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### **!** IMPORTANT

Before operating or maintaining this unit, please read this manual carefully, paying extra attention to the safety warnings and precautions.

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# Safety Information

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For your own safety and the safety of others, and to prevent possible electrical shock, fire, or damage to the device, your computer or the MaxiSys tablet on which it is applied, it is important that the safety instructions herein presented throughout this manual be read and understood by all persons operating, or coming into contact with, the device.

Before using the device, always refer to and follow the safety messages. Read, understand, and follow all safety messages and instructions in this manual. Safety protection built in the device may cease to function if the device is used incorrectly. This could cause damage to your device, or lead to injury to yourself and others. In addition, follow all generally accepted safety practices and procedures for working with and around electricity.

## Symbols

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These safety and electrical symbols may appear on the product or in this manual.


Symbols	Description
	Direct current.
	Alternating current.
	Chassis ground terminal.
	Device protected throughout by double insulation or reinforced insulation.
	Possibility of electric shock.
	Warning.
	Static awareness. Static discharge can damage parts.
<b>CAT</b>	EN61010 measurement category.
	Do not dispose of this product as unsorted municipal waste.

# Safety Messages

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Safety messages are provided to help prevent personal injury and equipment damage. All safety messages are introduced by a signal word indicating the hazard level.

 **DANGER:** Indicates conditions or practices that could result in death or serious injury to the operator or to bystanders.

 **WARNING:** Indicates conditions or practices that could result in damage to the product or equipment to which it is connected.

## Safety Instructions

The safety messages herein cover situations Autel is aware of. Autel cannot know, evaluate or advise you as to all of the possible hazards. You must be certain that any condition or service procedure encountered do not jeopardize your personal safety.

### *Maximum input ranges*

Observe all terminal ratings and warnings marked on the product.

 **DANGER:**

- To prevent electric shock, operate within the safe input range for the scope, refer to [Technical Specifications](#) on page 4.
- To prevent electric shock, take all necessary safety precautions when working on equipment where voltages above the specified input range may be present. Contact with voltages outside of the specified measuring range presents a risk of electric shock.
- To prevent injury or death, the oscilloscope must not be directly connected to the mains (line power). To measure mains voltages, use a differential isolating probe specifically rated for mains use.

 **WARNING:**

- Operation outside of the safe input range is likely to cause permanent damage to the oscilloscope and other connected equipment.

### *Grounding*

 **DANGER:**

- The scope's ground connection through the USB cable is for

measurement purposes only. The oscilloscope does not have a protective safety ground.

- Do not connect the ground input (chassis) to any electrical power source. To prevent personal injury or death, use a voltmeter to check that there is no significant AC or DC voltage between the oscilloscope ground and the point to which you intend to connect it.

 **WARNING:**

- Applying a voltage to the ground input is likely to cause permanent damage to the oscilloscope, the attached computer, and other equipment.
- To prevent measurement errors caused by poor grounding, always use the high-quality USB cable supplied with the oscilloscope.

*External connections*

 **DANGER:**

- To prevent injury or death, use only the power cord and adaptor supplied with the product.

*Environment*

 **DANGER:**

- To prevent injury or death, do not use in wet or damp conditions, or around explosive gas or vapor.

 **WARNING:**

- To prevent damage, always use and store your oscilloscope in appropriate environments. For detailed information on temperature and humidity specifications for both the storage and usage of the oscilloscope, see [Technical Specifications](#) on page 4.

*Product Maintenance*

The product contains no user-serviceable parts. Repair, servicing and calibration require specialized test equipment and must only be performed by Autel Tech Support or an approved service provider.

 **DANGER:**

- To prevent injury or death, do not use the product if it appears to be

damaged in any way, and stop use immediately if you are concerned by any abnormal operations.

 **WARNING:**

- Do not tamper with or disassemble the oscilloscope, connectors or accessories. Internal damage will affect performance.
- Do not block any of the instrument's air vents as overheating will cause damage to the oscilloscope.
- When cleaning the oscilloscope, use wet soft cloth with mild detergent in water. Do not allow water to enter the oscilloscope casing, as this will cause damage to the electronics inside.

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# 1 Using This Manual

This manual contains device usage instructions.

Some illustrations shown in this manual may contain features and optional equipment that are not included on your system. Contact your sales representative for availability of other features and optional tools or accessories.

## Conventions

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The following conventions are used.

### Bold Text

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Bold text is used to highlight selectable items such as buttons and menu options.

Example:

- Click **OK**.

### Terminology

The term “select” means highlighting a button or menu item and clicking it to confirm the selection.

### Notes and Important Messages

The following messages are used.

#### *Notes*

A **NOTE** provides helpful information such as additional explanations, tips, and comments.

A “\*” or “\*\*” symbol indicates that a related **NOTE** is written following the specific content.

## *Important*

**IMPORTANT** indicates a situation which, if not avoided, may result in damage to the equipment, or the attached computer.

## **Hyperlinks**

Hyperlinks or links that take you to other related articles, procedures, and illustrations are available in electronic documents. Blue italic text indicates a selectable hyperlink and blue underlined text indicates a website link or an email address link.

## **Illustrations**

Illustrations used in this manual are samples, and the actual testing screen may vary for each vehicle being tested. Observe the menu titles and on-screen instructions to make correct option selection.

## **Procedures**

An arrow icon indicates a procedure.

Example:

### ➤ **To install the app**

1. Download the MaxiScope App > Products > MaxiScope MP408 > Downloads.
2. Copy the MaxiScope app (for example: ScopeV1.15.apk) to the external SD card;
3. Open the Es File Explorer and find the app (for example: ScopeV1.15.apk), click it to **install**.



# 2 General Introduction

The MaxiScope™ MP408 is a 4-channel automotive oscilloscope. It works in combination with your MaxiSys Tablet, which turns into a powerful diagnostic tool, showing you what is really going on with a vehicle's electronic circuits. The system can be used to measure and test almost all of the electrical and electronic components and circuits in any modern vehicles.

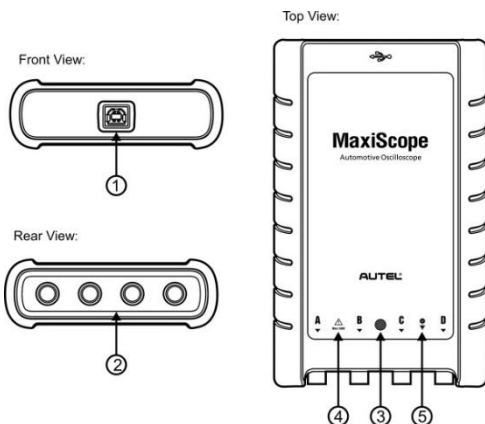
Power for the MaxiScope MP408 Module comes directly from the USB port of the connected tablet, so no batteries or power leads are required, making the system very versatile and portable to use.

This manual describes the construction and operation of the product and how it works to deliver test results.

## MP408 Scope Module

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### Functional Description



**Figure 2-1 Front, Rear, and Top View**

1. **USB Port Connector**

2. **Input Channel A/B/C/D**
3. **LED Breath Light** – lights up when powered on, blinks when communicating, and shimmers when error occurs
4. **Warning Triangle** – indicates potential safety hazard that exists on the indicated connections, and appropriate precautions should be taken. Make sure you read through the [Safety Information](#) before using.
5. **Equipotential Symbol** – indicates the outer shells of the indicated BNC connectors are all at the same potential. Therefore, necessary precautions should be taken to avoid applying a potential through the return connections of the indicated BNC terminals, as this may result in a large current flow, causing damage to the product and the connected equipment.

## Power Source

The MaxiScope MP408 Scope Module is powered directly by the USB port of the connected tablet, no batteries or power leads are required, making it suitable for use both for workshop-based and mobile automotive diagnostics.

## Technical Specifications

**Figure 2-2 Specifications**

Main Features	Description
Vertical resolution	12 bits
Channels	4
Bandwidth	20MHz
Accuracy	1%
Sensitivity	10mV/div to 20V/div
Input Ranges (full scale)	±50mV to ±100V in 11 ranges
Input Impedance	1MΩ in parallel with 22pF
Input Type	Single-ended, BNC connector
Input Coupling	Software selectable AC/DC

Overload Protection	±200V on single input
Maximum Sampling Rate (Single Shot) 1 and 2, or 3 and 4 channels in use 1 and 3 or 4, 2 and 3 or 4 channels in use	20MS/s*  80MS/s
Buffer Memory	32M samples shared among active channels
Waveform Buffer	Up to 1000 waveforms
Timebase Ranges	100ns/div to 1000s/div
Advanced Features	Math channels, Measurements
<b>Triggers</b>	<b>Description</b>
Source	Any input channel
Basic Triggers	Auto, Repeat, Single, None
Advanced Triggers	Rising edge, Falling edge
<b>Environmental</b>	<b>Description</b>
Operating Temp. Range	0 to 50°C (15 to 40°C for quoted accuracy)
Storage Temp. Range	-20 to +60°C
Storage Humidity Range	5 to 95%RH, Non-condensing
<b>Physical Characteristics</b>	<b>Description</b>
Dimensions (Protection rubber case included)	190x115x38 mm
Weight	<0.5 kg
<b>General</b>	<b>Description</b>
Tablet Interface	USB 2.0 – cable supplied
Power Requirements	Powered from USB port
Compliance	FCC (EMC), CE (EMC and LVD), RoHS
Warranty	1 year

**NOTE\*:**

Reduced to 20MS/s if channels A and B, or C and D, are enabled.

## Accessory Kit

### Supplied Accessories

The table below gives descriptions of the hardware and accessories supplied with the package.

