] key, and select the Error trigger.

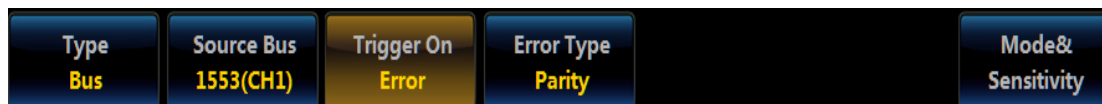


Fig. 11.240 1553 Error Trigger Menu

Click [Error Type] key, pop up the Error Type Level2 Menu, and select the Error Type.

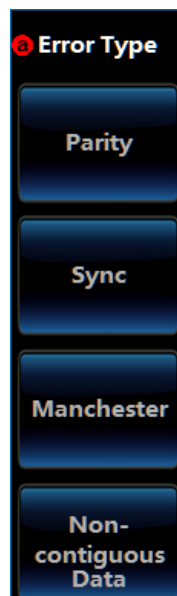


Fig. 11.241 1553 Error Trigger Setup Menu

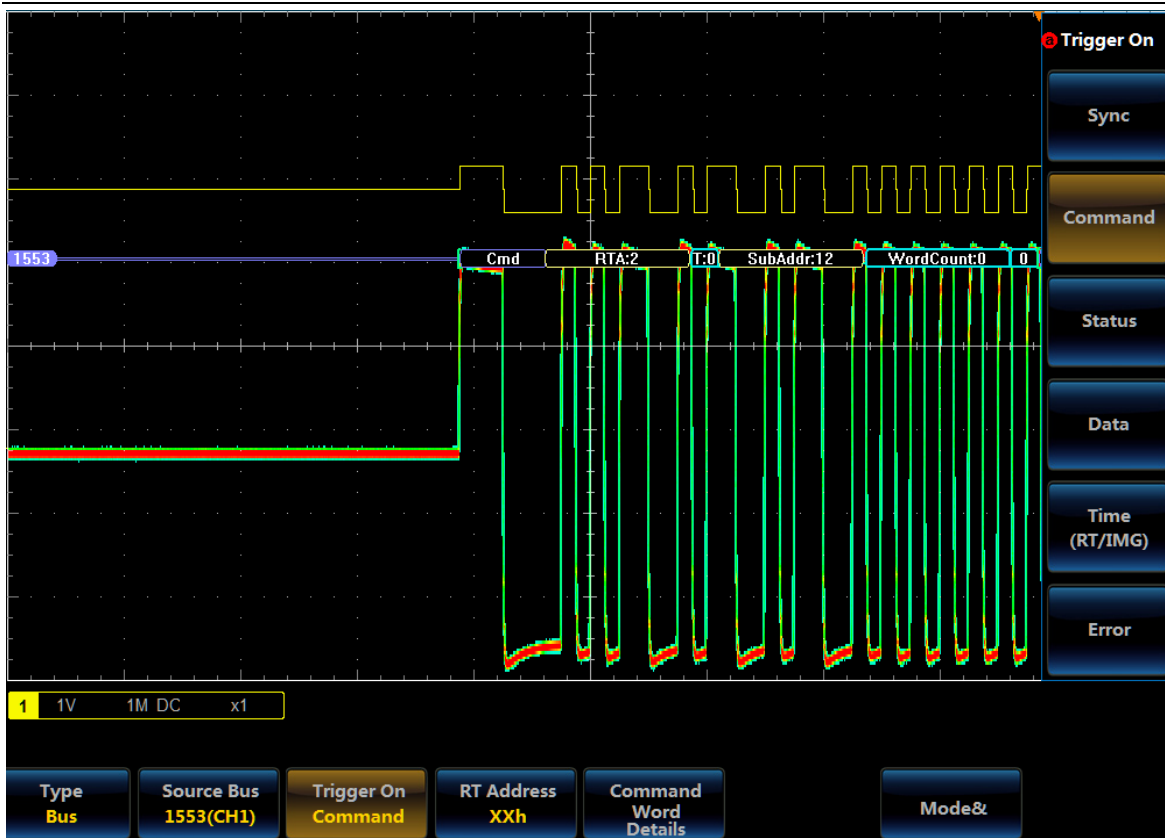


Fig. 11.242 1553 Trigger and Analysis Example

Chapter XII Limit/Mask Test (Option)

The 4456 series oscilloscope can monitor the input signal according to the mask, and determine whether the test passes or fails by judging the relationship between the input signal and the mask boundary range.

Press down **【Analyze】** key on the front panel, and open the Analysis menu.

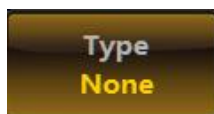


Fig. 12.1 Analysis Menu

Click [Type] menu key, select the “Limit/Mask Test” in the Type menu on the right side, and the Limit/Mask Test menu will be displayed at the bottom of the screen.

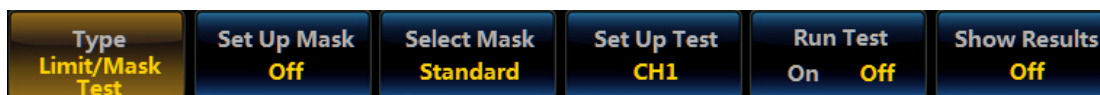


Fig. 12.2 Limit/Mask Test Menu

12.1 Set Up Mask

Click [Set Up Mask] menu key, and the Set Up Mask menu will pop up on the right side of the screen:

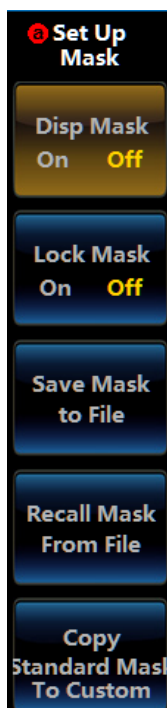


Fig. 12.3 Set Up Mask Menu

Disp Mask: Enable and disable the mask display.

Lock Mask: When it is enabled, the mask will change with horizontal and vertical parameters. When it is disabled, changes of horizontal and vertical parameters will not affect the mask display.

Save Mask to File: Save the currently displayed mask to a USB file.

Recall Mask from File: Read the mask file from the USB for display.

Copy Standard Mask To Custom: Copy the current standard mask into the custom mask to change the vertical margin for test.

The mask display interface is as follows:

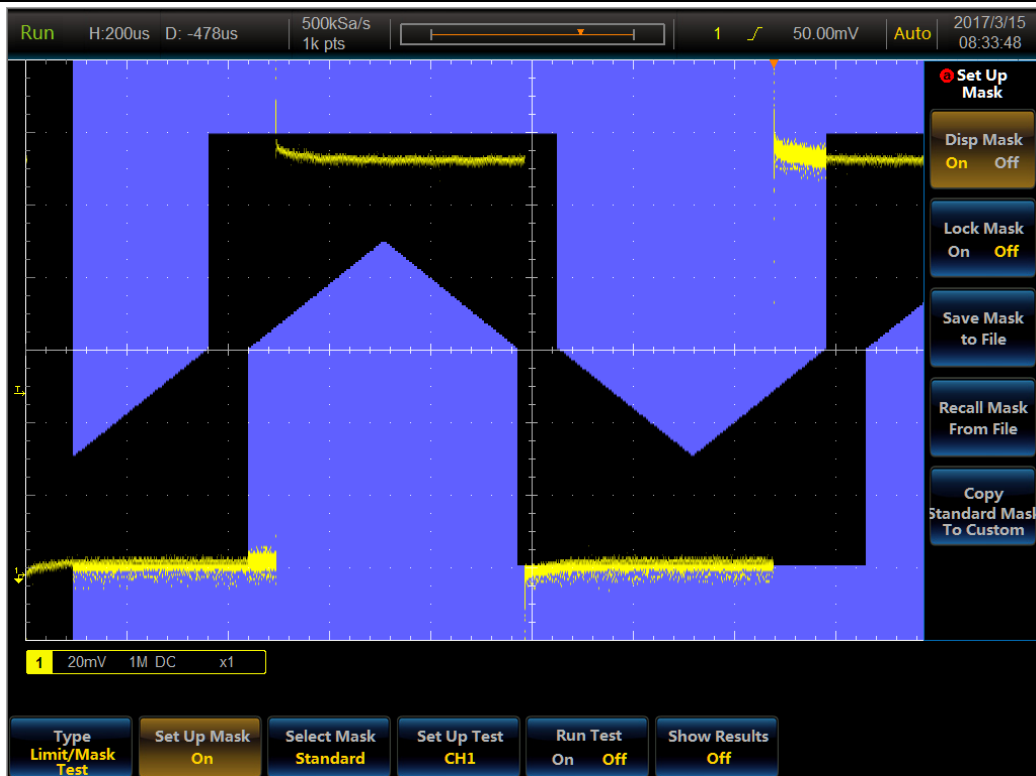


Fig. 12.4 Disp Mask Interface

12.2 Select Mask

Click [Select Mask] menu key, and the Select Mask menu will pop up on the right side of the screen:

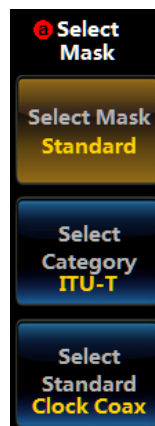


Fig. 12.5 Select Mask Menu

Select Mask: Standard, custom and limit test.

Standard mask: ITU-T, ANSI T1.102 and USB.

Custom mask: The vertical margin of the current mask can be adjusted within $\pm 50\%$.

Limit test: The current analog channel signal can be used to create the limit test mask.

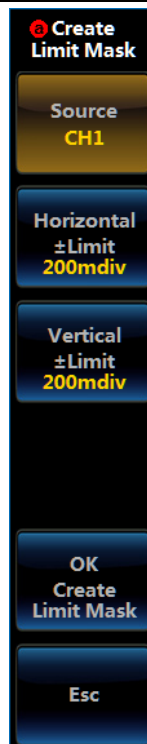


Fig. 12.6 Create Limit Mask Menu

Source: Select the analog channel to create the limit test mask.

Horizontal: Set the horizontal margin when the limit test mask is created. Adjustment range: 0 ~500 mdiv, with an increment of 1 mdiv.

Vertical: Set the vertical margin when the limit test mask is created. Adjustment range: 0 ~1 mdiv, with an increment of 1 mdiv.

Click [Create Limit Mask] menu key, and create the limit test mask according to current settings.

12.3 Set Up Test

Click [Set Up Test] menu key, and the Set Up Test menu will pop up on the right side of the screen:



Fig. 12.7 Set Up Test Menu

Source: The analog channel for executing the mask test.

Violation Threshold: When the violation count reaches the Violation Threshold, the test will fail. The Violation Threshold setting range is: 1 ~1,000,000, ∞.

Stop After: It means the test stop condition, and Waveforms or Time can be selected.

Waveforms/Time: Set the waveforms or test time when the test stops. The waveforms setting range is: 1 ~1,000,000, ∞, and the time setting range is: 1 s ~48 h, ∞.

Action on Failure: Select the action when the test fails, and None, Stop Acquire, Save Waveforms, Save Screen and AUX OUT can be selected. When selecting Save Waveforms or Save Screen, external USB shall be connected.

Action on Test Completion: Select the action when the test is completed, and None and AUX OUT can be selected.

Pre-Test Delay: Set the delay time before the test, and the settable scope is 0 s ~200 s.

Repeat on Completion: The function of restarting the test after on/off test is completed.

12.4 Run Test

Click [Run Test] menu key to enable and disable the limit/mask test.

12.5 Show Results

Click [Show Results] menu key, and the Show Results selection menu will pop up on the right side of the screen:

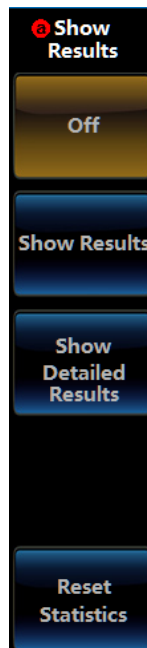


Fig. 12.8 Show Results Menu

Click the corresponding option button to display the result. When selecting "Show Detailed Results", the test data of each segment of mask will be displayed in the Show Results window.

Chapter XIII Power Measurement and Analysis (Option)

The 4456 series oscilloscope can measure and analyze the signal in aspects of Power Quality, Switching Loss, Harmonics, Ripple, Modulation, Safe Operating Area and Conversion Rate through input signals of the analog channel.

Press down **【Analyze】** key on the front panel, and open the Analysis menu.



Fig. 13.1 Analysis Menu

Click [Type] menu key, select the “Power Analysis” in the Type menu on the right side, and the Power Analysis menu will be displayed at the bottom of the screen.



Fig. 13.2 Power Analysis Menu

13.1 Measurement Type

Click [Analysis] menu key, and the Power Analysis Type will pop up on the right side of the screen:

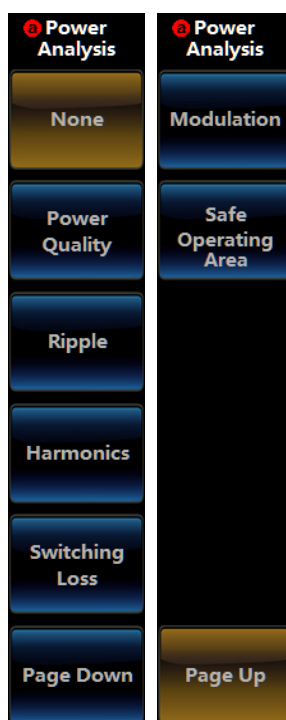


Fig. 13.3 Power Analysis Type Menu

13.2 Power Quality

Click [Power Quality] key of the Analysis menu, and the corresponding menu will be displayed at the bottom of the screen:

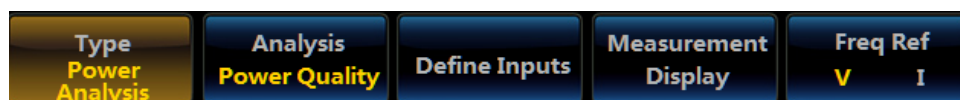


Fig. 13.4 Power Quality Operation Menu

13.2.1 Define Inputs

Click [Define Inputs], and the menu will pop up on the right side of the screen:

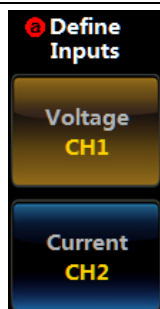


Fig. 13.5 Define Inputs Operation Menu

Click [Voltage] / [Current], and pop up the channel setting Level3 Menu:

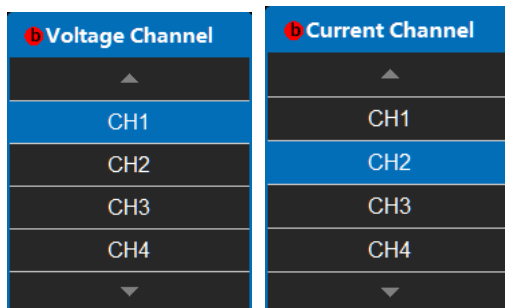


Fig. 13.6 Channel Setup Menu

13.2.2 Measurement Display

Click [Measurement Display], and the Measurement Display Setting Level2 Menu will pop up on the right side of the screen:

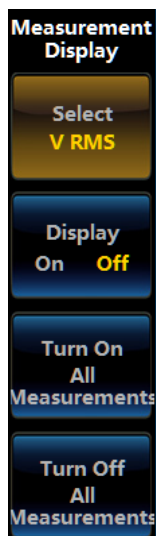


Fig. 13.7 Display Setup Menu

Click [Select], and pop up the Select list. After one option is clicked, the [Display/On Off] of the Level2 Menu can be used to set the display status. When the display is turned on, the measurement result of this option will be displayed in the measurement result area of the screen.

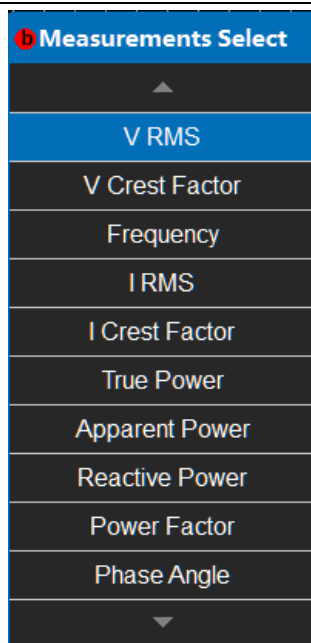


Fig. 13.8 Select Menu

Click [Turn On All Measurements], all the measurement results of Power Quality will be displayed.

Click [Turn Off All Measurements], no measurement results of Power Quality will be displayed.

13.2.3 Frequency Reference

Click [Freq Ref] to switch the Frequency Reference source to voltage signal or current signal.

13.3 Ripple

Click [Ripple] key of the Analysis menu, and the corresponding menu will be displayed at the bottom of the screen:

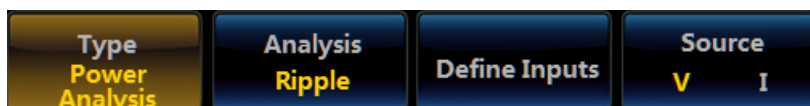


Fig. 13.9 Ripple Menu

13.3.1 Define Inputs

Click [Define Inputs], and the menu will pop up on the right side of the screen:

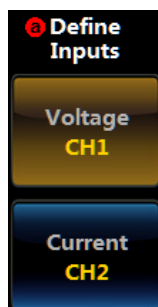


Fig. 13.10 Define Inputs Operation Menu

Click [Voltage]/[Current], and pop up the channel setting Level3 Menu:

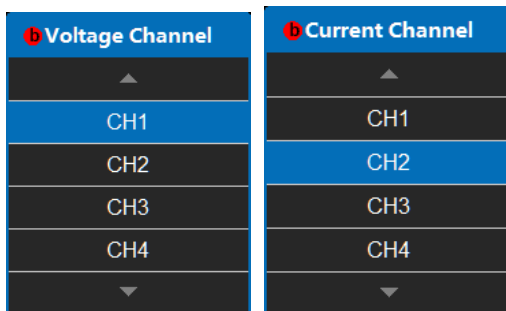


Fig. 13.11 Channel Setup Menu

13.3.2 Source

Click [Source], and select the voltage or current channel for ripple measurement.

13.4 Harmonics

Click [Harmonics] key of the Analysis menu, and the corresponding menu will be displayed at the bottom of the screen:

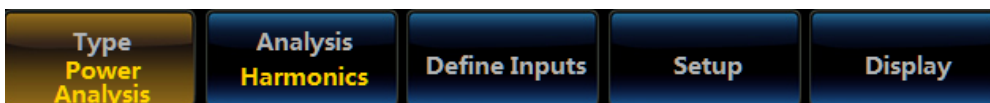


Fig. 13.12 Harmonics Menu

13.4.1 Define Inputs

Click [Define Inputs], and the menu will pop up on the right side of the screen:

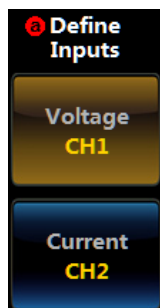


Fig. 13.13 Define Inputs Operation Menu

Click [Voltage] / [Current], and pop up the channel setting Level3 Menu:

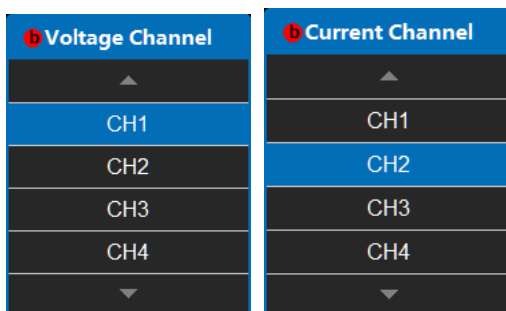


Fig. 13.14 Channel Setup Menu

13.4.2 Setup

Click [Setup], and the menu will pop up on the right side of the screen:

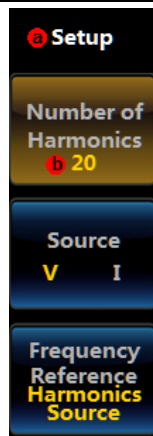


Fig. 13.15 Harmonics Setup Menu

Number of Harmonics: Set number of harmonics to be measured.

Source: Select the voltage or current channel for ripple measurement.

Frequency Reference: Set the harmonics measurement reference frequency.

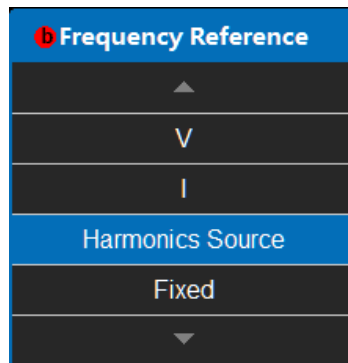


Fig. 13.16 Harmonics Frequency Setup Menu

V: Select the voltage channel signal as the harmonics measurement reference frequency.

I: Select the current channel signal as the harmonics measurement reference frequency.

Harmonics Source: Select the set harmonics source channel signal as the harmonics measurement reference frequency.

Fixed: Set a fixed frequency as the harmonics measurement reference frequency.

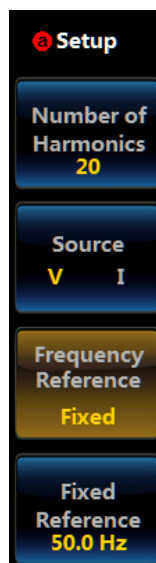


Fig. 13.17 Harmonics Fixed Frequency Reference Setup

13.4.3 Display

Click [Display], and the menu will pop up on the right side of the screen:

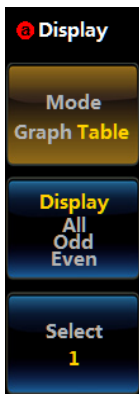


Fig. 13.18 Harmonics Display Setup

Mode: Select Graph or Table to display the harmonics measurement result.

Display: Select All, Odd and Even.

Select: Select the currently highlighted Number of Harmonics.

13.5 Switching Loss

Click [Switching Loss] key of the Analysis menu, and the corresponding menu will be displayed at the bottom of the screen:



Fig. 13.19 Switching Loss Menu

13.5.1 Define Inputs

Click [Define Inputs], and the menu will pop up on the right side of the screen:

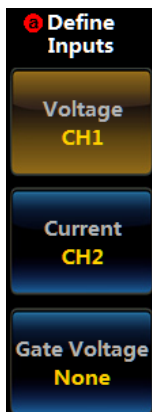


Fig. 13.20 Define Inputs Operation Menu

Click [Voltage] / [Current], and pop up the channel setting Level3 Menu:

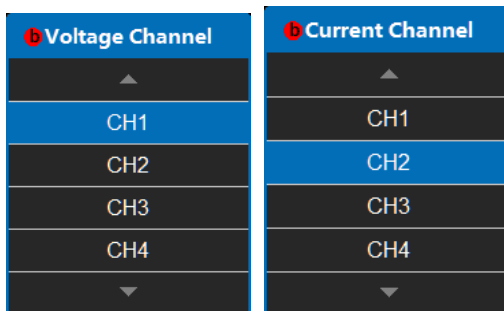


Fig. 13.21 Channel Setup Menu

Click [Gate Voltage], pop up the corresponding Level3 Operation Menu, and select the Gate Voltage channel as CH1 ~ CH4 and None. When selecting the analog channel, the polarity of the channel signal shall be set to Rise or Fall.

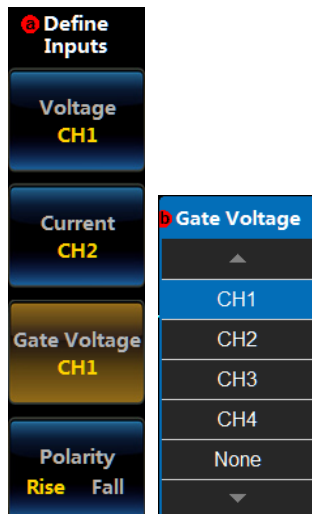


Fig. 13.22 Gate Voltage Setup Menu

13.5.2 Measurement Display

Click [Measurement Display], and the menu will pop up on the right side of the screen:

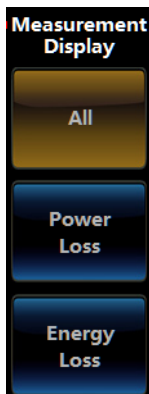


Fig. 13.23 Measurement Display Menu

All: Display all the measurement results.

Power Loss: Only display the power loss measurement results.

Energy Loss: Only display the energy loss measurement results.

13.5.3 Conduction Calculation

Click [Conduction Calculation], and the menu will pop up on the right side of the screen:

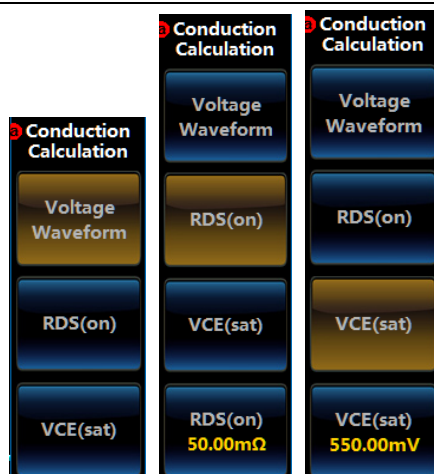


Fig. 13.24 Conduction Calculation Setting

Voltage Waveform: Select the voltage channel signal for conduction calculation.

RDS (on): Set the RDS (on) conduction resistance for conduction calculation.

VCE (sat): Set the VCE (sat) voltage for conduction calculation.

13.5.4 Reference Levels

Click [Reference Levels], and the Reference Levels setup menu will pop up on the right side of the screen. When the Gate Voltage channel is set, its Reference Levels shall also be set.

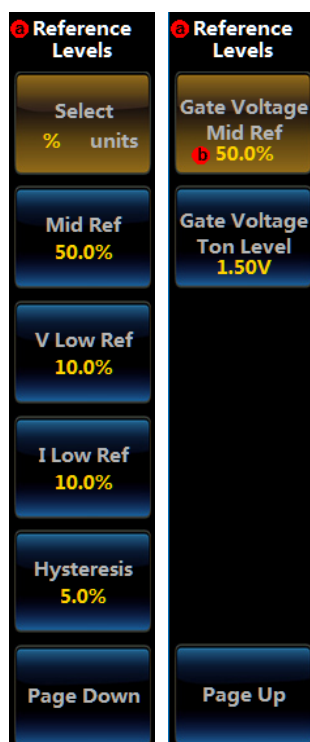


Fig. 13.25 Reference Levels Setup

The Reference Levels in can be set to % or units.

13.6 Modulation

Click [Modulation] key of the Analysis menu, and the corresponding menu will be displayed at the bottom of the screen:

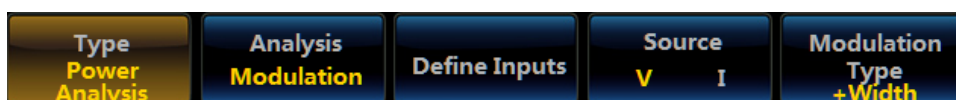


Fig. 13.26 Modulation Menu

13.6.1 Define Inputs

Click [Define Inputs], and the menu will pop up on the right side of the screen:

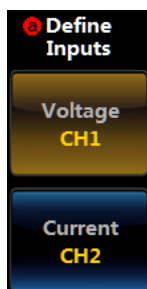


Fig. 13.27 Define Inputs Operation Menu

Click [Voltage] / [Current], and pop up the channel setting Level3 Menu:

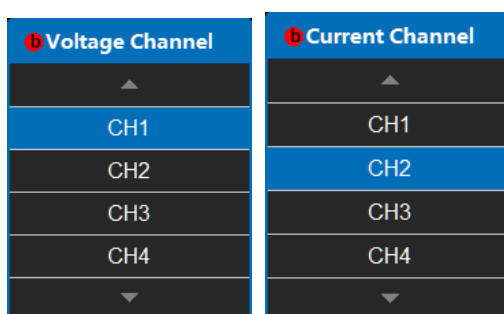


Fig. 13.28 Channel Setup Menu

13.6.2 Source

Click [Source], and select the voltage or current signal for measurement.

13.6.3 Modulation Type

Click [Modulation Type], and the Modulation Type option menu will pop up on the right side of the screen. Click the required measurement type.

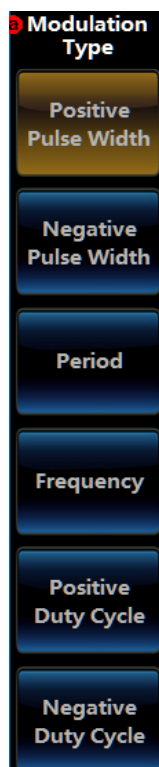


Fig. 13.29 Modulation Type

13.7 Safe Operating Area

Click [SOA] key of the Analysis menu, and the corresponding menu will be displayed at the bottom of the screen:

Attention: When SOA is selected, if the logic analyzer is enabled, it will automatically disable the logic analyzer.

