SDS5000X HD
SDS5000L Series
Digital Storage Oscilloscope

User Manual

EN01A

SIGLENT TECHNOLOGIES CO., LTD.

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1 Introduction

This user manual includes important safety and installation information related to the SDS5000A series of oscilloscopes and includes simple tutorials for basic operation of the instrument.

2 Important Safety Information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

2.1 General Safety Summary

Carefully read the following safety precautions to avoid personal injury and prevent damage to the instrument and any products connected to it. To avoid potential hazards, please use the instrument as specified.

To Avoid Fire or Personal Injury.

Use Proper Power Line.

Only use a local/state approved power cord for connecting the instrument to mains power sources.

Ground the Instrument.

The instrument grounds through the protective terra conductor of the power line. To avoid electric shock, the ground conductor must be connected to the earth. Make sure the instrument is grounded correctly before connect its input or output terminals.

Connect the Signal Wire Correctly.

The potential of the signal wire is equal to the earth, so do not connect the signal wire to a high voltage. Do not touch the exposed contacts or components.

Look over All Terminals' Ratings.

To avoid fire or electric shock, please look over all ratings and signed instructions of the instrument. Before connecting the instrument, please read the manual carefully to gain more information about the ratings.

Equipment Maintenance and Service.

When the equipment fails, please do not dismantle the machine for maintenance. The equipment contains capacitors, power supply, transformers, and other energy storage devices, which may cause high voltage damage. The internal devices of the equipment are sensitive to static electricity, and direct contact is easy to cause irreparable damage to the equipment. It is necessary to return to the factory or the company's designated maintenance organization for maintenance. Be sure to pull out the power supply when repairing the equipment. Live line operation is strictly prohibited. The equipment can only be powered on when the maintenance is completed and the maintenance is confirmed to be successful.

Identification of Normal State of Equipment.

After the equipment is started, there will be no alarm information and error information at the interface under normal conditions. The curve of the interface will scan from left to right freely; if there is a button in the scanning process or there is an alarm or error prompt, the device may be in an abnormal state. You need to view the specific prompt information. You can try to restart the setting. If the fault information is still in place, do not use it for testing. Contact the manufacturer or the maintenance department designated by the manufacturer to carry out maintenance to avoid the wrong test data caused by the use of the fault or endanger the personal safety.

Not Operate with Suspected Failures.

If you suspect that there is damage to the instrument, please let qualified service personnel check it.

Avoid Circuit or Wire Exposed Components Exposed.

Do not touch exposed contacts or components when the power is on.

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep the surface of the instrument clean and dry.

Only probe assemblies that meet the requirement of UL61010-031 and CAN/CSA-C22.2 No.61010-031 shall be used.

Only a lithium battery with the same specifications as the original battery should be used to replace the battery on board.

Not to use the equipment for measurements on mains circuits, not to use the equipment for

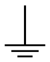
measurements on voltage exceed the voltage range describe in the manual. The maximum additional transient voltage cannot exceed 1300V.

The responsible body or operator should refer to the instruction manual to preserve the protection afforded by the equipment. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Any parts of the device and its accessories are not allowed to be changed or replaced, other than authorized by the manufacturer or agent.

2.2 Safety Terms and Symbols

When the following symbols or terms appear on the front or rear panel of the instrument or in this manual, they indicate special care in terms of safety.

	This symbol is used where caution is required. Refer to the accompanying information or documents to protect against personal injury or damage to the instrument.
	This symbol warns of a potential risk of shock hazard.
	This symbol is used to denote the measurement ground connection.
	This symbol is used to denote a safety ground connection.
	This symbol shows that the switch is an On/Standby switch. When it is pressed, the scope's state switches between Operation and Standby. This switch does not disconnect the device's power supply. To completely power off the scope, the power cord must be unplugged from the AC socket after the instrument is in the standby state.
~	This symbol is used to represent alternating current, or "AC".
CAUTION	The **"CAUTION"** symbol indicates a potential hazard. It calls attention to a procedure, practice, or condition which may be dangerous if not followed. Do not proceed until its conditions are fully understood and met.
WARNING	The **"WARNING"** symbol indicates a potential hazard. It calls attention to a procedure, practice, or condition which, if not followed, could cause bodily injury or death. If a WARNING is indicated, do not proceed until the safety conditions are fully understood and met.

2.3 Working Environment

The design of the instrument has been verified to conform to EN 61010-1 safety standard per the following limits:

Environment

The instrument is used indoors and should be operated in a clean and dry environment with an ambient temperature range.

Note:

Direct sunlight, electric heaters, and other heat sources should be considered when evaluating the ambient temperature.

WARNING:

Do not operate the instrument in explosive, dusty, or humid environments.

Ambient Temperature

Operating: 0 ℃ to +50 ℃

Non-operation: -30 ℃ to +70 ℃

Note:

Direct sunlight, radiators, and other heat sources should be taken into account when assessing the ambient temperature.

Humidity

Operating: 5% ~ 90% RH, 30 ℃, derate to 50% RH at 40 ℃

Non-operating: 5% ~ 95% RH

Mains supply voltage fluctuations

Refer to 2.5 Power and Ground Requirements

Altitude

Operating: ≤ 3,048 m, 25 ℃

Non-operating: ≤ 12,191 m

Installation (overvoltage) Category

This product is powered by mains conforming to installation (overvoltage) Category II.

	Note: Installation (overvoltage) category I refers to situations where equipment measurement terminals are connected to the source circuit. In these terminals, precautions are done to limit the transient voltage to a correspondingly low level. Installation (overvoltage) category II refers to the local power distribution level which applies to equipment connected to the AC line (AC power).

Degree of Pollution

The oscilloscopes may be operated in environments of Pollution Degree II.

	Note: Degree of Pollution II refers to a working environment that is dry and non-conductive pollution occurs. Occasional temporary conductivity caused by condensation is expected.

IP Rating

IP20 (as defined in IEC 60529).

2.4 Cooling Requirements

This instrument relies on the forced air cooling with internal fans and ventilation openings. Care must be taken to avoid restricting the airflow around the apertures (fan holes) at each side of the scope. To ensure adequate ventilation it is required to leave a 15 cm (6 inch) minimum gap around the sides of the instrument.

	CAUTION: Do not block the ventilation holes located on both sides of the scope.

⚠	**CAUTION:** Do not allow any foreign matter to enter the scope through the ventilation holes, etc.

2.5 Power and Grounding Requirements

The instrument operates with a single-phase, 100 to 240 Vrms (+/-10%) AC power at 50/60 Hz (+/-5%).

No manual voltage selection is required because the instrument automatically adapts to line voltage.

Depending on the type and number of options and accessories (probes, PC port plug-in, etc.), the instrument can consume up to 200 W of power.

Note: The instrument automatically adapts to the AC line input within the following ranges:

Voltage Range:	90-264 Vrms
Frequency Range:	47-63 Hz

The instrument includes a grounded cord set containing a molded three-terminal polarized plug and a standard IEC320 (Type C13) connector for making line voltage and safety ground connection. The AC inlet ground terminal is connected directly to the frame of the instrument. For adequate protection against electrical shock hazards, the power cord plug must be inserted into a mating AC outlet containing a safety ground contact. Use only the power cord specified for this instrument and certified for the country of use.

⚠	**WARNING:** Electrical Shock Hazard! Any interruption of the protective conductor inside or outside of the scope, or disconnection of the safety ground terminal creates a hazardous situation. Intentional interruption is prohibited.

The position of the instrument should allow easy access to the socket. To make the instrument completely power off, unplug the instrument power cord from the AC socket.

The power cord should be unplugged from the AC outlet if the scope is not to be used for an extended period.

	CAUTION: The outer shells of the front panel terminals (CH1, CH2, CH3, CH4, EXT) are connected to the instrument's chassis and therefore to the safety ground.

2.6 Cleaning

Clean only the exterior of the instrument, using a damp, soft cloth. Do not use chemicals or abrasive elements. Under no circumstances allow moisture to penetrate the instrument. To avoid electrical shock, unplug the power cord from the AC outlet before cleaning.

	WARNING: Electrical Shock Hazard! No operator serviceable parts inside. Do not remove covers. Refer servicing to qualified personnel.

2.7 Abnormal Conditions

Do not operate the scope if there is any visible sign of damage or has been subjected to severe transport stresses.

If you suspect the scope's protection has been impaired, disconnect the power cord and secure the instrument against any unintended operation.

Proper use of the instrument depends on careful reading of all instructions and labels.

	WARNING: Any use of the scope in a manner not specified by the manufacturer may impair the instrument's safety protection. This instrument should not be directly connected to human subjects or used for patient monitoring.

2.8 Safety Compliance

This section lists the safety standards with which the product complies.

U.S. nationally recognized testing laboratory listing

- UL 61010-1:2012/R: 2018-11. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.

- UL 61010-2-030:2018. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part2-030: Particular requirements for testing and measuring circuits.

Canadian certification

- CAN/CSA-C22.2 No. 61010-1:2012/A1:2018-11. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
- CAN/CSA-C22.2 No. 61010-2-030:2018. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 2-030: Particular requirements for testing and measuring circuits.

Informations essentielles sur la sécurité

Ce manuel contient des informations et des avertissements que les utilisateurs doivent suivre pour assurer la sécurité des opérations et maintenir les produits en sécurité.

Exigence de Sécurité

Lisez attentivement les précautions de sécurité ci – après afin d 'éviter les dommages corporels et de prévenir les dommages aux instruments et aux produits associés. Pour éviter les risques potentiels, utilisez les instruments prescrits.

Éviter l 'incendie ou les lésions corporelles.

Utilisez un cordon d'alimentation approprié.

N'utilisez que des cordons d'alimentation spécifiques aux instruments approuvés par les autorités locales.

Mettez l'instrument au sol.

L'instrument est mis à la Terre par un conducteur de mise à la terre de protection du cordon d'alimentation.Pour éviter un choc électrique, le conducteur de mise à la terre doit être mis à la terre.Assurez – vous que l'instrument est correctement mis à la terre avant de connecter les bornes d'entrée ou de sortie de l'instrument.

Connectez correctement le fil de signalisation.

Le potentiel de la ligne de signal est égal au potentiel au sol, donc ne connectez pas la ligne de signal à haute tension.Ne touchez pas les contacts ou les composants exposés.

Voir les cotes de tous les terminaux.

Pour éviter un incendie ou un choc électrique, vérifiez toutes les cotes et signez les instructions de l'instrument.Avant de brancher l'instrument, lisez attentivement ce manuel pour obtenir de plus amples renseignements sur les cotes.

Entretien du matériel.

En cas de défaillance de l'équipement, ne pas démonter et entretenir l'équipement sans autorisation.

L'équipement contient des condensateurs, de l'alimentation électrique, des transformateurs et d'autres dispositifs de stockage d'énergie, ce qui peut causer des blessures à haute tension. Les dispositifs internes de l'équipement sont sensibles à l'électricité statique. Le contact direct peut facilement causer des blessures irrécupérables à l'équipement. L'équipement doit être retourné à l'usine ou à l'organisme de maintenance désigné par l'entreprise pour l'entretien. L'alimentation électrique doit être retirée pendant l'entretienLa ligne ne doit pas être mise sous tension tant que l'entretien de l'équipement n'est pas terminé et que l'entretien n'est pas confirmé.

Identification de l'état normal de l'équipement.

Après le démarrage de l'équipement, dans des conditions normales, il n'y aura pas d'information d'alarme et d'erreur au bas de l'interface, et la courbe de l'interface sera balayée librement de gauche à droite; si un blocage se produit pendant le processus de numérisation, ou si l'information d'alarme ou d'erreur apparaît au bas de l'interface, l'équipement peut être dans un état anormal. Pour voir l'information d'alarme spécifique, vous pouvez d'abord essayer de redémarrerSi l'information sur la d éfaillance est toujours présente, ne l'utilisez pas pour l'essai. Contactez le fabricant ou le Service de réparation désigné par le fabricant pour effectuer l'entretien afin d'éviter d'apporter des données d'essai erronées ou de mettre en danger la sécurité personnelle en raison de l'utilisation de la défaillance.

Ne pas fonctionner en cas de suspicion de défaillance.

Si vous soupçonnez des dommages à l'instrument, demandez à un technicien qualifié de vérifier.

L 'exposition du circuit ou de l' élément d 'exposition du fil est évitée.

Lorsque l 'alimentation est connectée, aucun contact ou élément nu n' est mis en contact.

Ne pas fonctionner dans des conditions humides / humides.

Pas dans un environnement explosif.

Maintenez la surface de l 'instrument propre et sec.

Le Circuit d 'alimentation électrique ne peut pas être mesuré à l' aide du dispositif, ni la tension qui dépasse la plage de tension décrite dans le présent manuel.

Seuls les ensembles de sondes conformes aux spécifications du fabricant peuvent être utilisés.

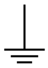
L'organisme ou l'opérateur responsable doit se référer au cahier des charges pour protéger la protection offerte par le matériel.La protection offerte par le matériel peut être compromise si celui - ci est utilisé de manière non spécifiée par le fabricant.

Aucune pièce du matériel et de ses annexes ne peut être remplacée ou remplacée sans l'autorisation de son fabricant.

Remplacer la batterie dans l 'appareil avec les mêmes spécifications de batterie au lithium.

Termes et symboles de sécurité

Lorsque les symboles ou termes suivants apparaissent sur le panneau avant ou arrière de l'instrument ou dans ce manuel, ils indiquent un soin particulier en termes de sécurité.

	Ce symbole est utilisé lorsque la prudence est requise. Reportez-vous aux informations ou documents joints afin de vous protéger contre les blessures ou les dommages à l'instrument.
	Ce symbole avertit d'un risque potentiel de choc électrique.
	Ce symbole est utilisé pour désigner la connexion de terre de mesure.
	Ce symbole est utilisé pour indiquer une connexion à la terre de sécurité.
	Ce symbole indique que l'interrupteur est un interrupteur marche / veille. Lorsqu'il est enfoncé, l'état de l'instruments bascule entre Fonctionnement et Veille. Ce commutateur ne déconnecte pas l'alimentation de l'appareil. Pour éteindre complètement l'instruments, le cordon d'alimentation doit être débranché de la prise secteur une fois l'instruments en état de veille.
	Ce symbole est utilisé pour représenter un courant alternatif, ou "AC".
CAUTION	Le symbole **"CAUTION"** indique un danger potentiel. Il attire l'attention sur une procédure, une pratique ou une condition qui peut être dangereuse si elle n'est pas suivie. Ne continuez pas tant que ses conditions n'ont pas été entièrement comprises et remplies.
WARNING	Le symbole **"WARNING"** indique un danger potentiel. Il attire l'attention sur une procédure, une pratique ou une condition qui, si elle n'est pas suivie, pourrait entraîner des blessures corporelles ou la mort. Si un AVERTISSEMENT est indiqué, ne continuez pas tant que les conditions de sécurité ne sont pas entièrement comprises et remplies.

Environnement de travail

La conception de l'instrument a été certifiée conforme à la norme EN 61010-1, sur la base des valeurs limites suivantes:

Environnement

L'instrument doit être utilisé à l'intérieur dans un environnement propre et sec dans la plage de température ambiante.

	Note: la lumière directe du soleil, les réchauffeurs électriques et d'autres sources de chaleur doivent être pris en considération lors de l'évaluation de la température ambiante.

	ATTENTION: Ne pas utiliser l'instrument dans l'air explosif, poussiéreux ou humide.

Température ambiante

En fonctionnement: 0 ℃ à +50 ℃

Hors fonctionnement: -30 ℃ à +70 ℃

	Note: pour évaluer la température de l'environnement, il convient de tenir compte des rayonnements solaires directs, des radiateurs thermiques et d'autres sources de chaleur.

Humidité

Fonctionnement: 5% ~ 90% HR, 30 ℃, 40 ℃ réduit à 50% HRHors fonctionnement: 5% ~ 95%, 65 ℃, 24 heures.

Fluctuation de la tension d'alimentation

Voir connexions d'alimentation et au sol.

Altitude

Fonctionnement: ≤ 3048 m

À l'arrêt: ≤ 12,191 m

Catégorie d 'installation (surtension)

Ce produit est alimenté par une alimentation électrique conforme à l 'installation (surtension) Catégorie II.

Installation (overvoltage) Category Definitions Définition de catégorie d 'installation (surtension)

La catégorie II d'installation (surtension) est un niveau de signal applicable aux terminaux de mesure d' équipement reliés au circuit source.Dans ces bornes, des mesures préventives sont prises pour limiter la tension transitoire à un niveau inférieur correspondant.

La catégorie II d'installation (surtension) désigne le niveau local de distribution d 'énergie d' un équipement conçu pour accéder à un circuit alternatif (alimentation alternative).

Degré de pollution

Un instruments peut être utilisé dans un environnement Pollution Degree II.

Note:

Pollution Degree II signifie que le milieu de travail est sec et qu'il y a une pollution non conductrice.Parfois, la condensation produit une conductivité temporaire.

IP Rating

IP20 (as defined in IEC 60529).

Exigences de refroidissement

Cet instrument repose sur un refroidissement à air forcé avec des ventilateurs internes et des ouvertures de ventilation. Des précautions doivent être prises pour éviter de restreindre le flux d'air autour des ouvertures (trous de ventilateur) de chaque côté de la lunette. Pour assurer une ventilation adéquate, il est nécessaire de laisser un espace minimum de 15 cm (6 pouces) sur les côtés de l'instrument.

⚠	**ATTENTION:** Ne bloquez pas les trous de ventilation situés des deux côtés de la lunette.

⚠	**ATTENTION:** Ne laissez aucun corps étranger pénétrer dans la lunette par les trous de ventilation, etc.

Connexions d'alimentation et de terre

L'instrument fonctionne avec une alimentation CA monophasée de 100 à 240 Vrms (+/- 10%) à 50/60 Hz (+/- 5%).

Aucune sélection manuelle de la tension n'est requise car l'instrument s'adapte automatiquement à la tension de ligne.

Selon le type et le nombre d'options et d'accessoires (sondes, plug-in de port PC, etc.), l'instrument peut consommer jusqu'à 200 W d'énergie.

Remarque: l'instrument s'adapte automatiquement à l'entrée de ligne CA dans les plages suivantes:

Plage de tension:	90-264 Vrms
Gamme de fréquences:	47-63 Hz

L'instrument comprend un jeu de cordons mis à la terre contenant une fiche polarisée à trois bornes moulée et un connecteur standard IEC320 (Type C13) pour établir la tension de ligne et la connexion de mise à la terre de sécurité. La borne de mise à la terre de l'entrée CA est directement connectée au châssis de l'instrument. Pour une protection adéquate contre les risques d'électrocution, la fiche du cordon d'alimentation doit être insérée dans une prise secteur correspondante contenant un contact de sécurité avec la terre. Utilisez uniquement le cordon d'alimentation spécifié pour cet instrument et certifié pour le pays d'utilisation.

⚠	**Avertissement:** Risque de choc électrique! Toute interruption du conducteur de terre de protection à l'intérieur ou à l'extérieur de la portée ou la déconnexion de la borne de terre de sécurité crée une situation dangereuse. L'interruption intentionnelle est interdite.

La position de l'instruments doit permettre un accès facile à la prise. Pour éteindre complètement l'instruments, débranchez le cordon d'alimentation de l'instrument de la prise secteur.

Le cordon d'alimentation doit être débranché de la prise secteur si la lunette ne doit pas être utilisée pendant une période prolongée.

⚠	**ATTENTION:** Les enveloppes extérieures des bornes du panneau avant (CH1, CH2, CH3, CH4, EXT) sont connectées au châssis de l'instrument et donc à la terre de sécurité.

Nettoyage

Nettoyez uniquement l'extérieur de l'instrument à l'aide d'un chiffon doux et humide. N'utilisez pas de produits chimiques ou d'éléments abrasifs. Ne laissez en aucun cas l'humidité pénétrer dans l'instrument. Pour éviter les chocs électriques, débranchez le cordon d'alimentation de la prise secteur avant de le nettoyer.

⚠	**Avertissement:** Risque de choc électrique! Aucune pièce réparable par l'opérateur à l'intérieur. Ne retirez pas les capots. Confiez l'entretien à un personnel qualifié.

Conditions anormales

Utilisez l'instrument uniquement aux fins spécifiées par le fabricant.

N'utilisez pas la lunette s'il y a des signes visibles de dommages ou si elle a été soumise à de fortes contraintes de transport.

Si vous pensez que la protection de l'instruments a été altérée, débranchez le cordon d'alimentation et sécurisez l'instrument contre toute opération involontaire.

Une bonne utilisation de l'instrument nécessite la lecture et la compréhension de toutes les instructions et étiquettes.

⚠	**Avertissement:** Toute utilisation de l'instruments d'une manière non spécifiée par le fabricant peut compromettre la protection de sécurité de l'instrument. Cet instrument ne doit pas être directement connecté à des sujets humains ni utilisé pour la surveillance des patients.

Conformité en matière de sécurité

La présente section présente les normes de sécurité applicables aux produits.

U.S. nationally recognized testing laboratory listing

- UL 61010-1:2012/R:2018-11. Prescriptions en matière de sécurité pour les appareils électriques utilisés en laboratoire et de mesure - partie 1: prescriptions générales.
- UL 61010-2-030:2018. Prescriptions de sécurité pour les appareils électriques de mesure, de contrôle et de laboratoire - partie 2 - 030: prescriptions spéciales pour les circuits d 'essai et de mesure.

Canadian certification

- CAN/CSA-C22.2 No. 61010-1:2012/A1:2018-11. Prescriptions en matière de sécurité pour les appareils électriques utilisés en laboratoire et de mesure - partie 1: prescriptions générales.
- CAN/CSA-C22.2 No. 61010-2-030:2018. Prescriptions de sécurité pour les appareils électriques de mesure, de contrôle et de laboratoire - partie 2 - 030: prescriptions spéciales pour les circuits d 'essai et de mesure.

3 First Steps

3.1 Delivery Checklist

First, verify that all items listed on the packing list have been delivered. If you note any omissions or damage, please contact your nearest **SIGLENT** customer service center or distributor as soon as possible. If you fail to contact us immediately in case of omission or damage, we will not be responsible for replacement.

3.2 Quality Assurance

The oscilloscope has a 3-year warranty (1-year warranty for probe and accessories) from the date of shipment, during normal use and operation. **SIGLENT** can repair or replace any product that is returned to the authorized service center during the warranty period. We must first examine the product to make sure that the defect is caused by the process or material, not by abuse, negligence, accident, abnormal conditions, or operation.

SIGLENT shall not be responsible for any defect, damage, or failure caused by any of the following:

a) Attempted repairs or installations by personnel other than **SIGLENT.**

b) Connection to incompatible devices/incorrect connection.

c) For any damage or malfunction caused by the use of non-**SIGLENT** supplies. Furthermore, **SIGLENT** shall not be obligated to service a product that has been modified. Spare, replacement parts and repairs have a 90-day warranty.

The oscilloscope's firmware has been thoroughly tested and is presumed to be functional. Nevertheless, it is supplied without a warranty of any kind covering detailed performance. Products not made by **SIGLENT** are covered solely by the warranty of the original equipment manufacturer.

3.3 Maintenance Agreement

We provide various services based on maintenance agreements. We offer extended warranties as well as installation, training, enhancement and on-site maintenance, and other services through specialized supplementary support agreements. For details, please consult your local **SIGLENT** customer service center or distributor.

4 Document Conventions

For convenience, text surrounded by a box border is used to represent the button of the front panel. For example, Print represents the "Print" button on the front panel. Italicized text with shading is used to represent the touchable or clickable menu/button/region on the touch screen. For example, *Display* represents the "Display" menu on the screen:

For the operations that contain multiple steps, the description is in the form of "Step 1 > Step 2 >...". As an example, follow each step in the sequence to enter the upgrade interface:

Utility > *Maintenance* > *Upgrade*

Press the Utility button on the front panel as step 1, click the *Maintenance* option on the screen as step 2, and click the *Update* option on the screen as step 3 to enter the upgrade interface.

5 Getting Started

5.1 Power on

After the oscilloscope is connected to the AC power supply through the power cord, you need to manually press the power button to turn on the oscilloscope.

5.2 Shut down

Press the power button for one second to turn off the oscilloscope. Or follow the steps below:

Utility > *Shutdown*

Note:

The front panel Power button does not disconnect the oscilloscope from the AC power supply. To disconnect the instrument from the mains, turn off the power switch on the rear panel of the instrument. The power cord should be unplugged from the AC outlet if the scope is not to be used for an extended period. The standby power consumption is about 4 W.

5.3 System Information

Follow the steps below to examine the software and hardware versions of the oscilloscope.

Utility > *Menu* > *System Info…*

See the section "System Information" for details.

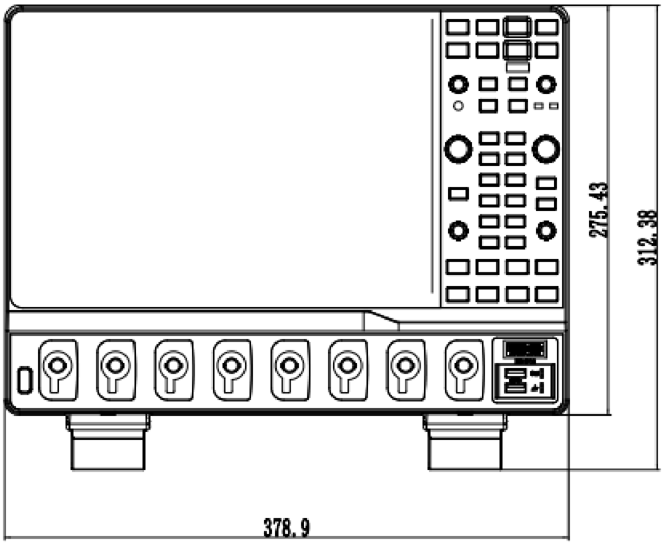
5.4 Install Options

A license is necessary to unlock a software option. See the section "Install Options" for details.

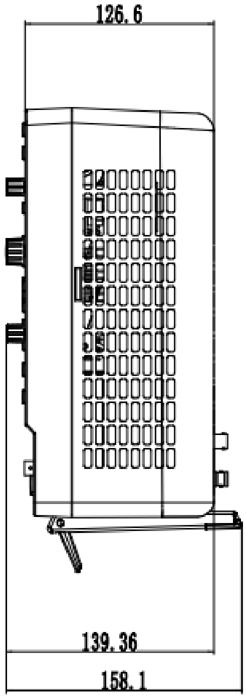
6 Quick Start

6.1 Mechanical Dimension

SDS5000X HD

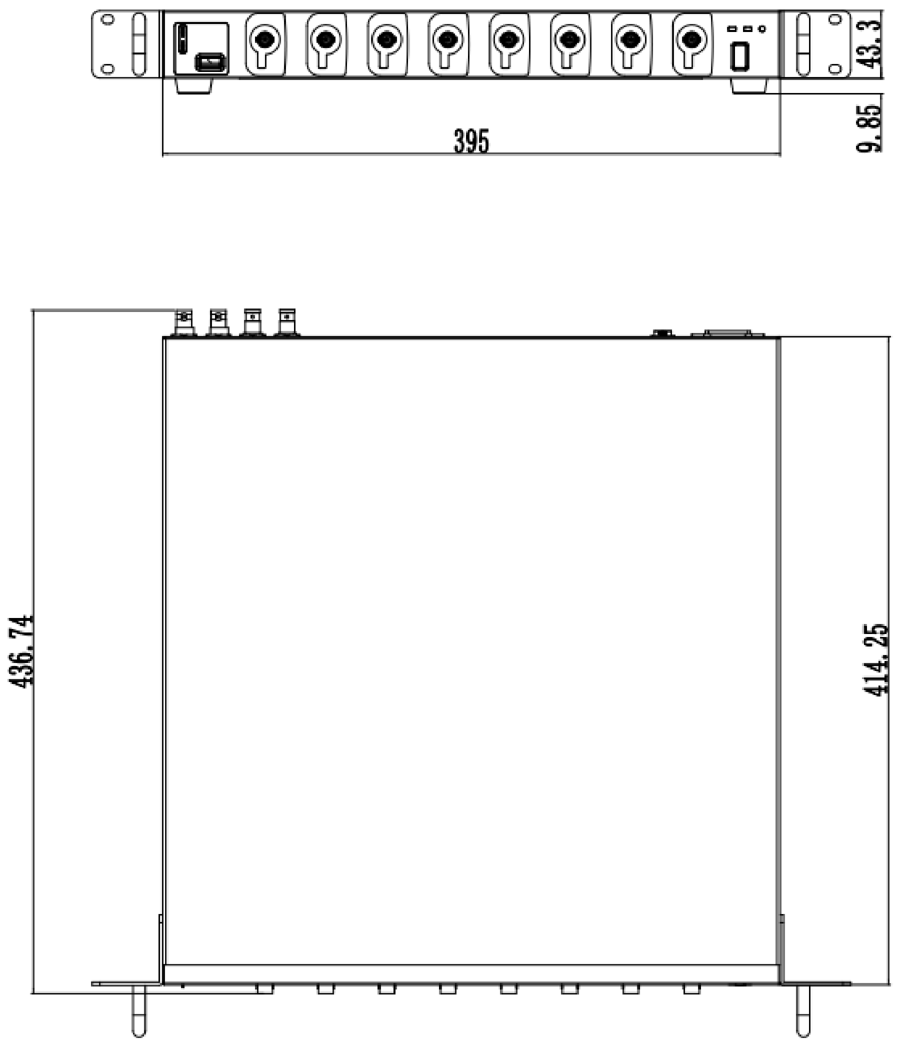


Front View



Side View

SDS5000L



Front View& Top View

6.2 Front Panel Overview

SDS5000X HD

A. Analog Input Connectors

B. Digital Input Connector

C. USB 3.0 Host Ports. Connect to USB storage devices for data transfer or USB mouse / keyboard for control

D. Probe Compensation / Ground Terminals

E. Touch Screen Display

F. Front Panel. Includes knobs and buttons. See the "Front Panel" chapter for more details

G. Power Switch

H. Supporting Legs

SDS5000L

A. Analog Input Connectors

B. Acquisition Status and LAN status LEDs

C. Reset for LAN

D. USB 3.0 Host Ports. Connect to USB storage devices for data transfer or USB mouse / keyboard for control

E. Probe Compensation / Ground Terminals

F. Power Switch

G. Handles

6.3 Rear Panel Overview

SDS5000X HD

A. AC Power Input

B. USB 2.0 Host Port. Connects to USB storage devices for data transfer or USB mouse / keyboard for control

C. USB 3.0 Device. Connects with a PC for remote control

D. 1000M LAN Port. Connects the port to the network for remote control

E. HDMI Video Output. Connects the port to an external monitor. The resolution is 1280 * 800

F. Auxiliary Out. Outputs the trigger indicator. When Mask Test is enabled, outputs the pass / fail signal

G. Ext Trigger Input

H. 10 MHz In

I. 10 MHz Out

J. Keyhole

K. Handle

SDS5000L

A. AC Power Input and Power Switch

B. HDMI Video Output. Connects the port to an external monitor. The resolution is 1280 * 800

C. 1000M LAN Port. Connects the port to the network for remote control

D. USB 3.0 Device. Connects with a PC for remote control

E. USB 2.0 Host Port. Connects to USB storage devices for data transfer or USB mouse / keyboard for control

F. Ext Trigger Input

G. Auxiliary Out. Outputs the trigger indicator. When Mask Test is enabled, outputs the pass / fail signal

H. 10 MHz In

I. 10 MHz Out

6.4 Connecting to External Devices/Systems

6.4.1 Power Supply

The standard power supply for the instrument is 100~240 V, 50/60 Hz. Please use the power cord provided with the instrument to connect it to AC power.