**Figure 2-3 Supplied Accessories**














Image	Description & Quantity
	<b>1.5m USB Cable - X1</b> Connects the Scope Module to the computer.
	<b>3m (10ft) Screened Test Leads - X4</b> BNC to 4mm. Connects the Scope Module to a test probe. Screened to keep out electrical interference.
	<b>Secondary Ignition Pickup - X1</b> For safe probing of HT leads without danger from high voltages.
	<b>2-pin Breakout Lead - X1</b> For standard 2-pin sensors and actuators. With 4mm plugs to connect to MaxiScope test leads.
	<b>Attenuators 20:1 - X2</b> Extends the range of the MaxiScope up to $\pm 400V$ to deal with primary ignition.
	<b>Large Crocodile Clip Set - X1 Pair</b> For hands-free probing of wires and small terminals.
	<b>Small Crocodile Clip Set - X1 Pair</b> For hands-free probing of wires and small terminals.



Image	Description & Quantity
	<p><b>Acupuncture Probe Set - X1</b></p> <p>For back-probing connectors without cutting or piercing the insulation. Accepts 4mm plugs.</p>
	<p><b>Multimeter Probes – X1 Pair</b></p> <p>For making voltage measurements. Accepts 4mm plugs.</p>

## Supported Accessories

The table below gives descriptions of additional accessories supported by the MaxiScope. If any of them is needed, please purchase by yourself.

**Table 2-1 Supported Accessories**

Image	Description & Quantity
	<p><b>HT306 6-Way Universal Breakout Leads</b></p> <p>Break into almost any connector up to 6 ways. Accepts 4mm plugs. (4 sizes supplied: 0.6 mm / 1.5 mm / 2.3 mm / 2.8 mm)</p>
	<p><b>60cm Spark Plug Extension Lead (With Ground Leads)</b></p> <p>Fits between coil pack and spark plug to give access to the HT lead. Suitable for use with secondary ignition pickup.</p>
	<p><b>65A Current Clamp</b></p> <p>Screened cable with BNC connector to keep out electrical interference.</p>
	<p><b>650A Current Clamp</b></p> <p>Screened cable with BNC connector to keep out electrical interference.</p>

	<p><b>60MHz High-speed Probe</b> For accurate measurement of fast signals like CAN bus and FlexRay. Standard BNC plug.</p>
	<p><b>Fuse Extension Lead (20A/30A)</b> In both mini and standard sizes. Plug the original fuse into the lead; plug the lead in the fuse socket, then use a current clamp to measure fuse current.</p>

## Attenuators

The attenuator supplied with the MaxiScope kit is a small adapter, usually connected to the BNC connectors between the Scope Module and the test lead; it is used to scale down the voltage input to the scope module when the measured voltage is likely to exceed 100 volts.

Each channel fitted with an attenuator must be configured using the Probes Menu. This ensures that the voltages displayed by MaxiScope are correct.

The AC/DC dropdown menu is available on each of the control pane which allows users to select AC or DC measurements.

# 3 MaxiScope Introduction

This section focuses on the instructions of using the MaxiScope with an Android tablet (only for some of Autel tools). Make sure to install the MaxiScope app before connecting the scope module for the first time.

Some illustrations shown in this manual may contain options or functions that are not included on your system. Contact your sales representative for availability of these features.

## Install MaxiScope App

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The MaxiScope App is a processing program that runs on the Android tablet, which presents as an operating interface displaying waveforms and menus, allowing you to set the testing options, triggers, probe types and various configurations.

### ➤ To install the app

1. Download the MaxiScope App > Products > MaxiScope MP408 > Downloads.
2. Copy the MaxiScope app (for example: ScopeV1.15.apk) to the external SD card;
3. Open the Es File Explorer and find the app (for example: ScopeV1.15.apk), click it to **install**.

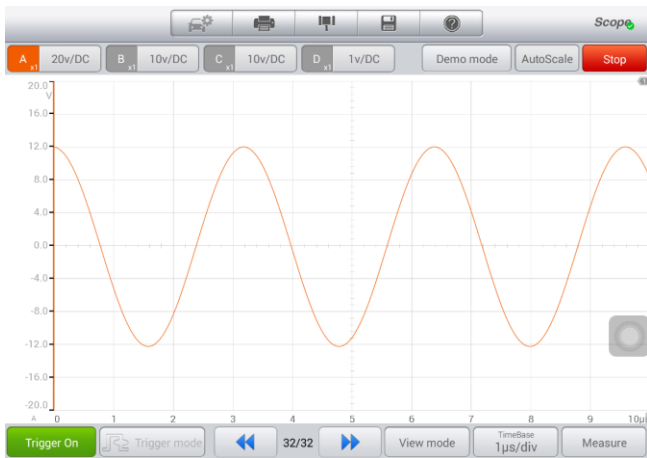
Then you may tap the Oscilloscope icon on the main menu of the MaxiSys system to start operations.

## Introduction

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The main purpose of oscilloscope MaxiScope MP408 is to display electronic signals, transfer electronic signals into waveform curves. By observing the waveform curves, users can determine whether the electronic component is working properly. It can be used in a wide range of industries, including Computer Science, Automotive Electronics, Mobile Phone Manufacture, Military Aviation, Power Supply and other industries related with electronic

signals. Below is the layout of the MaxiScope main screen, other functions will be described in the following sections



**Figure 3-1 MaxiScope App Main Screen**

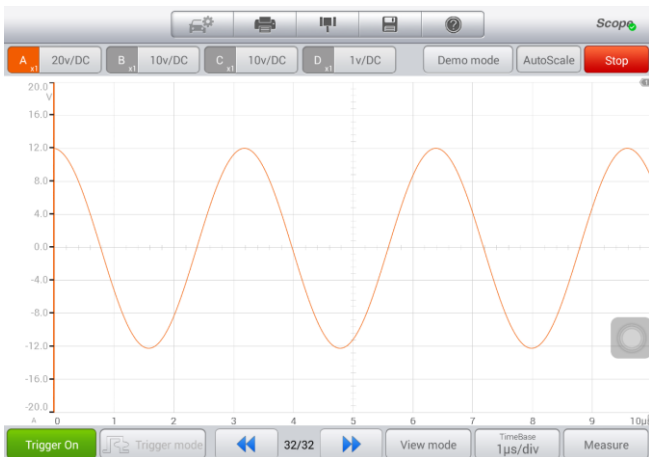
## MaxiScope Basics

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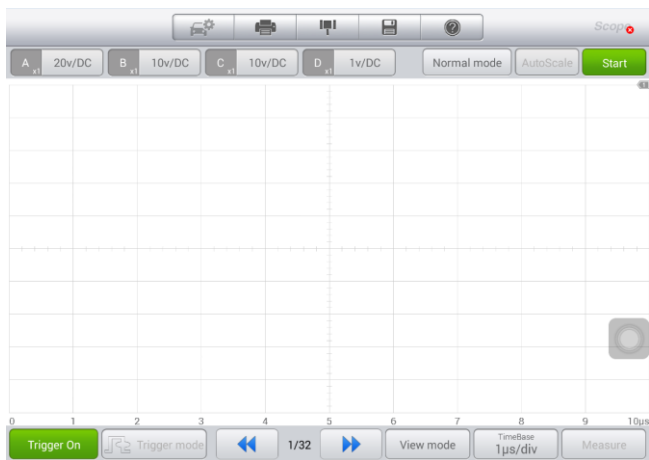
### Connection Status Icon

If the MaxiScope is connected to the tablet, a green check will display on the bottom of the *Scope* icon on the top right of the screen. Otherwise, a red cross displays.





**Figure 3-2 MaxiScope Connected**



**Figure 3-3 MaxiScope Disconnected**

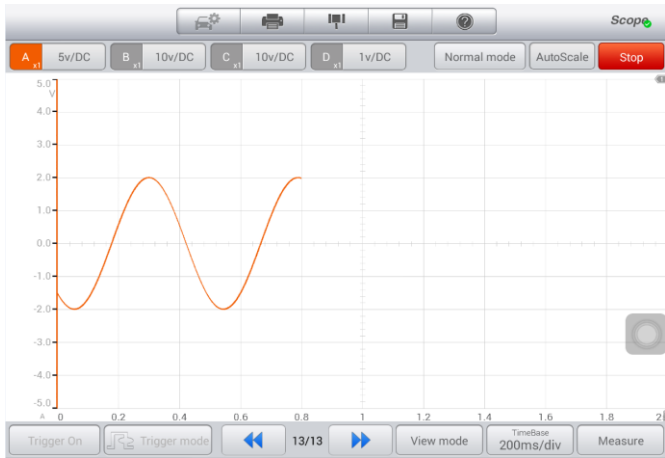
## MaxiScope View Mode

### Normal Mode

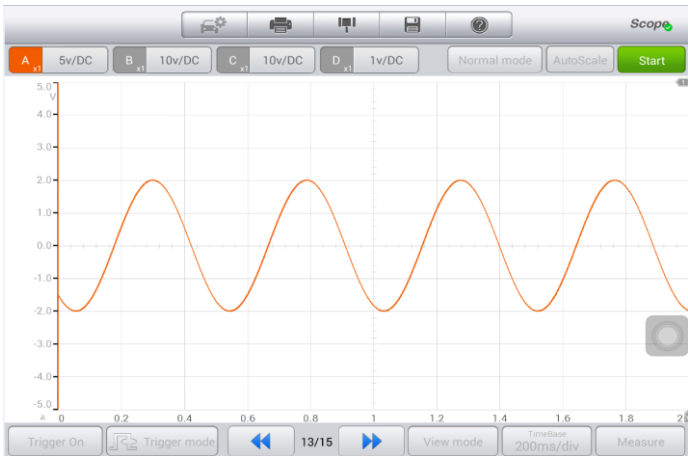
In Normal Mode, waveforms are captured when the time base is shorter than 200ms/div, and incontinuous between screens.

## Continuous Mode

In Continuous Mode, waveforms are captured when the time base is longer than 200ms/div, and continuous between screens.



**Figure 3-4 Normal Mode**



**Figure 3-5 Continuous Mode**

From the views displayed on Figure 3-5, we can know that in Continuous Mode, the data displays on one screen is actually captured in multiple phases.

## MaxiScope Channel Status Bar

It shows the ON/OFF status of each channel. Every channel displays in a unique color. The screenshot below shows the views with four channels open.