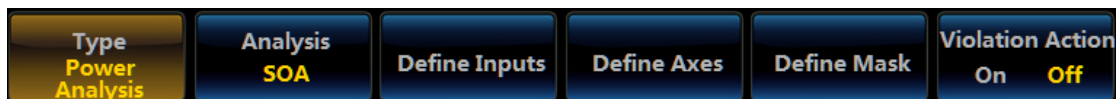


Fig. 13.30 Safe Operating Area Menu

13.7.1 Define Inputs

Click [Define Inputs], and the menu will pop up on the right side of the screen:

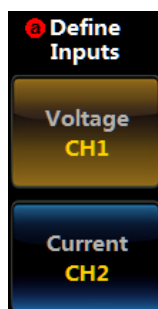


Fig. 13.31 Define Inputs Operation Menu

Click [Voltage] / [Current], and pop up the channel setting Level3 Menu:

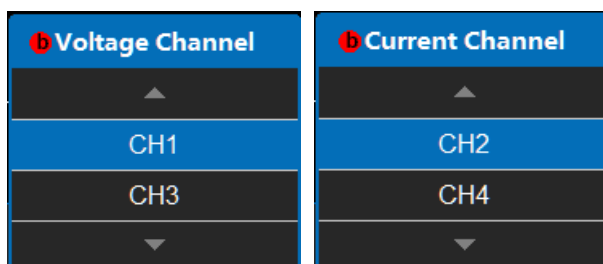


Fig. 13.32 Channel Setup Menu

The measurement of the Safe Operating Area needs two-way input signals, CH1/CH2 is a group, and CH3/CH4 is a group, namely, when the voltage channel is set to CH1, the corresponding current channel will be automatically set to CH2.

13.7.2 Define Axes

Click [Define Axes], and the Define Axes menu will pop up on the right side of the screen:



Fig. 13.33 Define Axes Menu

Axes Type: The coordinates scale can be set to Log and Linear.

Y Axis Max, Y Axis Min, X Axis Max, X Axis Min: Set the Max and Min of the coordinates scale.

13.7.3 Define Mask

Click [Define Mask], and the Mask setup menu will pop up on the right side of the screen:



Fig. 13.34 Define Mask Menu

Mask set: The mask can be set to Limits and Points.

When selecting “Limits”, set the max. voltage, max. current and max. power of the mask.

When selecting “Points”, set the points of the mask and voltage and current of each point. It can also be Insert Point and Delete Point.

13.7.4 Violation Stop

Click [Violation Stop] to set the on/off status of the Violation Stop.

Chapter XIV Logic Analyzer (Option)

The 4456 series provides the logic analyzer hardware option. The logic analyzer system and oscilloscope system are organically combined, which use the common horizontal system, trigger system and measurement system, provide cursor measurement and parameter measurement for digital signal, and can help you solve the design and analysis problems of analog-digital signal quickly. For details of the horizontal setting of logic analyzer, see Chapter IV “Horizontal System”, for details of the trigger setting, see Chapter V “Trigger System”, for details of the parameter measurement, see Chapter VI “Measurement System”.

The parameters of logic analyzer are as shown in the following Table:

Table 14.1 Parameters of Logic Analyzer

Logical analyzer	Digital channels	16
	Threshold grouping	Pod 1: D7 ~ D0, Pod2: D15 ~ D8
	Threshold selection	TTL (1.4 V), 5VCMOS (2.5 V), 3.3VCMOS (1.65 V), 2.5VCMOS (1.25 V), ECL (-1.3 V), PECL (3.7 V), user-defined
	User-defined threshold range	± 20 V, with an increment of 10 mV
	Threshold precision	$\pm (150 \text{ mV} + 3\% \text{ of threshold setting})$
	Maximum input voltage	± 40 V peak-peak value
	Input dynamic range	± 10 V relative to the threshold
	Minimum voltage amplitude	400mVpp
	Maximum input switching rate	400MHz
	Termination	100 k Ω $\pm 1\%$
	Vertical resolution	1bit
	Timing sample rate	2.5 GSa/s
	Memory depth	500 Mpts/CH (C/D/E)、200 Mpts/CH (CM/DM/EM)
	Minimum detection pulse width	2ns
Inter channel delay error	3.2ns	

14.1 Enable/disable digital logic

The logical analyzer option supports waveform color display of 16 digital channels, and you can change the height of each channel waveform and its display position on the screen. You can also flexibly group digital channels and display them with labels. After the grouping, all channels in the group can be positioned, so as to shorten the setting time required for traditional channel positioning one by one.

Press down **【Digital】** key in the Function Area on the front panel, and the logic function menu will pop up (if no logic analyzer hardware option is purchased, the corresponding prompt information will be given), and 16 digital waveforms will be displayed in the waveform window area.

Press down **【Digital】** key again to close the digital waveform and function menu.

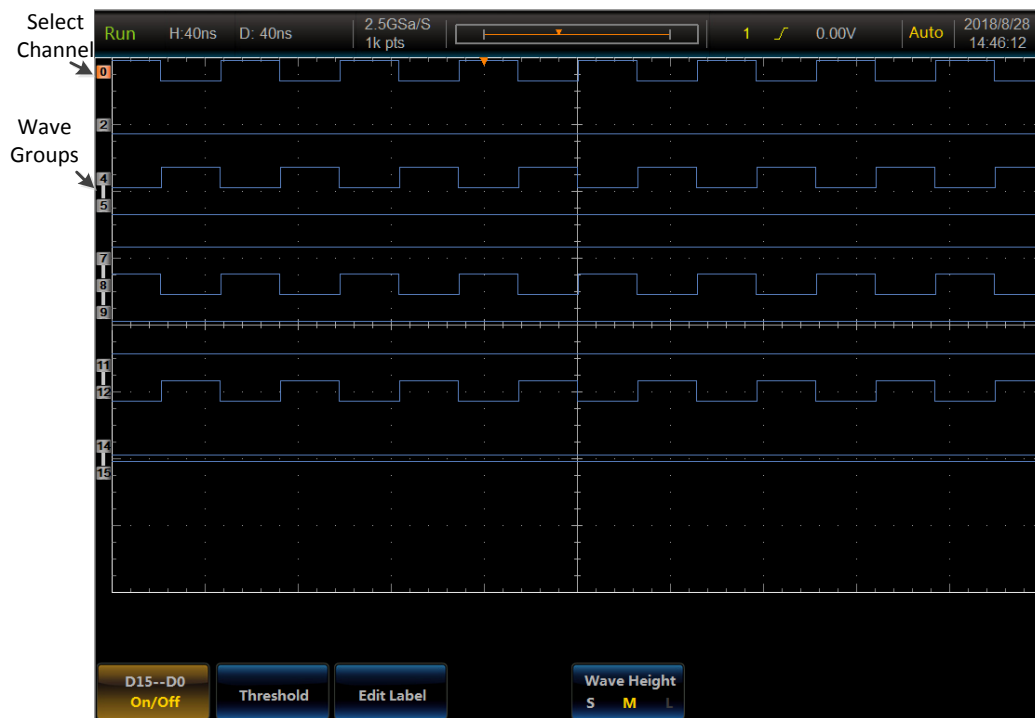


Fig. 14.1 Digital Waveform Example

The [Logic Function] menu will be displayed at the bottom of the screen.

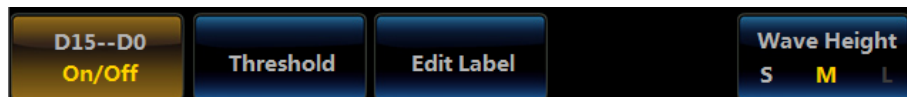


Fig. 14.2 Logic Function Menu

Function of each button on [Logic Function] menu:

D15--D0: Open the Level2 Menu for controlling the digital channel switch;

Threshold: Open the Level2 Menu for setting the digital channel threshold;

Edit Label: Open the Level2 Menu for editing the digital channel label;

Wave Height: Adjust the digital waveform height. There are S, M and L height categories. When the number of digital waveforms displayed in the window area is no more than 10, the height category L will be valid.

Click [D15--D0], [Thresholds] and [Edit Label] keys, and the corresponding Level2 Menu will pop up. The functions of these Level2 Menus will be introduced hereinafter.

14.2 D15--D0 On/Off

Click [D15--D0] menu key, and the D15--D0 On/off menu will be displayed on the right side.

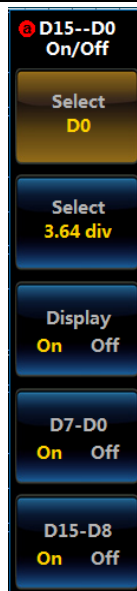


Fig. 14.3 D15--D0 On/Off Menu

Function of each key on [D15--D0 On/Off] menu:

Select: Select the waveform. Click to open the Level3 Menu. The waveform selection list includes combination of 16 channels and waveforms. Waveform combination: the adjacent waveform will be organized into a group, which will change dynamically in the list along with the open/close/move waveform.

Select: Adjust to select the waveform position. After clicking, the focus of the operation Multipurpose b is located on the button, and you can adjust Multipurpose b to change the waveform position. The center horizontal axis in the waveform window area is the reference 0 div, from top to bottom, +4 div ~ -4 div.

Display: Enable/disable channel selection.

D7-D0: Turn on/off D7-D0 at the same time.

D15-D8: Turn on/off D15-D8 at the same time.

Channel	On/Off
	▲
D10	√
D11	√
D12	√
D13	√
D14	√
D15	√
0-1	
2-3	
4-5	
6-7	
10-11	
8-9-12-13	
14-15	
	▼

Fig. 14.4 Waveform Selection List Menu

14.3 Thresholds

Click [Thresholds] menu key, and the Thresholds menu will be displayed on the right side.

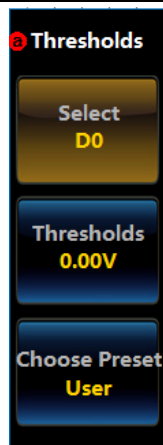


Fig. 14.5 Thresholds Menu

Function of each key on [Thresholds] menu:

Select: Select the waveform. Click to open the Level3 Menu, and the displayed channels will be displayed in the option list.

Thresholds: Adjust to select the waveform trigger level. After clicking, the focus of the operation Multipurpose b is located on the key, and you can adjust Multipurpose b to change the waveform trigger level.

Choose Preset: Automatically set the thresholds of the specific level signal, and the specific level includes TTL, CMOS and ECL.

b Family	Value
▲	
User	0.00V
TTL	1.40V
5.0V CMOS	2.50V
3.3V CMOS	1.65V
2.5V CMOS	1.25V
ECL	-1.30V
PECL	3.70V
0V	0.00V
▼	

Fig. 14.6 Choose Preset Menu

14.4 Edit Label

Click [Edit Label] menu key, and the Edit Label menu will be displayed on the right side.

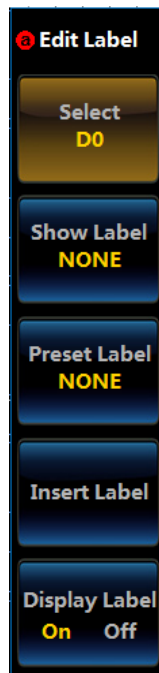


Fig. 14.7 Edit Label Menu

Select: Select the waveform. Click to open the Level3 Menu, and the option list includes 16 channels and its label names.

Show Label: Display the label name of the current channel. NONE means that the selected channel has no label name.

Preset Label: The system will provide common label names. Click to open the Level3 Menu, and it includes dozens of common label names.

Insert Label: Insert the label name for the selected channel.

Display Label: Display/hide the label name on the waveform.

b Preset Label	b Preset Label	b Preset Label
▲	▲	▲
NONE	DTACK	LOAD
ACK	ENABLE	NMI
AD0	HALT	OUT
ADDR	INT	PIN
ANALOG	IN	RAS
BIT	IRQ	READY
CAS	LATCH	RESET
CLK	LOAD	RX
CLOCK	NMI	SEND
CLR	OUT	SHIFT
COUNT	PIN	STROBE
DATA	RAS	TX
DTACK	READY	WR_
▼	▼	▼

Fig. 14.8 Choose Preset Label Menu

Chapter XV Waveform Generator (Option)

The 4456 series provides single-channel waveform generator hardware option, which can output standard waveforms such as Sine, Square and Ramp, as well as generates a number of modulation waveforms such as amplitude modulation, frequency modulation and key control. More importantly, it can generate any waveform edited by users and provide a number of built-in waveforms.

Table 15.1 Waveform Generator Option

Waveform generator	Channel	1
	Maximum output frequency	25MHz
	Maximum sample rate	200MSa/s
	Vertical resolution	14bit
	Output impedance	50Ω
	Modulation	AM, FM, FSK
	Output waveform	Standard waveforms: Sine, Square, Ramp, Pulse, DC and Noise Arbitrary: to be edited by users Built-in: Sin(x)/x, Exp Rise, Exp Decay, Gaussian, Lorentz, Haversine
	Sine	Frequency range: 0.1 Hz~25 MHz
	Square	Frequency range: 0.1 Hz~10MHz Duty ratio resolution: 0.1% or 5 ns (whichever is greater) Minimum pulse width: 40 ns
	Ramp	Frequency range: 0.1 Hz~1MHz Variable symmetry: 0~100%
	Pulse	Frequency range: 0.1 Hz~10MHz Minimum pulse width: 40 ns
	DC	Offset scope: -1.25 V ~ 1.25 V
	Noise	Bandwidth: 25 MHz
	Arbitrary	Frequency range: 0.1 Hz~10MHz Waveform length: 2~16,384
Built-in	Frequency range: 0.1 Hz~1MHz	

Press down **【WaveGen】** key in the Function Area on the front panel, and open WaveGen menu (if no waveform generator hardware option is purchased, the corresponding prompt information will be given). For different waveform types, the WaveGen menu will be adjusted accordingly. The corresponding menus of different waveforms are slightly different, as shown in the description of waveform types.



Fig. 15.1 WaveGen Menu

15.1 Waveforms

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, open the Waveforms menu on the right side of the screen, and click the corresponding options to select the corresponding type.

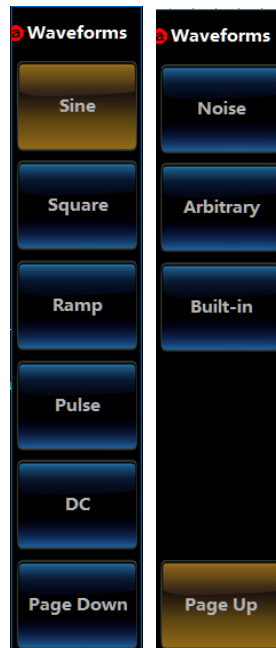


Fig. 15.2 Waveforms Menu

15.1.1 Sine

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [Sine] key, set the waveform to Sine, and adjust the WaveGen menu to corresponding menu of Sine after selection:



Fig. 15.3 WaveGen Menu (Sine)

Frequency/Period

Click [Frequency] or [Period] key, and the Frequency/Period menu will pop up on the right side of the screen:

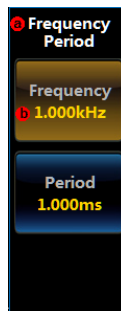


Fig. 15.4 Frequency/Period Menu

Click [Frequency] menu key to set the waveform frequency through the Multipurpose b or numeric keypad. The WaveGen menu will display the frequency value, with the frequency adjustment range of 100 mHz ~25 MHz.

Click [Period] menu key to set the waveform period through the Multipurpose b or numeric keypad. The WaveGen menu will display the frequency value, with the period adjustment range of 40 ns ~ 10 s.

Amplitude/High

Click [Amplitude] or [High] key, and the Amplitude/High menu will pop up on the right side of the screen:



Fig. 15.5 Amplitude/High Menu

Click [Amplitude] menu key to set the waveform amplitude through the Multipurpose b or numeric keypad. The WaveGen menu will display the amplitude and offset value, with the amplitude adjustment range of 10 mV ~ 2.5 V.

Click [High] menu key to set the waveform high level through the Multipurpose b or numeric keypad. The WaveGen menu will display the high level and low level value, with the high level adjustment range of -1.245 V ~ 2.5 V.

Offset/Low

Click [Offset] or [Low] key, and the Offset/Low menu will pop up on the right side of the screen:

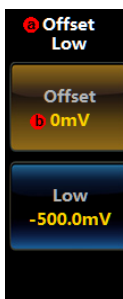


Fig. 15.6 Offset/Low Menu

Click [Offset] menu key to set the waveform offset through the Multipurpose b or numeric keypad. The WaveGen menu will display the amplitude and offset value, with the offset adjustment range of -1.25 V ~ 1.25 V.

Click [Low] menu key to set the waveform low level through the Multipurpose b or numeric keypad. The WaveGen menu will display the high level and low level value, with the low level adjustment range of -2.5 V ~ 1.245 V.

15.1.2 Square

Press down **WaveGen** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [Square] key, set the waveform to Square, and adjust the WaveGen to corresponding menu of Square after selection:



Fig. 15.7 WaveGen Menu (Square)

Frequency/Period

Click [Frequency] or [Period] key, and the Frequency/Period menu will pop up on the right side of the screen. The Frequency or Period can be set, with the frequency adjustment range of 100 mHz ~10 MHz and the period adjustment range of 100 ns ~ 10 s.

Amplitude/High

Click [Amplitude] or [High] key, and the Amplitude/High menu will pop up on the right side of the screen. The Amplitude or High can be set, with the amplitude adjustment range of 10 mV ~ 2.5 V and the high level adjustment range of -1.245 V ~ 2.5 V.

Offset/Low

Click [Offset] or [Low] key, and the Offset/Low menu will pop up on the right side of the screen. The Offset or

Low can be set, with the offset adjustment range of -1.25 V~1.25 V and the low level adjustment range of -2.5 V ~ 1.245 V.

15.1.3 Ramp

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [Ramp] key, set the waveform to Ramp, and adjust the WaveGen to corresponding menu of Ramp after selection:

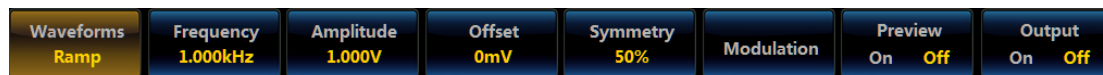


Fig. 15.8 WaveGen Menu (Ramp)

Frequency/Period

Click [Frequency] or [Period] key, and the Frequency/Period menu will pop up on the right side of the screen. The Frequency or Period can be set, with the frequency adjustment range of 100 mHz ~1MHz and the period adjustment range of 1 us ~ 10 s.

Amplitude/High

Click [Amplitude] or [High] key, and the Amplitude/High menu will pop up on the right side of the screen. The Amplitude or High can be set, with the amplitude adjustment range of 10 mV ~ 2.5 V and the high level adjustment range of -1.245 V ~ 2.5 V.

Offset/Low

Click [Offset] or [Low] key, and the Offset/Low menu will pop up on the right side of the screen. The Offset or Low can be set, with the offset adjustment range of -1.25 V~1.25 V and the low level adjustment range of -2.5 V ~ 1.245 V.

Symmetry

Click [Symmetry] key, and the Symmetry menu will pop up on the right side of the screen:

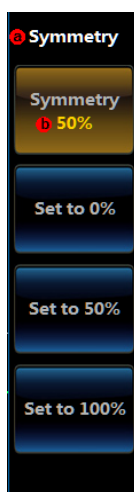


Fig. 15.9 Symmetry Menu

Click [Symmetry] menu key to set the ramp symmetry through the Multipurpose b or numeric keypad, with the Symmetry adjustment range of 0% ~ 100%.

Click [Set to 0%] menu key to quickly set the ramp symmetry to 0%.

Click [Set to 50%] menu key to quickly set the ramp symmetry to 50%.

Click [Set to 100%] menu key to quickly set the ramp symmetry to 100%.

15.1.4 Pulse

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [Pulse] key, set the waveform to Pulse, and adjust the WaveGen to corresponding menu of Pulse after selection:



Fig. 15.10 WaveGen Menu (Pulse)

Frequency/Period

Click [Frequency] or [Period] key, and the Frequency/Period menu will pop up on the right side of the screen. The Frequency or Period can be set, with the frequency adjustment range of 100 mHz ~10 MHz and the period adjustment range of 100 ns ~ 10 s.

Amplitude/High

Click [Amplitude] or [High] key, and the Amplitude/High menu will pop up on the right side of the screen. The Amplitude or High can be set, with the amplitude adjustment range of 10 mV ~ 2.5 V and the high level adjustment range of -1.245 V ~ 2.5 V.

Offset/Low

Click [Offset] or [Low] key, and the Offset/Low menu will pop up on the right side of the screen. The Offset or Low can be set, with the offset adjustment range of -1.25 V ~1.25 V and the low level adjustment range of -2.5 V ~ 1.245 V.

Duty Cycle

Click [Duty] key, and the Duty menu will pop up on the right side of the screen:

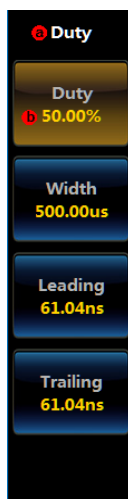


Fig. 15.11 Duty Menu

Click [Duty] menu key to set the Duty through the Multipurpose b or numeric keypad, and the value range is related to the pulse output frequency.

Click [Width] menu key to set the Width through the Multipurpose b or numeric keypad, and the value range is related to the pulse output frequency, with the min. width of 40 ns.

Click [Leading] menu key to set the Leading through the Multipurpose b or numeric keypad, and the value range is related to the pulse width, with the min. Leading of 20 ns.

Click [Trailing] menu key to set the Trailing through the Multipurpose b or numeric keypad, and the value range is related to the pulse width, with the min. Trailing of 20 ns.

15.1.5 DC

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [DC] key, set the waveform to DC, and adjust the WaveGen to corresponding menu of DC after selection:

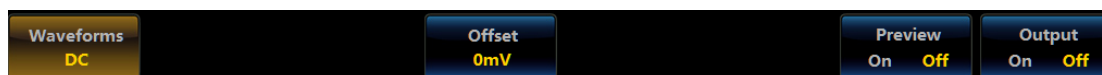


Fig. 15.12 WaveGen Menu (DC)

Offset

Click [Offset] key, and the Offset menu will pop up on the right side of the screen:



Fig. 15.13 DC Offset Menu

Click [Offset] menu key to set the DC offset through the Multipurpose b or numeric keypad, with the value range of -1.25 V ~ 1.25 V.

15.1.6 Noise

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [Noise] key, set the waveform to Noise, and adjust the WaveGen to corresponding menu of Noise after selection:



Fig. 15.14 WaveGen Menu (Noise)

Amplitude/High

Click [Amplitude] or [High] key, and the Amplitude/High menu will pop up on the right side of the screen. The Amplitude or High can be set, with the amplitude adjustment range of 10 mV ~ 2.5 V and the high level adjustment range of -1.245 V ~ 2.5 V.

Offset/Low

Click [Offset] or [Low] key, and the Offset/Low menu will pop up on the right side of the screen. The Offset or Low can be set, with the offset adjustment range of -1.25 V~1.25 V and the low level adjustment range of -2.5 V ~ 1.245 V.

15.1.7 Arbitrary

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [Arbitrary] key, set the waveform to Arbitrary, and adjust the WaveGen to corresponding menu of Arbitrary after selection:



Fig. 15.15 WaveGen Menu (Arbitrary)

Frequency/Period

Click [Frequency] or [Period] key, and the Frequency/Period menu will pop up on the right side of the screen. The Frequency or Period can be set, with the frequency adjustment range of 100 mHz ~10 MHz and the period adjustment range of 100 ns ~ 10 s.

Amplitude/High

Click [Amplitude] or [High] key, and the Amplitude/High menu will pop up on the right side of the screen. The Amplitude or High can be set, with the amplitude adjustment range of 10 mV ~ 2.5 V and the high level adjustment range of -1.245 V ~ 2.5 V.

Offset/Low

Click [Offset] or [Low] key, and the Offset/Low menu will pop up on the right side of the screen. The Offset or Low can be set, with the offset adjustment range of -1.25 V~1.25 V and the low level adjustment range of -2.5 V ~ 1.245 V.

Shape

Click [Shape] key, and the Shape menu will pop up on the right side of the screen:

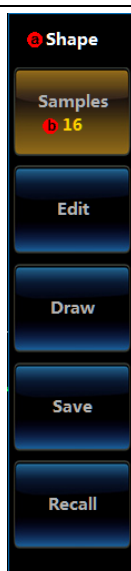


Fig. 15.16 Arbitrary Menu

Click [Samples] menu key to set the Samples through the Multipurpose b or numeric keypad, with the value range of 2 ~ 16,384 (the max. Samples is related to the Arbitrary frequency). Attention: Setup of Samples will offset the Samples voltage value.

Click [Edit] menu key to pop up the Arbitrary Samples Edit dialog box:

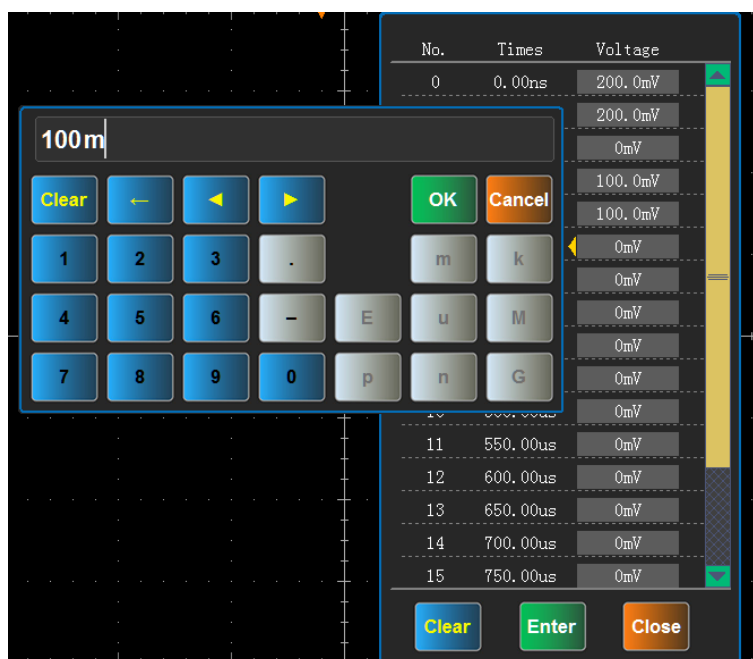


Fig. 15.17 Samples Edit

The dialog includes three parts, and the No. indicates the sequence of the Samples, starting from 0. The Times indicates the time value generated by the Samples. The Voltage indicates the output voltage of the Samples. Click [Clear] key in the dialog to set all the points to the offset center voltage value; click [Enter] key in the dialog to set all the points to the voltage value output, and click [Close] key in the dialog to close the dialog box.

Left click or touch the screen and click the Voltage area to pop up the numeric keypad, and set the corresponding Samples output voltage value through the numeric keypad. Right click or touch the screen and click the No. area or Times Area to pop up the right click menu, and carry out Samples Delete, Insert and Up/Down accordingly.

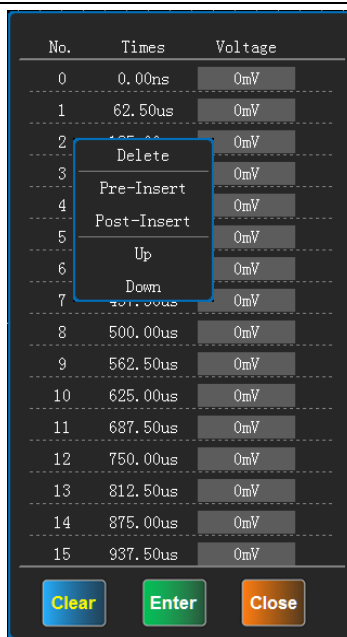


Fig. 15.18 Samples Edit Right Click Menu

Click [Draw] menu key to pop up the Arbitrary Samples Draw dialog box:

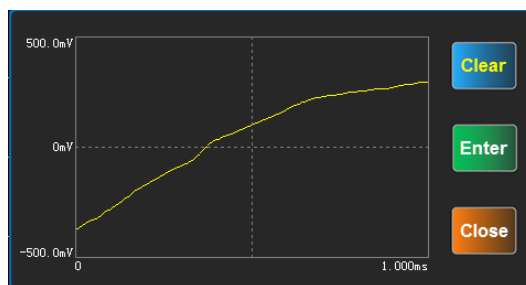


Fig. 15.19 Samples Draw

Draw any waveform by dragging the left mouse button or sliding across the touch screen. Click [Clear] key in the dialog to clear the drawn waveforms; click [Enter] key in the dialog to output the drawn waveforms, and click [Close] key in the dialog to close the dialog box.

Click [Save] menu key, pop up Arbitrary save dialog box, select save path, name the file name and then click Save to save waveform as a CSV file (.csv) or binary file (.bin). The default file name is 4456_AWG_YYYYMMDD_HHMMSS, among them the YYYYMMDD represents the information about the current date including year, month and day and the HHMMSS represents the information about the current time including hour, minute and second. The CSV file format saved for Arbitrary Wave is:

Table 15.2 Description of Arbitrary Wave CSV File Format

Content	Description
Model,ArbitraryWave	Description of file type
Samples,2	Saved samples
Period,1.000000e-003	Period value
Amplitude,1.000000	Amplitude value
Offset,0.000000	Offset value
ID,Voltage	Description of save information of samples
0,0.500000	No. and voltage of samples
1,-0.500000	

Click [Read] menu key, pop up the Arbitrary file opening dialog box. After the Arbitrary is selected, click to open the Arbitrary file to be read and saved.