6.4.2 Probes

The device series oscilloscope supports active probes and passive probes. The specifications and probe documents can be obtained at int.siglent.com, www.siglentna.com, or www.siglenteu.com.

Probe Compensation

When a passive probe is used for the first time, you should compensate it to match the input channel of the oscilloscope. Non-compensated or poorly compensated probes may increase measurement inaccuracy or error. The probe compensation procedures are as follows:

1. Connect the coaxial cable interface (BNC connector) of the passive probe to any channel of the oscilloscope.
2. Connect the probe to the "Compensation Signal Output Terminal" (Cal) on the front of the oscilloscope. Connect the ground alligator clip of the probe to the "Ground Terminal" under the compensation signal output terminal.

3. Perform *Acquire* > *Auto Setup* .
4. Check the waveform displayed and compare it with the following.

Under Compensated | Perfectly Compensated | Over Compensated

5. Use a non-metallic driver to adjust the low-frequency compensation adjustment hole on the

probe until the waveform displayed is as the “Perfectly compensated” in the figure above.

	Note: It’s not necessary to compensate an active probe.

6.4.3 LAN

Connect the LAN port to the network with a network cable with an RJ45 connector for remote control. See the chapter “ Remote Control ” for detailed information on remotely controlling the instrument.

Follow the steps below to set LAN connection:

Utility > *Menu* > *I/O* > *LAN Config…*

See section “LAN” for details of the configuration.

6.4.4 External Display

The SDS5000X HD comes with a capacitive touch display screen with a resolution of 1280x800, and also supports external displays. Use a video cable to connect the HDMI interface between the external monitor and the device's rear panel. Similar to computers, there are two multi-display modes: Duplicate or Extend. When the display mode is " Duplicate", the external monitor displays the same content as the oscilloscope. When the display mode is "Extend", the external monitor acts as an extension of the oscilloscope's main display and a window in the main display can be dragged to the external monitor. Multi-monitor settings are set in the following steps:

Dispaly > *External Monitor*

The SDS5000L has no display screen, only supports external displays. You can easily connect an external HDMI monitor to the HDMI output on the rear panel of the instrument using an HDMI cable. Connect a mouse to the instrument and it can then be used as a stand-alone oscilloscope.

6.4.5 Mouse and Keyboard

Connect the mouse or keyboard to the USB host port on the front of the oscilloscope. Mouse operation is equivalent to single point gesture operation on the touch screen. When the display mode of the external monitor is “Extend”, operations within the extended screen can only be performed with the mouse.

6.4.6 Auxiliary Output

When Mast Test is enabled, the port outputs the pass/fail signal, otherwise, it outputs the trigger indicator. The trigger indicator can be used to measure the waveform capture rate.

See the chapter “Mask Test” for more details on the pass/fail output.

6.4.7 Reference Input and Output

The device can use the internal 10 MHz clock, or a 10 MHz clock from another instrument, or source using the 10 MHz In port as the reference. The reference clock is a 10 MHz square wave and can be output from the 10 MHz Out port for synchronizing other instruments. To set the reference clock by following the steps:

Utility > *Menu* > *IO* > *Clock Source*

See the "Clock Source" section for details.

6.4.8 Waveform Generator

The device supports an external function/arbitrary waveform generator module.

You can purchase an external SAG1021I function/arbitrary waveform generator module with isolated output to use as a waveform generator. Connect the SAG1021I to any USB host port of the oscilloscope through a USB cable.

Perform *Utility* > *Wave Gen...* to set the waveform. See chapters “Waveform Generator” and “Bode Plot” for more relative information.

6.4.9 Logic Probe

- **To connect the logic probe:** Insert the probe, with the correct side facing up, until you hear a “click”.
- **To remove the logic probe:** Depress the buttons on each side of the probe, then pull out it.

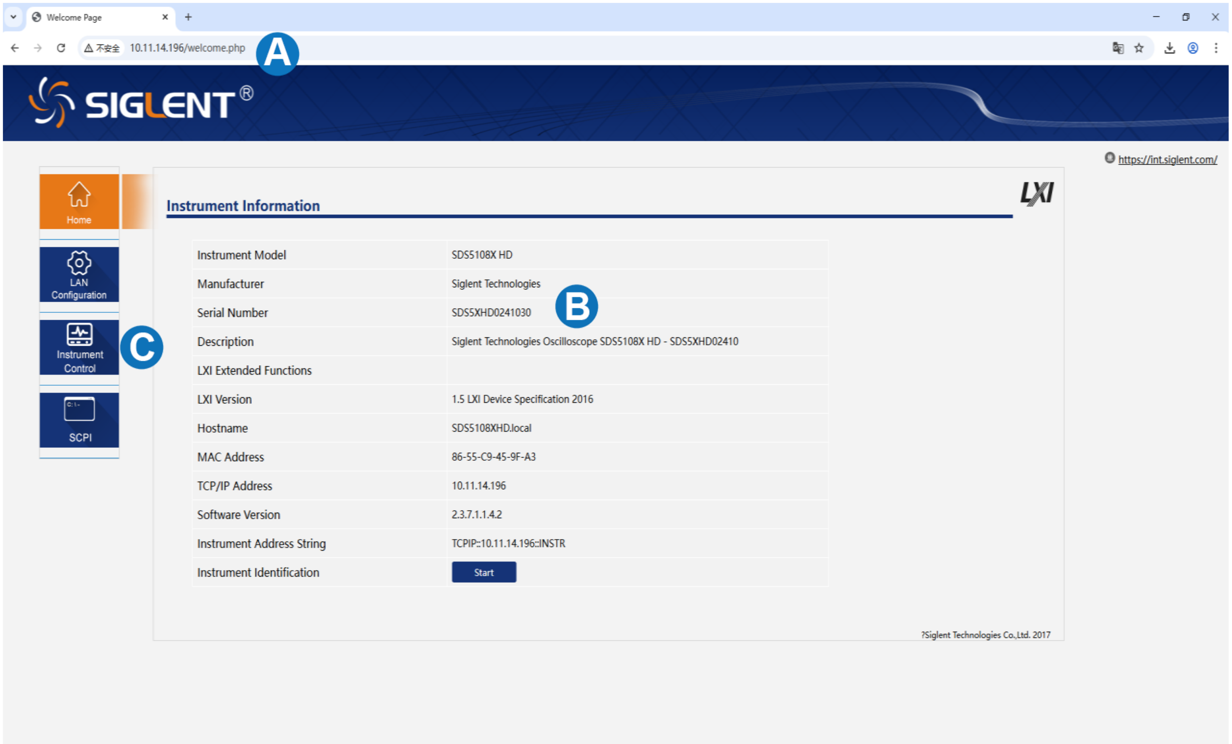
See the chapter “Digital Channels” for more information.

7 Remote Control

This device provides a LAN port and a USB Device port which can be used for remote control in multiple ways.

7.1 Web Browser

A built-in web server provides an approach to interact with the oscilloscope by a web browser. It doesn't require any additional software to be installed on the computer. Set the IP address of the oscilloscope in the browser address bar, and then the user can browse and control the oscilloscope on the web.

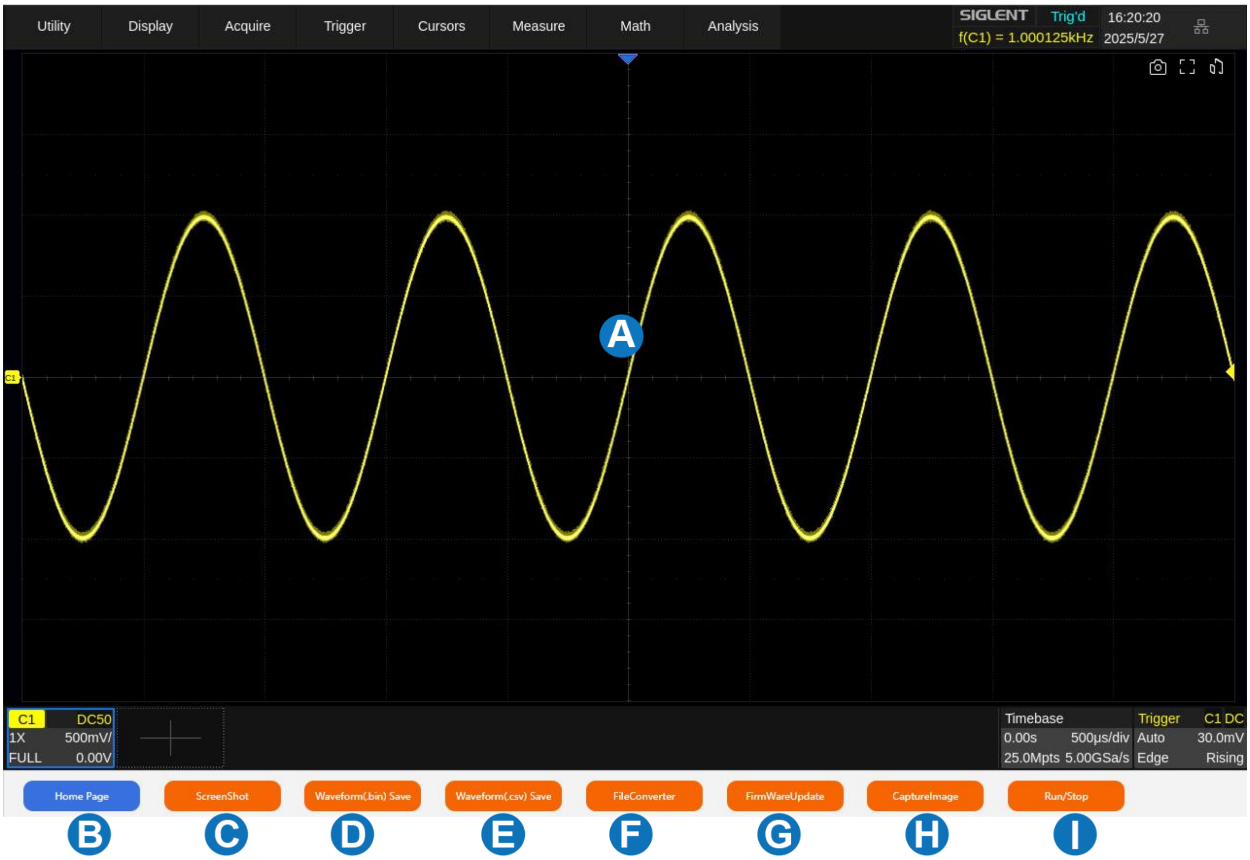


A. Input the IP address of the instrument

B. Instrument information

C. Click here to recall the instrument control interface

Below is the instrument control interface:



A. Display and control area of the instrument. The display in this area is a copy of the instrument display. Using the mouse to operate in the area is equivalent to directly operating on the display of the instrument

B. Click here to return to the homepage

C. Click here to perform a screenshot

D. Click here to save the waveform data as a bin file and download it to the local computer

E. Click here to save the waveform data as a CSV file and download it to the local computer

F. Click here to download the mini-tool for converting binary files to CSV

G. Click here to perform a firmware upgrade

H. Click to take a screenshot of the current screen, right-click the image to copy to clipboard or save

I. Start/stop acquisition, same as 

on the front panel

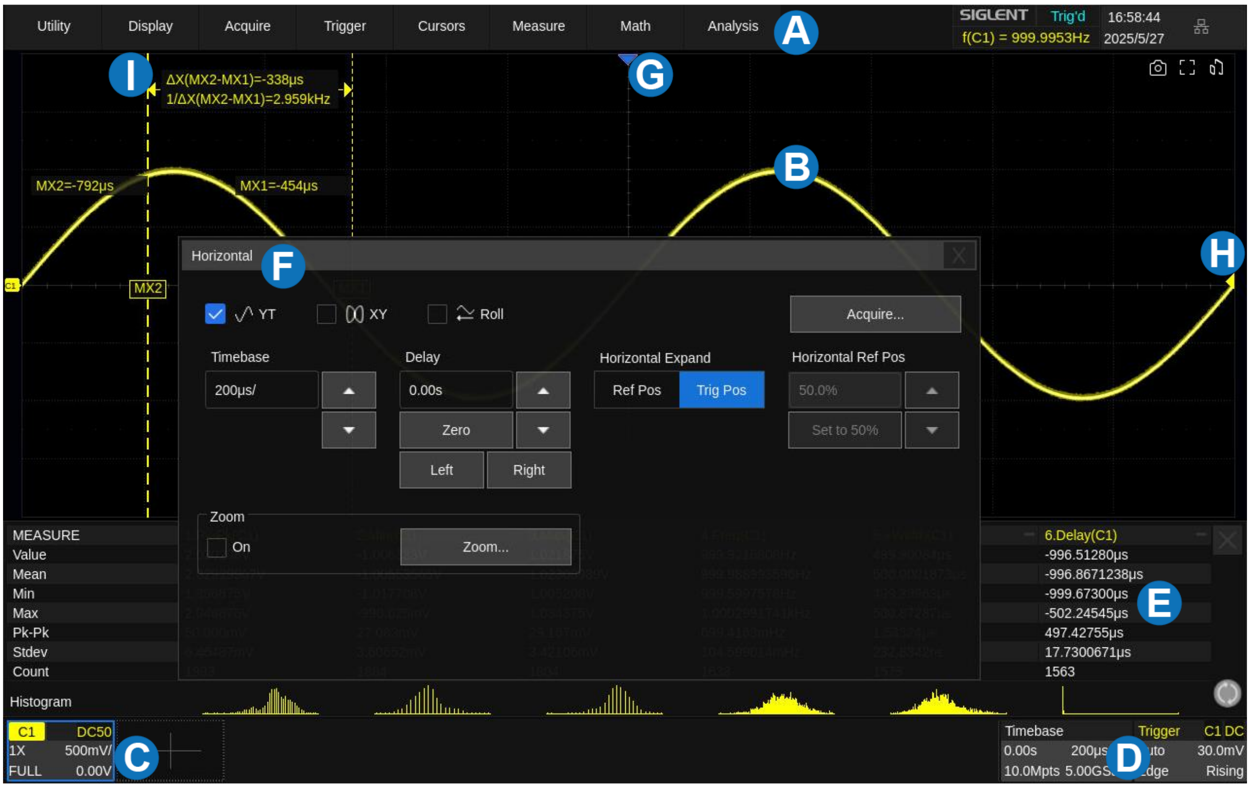
7.2 Other Connectivity

The device also supports remote control of the instrument by sending SCPI commands via NI-VISA, Telnet, or Socket. For more information, refer to the programming guide for this product.

8 Screen Display

8.1 Overview

The entire Oscilloscope display is a capacitive touch screen. Use your fingers to touch, drag, pinch, spread, or draw a selection box. Many controls that display information also work as “buttons” to access other functions. If you are using a mouse, you can click anywhere that you can touch to activate a control. You can alternate between clicking and touching the control, whichever is most convenient.



A. Menu Bar

B. Grid Area displays the waveform traces. Traces can be moved by dragging them

C. Channel Descriptor Boxes include analog channels (C1~C8), zoom traces (Z1~Z8), math traces (F1-F8), Memory traces (M1~M4) and digital channels (D) (Only SDS5000X HD) supported. They show the parameters of the corresponding traces. Clicking the boxes creates a dialog box

D. Timebase and Trigger Descriptor Boxes show the parameters of timebase and trigger respectively. Clicking the boxes creates a dialog box

E. Measurement parameter display area

F. Dialog Box is the main area to select the parameters for a chosen specific function

G. Trigger Delay Indicator locates where the trigger is on the horizontal axis

H. Trigger Level Indicator locates where the trigger is on the vertical axis

I. Cursors show where measurement points have been set

Channel Descriptor boxes include analog channels (Cx), zoom traces (Zx), digital channels (D), math (Fx), memory (Mx), and reference (Ref). They are located under the grid area, showing the parameters of the corresponding traces. Clicking the boxes creates a dialog box.

Timebase and Trigger Descriptor boxes show the parameters of the timebase and trigger respectively. Clicking the boxes creates a dialog box for the selected item.

Trigger Delay Indicator (Vertical) and **Trigger Level Line** (Horizontal) show the trigger position of the waveform.

Cursors show where measurement points have been set. Move the cursors to quickly reposition the measurement point.

The backlight of the display area is adjustable and can be adjusted through the following operations:

Display > *LCD*

8.2 Menu Bar

Menu bar with drop-down menus lets you access set-up dialogs and other functions. All functionality can be accessed through the menu bar. It is not necessary for common operations. You can enter most menus by using the front panel or parameter description labels instead of the menu bar. However, the following operations can only be accessed through the menu bar:

Utility > *Help*

Utility > *Reboot*

Analysis > *Mask Test*

Analysis > *DVM*

Analysis > *History*

Analysis > *Bode Plot*

Analysis > *Power Analysis*

Analysis > *Counter*

Analysis > *Double Pulse Test*

Analysis > *Three Phase Electrical Analysis*

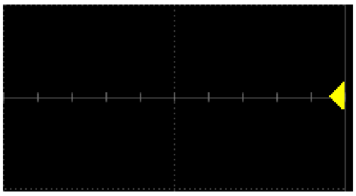
8.3 Grid Area

The grid area displays the waveform traces. Traces can be moved by the mouse. The area is divided into 8 (vertical) * 10 (horizontal) grids. The best display effect can be obtained by adjusting the waveform intensity and graticule. Follow the steps below to set these parameters:

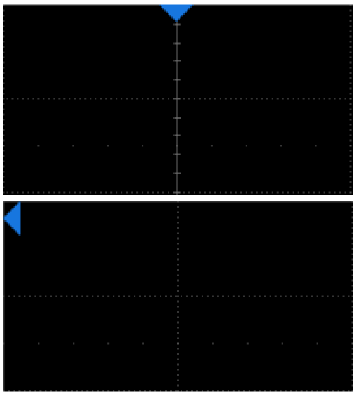
Display > *Intensity* ,

Display > *Griticule*

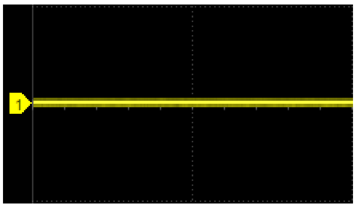
There are multiple indicators on the grid:



Trigger Level Indicator shows the level where the waveform triggers on the vertical axis.



Trigger Delay Indicator locates where the waveform triggers on the horizontal axis. When the trigger position is outside the screen, the direction of the triangle changes to point outside the screen.



Channel Offset Indicator with a channel number shows the offset position of the corresponding channel.

8.4 Channel Descriptor Box

Channel Descriptor boxes include analog channels (Cx), zoom traces (Zx), digital channels (D), math (Fx), memory (Mx), and reference (Ref). They are located under the grid area, showing the parameters of the corresponding traces. Clicking the boxes creates a dialog box. See the chapter “Vertical Setup” for more details. Below is an example for analog channel 1:

A. Channel Index
B. Coupling and Input Impedance
C. Vertical Scale
D. Vertical Offset
E. Bandwidth Information
F. Probe Attenuation Factor

Bandwidth Information:

The bandwidth information is indicated by the following icons:

20M : 20 MHz bandwidth limit

200M : 200 MHz bandwidth limit

FULL : Full bandwidth

Invert Indicator: shows that the current channel is inverted:

I : Invert has been turned on

None: Invert has been turned off

Coupling and Input Impedance:

DC1M : DC coupling, 1 MΩ impedance

DC50 : DC coupling, 50 Ω impedance

AC1M : AC coupling, 1 MΩ impedance

DC50 : AC coupling, 50 Ω impedance

GND : Ground

Vertical Scale: The scale of each grid in the vertical direction. For example, when the vertical scale is 1.00 V/div, the full scale of the oscilloscope is 1.00 V/div * 8 div=8 V.

Vertical Offset: The offset of the channel in the vertical direction. When the vertical offset is 0, the channel offset indicator is located in the middle of the vertical axis.

Probe Attenuation Factor: Set the probe attenuation factor to match the actual attenuation of the probe. The oscilloscope automatically calculates the vertical scale according to the probe attenuation factor. For example, the vertical scale of the oscilloscope is 100mV/div with 1X attenuation, and 1 V/div if the attenuation factor is changed to 10X. When inserting a standard 10X passive probe with a probe sense terminal, the oscilloscope will automatically set the factor to 10X.

1X : 1:1 attenuation, suitable for direct coaxial cable connection or passive probes with 1X attenuation

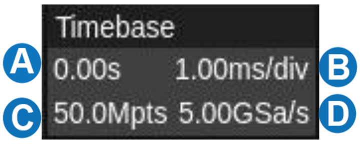
10X : 10:1 attenuation, suitable for general passive probes or active probes with 10X attenuation

100X : 100:1 attenuation, suitable for some high-voltage probes

 : Custom attenuation factor

8.5 Timebase and Trigger Descriptor Boxes

The Timebase Descriptor box shows the current parameters of the timebase. See the chapter “Horizontal and Acquisition Setup” for more information.



A. Trigger delay

B. Horizontal scale (timebase)

C. # Samples

D. Sample Rate

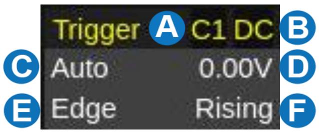
Trigger delay: The time offset of trigger position. When the trigger delay is 0, the trigger delay indicator is in the center of the horizontal axis of the grid area.

Horizontal scale: Timebase, the time of each grid in the horizontal direction. For example, if the scale is 500us/div, the time of each grid is 500 us, and the full-screen time range of the oscilloscope is 500 us/div * 10 div = 5 ms.

 # Samples: The number of sample points corresponding to one waveform frame.

Sample Rate: The current sample rate.

The Trigger Descriptor box shows the parameters of the trigger setting. See the chapter “Trigger” for detailed information.



A. Trigger source
B. Trigger coupling
C. Trigger mode
D. Trigger level
E. Trigger type
F. Trigger slope

Trigger source

C1~C8: Analog channels

EXT: External trigger channel

EXT/5: 5x attenuation of external trigger channel

AC Line: AC mains supply

D0~D15: Digital channels

Trigger coupling: Coupling mode of the current trigger source. It is only valid when the trigger source is C1~C8, EXT, or EXT/5.

DC: All the signal's frequency components are coupled to the trigger circuit for high-frequency bursts or where the use of AC coupling would shift the effective trigger level.

AC: The signal is capacitively coupled. DC levels are rejected. See the datasheet for details of the cut-off frequency.

HFR: Signals are DC coupled to the trigger circuit, and a low-pass filter network attenuates high frequencies (used for triggering on low frequencies). See the datasheet for details of the cut-off frequency.

LFR: The signal is coupled through a capacitive high-pass filter network, DC is rejected and low frequencies are attenuated. For stable triggering on medium to high-frequency signals. See the datasheet for details of the cut-off frequency.

Trigger mode

Auto: The oscilloscope will sweep without a set trigger. An internal timer triggers the sweep after a preset timeout period so that the display refreshes continuously. This is helpful when first analyzing unknown signals. Otherwise, Auto functions the same as Normal when a trigger condition is found.

Normal: Sweeps only if the input signal meets the trigger condition. Otherwise, it continues to display the last acquired waveform.

Single: Stops the acquisition and displays the last acquired waveform.

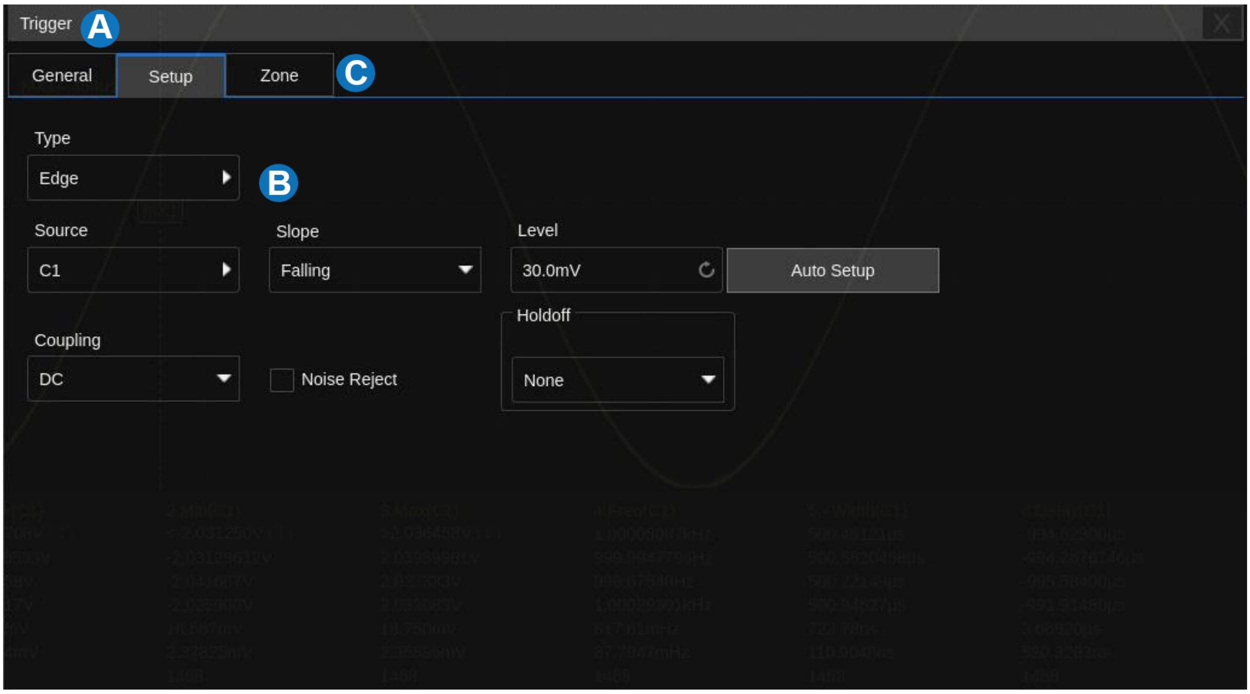
Force: Force an acquisition, regardless of whether the input signal meets the trigger conditions or not.

Trigger level: The source voltage level or levels that mark the threshold for the trigger to fire. Trigger levels specified in Volts normally remain unchanged when the vertical gain or offset is modified.

Trigger type: See the chapter "Trigger" for details.

8.6 Dialog Box

The dialog box is the main area for setting parameters for the selected function, and selecting the corresponding function will pop up.



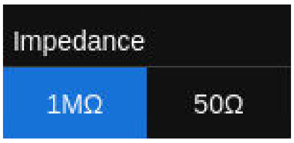
A. Title bar. The title of the dialog box varies depending on the selected function

B. Parameter setting area

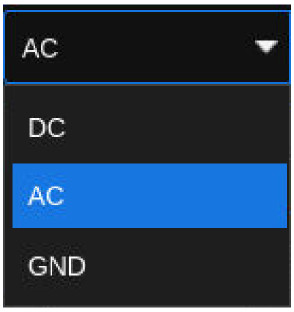
C. Tabs

To Set Parameters

Several different ways are provided to set parameters.



Switch -- Sets parameters with two states, such as to enable or disable a function. Click the switch region to change from one state to the other.



List -- Sets parameters with more than two options, such as the coupling mode of channels. Click the parameter region, and then select the expected option from the pop-up list.

Radio Button -- Switches between two optional parameters, such as enabling and disabling a specified function. Click on the radio button to switch.

Virtual Keypad -- Sets parameters with a numerical value. Click the parameter region, and the parameter can be adjusted by rolling the mouse wheel; click the region again, then the virtual keypad appears.

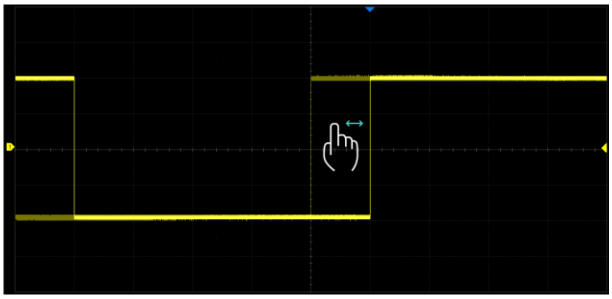
To use the operation of setting "deskew" of the channel as an example: If the expected value is 65 ns, input "65" on the virtual keypad, and then choose the unit n to complete the operation. On the virtual keypad, clicking the button Max , Min , and Default quickly sets the parameter to its maximum, minimum and default values.

Hide Dialog Box

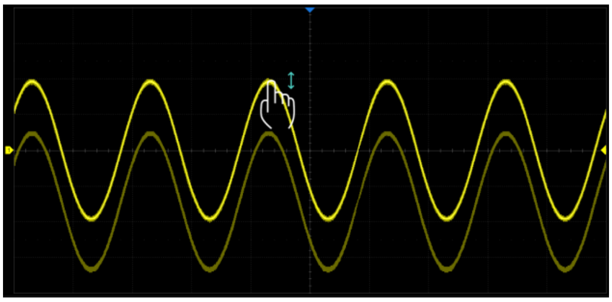
After setting the parameters, to achieve the best waveform display effect, click the X in the upper right corner to hide the dialog box.