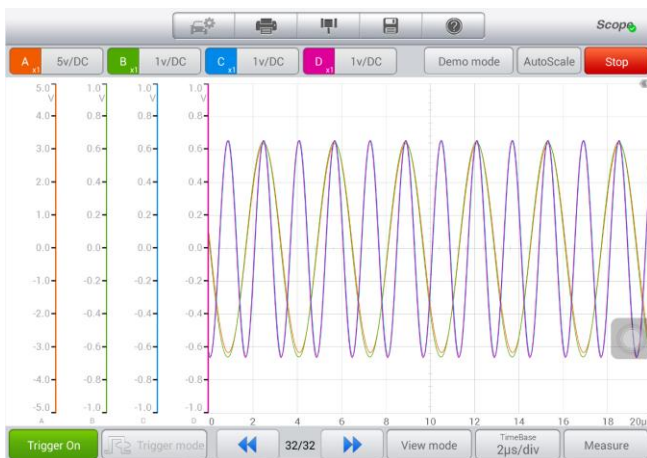


Figure 3-6 Views with Four Channels

## MaxiScope Channel Setting Bar

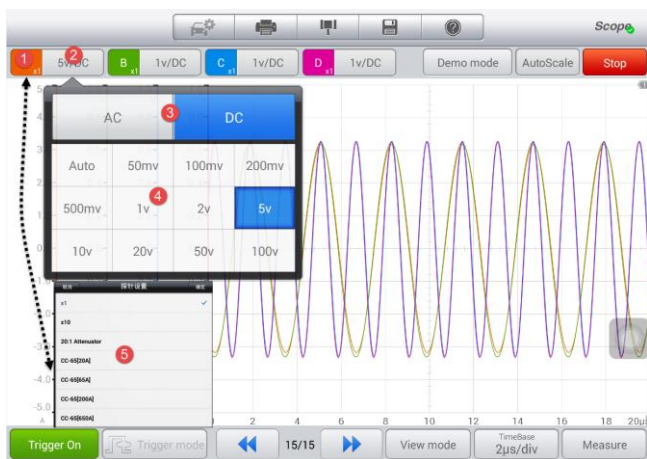


Figure 3-7 Channel Settings

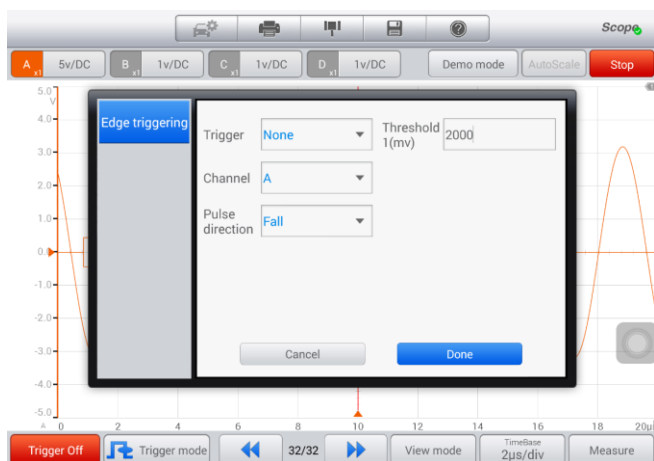
**Channel settings:** Change channel settings including Amplitude, Probe and AC/DC settings.

**Amplitude range:** Set the coordinate range of Y-axis, see ④ in the image below.

**AC/DC:** Alternative current/direct current, see ③ in the image below.

**Probe zoom scale:** Set the scale based on the specific probe being used. Long press ① to open the Probe Settings⑤.

## Trigger Setting Bar



**Figure 3-8 Trigger Settings**

**Trigger:** Used to filter and capture the specified waveform data.

**Trigger type:** The specified trigger type, in the case above, the trigger type is Edge Triggering.

**Trigger mode:** There are four trigger modes: None, Auto, Repeat, and Single.

- 1) None: Capture the data repeatedly and no need to wait for the waveform for triggering.
- 2) Auto: Automatically start to capture data if the triggered waveform is not captured in a reasonable scale of time.
- 3) Repeat: Wait for trigger waveform indefinitely before displaying data.

4) **Single**: Stop to capture data once one waveform is captured.

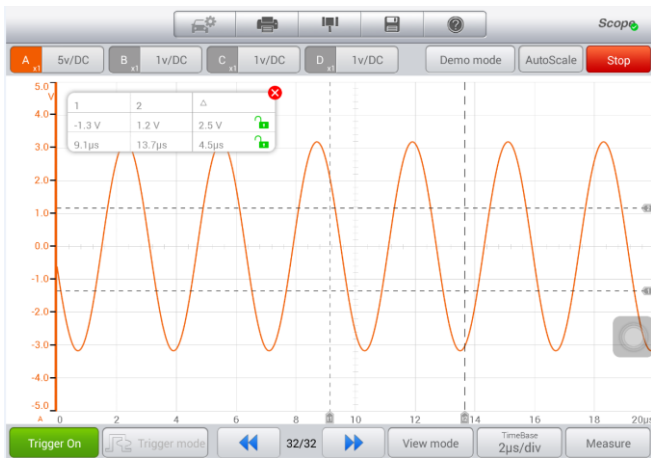
**Trigger threshold**: The amplitude of the trigger point.

**Trigger edge**: Includes Rise and Fall.

1) **Rise**: Waveform is triggered on Rise edge.

2) **Fall**: Waveform is triggered on Fall edge.

## Measurement Rulers



**Figure 3-9 Measurement Rulers**

**Amplitude ruler**: Used to measure relative or absolute signals.

**Time ruler**: Used to measure relative or absolute time.

## File

**Save as PDF**: Save as PDF file.

**Save as text**: Save as txt file.

**Save as XLS**: Save as xls file.

**Save current page**: Save the current page as jpg files.

**Save**: Save the MSData file.

**Open**: Open the saved MSData file and turn the saved data into image.

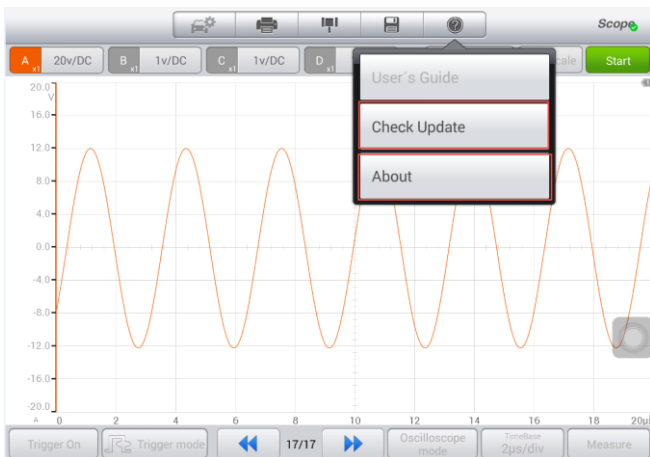


**Figure 3-10 File Tools**

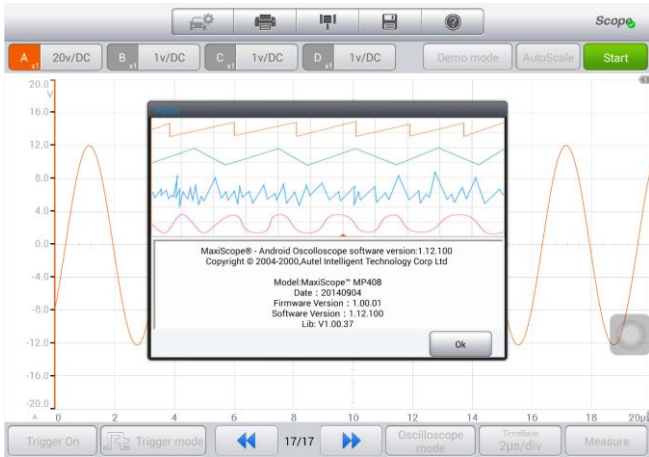
## Help

**About:** Used to check the hardware version number and software version number and other information about the device.

**Check update:** Provides software and firmware update. Connect to the internet to check if new updates are available.



**Figure 3-11 Help**



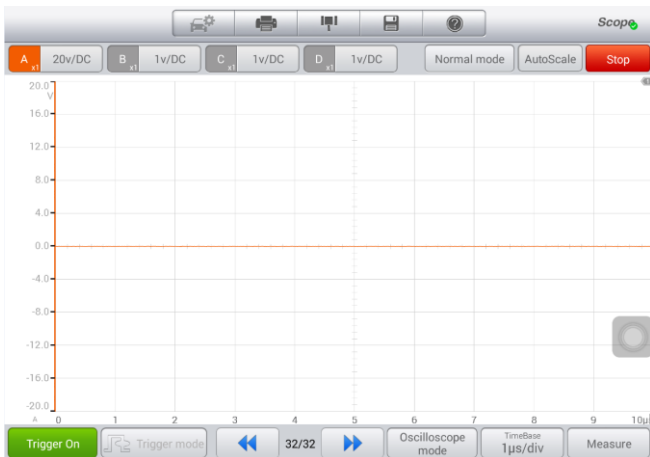
**Figure 3-12 About**

## MaxiScope Functions

### Data Collection Mode

#### *Normal Mode*

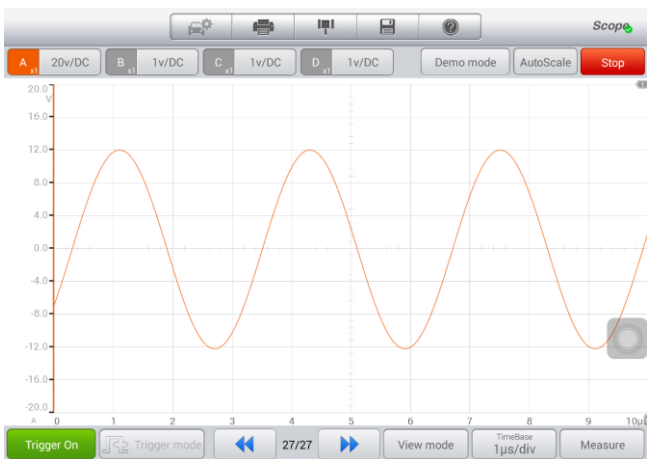
It is used to connect to the signal source to capture hardware data and view and waveform. When there is no input signal, the software shows as below.