The CSV waveform files saved by the Arbitrary-compatible oscilloscope can output waveforms acquired by the oscilloscope. However, due to limit of the Arbitrary sample rate and the Samples, not all the oscilloscope files can be recovered to Arbitrary Samples output. Generally, the oscilloscope waveform sample rate range is 1 kHz ~ 100 MHz, and the voltage waveform with the acquire depth of 1 K can be recovered.

The Arbitrary Wave supports CSV file edited by tools such as Excel or notepad, and its format shall be in strict accordance with the Arbitrary save CSV format, and its Samples, Period, Amplitude and Offset scope shall satisfy the Arbitrary exponent requirements.

15.1.8 Built-in

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Waveforms] key, and open the Waveforms menu on the right side of the screen. Click [Built-in] key, set the waveform to Built-in, and adjust the WaveGen to corresponding menu of Built-in after selection:



Fig. 15.20 WaveGen Menu (Built-in)

Frequency/Period

Click [Frequency] or [Period] key, and the Frequency/Period menu will pop up on the right side of the screen. The Frequency or Period can be set, with the frequency adjustment range of 100 mHz ~ 1MHz and the period adjustment range of 1 us ~ 10 s.

Amplitude/High

Click [Amplitude] or [High] key, and the Amplitude/High menu will pop up on the right side of the screen. The Amplitude or High can be set, with the amplitude adjustment range of 10 mV ~ 2.5 V and the high level adjustment range of -1.245 V ~ 2.5 V.

Offset/Low

Click [Offset] or [Low] key, and the Offset/Low menu will pop up on the right side of the screen. The Offset or Low can be set, with the offset adjustment range of -1.25 V ~ 1.25 V and the low level adjustment range of -2.5 V ~ 1.245 V.

Shape

Click [Shape] key, and the Shape menu will pop up on the right side of the screen:

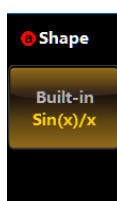


Fig. 15.21 Built-in Menu

Click [Built-in] menu key, and pop up the Built-in option menu:

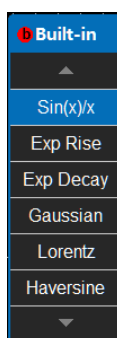


Fig. 15.22 Built-in Option Menu

The corresponding Built-in can be selected by directly clicking the Built-in option or by pressing down the Multipurpose b.

15.2 Modulation

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Modulation] key, and open the Modulation menu on the right side of the screen. Only the Sine, Square, Ramp, Arbitrary and Built-in have modulation functions, and the Pulse, DC and Noise can't be modulated.

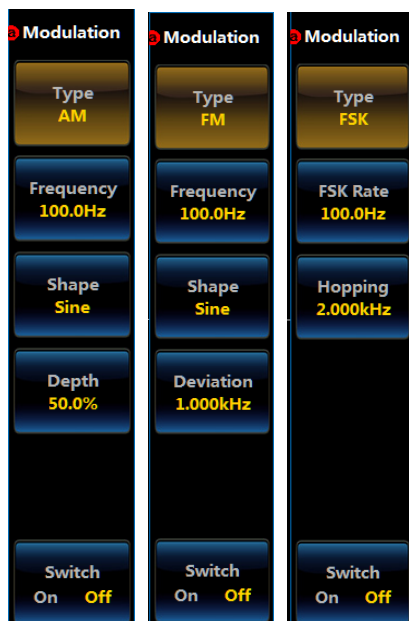


Fig. 15.23 AM, FM, FSK Modulation Menu

15.2.1 Modulation Type

Click [Type] menu key, and the Type option menu will pop up:

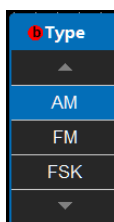


Fig. 15.24 Type Option Menu

The corresponding Type can be selected by directly clicking the Type option or by pressing down the Multipurpose b.

AM

The AM is an abbreviation for amplitude modulation, which means that the low frequency modulation signal is used to control the amplitude of the high frequency carrier signals to make the amplitude of carrier change with the change of the modulation signal.

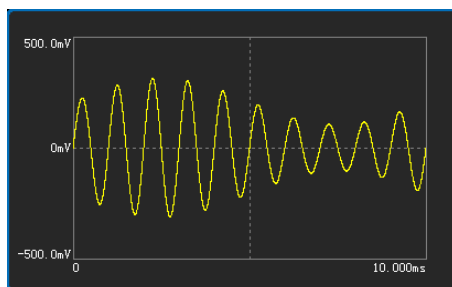


Fig. 15.25 Amplitude modulation

Click [Depth] menu key to set the AM Depth through the Multipurpose b or numeric keypad, with the value range of 0% ~ 120%.

FM

The FM is an abbreviation for frequency modulation, which means that the frequency of the carrier signal will change linearly with the amplitude of the modulation signal.

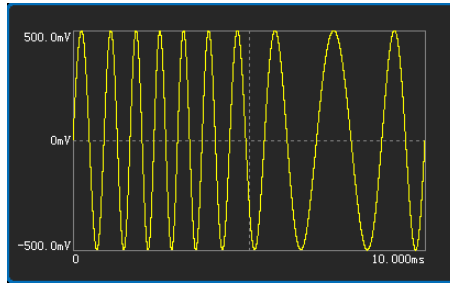


Fig. 15.26 Frequency modulation

Click [Deviation] menu key to set the FM deviation through the Multipurpose b or numeric keypad, with the value range of 0 ~ carrier frequency (the output after modulation will not exceed the max. output frequency).

FSK

The FSK, the short for frequency shift keying, means that the frequency of the output waveform will change with the change of the modulation signal. When the modulation signal is 1, the output frequency will be 1, and when the modulation signal is 0, the output frequency will be 2.

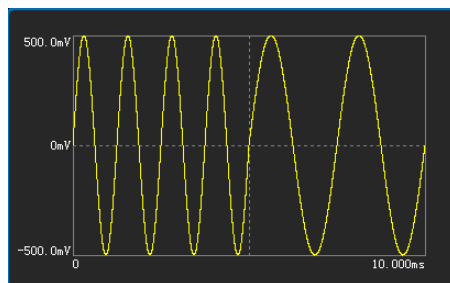


Fig. 15.27 Frequency Shift Keying

Click [Hopping] menu key to set the FSK Hopping Frequency through the Multipurpose b or numeric keypad, with the value range as follows: Sine: 100 mHz ~ 25 MHz; Square/Arbitrary: 100 mHz ~ 10 MHz; Ramp/Built-in: 100 mHz ~ 1 MHz.

15.2.2 Frequency/FSK Rate

Click [FM] menu key to set the AM and FM Frequency through the Multipurpose b or numeric keypad, with the value range of 100 mHz ~ 50 kHz.

Click [FSK Rate] menu key to set the FSK Rate through the Multipurpose b or numeric keypad, with the value range of 100 mHz ~ 1 MHz.

15.2.3 Shape

Click [Shape] menu key (FSK modulation waveform is Square, this option is unavailable), and pop up the Shape option menu:

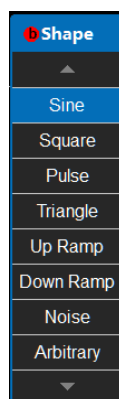


Fig. 15.28 Shape Option Menu

The corresponding Shape can be selected by directly clicking the Shape option or by pressing down the Multipurpose b. The pulse modulation waveform is the pulse waveform with 10% duty cycle. When the Arbitrary is set as the modulation wave, the Arbitrary waveform saved in the Arbitrary waveform file (binary file*.bin) shall be read.

15.2.4 Modulation switch

Click [Switch] menu key to enable/disable the modulation function.

15.3 Preview

In order to observe the output waveform more directly, it has the Preview function. The Preview window only completes the preview display of the waveform. The virtual waveform preview which is carried out according to the theoretical waveform calculated by setting the waveforms and parameters can help users analyze the waveform conditions more quickly and intuitively. The Preview window provides the display of the output waveform and parameters, and prompts the basic meaning of the parameters during setting.

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Preview] key, and open/close the Preview window.

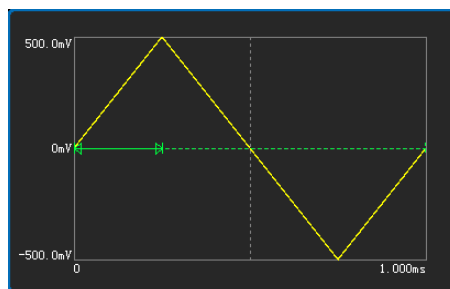


Fig. 15.29 Preview Window

15.4 Output

Press down **【WaveGen】** key on the front panel, open the WaveGen menu, click [Output] key, and enable/disable the Output function.

Chapter XVI Oscilloscope Probe (Option)

The 4456 series oscilloscope supports passive voltage probe, high voltage single end probe, high voltage differential probe, current probe and logic probe to satisfy the test requirements of probe in different cases.

16.1 P9350A passive voltage probe

As a passive single end probe, the P9350A passive voltage probe has a bandwidth of 350 MHz, fixed attenuation of 10:1 and input impedance of 10 M Ω , which supports automatic identification functions. It is a standard probe of 4456C/CM, which can be purchased by users. The option number is 4456-H14.

16.1.1 Operating Instructions

The P9350A probe is equipped with accessories for easy testing. Please be familiar with the description of relevant accessories before use to make better use of this product.

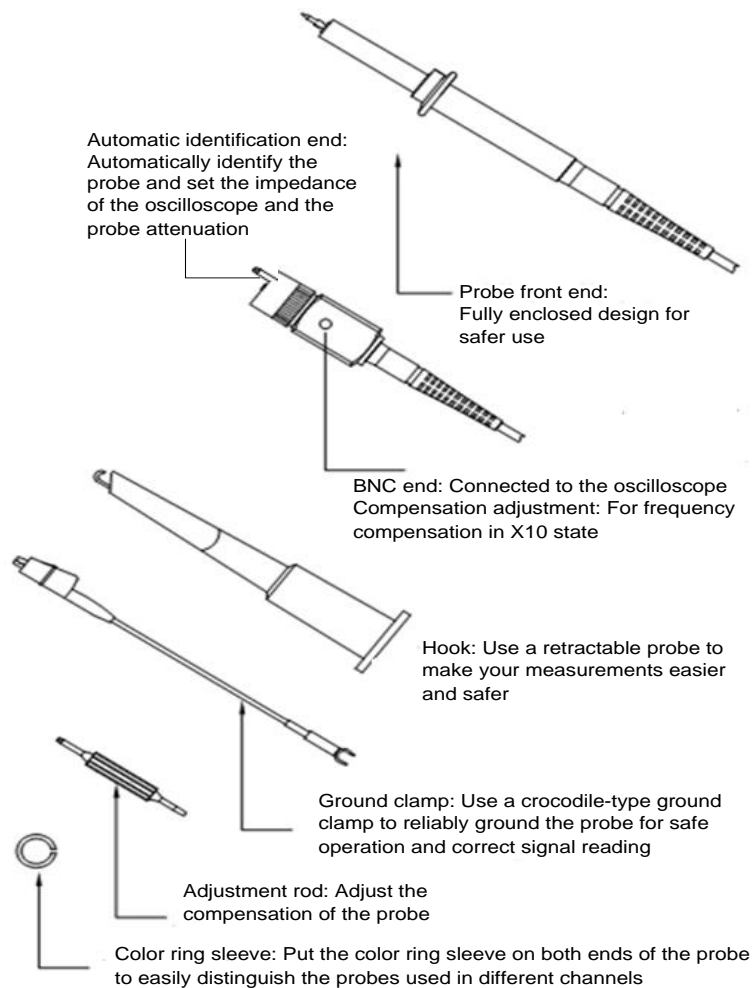


Fig. 16.1 Diagram of P9350A Probe Accessories

When the P9350A passive voltage probe is used, the input impedance of the oscilloscope is automatically set to 1M Ω , the probe type is automatically set to voltage, and the probe attenuation is automatically set to $\times 10$. To avoid the error caused by the probe connection, the probe should be connected to a probe calibration square wave signal on the front panel of the oscilloscope, with about 1 kHz frequency and 3 V_{pp} amplitude, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the compensation capacitance of the probe.

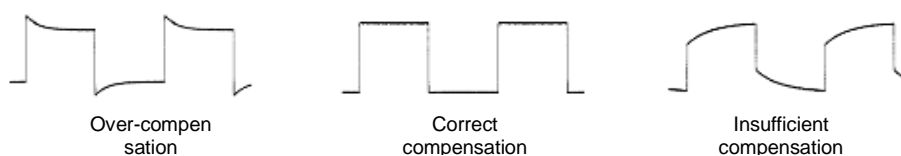


Fig. 16.2 Schematic Diagram of Probe Compensation



Warning: The maximum input voltage of the P9350A passive voltage probe is 300V (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.1.2 Main Parameters of Probe

The main parameters of the P9350A probe are shown in the table below.

Table 16.1 P9350A Probe Parameters

Model	P9350A
Bandwidth	350MHz
Termination	10MΩ ±2%
Input capacitance	10pF ±2pF
Attenuation ratio	10:1
Maximum input voltage	300V (DC+ACpk)
Capacitance compensation range	8-25pF
Probe length	140 ±2cm
Operating temperature	0-50°C
Storage temperature	-20-75°C

The maximum input voltage-frequency characteristic of the P9350A is shown in the figure below.

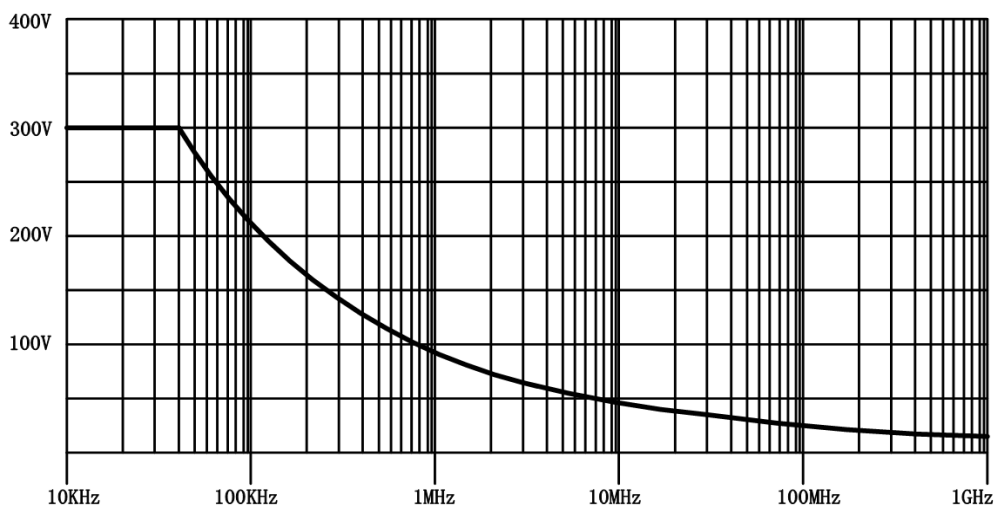


Fig. 16.3 P9350A Probe Maximum Input Voltage-Frequency Characteristic Diagram

16.2 P9550A passive voltage probe

As a passive single end probe, the P9550A passive voltage probe has a bandwidth of 500MHz, fixed attenuation of 10:1 and input impedance of 10 MΩ, which supports automatic identification functions. It is a standard probe of 4456D/DM/E/EM. It can be purchased by users. The option number is 4456-H12.

16.2.1 Operating Instructions

The P9550A probe is equipped with accessories for easy testing. Please be familiar with the description of relevant accessories before use to make better use of this product.



Warning: The maximum input voltage of the P9550A passive voltage probe is 300V (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

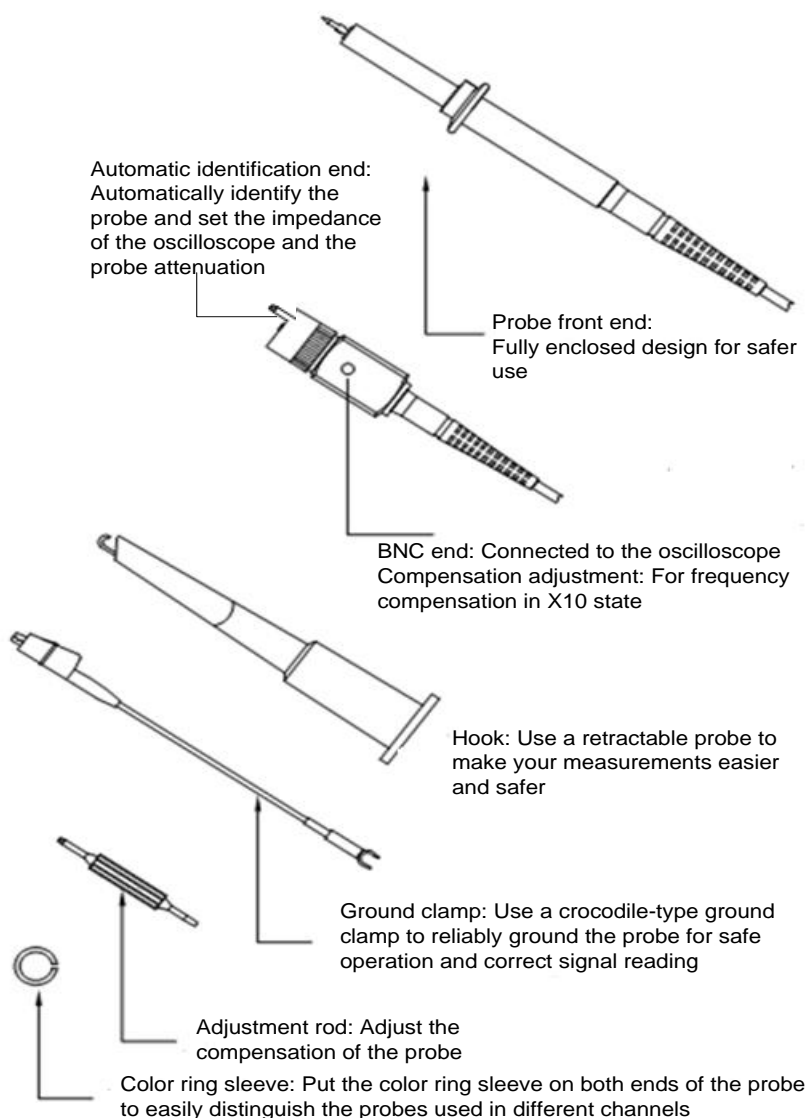


Fig. 16.4 Diagram of P9550A Probe Accessories

When the P9550A passive voltage probe is used, the input impedance of the oscilloscope is automatically set to $1\text{M}\Omega$, the probe type is automatically set to voltage, and the probe attenuation is automatically set to $\times 10$. To avoid the error caused by the probe connection, the probe should be connected to a probe calibration square wave signal on the front panel of the oscilloscope, with about 1 kHz frequency and 3 V_{pp} amplitude, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the compensation capacitance of the probe.

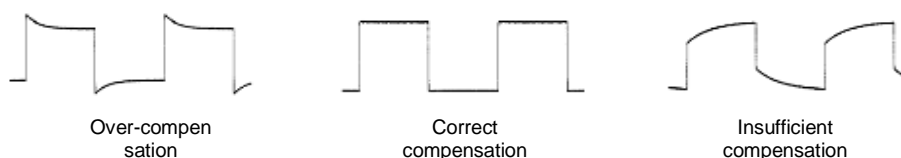


Fig. 16.5 Schematic Diagram of Probe Compensation

16.2.2 Main Parameters of Probe

The main parameters of the P9550A probe are shown in the table below.

Table 16.2 Table of P9550A Probe Parameters

Model	P9550A
Bandwidth	500MHz
Termination	10M Ω \pm 2%
Input capacitance	10pF \pm 2pF
Attenuation ratio	10:1
Maximum input voltage	300VDC+ACpk
Capacitance compensation range	8-25pF
Probe length	140 \pm 2cm
Operating temperature	0-50 $^{\circ}$ C
Storage temperature	-20-75 $^{\circ}$ C

The maximum input voltage-frequency characteristic of the P9550A is shown in the figure below.

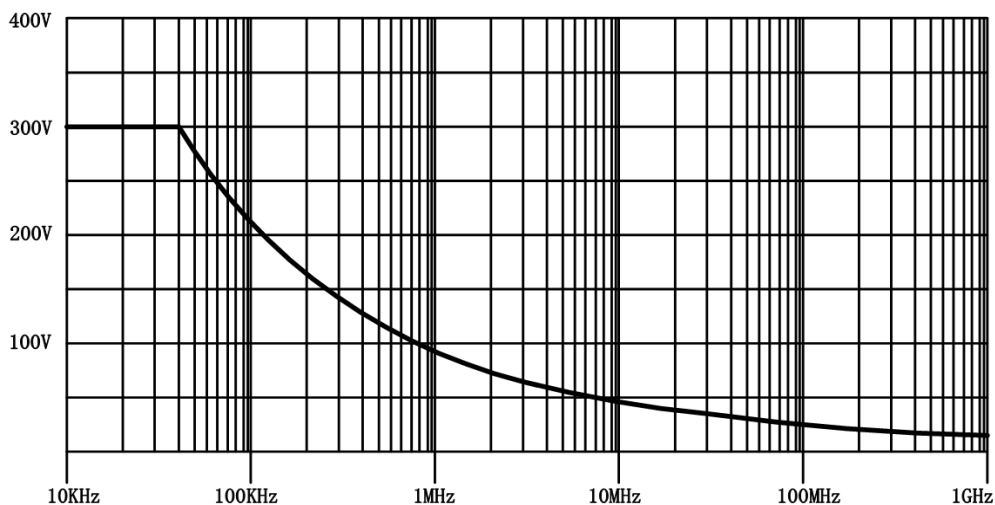


Fig. 16.6 P9550A Probe Maximum Input Voltage-Frequency Characteristic Diagram

16.3 P9551 passive voltage probe

As a passive single end probe, the P9551 passive voltage probe has a bandwidth of 500MHz, fixed attenuation of 10:1 and input impedance of 10 M Ω , which does not support automatic identification functions. It can be purchased by users. The option number is 4456-H13.

16.3.1 Operating Instructions

The P9551 probe is equipped with accessories for easy testing. Please be familiar with the description of relevant accessories before use to make better use of this product.

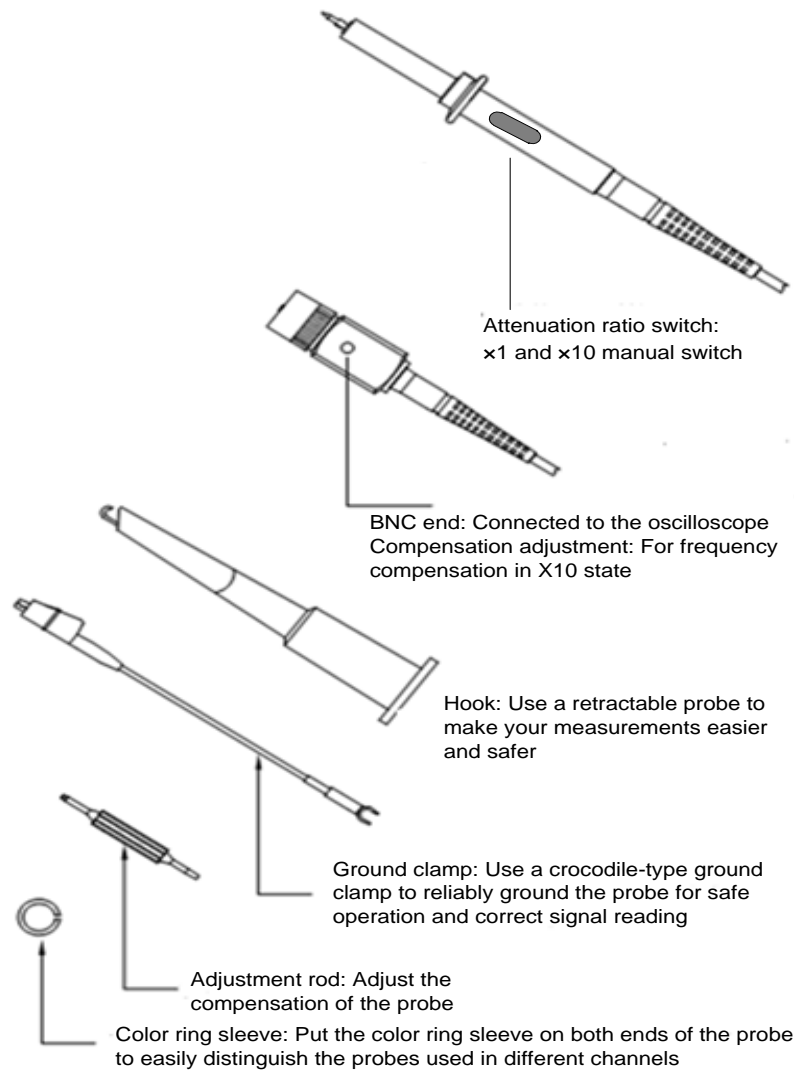


Fig. 16.7 Diagram of P9551 Probe Accessories

When the P9551 passive voltage probe is used, the input impedance of the oscilloscope is set to $1M\Omega$ and the probe type is set to voltage. When the attenuation ratio switch on the P9551 front end is set to $\times 1$, the probe attenuation of the oscilloscope end is set to $\times 1$. When the attenuation ratio switch on the P9551 front end is set to $\times 10$, the probe attenuation of the oscilloscope end is set to $\times 10$. When the probe attenuation of the oscilloscope is set to $\times 10$, the probe should be connected to a probe calibration square wave signal on the front panel of the oscilloscope in order to avoid the error caused by the probe connection with about 1 kHz frequency and 3 V_{pp} amplitude, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the compensation capacitance of the probe.

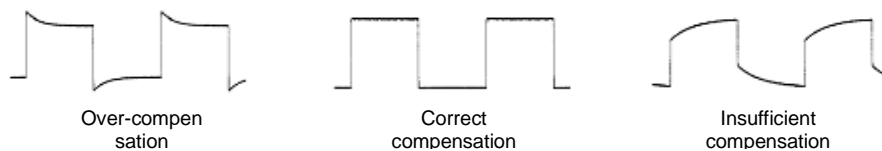


Fig. 16.8 Schematic Diagram of Probe Compensation



Warning: The maximum input voltage of the P9551 passive voltage probe is 300V (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

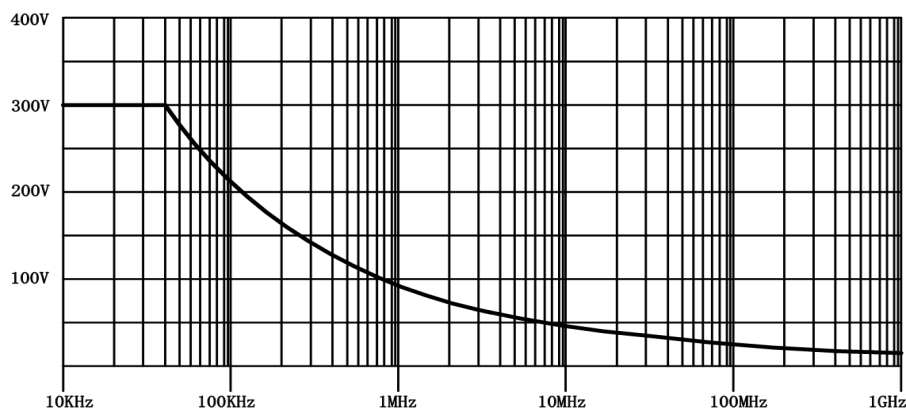
16.3.2 Main Parameters of Probe

The main parameters of the P9551 probe are shown in the table below.

Table 16.3 P9551 Probe Parameters

Model	P9551
Bandwidth	500MHz
Termination	10M Ω \pm 2% (10:1)
	1M Ω \pm 2% (1:1)
Input capacitance	10pF \pm 2pF (10:1)
	95pF \pm 5pF (1:1)
Attenuation ratio	10:1, 1:1
Maximum input voltage	150VDC+ACpk (1:1)
	300VDC+ACpk (10:1)
Capacitance compensation range	8-25pF
Probe length	140 \pm 2cm
Operating temperature	0-50 $^{\circ}$ C
Storage temperature	-20-75 $^{\circ}$ C

The maximum input voltage-frequency characteristic of the P9551 is shown in the figure below.

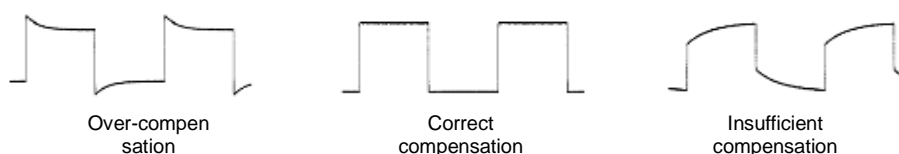
**Fig. 16.9 P9551 Probe Maximum Input Voltage-Frequency Characteristic Diagram**

16.4 P9600A passive voltage probe

As a passive single end probe, the P9600A passive voltage probe has a bandwidth of 600MHz, fixed attenuation of 10:1 and input impedance of 10 M Ω , which supports automatic identification functions. It can be purchased by users. The option number is 4456-H15.