8.7 Touch Gestures and Mouse Control

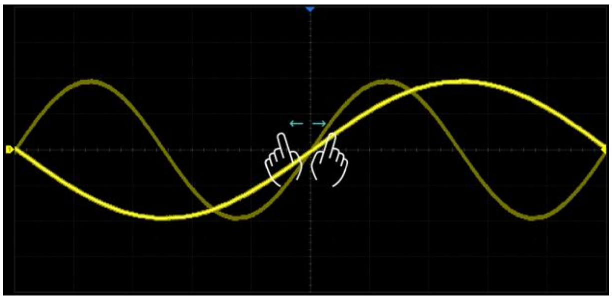
Waveforms, cursors, and trigger levels can be adjusted by touch gestures or using the mouse. It can also be used to define Zone Trigger areas as shown below:



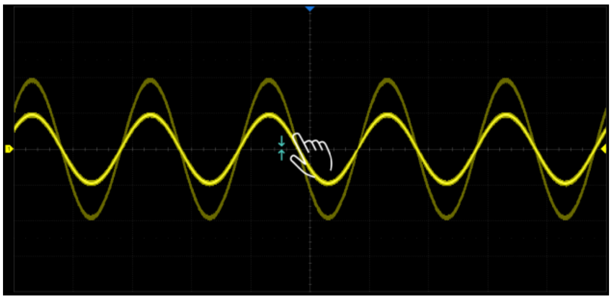
Drag the waveform left and right to move it on the horizontal axis



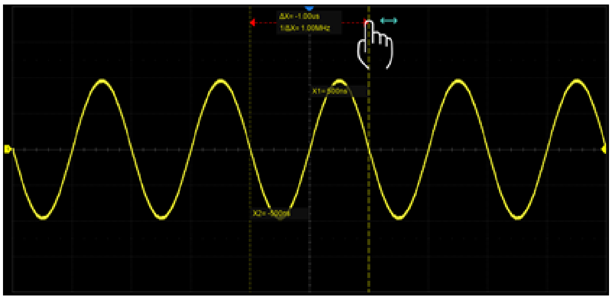
Drag the waveform up and down to move it on the vertical axis



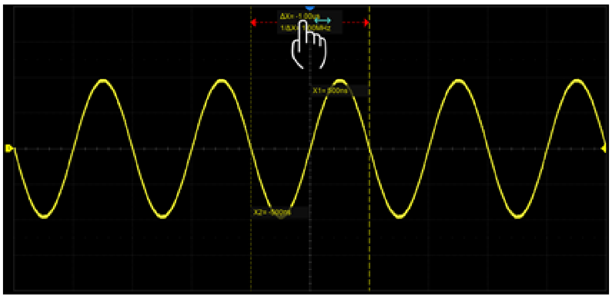
Pinch and spread the waveform horizontally to re-scale the timebase



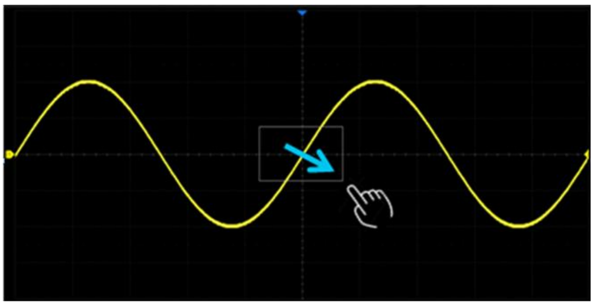
Pinch and spread the waveform vertically to re-scale the vertical gain



Click and drag the cursor to move it



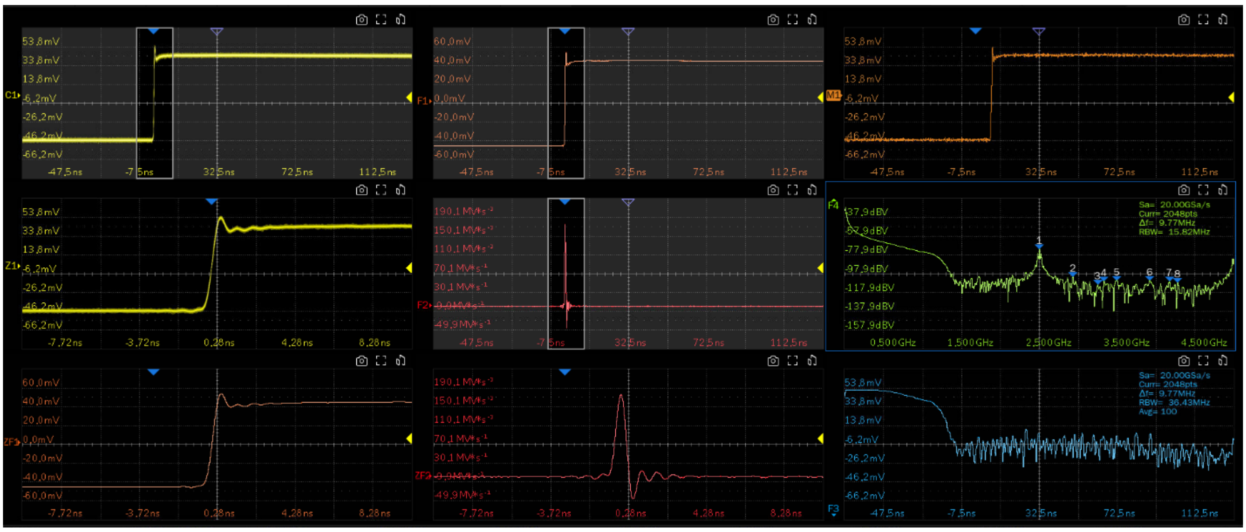
Click and drag the cursor information region to move the pair of cursors simultaneously



Draw a rectangular box to create a zone or a histogram region. At the beginning of the gesture keep the angle close to 45° so it can be recognized as the drawing box gesture

8.8 Multi-windows Display

The display screen of the device has a high-definition resolution of 1280 * 800, which can display more content on the screen. The device supports up to 9 windows on the touch screen display, and also supports an external display as an extension screen.



For more information on multi window settings, please refer to the "Window Layout Setting" section.

For details on the settings of external display screens, please refer to the "Multiple Displays Setting" section.

8.9 Mouse and Keyboard Operation

The user interface features mouse control as well as a touch screen. If the oscilloscope is connected to a USB mouse, you can click on the object with the mouse instead of touching the object. Similarly, if a USB keyboard is connected, you can use the keyboard to input characters instead of using the virtual keyboard.

8.10 Choosing the Language

Follow *Utility* > *Menu* > *System* > *Language* to choose the language. See the section " Language " for details.

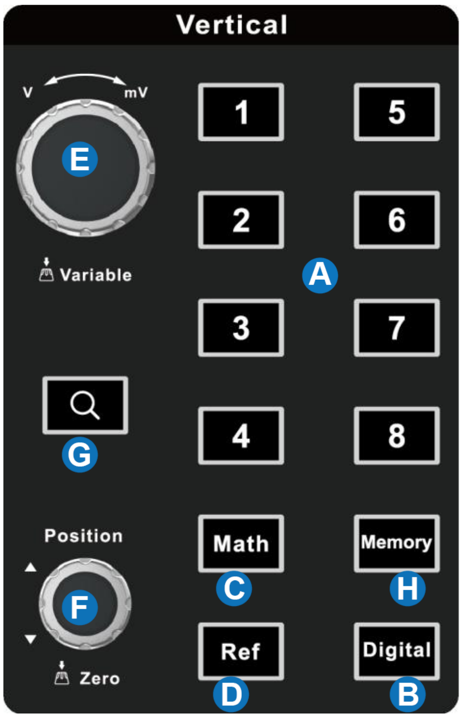
9 Front Panel

9.1 Overview

The front panel is designed to operate the basic functions without having to open the software menu. Most of the front panel controls duplicate functionality available through the touch screen display but the operation is more quickly achieved.

All the knobs on the front panel are multi-function. They can be pushed as well as rotated. Pushing a knob quickly recalls a specific function, which is indicated by the silkscreen near the knob

9.2 Vertical Control



A. When a channel is disabled, push its channel button to turn it on. When a channel is turned on but not activated, push the button to activate it. When the channel is turned on and activated, push the button to disable it

B. Press the button to turn on the digital channel. Press again to turn off the digital channels

C. Press the button to turn on the math function. Press again to turn off the math function.

D. Press the button to turn on the Ref waveform function. Press again to turn off the Ref waveform function.

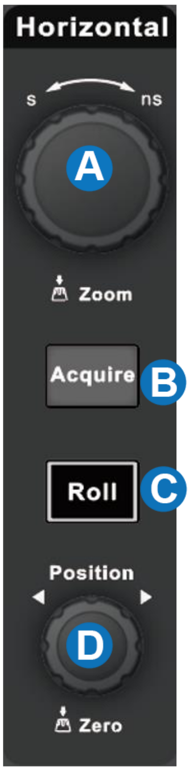
E. Analog channels (C1-C8), digital channels (D), math (F1-F8), Ref waveform (RefA-RefH) and memory waveform (M1~M4) share the same vertical knob. Rotate the knob to adjust the vertical scale (volt/div) of the activated trace. Push to alternate between coarse and fine adjustments. When the digital channel is active, rotate the knob to change the selected digital channel.

F. Analog channels (C1-C8), digital channels (D), math (F1-F8), Ref waveform (RefA-RefH) and memory waveform (M1~M4) share the same offset knob. Rotate the knob to adjust the DC offset or vertical position of the activated trace. Push to set the offset to zero. When the digital channel is active, rotate the knob to change the position of the selected digital channel.

G. Push to enable Zoom. Push again to exit Zoom mode.

H. Press the button once to turn on the memory waveform function. Press again to turn off the memory waveform function.

9.3 Horizontal Control



A. Rotate the knob to change the horizontal gear (Timebase, Time/div); Press to turn on Zoom, and the oscilloscope will automatically open a window displaying Zoom waveforms.

B. Press the button to open the Acquire function

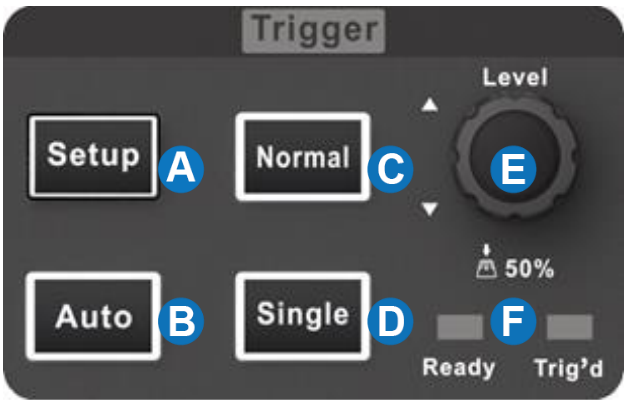
C. Press the button to enter the Roll mode of the oscilloscope. Press again to exit Roll mode

D. Rotate to change the level trigger delay; Press this knob to reset the horizontal trigger delay to zero.

Note:

At certain very high time bases (≥ 50ms/div), it is recommended that the oscilloscope adopt a rolling working mode to collect signals for a long time without delaying the display on the screen.

9.4 Trigger Control



A. Opens the trigger setup dialog box

B. Auto mode: Triggers after a preset period if no valid trigger occurs

C. Normal mode: Triggers repeatedly when all conditions are met

D. Single mode: Triggers once when all conditions are met

E. Trigger level adjustment: Push to set the level to 50% of the waveform

F. Trigger status LED, Ready and Trig'd

9.5 Cursors Control

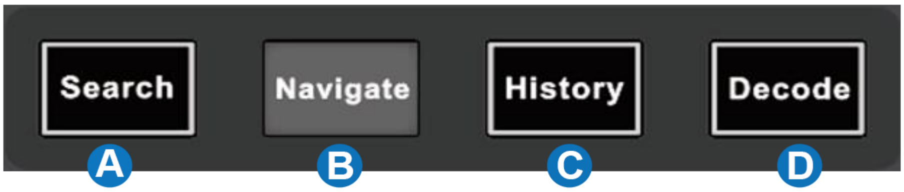
A. Press the button to open the cursors setup dialog box

B. Rotate the knob to move the selected cursor; push to select a different cursor

9.6 Universal Knob

When the parameter setting area is highlighted, the Universal Knob A can be used to adjust the parameter. Press the knob to select an option from the list. The default function of the Universal Knob is to adjust the intensity of the waveform traces.

9.7 Common Functions



A. Press the button to enable the Search function and open the search settings dialog box. Press again to turn off the Search function

B. Press the button to enable the Navigate function and open the navigate settings dialog box. Press again to turn off the Navigate function.

C. Press this button to enable the History mode and open the history settings dialog box. Press again to turn off the History mode.

D. Press the button to enable the Decod function and open the decod settings dialog box. Press again to turn off the Decode function.

9.8 Other Buttons

Press this button to start the acquisition, and the green light will be on at this time; Press this button again to stop the collection, and the red light will be on.

Automatically set time base, trigger, and vertical gear, displaying various repetitive signals. An Auto Setup operation can also be performed by following the steps *Acquire* > *Auto Setup*.

Resets the oscilloscope to the default configuration. When pressing this button, the oscilloscope will prompt whether to continue. Click on "Continue" on the screen or press the button again will execute the operation.

Enables/Disables the touch screen. The LED on the button lights to indicate that the touch screen is working.

Clears the data or displays in multiple sweeps, including display persistence, measurement statistics, average sweeps, and Pass/Fail statistics.

When connecting to external storage, images can be stored in the set format using this shortcut key . Supported format types .bmp\.jpg\.png。

Press the button to activate the Measure function and display the *Measure* settings dialog box. Press again to turn off the measurement function.

Recalls the *Wave Gen...* dialog box. The LED on the button lights to indicate the output of the AWG is enabled.

Press the button to recall the *Display* dialog box. The second press turns on Persist and lights the button. Press the button again to turn off Persist.

Press the button to recall the *Save/Recall* dialog box.

Press the button to recall the *Utility* dialog box.

10 Multiple Approaches to Recall Functions

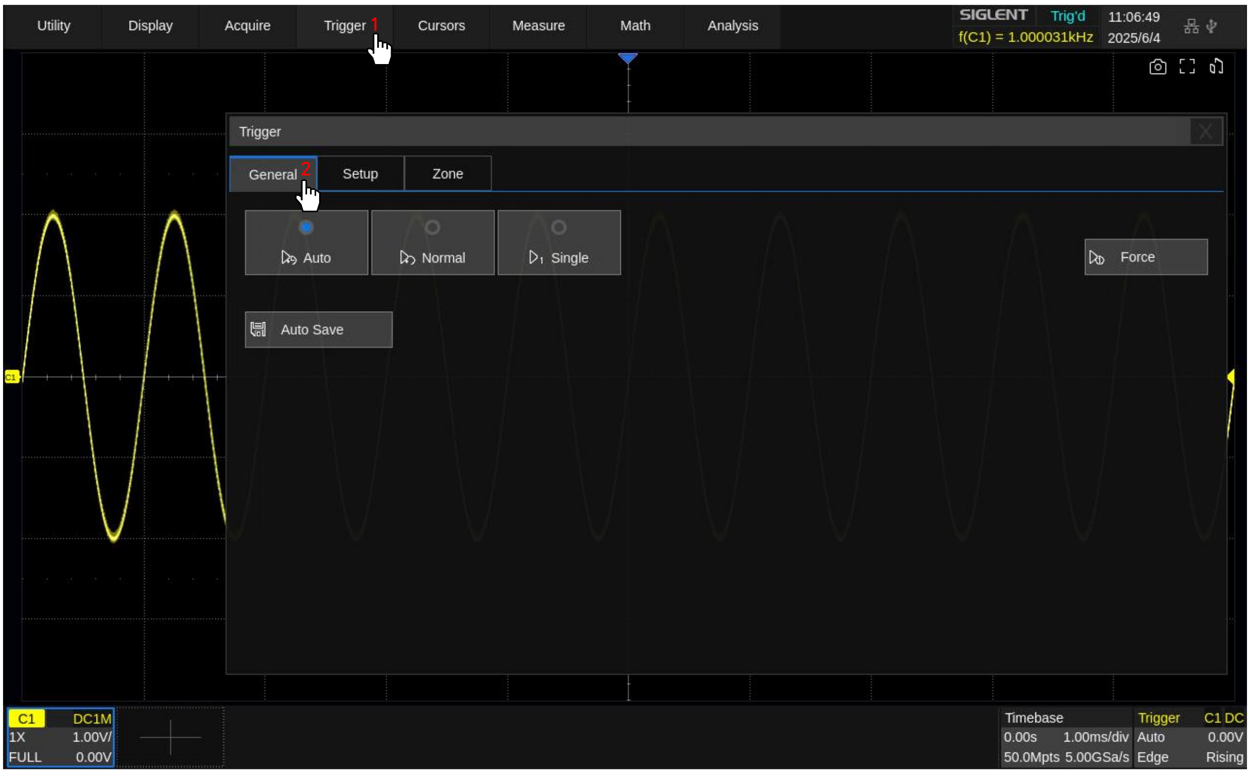
The oscilloscope can recall functions through different approaches.

10.1 Menu Bar

If you are familiar with common computer programs, you may first choose to access a function by the drop-down menu from the menu bar at the top of the display.

For example, to open the trigger setup dialog box, you can follow the steps below:

Trigger > *General*



The operations can be completed either by touch or by mouse clicks.

10.2 Descriptor Box

For the setup of channels, timebase(horizontal), and trigger, etc, there are dialog boxes at the bottom of the display. For the introduction of the descriptor box, see sections "Channel Descriptor Box" and "Timebase and Trigger Descriptor Boxes".

For the example above, click the trigger descriptor box and the trigger setup dialog box will be activated.

10.3 Shortcut Button on the Front Panel

Most of the functions of the oscilloscope can be recalled directly by the shortcut buttons on the front panel. See the chapter “Front Panel” for details.

To open the trigger setup dialog box, press the Setup button in the trigger control area on the front panel.

11 Quickly Capture the Signal

This is an example of how to acquire a signal quickly. In this example, we assume the signal is connected to channel 1 and channel 1 is turned off.

First, press the channel 1 button to turn on channel 1. The LED on the button lights and the descriptor box of channel 1 is displayed at the bottom of the screen.

Second, press the Auto Setup button. The oscilloscope will automatically adjust the vertical scale, horizontal scale, and trigger level according to the input signal to get an optimum waveform display.

Auto Setup will not work on all signal types, especially time-varying bursts or slow signals (<100 Hz). If Auto Setup cannot achieve desired settings, manually adjustment of the vertical, horizontal, and trigger systems is preferred. See the chapters "Vertical Setup", "Horizontal and Acquisition Setup" and "Trigger" for details.

12 Vertical Setup

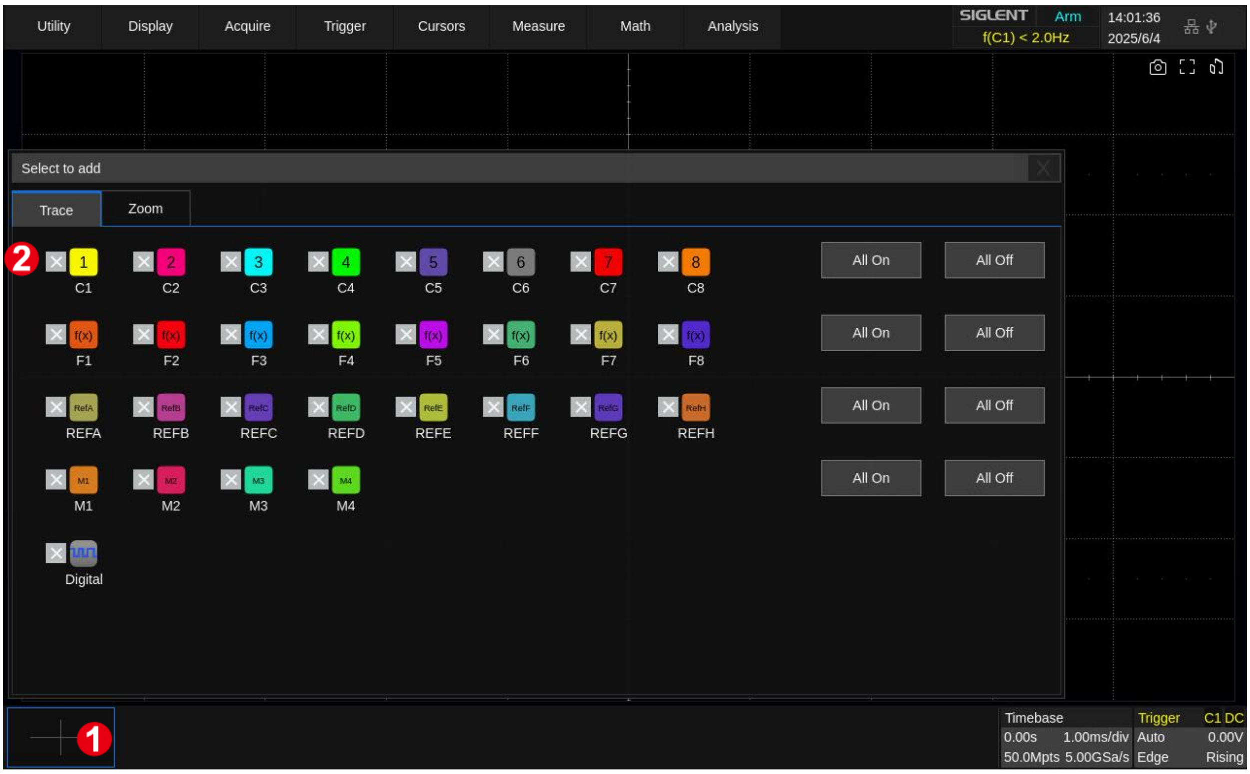
12.1 Turn on/off a Channel

From the Front Panel

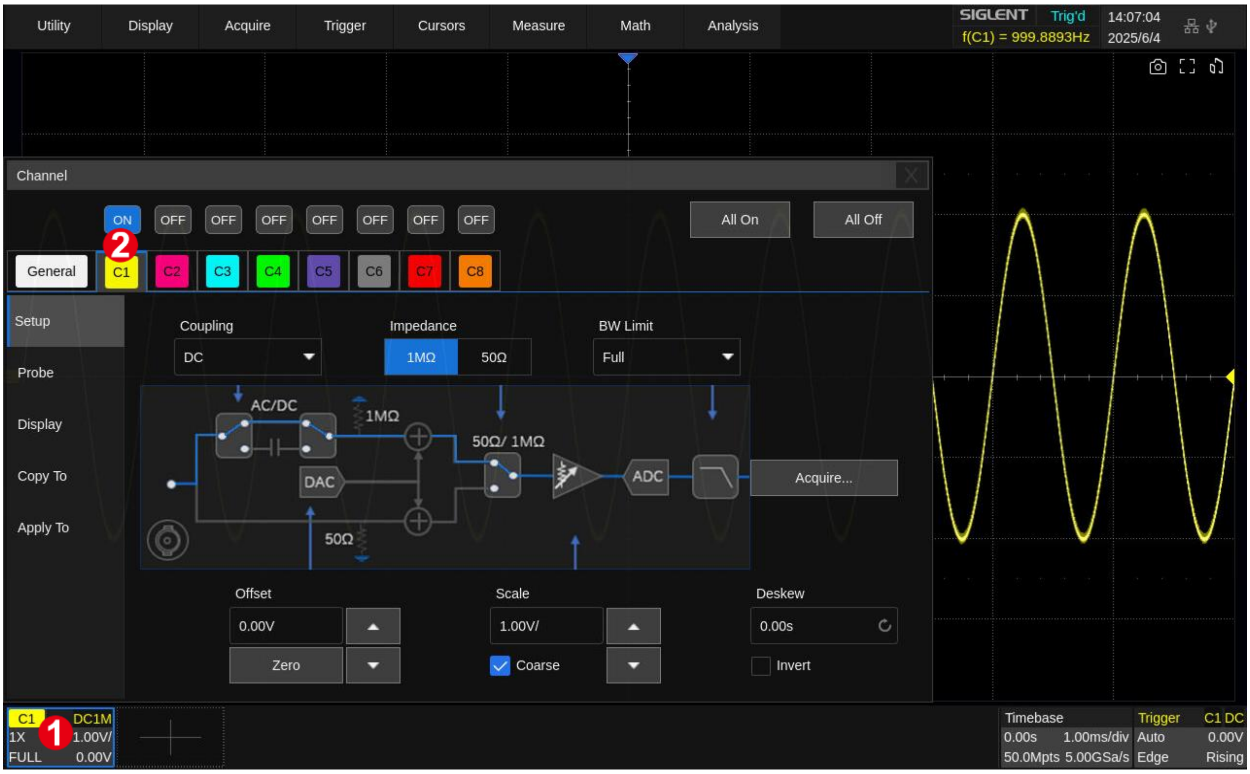
For the SDS5000X HD users can push the channel button (1-8, Digital, Math, Ref) to turn on the corresponding channel. If a channel is already on but not activated, push the button to activate it. If a channel is already on and activated, push the same button again to disable the channel.

From the Touch Screen

Click the *+* button and then select the expected channel to turn it on, click again to turn off. Click the channel descriptor box and then click the *ON/OFF* in the dialog box.



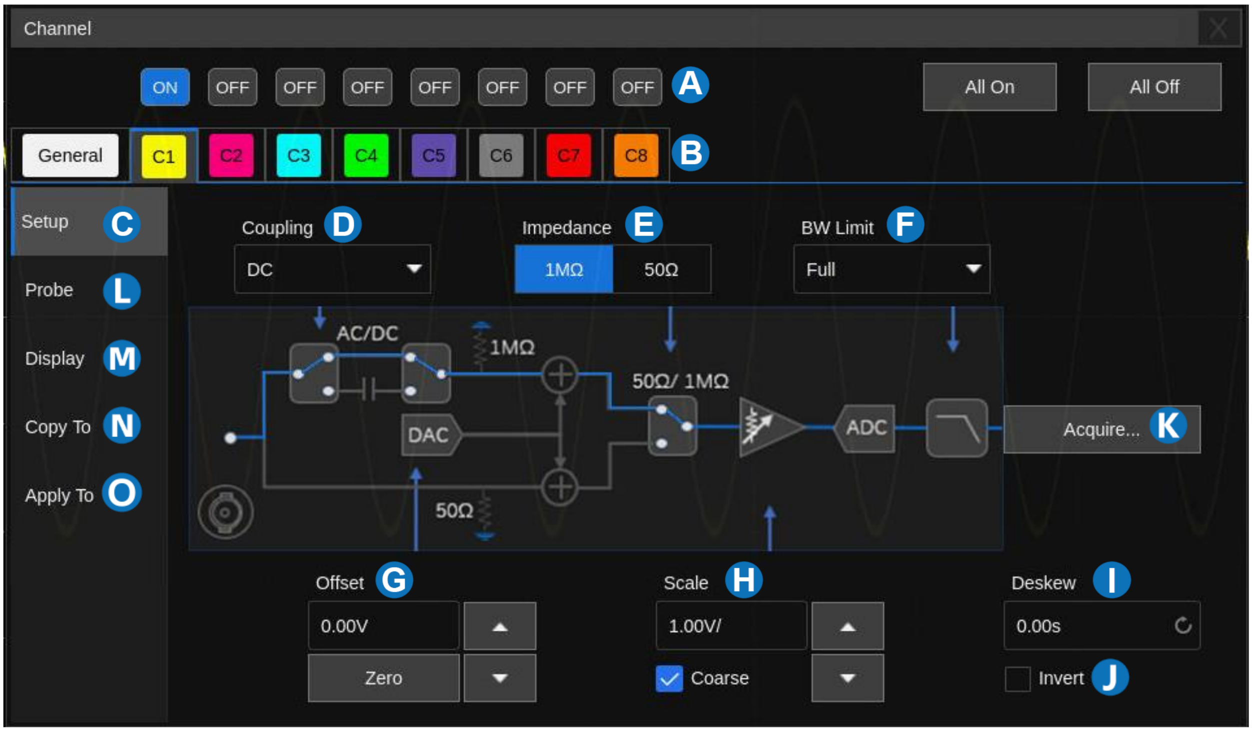
Turn on C1



Turn off C1

12.2 Channel Setup

Click the channel descriptor box to open the channel settings dialog box:



A. Turn channel on/off. Click *All On/All Off* to turn on/off all channels

B. Tabs. Vertical expand strategy can be set on the General tab; Corresponding channel parameters can be set on the channel tab

C. Basic channel settings

D. Coupling (DC, AC, or GND)

E. Impedance

F. Bandwidth limit (Full, 200 MHz, or 20 MHz)

G. Click the region to set the offset with the mouse wheel or virtual keypad. ▲ to increase the offset and ▼ to decrease. The SDS5000X HD can also be set through the vertical offset knob; Click *Zero* to set the offset to zero

H. Click the region to set the vertical scale with the mouse wheel or virtual keypad. ▲ to increase the vertical scale and ▼ to decrease. The SDS5000X HD can also be set through the vertical scale knob. Check to coarsely adjust the vertical scale and uncheck to enable fine adjustment

I. Deskew

J. Enable/disable invert

K. Open the Acquire Settings dialog box

L. Channel probe settings. Set probe attenuation ratio (1X, 10X, 100X or custom)

M. Channel display settings. Set channel units, labels, trace visible/hidden

N. Copy the setting of the current channel to another channel

O. Quickly select the current channel as the source of a specified operation (Trigger, FFT, Measure, Cursor, Search, DVM, and Counter)

Coupling

DC: All of the input signal frequency components are passed to the display.

AC: The signal is capacitively coupled. DC signal components are rejected. See the datasheet for details of the cut-off frequency.AC coupling is suitable for observing AC signals with DC offset, such as power ripple.

GND: The channel is grounded by an internal switch. GND coupling is used to observe the zero-offset error of the analog channels or determine the source of noise in the waveform (from the signal or from the oscilloscope itself)

Impedance

1 MΩ: When a passive probe with high impedance is connected, the impedance must be set to 1 MΩ, otherwise the signal will not be detected.

50 Ω: Suitable for high-frequency signals transmitted through 50 Ω coaxial cables or active probes.

This can minimize the amplitude distortion caused by impedance mismatching.

Bandwidth Limit

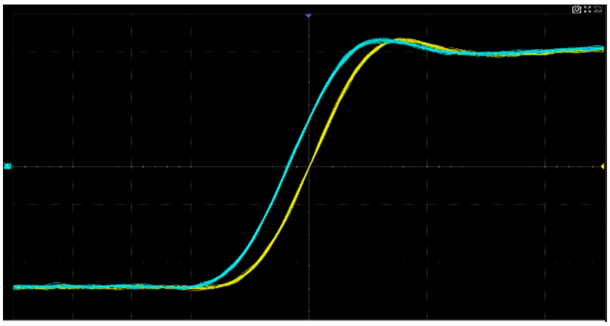
Full bandwidth passes through signals with high-frequency components, but it also means that noise with high-frequency components can pass through. When the frequency component of the signal is very low, better signal-to-noise ratios (SNR) can be obtained by turning on a bandwidth limit. This device the provides two hardware bandwidth limit options: 20 MHz and 200 MHz.

	Note: When Bandwidth Limit is turned on, the waveform refresh rate of the oscilloscope will be reduced.

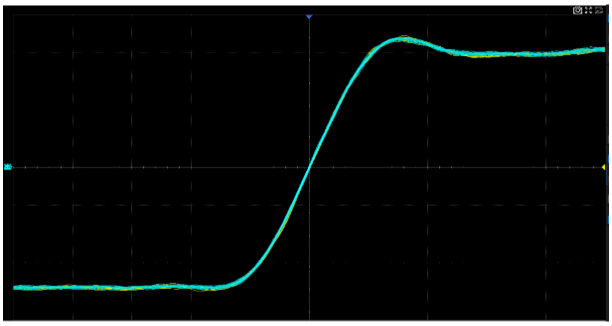
Deskew

Due to the skew between channels, cables, or probes, the delay of signals passing through different measurement paths may be inconsistent. For example, two coaxial cables with a 1-inch difference in length could introduce a skew of more than 100 ps. In some scenarios (e.g. measuring the setup/hold time between the clock and data), it may be necessary to compensate for the skew between channels.

The method of compensation: Probe the same signal simultaneously using two channels (including the cables or probes that you intend to use for measurements) and adjust the deskew parameter of one channel until the waveforms of the two channels observed on the screen coincide horizontally.