**Figure 3-13 Normal Mode**

### *Demo Mode*

It allows user to use MaxiScope for demonstration when no signal source is connection. The following image shows the status when no signal source is connected.

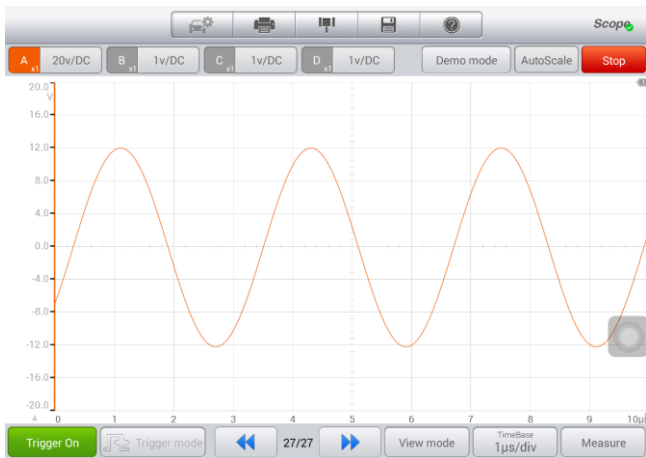


**Figure 3-14 Demo Mode**



## Auto Setup

Click it to set the range of X-axis and Y-axis, and generally waveforms of 3 to 5 periods will display. The range of X-axis and Y-axis will be set at the same time, and time base and amplitude can be set manually for waveform viewing.



**Figure 3-15 Auto Setup 1**

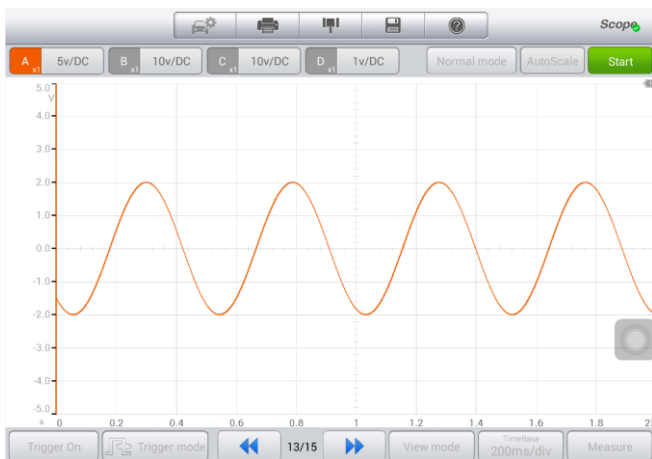


**Figure 3-16 Auto Setup 2**

## Start/Stop

**Start:** Click it to start data collection.

**Stop:** Click it to stop data collection.



**Figure 3-17 Start Screen**



**Figure 3-18 Stop Screen**

## Time Base

The time for collect one measurement unit of data.

Normal mode: The time base is shorter than 200ms/div.

Continuous mode: The time base is longer than 200ms/div.



**Figure 3-19 Time Base Selection**

## Waveform Cache

It is used to view the waveform records.

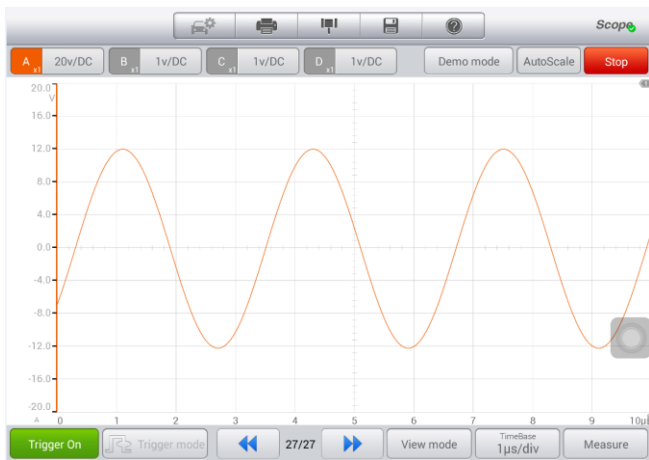


**Figure 3-20 Waveform Cache**

## View Mode

### *Oscilloscope Mode*

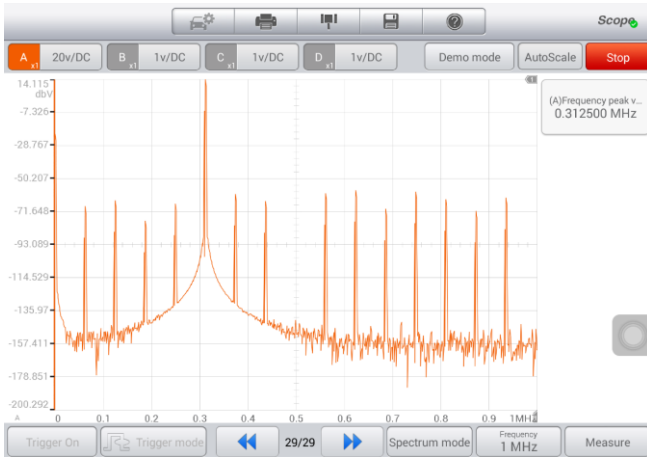
It is used with Time Base to set the time of data collection to capture waveform data.



**Figure 3-21 Oscilloscope Mode**

### *Spectrum Mode*

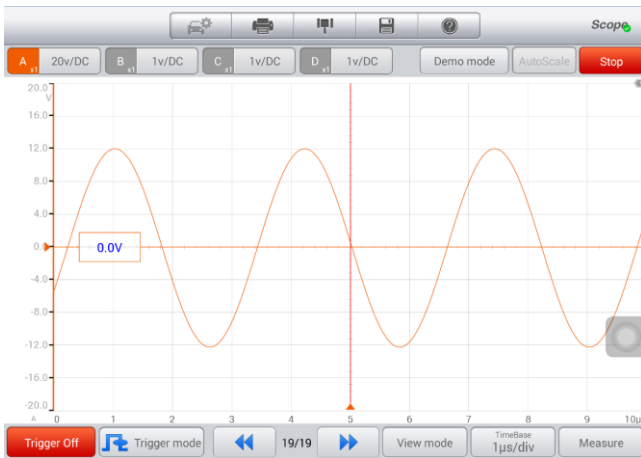
It is used with Current Data Collection Frequency to set the frequency and quantity of data collection.



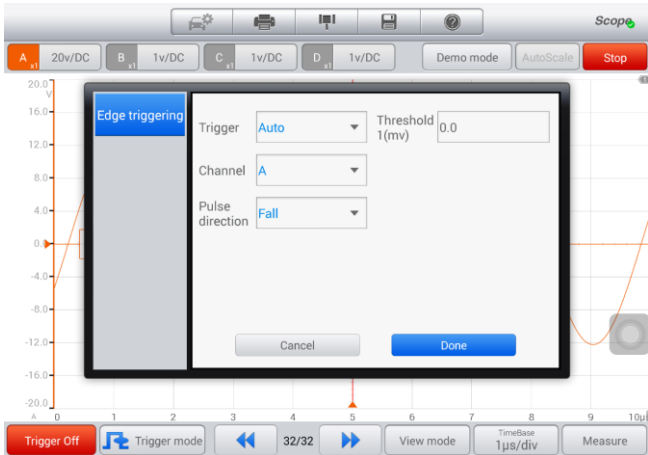
**Figure 3-22 Spectrum Mode**

## Trigger Function

Trigger: It is used to filter and capture specified waveform data (Figure 3-20). The position of the trigger point can be modified by changing the trigger threshold or the trigger time. Trigger source (channel), trigger mode, trigger direction, trigger type and trigger threshold can be set by clicking the trigger mode.



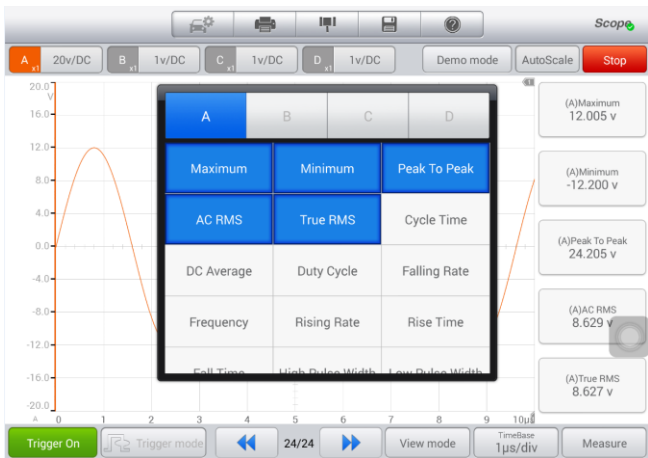
**Figure 3-23 Trigger Mode Setting 1**



**Figure 3-24 Trigger Mode Setting 2**

## Measurement

It is used to calculate the parameters in the currently captured signal and display the signal graph in digitals. As shown in the image below, at most 5 measurements can be displayed at the same time.



**Figure 3-25 Measurements**

**Table 3-1 Measurements**

<b>Measurements</b>	
Maximum	The highest level reached by the signal.
Minimum	The lowest level reached by the signal.
Peak to Peak	The difference between Maximum and Minimum.
AC RMS	The root mean square (RMS) value of the waveform minus the DC Average.
True (RMS)	The root mean square (RMS) value of the waveform, including the DC component.
Cycle Time	The time of a signal cycle.
DC Average	The mean value of the waveform.
Duty Cycle	The amount of time that a signal spends above its mean value, expressed as a percentage of the signal period.
Falling Rate	The rate at which the signal level falls.
Frequency	The number of cycles of the waveform per second.
Rising Rate	The rate at which the signal level rises.
Rising Time	The time the signal takes to rise from the lower threshold to the upper threshold.
Falling Time	The time the signal takes to fall from the upper threshold to the lower threshold.
High Pulse Width	The amount of time that the signal spends above its mean value.
Low Pulse Width	The amount of time that the signal spends below its mean value.
X@Max	The value on the X-axis when the signal on Y-axis reaches to the maximum value.