16.4.1 Operating Instructions

When the P9600A passive voltage probe is used, the input impedance of the oscilloscope is automatically set to 1M Ω , the probe type is automatically set to voltage, and the probe attenuation is automatically set to \times 10. To avoid the error caused by the probe connection, the probe should be connected to a probe calibration square wave signal on the front panel of the oscilloscope, with about 1 kHz frequency and 3 Vpp amplitude, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the compensation capacitance of the probe.

**Fig. 16.10 Schematic Diagram of Probe Compensation**

The P9600A probe is equipped with accessories for easy testing. Please be familiar with the description of relevant accessories before use to make better use of this product.



Fig. 16.11 Diagram of P9600A Probe



Warning: The maximum input voltage of the P9600A passive voltage probe is 300V (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.4.2 Main Parameters of Probe

The main parameters of the P9600A probe are shown in the table below.

Table 16.4 P9600A Probe Parameters

Model	P9600A
Bandwidth	600MHz
Termination	10MΩ ±2%
Input capacitance	12pF ±2pF
Attenuation ratio	10:1
Maximum input voltage	300VDC+ACpk
Capacitance compensation range	6-22pF
Probe length	120 ±2cm
Safety	Complies with EN61010-031 CATII

Operating temperature	0-50°C
Storage temperature	-20-75°C

The maximum input voltage-frequency characteristic of the P9600A is shown in the figure below.

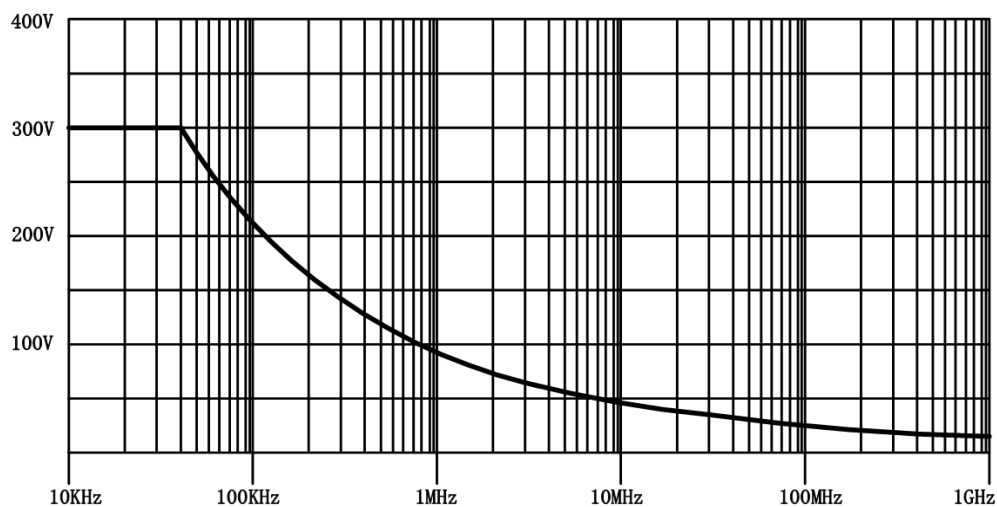


Fig. 16.12 P9600A Probe Maximum Input Voltage-Frequency Characteristic Diagram

16.5 P9558 Passive voltage probe

The P9558 high voltage single end probe is a passive high voltage single end probe with the option number of 4456-H03.

16.5.1 Operating Instructions

The P9558 probe is equipped with accessories for easy testing. Please be familiar with the description of relevant accessories before use to make better use of this product.

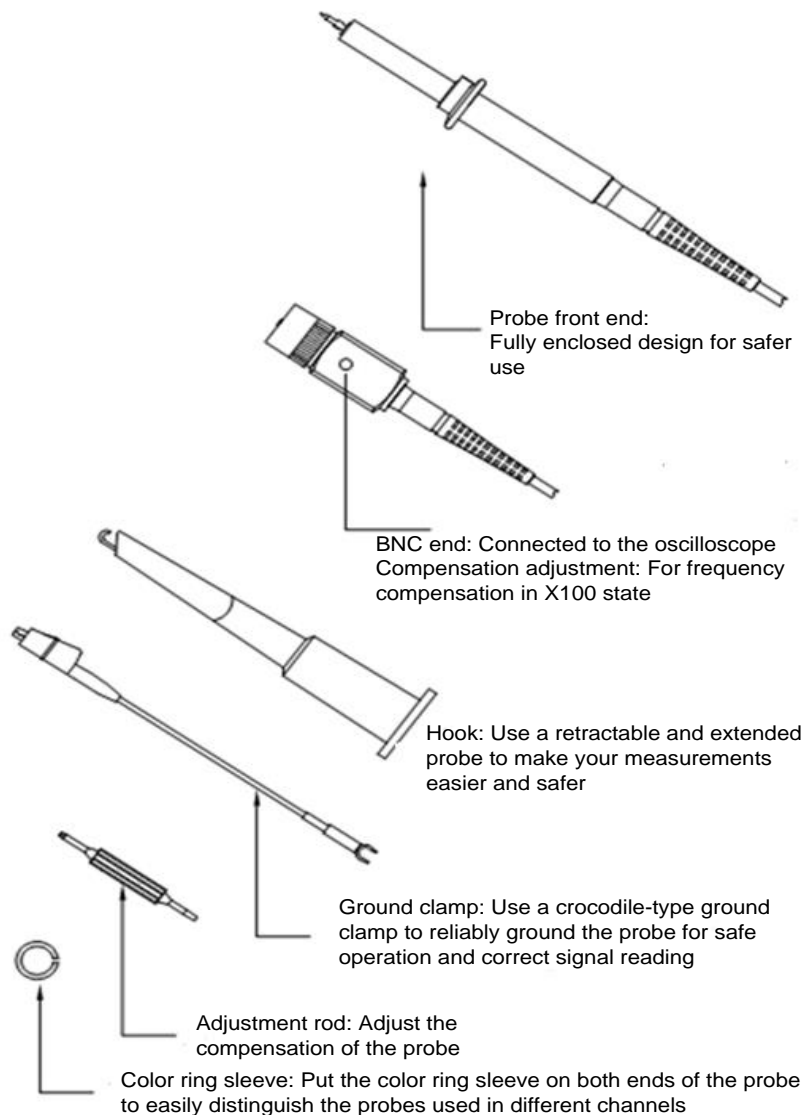


Fig. 16.13 Diagram of P9558 Probe Accessories

When the P9558 probe is used, the input impedance of the oscilloscope is set to $1M\Omega$, the probe type is set to voltage, and the probe attenuation is set to $\times 100$. To avoid the error caused by the probe connection, the probe should be connected to a probe calibration square wave signal on the front panel of the oscilloscope, with about 1 kHz frequency and 3 V_{pp} amplitude, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the compensation capacitance of the probe.

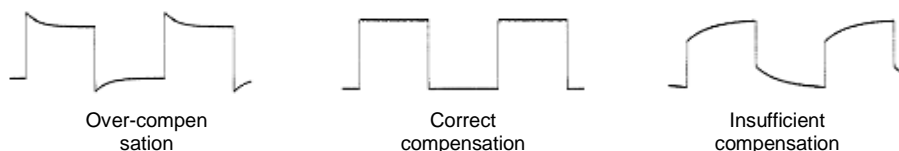


Fig. 16.14 Schematic Diagram of Probe Compensation



Warning: The maximum input voltage of the P558 high voltage single end probe is 3000V(DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.5.2 Main Parameters of Probe

The main parameters of the P9558 probe are shown in the table below.

Table 16.5 P9558 Probe Parameters

Model	P9558
Bandwidth	250MHz
Termination	100MΩ±2%
Input capacitance	4pF±1pF
Attenuation ratio	100:1
Maximum input voltage	3000V (DC+ACpk)
Capacitance compensation range	7-30pF
Probe length	200±2cm
Operating temperature	0-50°C
Storage temperature	-20-75°C

The maximum input voltage-frequency characteristic of the P9558 is shown in the figure below.

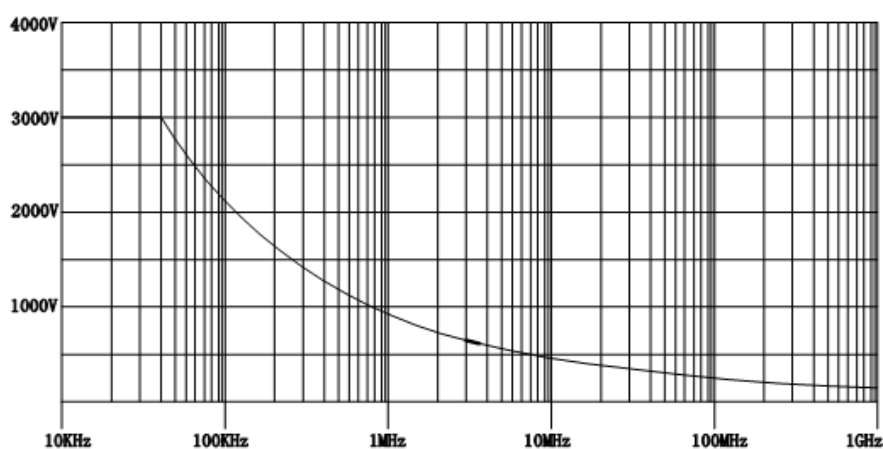


Fig. 16.15 P9558 Probe Maximum Input Voltage-Frequency Characteristic Diagram

16.6 P3258 High Voltage Single End Probe

The P3258 high voltage single end probe is a passive high voltage single end probe with the option number of 4456-H04.

16.6.1 Operating Instructions

The P3258 probe is equipped with accessories for easy testing. Please be familiar with the description of relevant accessories before use to make better use of this product.

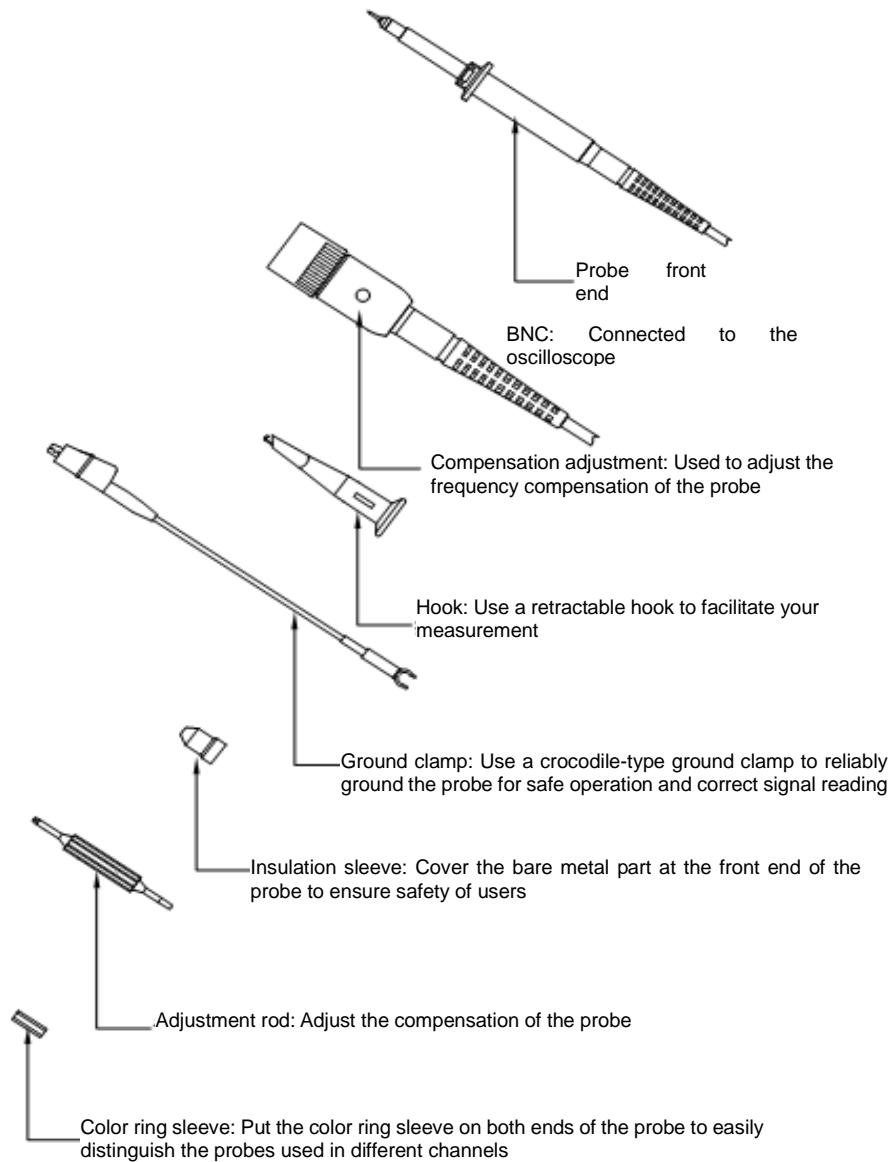


Fig. 16.16 Diagram of P3258 Probe Accessories

When the P3258 probe is used, the input impedance of the oscilloscope is set to $1M\Omega$, the probe type is set to voltage, and the probe attenuation is set to $\times 100$. To avoid the error caused by the probe connection, the probe should be connected to a probe calibration square wave signal on the front panel of the oscilloscope, with about 1 kHz frequency and 3 V_{pp} amplitude, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the compensation capacitance of the probe.

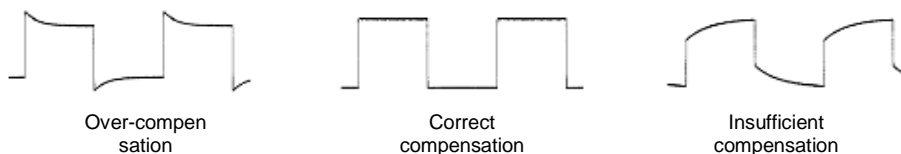


Fig. 16.17 Schematic Diagram of Probe Compensation



Warning: The maximum input voltage of the P3258 high voltage single end probe is 1500V(DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.6.2 Main Parameters of Probe

The main parameters of the P3258 probe are shown in the table below.

Table 16.6 P3258 Probe Parameters

Model	P3258
Bandwidth	100MHz
Termination	100MΩ±2%
Input capacitance	10pF±1pF
Attenuation ratio	100:1
Maximum input voltage	1500V (DC+ACpk)
Capacitance compensation range	10-25pF
Probe length	120±2cm
Operating temperature	0-50°C
Storage temperature	-20-75°C

The maximum input voltage-frequency characteristic of the P3258 is shown in the figure below.

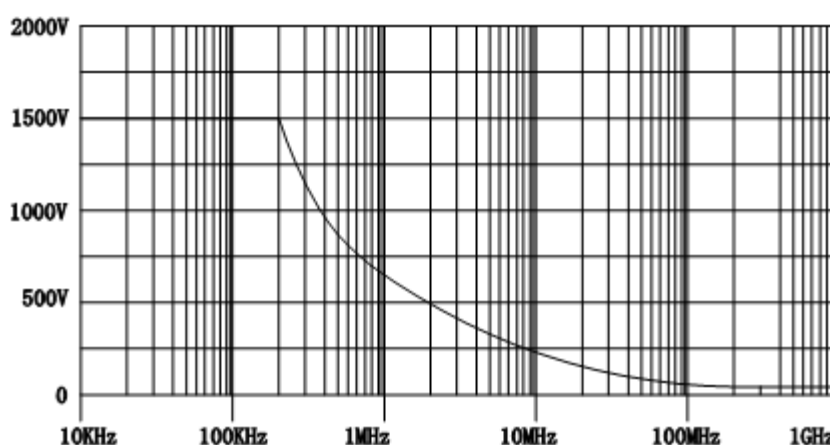


Fig. 16.18 P3258 Probe Maximum Input Voltage-Frequency Characteristic Diagram

16.7 P4220 high voltage single end probe

The P4220 high voltage single end probe is a passive high voltage single end probe with the option number of 4456-H20.

16.7.1 Instructions for Safe Use

The high voltage test probe is a product designed to prevent testers from being accidentally shocked during high voltage measurements. The operator shall read the safety rules and fully understand them before using the high voltage probe.

In addition, such high voltage test probe can be only used by testers who have received high voltage test probe training, who have experience in high voltage testing or who can identify high voltage hazards. Do not work alone at a voltage that exceeds the safe range of the human body. For your own safety, carefully check surface wear and damage of the high pressure probe before using it. Do not use this probe if there is any wear or damage.

Keep your hands, shoes, floor and work chair dry and avoid measuring in wet, moldy or other environments that affect safe measurements. Turn off the high voltage power supply before connecting or removing the test rod. Keep the high pressure probe clean because contaminants such as dirt may be conductive on the surface of the probe. It is necessary to use a probe without any safety hazard.

When you use the P4220 high voltage single end probe, the precautions are as follows:

Do not attempt to remove the ground wire of the test equipment from the ground terminal.

The grounding connection is a key point during safe operation of the probe. During high voltage measurement, if there is no such connection, it may cause personal injury or damage to the connected oscilloscope and probe. Before connecting the high voltage to the test end of the probe, be sure to connect the ground wire and avoid removing such grounding connection until the high voltage test end

is away from the high voltage source.

Never ground the ground wire with the high voltage power supply or the probe test end.

Before turning on the high voltage source, make sure that no part of your body is in contact with the test equipment.

Be sure to disconnect the probe test end from the high voltage source before removing the ground clamp.

When using the probe, be careful not to pull the probe cable vigorously, but leave enough space. Excessive pulling of the cable may cause falling off of the core wire, poor contact and damage to the cable. And use it with care. In any case, be sure to turn off the high voltage power supply before connecting for tests.

16.7.2 Operating Instructions

The P4220 probe is equipped with accessories for easy testing. Please be familiar with the description of relevant accessories before use to make better use of this product. Connect the ground wire (crocodile clip) at the attenuation end of the probe to a good ground point or a reliable ground test end. Connect the BNC connector to the BNC input port of the oscilloscope and select the range required by the oscilloscope.



Fig. 16.19 Diagram of P4220 Probe Accessories

When the P4220 probe is used, the input impedance of the oscilloscope is set to $1M\Omega$, the probe type is set to voltage, and the probe attenuation is set to $\times 1000$. To avoid the error caused by the probe connection, the probe should be connected to the function generator with the signal source frequency of about 200Hz and the amplitude of 20Vpp, so as to keep flat amplitude-frequency characteristics of the oscilloscope by adjusting the compensation capacitance of the probe.

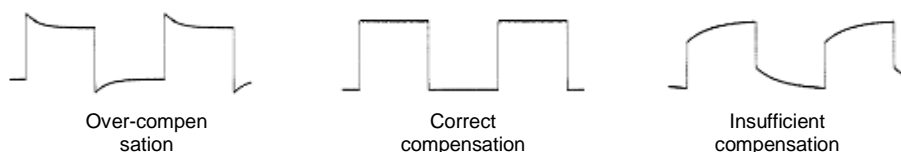


Fig. 16.20 Schematic Diagram of Probe Compensation



Warning:

The maximum input voltage of the P4220 high voltage single end probe is 39kV (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs. When the measured voltage exceeds 30kVDC or 20kV AC, the probe is not suitable for long-term use because the high voltage measurement source will discharge in the air, causing that the voltage stabilizing circuit of the high-voltage source fails to respond. There will be a pulse high voltage instantaneously, which may exceed the rating of this product and will cause serious damage to this product.



Warning:

When the P4220 high voltage single end probe is tested at a frequency exceeding 40MHz, replace the long ground wire with the crocodile clip in order to achieve a better frequency response. When the measured voltage exceeds 25kV, install the attached accessory HI-25, which will obtain a surface distance of 40cm or more (the insulator must have a surface distance of more than 39 cm during measuring 39KV voltage according to the CE guidelines)

16.7.3 Main Parameters of Probe

The main parameters of the P4220 probe are shown in the table below.

Table 16.7 P4220 Probe Parameters

Model	P4220
Bandwidth	220Mhz
Attenuation ratio	1/1000
Termination	900MΩ
Input capacitance	2pF
Maximum input voltage	39kV (DC+ACpk)
Maximum load current	45uA
Signal-to-noise Ratio	>60dB @1kHz
DC signal error	±3% (0-35kV)
Capacitance compensation range	10-35pF
Safety inspection	EN61010-031 CATII
Test cable length	2±0.2 m
Weight	460g
Size	320×80×80 mm
Operating temperature	0-50℃
Storage temperature	-20-70℃

The maximum input voltage-frequency characteristic of the P4220 is shown in the figure below.

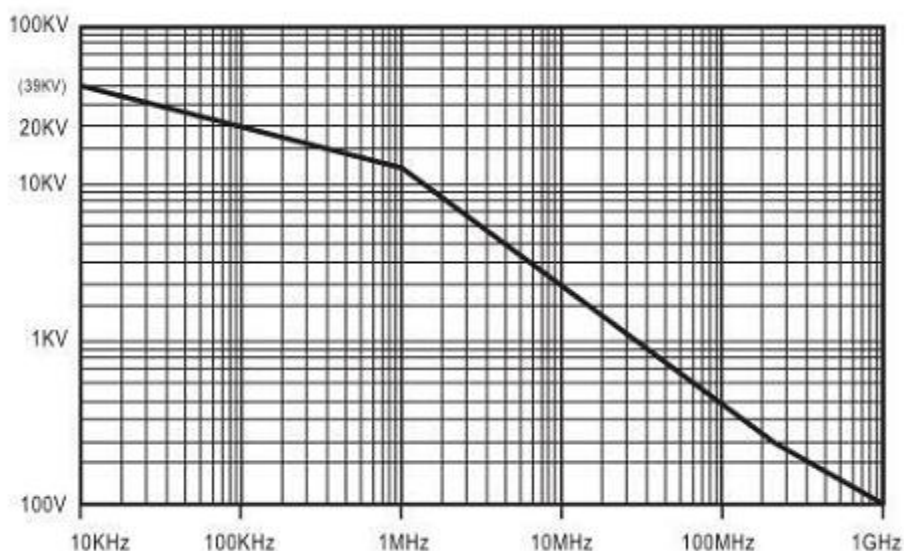


Fig. 16.21 P4220 Probe Maximum Input Voltage-Frequency Characteristic Diagram

16.8 P8050 High voltage differential probe

The P8050 high voltage differential probe uses a differential input mode and is mainly used for places where high voltage floating measurements are required. The probe has a bandwidth of 50MHz and is available with 1/50 and 1/500 attenuations. Its differential mode measurement range is 130V (DC + peak AC) and 1300V (DC + peak AC). The probe has the function of over-range alarm with a red LED. It can be purchased by users. The option number is 4456-H05.

16.8.1 Instructions for Safe Use

The P8050 high voltage differential probe uses a differential input mode and is mainly used for places where high voltage floating measurements are required. To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

Use correct power adapter: You must use the original power adapter of this product to avoid damage to the probe.

Master and use correct connection and disconnection methods: When connecting, connect the probe output to the test instrument and then connect the probe input; connect the test input auxiliary accessory and then connect the input circuit. When disconnecting, disconnect the test input and then disconnect the probe output end.

Grounding: This product is connected to the earth of the oscilloscope through the BNC output terminal. It is necessary to ensure reliable grounding during use.

Pay attention to the input measurement voltage range to avoid exceeding the range. Use 1/500 attenuation when the measured voltage cannot be estimated and must be measured. When the over-range warning light illuminates, stop using it immediately and disconnect the power supply and the input voltage.

Do not use this product and its accessories with the product case open. Non-professionals do not open the casing of this product and its accessories.

Do not use the instrument in flammable or explosive environments.

Do not use the instrument in too humid environments.

16.8.2 Operating Instructions



Fig. 16.22 Diagram of P8050 Probe Accessories

When the P8050 high voltage differential probe is used, the input impedance of the oscilloscope is set to $1M\Omega$, the probe type is set to voltage, and the probe attenuation is set to the same as that of the P8050.

The P8050 high voltage differential probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Make sure the input power supply voltage of the power adapter is normal before use.
- 2) The amplitude of the measured voltage should be estimated before test. If it exceeds the voltage range, the probe may be damaged.
- 3) Connect the probe output BNC terminal to the oscilloscope or other measuring instrument and then connect the input terminal to the test hook clamp to be used.

- 4) The power adapter is connected to the probe and the green power (POWER) indicator lights up.
- 5) Select the appropriate range for the probe based on the measured voltage. When the measured voltage exceeds the range during test, the red overload (OVER RANGE) indicator will light up and at this time the power supply and the input should be disconnected immediately.
- 6) Set the attenuation ratio of the oscilloscope or other instruments based on the probe range. After starting the measurement, set the appropriate sensitivity of the oscilloscope according to the size of the measured signal.
- 7) Connect the measured object to start measurement. Upon measuring, the probe body should be kept away from the high voltage pulse circuit to reduce errors caused by interference.
- 8) After the completion of the test, disconnect the probe power supply, disconnect the two input ends from the measured point and then unplug the input BNC terminal from the oscilloscope.

Tips for use of P8050 high voltage differential probe:

- 1) The input line should be winded during measurement, which can better eliminate noise and improve high-frequency response capability. The winding method is as shown below:

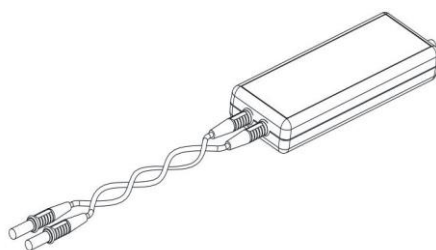


Fig. 16.23 Diagram of P8050 Probe Winding Method

- 2) Do not extend the input line during measurement, otherwise this will introduce more noise. If the input line must be extended, the lengths of the extensions should be the same. Moreover, the frequency of the measured input signal should not exceed 10 MHz at this time. If the frequency exceeds 10 MHz, the error will be big.
- 3) To obtain high-precision measurement results, the measurement shall be made after the probe and the measuring instrument are warmed up for 20 minutes.



Warning: The maximum input voltage of the P8050 high voltage differential probe is 1300V (DC+ACpp). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.8.3 Main Parameters of Probe

The main parameters of the P8050 probe are shown in the table below.

Table 16.8 P8050 Probe Parameters

Model	P8050
Bandwidth (-3dB)	50MHz
Rise time	7ns
Precision	± 2%
Attenuation ratio	1/50, 1/500
Termination	Between two input ends: 8MΩ
Input capacitance	Between two input ends: 3.5pF
Maximum differential measurement voltage	1/50: 130V (DC + ACpeak)
	1/500: 1300V (DC + ACpeak)
Maximum common mode input	1000Vrms CATII

voltage	600Vrms CATIII
Noise	1/50: $\leq 1.5\text{mVrms}$
	1/500: $\leq 1\text{mVrms}$
Linearity	$\pm 1\%$
Delay	20ns \pm 1ns
CMRR	DC: $\geq 80\text{dB}$
	100Hz: $\geq 60\text{dB}$
	1MHz: $\geq 50\text{dB}$
Over-range alarm voltage threshold	1/50: 140V \pm 4V (DC + ACpeak)
	1/500: 1400V \pm 40V (DC + ACpeak)
Power adapter output voltage	DC9V, 1000mA
Power adapter input voltage	AC100 ~ 240V, 50 ~ 60Hz
Probe body	120 \times 55 \times 24 (mm)
Weight	160g
Environmental characteristics	
Operating temperature	0 ~ 40 °C
Storage temperature	-10 ~ 45 °C

16.9 P8100 High Voltage Differential Probe

The P8100 high voltage differential probe uses a differential input mode and is mainly used for places where high voltage floating measurements are required. The probe has a bandwidth of 100MHz and is available with 1/50 and 1/500 attenuations. Its differential mode measurement range is 130V (DC + peak AC) and 1300V (DC + peak AC). The probe has the function of over-range alarm with a red LED. The option can be purchased by users. The option number is 4456-H06.

16.9.1 Instructions for Safe Use

The P8100 high voltage differential probe uses a differential input mode and is mainly used for places where high voltage floating measurements are required. To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

Use correct power adapter: You must use the original power adapter of this product to avoid damage to the probe.

Master and use correct connection and disconnection methods: When connecting, connect the probe output to the test instrument and then connect the probe input; connect the test input auxiliary accessory and then connect the input circuit. When disconnecting, disconnect the test input and then disconnect the probe output end.

Grounding: This product is connected to the earth of the oscilloscope through the BNC output terminal. It is necessary to ensure reliable grounding during use.

Pay attention to the input measurement voltage range to avoid exceeding the range. Use 1/500 attenuation when the measured voltage cannot be estimated and must be measured. When the over-range warning light illuminates, stop using it immediately and disconnect the power supply and the input voltage.

Do not use this product and its accessories with the product case open. Non-professionals do not open the casing of this product and its accessories.

Do not use the instrument in flammable or explosive environments.