Before deskew

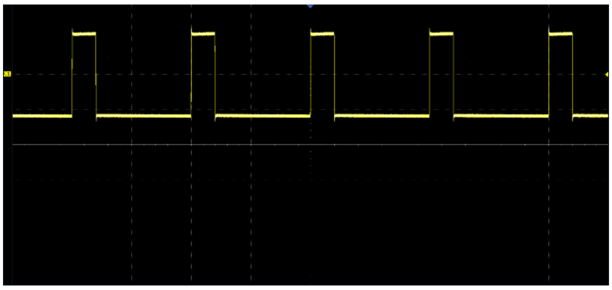


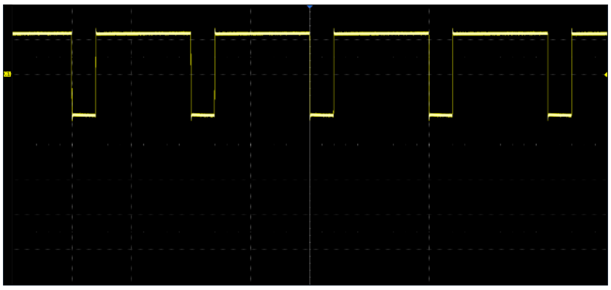
After deskew

	Note: When the channel with delay compensation is the trigger source, the trigger delay indicator will not change at any time when the deskew value changes.

Invert

When invert is enabled, the waveform is rotated 180 degrees around earth potential (0 Volts).


Before invert

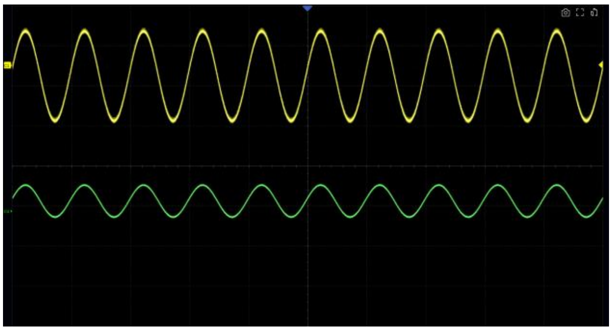

After invert

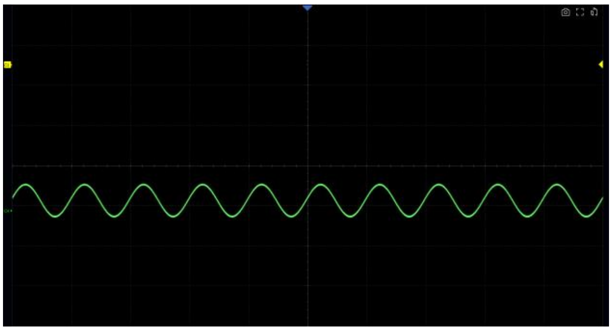
Probe Settings

The device provides 1X, 10X, 100X, and custom probe attenuation factor options. The custom values can be between 10^{-6}~10^{6}. The oscilloscope will automatically convert the vertical scale according to the current probe attenuation factor. For example, the vertical scale of the oscilloscope under 1X attenuation is 100 mV/div, and the vertical scale will be automatically set to 1 V/div if the probe attenuation is changed to 10X. If a standard probe with a readout terminal is connected, the oscilloscope will automatically set the probe attenuation to match the probe.

Trace

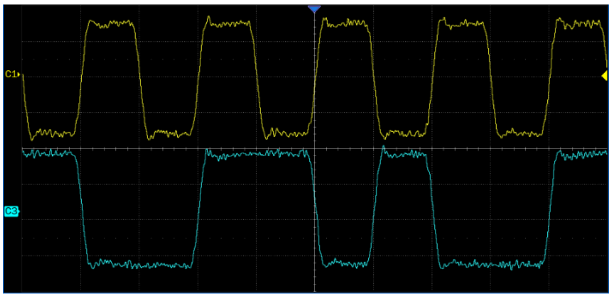
When the trace is hidden, the channel waveform is no longer displayed on the screen, while the acquisition is still running in the background.


Trace visible

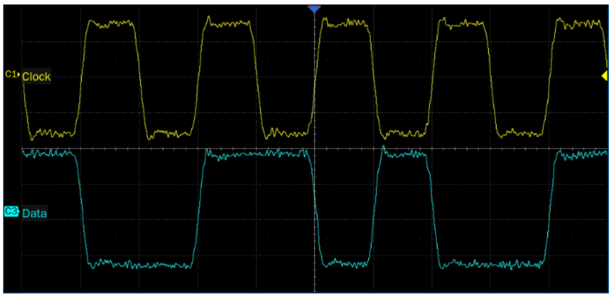

Trace hidden

Label

Users can set the label text for channels. Open the channel setting dialog box to customize the label text, and set the display. The length of the label is limited to 128 characters. The characters beyond this length will not be displayed. When enable the label, it will be displayed on the right side of the channel offset indicator.



The labels are hidden



The labels are displayed

Unit

Voltage unit "V" or current unit "A”. When using the current probe, the unit should be set to "A".

Apply to

With this setting, some common functions such as Measure, FFT, Search, DVM, Histogram, and Mask Test can be quickly applied to the selected channel. Once a function is specified, it will switch directly to the function menu and automatically set that channel as the source.

Vertical Expand

Set the strategy for the offset value change in the vertical direction when the vertical scale is changed.

- Center: When the vertical scale is changed, the vertical offset remains fixed. As the vertical scale is changed, the waveform expands/contracts around the main X-axis of the display
- Offset: When the vertical scale is changed, the vertical offset remains fixed to the grid position on the display. As the vertical scale is changed, the waveform expands/contracts around the position of the vertical position on the display.

13 Digital Channels

13.1 Overview

SPL2016 Probe

The SPL2016 is a logic probe designed to monitor up to 16 digital signals at once. The 16 digital channels are separated into two groups and each group has its threshold, making it possible to simultaneously view data from different logic families.

⚠	To avoid personal injury or damage to the logic probe and any associated equipment, the following safety precautions should be noted.

The equipment shall be used only for the purposes specified by the manufacturer. The SPL2016 probe is used only for SIGLENT's special series of oscilloscopes. Protection mechanisms can be compromised if the way the devices connected by the SPL2016 are not used for their intended purpose.

Connect and disconnect correctly. Excessive bending can damage the cable.

Do not use equipment in humid or explosive environments.

Only used indoors. The SPL2016 is designed to be used indoors and should only be operated in a clean, dry environment.

Do not use the equipment when you suspect a problem. Do not use the SPL2016 if any parts are damaged. Maintenance work shall be performed by maintenance personnel with appropriate qualifications.

Keep product surface clean and dry.

The digital channels of the oscilloscope supports the following functions:

Digital channel acquisition and analysis -- Acquire and analyze the signals connected to the digital logic probe, including waveform display, save, parameter measurement, etc.

Trigger on a digital channel -- Trigger with the digital channel as the trigger source, isolating events of interest.

Decode on a digital channel -- Serial protocol decoding of a digital channel requires the installation of the serial decode option.

13.2 Enable/Disable the Digital Channels

Turning on or off the digital channels is similar to analog channels. Digital data can be stored as waveform files. Horizontal cursors and most horizontal measurements also apply to digital waveforms.

A. Digital channel waveform display, which shares the same grid area with the analog channels.

B. Digital channel descriptor box

C. Digital channel indicators. Up to 16 digital channels are organized in two groups with different thresholds: D15~D8 and D7~D0. Every channel can be turned on or off individually.

D. Labels can be set to data, address, or custom characters.

Click + at the bottom of the display and select the "Digital" to turn it on. Click the digital channel descriptor box, and select *Off* on the dialog box to turn it off. Refer to the operation in the chapter "Vertical Setup" for details.

13.3 Digital Channel Setup

Click the digital descriptor box to open the dialog box:

A. Turn on/off the digital channels

B. Set the channels to be displayed. Click *All On/All Off* to turn on/off all digital channel

C. Logic threshold of D7~D0 and D15~D8. The oscilloscope will automatically set the threshold according to the specified logic family, or the user can set the threshold manually using the Custom option

D. Upper position limit of the digital channel display area. Use the mouse wheel or virtual keypad to set it. Decrease the height to provide more adjustment area. ▲ to increase position and ▼ to decrease the channel location. Click *Reset* to set the position to the default value

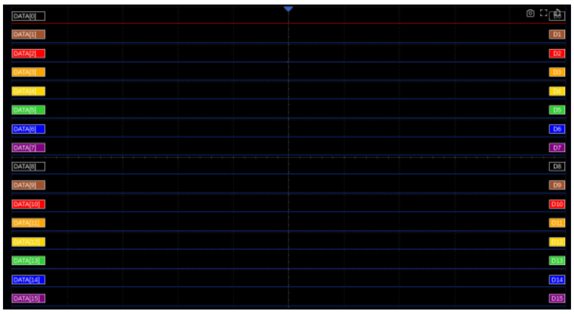
E. The range in height of the digital channels displays area. Use the mouse wheel or virtual keypad to set it. If the display height covers all of the available divisions, there will not be room to adjust the position. ▲ to increase and ▼ to decrease the number of divisions occupied by the digital channels . Click *Reset* to set the height to the default value

F. Deskew setting, the same as setting analog channels

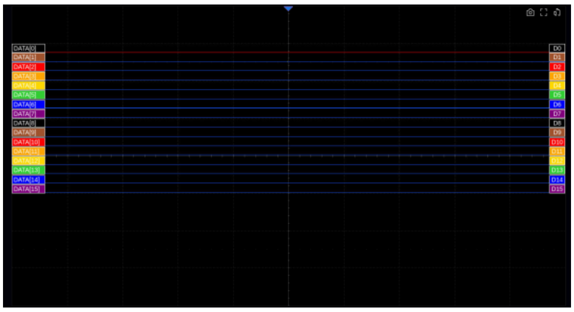
G. Adjust the display position of each digital channel, and set labels, etc

H. Bus1 setting

I. Bus2 setting



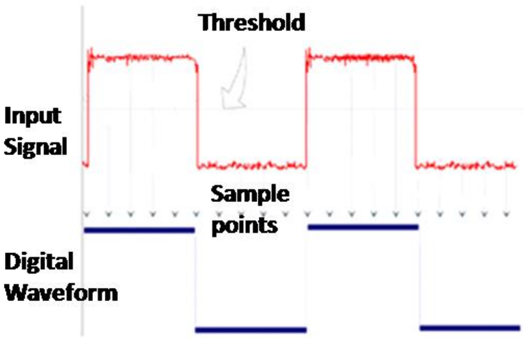
Height=8div, Position=0div

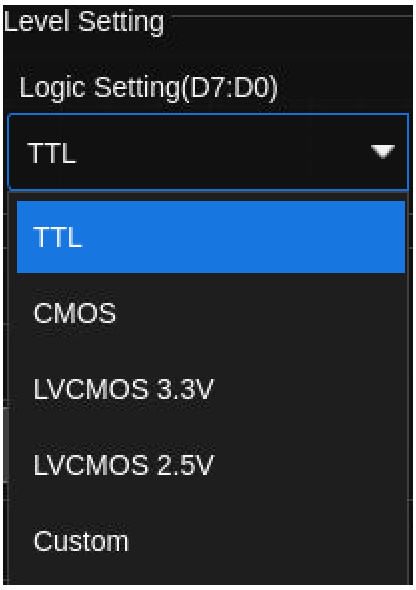


Height=4div, Position=1div

Logic Threshold Setting

The threshold level determines how the input signal is evaluated. The threshold level can be set in the *Level Setting* . The input voltage less than the threshold is recognized as a '0', and the input voltage greater than the threshold is recognized as a '1'.



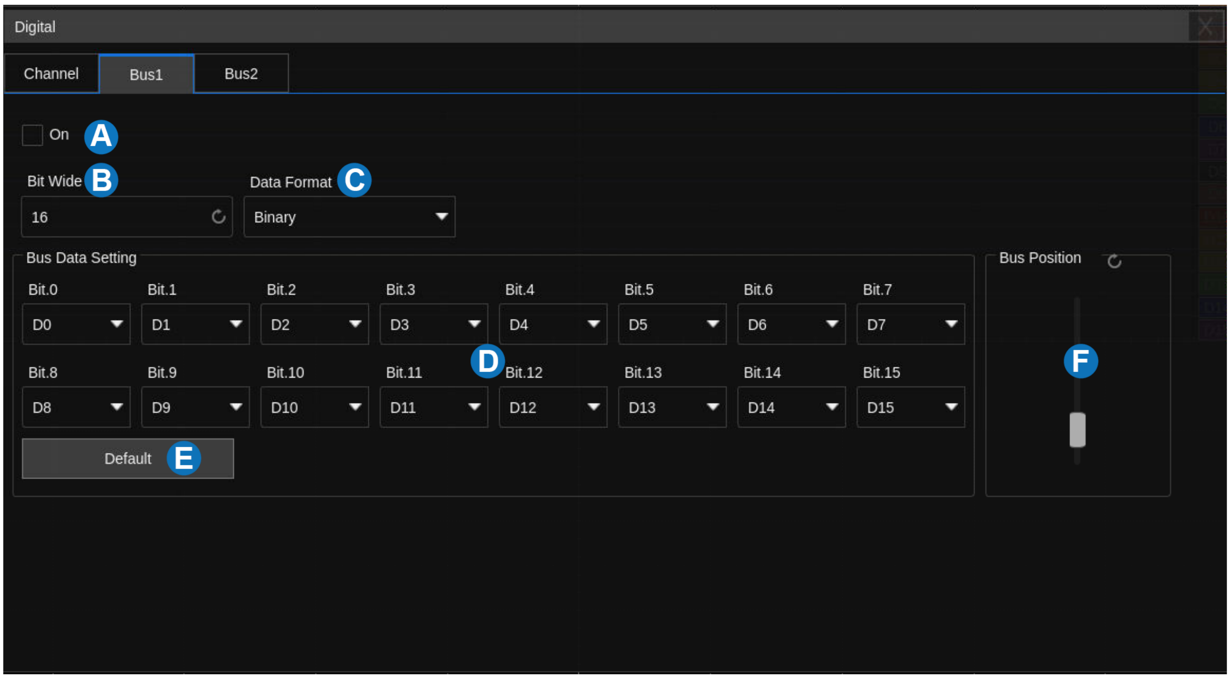


The configurable logical level includes TTL, CMOS, LVCMOS 3.3 V, LVCMOS 2.5 V, and Custom.

The setting range of the custom threshold is – 10.0 V to + 10.0 V.

Bus Setting

Switch the Tab to *Bus1* or *Bus2* to open the bus setting dialog box.



A. Turn on/off bus display

B. Set the bit width of the digital bus

C. Set the data format of the digital bus

D. Set the digital bus data

E. Reset the digital bus data to the default state

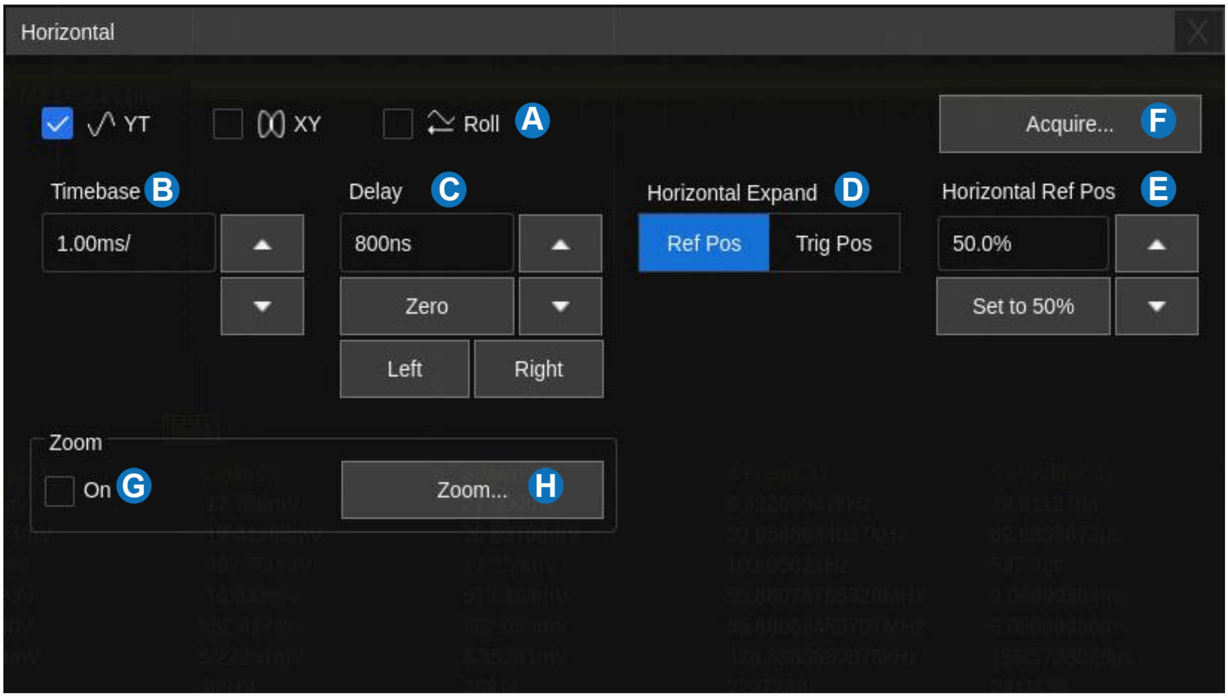
F. Set the vertical position of the bus

14 Horizontal and Acquisition Setup

14.1 Timebase Setup

The timebase setup is used to adjust the scale and offset of the X (horizontal) axis. This setting applies to all analog, and digital channels as well as all math traces except FFT.

Click the timebase descriptor box to open the Horizontal Settings dialog box:



A. Set horizontal mode (YT, XY, or Roll)

B. Set the horizontal scale (timebase) by the virtual keypad. ▲ to increase and ▼ to decrease the horizontal scale. The SDS5000X HD can also be set through the horizontal scale knob

C. Set the trigger delay by the virtual keypad. ▲ to increase and ▼ to decrease the trigger delay. SDS5000X HD can be set through the delay knob. Click *zero* to set the trigger delay to zero. Click *Left* to set the trigger point to the left part of the screen. Click *Right* to set the trigger point to the right part of the screen

D. Select horizontal expand strategy.

E. Set the horizontal reference position when the horizontal expand is "Ref Pos". Click the region to set with the virtual keypad. ▲ to increase and ▼ to decrease the horizontal reference position. Click *set to 50%* to set the horizontal reference position to 50%

F. Open the Acquire Settings dialog box

G. Turn on/off Zoom

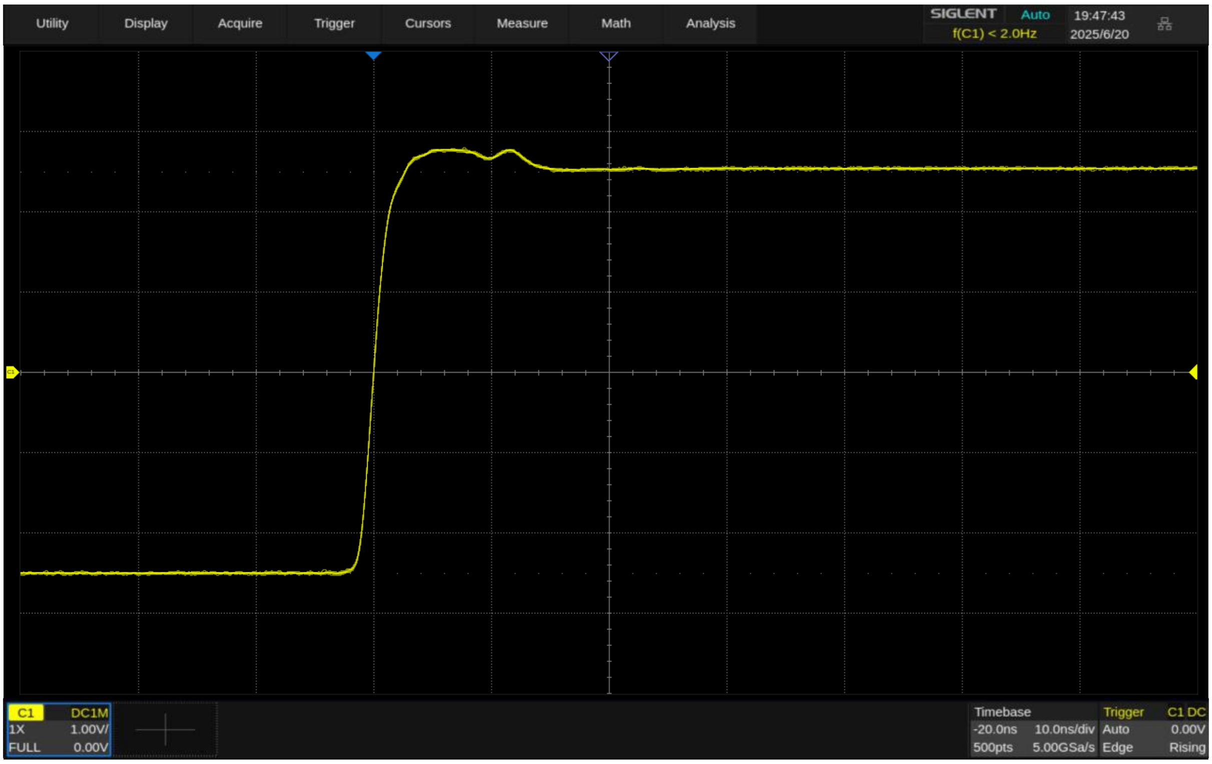
H. Open the Zoom dialog box

Horizontal Expand

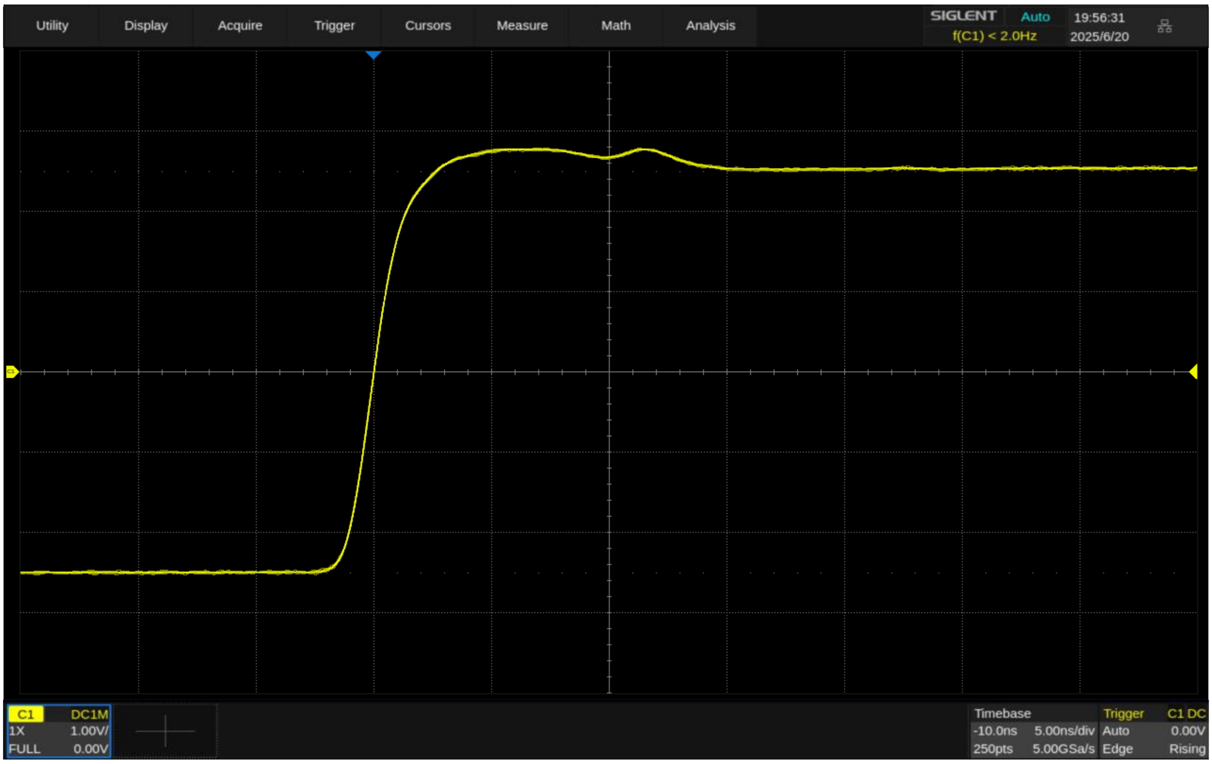
Set the strategy for the delay value change in the horizontal direction when the horizontal scale is changed.

- **Ref Pos** -- When the time base is changed, the horizontal delay value remains fixed. As the horizontal timebase scale is changed, the waveform expands/contracts around the center of the display.
- **Trig Pos** -- When the time base is changed, the horizontal delay remains fixed to the grid position on the display. As the horizontal timebase scale is changed, the waveform expands/contracts around the position of the horizontal display.

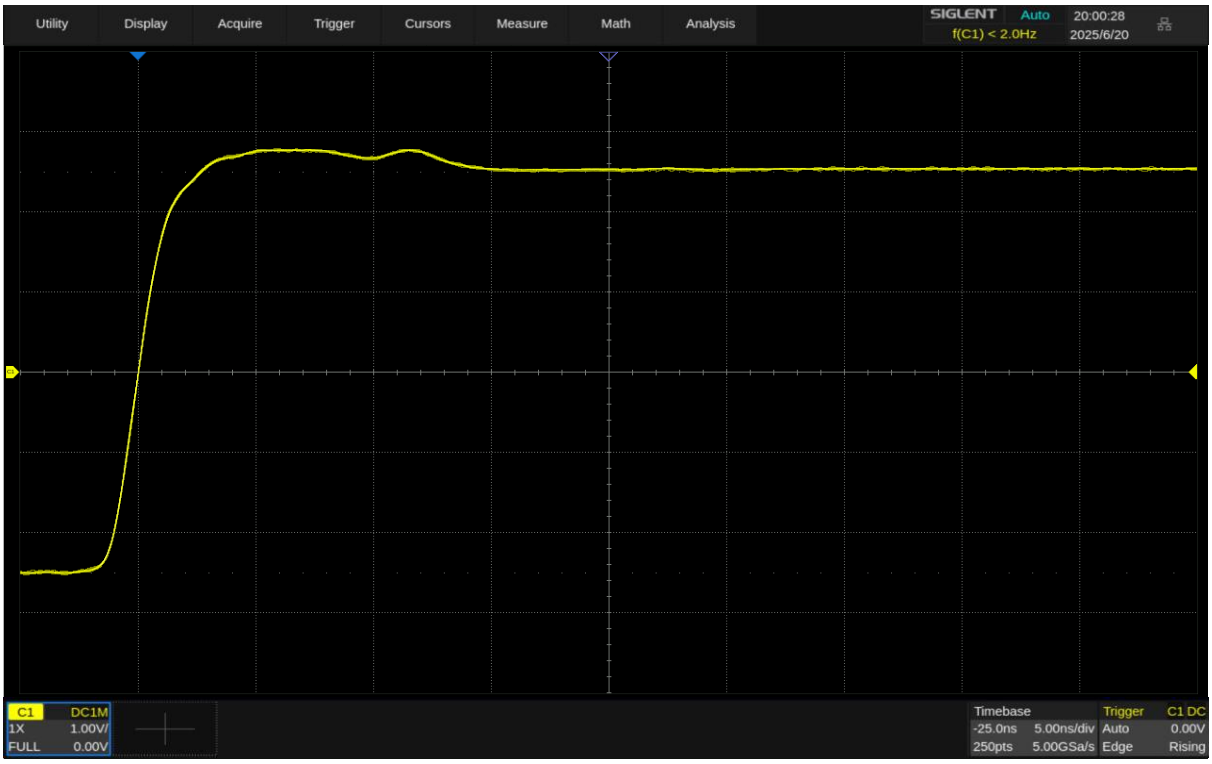
Take Horizontal Ref as an example to demonstrate the scaling effect of different settings:



Timebase = 10 ns/div, Horizontal Delay = -20 ns = - 2 div



Trig Pos, timebase is changed to 5 ns/div, the grid number of delay (−2div) remains fixed, while the horizontal delay changes to −10 ns



Ref Pos, timebase is changed to 5 ns/div, the horizontal delay value remains fixed, while the grid number of delay changes to -4div

14.1.1 XY mode

Use one frame of data input from C1 as the X-axis, and use one frame of data synchronously collected from C2 as the Y-axis to display the relationship between the two signals. The XY mode is usually used to draw Lissajous diagrams or volt-ampere diagrams of components.

14.1.2 Roll Mode

Click *Roll* to enter roll mode. In this mode, the waveform moves across the screen from right to left, similar to a strip chart recorder. The horizontal delay control of the waveform will be disabled when roll mode is active. It only operates at timebase values of 50 ms/div and above.

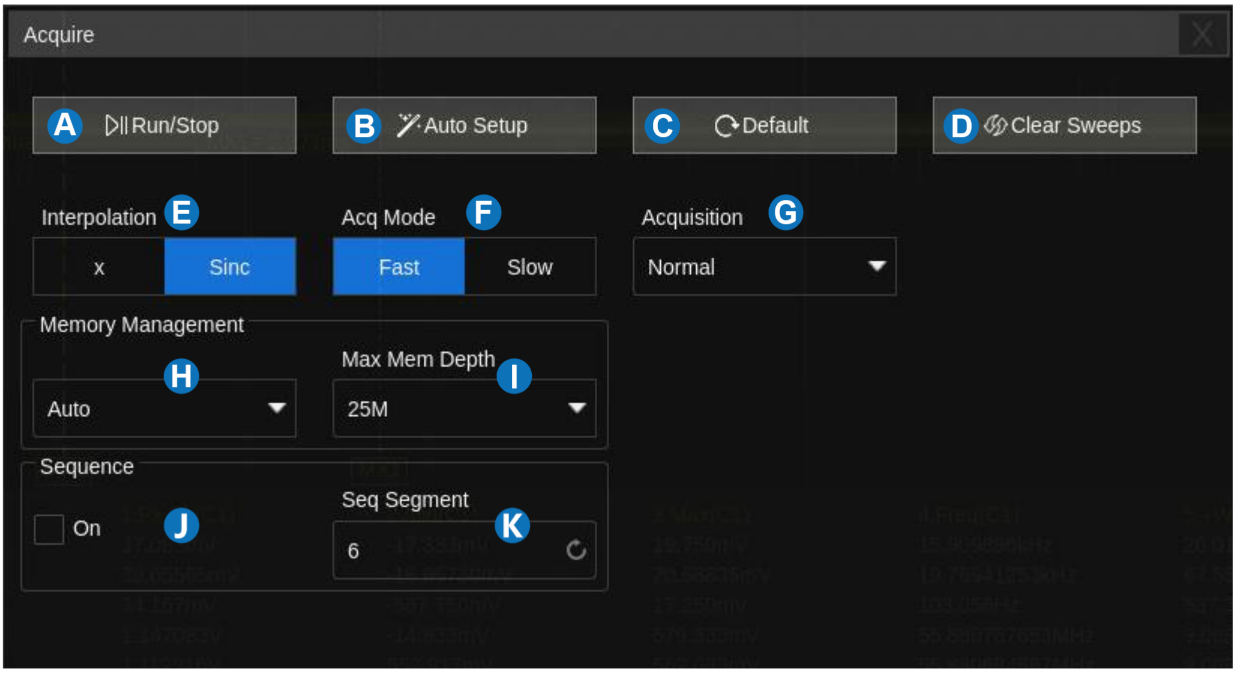
If you would like to stop the display in Roll mode, click *Acquire* > *Run/Stop* . To clear the display and restart an acquisition in Roll mode, perform *Acquire* > *Run/Stop* again.