X@Min	The value on the X-axis when the signal on Y-axis reaches to the minimum value.
Positive Acreage	The acreage of waveform above the zero reference in N full-cycle waveforms displayed on the screen.
Negative Acreage	The acreage of waveform below the zero reference in N full-cycle waveforms displayed on the screen.
Full Acreage	Full positive acreage + full negative acreage
Positive Duty Ratio	$(\text{Positive pulse width}/\text{period}) * 100\%$
Negative Duty Ratio	$(\text{Negative pulse width}/\text{period}) * 100\%$
Top Value	The voltage value when the waveform top to ground.
Bottom Value	The voltage value when the waveform bottom to ground.
Range	The range from top value to bottom value.
Positive Overshoot	$(\text{Local maximum} - \text{top value})/\text{amplitude} * 100\%$
Negative Overshoot	$(\text{Bottom value} - \text{local minimum})/\text{amplitude} * 100\%$
Positive Pre-shoot	$(\text{Bottom value} - \text{local minimum})/\text{amplitude} * 100\%$
Negative Pre-shoot	$(\text{Local maximum} - \text{top value})/\text{amplitude} * 100\%$

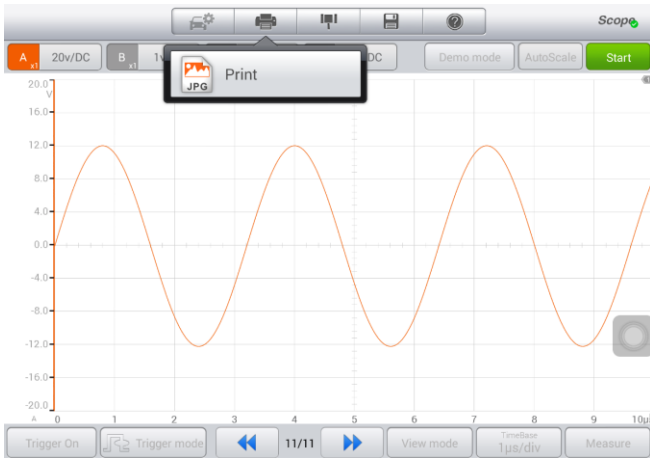
## MaxiScope Menu Bar

### *Print*

Connect the tablet to a printer via PC or connect the tablet to a Wi-Fi printer via a Wi-Fi printing app.



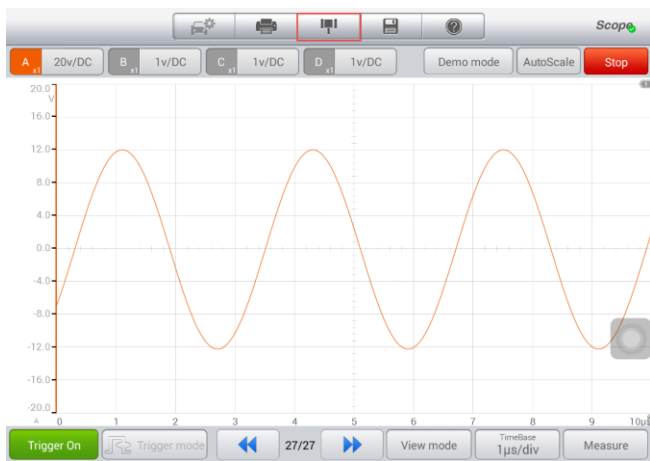
Tap the **Print** button, the current screen will be printed as images.



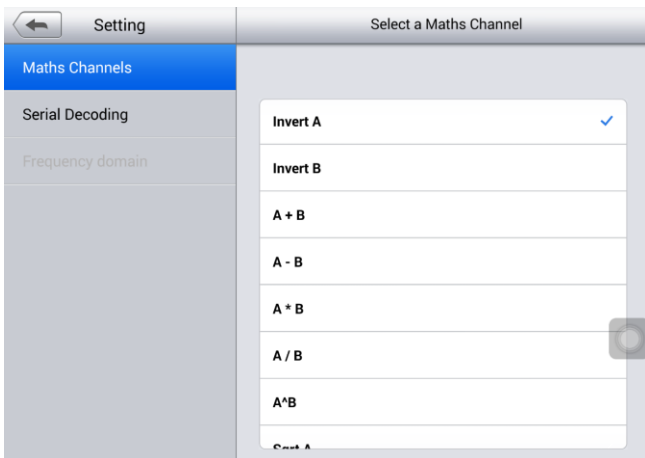
**Figure 3-26 Print**

### Settings

Tap this button to select and set parameters for math channel, serial decoding and frequency domain.



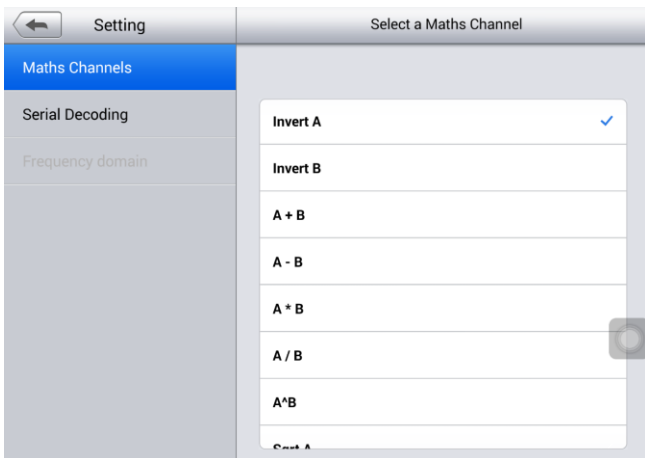
**Figure 3-27 Settings 1**



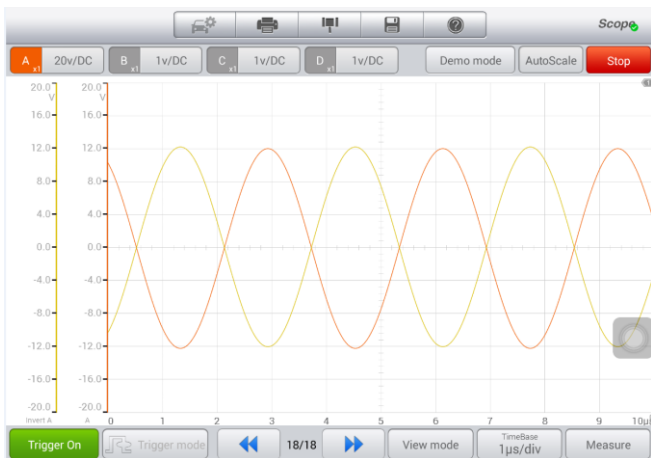
**Figure 3-28 Settings 2**

### *Mathematic Calculation*

Math Channel: Operates some basic calculations on the captured data. Currently, only the data from Channel A and B can be processed and at most 4 calculations can be conducted at the same time.



**Figure 3-29 Mathematic Calculation 1**



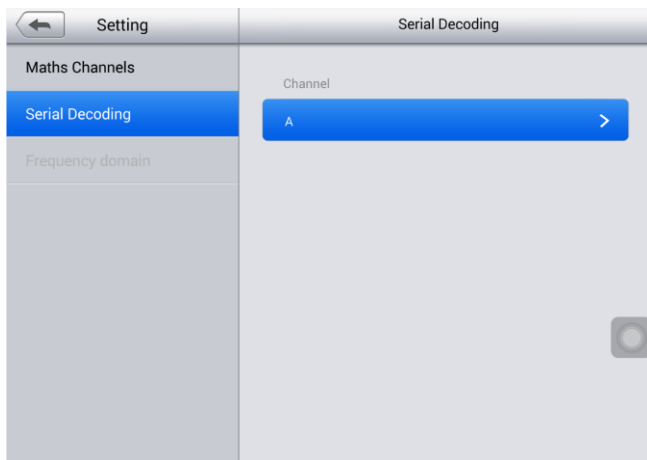
**Figure 3-30 Mathematic Calculation 2**

**NOTE**

Currently, Sqrt, Abs, Sin, Cos and Tan only support calculations on Channel A data.

*Serial Decoding*

Decode data from a serial bus, including CAN, LIN, FlexRay, UART/RS232, I<sup>2</sup>C, SPI, I<sup>2</sup>S and USB.



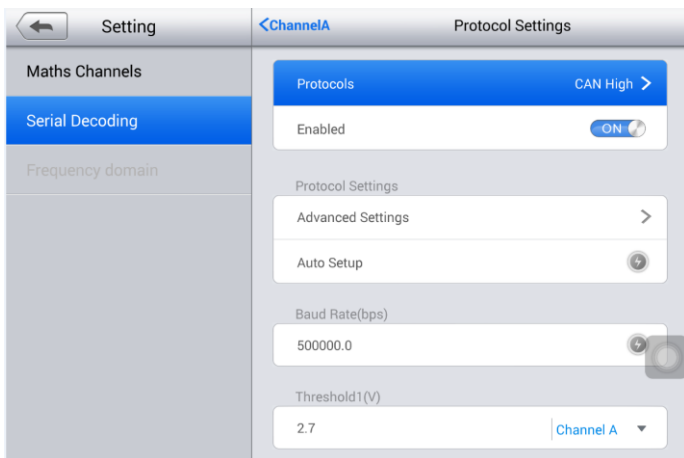
**Figure 3-31 Serial Decoding 1**

Decoding setting dialog contains three parts: protocol, protocol settings and display setting.

**Protocol:** There are three options in this table: Channel, Protocol and Enable.

**Protocol settings:** Set Baud Rate (protocol related), Threshold (for distinguishing high and low electrical levels) and Advanced Settings (protocol related) in this section.