Do not use the instrument in too humid environments.

16.9.2 Operating Instructions

When the P8100 high voltage differential probe is used, the input impedance of the oscilloscope is set to 1M Ω , the probe type is set to voltage, and the probe attenuation is set to the same as that of the P8100.

The P8100 high voltage differential probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Make sure the input power supply voltage of the power adapter is normal before use.
- 2) The amplitude of the measured voltage should be estimated before test. If it exceeds the voltage range, the probe may be damaged.
- 3) Connect the probe output BNC terminal to the oscilloscope or other measuring instrument and then connect the input terminal to the test hook clamp to be used.
- 4) The power adapter is connected to the probe and the green power (POWER) indicator lights up.
- 5) Select the appropriate range for the probe based on the measured voltage. When the measured voltage exceeds the range during test, the red overload (OVER RANGE) indicator will light up and at this time the power supply and the input should be disconnected immediately.
- 6) Set the attenuation ratio of the oscilloscope or other instruments based on the probe range. After starting the measurement, set the appropriate sensitivity of the oscilloscope according to the size of the measured signal.
- 7) Connect the measured object to start measurement. Upon measuring, the probe body should be kept away from the high voltage pulse circuit to reduce errors caused by interference.
- 8) After the completion of the test, disconnect the probe power supply, disconnect the two input ends from the measured point and then unplug the input BNC terminal from the oscilloscope.



Fig. 16.24 Diagram of P8100 Probe Accessories

Tips for use of P8100 high voltage differential probe:

- 1) The input line should be wound during measurement, which can better eliminate noise and improve high-frequency response capability. The winding method is as shown below:

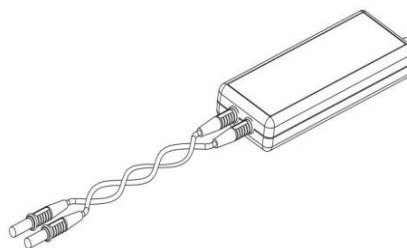


Fig. 16.25 Diagram of P8050 Probe Winding Method

- 2) Do not extend the input line during measurement, otherwise this will introduce more noise. If the input line

must be extended, the lengths of the extensions should be the same. Moreover, the frequency of the measured input signal should not exceed 10 MHz at this time. If the frequency exceeds 10 MHz, the error will be big.

- 3) To obtain high-precision measurement results, the measurement shall be made after the probe and the measuring instrument are warmed up for 20 minutes.



Warning: The maximum input voltage of the P8100 high voltage differential probe is 1300V (DC+ACpp). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.9.3 Main Parameters of Probe

The main parameters of the P8100 probe are shown in the table below.

Table 16.9 P8100 Probe Parameters

Model	P8100
Bandwidth (-3dB)	100MHz
Rise time	3.5ns
Precision	±2%
Attenuation ratio	1/50, 1/500
Termination	Single end to ground: 4MΩ, between two input ends: 8MΩ
Input capacitance	Single end to ground: 7pF, between two input ends: 3.5pF
Maximum differential measurement voltage	1/50: 130V (DC + ACpeak)
	1/500: 1300V (DC + ACpeak)
Maximum common mode input voltage	1000Vrms CATII
	600Vrms CATIII
Noise	1/50: ≤ 1.5mVrms
	1/500: ≤ 1mVrms
Linearity	±1%
Delay	20ns±1ns
CMRR	DC: ≥80dB
	100Hz: ≥ 60dB
	1MHz: ≥ 50dB
Over-range alarm voltage threshold	1/50: 140V ±4V (DC + ACpeak)
	1/500: 1400V ±40V (DC + ACpeak)
Power adapter output voltage	DC9V, 1000mA
Power adapter input voltage	AC100 ~ 240V, 50 ~ 60Hz
Probe body	120×55×24 (mm)
Weight	160g
Environmental characteristics	
Operating temperature	0 ~ 40 °C
Storage temperature	-10 ~ 45 °C

16.10 P5020 high voltage differential probe

The P5020 high voltage differential probe uses a differential input mode and is mainly used for places where high voltage floating measurements are required. The probe has a bandwidth of 20MHz and is available with 1/500 and 1/5000 attenuations. Its differential mode measurement range is 4kVpp and 40kVpp. The option can be purchased by users. The option number is 4456-H17.

16.10.1 Instructions for Safe Use

The P5020 high voltage differential probe is mainly used for places where high voltage floating measurements are required. To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

Be careful of electric shocks.

Pay attention to the highest input voltage.

The highest differential voltage is 40kV (DC+ACpp) or 14kVrms.

The maximum differential voltage between the input and ground ends is 10kVrms.

Do not use this product in a humid environment or at an explosive risk.

Cut off the output and input ends when opening the box cover of this product.

16.10.2 Operating Instructions

When the P5020 high voltage differential probe is used, the input impedance of the oscilloscope is set to $1M\Omega$, the probe type is set to voltage, and the probe attenuation is set to the same as that of the P5020.

The P5020 high voltage differential probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Connect the accessory BP-366N with BP-266N or BP-276N, insert it into the P5020 input end, and connect BP-266N or BP-276N to the measured object.
- 2) Connect the BP-250 to the P5020 output end and connect it to the oscilloscope.
- 3) Turn on the power supply of the P5020 power adapter
- 4) Set the oscilloscope impedance to $1M\Omega$, set the probe type to voltage, and set the same probe attenuation as the attenuation ratio multiple of the P5020. Adjust the oscilloscope's vertical sensitivity knob to the appropriate position.



Fig. 16.26 Diagram of P5020 Probe



Warning: The maximum input voltage of the P5020 high voltage differential probe is 40kV (DC+ACpp). Do not exceed this voltage when using it. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.10.3 Main Parameters of Probe

The main parameters of the P5020 probe are shown in the table below.

Table 16.10 P5020 Probe Parameters

Model	P5020
Bandwidth (-3dB)	20MHz
Precision	± 2%
Attenuation ratio	1/500, 1/5000
Termination	Between two input ends: 100MΩ
Input capacitance	Between two input ends: 1pF
Maximum differential measurement voltage	1/500: 4kV (DC+ACpp)
	1/5000: 40kV (DC+ACpp)
CMRR	60Hz: > 80dB
	100Hz: > 60dB

	1MHz::>50dB
Output voltage (50Ω load)	±4V
Power adapter output voltage	DC9V, 200mA
Power adapter input voltage	AC100 ~ 240V, 50 ~ 60Hz
Size	Approximately 218×83×30 (mm)
Weight	390g
Electronic safety specification	IEC1010-1
Environmental characteristics	
Operating temperature	0 ~ 50°C
Storage temperature	-30 ~ 70°C

The withstanding voltage test curve of the P5020 probe is shown below.

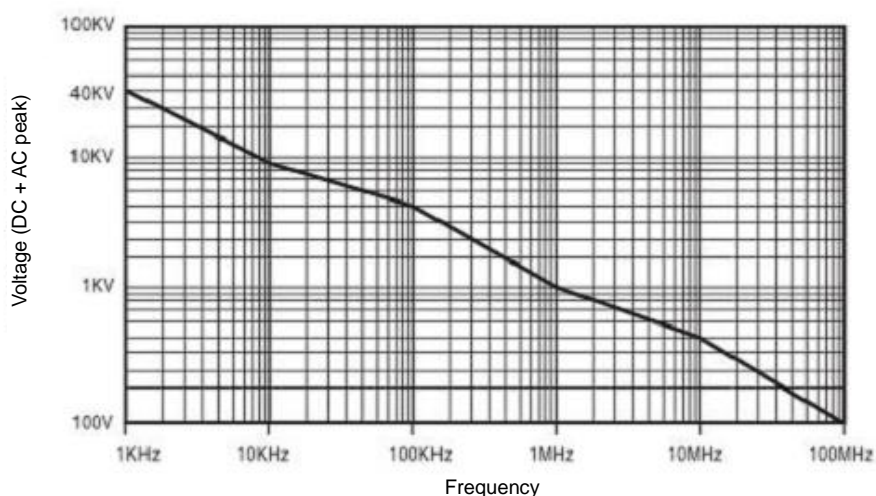


Fig. 16.27 P5020 Probe Withstanding Voltage Test Curve

16.11 P6100 high voltage differential probe

The P6100 high voltage differential probe uses a differential input mode and is mainly used for places where high voltage floating measurements are required. The probe has a bandwidth of 100MHz and is available with 1/100 and 1/1000 attenuations. Its differential mode measurement range is 1.4kVpp and 14kVpp. The option can be purchased by users. The option number is 4456-H18.

16.11.1 Instructions for Safe Use

The P6100 high voltage differential probe is mainly used for places where high voltage floating measurements are required. To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

- Be careful of electric shocks.
- Pay attention to the highest input voltage.
- The highest differential voltage is 14kV (DC+ACpp).
- Do not use this product in a humid environment or at an explosive risk.
- Cut off the output and input ends when opening the box cover of this product.

16.11.2 Operating Instructions

When the P6100 high voltage differential probe is used, the input impedance of the oscilloscope is set to 1MΩ, the probe type is set to voltage, and the probe attenuation is set to the same as that of the P6100.

The P6100 high voltage differential probe is easy to use, but users who are not familiar with this product should

read this manual completely before starting the operation:

- 1) Connect the hook to the P6100 input end.
- 2) Connect the BNC at the output end of the P6100 to the oscilloscope.
- 3) Turn on the power switch of the P6100 power adapter and select the appropriate range position.
- 4) Set the oscilloscope impedance to $1M\Omega$, set the probe type to voltage, and set the same probe attenuation as the attenuation ratio multiple of the P6100. Adjust the oscilloscope's vertical sensitivity knob to the appropriate position.

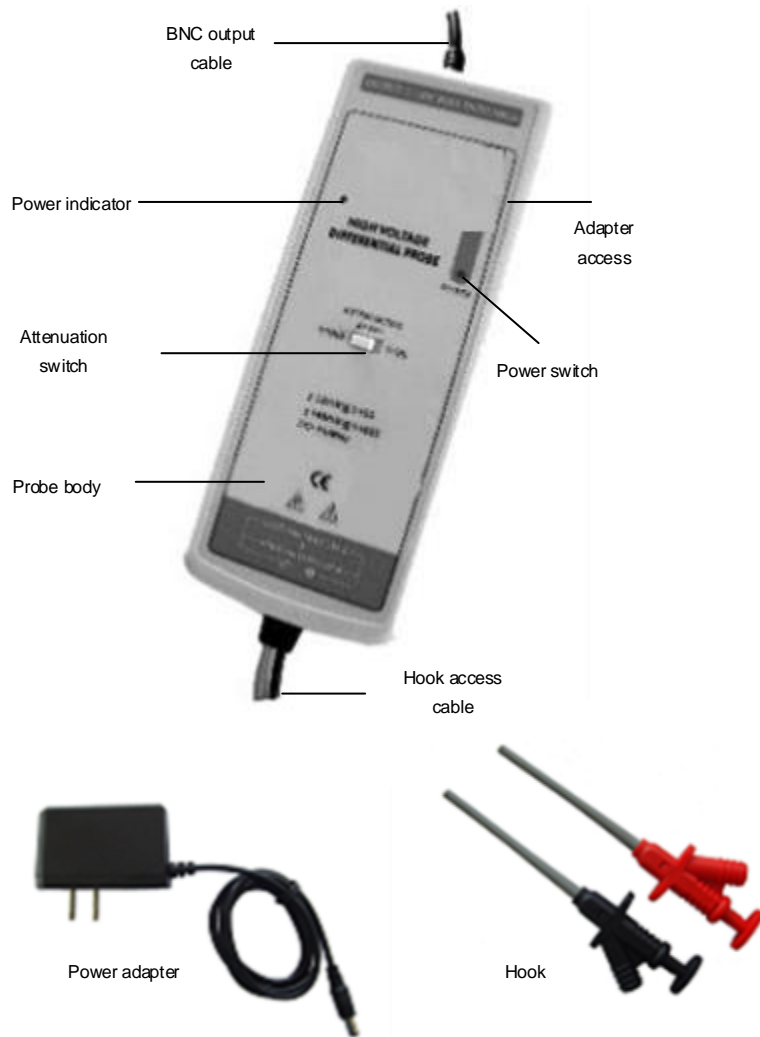


Fig. 16.28 Diagram of P6100 Probe Accessories



Warning: The maximum input voltage of the P6100 high voltage differential probe is 14kV (DC+ACpp). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.11.3 Main Parameters of Probe

The main parameters of the P6100 probe are shown in the table below.

Table 16.11 P6100 Probe Parameters

Model	P6100
Bandwidth (-3dB)	100MHz
Precision	$\pm 1\%$
Attenuation ratio	1/100, 1/1000

Termination	Between input end and ground: 20M Ω
Input capacitance	Between input end and ground: 1pF
Maximum differential measurement voltage	1/100: 1.4kV (DC+ACpp)
	1/1000: 14kVpp (DC+ACpp)
CMRR	60Hz: >80dB
	100Hz: >60dB
	1MHz: >50dB
Output voltage (50 Ω load)	$\pm 7V$
Power adapter output voltage	DC6V, 150mA
Power adapter input voltage	AC100 ~ 240V, 50 ~ 60Hz
Built-in batteries for power supply	4 \times AA cells
Size	Approximately 245 \times 84 \times 36 (mm)
Weight	500g
Electronic safety specification	IEC1010-1
Environmental characteristics	
Operating temperature	0 ~ 50 $^{\circ}C$
Storage temperature	-30 ~ 70 $^{\circ}C$

16.12 P7100 high voltage differential probe

The P7100 high voltage differential probe uses a differential input mode and is mainly used for places where high voltage floating measurements are required. The probe has a bandwidth of 100MHz and is available with 1/100 and 1/1000 attenuations. Its differential mode measurement range is 0.7kVpp and 7kVpp. The option can be purchased by users. The option number is 4456-H19.

16.12.1 Instructions for Safe Use

The P7100 high voltage differential probe is mainly used for places where high voltage floating measurements are required. To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

Be careful of electric shocks.

Pay attention to the highest input voltage.

The highest differential voltage is 7kV (DC+ACpp).

Do not use this product in a humid environment or at an explosive risk.

Cut off the output and input ends when opening the box cover of this product.

16.12.2 Operating Instructions

When the P7100 high voltage differential probe is used, the input impedance of the oscilloscope is set to 1M Ω , the probe type is set to voltage, and the probe attenuation is set to the same as that of the P7100.

The P7100 high voltage differential probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Connect the hook to the P7100 input end.
- 2) Connect the BNC at the output end of the P7100 to the oscilloscope.
- 3) Turn on the power switch of the P7100 power adapter and select the appropriate range position.
- 4) Set the oscilloscope impedance to 1M Ω , set the probe type to voltage, and set the same probe attenuation as the attenuation ratio multiple of the P7100. Adjust the oscilloscope's vertical sensitivity knob to the appropriate position.

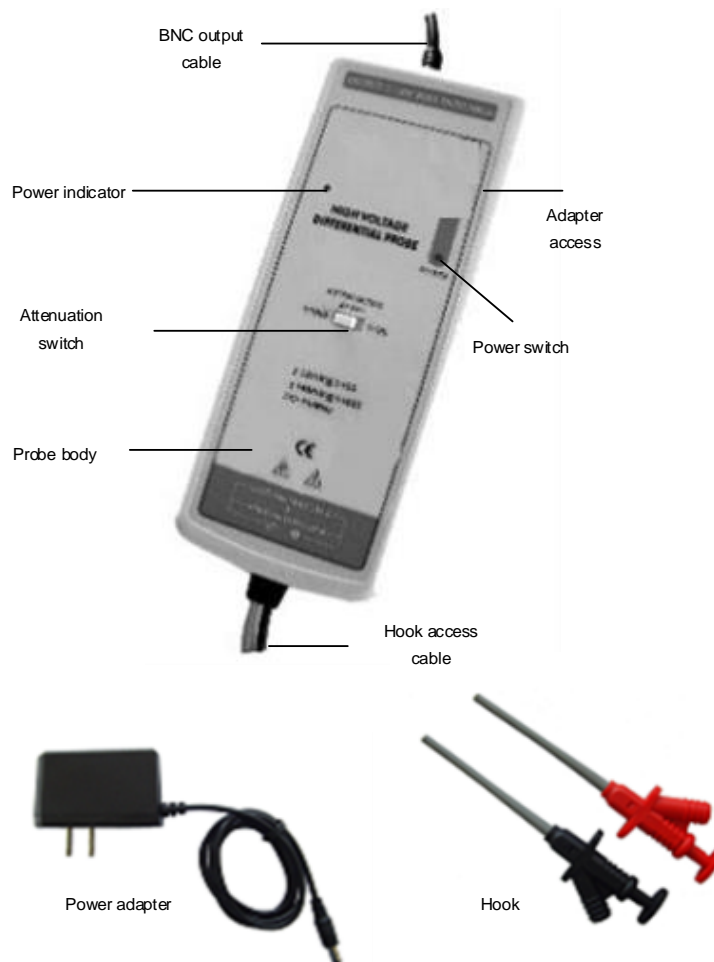


Fig. 16.29 Diagram of P7100 Probe Accessories



Warning: The maximum input voltage of the P7100 high voltage differential probe is 7kV (DC+ACpp). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.12.3 Main Parameters of Probe

The main parameters of the P7100 probe are shown in the table below.

Table 16.12 P7100 Probe Parameters

Model	P7100
Bandwidth (-3dB)	100MHz
Precision	± 1%
Attenuation ratio	1/100, 1/1000
Termination	Between input end and ground: 10MΩ
Input capacitance	Between input end and ground: 2pF
Maximum differential measurement voltage	1/100: 0.7kV (DC+ACpp)
	1/1000: 7kV (DC+ACpp)
CMRR	60Hz: ≥80dB
	1MHz: ≥ 50dB
Output voltage (50kΩ load)	± 7V
Power adapter output voltage	DC6V, 700mA
Power adapter input voltage	AC100 ~ 240V, 50 ~ 60Hz

Built-in batteries for power supply	4×AA cells
Size	Approximately 245×84×36 (mm)
Weight	500g
Electronic safety specification	IEC1010-1
Environmental characteristics	
Operating temperature	0 ~ 50°C
Storage temperature	-50 ~ 70 °C

16.13 AP202 Current probe

The AP202 current probe uses an advanced magnetic sensor to accurately measure current signals by testing magnetic field signals generated by current. It is mainly used for measurement and analysis of conductor current. The probe's current measurement range is 20A (DC + ACpk), which can measure the frequency bandwidth of current signals up to 25MHz. The option can be purchased by users. The option number is 4456-H08.

16.13.1 Instructions for Safe Use

To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

Use correct power adapter: You must use the original power adapter of this product to avoid damage to the probe.

Master and use correct connection and disconnection methods: Ensure that the tested object is dead before connecting or disconnecting the object.

Master and use correct connection and disconnection methods: When connecting, connect the probe output end to the test instrument and then connect the probe input; when disconnecting, disconnect the test input and then disconnect the probe output end.

Grounding: This product is connected to the earth of the oscilloscope through the BNC output terminal. It is necessary to ensure reliable grounding during use.

Pay attention to the voltage range of measured objects of this product to avoid exceeding the range.

Do not use this product with the product case open. Non-professionals do not open the casing of this product.

Do not use the instrument in flammable or explosive environments.

Do not use the instrument in too humid environments. Keep this product dry and tidy.

16.13.2 Operating Instructions

When the AP202 current probe is used, the input impedance of the oscilloscope is set to 1MΩ, the probe type is set to current, and the probe attenuation is set to the same as that of the AP202.

The AP202 current probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Make sure the input power supply voltage of the power adapter is normal before use.
- 2) In order to obtain accurate measurement results in different test cases, demagnetization and DC balance adjustment should be performed before the test. The specific steps are as follows:

Warm up the oscilloscope for 20 minutes and set the vertical offset of the oscilloscope channel for connecting the probe to zero

Connect the output BNC of the current probe to the input end of zeroing channel of the oscilloscope

Keep the test card slot of the current probe empty and toggle the sliding switch on the card slot upper cover to ensure that the upper cover is well closed

Press the demagnetizing button and adjust the balance knob to make the display signal zero

- 3) Slide the sliding switch on the card slot upper cover backward, open the test card slot upper cover, put the

test conductor into the test card slot, push the sliding switch and close the card slot upper cover. The test conductor shall be not powered on in this process.

- 4) Power on the conductor, adjust the oscilloscope settings as needed, and read the measurement result. When the measurement result is positive, it means that the current flowing through the conductor is in the same direction as the arrow indicated on the upper cover of the test card slot.
- 5) After the test is completed, disconnect the conductor power supply and then take out the conductor from the card slot.

Tips for use of AP202 current probe:

- 1) When it is necessary to measure the differential current waveforms of two conductors, the two conductors can be simultaneously inserted into the test card slot in the opposite direction of the current for measurement.
- 2) When it is necessary to measure the superimposed current waveforms of two conductors, the two conductors can be parallelly inserted into the test card slot in the same current direction for measurement.
- 3) When it is necessary to increase the sensitivity due to small test current, the wires can be wound for a few turns before passing through the card slot. The measured reading is divided by the number of wires passing through the card slot to obtain the desired result.



Fig. 16.30 Diagram of AP202 Probe



Warning: The maximum input voltage of the AP202 current probe is 20A (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.13.3 Main Parameters of Probe

The main parameters of the AP202 probe are shown in the table below.

Table 16.13 AP202 Probe Parameters

Model	AP202
Bandwidth (-3dB)	25MHz
Rise time	14ns
Precision	± 3%
Current conversion ratio	100mV/A
Maximum measuring current	20A(DC+ACpk)
Maximum measuring pulse current	50A (Tp ≤10μs)
Maximum measuring voltage to ground	400V (DC+ACpk)
Noise	≤ 1mVrms
Linearity	± 1%
Delay	20ns±1ns
Power adapter output voltage	DC9V, 1000mA
Power adapter input voltage	AC100 ~ 240V, 50 ~ 60Hz
Maximum measuring wire diameter	4.5mm
Probe body size	Approximately 188×40×24 (mm)
Probe body weight	150g
Environmental characteristics	
Operating temperature	0 ~ 40 °C
Storage temperature	-10 ~ 45 °C

16.14 AP204A current probe

The AP204A current probe uses an advanced magnetic sensor to accurately measure current signals by testing magnetic field signals generated by current. It is mainly used for measurement and analysis of conductor current. The probe's current measurement range is 40A (DC + ACpk), which can measure the frequency bandwidth of current signals up to 50MHz. The option can be purchased by users. The option number is 4456-H23.

16.14.1 Instructions for Safe Use

To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

Use correct power adapter: You must use the original power adapter of this product to avoid damage to the probe.

Master and use correct connection and disconnection methods: Ensure that the tested object is dead before connecting or disconnecting the object.

Master and use correct connection and disconnection methods: When connecting, connect the probe output end to the test instrument and then connect the probe input; when disconnecting, disconnect the test input and then disconnect the probe output end.

Grounding: This product is connected to the earth of the oscilloscope through the BNC output terminal. It is necessary to ensure reliable grounding during use.

Pay attention to the voltage range of measured objects of this product to avoid exceeding the range.

Do not use this product with the product case open. Non-professionals do not open the casing of this product.

Do not use the instrument in flammable or explosive environments.

Do not use the instrument in too humid environments. Keep this product dry and tidy.

16.14.2 Operating Instructions

When the AP204A current probe is used, the input impedance of the oscilloscope is set to 1MΩ, the probe type is

set to current, and the probe attenuation is set to the same as that of the AP204A.

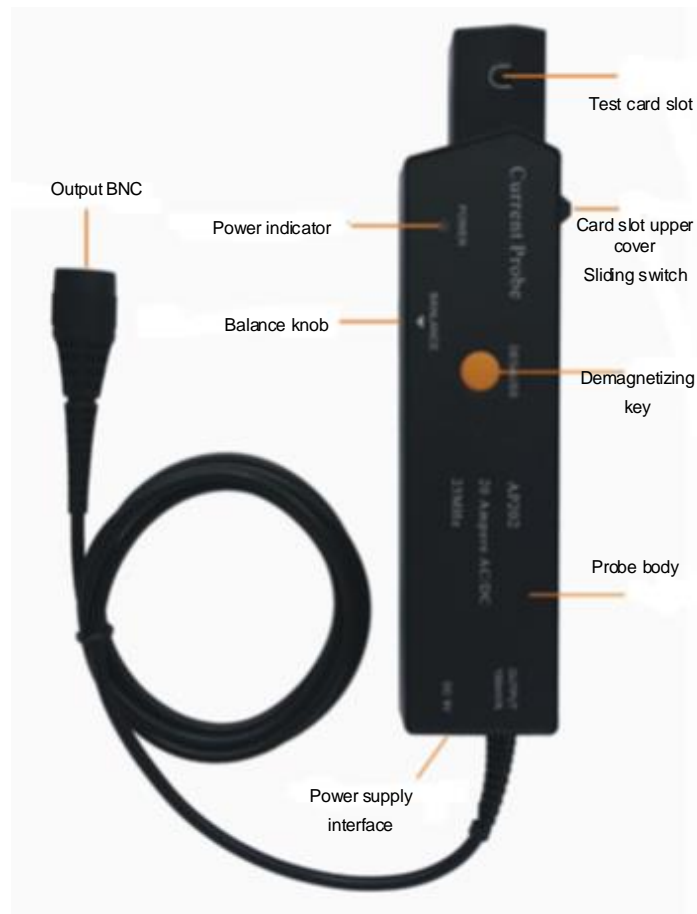


Fig. 16.31 Diagram of AP204A Probe

The AP204A current probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Make sure the input power supply voltage of the power adapter is normal before use.
- 2) In order to obtain accurate measurement results in different test cases, demagnetization and DC balance adjustment should be performed before the test. The specific steps are as follows:
 - Warm up the oscilloscope for 20 minutes and set the vertical offset of the oscilloscope channel for connecting the probe to zero
 - Connect the output BNC of the current probe to the input end of zeroing channel of the oscilloscope
 - Keep the test card slot of the current probe empty and toggle the sliding switch on the card slot upper cover to ensure that the upper cover is well closed
 - Press the demagnetizing button and adjust the balance knob to make the display signal zero
- 3) Slide the sliding switch on the card slot upper cover backward, open the test card slot upper cover, put the test conductor into the test card slot, push the sliding switch and close the card slot upper cover. The test conductor shall be not powered on in this process.
- 4) Power on the conductor, adjust the oscilloscope settings as needed, and read the measurement result. When the measurement result is positive, it means that the current flowing through the conductor is in the same direction as the arrow indicated on the upper cover of the test card slot.
- 5) After the test is completed, disconnect the conductor power supply and then take out the conductor from the card slot.

Tips for use of AP204A current probe:

- 1) When it is necessary to measure the differential current waveforms of two conductors, the two conductors

can be simultaneously inserted into the test card slot in the opposite direction of the current for measurement.

- 2) When it is necessary to measure the superimposed current waveforms of two conductors, the two conductors can be parallelly inserted into the test card slot in the same current direction for measurement.
- 3) When it is necessary to increase the sensitivity due to small test current, the wires can be wound for a few turns before passing through the card slot. The measured reading is divided by the number of wires passing through the card slot to obtain the desired result.



Warning: The maximum input voltage of the AP202 current probe is 40A (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.14.3 Main Parameters of Probe

The main parameters of the AP204A probe are shown in the table below.

Table 16.14 AP204A Probe Parameters

Model	AP204A
Bandwidth (-3dB)	50MHz
Rise time	7ns
Precision	± 3%
Current conversion ratio	50mV/A
Maximum measuring current	20A(DC+ACpk)
Maximum measuring pulse current	50A (Tp ≤10μs)
Maximum measuring voltage to ground	400V (DC+ACpk)
Noise	≤ 1mVrms
Linearity	± 1%
Delay	20ns±1ns
Power adapter output voltage	DC9V, 1000mA
Power adapter input voltage	AC100 ~ 240V, 50 ~ 60Hz
Maximum measuring wire diameter	4.5mm
Probe body size	Approximately 188×40×24 (mm)
Probe body weight	150g
Environmental characteristics	
Operating temperature	0 ~ 40 °C
Storage temperature	-10 ~ 45 °C

16.15 AP622 Current Probe

The AP622 current probe is a cost-effective, common current probe that can measure DC and AC at the same time. Its measuring current ranges from 50mA to 60A peak and the bandwidth is up to 100kHz. It provides two ranges (10A and 100A) for easy switching between low and high current measurements. The probe has a power indicator and an overload indicator and is battery powered for easy measurement. The option can be purchased by users. The option number is 4456-H07.

16.15.1 Instructions for Safe Use

To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

- Avoid fire or personal injury
- Connect and pull out correctly.

- Replace the battery correctly.
- Do not operate without the cover.
- Avoid the exposed circuits.
- You must ensure that all equipment is well grounded during operation.
- Do not operate in a humid environment.
- Do not operate in a flammable environment.

16.15.2 Operating Instructions

When the AP622 current probe is used, the input impedance of the oscilloscope is set to $1M\Omega$, the probe type is set to current, and the probe attenuation is set to the same as that of the AP622.