	Note: Zoom is only supported after Stop in Roll mode.

14.2 Acquisition Setup

14.2.1 Overview

Click the menu bar *Acquire* to open the Acquire dialog box:



A. Start/stop acquisition, which is same as RunStop on the front panel of SDS5000X HD

B. Automatically set the time base, trigger, and vertical scale to display periodic signal. It is same as AutoSetup on the front panel of SDS5000X HD

C. Reset the oscilloscope's state to default configuration. It is same as Default on the front panel of SDS5000X HD

D. Clears the data or displays in multiple sweeps, including display persistence, measurement statistics, average sweeps, and Pass/Fail statistics. It is same as ClearSweeps on the front panel of SDS5000X HD

E. Select the interpolation mode

F. Select the Acq mode

G. Select the acquisition mode (Normal / Peak / Average / Hi-Res)

H. Select the Memory Management mode (Auto, Fixed Sample Rate, and Fixed Memory)

I. Select the maximum memory depth

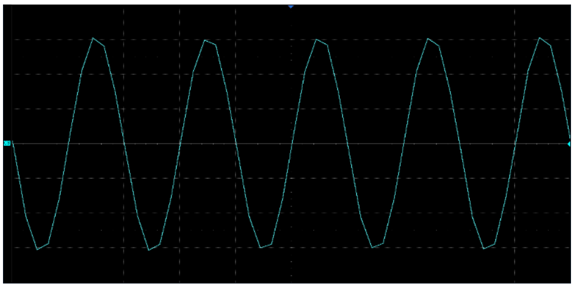
J. Turn on/off the sequence

K. Set the segment of the sequence

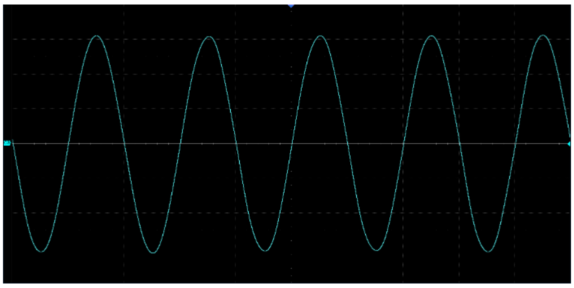
Interpolation -- At small timebase settings, the number of original points on the screen may be less than the number of display pixels in the grid area, so interpolation is necessary to display a continuous waveform. For example, at 1 ns/div timebase and 10 GSa/s sample rate, the number of original points is 100, but the number of pixels in the grid area is far greater than 100. In this case, the oscilloscope needs to interpolate the original points to make the waveform display on the screen continuous.

X: Linear interpolation, the simplest way of interpolation, connects two original points with a straight line.

Sinc: Sin(x)/x interpolation, the original point is interpolated according to the Nyquist reconstruction formula, which has a good time-domain recovery effect for a sine wave. But for step signals / fast rise times, it will introduce false overshoot due to the Gibbs phenomenon.



X Interpolation



Sinc Interpolation

Acq mode: "Fast" is the default setting. The device provides a very high waveform update rate in fast mode. "Slow" mode will slow down the waveform update on purpose.

Acquisition -- Refer to the "Acquisition" section for details.

Memory Management -- Refer to the "Memory Management" section for details

Max Mem Depth -- The data length of one waveform frame. According to the formula "acquisition time = sample points x sample interval", setting a larger storage depth can obtain a higher sampling rate under a large time base, but as the number of points processed by the oscilloscope increases, the waveform refresh rate may be reduced. The device can can obtain the best waveform refresh rate when only one channel is turned on , 2.5 GSa, 50 ns/div, point display mode, all data analysis functions (Measure, Math, Decode, cursors, etc.) are turned off. At full storage depth, this device can still operate at full speed sampling on a time base of 50 ms/div, achieving a balance between overall and detail.

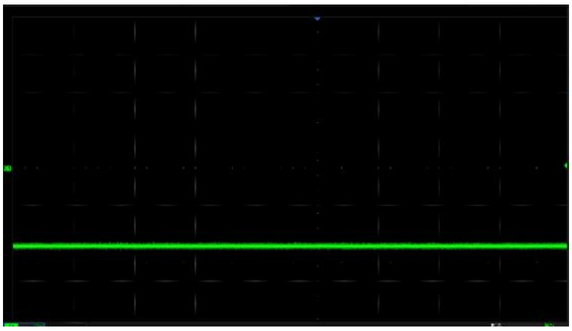
14.2.2 Acquisition

The acquisition mode is used to determine how to acquire and process the signal. The waveform acquisition modes include Normal, Peak, Average and Hi-Res.

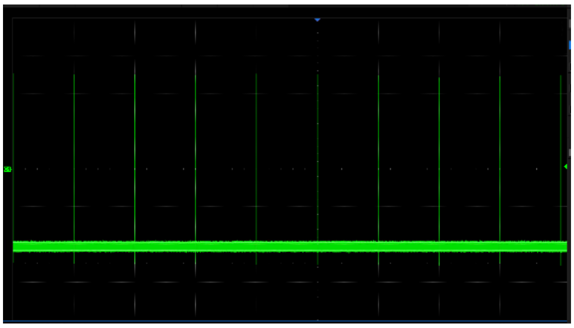
Normal -- The oscilloscope samples the signal with equal time intervals. For most waveforms, the best display effect can be obtained using this mode.

Peak -- Peak detect mode. The oscilloscope acquires the maximum and minimum values of the signal within the sample interval so the peak (maximum-minimum) in the interval is obtained. This mode is effective to observe occasional narrow pulses or spurs with a low sample rate, but the noise displayed is larger. In peak mode, the oscilloscope will display all pulses with a pulse width longer than 0.5 ns.

In the following example, a narrow pulse sequence with a pulse width of 3.4 ns and a period of 200 Hz is sampled at a 5 MSa/s sample rate in normal mode and peak mode. As we can see, because the sample interval (200 ns) is much larger than the pulse width (3.4 ns), it is difficult to capture the narrow pulses in normal mode, but peak mode can ensure that each pulse is captured.

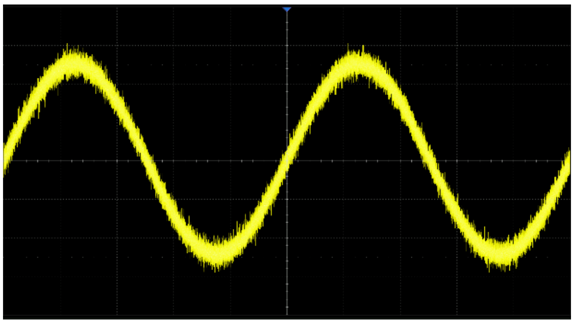


Normal mode

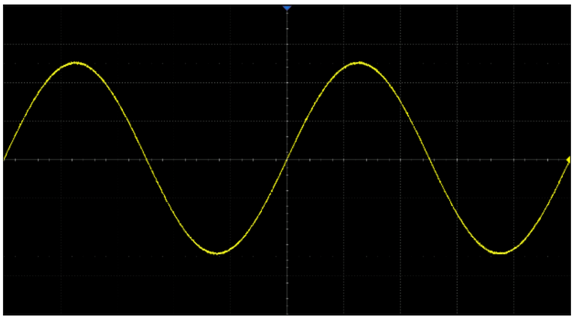


Peak mode

Average -- The oscilloscope accumulates multiple waveform frames and calculates the average as the result. If a stable trigger is available, the resulting average has a random noise component lower than that of a single-shot record. The more frames that are accumulated, the lower the noise is. For the device, average processing is implemented by the hardware engine, so it can still maintain a high waveform update rate when the acquisition mode is set to average.



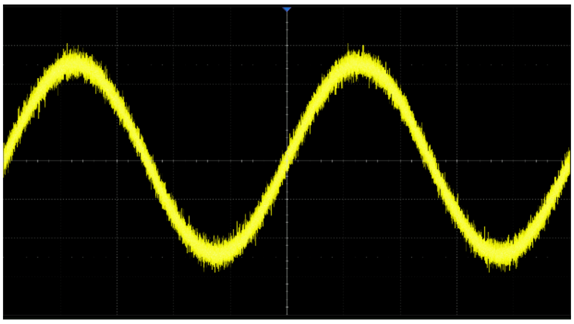
Normal mode



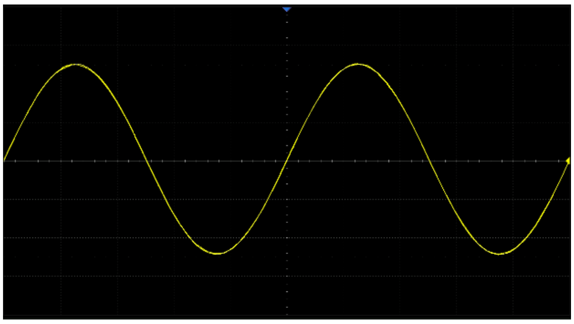
Average mode (32)

	Note: Average acquisition is only valid for periodic signals, and it is important to ensure that the waveform is triggering stably when using average mode.

High Resolution (Hi-Res) -- In this mode, the oscilloscope performs digital filtering on the sampling points to reduce broadband random noise on the input signal, improve signal-to-noise ratio, and thus enhance the effective resolution (ENOB) of the oscilloscope. The Hi Res processing of this device is implemented by a hardware engine, so it can still maintain a high waveform refresh rate when Hi Res is turned on.



Normal mode



Hi-Res mode (4.0)

Hi-Res acquisition does not require the signal to be periodic, nor does it require stable triggering, but due to the digital filtering, the system bandwidth of the oscilloscope will degrade. The higher the enhanced bits, the lower the bandwidth. The following table shows the relationship between enhanced bits and bandwidth:

Enhanced Bits	-3dB bandwidth
1.0	0.25*Sample rate
2.0	0.115*Sample rate
3.0	0.055*Sample rate
4.0	0.028*Sample rate

14.2.3 Memory Management

Memory Management controls how the instrument stores the acquired samples.

Auto: The default acquisition setting. After setting the maximum memory in the Auto mode, the oscilloscope automatically adjusts the sample rate and memory depth according to the time base. The adjustment principle is to follow the formula:

Sample rate = number of samples/time of acquisition

Where the time of acquisition is the time corresponding to the full display (i.e. 10 horizontal divisions).

	Note: The maximum memory here is the upper limit of the memory space allocated by the oscilloscope. The actual sample points are related to the current time base and may be less than memory depth. The actual sample points information can be obtained in the timebase descriptor box (see the section "Timebase and Trigger Descriptor Boxes" for details).

Fixed Sample Rate: The sample rate is fixed as set, and the oscilloscope automatically adjusts memory depth according to the time base. The time of acquisition is the time corresponding to the full display (i.e., 10 horizontal divisions).

> **Note:**
>
> When the sample rate is fixed, it is necessary to pay attention to whether the set sampling rate and the maximum frequency of the input signal meet the Nyquist Nyquist-Shannon sampling theorem. If the set sampling rate is less than twice the maximum frequency of the input signal, distorted signals will be obtained due to sampling aliasing.

Fixed Memory: The memory depth is fixed as set, and the oscilloscope automatically adjusts the sample rate according to the time base. With a small time scale (such as 1 ns/div) the memory depth is beyond the time of the full display, so it needs to zoom out the acquired frame for viewing the complete frame in Stop mode.

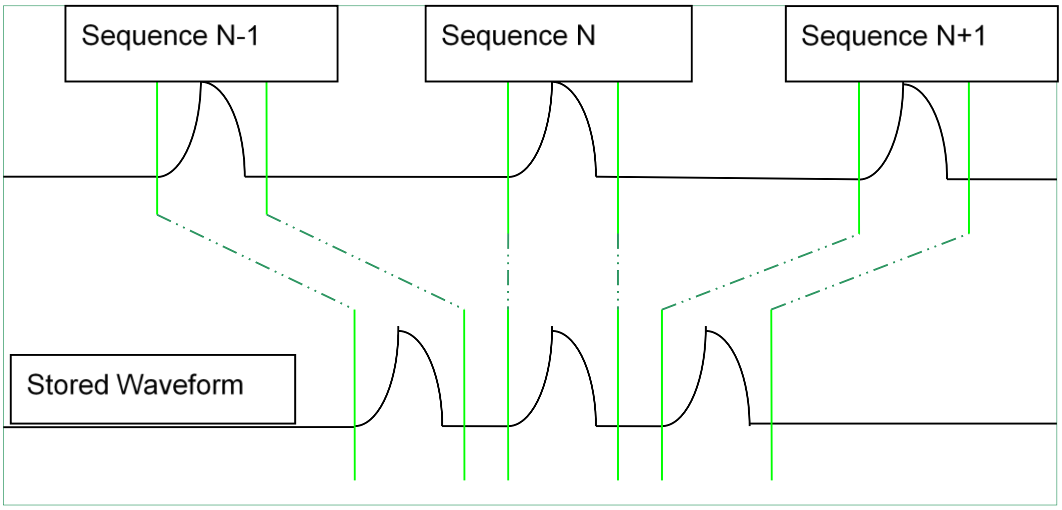
> **Note:**
>
> When the status is Run, the scope only processes the data on the display, which means measure, math, decode, search, etc. only analyzes the data on the display. This is identical to the "Auto" memory management mode.

14.2.4 Sequence

Sequence mode is a fast acquisition mode, which divides the memory depth into multiple segments (up to 170,000), each of which stores a single shot. In sequence mode, the oscilloscope only acquires and stores data without processing and displaying it until the specified segments are acquired. As a result, the dead time between trigger events is minimized, thus greatly improving the waveform update rate. If sequence mode is enabled, the display will not update until all of the sequences have been acquired. The device can achieve a minimum 1.5us trigger interval in Sequence mode, corresponding to a waveform update rate of 650 000 wfm/s.

After the acquisition is finished, the oscilloscope will map all the segments together to the screen. If you need to view and analyze each frame separately, history mode will help (see the section "History" for details). History mode provides timestamp labels for each segment.

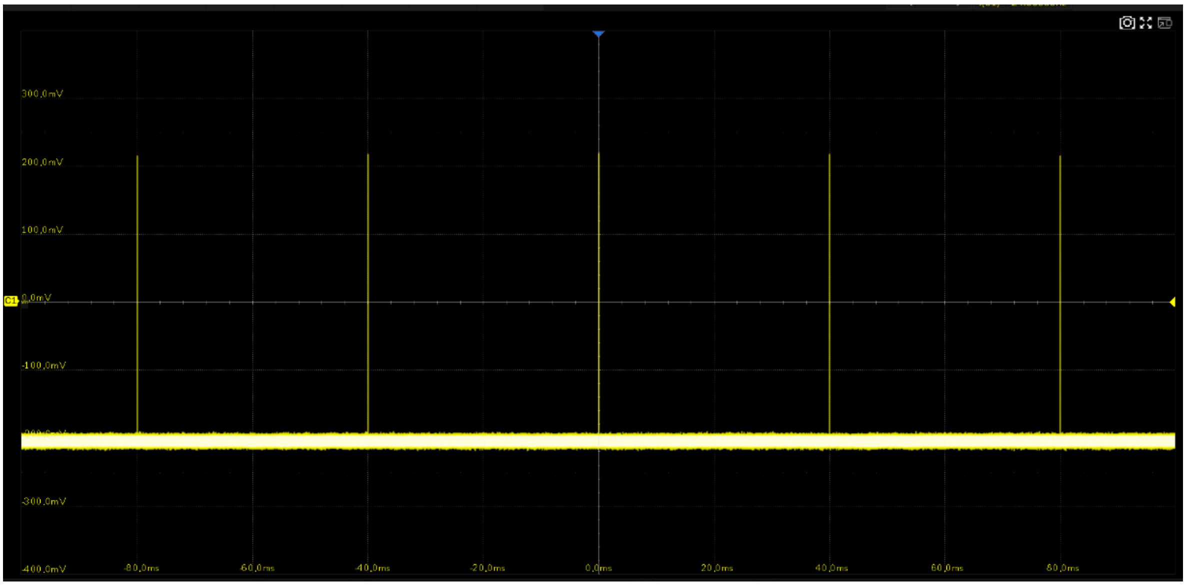
In addition to minimizing the dead time, another advantage of Sequence mode is that it can capture and record rare events over long periods. The oscilloscope can capture multiple events that satisfy the trigger conditions, ignoring the periods of no interest between adjacent events, thus maximizing the use of waveform memory. You can use the full accuracy of the acquisition timebase to measure selected segments.



Example:

Input a pulse sequence with a period of 40 ms to C1. The rise time of the pulse is 150 ns, the fall time is 70 ns, the pulse width is 200 ns, and amplitude is 0.4 Vpp. Perform Auto Setup.

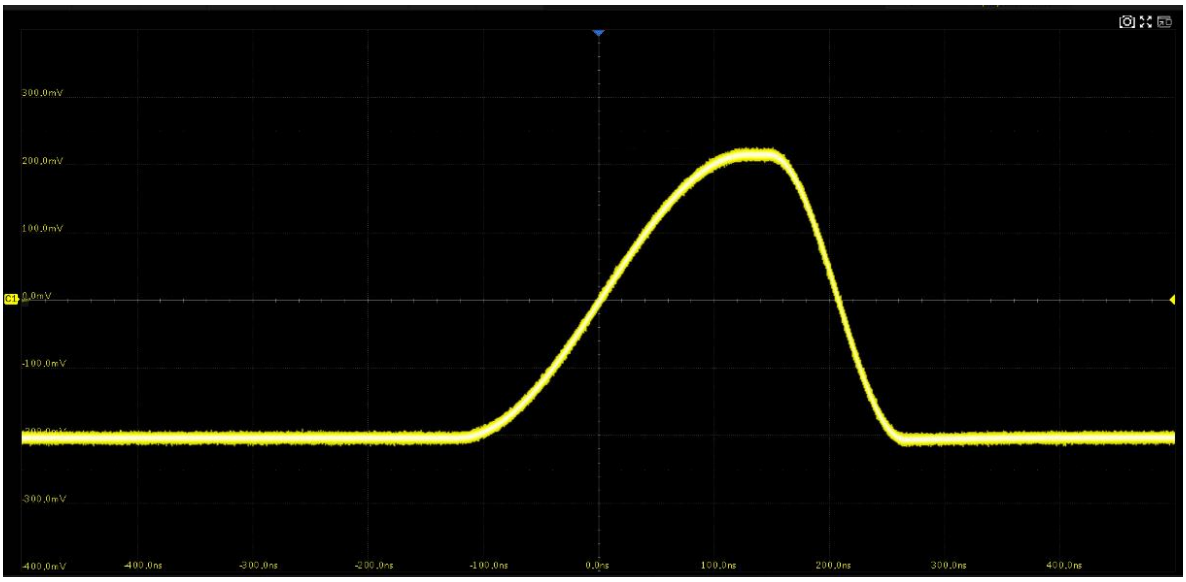
Set the coupling mode of C1 to DC50Ω, and vertical scale to 100 mV/div, vertical offset to 0. Set the trigger level to 0. Set the storage depth to 100Mpts.



In normal mode, 5 pulses can be obtained on the screen with the sample rate of 500MSa/s at 100Mpts memory depth.

Set the trigger mode to "Single" and the timebase to 100 ns/div. Turn on the Sequence mode, and set the segments to maximum (43,231 in this example, up to 170,000 depending on the number of samples at the current time base). Wait patiently until the acquisition completes, then all the waveforms satisfying the trigger conditions are displayed on the screen.

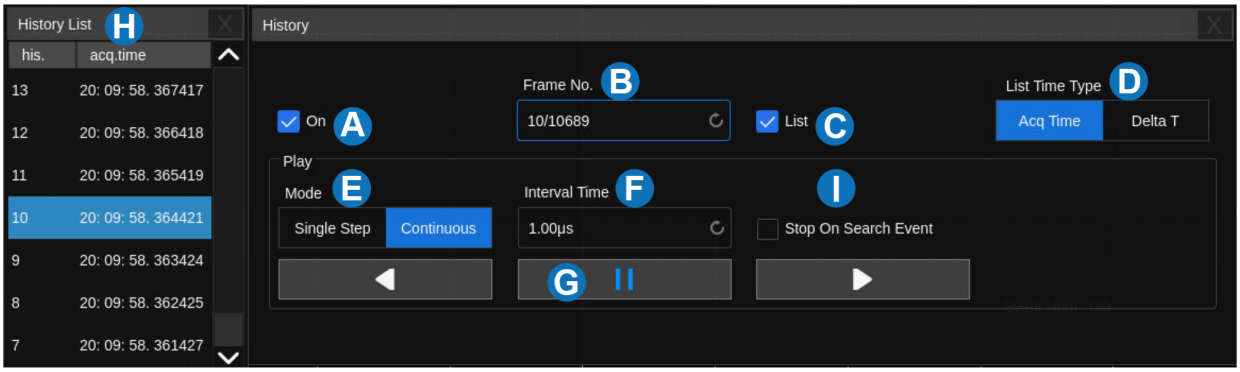
In Sequence mode, there is no waveform displayed on the screen until the acquisition is completed. During acquisition, there is a counter on the screen indicating the number of segments that have been acquired.



In the example, 43231 pulses can be obtained with the sample rate of 5 GSa/s at the maximum memory depth.

14.3 History

Click *Analysis* > *History* to open the history setup dialog box.



A. Turn on/off history mode

B. Specify the frame index

C. Turn on or off the list

D. List time type

E. Set the playing mode

F. Set the time interval between two frames when playing automatically

G. Play backward, pause, and play forward

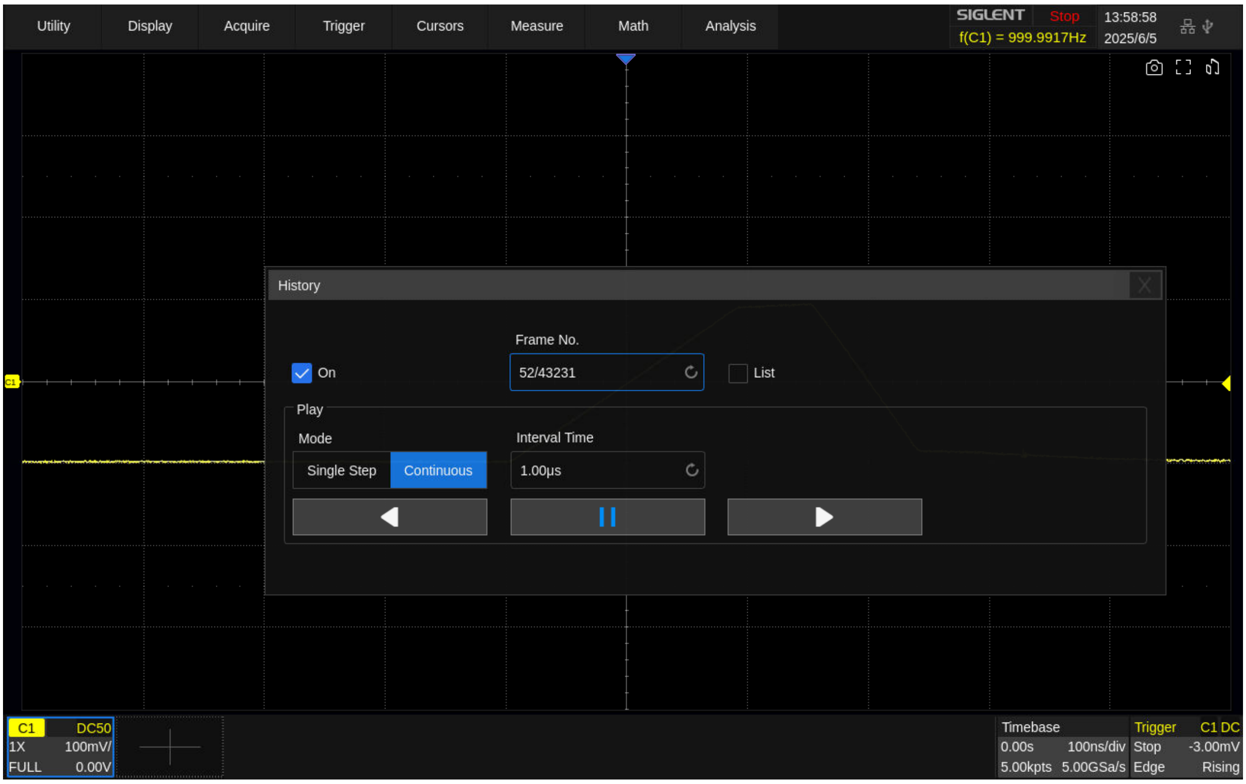
H. List displays the frame index and time label for each frame

I. Enable the “Stop on Search Event” function, which allows navigating search events across history frames

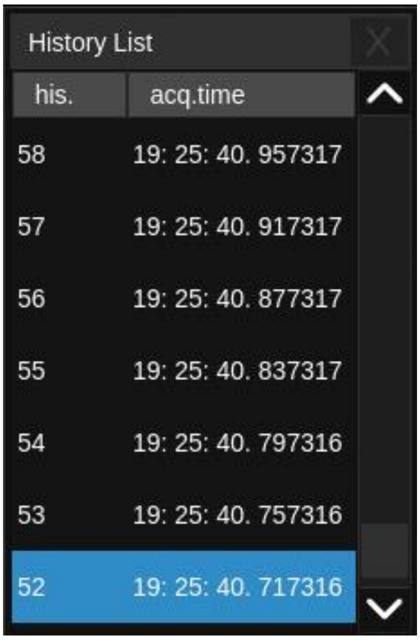
The oscilloscope automatically stores acquired frames. It can store up to 170,000 frames but the number may vary due to the memory depth and timebase settings. Turn on history mode, then the stored frames can be recalled and measured.

Continue with the example in the section above. In Sequence mode, all waveforms that satisfy the trigger conditions are mapped to the display. If you need to observe a single frame, you can use history mode.

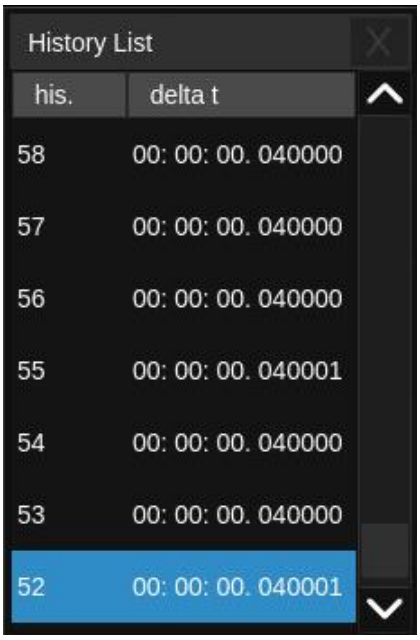
To enable history mode, click the *Frame No.* area twice, then the virtual numeric keypad pops up. Input the number "52" to specify the 52th segment (frame).



Click the *List* area and turn on the list. The time label corresponding to the 52th waveform is displayed. The time resolution is microseconds. Time label types include *AcqTime* or *Delta T* , AcqTime corresponds to the absolute time of the frame, synchronized with the real-time clock of the oscilloscope; Delta T is the acquisition time interval between adjacent two frames, it is shown as 40ms in the following diagram, which is consistent with the period of the actual waveform.



Acq Time label



Delta T label

In addition to manually specifying a frame, history mode supports auto-play:

Click the  softkey to replay the waveform from the current frame to the first.

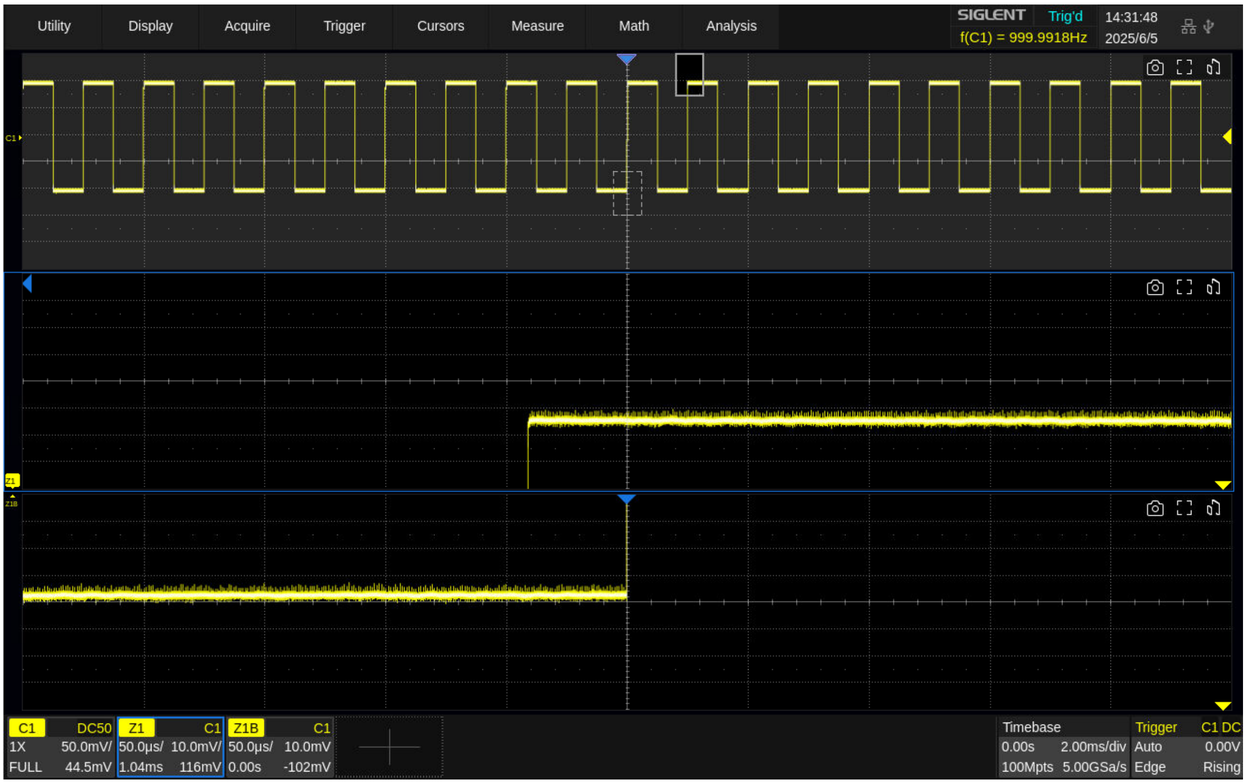
Click the  softkey to stop replay.

Click the  softkey to replay the waveform from the current frame to the last.

Click the *Interval Time* area to control the speed of automatic play. In the process of automatic play, the list will automatically scroll to the current frame.