**Display settings:** Set display format of data in the table.



**Figure 3-32 Protocol Settings 1**

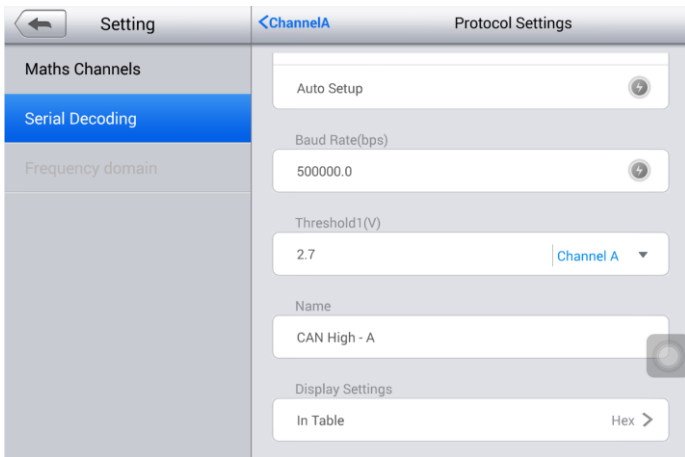


Figure 3-33 Protocol Settings 2

## Serial Protocol Introduction

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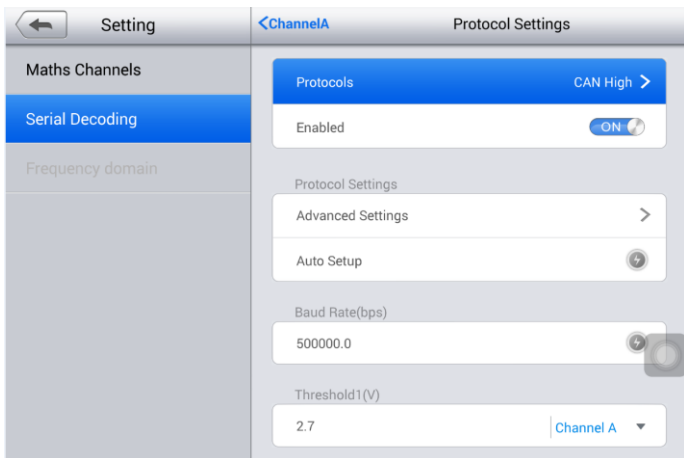
### CAN Protocol

CAN (Controller Area Network) is a serial protocol used in automotive and industrial machinery, which allows microcontrollers communicating with each other. MaxiScope can decode CAN\_H and CAN\_L signals.

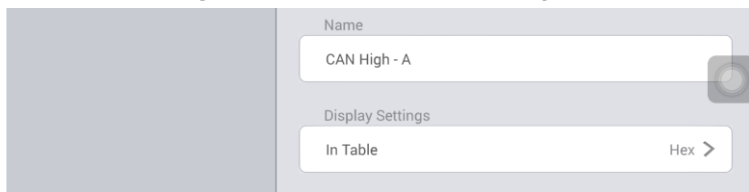
**Threshold:** It is the median between high and low logical electrical levels. It is recommended to set the waveform median as the threshold, or manually adjust this value according to actual condition.

**Baud rate:** The transmission speed of CAN bus. This value should be set to match the data bus transmission speed.

**Display settings:** Set the display format of the view.



**Figure 3-34 CAN Protocol Settings 1**



**Figure 3-35 CAN Protocol Settings 2**

### *CAN Protocol Data List*

**Number (No.):** The serial number of frames (decimal). It indicates the CAN protocol frame number that currently decoded.

**Frame ID:** Identifier (hexadecimal). It is unique for specific data type, the base frame has an 11-bit identifier, and the extended frame has a 29-bit identifier.

**RTR:** Remote transfer request.

**SRR:** Used only in extended frame.

**IDE:** Extended frame identifier.

**R0:** Reserved bit.

**R1:** Reserved bit, only for extended frame.

**DLC:** Data length code. It indicates the number of data bytes.

**Data byte:** Data content of the packet, DLC byte length (hexadecimal).

**CRC sequence:** Data cyclic redundancy check (hexadecimal).

**CRC delimiter:** The fixed bit after the CRC sequence field.

**ACK:** Node asserts this bit to acknowledge receipt.

**ACK delimiter:** The fixed bit after ACK field.

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

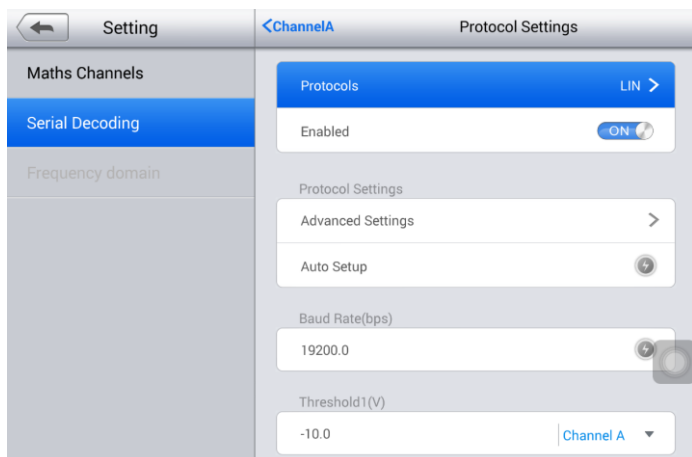
## LIN Protocol

LIN (Local Interconnect Network) is a serial protocol used in automotive electronics to allow microcontrollers to communicate with low-speed peripherals.

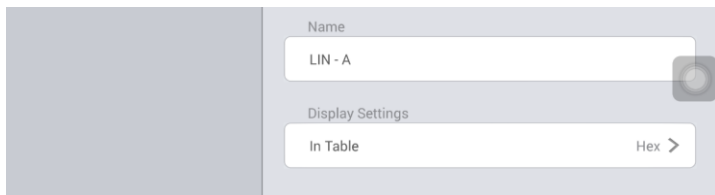
**Threshold:** Used to distinguish the voltage values between high and low logic electrical levels.

**Baud rate:** Data transmission speed that LIN protocol set in the device.

**Display setting:** Set the display format of the view.



**Figure 3-36 LIN Protocol Settings 1**



**Figure 3-37 LIN Protocol Settings 2**

### *LIN Protocol Data List*

**Number (No.):** The serial number of frames (decimal). It indicates the LIN protocol frame number that currently decoded.

**Break:** An indicator for frame starting.

**Sync:** A fixed value (0x55) used for automatic baud rate detection.

**Frame ID:** Six-bit value of the data type carried by the identification frame.

**Data count:** The number of bytes of the data in the frame.

**Data byte:** The data content of the packet.

**Checksum:** A cyclic redundancy check of the data (hexadecimal).

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

## **FlexRay Protocol**

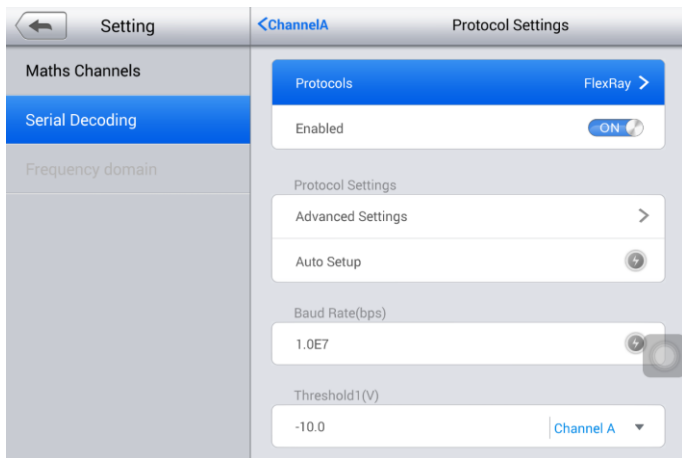
FlexRay is an automotive network communications protocol for high-speed data. It is designed to be fault-tolerant.

**Threshold:** Used to distinguish the voltage values between high and low logic electrical levels.

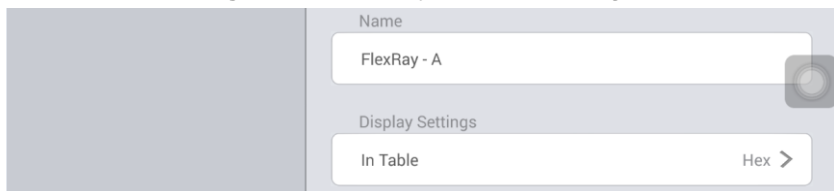
**Baud rate:** Data transmission speed that FlexRay protocol set in the device.

**Display setting:** Set the display format of the view.





**Figure 3-38 FlexRay Protocol Settings 1**



**Figure 3-39 FlexRay Protocol Settings 2**

### *FlexRay Protocol Data List*

**Number (No.):** The serial number of frames (decimal). It indicates the FlexRay protocol frame number that currently decoded.

**TSS:** Transmission starting signal. The frame is bit 0.

**FSS:** Frame starting signal. The frame is bit 1.

**BSS:** Byte starting signal. It is a fixed 2-bit code.

**Reserved bit:** Undefined.

**Payload preamble indicator:** Indicates the presence of a network management vector or message ID.

**Null frame indicator:** Indicates that the payload contains no useful payload data.

**Sync frame indicator:** Indicates whether the frame is a synchronization frame.

**Frame ID:** Defines the slot in which the frame is transmitted.

**Payload length:** The number of payload bytes divided by 2.

**Header CRC:** Cyclic redundancy check of data from the sync frame indicator to the payload length.

**Cycle count:** Cycler counter.

**Payload:** 0-254 bytes of the data.

**Payload CRC:** Frame CRC.

**FES:** Frame ending signal.

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

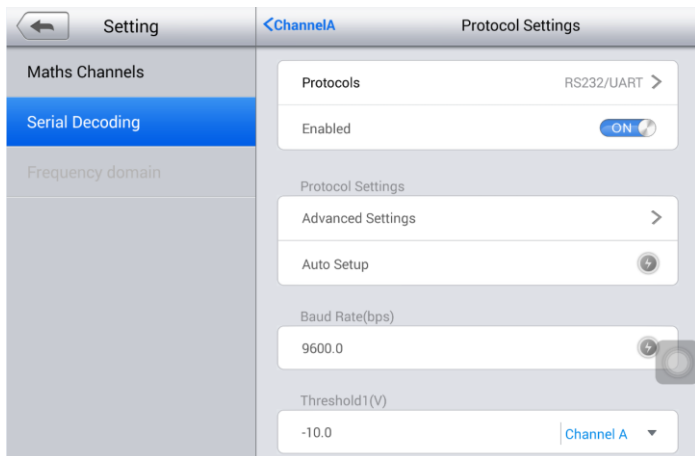
## UART/RS232 Protocol

RS232 is the serial data standard used by serial or COM ports UART once commonly found on computers. The full standard uses a voltage range of  $\pm 12V$ . The simplest RS232 connection contains two signals: RX (Receive) and Tx (Send).