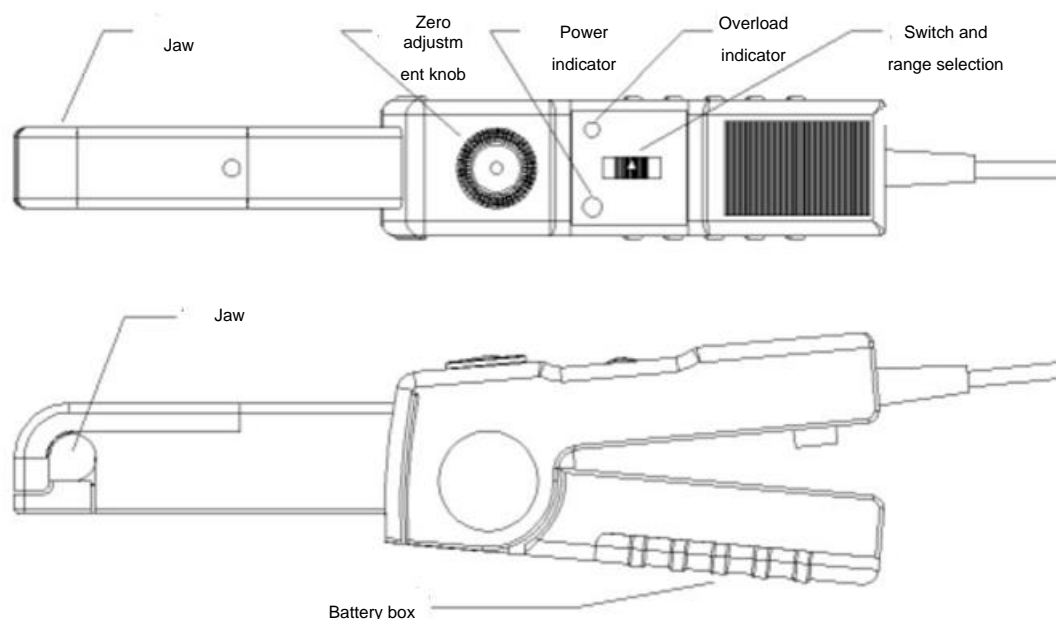


Fig. 16.32 Diagram of AP622 Probe

The AP622 current probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Push the switch to the appropriate range position according to the measured current. The power indicator turns green and the overload indicator does not light up.
- 2) Connect the BNC plug to the oscilloscope.
- 3) Oscilloscope setting: Set the oscilloscope's impedance to $1M\Omega$, set the coupling mode to DC, and select the appropriate oscilloscope range according to the measured current.
- 4) Zero adjustment: Zero adjustment is required before each test. Turn the zero adjustment knob of the current probe to set the display value on the oscilloscope to zero.
- 5) Measurement: Open the clamp and pass the tested wire through the center of the jaw. Note that the diameter of the tested wire cannot exceed the size of the jaw. When the measurement range is exceeded, the overload indicator will light up. Select the appropriate range and repeat the zero adjustment measurement.
- 6) After the test is completed, disconnect the conductor power supply and then take out the conductor from the card slot.



Warning: The maximum input voltage of the AP622 probe is 100V (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.15.3 Main Parameters of Probe

The main parameters of the AP622 probe are shown in the table below.

Table 16.15 AP622 Probe Parameters

Model	AP622	
Current range	50mA-10A peak	1A-100A peak
Range sensitivity	100mV/A	10mV/A
Output signal percentage error	$\pm(3\%+5mV)$	500mA-10A: $\pm(4\%+500\mu V)$ 10A-60A: $\pm 15\%$
Bandwidth (-3dB)	DC-100kHz	
Noise	6mV	0.6mV
Operating voltage	Maximum 600Vrms	
Common mode voltage	Maximum 600Vrms	
Battery	9V alkaline battery	
Maximum measuring wire diameter	11.8mm	
Probe body size	Approximately 231×67×36 (mm)	
Probe body weight	310g (excluding the battery)	
Environmental characteristics		
Operating temperature	0 ~ 50°C	
Storage temperature	-20 ~ 75°C	

16.16 AP622D current probe

The AP622D current probe is a cost-effective, common current probe that can measure DC and AC at the same time. Its maximum measuring current is 80A peak-to-peak value and the bandwidth is up to 1.5MHz. It provides 2 ranges for easy switching between low and high current measurements. The probe has a power indicator and an overload indicator and is battery powered for easy measurement. The option can be purchased by users. The option number is 4456-H22.

16.16.1 Instructions for Safe Use

To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

- Avoid fire or personal injury
- Connect and pull out correctly.
- Replace the battery correctly.
- Do not operate without the cover.
- Avoid the exposed circuits.
- You must ensure that all equipment is well grounded during operation.
- Do not operate in a humid environment.
- Do not operate in a flammable environment.

16.16.2 Operating Instructions

When the AP622D current probe is used, the input impedance of the oscilloscope is set to 1M Ω , the probe type is set to current, and the probe attenuation is set to the same as that of the AP622D.

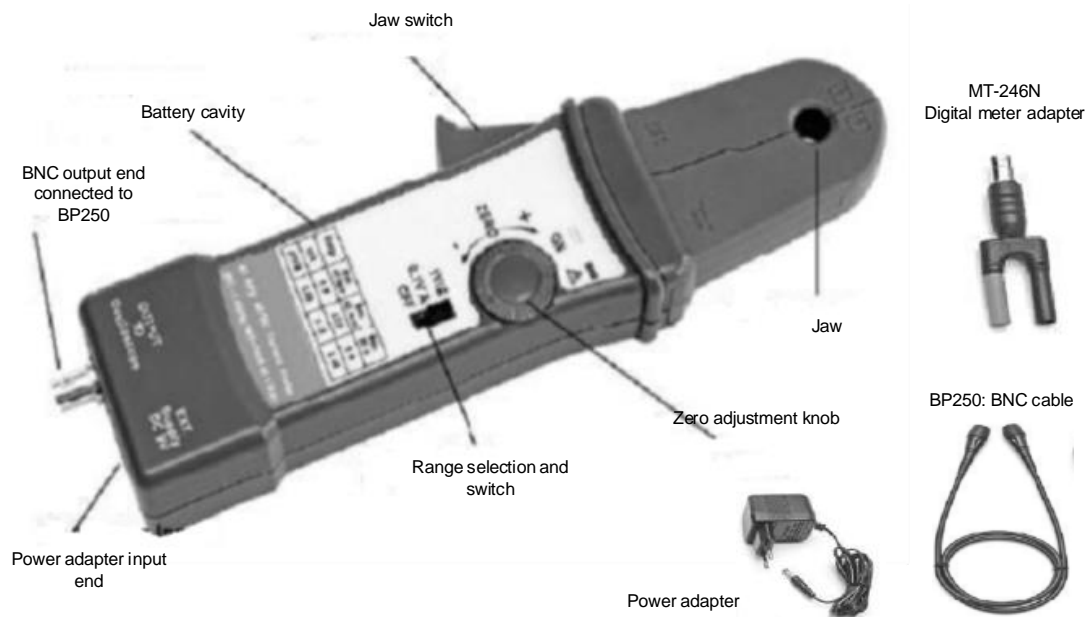


Fig. 16.33 Diagram of AP622D Probe

The AP622D current probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Connect the BNC of the current test clamp to the BP250 cable and then connect it to the input end of the oscilloscope.
- 2) Push the switch to the appropriate range position according to the measured current. The power indicator turns green.
- 3) Oscilloscope setting: Set the oscilloscope's impedance to $1M\Omega$, set the coupling mode to DC, and select the appropriate oscilloscope range according to the measured current.
- 4) Zero adjustment: Zero adjustment is required before each test. Turn the zero adjustment knob of the current probe to set the display value on the oscilloscope to zero.
- 5) Measurement: Open the clamp and pass the tested wire through the center of the jaw. Note that the diameter of the tested wire cannot exceed the size of the jaw.
- 6) After the test is completed, disconnect the conductor power supply and then take out the conductor from the card slot.



Warning: The maximum input voltage of the AP622D probe is 40V (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.16.3 Main Parameters of Probe

The main parameters of the AP622D probe are shown in the table below.

Table 16.16 AP622D Probe Parameters

Model	AP622D
Range sensitivity	100mV/A, 1V/A
Measurement accuracy	$\pm(3\%+10\text{mA})$ 10mA-4Apk @ 1V/A
	$\pm(4\%+100\text{mA})$ 0.1A-40Apk @ 0.1V/A
Bandwidth (-3dB)	1.5MHz
Maximum DC measured value	40A (DC)
Maximum AC peak-to-peak value	80A (ACpp)
Maximum AC RMS	28A(RMS)

Maximum sensitivity	1mA
Maximum operating voltage	300V CATIII
Maximum common mode voltage	600V CATII
Battery	9V alkaline battery
Maximum measuring wire diameter	10.3mm
Probe body size	262×81×36 (mm)
Probe body weight	310g (excluding the battery)
Environmental characteristics	
Operating temperature	0 ~ 50°C
Storage temperature	-20 ~ 75°C

16.17 AP621 current probe

The AP621 current probe is a cost-effective, common current probe for measuring AC. Its maximum measuring current is 2000A peak value and the bandwidth is 10 Hz - 100 kHz. It provides 3 ranges for easy switching between low and high current measurements so that the measurements become easier. The option can be purchased by users. The option number is 4456-H21.

16.17.1 Instructions for Safe Use

To ensure the safety of users and the product and the equipment connected to the product, you shall strictly observe the following safety operation specifications:

- Avoid fire or personal injury
- Connect and pull out correctly.
- Replace the battery correctly.
- Do not operate without the cover.
- Avoid the exposed circuits.
- Ensure that all equipment is well grounded during operation.
- Do not operate in a humid environment.
- Do not operate in a flammable environment.

16.17.2 Operating Instructions

When the AP621 current probe is used, the input impedance of the oscilloscope is set to 1MΩ, the probe type is set to current, and the probe attenuation is set to the same as that of the AP621.



Fig. 16.34 Diagram Accessories of AP621 Probe

The AP621 current probe is easy to use, but users who are not familiar with this product should read this manual completely before starting the operation:

- 1) Push the switch to the appropriate range position according to the measured current.
- 2) Connect the BNC plug to the oscilloscope.
- 3) Oscilloscope setting: Set the oscilloscope's impedance to $1M\Omega$, set the coupling mode to DC, and select the appropriate oscilloscope range according to the measured current.
- 4) Measurement: Open the clamp and pass the tested wire through the center of the jaw. Note that the diameter of the tested wire cannot exceed the size of the jaw.
- 5) After the test is completed, take out the conductor from the card slot.



Warning: The maximum input voltage of the AP621 probe is 2000V (DC+ACpk). Do not exceed this voltage in use. Otherwise, it will cause personal hazard or injury or damage to the DUTs.

16.17.3 Main Parameters of Probe

The main parameters of the AP621 probe are shown in the table below.

Table 16.17 AP621 Probe Parameters

Model	AP621		
Range sensitivity	100mV/A	10mV/A	1mV/A
Current range	0.1A-20A peak	1A-200A peak	10A-2000A peak
Output error	3%+10mV	2%+5mV	1%+1mV
Bandwidth	10Hz to 100kHz		
Maximum operating voltage	600Vrms		
Maximum common mode voltage	600V CATIII		
Maximum measuring wire diameter	53mm		

Probe body size	Approximately 216×111×45 (mm)
Weight	550g
Environmental characteristics	
Operating temperature	0 ~ 40 °C
Storage temperature	-10 ~ 55°C

Chapter XVII Digital voltmeter

The oscilloscope realizes the measurement function of the digital voltmeter by multiplexing the oscilloscope channels and can measure voltages, frequencies and periods of signals. The effective number of bits is 4 for voltage measurement and 6 for frequency counter.

Press the **【Meter】** key on the front panel to open the voltmeter measurement menu:



Fig. 17.1 Voltmeter Menu

Source: Select the analog channel to be measured.

Type: Select the type of voltage measurement, including: ACRMS, DC and DCRMS.

Freq Disp: Turn on or off the frequency measurement result display of the source channel.

Period Disp: Turn on or off the period measurement result display of the source channel.

The voltmeter measurement results are displayed at the upper left corner of the screen, as shown below:

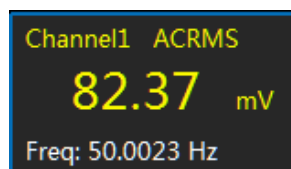


Fig. 17.2 Voltmeter Measurement Result Display

Chapter XVIII Working Principle

The complete circuits of 4456 Series Digital Phosphor Oscilloscope consist of analog channel, clock and acquisition circuit, trigger circuit, digital signal processing circuit (data receiving, DPX processing and data storage), embedded CPU, power supply circuit, logic analyzer module (option 001) and waveform generation module (option 002). The block diagram of the hardware is shown in Figure 18.1.

The design of the analog channel bandwidth is always the core part of circuit design. During design, it is necessary to select the appropriate bandwidth of the low noise amplifier and relay switch according to the bandwidth specifications of different models, thus reducing the cost and system power consumption according to different bandwidths. Therefore, during the design of the analog channel, the serialization extension of the whole model is realized by replacing different channels based on the modularization and serialization concepts.

The clock and acquisition circuit mainly consists of a highly stable clock phase-locked loop and a fast ADC. The clock generator is composed of a frequency synthesizer and a reference clock oscillator. The generated 2.5 GHz clock signal is divided into two and sent to the two ADCs at the back end as the input clock of the A/D converter. The 4456C/D uses two ADCs for acquisition upon designing the acquisition circuit. The first ADC collects the signals of CH1 and CH2 and the second ADC collects the signals of CH3 and CH4. The highest sample rate can be 5GSa/s when single or dual channels are used simultaneously or 2.5GSa/s when three or four channels are used simultaneously. The 4456CM/DM uses one ADC for acquisition upon designing the acquisition circuit. The highest sample rate can be 5GSa/s for a single channel, 2.5GSa/s for dual channels and 1.25GSa/s for three or four channels used simultaneously.

The trigger circuit includes the analog and digital trigger circuits. The video and external triggers are implemented by using traditional analog trigger, while the edge, pulse width, pattern, logic and runt triggers are implemented by using new digital trigger. The digital trigger technology uses the digital signal processing method to perform trigger point determination against ADC samples collected and detect effective trigger events with an accurate algorithm. It can accurately display and analyze the measurement signal and has such features as lower trigger jitter, higher trigger sensitivity, smaller pulse detection width and more accurate channel delay calibration.

The digital signal processing circuit includes high-speed data receiving, deceleration and storage, digital fluorescent display processing, protocol trigger and analysis and other function units. The processing speed of this part directly determines the waveform capture rate of the whole instrument. This product uses 2 high-performance FPGAs, one as the main FPGA and the other as the slave FPGA. The slave FPGA is used to complete data acquisition and storage, waveform generation, protocol trigger and analysis, and data communication; the main FPGA is used to complete data acquisition and storage, waveform generation, image synthesis, fluorescent display, digital trigger, and data communication.

The embedded CPU system is mainly used to complete the control of the whole instrument and the parameter measurement of waveforms, mathematical operation, FFT spectrum analysis, limit/mask test, and power measurement. This part also provides rich communication interface functions, including USB main control, USB device, Ethernet interface, VGA display interface, and reference clock input and output interfaces. The Ethernet interface enables remote programmable control and can be used to build a distributed system.

The logic analyzer module (option 001) is mainly used for signal acquisition of 16 digital channels. It can be combined with the oscilloscope module to realize the functions of a mixed signal oscilloscope.

The waveform generator module (option 002) is mainly used for waveform generation of one channel and can output sine wave, square wave/pulse, triangle/oblique wave, noise signal, and arbitrary waveform.

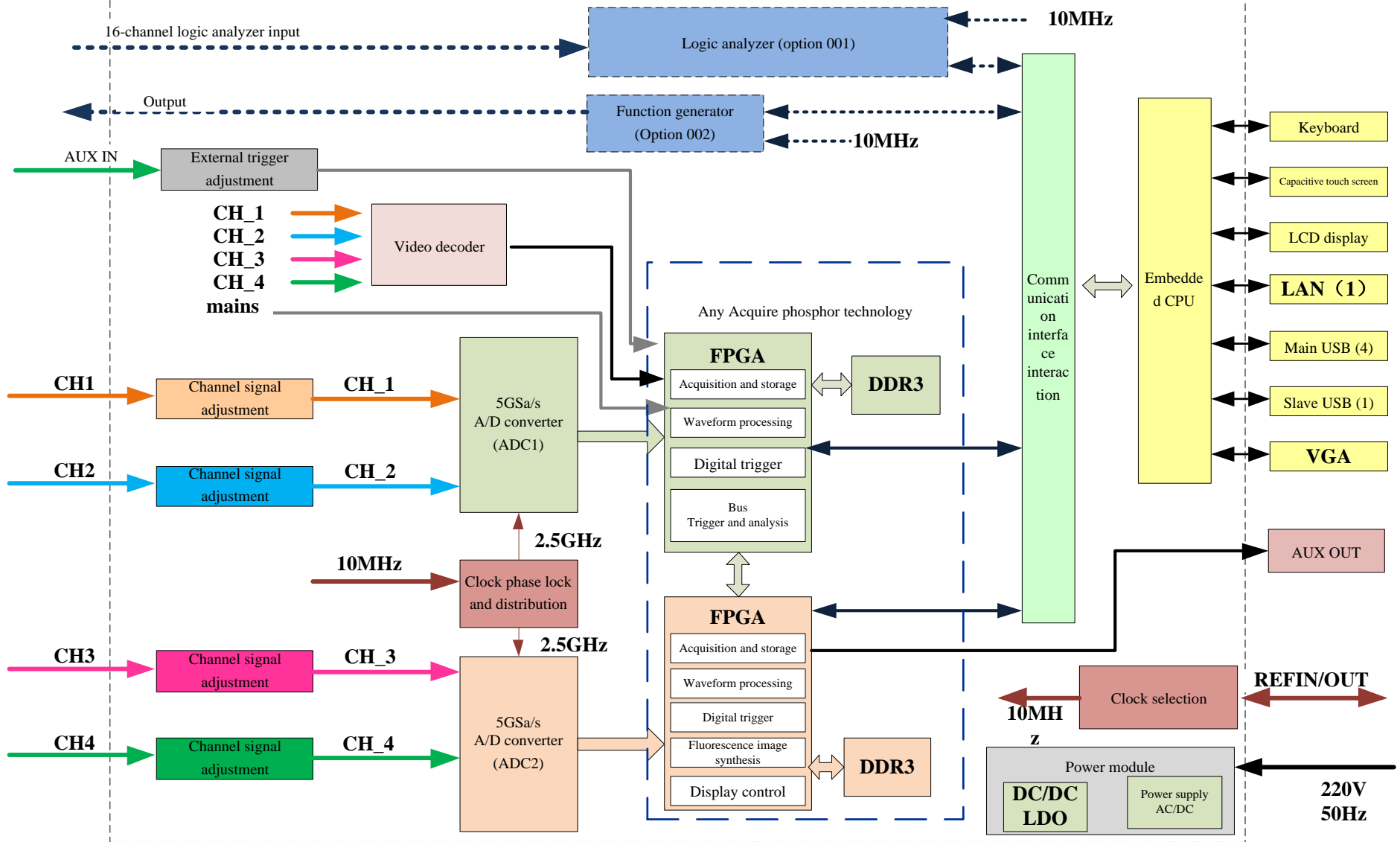


Fig. 18.1 Principle Block Diagram of Digital Phosphor Oscilloscope

Chapter XIX Application Examples

19.1 Measuring Simple Signal

There is an unknown signal in the circuit and you need to quickly display and measure the frequency and amplitude of the signal. Follow the following steps:

- 1) Connect the ground wire on the probe to the circuit under test. The needle of the probe touches the measured point of the circuit.
- 2) Press **【AutoSet】** key and the oscilloscope will automatically set to display optimal waveforms. On the basis of this, you may further adjust the vertical and horizontal positions until the waveform display meets your requirements.
- 3) To measure the frequency and amplitude, press the **【Measure】** key to display the level 1 menu. Click the [Add Measurement] menu to pop up the Add Level2 Menu on the right of the screen.
- 4) Click [Source] and select the corresponding measurement channels CH1-CH4.
- 5) Click [Type] and select the corresponding measurement parameters such as frequency, amplitude and peak.



Fig. 19.1 Automatic Measurement Example

19.2 Measuring Pulse Signal

In the circuit there is a pulse signal with the period of 1 kHz, the pulse width of 8 ns and the amplitude of 200 mV. You can observe the complete signal by following the steps below.

- 1) Connect the ground wire on the probe to the circuit under test. The needle of the probe touches the measured point of the circuit.
- 2) Press the **【Acquire】** button to display the level 1 menu at the bottom of the screen, click the [Acquisition Mode] menu to pop up the Level2 Menu on the right side of the screen, and select the [Peak Detect] mode through the Multipurpose button or the touch screen.
- 3) Adjust the Scale knob to change the time base position and adjust the time base to 1ms/div.
- 4) Adjust the Scale knob and adjust the vertical sensitivity to 50mV/div.
- 5) Press the **【Trigger】** key to pop up the trigger main menu, click the [Source] menu, select the corresponding trigger channel, and adjust the trigger level knob to display the waveform stably.
- 6) You can observe a stable pulse signal.



Fig. 19.2 Example of Pulse Measurement by Using Peak Detect Mode

19.3 Viewing Phase Difference between Two Signals

For viewing the phase difference between two signals with the same frequency and amplitude, there are two common methods: XY measurement method and direct parameter measurement method.

19.3.1 XY Measurement Method

In XY mode, the oscilloscope will convert two input channels to voltage-voltage display from voltage-time display. The X axis and Y axis will track the voltage of CH1 and CH2 respectively. The phase difference between two signals with the same frequency can be easily displayed and measured with Lissajous method.

The operation steps are as follows:

- 1) Connect the ground wire on the probe to the circuit under test. The needle of the probe touches the measured point of the circuit.
- 2) Press **【AutoSet】** key and the oscilloscope will automatically set to display optimal waveforms. On the basis of this, you may further adjust the vertical and horizontal positions until the waveform display meets your requirements.
- 3) Press the **【Display】** key to pop up the level 1 menu at the bottom of the screen and click the [XY Display] menu.
- 4) Calculate the phase difference of the two signals according to the principle of Figure XY. The figure below shows the XY display graphs of several common phase differences.

Signal	Phase difference					
	0 degrees	45 degrees	90 degrees	180 degrees	270 degrees	360 degrees
1: 1						

Fig. 19.3 Principle Diagram of Phase Difference Measurement

- 5) If the frequency or phase difference of the two measured signals is an integer multiple, the frequency and phase relationship between the two signals can be derived from the graph.

19.3.2 Parameter Automatic Measurement Method

The delay measurement of the two signals is automatically realized by using the phase difference in the parameter automatic measurement menu. For measuring the delay of the rising edges in the CH1 and CH2, the operation is as follows:

- 1) Connect the ground wire on the probe to the circuit under test. The needle of the probe touches the measured point of the circuit.
- 2) Press **【AutoSet】** key and the oscilloscope will automatically set to display optimal waveforms. On the basis of this, you may further adjust the vertical and horizontal positions until the waveform display meets your requirements.
- 3) Press **【Measure】** to pop up the level 1 menu at the bottom of the screen, click the [Add Measurement] menu to pop up the Level2 Menu on the right side of the screen, click the [Measurement Type] menu to pop up the Level3 Menu, select the [Delay] parameter measurement through the Multipurpose b or the touch screen, set the delay measurement type, and read the delay time of CH1-CH2.

19.4 I2C Trigger and Analysis Example

If you want to observe the transmission of signals on the I2C bus, you can follow these steps below:

- 1) Connect the clock line (SCLK) of the I2C bus to the channel 1, connect the data line (SDA) to the channel 2, and click the channel control key on the front panel to open the channels 1 and 2;
- 2) Click the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [I2C], select the I2C bus type, and switch to the I2C bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Define Inputs] to pop up the I2C input setup menu on the right side of the screen. Click the menu key [SCLK Input] to pop up the Level3 Menu of SCLK input selection on the left side of the menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu of the right menu;
- 5) Click the menu key [SDA Input] to pop up the Level3 Menu of SDA input selection on the left side of the menu. Select the channel 2 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 2 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu of the right menu;
- 6) Click the menu key [Thresholds] to pop up the I2C channel threshold setup menu on the right side of the screen. Click the menu key [SCLK] and turn the Multipurpose b to set the threshold of SCLK input channel. Click the menu key [SDA] and turn the Multipurpose b to set the threshold of SDA input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection on the screen;
- 7) Click the menu key [Include R/W in Address] to pop up Include R/W in I2C Address setup menu on the right side of the screen. Click the menu key [Yes] or [No] to set whether R/W is included in I2C address;
- 8) Click the menu key [Bus Display] to pop up the I2C bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set directly by clicking the Bus and Waveforms option in the Level3 Menu; click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or directly set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;
- 9) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the

screen, and click the menu key [Bus] to select the protocol trigger mode;

- 10) Click the menu key [Trigger On] at the bottom of the screen to pop up the I2C trigger type setup menu on the right side of the screen, and click the menu key [Start] to set the I2C trigger type to Start.

In this way, connect the clock line of I2C bus to the channel 1 and connect the data line to the channel 2. The I2C bus decoding trigger with the bus start position as the trigger point is displayed in the figure below:

The Frame Start of the I2C bus is indicated by a green left square bracket [. The Repeat Start occurs when another start is displayed without a previous stop.

The Address is displayed in a yellow box, [w] means write and [R] means read.

The Data is displayed in a cyan box

The Missing Ack is indicated by an exclamation point in a red box.

The Stop is indicated by a red right square bracket]

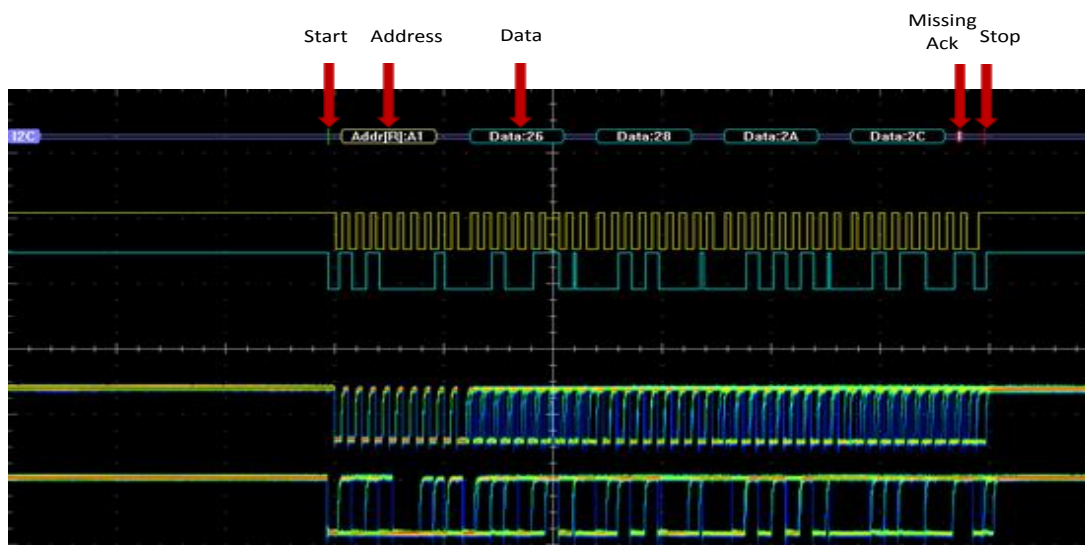


Fig. 19.4 I2C Trigger and Analysis Example

19.5 CAN Trigger and Analysis Example

If you want to observe the transmission of signals on the CAN bus, you can follow these steps below:

- 1) Connect the CAN_L signal of CAN bus to channel 1 and click the channel control key on the front panel to open channel 1;
- 2) Click the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [CAN], select the CAN bus type, and switch to the CAN bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Define Inputs] to pop up the CAN input setup menu on the right side of the screen. Click the menu key [CAN Inputs] to pop up the Level3 Menu of CAN input selection on the left side of the menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu of the right menu;
- 5) Click the menu key [Signal Type] to pop up the Level3 Menu of signal type selection on the left side of the menu: select the CAN_L signal type by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the CAN_L signal type in the Level3 Menu on the screen. The selected signal type is displayed on the right signal type selection menu;
- 6) Click the menu key [Sample Point] and turn the Multipurpose b to change the position of the sample point. The sample point can be set to 70%;
- 7) Click the menu key [Thresholds] to pop up the CAN channel threshold setup menu on the right side of the

screen. Click the menu key [Thresholds] and turn the Multipurpose b to set the threshold of CAN input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection on the screen;

- 8) Click the menu key [Bit Rate] to pop up the CAN bit rate setup menu on the right side of the screen. Click the menu key [Bit Rate] and turn the Multipurpose b to set the bit rate of CAN bus to 500kbps, or click the menu key [Choose Preset] to pop up the bit rate preset type selection menu on the left side of the menu and turn the Multipurpose b to select 500kbps and then press the Multipurpose b to confirm Select or directly click 500kbps for selection in the Level3 Menu on the screen;
- 9) Click the menu key [Bus Display] to pop up the CAN bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode setting on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set by clicking the Bus and Waveforms option in the Level3 Menu; click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;
- 10) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen: click the menu key [Bus] to select the protocol trigger type and switch to the protocol trigger setup menu at the bottom of the screen;
- 11) Click the menu key [Trigger On] at the bottom of the screen to pop up the CAN Trigger type setup menu on the right side of the screen, and click the menu key [Start of Frame] to set the CAN Trigger type to Start of Frame.