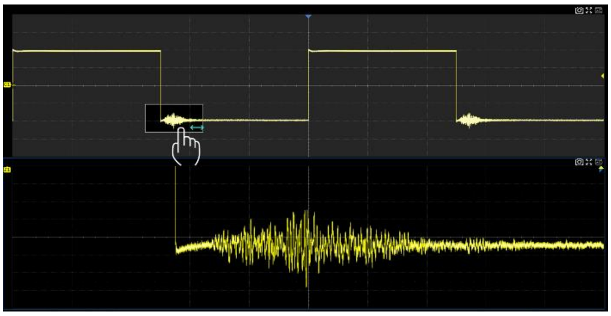
15 Zoom

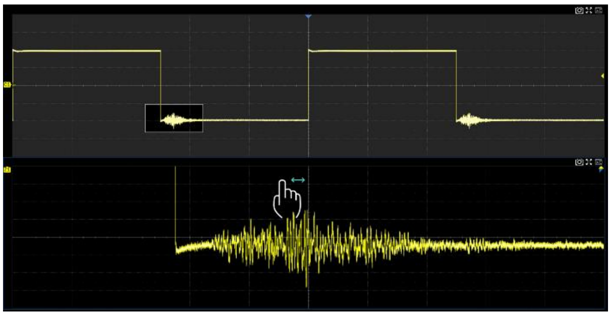
Press  button, or click the Zoom in Horizontal dialg box to turn on Zoom. After Zoom is turned on, the oscilloscope will open another window specifically for displaying Zoom waveforms. The Zoom window can zoom in on waveforms in both vertical and horizontal directions. In the *General* tab of the Zoom dialog box, check *Dual Zoom* to turn on double Zoom waveforms and observe the waveform details in different areas simultaneously.



The area not covered by the gray background in the main waveform area is the range to be zoomed in (zoom area). Click the descriptor box of the zoom trace to recall the quick dialogs for setting the vertical and horizontal parameters of the zoom window.

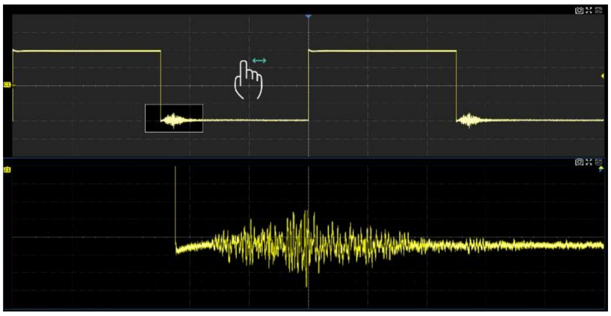
When the zoom window is activated, the zoom area can be expanded or compressed by rotating the horizontal and vertical scale knob. Rotating the horizontal and vertical position knob to move the position of the region. When the main window is activated, the scale knobs and position knobs are used to change the scale and delay/offset of the main window. The operations above can also be performed by different gestures. Below is the example of changing the setting in the horizontal direction by gestures. The gestures for changing the setting in the vertical direction are similar.





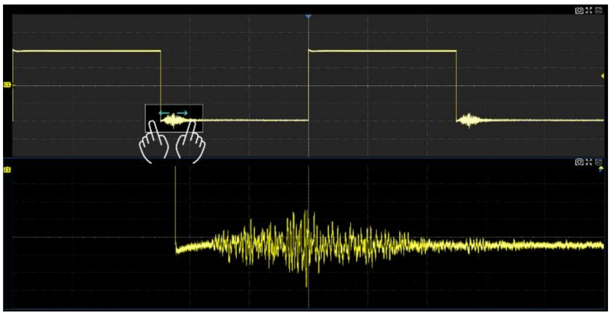
Adjust the horizontal position of the zoom area by dragging left and right in the zoom area of the main window or waveform in the Zoom window.

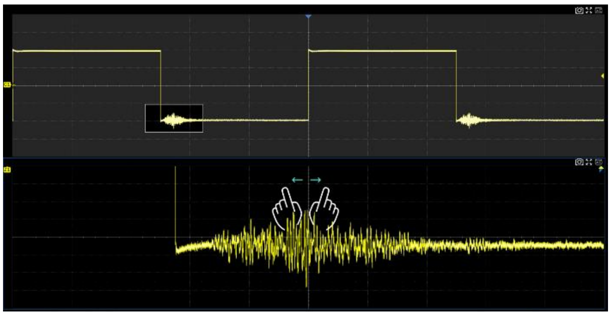
Adjust the vertical position of the zoom area by dragging up and down in the zoom area of the main window or waveform in the Zoom window.



Adjust the horizontal position of the waveform by dragging the gray area of the main window left and right.

Adjust the vertical position of the waveform by dragging the gray area of the main window up and down.

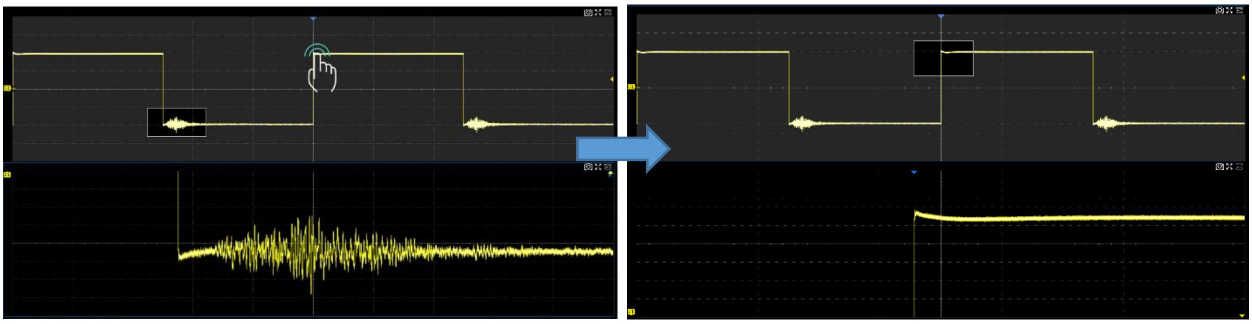




Adjust the horizontal scale of Zoom window by horizontal pinch and spread in the zoom area of the main window or the Zoom window.

Adjust the vertical position of the zoom area by dragging up and down in the zoom area of the main window or waveform in the Zoom window.

Adjust the horizontal/vertical scale of the main window by using a pinching or spreading gesture in the gray area of the main window.



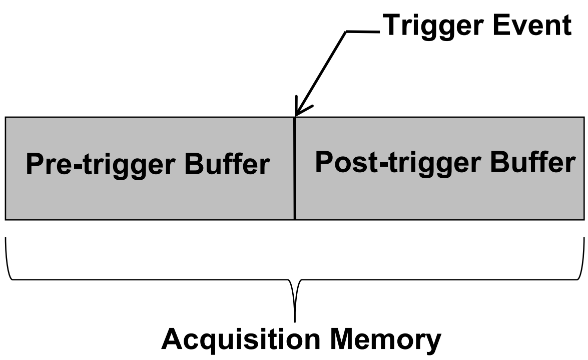
Double click a location in the main window to quickly set the center of the zoom area.

16 Trigger

16.1 Overview

The oscilloscope only acquires waveforms of interest (i.e., the ones that satisfy the trigger condition) and aligns all trigger events at the trigger position to form a stable waveform display. The trigger is one of the most important features of an oscilloscope since we can only analyze a signal that we can trigger reliably and stably.

The trigger position is movable on the display. The following diagram shows the structure of the acquisition memory. The acquisition memory is divided into pre-trigger and post-trigger buffers and the boundary between them is the trigger position. Before the trigger event arrives, the oscilloscope fills the pre-trigger buffer first, and then continuously updates it in FIFO mode until the trigger event arrives. After the trigger event, the data fills the post-trigger buffer. When the post-trigger buffer is full, an acquisition is completed.



Below is the definition of the states in the process of filling the acquisition memory:

Arm: The pre-trigger buffer is not full, and the oscilloscope does not respond to any trigger events.

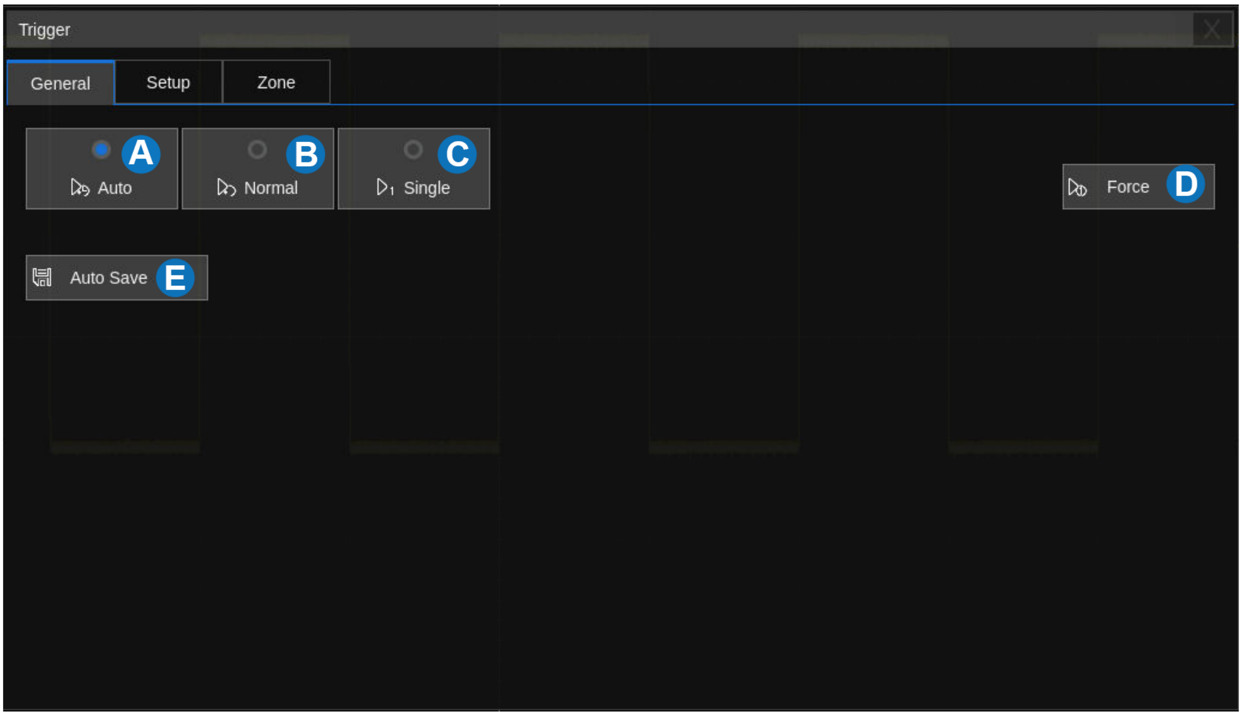
Ready: The pre-trigger buffer is full, and the oscilloscope is waiting for the trigger event.

Trig'd: A trigger event is detected and the oscilloscope starts to fill the post-trigger buffer.

Trigger settings should be based on the features of the input signal. For example, a sine wave with a repeatable period can be triggered on the rising edge; for capturing hazards in a combinational logic circuit, the pulse trigger can be set. You need to have some knowledge of the signal-under-test to quickly capture the desired waveform.

16.2 Trigger Setup

Click the menu bar *Trigger* or the trigger descriptor box to open the trigger settings dialog box. Under the General tab:



A. Set the trigger mode to "Auto", which is equivalent to pressing the Auto button on the front panel

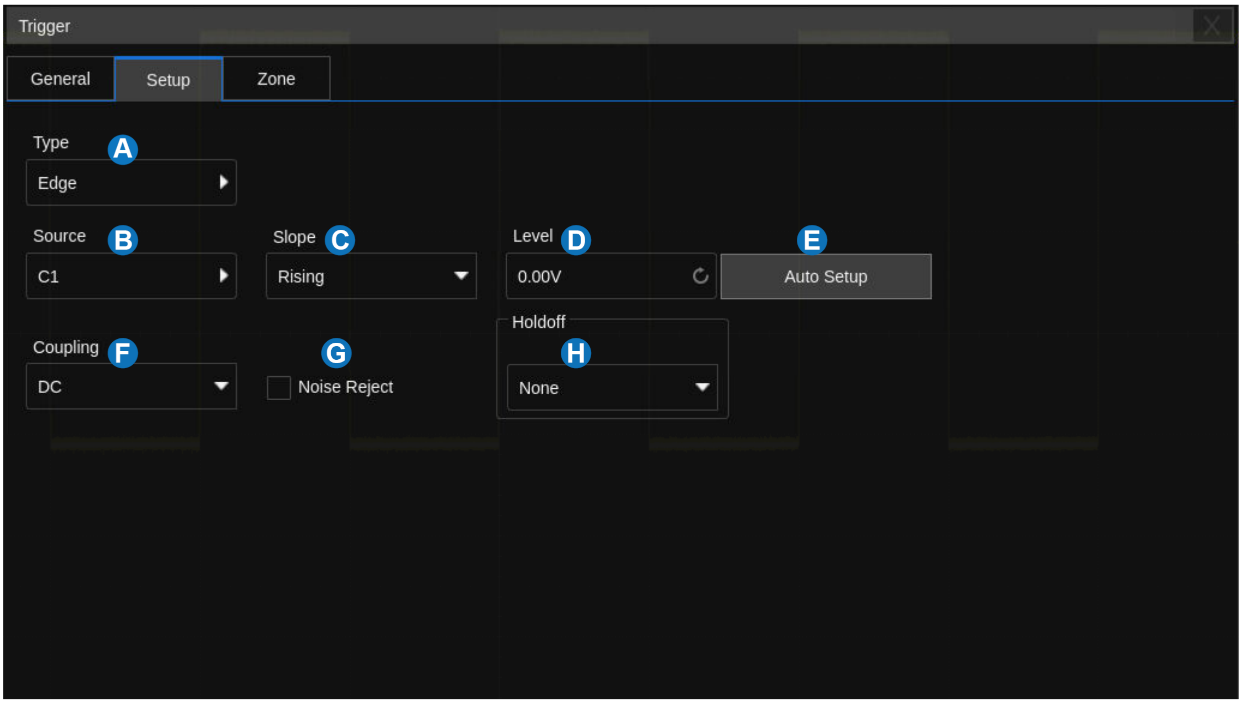
B. Set the trigger mode to "Single", which is equivalent to pressing the Single button on the front panel

C. Set the trigger mode to "Normal", which is equivalent to pressing the Normal button on the front panel

D. Perform a force trigger

E. Recall the auto save settings dialog

Switch to *Setup* tab for more trigger settings:



A. Select trigger type

B. Select the trigger source

C. Select the trigger slope (When the trigger type is "Edge", "Slope" and other specific types)

D. Trigger level setting region. It can also be set by the ”Level” knob on the front panel

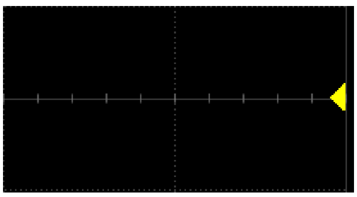
E. Automatically set the trigger level to the vertical center of the waveform

F. Set trigger coupling mode (DC / AC / LF Reject / HF Reject)

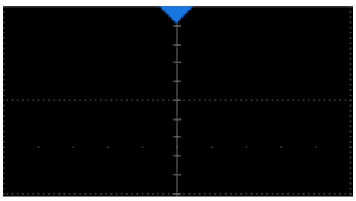
G. Enable / disable Noise Rejection. When Noise Reject is on, the trigger hysteresis is increased, so the noise immunity of the trigger circuit is better. As a compromise, the trigger sensitivity degrades

H. Set holdoff (None / Time / Events)

Trigger Related Label



Trigger level Indicator

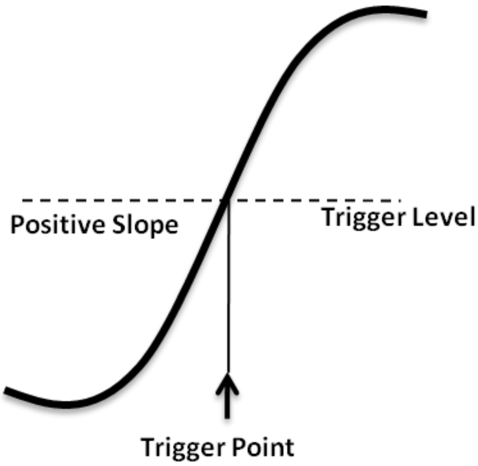


Horizontal 0 position Indicator

Horizontal 0 position (out of screen) Indicator

16.3 Trigger Level

Both analog and digital triggers must have a correct trigger level value. The oscilloscope judges whether a waveform satisfies the trigger condition when it crosses the trigger level. If it does, the crossing time is the trigger position. In the following figure, the trigger condition is set as a rising edge. When the signal with a positive slope crosses the trigger level, the trigger condition is satisfied and the time point the signal crosses the level is the trigger position.



In some special triggers, the system will automatically set the trigger level, such as using AC Line as the trigger source.

16.4 Trigger Mode

The trigger mode determines how the oscilloscope acquires waveforms.

Auto: An internal timer triggers the sweep after a preset timeout period if no trigger has been found so that the oscilloscope continuously updates the display whether a trigger happens or not. Auto mode is suitable for unknown signals or DC signals.

	Note: In Auto mode, if the signal satisfies the trigger conditions but cannot trigger the oscilloscope stably, it may be that interval between two trigger events exceeds the timeout period. Try Normal mode in this case.

Normal: Triggers and acquisitions only occur when the trigger conditions are met. Otherwise, the oscilloscope holds the last waveform on the display and waits for the next trigger. Normal mode is suitable for acquiring:

- Only events specified by the trigger settings
- Rare events

Single: Captures and displays a single frame that satisfies the trigger conditions, and then stops. The following trigger events are ignored until the Single acquisition is restarted. Single-mode is suitable for:

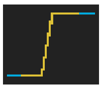
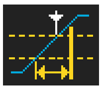
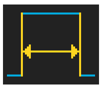
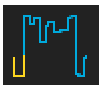
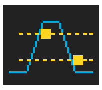
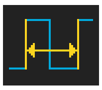
- One-shot events or periodic signals, such as power-on\off waveforms on a power rail
- Rare events

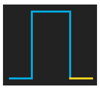
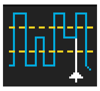
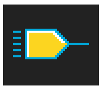
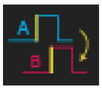
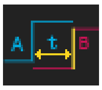
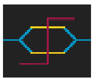
Force: The oscilloscope triggers regardless of whether the input signal meets the trigger conditions or not.

16.5 Trigger Type

16.5.1 Overview

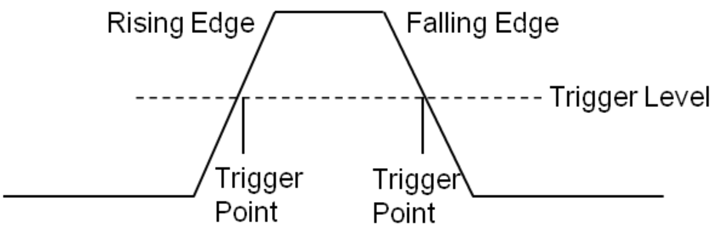
The trigger modes of the device are digital designs. Compared with analog trigger circuits, digital triggers can not only greatly optimize trigger precision and trigger jitter, but also support multiple trigger types and complex trigger conditions.

	**Edge** -- Trigger on a rising edge, falling edge or both
	**Slope** -- Trigger when an edge crosses two thresholds that lie inside or outside a selected time range
	**Pulse** -- Trigger at the end of a pulse when the pulse width lies inside or outside a selected time range
	**Video** -- TV trigger on falling edge
	**Window** -- Trigger when the signal leaves the widow region.
	**Interval** -- Trigger on the second edge when the time between the edges is inside or outside a selected time range

	**Dropout** -- Trigger when the signal disappears for longer than the Dropout value.
	**Runt** -- Trigger when a pulse crosses the 1st threshold but not the 2nd before re-crossing the 1st threshold again
	**Pattern** -- Trigger when pattern condition transitions from false to true. All inputs set to DC coupling
	**Serial** --Trigger on specified condition in a serial bus. See the chapter "Serial Trigger and Decode" for details.
	**Qualified** -- Trigger with edge trigger setting only after the qualifying condition is satisfied
	**Nth Edge** –Trigger on the Nth edge of a burst that occurs after a specified idle time
	**Delay** --Trigger when the delay time between source A and source B meets the limit condition
	**Setup/Hold** --Trigger when the setup time or hold time meets the limit condition

16.5.2 Edge Trigger

Edge trigger distinguishes the trigger points by seeking the specified edge (rising, falling, alternating) and trigger level. The trigger source and slope can be set in the trigger dialog box.



Click the *Source* area to select the trigger source, and click the *Slope* area to select rising, falling, or alternating.

Rising -- Only trigger on the rising edge

Falling -- Only trigger on the falling edge

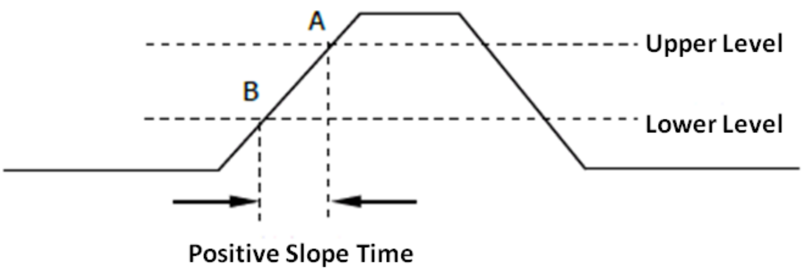
Alternating -- Trigger on both the rising and falling edge

Holdoff, coupling, and noise reject can be set in edge trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

	Note: Perform *Auto Setup* , and the oscilloscope will set the trigger type to Edge.

16.5.3 Slope Trigger

The slope trigger looks for a rising or falling transition from one level to another level in the specified time range. For example, positive slope time is defined as the time difference between the two crossing points of trigger level lines A and B with the positive edge as shown in the figure below.



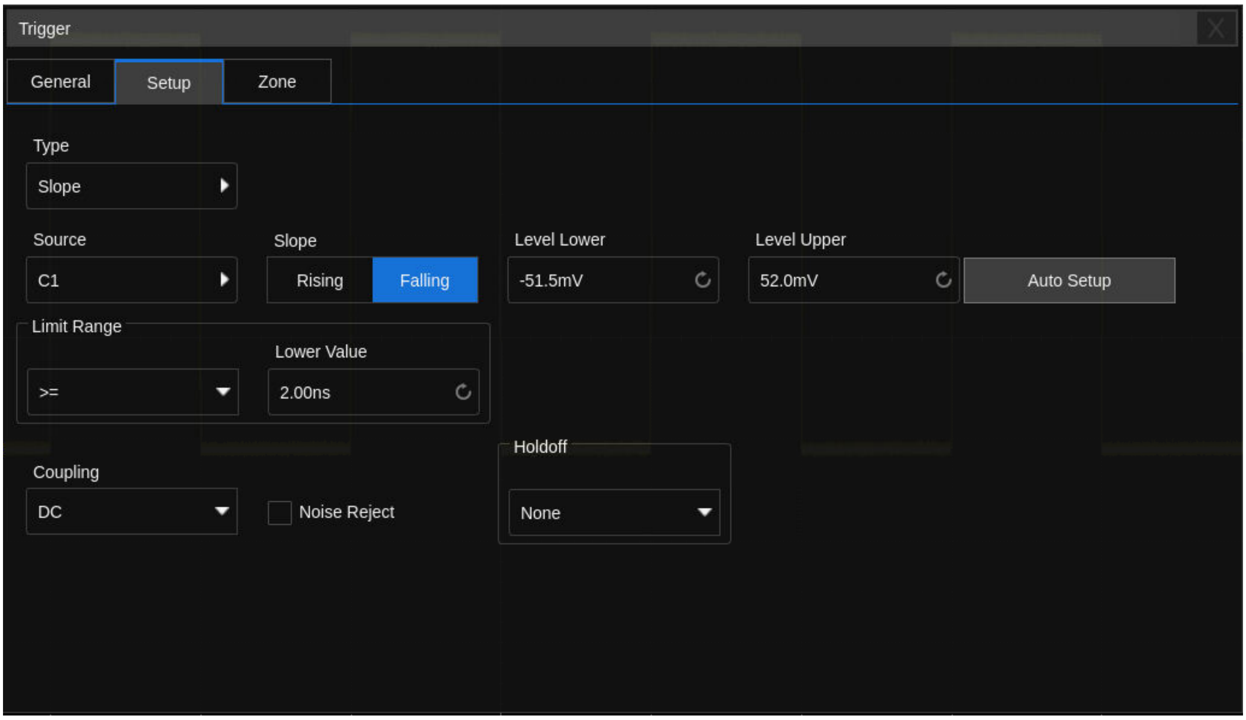
Click the *Source* area to select the trigger source, and click the *Slope* area to select rising or falling.

Rising -- Only trigger on the positive slope

Falling -- Only trigger on the negative slope

Adjust the Upper/Lower Level

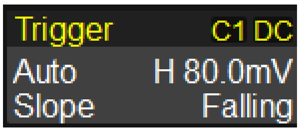
The slope trigger requires upper and lower trigger levels. When the trigger type is sloping trigger, click the trigger descriptor box, the pop-up quick menu will show two levels.

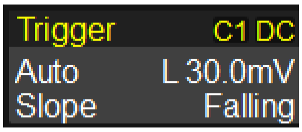


The upper/lower level can be set in the following way:

Click the *Level Upper* area in the quick menu to select the upper level, and then set the level value by the virtual keypad, or the multi-functional knob, or the mouse wheel. To set the lower level is similar.

The lower level should always be less than or equal to the upper level. In the trigger descriptor box, the current active level is displayed. On the left side of the following figure, "H" represents high level; On the right side of the following figure, "L" represents low level.





Set Limit Range

Click the *Limit Range* area in the trigger dialog box to select the time condition and set the corresponding time in the *Upper Value* / *Lower Value* area.

Less than a time value (≤) -- Trigger when the positive or negative slope time of the input signal is lower than the specified time value.

Great than a time value (≥) -- Trigger when the positive or negative slope time of the input signal is greater than the specified time value.

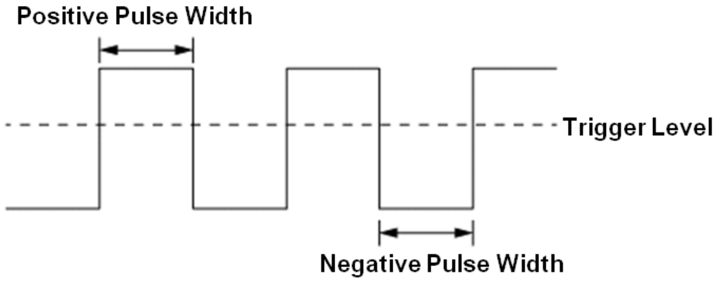
Within a range of time values ([--,--]) -- Trigger when the positive or negative slope time of the input signal is greater than the specified lower limit of time and lower than the specified upper limit of time value.

Outside a range of time value (--][--) -- Trigger when the positive or negative slope time of the input signal is greater than the specified upper limit of time and lower than the specified lower limit of time value.

Holdoff, coupling, and noise reject can be set in slope trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

16.5.4 Pulse Trigger

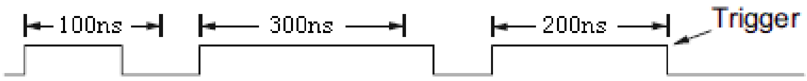
Trigger on a positive or negative pulse with a specified width. Trigger source, polarity (positive, negative), limit range, and time value can be set in the trigger dialog box.



Less than a time value (≤) -- Trigger when the positive or negative pulse time of the input signal is lower than the specified time value. Below is an example of a trigger condition set to a positive pulse width < 100ns

Great than a time value (≥) -- Trigger when the positive or negative pulse time of the input signal is greater than the specified time value. Below is an example of a trigger condition set to a positive pulse width > 100ns

Within a range of time values ([--,--]) -- Trigger when the positive or negative pulse time of the input signal is greater than the specified lower limit of time and lower than the specified upper limit of the time value. Below is an example of a trigger condition set to 100 ns < positive pulse width < 300 ns.



Outside a range of time value (--][--) -- Trigger when the positive or negative pulse time of the input signal is greater than the specified upper limit of time and lower than the specified lower limit of the time value.

Holdoff, coupling, and noise reject can be set in pulse trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

16.5.5 Video Trigger

Video trigger can be used to capture the complicated waveforms of most standard analog video signals. The trigger circuitry detects the vertical and horizontal interval of the waveform and produces a trigger based on the video trigger settings you have selected. The device supports standard video signals for NTSC (National Television Standards Committee), PAL (Phase Alternating Line), HDTV (High-Definition Television), and a custom video signal trigger.

Source, standard, and synchronization mode can be set in the video trigger dialog box. When the synchronization mode is "Select", line and field can be specified.

Click the *Standard* and select the video standard. The device supports the following video standards:

TV Standard	Scan Type	Sync Pulse
NTSC	Interlaced	Bi-level
PAL	Interlaced	Bi-level
HDTV 720P/50	Progressive	Tri-level
HDTV 720P/60	Progressive	Tri-level
HDTV 1080P/50	Progressive	Tri-level
HDTV 1080P/60	Progressive	Tri-level
HDTV 1080i/50	Interlaced	Tri-level
HDTV 1080i/60	Interlaced	Tri-level
Custom		

The table below shows the parameters of the custom video trigger:

Frame Rate	25Hz, 30 Hz, 50 Hz,60 Hz	
Of Lines	300 ~ 2000	
Of Fields	1,2,4,8	
Interlace	1:1, 2:1,4:1,8:1	
Trigger Position	Line	Field
	(line value)/1(1:1)	1
	(line value)/2 (2:1)	1, 2, 3, 4, 5, 6, 7, 8
	(line value)/4(4:1)	1, 2, 3, 4, 5, 6, 7, 8
	(line value)/8(8:1)	1, 2, 3, 4, 5, 6, 7, 8

Line value: The number of lines set in the *Line* (300 ~ 2000).

In the custom video trigger type, the corresponding "Of Fields" varies with the selection of the “Interlace” ratio. Therefore, the number of fields selected and the number of lines corresponding to each field can also be varied. If the "Of Lines" is set to 800, the correct relationship between them is as follows:

Of Lines	Interlace	Of Fields	Trigger Line	Trigger Field
800	1:1	1	800	1
800	2:1	1/2/4/8	400	1/1~2/1~4/1~8
800	4:1	1/2/4/8	200	1/1~2/1~4/1~8
800	8:1	1/2/4/8	100	1/1~2/1~4/1~8

Set the video trigger for a video signal

Click *Sync* for trigger mode selection, video trigger mode has "Any" and "Select" options. In "Any" mode, the video signal can be triggered on any line that meets the conditions. In the "Select" mode, the signal can be triggered by a specified field and a specified line.

For progressive scanning signals (e.g., 720p/50, 720p/60, 1080p/50, 1080p/60), only the specified line can be selected to trigger when the synchronization mode is “Select”.

For interlaced scanning signals (such as NTSC, PAL, 1080i/50, 1080i/60, and Custom), when the synchronization mode is "Select", the specified line and the specified field can be selected to trigger.