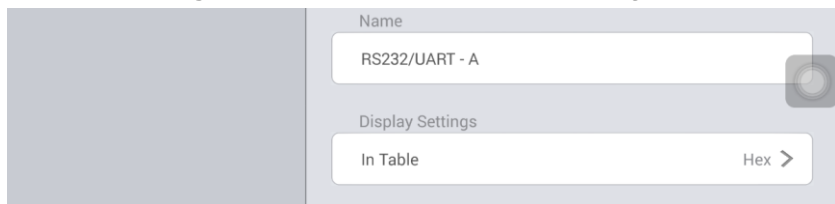
**Threshold:** Used to distinguish the voltage values between high and low logic electrical levels.

**Baud rate:** Data transmission speed that UART/RS232 protocol set in the device.

**Display setting:** Set the display format of the view.



**Figure 3-40 UART/RS232 Protocol Settings 1**



**Figure 3-41 UART/RS232 Protocol Settings 2**

### *UART/RS232 Protocol Data List*

**Number (No.):** The serial number of frames (decimal). It indicates the UART/RS232 protocol frame number that currently decoded.

**Packet:** All packet in this form are classified as data.

**Start bit:** A fixed bit of 1-bit.

**Data byte:** The content of the packet.

**Parity byte:** Error-checking bit at the end of the byte (if available).

**End byte:** 1-2 bits at the end of the byte.

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

## SPI Protocol

SPI (Serial Peripheral Interface) bus is the serial data standard for the communications between microcontrollers and peripherals. It originally used 4-line links, 3-line and 2-line links are also in application, MaxiScope uses 3-line link to analyze this protocol.

**CLK:** Indicates the channel connected to clock signal.

**Clock threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the clock signal.

**DATA:** Indicates the channel connected to data signal.

**Data threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the data signal.

**SEL:** Indicates the channel connected to chip select signal.

**Chip select threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the chip select signal.

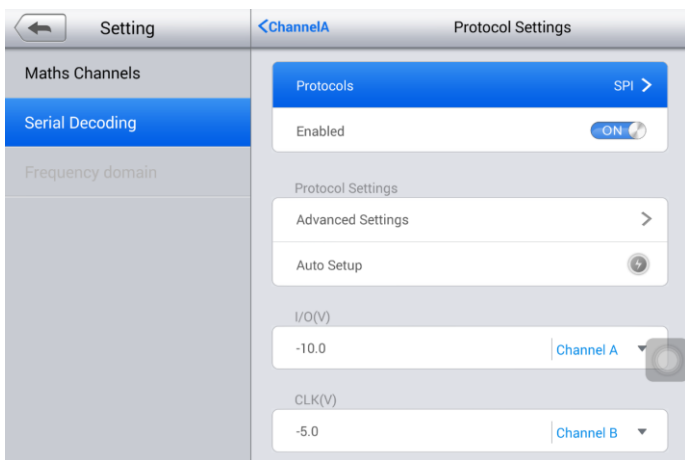


Figure 3-42 SPI Protocol Settings 1



**Figure 3-43 SPI Protocol Settings 2**

### *SPI Protocol Data List*

**Number (No.):** The serial number of frames (decimal). It indicates the SPI protocol frame number that currently decoded.

**Packet:** Packet types: start, end, address, data and undefined.

**Start bit:** The content of the packet.

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

## **I<sup>2</sup>S Protocol**

I<sup>2</sup>S (Inter-IC Sound) is a serial protocol used in digital audio devices for communications between circuits such as CD transports and audio DACs. It uses three signals: clock (SCK), word select (WS) and data (SD).

**SCL:** Indicates the channel connected to clock signal.

**Clock threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the clock signal.

**SDA:** Indicates the channel connected to data signal.

**Data threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the data signal.

**WS:** indicates the channel connected to word select (WS) signal.

**WS threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the chip select (WS) signal.

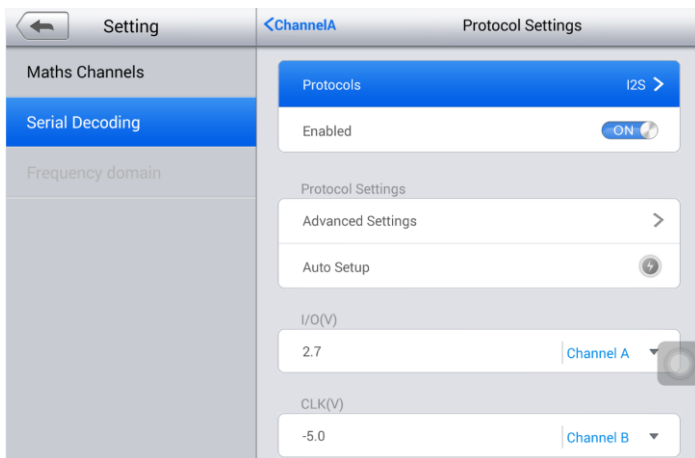


Figure 3-44  $\mathcal{P}S$  Protocol Settings 1



Figure 3-45  $\mathcal{P}S$  Protocol Settings 2

### $\mathcal{P}S$ Protocol Data List

**Number (No.):** The serial number of frames (decimal). It indicates the I<sup>2</sup>S protocol frame number that currently decoded.

**Packet:** All packet in this form are classified as data.

**Start bit:** The content of the packet.

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

## I<sup>2</sup>C Protocol

I<sup>2</sup>C (Inter-Integrated Circuit) is a serial protocol used in consumer electronics for communications between components on the same electric board and between computers and monitors. It uses two signals: clock (SCL) and data (SDA).

**SCL:** Indicates the channel connected to clock signal.

**Clock threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the clock signal.

**SDA:** Indicates the channel connected to data signal.

**Data threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the data signal.

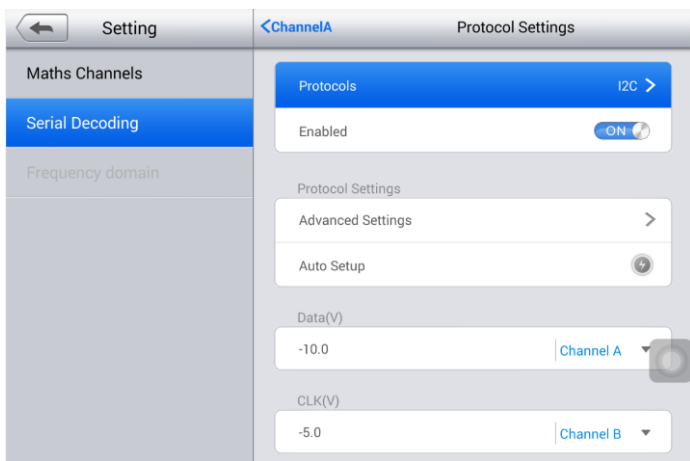


Figure 3-46 I<sup>2</sup>C Protocol Settings 1



Figure 3-47 I<sup>2</sup>C Protocol Settings 2

## *I<sup>2</sup>C Protocol Data List*

**Number (No.):** The serial number of frames (decimal). It indicates the I<sup>2</sup>C protocol frame number that currently decoded.

**Packet:** Packet types: start, end, address, data and undefined.

**Address:** Shown for address packets.

**R/W:** Polarity of the read/write flag.

**Data byte:** The content of the packet.

**ACK:** Whether the address confirms the packet.

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

## **USB Protocol**

All USB (Universal Serial Bus) data communications (both uplink communication and downlink communication) are launched by the USB host, therefore the USB host dominates the whole data transmission process. Only one host can exist in the USB system.

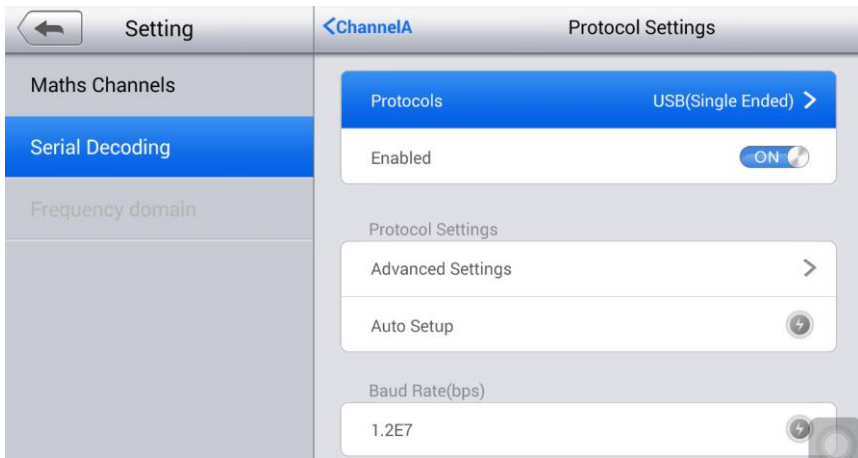
**D-:** Indicates the channel connected to data signal.