In this way, connect the CAN_L signal of CAN bus to the channel 1. The CAN bus decoding trigger with the bus Start of Frame position as the trigger point is displayed in the figure below:

The CAN bus Start of Frame is indicated by a green left square bracket [.

The Address is displayed in a yellow box.

The DLC is displayed in a purple box.

The Data is displayed in a cyan box.

The CRC Check is displayed in a purple box when it is correct and in a red box when it is wrong.

The End of Frame is indicated by a green right square bracket].

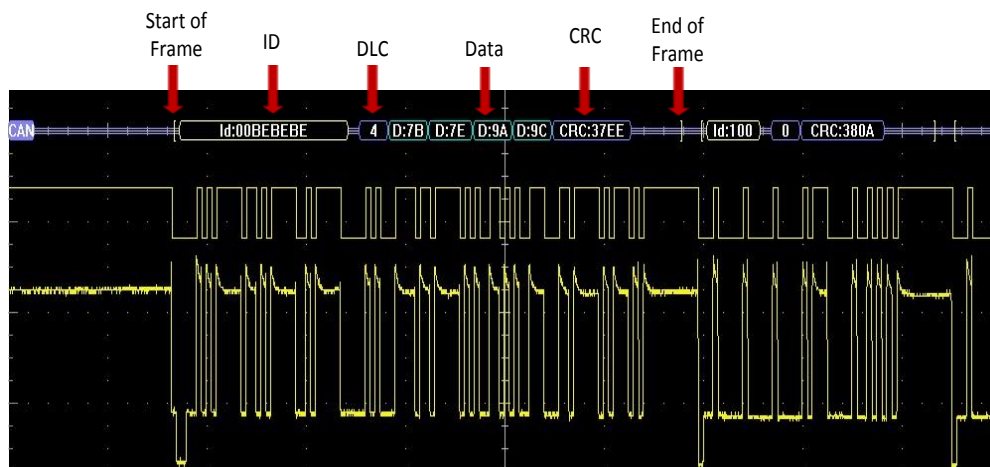


Fig. 19.5 CAN Trigger and Analysis Example

19.6 LIN Trigger and Analysis Example

If you want to observe the transmission of signals on the LIN bus, you can follow these steps below:

- 1) Connect the signal of the LIN bus to channel 1 and click the channel control key on the front panel to open channel 1;
- 2) Press the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [LIN], select the LIN bus type, and switch to the LIN bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Define Inputs] to pop up the LIN input setup menu on the right side of the screen. Click the menu key [LIN Inputs] to pop up the Level3 Menu of LIN input selection on the left side of the menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu of the right menu;
- 5) Click the menu key [Sample Point] and turn the Multipurpose b to change the position of the sample point. The sample point can be set to 70%;
- 6) Click the menu key [Polarity] to pop up the Level3 Menu of polarity setting on the left side of the menu. Select the Polarity Normal option by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the Polarity Normal option on the screen. The selected polarity is displayed on the right polarity selection menu;
- 7) Click the menu key [Thresholds] to pop up the LIN channel threshold setup menu on the right side of the screen. Click the menu key [LIN (Channel)] and turn the Multipurpose b to set the threshold of LIN input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu;
- 8) Click the menu key [Configure] to pop up the LIN Configure setup menu on the right side of the screen. Click the menu key [Bit Rate] and turn the Multipurpose b to set the bit rate of LIN bus to 19200bps, or click the menu key [Bit Rate Choose Preset] to pop up the bit rate preset type selection menu on the left side of the menu and turn the Multipurpose b to select 19.2kbps and then press the Multipurpose b to confirm Select or directly click the preset bit rate 19.2kbps for selection in the Level3 Menu on the screen;
- 9) Click the menu key [Configure] to pop up the LIN Configure setup menu on the right side of the screen. Click the menu key [LIN Standard] to pop up the LIN Standard setup menu on the left side of the menu. Select the corresponding Both by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the standard type of Both on the screen;
- 10) Click the menu key [Configure] to pop up the LIN Configure setup menu on the right side of the screen and click the menu key [Id With Parity] to set Yes or No;
- 11) Click the menu key [Bus Display] to pop up the CAN bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode setting on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set by clicking the Bus and Waveforms option in the Level3 Menu; click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;
- 12) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen: click the menu key [Bus] to select the protocol trigger type and switch to the protocol trigger setup menu at the bottom of the screen;
- 13) Click the menu key [Trigger On] at the bottom of the screen to pop up the LIN Trigger type setup menu on the right side of the screen, and click the menu key [Sync] to set the LIN Trigger type to Sync.

In this way, connect the signal of LIN bus to the channel 1. The LIN bus decoding trigger with the bus Frame Sync position as the trigger point is displayed in the figure below:

The LIN bus Start of Frame is indicated by a green left square bracket [.

The Sync Interval (interrupt field) is displayed in a purple box.

The Sync Segment is displayed in a purple box.

The Id Address is displayed in a yellow box. It is displayed in a red box if the Id includes parity and if the check is wrong.

The Parity is displayed in a yellow box.

The Data is displayed in a cyan box.

It is displayed in a purple box when the checksum is correct and in a red box when the checksum is wrong.

The End of Frame is indicated by a green right square bracket].

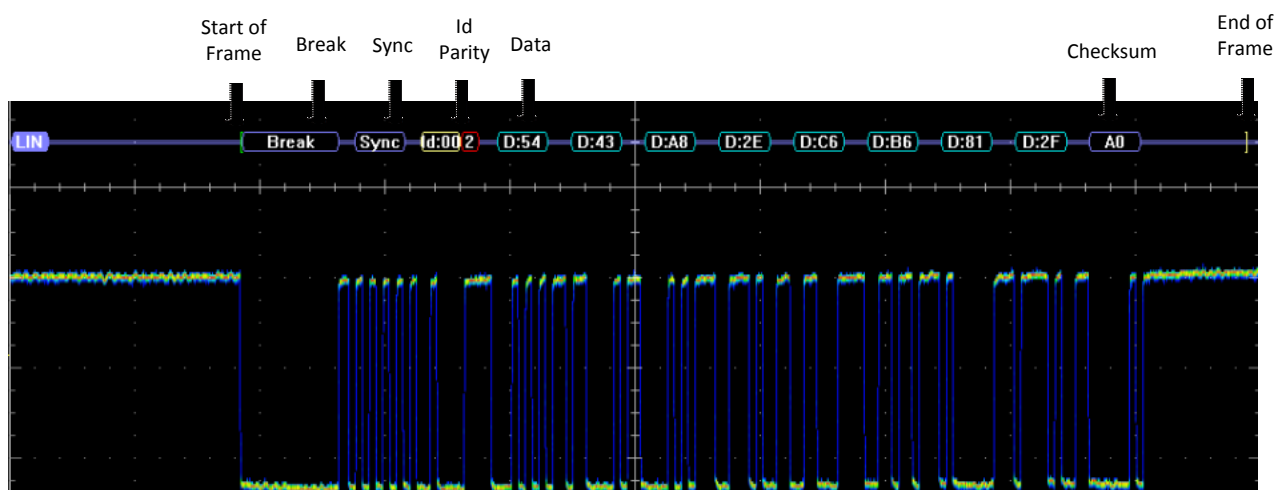


Fig. 19.6 LIN Trigger and Analysis Example

19.7 FlexRay Trigger and Analysis Example

If you want to observe the transmission of signals on the FlexRay bus, you can follow these steps below:

- 1) Connect the Tx signal of the FlexRay bus to channel 1 and click the channel control key on the front panel to open channel 1;
- 2) Press the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [FlexRay], select the FlexRay bus type, and switch to the FlexRay bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Define Inputs] to pop up the FlexRay input setup menu on the right side of the screen. Click the menu key [FlexRay Inputs] to pop up the Level3 Menu of FlexRay input selection on the left side of the menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu of the right menu;
- 5) Click the menu key [Channel Type] and set the input channel type of FlexRay bus to A;
- 6) Click the menu key [Signal Type] to pop up the Level3 Menu of signal type setting on the left side of the menu. Select the signal type of Tx or Rx by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the signal type of Tx or Rx in the Level3 Menu on the screen. The selected signal type is displayed on the signal type button of the right menu;
- 7) Click the menu key [Thresholds] to pop up the FlexRay channel threshold setup menu on the right side of the screen. Click the menu key [Thresholds] and turn the Multipurpose b to set the threshold of FlexRay input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection

on the screen;

- 8) Click the menu key [Bit Rate] to pop up the FlexRay bit rate setup menu on the right side of the screen and click the menu key [10M] to set the FlexRay bit rate to 10Mbps;
- 9) Click the menu key [Bus Display] to pop up the FlexRay bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set by clicking the Bus and Waveforms option in the Level3 Menu. Click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or set by clicking the Hex option in the Level3 Menu. Click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area. Click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;
- 10) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen. Click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen. Click the menu key [Bus] to select the protocol trigger type and switch to the protocol trigger setup menu at the bottom of the screen;
- 11) Click the menu key [Trigger On] at the bottom of the screen to pop up the FlexRay protocol trigger type setup menu on the right side of the screen, and click the menu key [Start of Frame] to set the FlexRay protocol trigger type to Start of Frame.

In this way, connect the Tx signal of FlexRay bus to the channel 1. The FlexRay bus decoding trigger with the bus Start of Frame position as the trigger point is displayed in the figure below:

The FlexRay bus Start of Frame is indicated by a green left square bracket [.

The TSS is displayed in a purple box.

The Indicator Bits are displayed in a purple box.

The Id is displayed in a yellow box.

The Payload Length is displayed in a purple box.

The Header CRC is displayed in a purple box if it is correct and in a red box if it is wrong.

The Cycle Count is displayed in a yellow box.

The Data is displayed in a cyan box.

The End of Frame is indicated by a red right square bracket].

The DTS is displayed in a purple box.

The CID is displayed in a purple box.

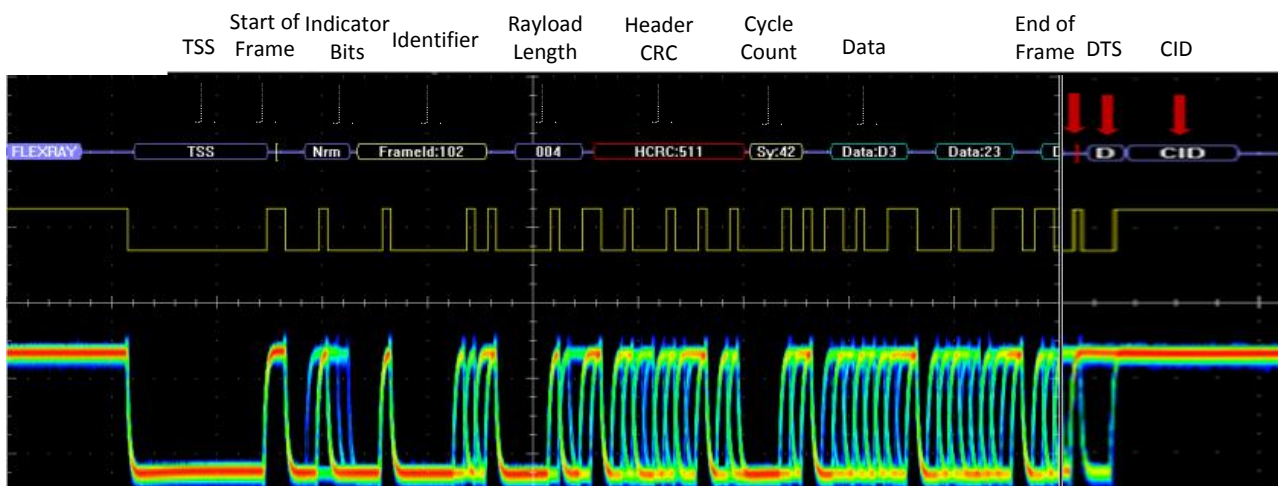


Fig. 19.7 FlexRay Trigger and Analysis Example

19.8 RS232 Trigger and Analysis Example

If you want to observe the transmission of signals on the RS232 bus, you can follow these steps below:

- 1) Connect the Tx signal of the RS232 bus to channel 1 and click the channel control key on the front panel to open channel 1;
- 2) Press the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [RS232], select the RS232 bus type, and switch to the RS232 bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Define Inputs] to pop up the RS232 input setup menu on the right side of the screen. Click the menu key [Tx Input] to pop up the Level3 Menu of RS232 input selection on the left side of the menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu of the right menu;
- 5) Click the menu key [Thresholds] to pop up the RS232 channel threshold setup menu on the right side of the screen. Click the menu key [Tx] and turn the Multipurpose b to set the threshold of RS232 input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection on the screen;
- 6) Click the menu key [Bit Rate] to pop up the RS232 bit rate setup menu on the right side of the screen. Click the menu key [Bit Rate] and turn the Multipurpose b to set the bit rate of RS232 bus to the corresponding value, or click the menu key [Choose Preset] to pop up the bit rate preset type selection menu on the left side of the menu and turn the Multipurpose b to select the corresponding value and then press the Multipurpose b to confirm Select or directly click the corresponding value in the Level3 Menu on the screen;
- 7) Click the menu key [Bus Display] to pop up the RS232 bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode setting on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set by clicking the Bus and Waveforms option in the Level3 Menu; click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;
- 8) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen: click the menu key [Bus] to select the protocol trigger type and switch to the protocol trigger setup menu at the bottom of the screen;
- 9) Click the menu key [Trigger On] at the bottom of the screen to pop up the RS232 protocol trigger type setup menu on the right side of the screen, and click the menu key [Frame Tx Start Bit] to set the RS232 protocol trigger type to Tx Start Bit. The RS232 bus decoding trigger is displayed in the figure below:

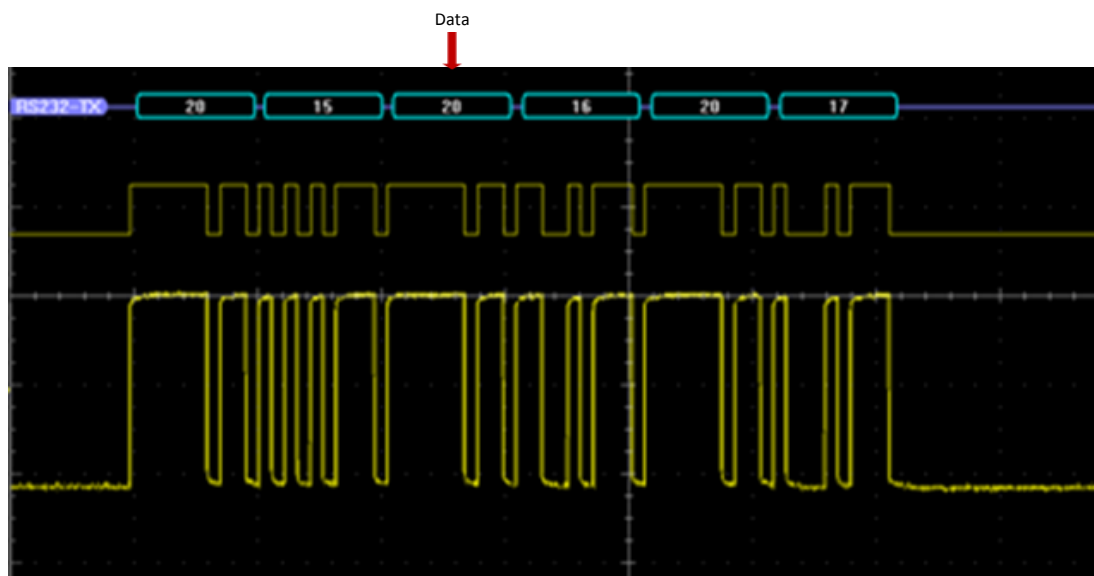


Fig. 19.8 RS232 Trigger and Analysis Example

19.9 SPI Trigger and Analysis Example

If you want to observe the transmission of signals on the SPI bus, you can follow these steps below:

- 1) Connect the clock line of the SPI bus to the channel 1, connect the SS line to the channel 2, connect the data line to the channel 3, and click the channel control key on the front panel to open the channels 1, 2 and 3;
- 2) Press the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [SPI], select the SPI bus type, and switch to the SPI bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Define Inputs] to pop up the SPI input setup menu on the right side of the screen. Click the menu key [SCLK Input] to pop up the Level3 Menu of SCLK input selection on the left side of the menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
- 5) Click the menu key [SS Input] to pop up the Level3 Menu of SS input selection on the left side of the menu. Select the channel 2 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 2 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
- 6) Click the menu key [MOSI Input] to pop up the Level3 Menu of MOSI input selection on the left side of the menu. Select the channel 2 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 2 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
- 7) Click the menu key [Thresholds] to pop up the SPI channel threshold setup menu on the right side of the screen. Click the menu key [Channel] to pop up the Level3 Menu of the channel selection on the left side of the menu and turn the Multipurpose b to select SCLK. Click the menu key [Threshold] and turn the Multipurpose b to set the threshold of SCLK input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection on the screen. Set the thresholds of SS and MOSI in the same way;
- 8) Click the menu key [Bus Display] to pop up the SPI bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set directly by clicking the Bus and Waveforms option in the Level3 Menu; click the menu

key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or directly set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;

- 9) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen, and click the menu key [Bus] to select the protocol trigger mode;
- 10) Click the menu key [Trigger On] at the bottom of the screen to pop up the SPI protocol trigger type setup menu on the right side of the screen, and click the menu key [SS Valid] to set the SPI protocol trigger type to SS Valid.

The SPI bus decoding trigger is displayed in the figure below:

The Frame Start of the SPI bus is indicated by a green left square bracket [.

The Data is displayed in a blue box.

The Stop is indicated by a red right square bracket].

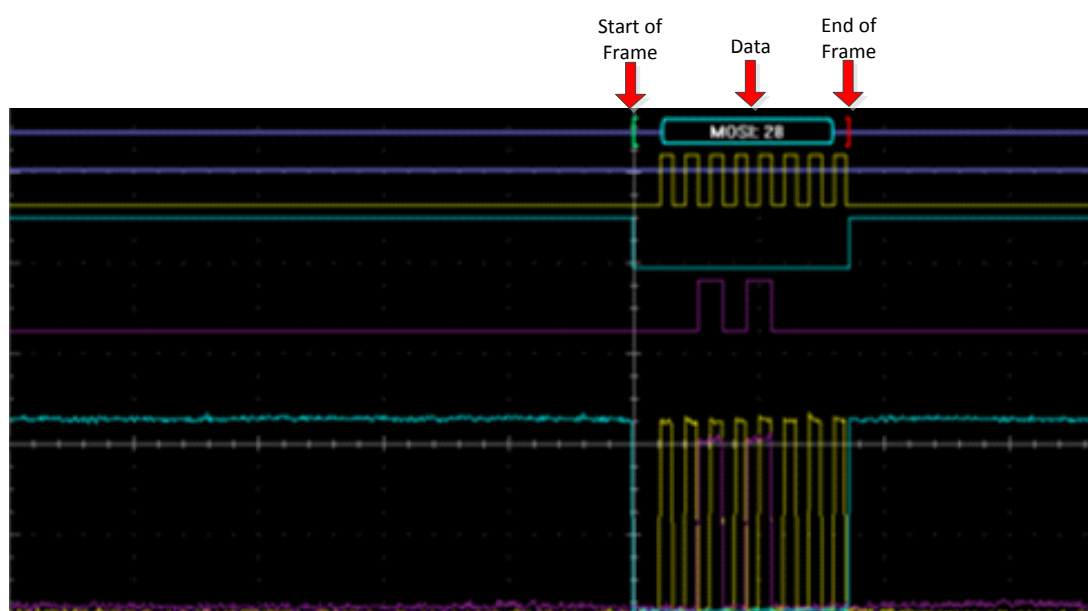


Fig. 19.9 SPI Trigger and Analysis Example

19.10 Audio Trigger and Analysis Example

If you want to observe the transmission of signals on the Audio bus, you can follow these steps below:

- 1) Connect the clock line of the Audio bus to the channel 1, connect the Bit Select line to the channel 2, connect the data line to the channel 3, and click the channel control key on the front panel to open the channels 1, 2 and 3;
- 2) Press the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [Audio], select the Audio bus type, and switch to the Audio bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Audio Type] to pop up the Level3 Menu of the Audio type selection on the left side of the menu. Select the LJ by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the LJ in the Level3 Menu on the screen. The selected channel is displayed in the Audio type menu on the right side;
- 5) Click the menu key [Bit Clock] to pop up the Level3 Menu of bit clock input selection on the left side of the

- menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
- 6) Click the menu key [Bit Select] to pop up the Level3 Menu of Bit Select input selection on the left side of the menu. Select the channel 2 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 2 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
 - 7) Click the menu key [Data] to pop up the Level3 Menu of data input selection on the left side of the menu. Select the channel 3 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 3 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
 - 8) Click the menu key [Thresholds] to pop up the Audio channel threshold setup menu on the right side of the screen. Click the menu key [Channel] to pop up the Level3 Menu of the channel selection on the left side of the menu and turn the Multipurpose b to select the Bit Clock. Click the menu key [Threshold] and turn the Multipurpose b to set the threshold of the bit clock input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection on the screen. Set the thresholds of Bit Select and Data in the same way;
 - 9) Click the menu key [Bus Display] to pop up the Audio bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set directly by clicking the Bus and Waveforms option in the Level3 Menu; click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or directly set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;
 - 10) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen, and click the menu key [Bus] to select the protocol trigger mode;
 - 11) Click the menu key [Trigger On] at the bottom of the screen to pop up the Audio protocol trigger type setup menu on the right side of the screen, and click the menu key [Word Select] to set the Audio protocol trigger type to Word Select.

The Audio bus decoding trigger is displayed in the figure below:

The Frame Start of the Audio bus is indicated by a green left square bracket [.

The Data is displayed in a cyan box

The Stop is indicated by a red right square bracket].

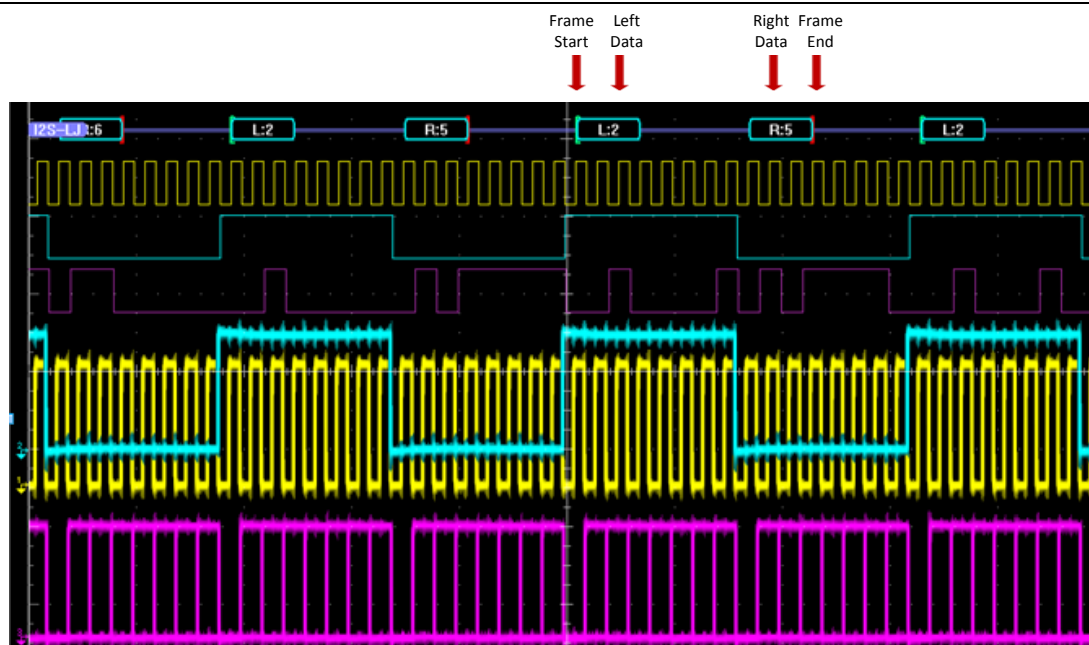


Fig. 19.10 Audio Trigger and Analysis Example

19.11 USB Trigger and Analysis Example

If you want to observe the transmission of signals on the USB bus, you can follow these steps below:

- 1) Connect D+ line of the USB bus to the channel 1, connect the D- line to the channel 2, and click the channel control key on the front panel to open the channels 1 and 2;
- 2) Press the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the [Bus] menu key on the menu to pop up the bus type selection menu on the right side of the screen. Click the [USB] menu key, select the USB, and switch to the USB setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the [Define Inputs] menu key to pop up the USB input setup menu on the right side of the screen. Click the [Speed] menu key to select the Low.
- 5) Click the menu key [Signal Type] to select the Single-ended.
- 6) Click the menu key [D+] to pop up the Level3 Menu of D+ channel input selection on the left side of the menu. Select the channel 1 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 1 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
- 7) Click the menu key [D-] to pop up the Level3 Menu of D- channel input selection on the left side of the menu. Select the channel 2 by turning the Multipurpose b and then pressing the Multipurpose b to confirm Select, or by directly clicking the channel 2 in the Level3 Menu on the screen. The selected channel is displayed in the channel selection menu on the right side;
- 8) Click the menu key [Thresholds] to pop up the USB channel threshold setup menu on the right side of the screen. Click the menu key [D+] and turn the Multipurpose b to set the threshold of D+ input channel. Click the menu key [D+] and turn the Multipurpose b to set the threshold of D+ input channel, or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection on the screen. Set the Threshold of D- channel in the same way;
- 9) Click the menu key [Bus Display] to pop up the USB bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set directly by clicking the Bus and Waveforms option in the Level3 Menu; click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu,

turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or directly set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;

- 10) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen, and click the menu key [Bus] to select the protocol trigger mode;
- 11) Click the menu key [Trigger On] at the bottom of the screen to pop up the USB protocol trigger type setup menu on the right side of the screen, and click the menu key [Sync] to set the USB protocol trigger type to Sync.

The USB bus decoding trigger is displayed in the figure below:

The Frame Start of the USB bus is indicated by a green left square bracket [.

The Sync and CRC Check are displayed in purple boxes.

The PID Type, Address and Endpoint are displayed in yellow boxes.

The Stop is indicated by a red right square bracket].

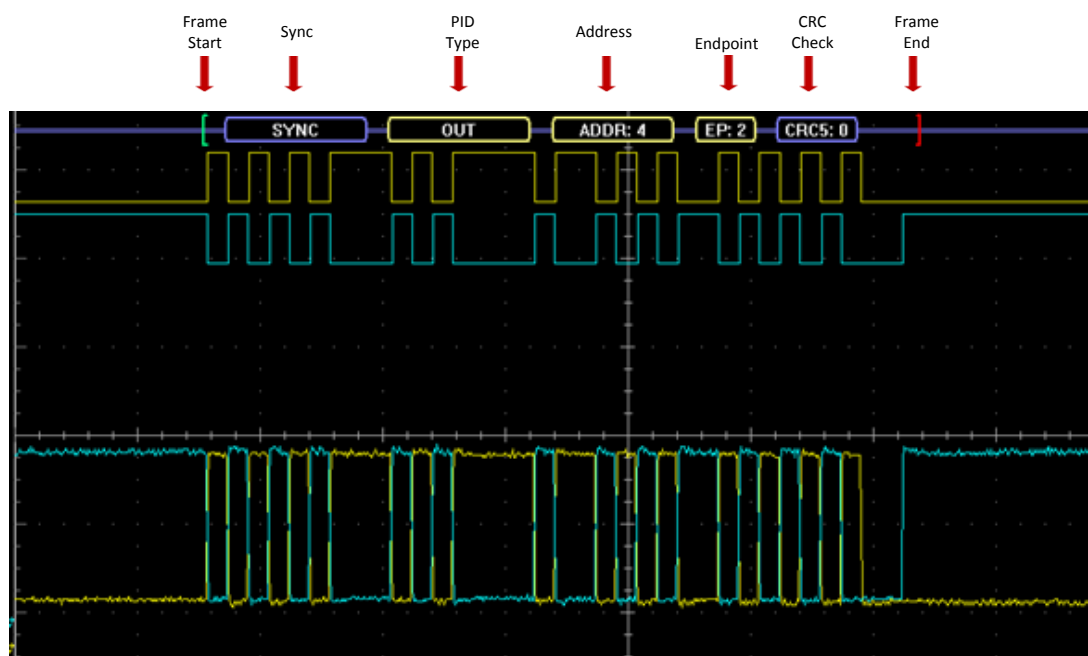


Fig. 19.11 USB Trigger and Analysis Example

19.12 1553 Trigger and Analysis Example

If you want to observe the transmission of signals on the 1553 bus, you can follow these steps:

- 1) Connect the input channel of the 1553 bus to channel 1 and click the channel control key on the front panel to open channel 1;
- 2) Press the **【Bus】** key in the Function Area on the front panel to pop up the bus setup menu on the lower screen. Click the menu key [Bus] on the menu to pop up the bus type selection menu on the right side of the screen. Click the menu key [1553], select the 1553 bus type, and switch to the 1553 bus setup menu at the bottom of the screen;
- 3) Click the menu key [Bus Switch] at the bottom of the screen to turn on the bus decoding function;
- 4) Click the menu key [Define Inputs] to pop up the 1553 input setup menu on the right side of the screen. Click the menu key [1553 Input] to pop up the channel selection menu, and select the channel 1.
- 5) Click the menu key [Polarity] to select the Normal.
- 6) Click the menu key [Thresholds] to pop up the 1553 channel threshold setup menu on the right side of the

screen. Click the menu key [High] and turn the Multipurpose b to set the high threshold. Click the menu key [Low] and turn the Multipurpose b to set the low threshold. Or click the menu key [Choose Preset] to pop up the Level3 Menu of the preset type selection on the left side of the menu and turn the Multipurpose b to select the preset threshold and then press the Multipurpose b to select the corresponding preset type or directly click the corresponding type for selection on the screen.