The following table shows the corresponding relations between line and field for all video standards (except for Custom)

Standard	Field 1	Field 2
NTSC	1 to 263	1 to 262
PAL	1 to 313	1 to 312
HDTV 720P/50, 720P/60	1 to 750	
HDTV 1080P/50, 1080P/60	1 to 1125	
HDTV 1080i/50, 1080i/60	1 to 563	1 to 562

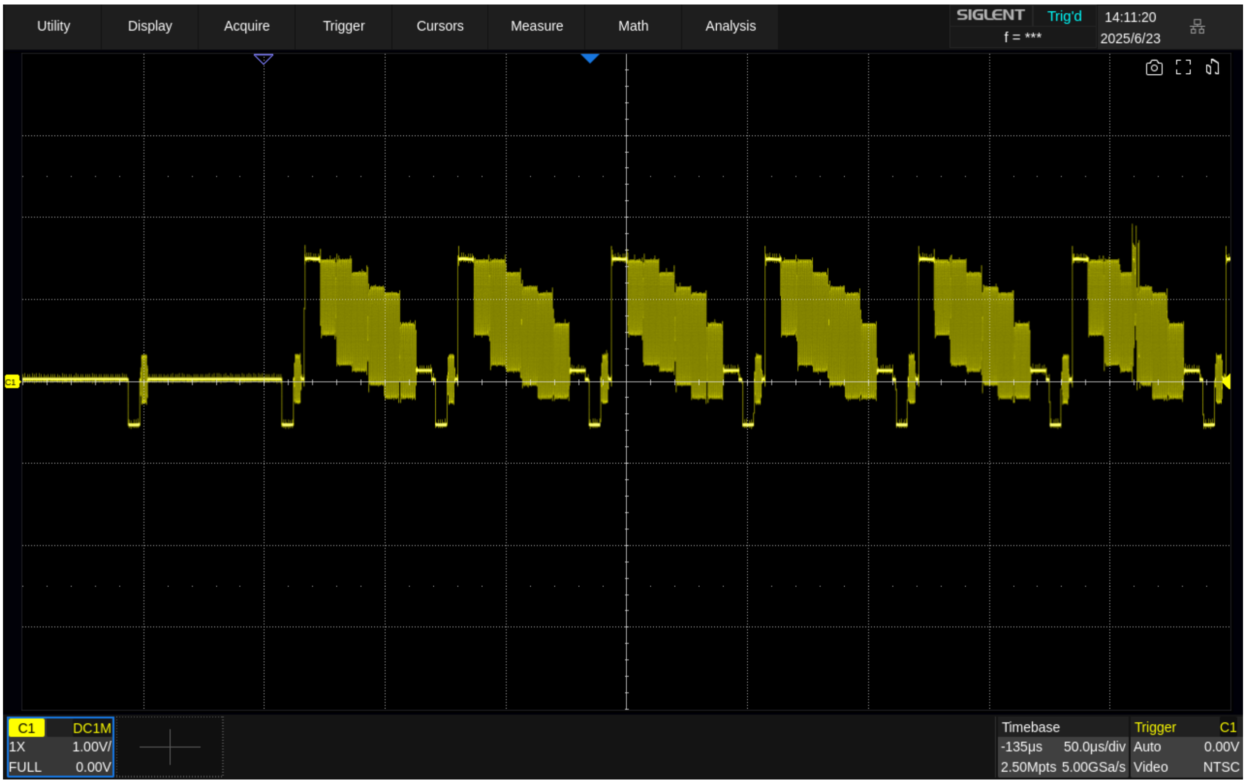
To gain familiarization with the video trigger, try these two examples:

- Trigger on a specific line of video (NTSC standard)
- Use “Custom” to trigger video signals

Trigger on a Specific Line of Video

Video trigger requires that any analog channel can be used as the trigger source with a synchronization amplitude greater than 1/2 grid. The example below sets to trigger on Field 1, Line 22 using the NTSC video standard.

1. Open the trigger menu.
2. In the trigger menu, click *Type* , and select "Video".
3. Click the *Source* and select C1 as the trigger source.
4. Click the *Standard* and select the "NTSC".
5. Click the *Sync* and select the "Select" to make the Field and Line optional, then select "1" in the "Field", and set the "Line" to "22" by using the mouse wheel or the virtual keypad.



Trigger on a Specific Line of Video (NTSC)

Use "Custom" to Trigger Video Signals

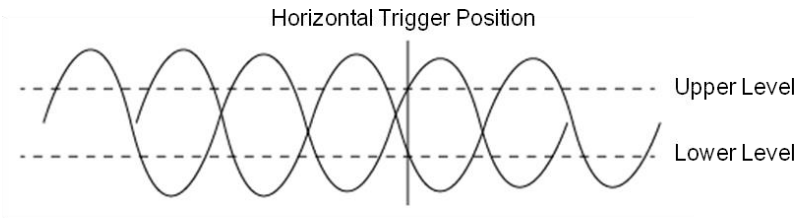
Custom video trigger supports video signals with frame rates of 25, 30, 50, and 60 Hz respectively, and the specified row is within the range of 300 to 2000. The following describes how to trigger a "Custom" video signal.

1. Open the trigger menu.
2. In the trigger menu, click the *Type* , and select "Video".
3. Click the *Source* and select C1 as the trigger source.
4. Click the *Standard* and select the "Custom".
5. Click the *Custom Setting* to open the custom setting menu and click the *Interlace* to select the required interlace ratio (assuming that the interlace ratio is 8:1). Then set the frame rate and select the number of lines and the number of fields.
6. Click the *Sync* to select the synchronization mode for the input signal:
   a) Select the "Any" mode, and the signal can be triggered on any line that meets the trigger condition.
   b) Select the "Select" mode, then set the specified line and the specified field to trigger the signal. Assuming that the "Field" is set to 8, you can select any field from 1 to 8, and each field can choose any line from 1 to 100.

16.5.6 Window Trigger

The window trigger is similar to the edge trigger, except that it provides an upper and a lower trigger level. The instrument triggers when the input signal passes through the upper level or the lower level.

There are two kinds of window types: Absolute and Relative. They have different trigger-level adjustment methods. Under the Absolute window type, the lower and the upper trigger levels can be adjusted separately. The relative window provides adjustment for the Center value to set the window center and the Delta value to set the window range. In this mode, the lower and the upper trigger levels always move together.



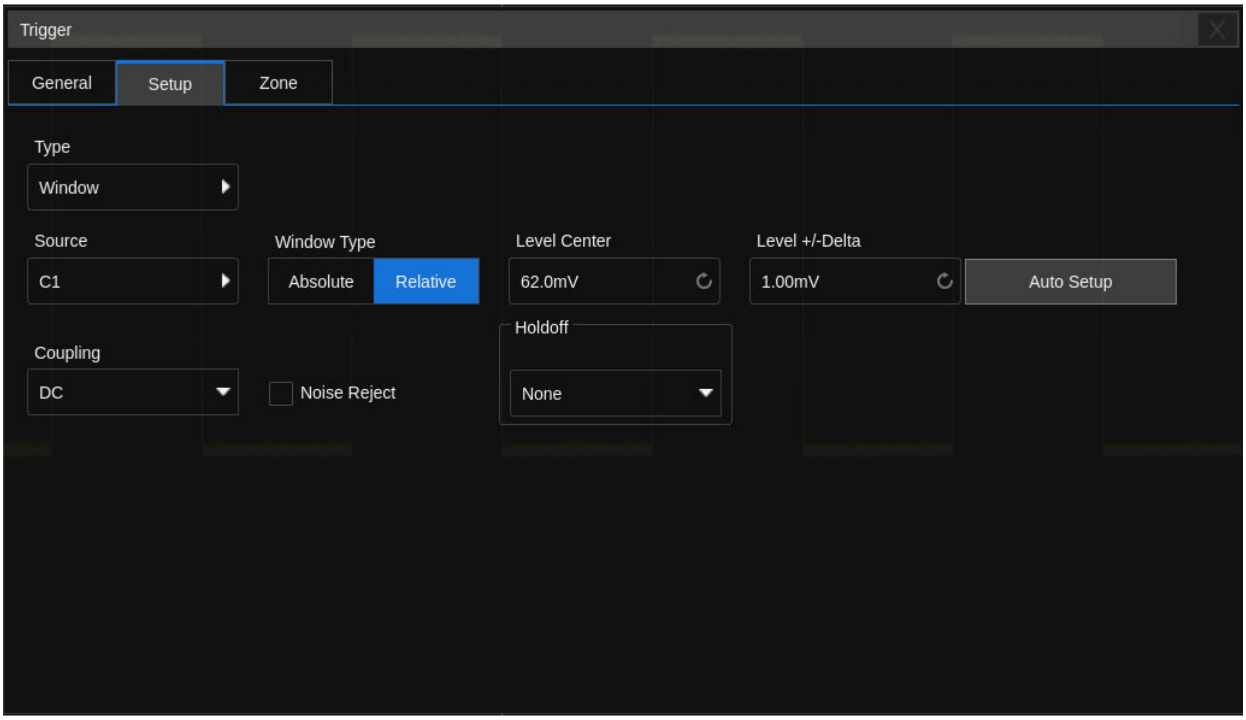
- If the lower and the upper trigger levels are both within the waveform amplitude range, the oscilloscope will trigger on both rising and falling edges.
- If the upper trigger level is within the waveform amplitude range while the lower trigger level is out of the waveform amplitude range, the oscilloscope will trigger on the rising edge only.
- If the lower trigger level is within the waveform amplitude range while the upper trigger level is out of the waveform amplitude range, the oscilloscope will trigger on the falling edge only.

To set window trigger via the Absolute window type

Refer to "Adjust Upper/Lower Level" in the section "Slope Trigger".

To set window trigger via the Relative window type

When the window trigger type is set to "Relative", click the trigger descriptor box. The pop-up menu will show two user-defined parameters: “Level +/-Delta" and "Level Center"



The above two parameters can be set in the following way:

Select the parameter in the *Level +/-Delta* area of the quick menu, then set the parameter value by the virtual keypad, or the multi-functional knob or the mouse wheel. Setting the center level is similar. In the trigger descriptor box, the current active level is displayed. "C" represents center level, "D" represents scale.

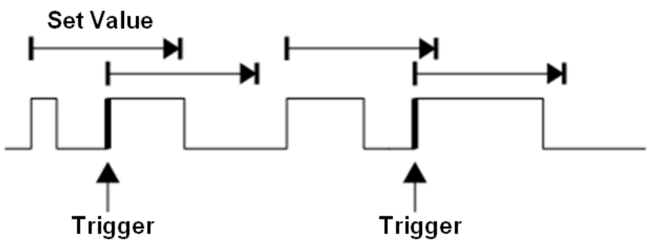
Note:
"Level +/-Delta" represents half of the actual window area. For example, when the value is 200mV, it represents a range of ±200 mV, which is a 400mV window.

Holdoff, coupling, and noise reject can be set in the window trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

16.5.7 Interval Trigger

Trigger when the time difference between the neighboring rising or falling edges meets the time limit condition.

When the trigger condition is set as an interval between two neighboring rising edges and it is less than the set time value, the trigger diagram is as follows:



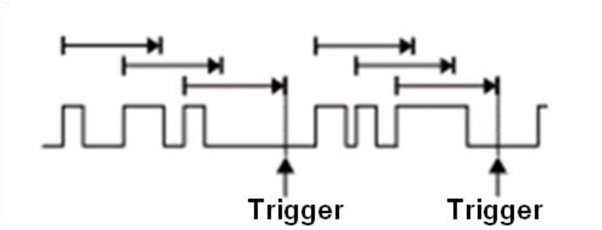
Trigger source, slope (rising, falling), limit range, and time value can be set in the trigger dialog box. Holdoff, coupling, and noise reject can be set in interval trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

16.5.8 Dropout Trigger

Dropout trigger includes two types: Edge and State.

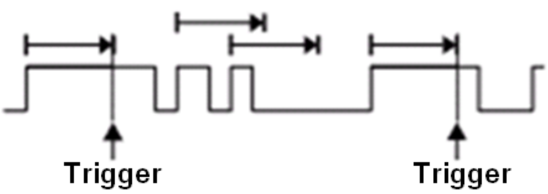
Edge

Trigger when the time interval (△T) from when the rising edge (or falling edge) of the input signal passes through the trigger level to when the neighboring rising edge (or falling edge) passes through the trigger level is greater than the set time, as shown in the figure below:



State

Trigger when the time interval (△T) from when the rising edge (or falling edge) of the input signal passes through the trigger level to when the neighboring falling edge (or rising edge) passes through the trigger level is greater than the set time, as shown in the figure below:



Trigger source, slope (rising, falling), dropout type, and time value can be set in the trigger dialog box.

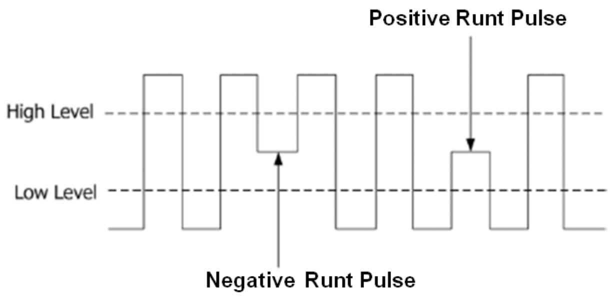
Holdoff, coupling, and noise reject can be set in the dropout trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

Note:

Under dropout trigger, selecting the upper or lower edge refers to calculating the timeout time from the edge, and the waveform may not necessarily be triggered on the edge. As long as the set time value is less than △T, the waveform is triggered from the selected edge to the position where the set time value is met.

16.5.9 Runt Trigger

Runt trigger looks for pulses that cross one threshold but not another as shown in the figure below:

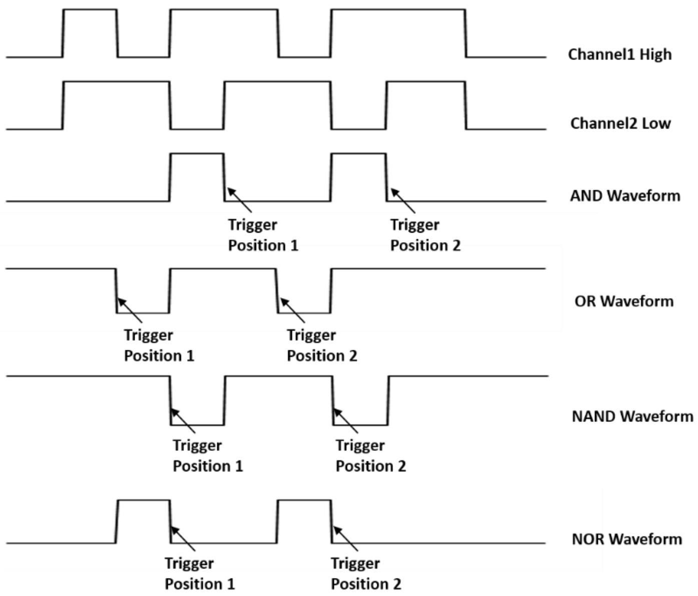


- A positive runt pulse across through the low level but not the high level.
- A negative runt pulse across through the high level but not the low level.

Holdoff, coupling, and noise reject can be set in the dropout trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

16.5.10 Pattern Trigger

The Pattern trigger identifies a trigger condition by looking for a specified pattern. The device provides 4 patterns: logical AND, OR, NAND and NOR combination of the channels. Each channel can be set to "Low", "High" or "Don't Care". If all channels are set to "Don't Care", the oscilloscope will not trigger. The result after the logical operation is triggered from true to false, that is, triggers on the falling edge of the combined waveform.

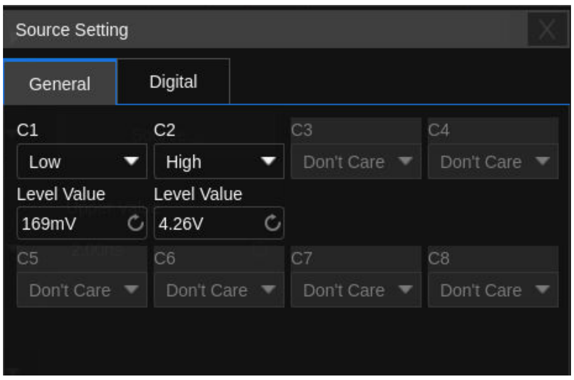


Logic (AND, OR, NAND, NOR), source, limit range, and time value can be set in the trigger dialog box.

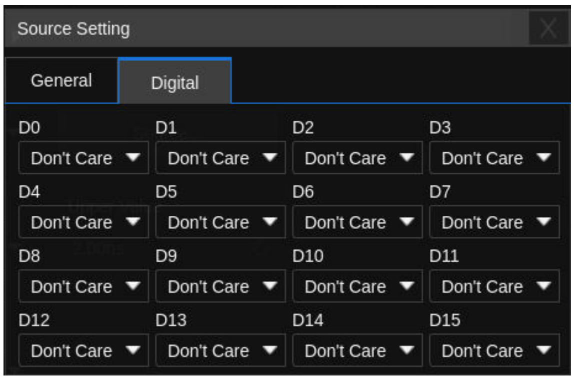
Source Setting

Click the *Source Setting* area to recall the following dialog box and set up for each channel separately. Each channel can be set to "Low", "High" or "Don't Care". The threshold can be determined by setting the *Level Value* .

When digital channels are turned on, the logic state of the digital channel can also be set in the source setting dialog box.



The logical setting of analog channels



The logical setting of digital channels

Limit Range

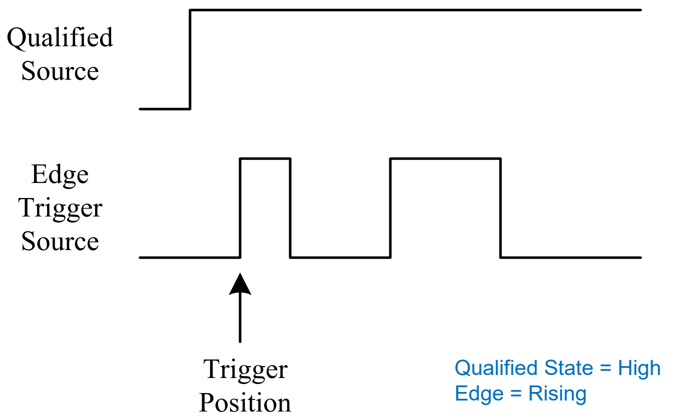
This setting is particularly useful to filter the hazard signals of combinational logic. When multiple triggering positions simultaneously meet the pattern trigger conditions, a specific time value can be set to trigger the oscilloscope at the code type combination position that meets the time value. This setting is particularly useful when filtering hazards in a combinational logic.

Holdoff can be set in pattern trigger, see the section "Holdoff" for details.

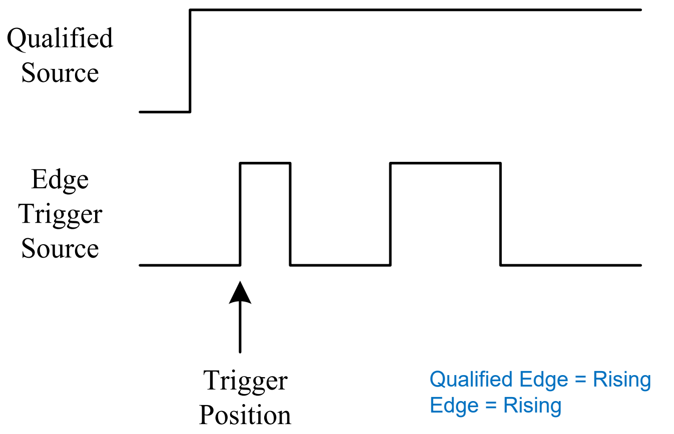
16.5.11 Qualified Trigger

The qualified trigger is an edge trigger after a user-defined qualified condition is satisfied. So a qualified trigger has two sources; one is the source of the edge trigger, and the other is the qualified source.

The qualified types include “State”, “State with Delay”, “Edge”, and “Edge with Delay”. When the type is “State”, the oscilloscope triggers on the first edge when the qualified source is in the specified state (High or Low). When the type is “State with Delay”, a time limit condition is also available.



When the type is “Edge”, the oscilloscope triggers at the first edge after the specified edge (Rising or Falling) of the qualified source; when the type is “Edge with Delay”, a time limit condition is available.



Click the *Qualify Setting* region to set the qualified source and threshold; Click the *Edge Setting* region to set the edge trigger source, threshold, and slope.

16.5.12 Nth Edge Trigger

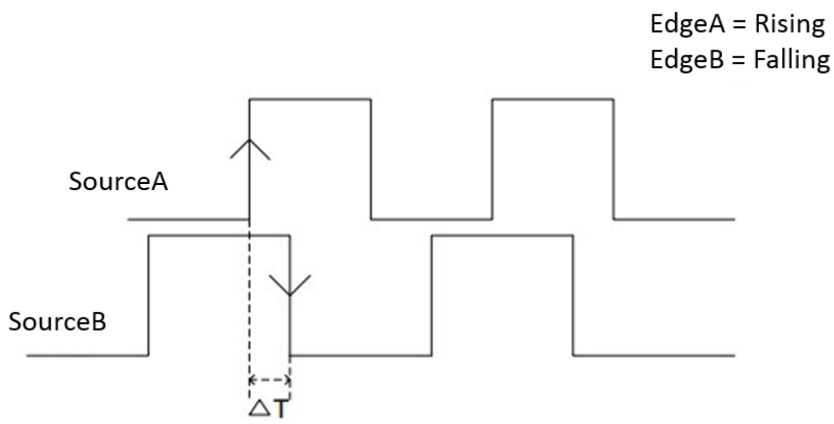
Nth edge trigger is similar to an edge trigger with conditions. The trigger is satisfied after meeting the user-defined idle time and edge number conditions. As shown in the figure below, when the idle time between the pulse trains is greater than the specified idle time, it is triggered on the third falling edge of the pulse train.

Trigger source, slope (rising, falling), idle time, and edge number can be set in the trigger dialog box.

Holdoff, coupling, and noise reject can be set in the Nth edge trigger, see the sections "Holdoff", "Trigger Coupling" and "Noise Reject" for details.

16.5.13 Delay Trigger

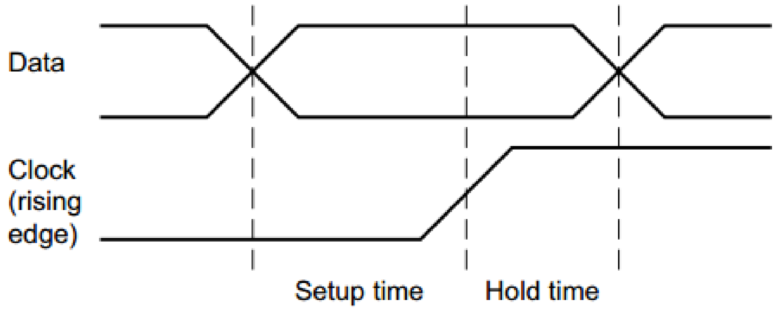
A delay trigger is true when the edge of source B occurs after meeting the set conditions of source A and a user-defined delay time. The setting of source A is similar to that of the pattern trigger and can be used for logical "and" combination of multiple channels. The slope in the source A setting refers to the *Slope* of the combined logical results in the *Source Setting* .



Click the *SourceB Setting* region to set the edge trigger source and slope. Click the *Limit Range* and *Upper / Lower Value* region to set the delay time condition.

16.5.14 Setup/Hold Trigger

The clock and data sources need to be set in the setup/hold trigger setting. The set-up time starts when the data signal crosses the trigger level and ends when the specified clock edge arrives. The holding time starts when the specified clock edge arrives and ends when the data signal crosses the trigger level again (as shown in the figure below). When the set-up time or hold time meets the preset time limit conditions, the oscilloscope will trigger.



Click the *Clk Setting* region to set the clock source, threshold, and slope; Click the *Data Setting* region to set the data source, threshold, and state.

16.5.15 Serial Trigger

Refer to Chapter "Serial Trigger and Decode" for detailed information.

16.6 Trigger Source

The trigger sources supported by each trigger type are different. See the table below for details :

Trigger Type	C1~C8	EXT, EXT/5	AC Line	D0~D15
Edge	√	√	√	√
Slope	√	×	×	×
Pulse	√	×	×	√
Video	√	×	×	×
Window	√	×	×	×
Interval	√	×	×	√
Dropout	√	×	×	√
Runt	√	×	×	×
Pattern	√	×	×	√
Serial	√	×	×	√
Qualified	√	×	×	√
Nth Edge	√	×	×	√
Delay	√	×	×	√
Setup/Hold	√	×	×	√

16.7 Holdoff

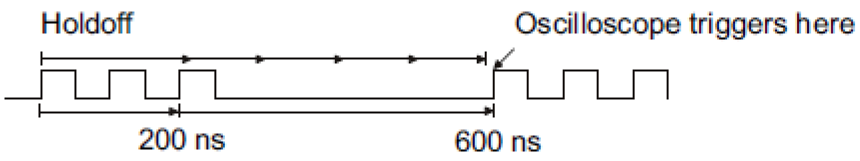
Holdoff is an additional condition for triggers and can be used to stabilize the triggering of complex waveforms (such as a pulse series). It can be set to a time or number of events.

Holdoff by Time

Holdoff time is the amount of time that the oscilloscope waits before re-arming the trigger circuitry. The oscilloscope will not trigger until the holdoff time expires.

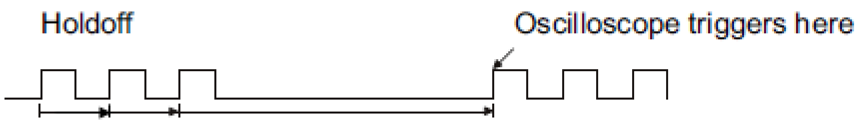
Use the holdoff to trigger on repetitive waveforms that have multiple edges (or other events) between waveform repetitions. You can also use holdoff to trigger on the first edge of a burst when you know the minimum time between bursts.

For example, to achieve a stable trigger on the repetitive pulses shown in the figure below set the holdoff time (t) to 200ns<t<600ns.

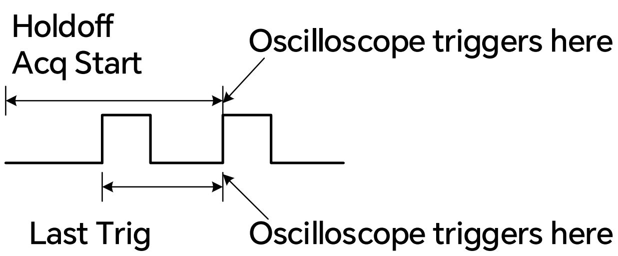


Holdoff by Event

The Holdoff event sets the number of events that the oscilloscope counts before re-arming the trigger circuitry. The oscilloscope will not trigger until the counter that tracks holdoff events reaches the set value. In the following figure, the holdoff event is set to 3, and the signal is triggered on the fourth edge.



Parameter **Start Holdoff On** defines the initial position of holdoff. It characterizes the relationship between the initial starting position of each holdoff and the previous triggering position.



Acq Start -- The initial position of holdoff is the first-time point satisfying the trigger condition. In the example above, each holdoff starts from the first rising edge of the pulse sequence, the triggering interval is always greater than one pulse cycle.

Last Trig Time --The initial position of holdoff is the time of the last trigger. In the example above, the last trigger position is at the first rising edge of the pulse sequence and the holdoff starts from that point, the triggering interval is equal to one pulse cycle.

16.8 Trigger Coupling

The coupling setting of a trigger is only valid when the trigger source is C1~C8, EXT, or EXT/5.

DC: All of the signal's frequency components are coupled to the trigger circuit for high-frequency bursts or where the use of AC coupling would shift the effective trigger level.

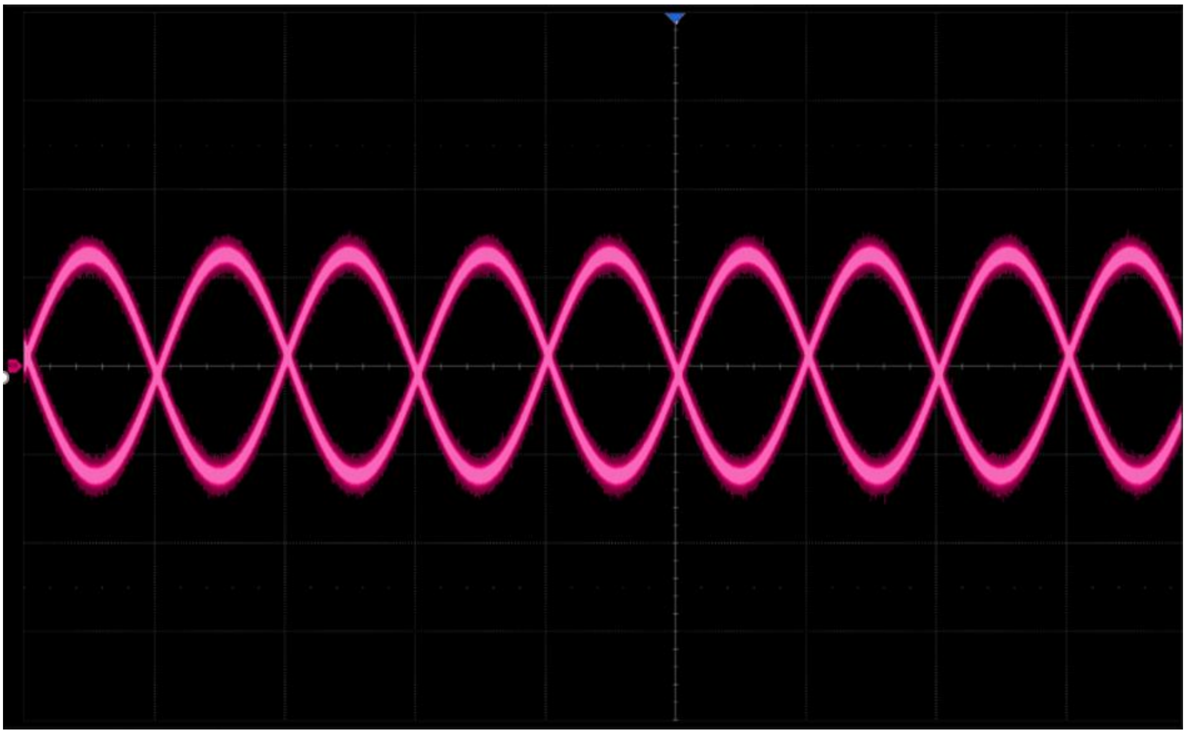
AC: The signal is capacitively coupled. DC levels are rejected. See the datasheet for details of the cut-off frequency.

HFR: Signals are DC coupled to the trigger circuit and a low-pass filter network attenuates high frequencies (used for triggering on low frequencies). See the datasheet for details of the cut-off frequency.