**Clock threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the clock signal.

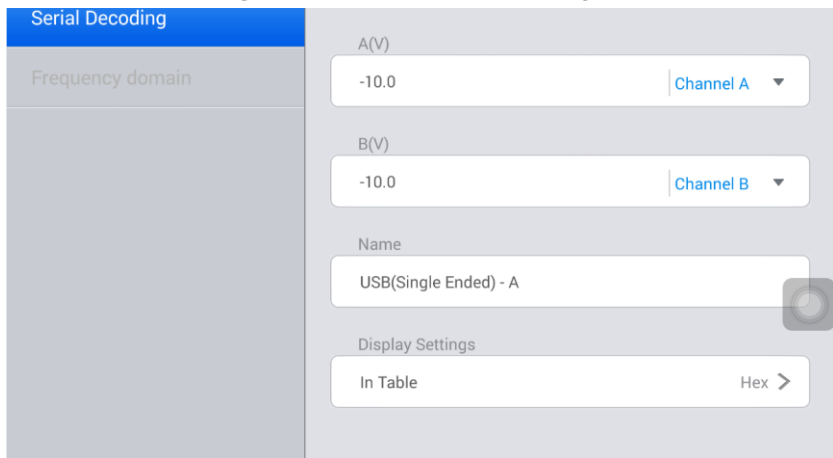
**D+:** Indicates the channel connected to data signal.

**Data threshold:** Used to distinguish the voltage values between high and low logic electrical levels of the data signal.





**Figure 3-48 USB Protocol Settings 1**



**Figure 3-49 USB Protocol Settings 2**

### *USB Protocol Data List*

**Number (No.):** The serial number of frames (decimal). It indicates the USB protocol frame number that currently decoded.

**Sync:** An 8-bit preamble for each data packet to synchronize the packet transmission rate of the USB device with the bus. The value has a fixed bit 00000001.

**PID field:** Used to indicate the packet type, including token, data, handshake and special.

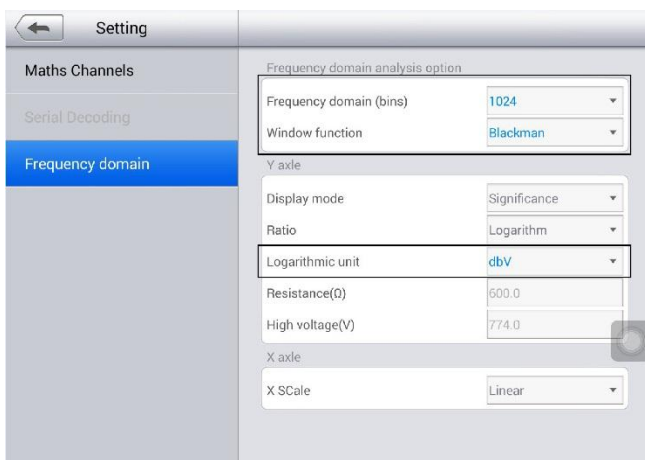
**Data field:** Used to carry the information to be transited between the host and the device. The content and length vary by identifier and transmission type. In the USB packet, the data segment may contain the device address, endpoint number, frame serial number, data and other content.

**CRC:** The number of bits in CRC data vary by packet type. Important data uses CRC16 data field while others use CRC5.

**Start time:** The value of the time base when the frame starts.

**End time:** The value of the time base when the frame ends.

## Frequency Domain Settings



**Figure 3-50 Frequency Domain Settings**

Generally, the default configuration works for most applications, but occasionally the two highlighted part in the above image need to be configured as well.

**Spectrum bins:** The number of frequency bins into which the spectrum is divided. It is used to set the maximum number of frequency bins, which the software may or may not be able to provide depending on other settings. The main constraint is that the number of the windows cannot exceed half

the number of samples in the source waveform. If the source waveform contains fewer samples than required (that is, fewer than twice the number of the frequency bins), then MaxiScope will zero-pad the waveform up to the next power of two. For example, if the scope view contains 10,000 samples, and you set Spectrum Bins to 16,384, then MaxiScope zero-pads the waveform to 16,384 samples, which is the nearest power of two above 10,000. It then uses 16,384 samples to provide 8192 frequency bins, not the 16,384 requested. If the source waveform contains more samples than required, then MaxiScope uses as many samples as necessary, starting from the beginning of the waveform buffer. For example, if the source waveform contains 100,000 samples and you request 16,384 frequency bins, MaxiScope needs only  $2 \times 16,384 = 32,768$  samples, so it uses the first 32,768 samples from the waveform buffer and ignore the rest.

**Window Function:** Allows you to choose one standard window function to reduce the effect of operating on a time-limited waveform.

**Table 3-2 Window Function**

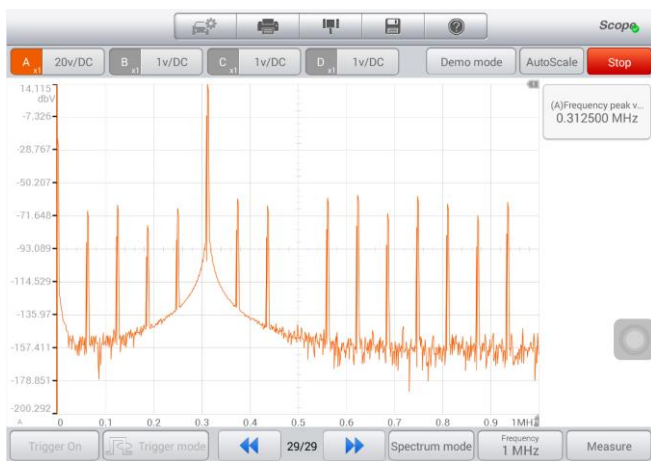
Window	Main peak width (bins @-3 dB)	Highest side lobe (dB)	Side lobe roll-off (dB/octave)	Remarks
Blackman	1.68	-58	18	Often used for audio work
Gaussian	1.33 to 1.79	-42 to -69	6	Gives minimal time and frequency errors
Triangular	1.28	-27	12	Also called Bartlett window
Hamming	1.30	-41.9	6	Also called raised sine-squared; used in speech analysis
Hann	1.20 to 1.86	-23 to -47	12 to 30	Also called sine-squared; used for audio and vibration work

Blackman-Harris	1.90	-92	6	General-purpose
Flat-top	2.94	-44	6	Negligible pass-band ripple; used mainly for calibration
Rectangular	0.89	-13.2	6	No fading; maximal sharpness; used for short transients

**Display mode:** The current version only support importance.

**Logarithmic unit:** Indicates the logarithmic unit used on Y-axis.

## Sampling Frequency Setting



**Figure 3-51 Sampling Frequency Setting**

It is recommended to use twice the signal frequency ( $s$ ) as the sampling frequency ( $f_s$ ) to ensure the sampling theorem is met without causing distortion and also eliminate unnecessary noise.

## Spectrum Measurements



**Figure 3-52 Spectrum Measurements**

**Frequency at peak:** The frequency at which the peak signal value appears.

**Amplitude at peak:** The amplitude of the peak signal value.

**Average amplitude at peak:** The amplitude of the peak signal value averaged over a number of captures.

**Total power:** The power of the whole signal captured in the spectrum view, calculated by adding the powers in all spectrum bins.

**Total harmonic distortion (THD)%:** The ratio of the sum of harmonic powers to the power at the fundamental frequency.

$$\text{THD} = \frac{\sqrt{V_1^2 + V_2^2 + V_3^2 + V_4^2 + V_5^2}}{V_f}$$

**Total harmonic distortion dB (THD):** The ratio of the sum of harmonic powers to the power at the fundamental frequency.

$$\text{THD} = 10\log_{10} \left( \frac{\sqrt{V_1^2 + V_2^2 + V_3^2 + V_4^2 + V_5^2}}{V_f} \right)$$

**Total harmonic distortion plus noise (THD+N):** The ratio of the harmonic power plus noise to the fundamental power. The THD+N values are always greater than the THD values for the same signal.

$$\text{THD} + \text{N} = 10\log_{10}\left(\frac{\text{THD} + \text{N}}{V_f}\right)$$

**Spurious-free dynamic range (SFDR):** This is the ratio of the amplitude of specific point (generally, the highest peak) in the spectrum to that of the second highest peak (it is called the SFDR frequency). SFDR frequency is not necessarily a harmonic of the fundamental frequency. For example, it might be a strong, independent noise signal.

**Signal to noise and distortion ratio (SINAD):** The ratio, in decibels, of the signal-plus-noise-plus-distortion to noise-plus-distortion.

$$\text{SINAD} = 10\log_{10}\left(\frac{\text{Signal}}{\text{Noise} + \text{noise}}\right)$$

**Signal to noise ratio (SNR):** The ratio, in decibels, of the signal to noise. Hanning or Blackman windows are recommended because of their low noise.

$$\text{SINAD} = 10\log_{10}\left(\frac{\text{Signal}}{\text{Noise}}\right)$$

**Intermodulation distortion (IMD):** A measure of the distortion caused by the nonlinear mixing of two tones. When multiple signals are injected into a device, modulation or nonlinear mixing of these two signals can occur. For input signal at frequencies  $f_1$  and  $f_2$ , the two second-order distortion signals will be found at frequencies:  $f_3 = (f_1 + f_2)$  and  $f_4 = (f_1 - f_2)$ . IMD is expressed as the dB ratio of the RMS sum of the distortion terms to the RMS sum of the two input tones. IMS can be measured for distortion terms of any order, but the second-order terms are most commonly used. In the second-order case, the intermodulation distortion is given by:

$$\text{IMD} = \sqrt{\frac{F_3^2 + F_4^2}{F_1^2 + F_2^2}}$$

Where  $F_3$  AND  $F_4$  are the amplitudes of the two second-order distortion terms (at frequencies  $f_3$  and  $f_4$  defined above) and  $F_1$  and  $F_2$  are the amplitudes of the input tones (at frequencies  $f_1$  and  $f_2$ , as marked by the

frequency rulers in the spectrum window). For reference, the third-order terms are at frequencies  $(2F_1 + F_2)$ ,  $(2F_1 - F_2)$ ,  $(F_1 + 2F_2)$  and  $(F_1 - 2F_2)$ .

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ⓘ **NOTE**

Hanning or Blackman windows are recommended because of their low noise. An FFT size of 4096 or greater is recommended in order to provide adequate spectral resolution for the IMD measurements.

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# 4 Compliance Information

## *FCC Compliance*

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.