- 7) Click the menu key [Bus Display] to pop up the 1553 bus display setup menu on the right side of the screen, click the menu key [Display] to pop up the Level3 Menu of the bus display mode on the left side of the menu, turn the Multipurpose b to select the bus and waveform display mode and then press the Multipurpose b to confirm Select, or set directly by clicking the Bus and Waveforms option in the Level3 Menu; click the menu key [Number Format] to pop up the Level3 Menu of the number format setting on the left side of the menu, turn the Multipurpose b to select Hex and then press the Multipurpose b to confirm Select, or directly set by clicking the Hex option in the Level3 Menu; click the menu key [Bus Offset] and turn the Multipurpose b to change the position of the bus in the vertical direction of the display area; click the menu key [Waveforms Offset] and turn the Multipurpose b to change the position of the digital waveform in the vertical direction of the display area;
- 8) Press the **【Trigger】** key in the Function Area on the front panel to pop up the trigger setup menu on the lower screen, click the menu key [Type] to pop up the trigger type selection menu on the right side of the screen, and click the menu key [Bus] to select the protocol trigger mode;
- 9) Click the menu key [Trigger On] at the bottom of the screen to pop up the 1553 protocol trigger type setup menu on the right side of the screen, and click the menu key [Sync] to set the 1553 protocol trigger type to Sync.

The 1553 bus decoding trigger is displayed in the figure below:

The Frame Start of the 1553 bus is indicated by a green left square bracket [.

The Sync, Send Bit, Word Count, and Parity Check are displayed in purple boxes.

The RTA Address and Sub Address are displayed in yellow boxes.

The Stop is indicated by a red right square bracket].

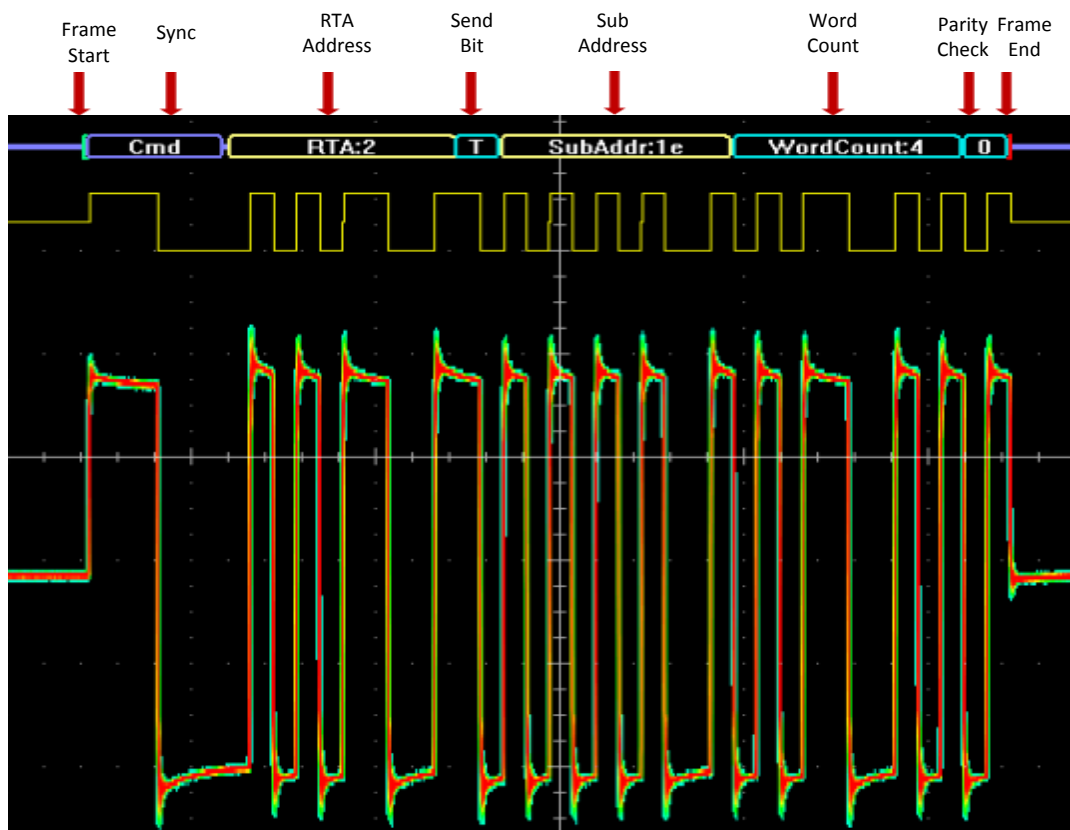


Fig. 19.12 1553 Trigger and Analysis Example

Chapter XX Fault Detection and Troubleshooting

This chapter mainly introduces the troubleshooting and repair of the 4456 Series Digital Phosphor Oscilloscope, and shows possible faults and troubleshooting of the 4456 Series Digital Phosphor Oscilloscope.

Table 20.1 Faults and Troubleshooting

Fault	Cause	Troubleshooting
Black screen	The switch closed on the rear panel or the internal fuse damaged	Turn on the power button on the rear panel and replace the internal fuse
	The oscilloscope internal power module damaged	Replace the power module
	Loose LCD cable	Re-plug the LCD cable
Start failure of WINDOWS system	CPU module damaged or unreliable connector connection	Replace it with a new CPU module or reinstall
	Hard disk damaged or unreliable connector connection	Replace it with a new hard disk module or reinstall to repair the system boot area
No trace on the screen after the application starts	System clock losing lock	Run the self-test menu to confirm
	Acquisition not finished	Run the self-test menu to confirm
	Auto trigger mode in running state	Check the parameter settings of the instrument
Abnormal waveform display	Loss of calibration data	Recalibration
	Probe damaged	When the sensor is replaced
	System power fault, system clock losing lock or abnormal PCI communication	Run the self-test program for fast fault positioning
Inaccurate parameter measurement	Heavy signal noise	Select Average or Hi Res mode
	Incorrect input coupling or impedance setting	Select the correct input impedance and coupling
	Incorrect probe attenuation	Set the probe attenuation correctly
	Incorrect calibration data	Recalibrate the oscilloscope
	Probe not calibrated	Recalibrate the probe

Appendix 1: Technical Specifications

Table A1.1 Detailed Technical Specifications

Indicator \ Model		Standard Model			Economic Model		
		4456C	4456D	4456E	4456CM	4456DM	4456EM
Vertical System	Analog channels	4					
	Bandwidth (Note: > 5mV/div, 50Ω)	350MHz	500MHz	1GHz	350MHz	500MHz	1GHz
	Rise time (Note: > 5mV/div, 50Ω)	<1ns	<700ps	<450ps	<1ns	<700ps	<450ps
	Bandwidth	20MHz, 250MHz					
	Termination	1MΩ±1%, 50Ω±1%					
	Coupling	DC, AC					
	Input sensitivity range	1MΩ: 1mV/div ~ 10V/div					
		50Ω: 1mV/div ~ 1V/div					
	Amplitude accuracy	±3% (Note: > 5mV/div)					
	Maximum input voltage	1MΩ: 300Vrms, 50Ω: 5Vrms					
	Vertical resolution	8bit					
	Offset range	±1V (1mV/div ~ 100mV/div)					
		±10V (200mV/div ~ 1V/div)					
		±100V (2V/div ~ 10V/div)					
Channel isolation	≥40dB						
Horizontal	Maximum sample rate	5GSa/s (1ch or 2ch), 2.5GSa/s (3ch or 4ch)			5GSa/s (1ch), 2.5GSa/s (2ch) 1.25GSa/s (3ch or 4ch)		
	Maximum memory depth	500 Mpts/CH			200Mpts/CH		
System	Mode	Normal: acquire sampled values					
		Peak Detect: capture glitches as narrow as 200ps			Peak Detect: capture glitches as narrow as 800ps		
		Hi Res: 11 digits resolution, can reduce random noise					
		Envelope: min-max envelope reflecting peak detect data over multiple acquisitions					

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		Average: from 2 to 512 waveforms included in average	
		Roll: scroll waveforms right to left across the screen, time-base: 100ms/div ~ 1000s/div	
		Segmentation: The standard acquisition memory can be divided into 131072 segments maximally	Segmentation: The economical acquisition memory can be divided into 131,072 segments maximally
	Max. duration at highest sample rate	100ms	40ms
	Maximum waveform capture rate	Quick Acq mode: 1,000,000 wfms/s	
		Segmentation mode: 700,000 wfms/s	
	Time base range	200ps/div ~ 1000s/div	400ps/div ~ 1000s/div
	Time base accuracy	±5ppm	
	Time base delay time range	-10 divisions to 5000s	
Ch to ch deskew range	±150ns, resolution: 400ps	±150.4ns, resolution 800ps	
Trigger generator System	Trigger source	Analog (CH1~CH4), EXT, digital (D0~D15), 220VAC	
	Trigger mode	Auto, normal, single	
	Trigger hold off range	6.4ns~12.8s	
	Trigger level ranges	Int (CH1~CH4): ±4 divisions	
		Ext: ±0.4V, Ext/10: ±4V	
	Trigger sensitivity	Int (CH1~CH4): users can adjust, step by 0.1 div	
		Ext: 50mV、 Ext/10: 500mV	
	Trigger type	Zone trigger (visual trigger): Trigger on a user-defined zone drawn on the display	
		Edge: Trigger at rising or falling edge in any channel or auxiliary input	
		Sequence: Prepare at a chosen edge in any channel, trigger at a chosen time or other chosen edge of the event	
Runt: Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again			
Pulse width: Trigger on width of positive or negative pulses that are >, <, =, or ≠ a specified period of time. Pulse width range: 0.8ns ~ 10s with the resolution of 0.8ns			
Logic: Trigger when any logical pattern of channels goes false or stays true for specified period of time. Any input can be used as a clock to look for the pattern on a clock edge			
Setup&Hold: Trigger on violations of both setup time and hold time between clock and data present on any channel			

Appendix 1: Technical Specifications

		Rise/Fall Time: Trigger on pulse edge rates that are faster or slower than the specified	
		Video: trigger on all lines, odd, even, or all fields on NTSC, PAL, and SECAM video signals	
		HD video (option S03): Trigger on 480p/60, 576p/50, 720p/50, 720p/60, 1080i/50, 1080i/60, 1080p/24, 1080p/25, 1080p/30, 1080p/50 and 1080p/60	
Measurement and analysis system	Auto measurement	30, of which up to eight can be displayed on-screen at any one time Measurements include: period, frequency, delay, top drop, rise time, fall time, positive duty cycle, negative duty cycle, positive pulse width, negative pulse width, burst width, phase, positive overshoot, negative overshoot, peak to peak, amplitude, high, low, max, min, mean, cycle mean, RMS, cycle RMS, positive pulse count, negative pulse count, rising edge count, falling edge count, area and cycle area	
	Cursor	Waveform and screen	
	Measurement statistics	Mean, min, max, standard deviation	
	Reference Levels	User-definable reference levels for automatic measurements can be specified in either percent or units.	
	Gating	Isolate the specific occurrence within an acquisition to take measurements on, using either the screen or waveform cursors.	
	Waveform histogram		A waveform histogram provides an array of data values representing the total number of hits inside of a user-defined region of the display
			Source: CH1~CH4, REF1~REF4, math
			Type: vertical, horizontal
			Measurement types: 12, including waveform count, hits in box, peak hits, median, max, min, peak-to-peak, mean, standard deviation, Sigma 1, Sigma 2 and Sigma 3
	Waveform mathematics		Arithmetic: addition, subtraction, multiplication and division
			Math functions: integrate, differentiate, FFT
			FFT: Set FFT vertical scale to Linear RMS or dBVRMS, and set FFT window to Rectangular, Hamming, Hanning or Blackman-Harris
			Advanced math: Define extensive algebraic expressions including waveforms, reference waveforms, math functions, scalars, up to two user-adjustable variables and results of parametric measurements
	Limit/mask test (Option S01)		Included standard masks: ITU-T, ANSI T1.102, USB
			Mask test source: CH1~CH4
			Limit test source: CH1~CH4, REF1~REF4
			Mask creation: Limit test vertical tolerance from 0 to 1 division; limit test horizontal tolerance from 0 to 500 m division. Load standard mask or custom mask
		Mask scaling: Lock to source on, lock to source off	

Appendix 1: Technical Specifications

		Test run time: Minimum number of waveforms (from 1 to 1,000,000 and infinity); the shortest time (1 s-48 h; infinity)
		Violation threshold: 1~1000000
		Actions on test failure: Stop acquisition, save screen image to file, save waveform to file, and trigger out pulse
		Actions on test complete: Trigger out pulse
		Result display: Test status, total waveforms, number of violations, violation rate, total tests, failed tests, test failure rate, elapsed time, and total hits for each mask segment
	Power measurement and analysis (Option S02)	Power quality test: V_{RMS} , $V_{crest\ factor}$, frequency, I_{RMS} , $I_{crest\ factor}$, active power, apparent power, reactive power, power factor, phase angle
		Switching loss measurement: Power loss and energy loss, including T_{on} , T_{off} , conduction, total loss
		Harmonics: THD-F, THD-R, RMS measurement, harmonic graphic display and table display
		Ripple measurement: V_{ripple} and I_{ripple}
		Modulation analysis: Graphic display of modulation types including +pulse width, -pulse width, period, frequency, +duty ratio and -duty ratio
		Safety operation area: Graphic display of measurement of safety operation areas of the switching equipment and template test
	Measurement of dV/dt and dI/dt: Conversion rate marker measurement	
Protocol Analyzer Options	Decode channel	1
	Display format	Binary, hexadecimal
	Display	Bus, digital, event list with time scale information.
	I ² C option S04	Trigger on start, repeated start, stop, missing ACK, address, data, or address and data on I ² C buses up to 10 Mb/s.
		Signal rate: ≤10Mbps; Protocol type: 7 digits /10 digits address
	RS232 trigger and analysis option S05	Trigger on Tx start bit, Rx start bit, Tx end of packet, Rx end of packet, Tx data, Rx data, Tx parity error, and Rx parity error up to 2Mbps.
		Signal rate: 50bps~2Mbps
	SPI trigger and analysis option S06	Trigger on start of frame, MOSI, MISO, or MOSI and MISO on SPI buses up to 10 Mbps
		Signal rate: ≤10Mbps
	CAN trigger and analysis option S07	Trigger on start of frame, frame type, identifier, data, identifier and data, end of frame, missing ACK, or bit stuffing error on CAN signals up to 1 Mb/s.
Signal rate: 10kbps~1Mbps		
LIN trigger and analysis	Trigger on sync, identifier, data, identifier and data, wakeup frame, sleep frame, errors, up to 100 kb/s.	

Appendix 1: Technical Specifications

	option S08	Signal rate: 800bps ~ 100kbps; protocol standard: 1.x, 2.x	
	FlexRay trigger and analysis option S09	Trigger on start of frame, type of frame, identifier, cycle count, complete header field, data, identifier and data, end of frame or errors, up to 10 Mb/s.	
		Signal rate: 2.5Mbps、 5Mbps、 10Mbps	
	Audio trigger and analysis option S10	Trigger on word select, frame sync, or data. Maximum data rate for I ² S/LJ/RJ/TDM is 10 Mb/s.	
		Signal rate: ≤10Mbps; Protocol type: I ² S, LJ, RJ, TDM	
	USB trigger and analysis option S11	Trigger on sync active, start of frame, reset, suspend, resume, end of packet, token packet, data packet, handshake packet, special packet, error. Low speed is 1.5Mbps and full speed is 12Mbps.	
Signal rate: Low speed 1.5 Mbps, full speed 12 Mbps			
MIL-STD-1553(Option S12)	Trigger on sync, word type, command word, data word, error and idle time, with a rate of 1Mbps		
	Signal rate: 1Mbps		
Logical analyzer Options Option H01	Digital channels	16	
	Threshold grouping	Pod 1: D7 ~ D0, Pod2: D15 ~ D8	
	Threshold selection	TTL (1.4 V), 5VCMOS (2.5 V), 3.3VCMOS (1.65 V), 2.5VCMOS (1.25 V), ECL (-1.3 V), PECL (3.7 V), user-defined	
	User-defined threshold range	±20 V, with an increment of 10 mV	
	Threshold precision	±(150 mV+3% of threshold setting)	
	Maximum input voltage	±40 V peak-peak value	
	Input dynamic range	±10 V relative to the threshold	
	Minimum voltage amplitude	500mVpp	
	Maximum input switching rate	400MHz	
	Termination	100 kΩ±1%	
	Vertical resolution	1bit	
	Timing sample rate	2.5 GSa/s	
	Memory depth	500 Mpts/CH (standard C/D/E)	200 Mpts/CH (economical CM/DM/EM)
Minimum detection pulse width	2ns		

Appendix 1: Technical Specifications

	Inter channel delay error	3.2ns	
Function Generator Option H02	Number of channels	1	
	Maximum output frequency	25MHz	
	Maximum sample rate	200MSa/s	
	Vertical resolution	14bit	
	Output impedance	50Ω (typical value)	
	Output waveform	Standard waveforms: Sine, Square, Ramp, Pulse, DC, Noise and Arbitrary Built-in waveforms: SinC, index rise/fall, Gaussian, lorenz curve and haversine curve	
	Modulation	FM, AM, FSK	
	Sine	Frequency range: 0.1 Hz~25 MHz	
		Harmonic distortion: -40 dBc	
		Stray: -40 dBc	
		Total harmonic distortion: 1%	
		Signal-to-noise ratio: 40 dB	
	Square wave/pulse	Frequency range: 0.1 Hz~10MHz	
		Duty ratio: 1%~99%	
		Duty ratio resolution: 0.1% or 5 ns (whichever is greater)	
		Minimum pulse width: 40 ns	
		Pulse width resolution: 5 ns or 4 digits (the larger one prevails)	
	Oblique/triangular wave	Frequency range: 0.1 Hz~1MHz	
		Linearity: 1%	
		Variable symmetry: 0~100%	
Noise	Bandwidth: 25 MHz		
Built-in waveform frequency	0.1Hz ~ 1MHz		
Arbitrary waveform	Waveform length: 1~16,384		

Appendix 1: Technical Specifications

	Frequency	Frequency range: 0.1 Hz~10MHz
		Precision: 100 ppm Resolution: 0.1 Hz or 4 digits (the larger one prevails)
	Amplitude	Output range: 50 mVpp~2.5 Vpp (50Ω)
		Precision: $\pm(1.5\%$ of DC offset setting +1.5% of peak to peak amplitude setting +1 mV)
	DC offset	Offset range: ± 1.25 V (50Ω)
		Offset resolution: 1 mV (50Ω)
Offset precision: $\pm(2\%$ of the offset setting value+1mV)		
Digital voltmeter	Source	CH1、CH2、CH3、CH4
	Measurement Type	AC RMS, DC, DC+AC RMS, frequency
	Resolution	Digital voltmeter: 4 digits
Frequency counter: 6 digits		
Display System	Display type	10.4 inch color LCD
	Display resolution	1024×768
	Graticules	Full, grid, crosshair, frame
	Touch screen	Capacitive, supports waveform and menu operation
	Waveforms	Dots, vectors, persistence.
	Display format	YT、XY
	Grey level	256
	Waveform color	Normal, reversed,temperature, spectrum
	Lang	Chinese, English
	Brightness	The waveform, scale and screen brightness can be freely adjusted
Input/Output Port	USB HOST	Two ports on front and two ports on rear of instrument for screen image printing, instrument setting and waveform data storage
	USB DEVICE	One port on rear of instrument.
	LAN	RJ-45 connector, supports 10/100/1000 Mb/s
	Video output port	DB-15 hole connector for connecting the oscilloscope to external monitor
	AUX IN	Rear panel BNC, 1MΩ impedance, max. input: 300Vrms.

Appendix 1: Technical Specifications

	AUX OUT	Rear panel BNC, used for trigger pulse signal output, event output of limit/mask test, or built-in training signal output
	Reference input/output	Rear panel BNC, time base systems is used for input or output of reference clock, frequency is 10MHz
	Probe compensator output	Front panel pins, frequency is 1kHz, amplitude is approx. 3V
Structure	Structural style	Portable
	Power supply	100V~240V _{AC} , 50Hz~60Hz
		Maximum power consumption: 150 W
	Operating temperature	0 °C~+50 °C
	Overall dimensions (width × height × depth)	426 mm × 221.5mm × 160mm (excluding corners and handles)
Maximum weight	6kg	

Appendix 2: Accessories and Options

The accessories for the standard configuration of the 4456 Series Digital Phosphor Oscilloscope are shown in the table below.

(1) Host

Standard model:

4456C Digital Phosphor Oscilloscope 4CH, 350MHz, 5GSa/s (1ch), 2.5GSa/s (4ch)

4456D Digital Phosphor Oscilloscope 4CH, 500MHz, 5GSa/s (1ch), 2.5GSa/s (4ch)

4456E Digital Phosphor Oscilloscope 4CH, 1GHz, 5GSa/s (1ch), 2.5GSa/s (4ch)

Economic model:

4456CM Digital Phosphor Oscilloscope 4CH, 350MHz, 5GSa/s (1ch), 1.25GSa/s (4ch)

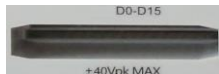





4456DM Digital Phosphor Oscilloscope 4CH, 500MHz, 5GSa/s (1ch), 1.25GSa/s (4ch)

4456EM Digital Phosphor Oscilloscope 4CH, 1GHz, 5GSa/s (1ch), 1.25GSa/s (4ch)












(2) Accessories

No.	Item	Description
1	Passive voltage probe	4
2	Power cord	1, standard three-core power cord
3	User Manual	1
4	Programming Manual	1
5	Certificate of Conformity	1










(3) Options

Option No.	Item	Function	Remarks
4456-H01	Logical analyzer option	Necessary for the mixed signal oscilloscope, 16 digital channels, including 1 logic probe	
4456-H02	Waveform Generator Option	1 channel and 25MHz waveform generation	
4456-H03	P9558 Passive voltage probe	Bandwidth: DC~250MHz Attenuation: 100:1 Maximum voltage: 3000V	
4456-H04	P3258 High Voltage Single End Probe	Bandwidth: DC~100MHz Attenuation: 100:1 Maximum voltage: 1500Vpk	
4456-H05	P8050 High voltage differential probe	Bandwidth: DC~50MHz Attenuation: 50:1, 500:1 Precision: $\pm 2\%$ Maximum voltage: 1300V (DC+ACpk) Power supply: 9VDC	
4456-H06	P8100 High Voltage Differential Probe	Bandwidth: DC~100MHz Attenuation: 50:1, 500:1 Precision: $\pm 2\%$ Maximum voltage: 1300V (DC+ACpk) Power supply: 9VDC	

Appendix 2: Accessories and Options

4456-H07	AP622 Current Probe	Bandwidth: DC~100kHz Measurement range: 50mA~100A peak value Range: 10mV/A, 100mV/A Power supply: 9V alkaline battery	
4456-H08	AP202 Current probe	Bandwidth: DC~25MHz Precision: ±3% Maximum current: 20A (DC+ACpk) Range: 100mV/A Power supply: 9VDC	
4456-H09	Rack mount kit	Rack mount kit	
4456-H10	Aluminum alloy transportation case	Aluminum alloy transportation case	
4456-H11	English front panel	English label and English rubber keys	
4456-H12	P9550A passive voltage probe	Bandwidth: DC~500MHz Attenuation: 10:1 Input impedance: 10M Ω//10pF±2pF Maximum voltage: 300V CATII It supports automatic identification functions	
4456-H13	P9551 passive voltage probe	Bandwidth: DC~500MHz Attenuation: 10:1, 1:1 Input impedance: 10MΩ//10pF±2pF Maximum voltage: 300V CATII It doesn't support automatic identification functions	
4456-H14	P9350A passive voltage probe	Bandwidth: DC~350MHz Attenuation: 10:1 Input impedance: 10MΩ//10pF±2pF Maximum voltage: 300V CATII It supports automatic identification functions	
4456-H15	P9600A passive voltage probe	Bandwidth: DC~600MHz Attenuation: 10:1 Input impedance: 10MΩ//10pF±2pF Maximum voltage: 300V CATII It supports automatic identification functions	
4456-H16	LAP500 Logic probe	Number of channels: 16 Input impedance: 100 kΩ±2% Maximum voltage: ±40Vpk	
4456-H17	P5020 high voltage differential probe	Bandwidth: DC~20MHz Attenuation: 500:1, 5000:1 Precision: ±2% Maximum voltage: 40 kV (DC+ACpk-pk)	

Appendix 2: Accessories and Options

4456-H18	P6100 high voltage differential probe	Bandwidth: DC~100MHz Attenuation: 100:1, 1000:1 Precision: $\pm 1\%$ Maximum voltage: 14kVpp	
4456-H19	P7100 high voltage differential probe	Bandwidth: DC~100MHz Attenuation: 100:1, 1000:1 Precision: $\pm 1\%$ Maximum voltage: 7000Vpp	
4456-H20	P4220 high voltage single end probe	Bandwidth: DC~220MHz Attenuation: 1000:1 Precision: $\pm 3\%$ Maximum voltage: 39kV (DC+ACpk)	
4456-H21	AP621 current probe	Bandwidth: 10Hz-100kHz Measurement range: 2,000 A peak value Range: 100 mV/A, 10 mV/A, 1 mV/A	
4456-H22	AP622D current probe	Bandwidth: DC~1.5MHz Measurement range: 1mA~40A peak value Range: 100 mV/A, 1 V/A	
4456-H23	AP204A current probe	Bandwidth: DC~50MHz Precision: $\pm 3\%$ Maximum current: 40A (DC+ACpk) Range: 50mV/A	
4456-H24	PL-50 matcher	Impedance: $50\Omega \pm 1\%$ Bandwidth: DC~2GHz	
4456-H25	PL-75 matcher	Impedance: $75\Omega \pm 1\%$ Bandwidth: DC~1GHz	
4456-H26	PL-93 matcher	Impedance: $93\Omega \pm 1\%$ Bandwidth: DC~1GHz	

Option No.	Item	Function	Remarks
4456-S01	Limit/mask test module	Support ITU-T, ANSI T1.102, USB and other standard mask or user creation	-
4456-S02	Power measurement and analysis module	It supports power supply quality, switching loss, harmonic wave, ripple and modulation tests	-
4456-S03	HD video trigger module	Support 480p, 576p, 720p, 1080p, 1080i and other formats	-
4456-S04	I ² C trigger and analysis module	Signal rate: ≤10Mbps Protocol type: 7 digits/10 digits address Signal type: single-ended	-
4456-S05	RS232 trigger and analysis module	Signal rate: 50~2Mbps Signal type: single-ended	-
4456-S06	SPI trigger and analysis module	Signal rate: ≤10Mbps Signal type: single-ended	-
4456-S07	CAN trigger and analysis module	Signal rate: 10kbps~1Mbps Signal type: single-ended, differential CAN_L, CAN_H	-
4456-S08	LIN trigger and analysis module	Signal rate: 800bps~100kbps Protocol standard: 1.X, 2.X Signal type: single-ended	-
4456-S09	FlexRay trigger and analysis module	Signal rate: 2.5/5/10Mbps Signal type: BP, BM, Tx/Rx	-
4456-S10	Audio trigger and analysis module	Signal rate: ≤10Mbps Protocol standard: I ² S, LJ, RJ, TDM Signal type: single-ended	-
4456-S11	USB trigger and analysis module	Signal rate: 1.5Mbps, 12Mbps Signal type: Single end and differential	-
4456-S12	MIL-STD-1553 trigger and analysis module	Signal rate: 1Mbps Signal type: Single end and differential	-