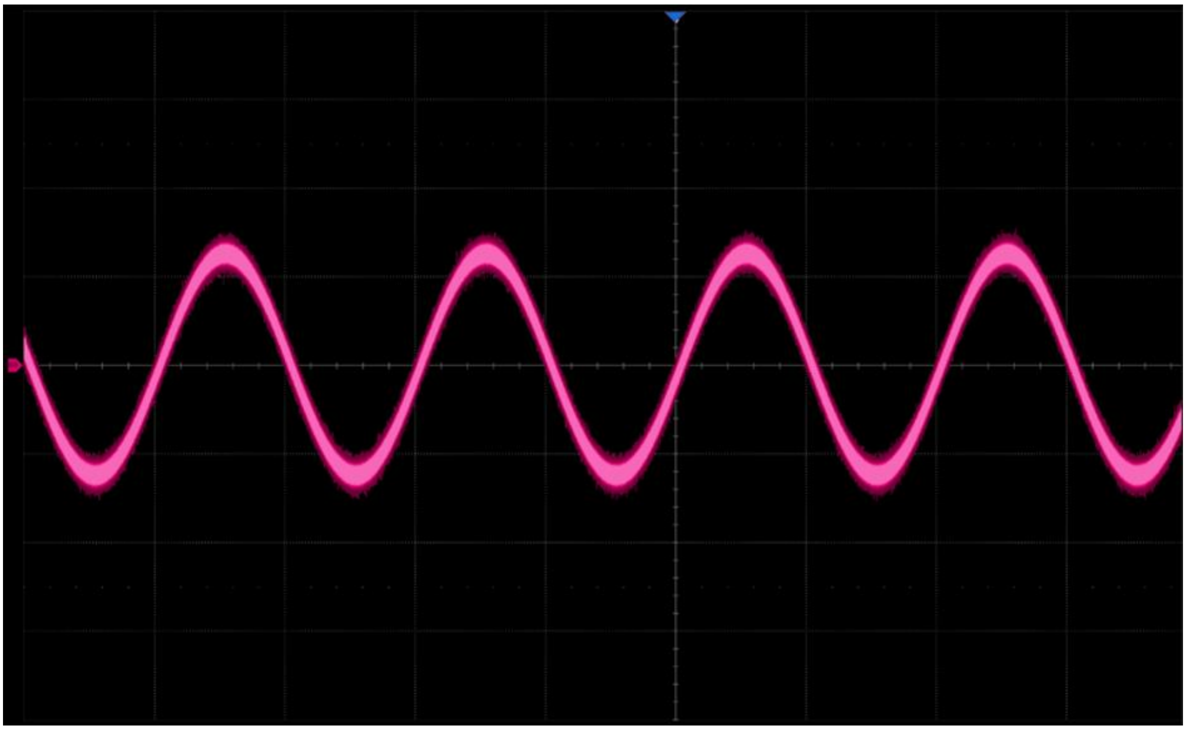
LFR: The signal is coupled through a capacitive high-pass filter network, DC is rejected and low frequencies are attenuated. For stable triggering on medium to high-frequency signals. See the datasheet for details of the cut-off frequency.

16.9 Noise Reject

Noise Reject adds additional hysteresis to the trigger circuitry. By increasing the trigger hysteresis, the noise immunity becomes better but the trigger sensitivity degrades.



Noise Reject = Off

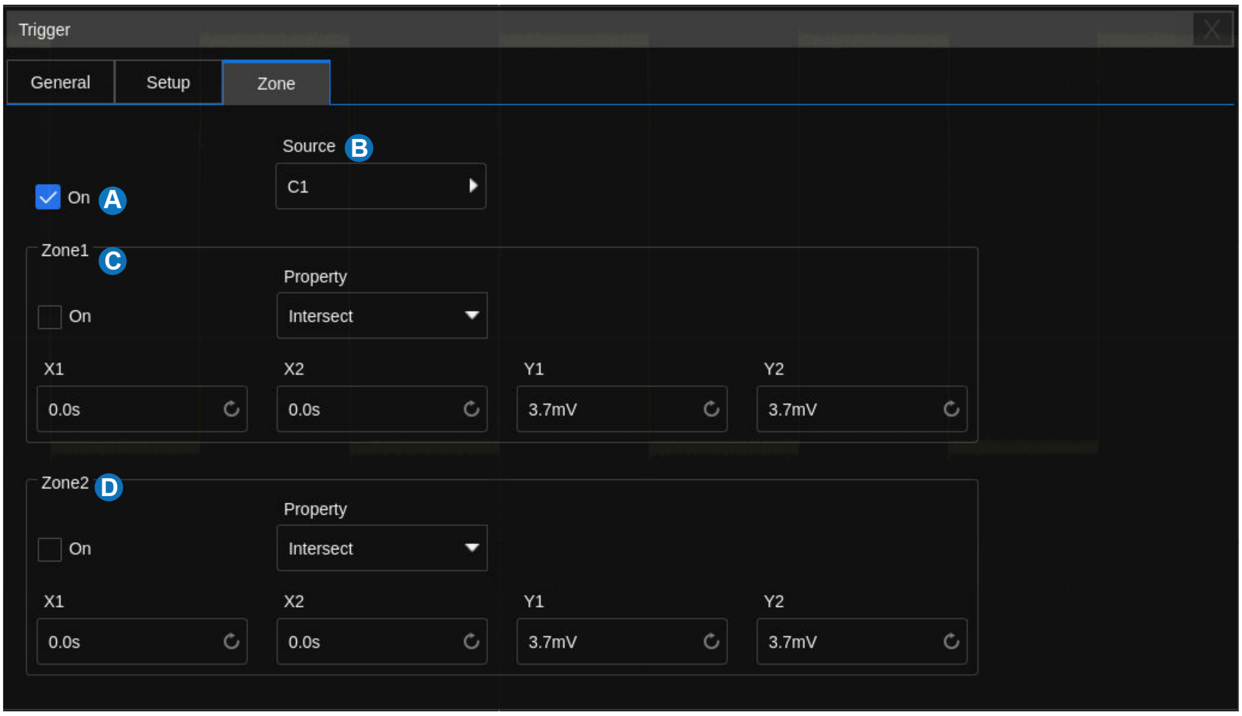


Noise Reject = On

16.10 Zone Trigger

The device includes a zone trigger to help isolate elusive glitches. There are two user-defined areas: Zone1 and Zone2. Users can set the property of each zone as "intersect" or "not intersect" as an additional condition to further isolate the interesting event quickly. "Intersect" only includes events that occur within the zone. "Not-intersect" events include all events that occur outside of the zone.

Click *Trigger* > *Zone* to recall zone dialog box:



A. Turn on/off zone trigger

B. Select the source: C1~ C8

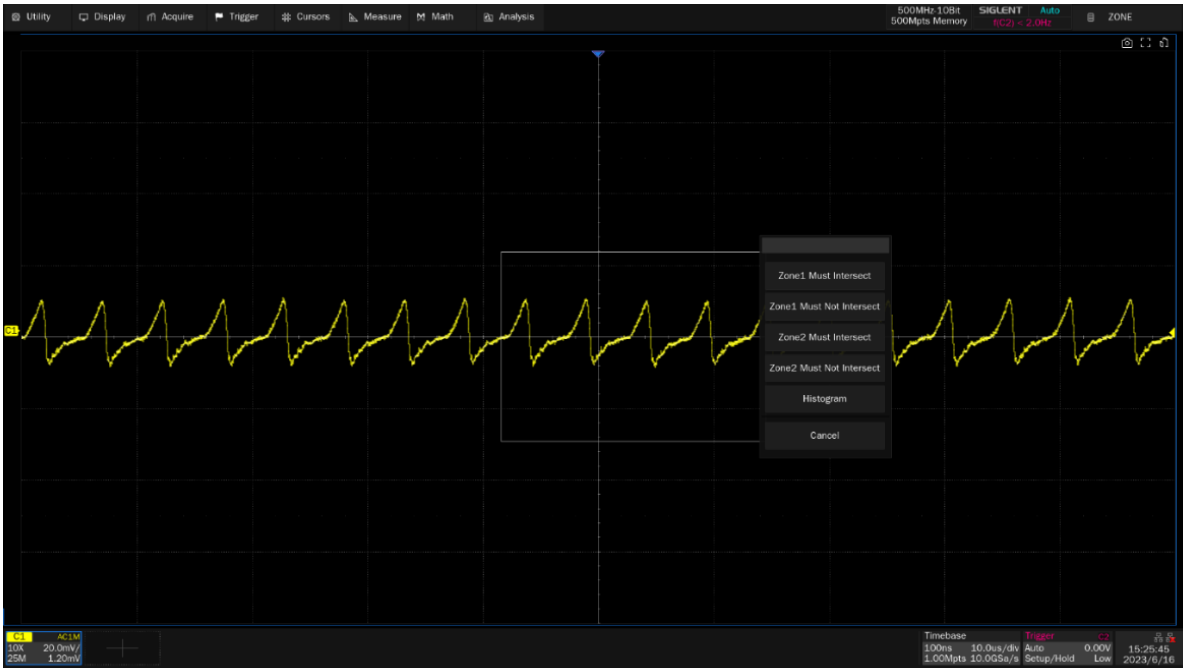
C. Zone1 Parameter settings. Turn on or off zone1. Set the property of zone1: Intersect or Not Intersect. Set the coordinate of zone1. The range is within the waveform area.

D. Zone2 Parameter settings. Turn on or off zone2. Set the property of zone2: Intersect or Not Intersect. Set the coordinate of zone2. The range is within the waveform area.

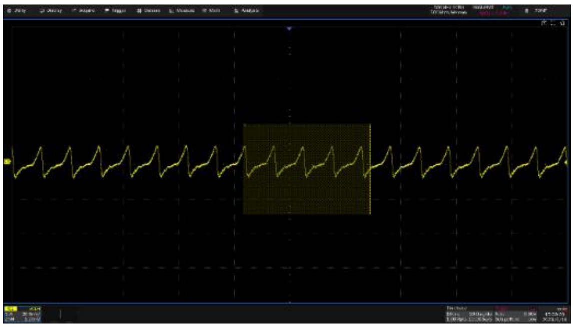
The zones can be created and moved by the mouse or by setting *Zone Setting* in the dialog box. The color of the zone's outline is consistent with the color of the specified source (Channel 1 = Yellow, etc...).

Mouse

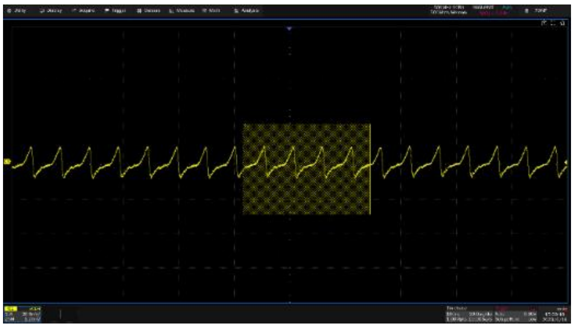
When the zone trigger is turned on, click-and-hold on any position within the waveform area and draw a rectangular box, as shown in the following figure:



Once a zone is created, it can be moved by dragging.



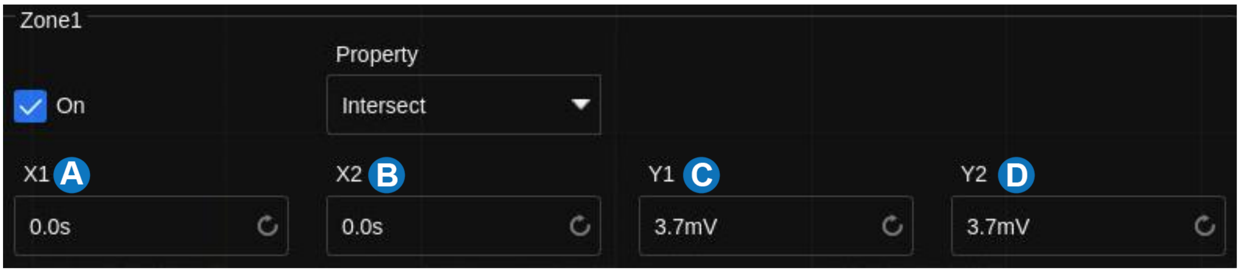
Select C1 as the source, turn on zone1, and set the property as "Intersect"



Select C1 as the source, turn on zone1, and set the property as "Not Intersect"

Dialog Box

Click *Trigger* > *Zone* to recall the dialog box.



A. Set the left border of the zone

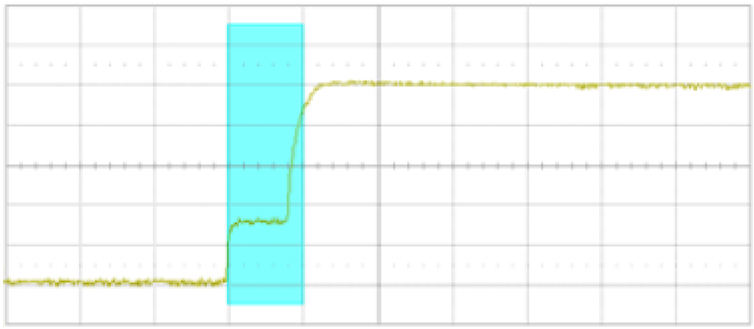
B. Set the right border of the zone

C. Set the top border of the zone

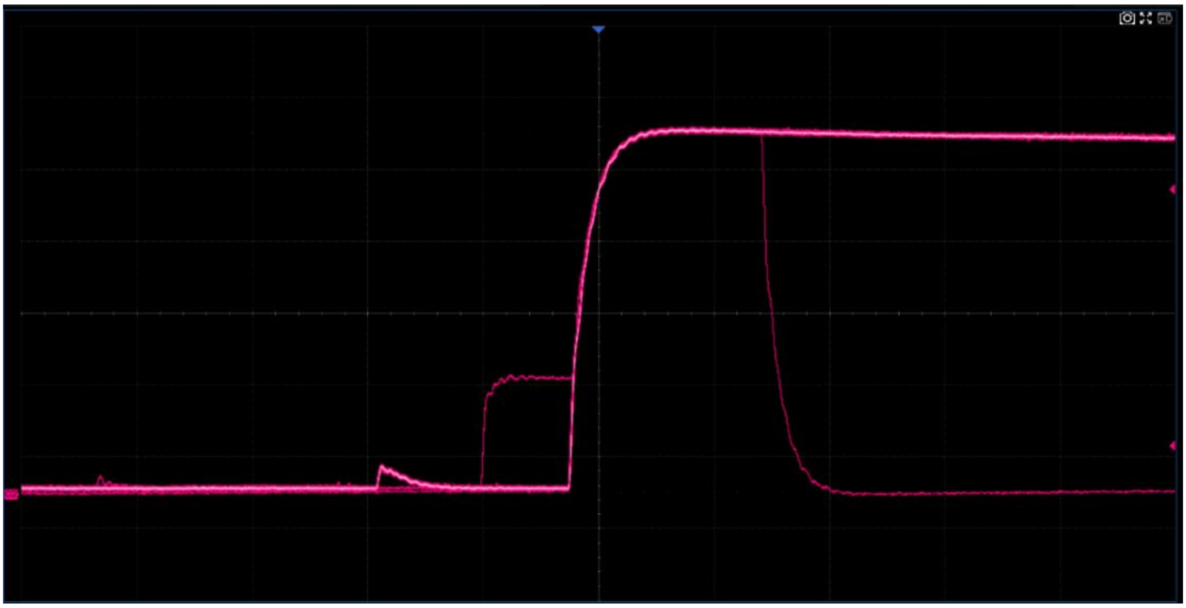
D. Set the bottom border of the zone

	Note: If zone1 and zone2 are both turned on, the result of the "AND" operation in two zones becomes the qualified condition of triggering.

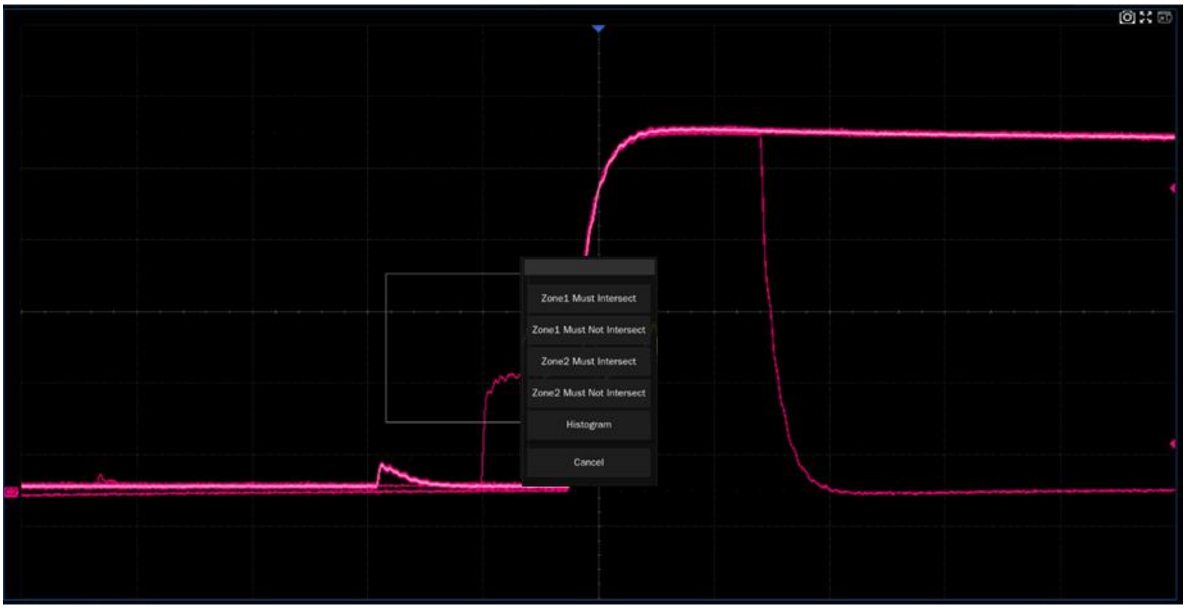
Below is an example in which we want to capture a waveform of bus contention using the device :



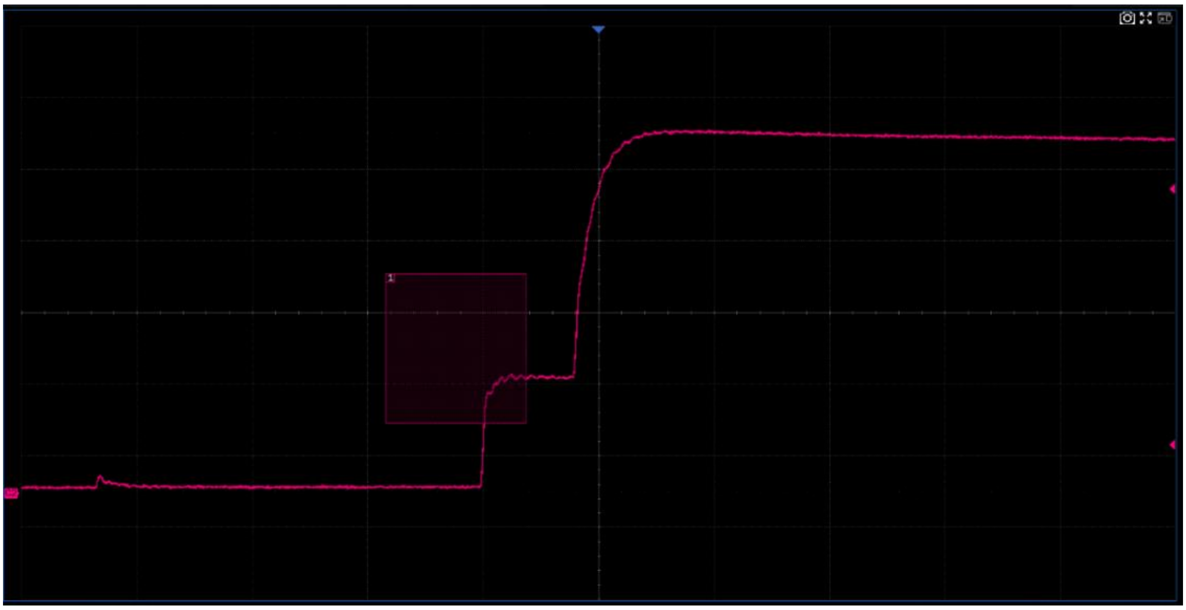
With a simple edge trigger, it is unlikely to trigger consistently on this anomaly. Thanks to the high waveform update rate of the device, we can confirm there is bus contention happening by enabling the persistence display, as shown in the figure below:



In this case zone trigger is a quick and simple way to capture the waveform. Enable the zone trigger, and draw a box to intersect with the bus contention part, as shown in the figure below:



Now, we can accurately capture the exact bus contention waveform:

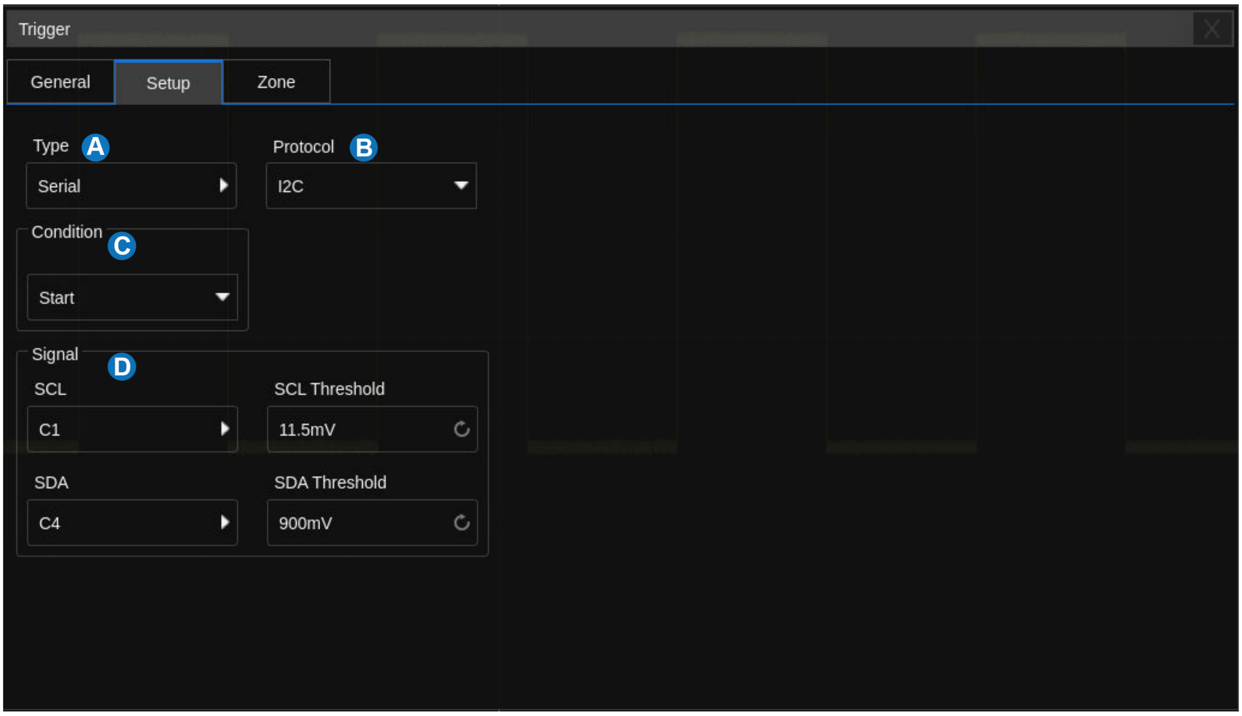


17 Serial Trigger and Decode

17.1 Overview

The device supports serial bus trigger and decode on the following serial bus protocols: I2C, SPI, UART, CAN, LIN, FlexRay, CAN FD, I2S, MIL-STD-1553B, SENT, Manchester, ARINC429 and CAN XL.

Click the trigger descriptor box, and then select the *Type* as *Serial* in the trigger dialog box to set the serial trigger:



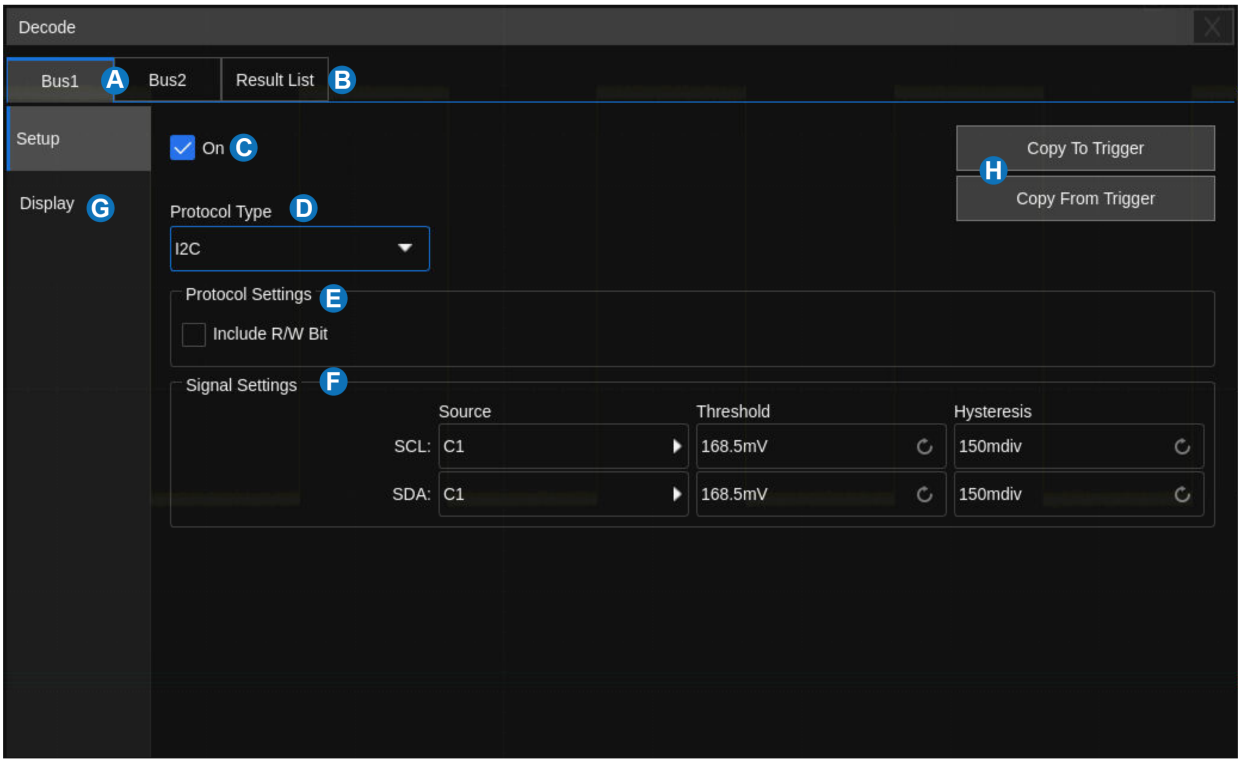
A. Select the type as *Serial*

B. Select the serial bus protocol

C. Set the trigger condition

D. Set the signal, including the mapping relation between channels and bus signals, and the thresholds

Perform *Analysis* > *Decode...* to turn on the serial decode dialog box:



A. Select the bus to set, Bus1 or Bus2

B. Set the list of decoded results

C. Turn on/off the bus

D. Select the serial bus protocol

E. Configure the bus protocol

F. Click to set the signal, including the mapping relation between channels and bus signals, and the thresholds. This is similar to the signal setting of a serial trigger.

G. Set the bus position and display format (Binary, Decimal, Hex, and ASCII)

H. Synchronize the settings between a serial trigger and decode

	Note: The synchronization is not automatic. If the settings in one place change, a copy operation is necessary to re-synchronize.

Below are detailed descriptions of the trigger and decode steps for each protocol.

- I2C Trigger and Serial Decode
- SPI Trigger and Serial Decode
- UART Trigger and Serial Decode
- CAN Trigger and Serial Decode

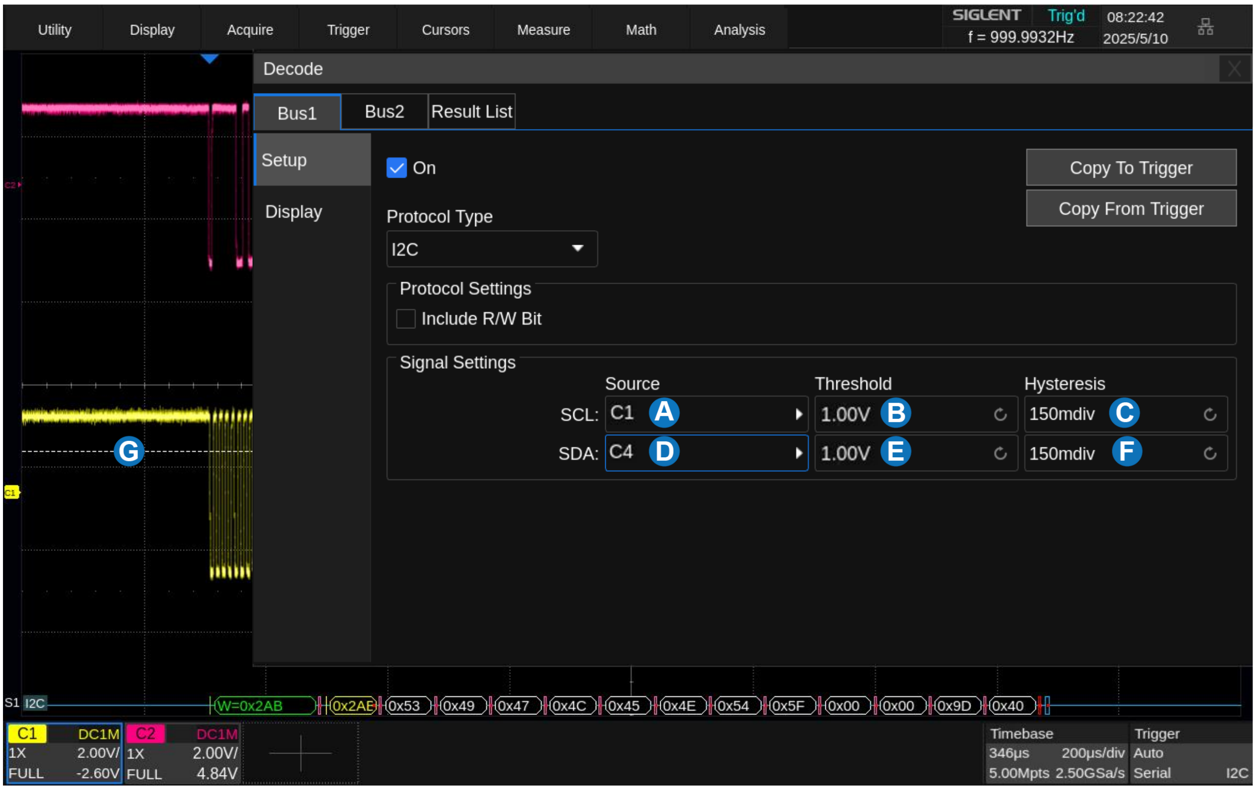
- LIN Trigger and Serial Decode
- FlexRay Trigger and Serial Decode
- CAN FD Trigger and Serial Decode
- I2S Trigger and Serial Decode
- MIL-STD-1553B Trigger and Serial Decode
- SENT Trigger and Serial Decode
- Manchester Serial Decode
- ARINC 429 Trigger and Serial Decode
- CAN XL Serial Decode

17.2 I2C Trigger and Serial Decode

This section covers triggering and decoding I2C signals. Please read the following for more details: "I2C Signal Settings", "I2C Trigger" and "I2C Serial Decode".

17.2.1 I2C Signal Settings

Connect the serial data signal (SDA) and the serial clock signal (SCL) to the oscilloscope, set the mapping relation between channels and signals, and then set the threshold level of each signal. The signal settings of the decode and trigger are independent. If you want to synchronize the settings between decode and trigger, please perform *Copy To Trigger* or *Copy From Trigger* in the decode dialog box.



A. Set the source of SCL. In the example above, SCL is connected to C1.

B. Set the threshold level of SCL. It is 1.00V for the LVTTL signal in this example.

C. Set the hysteresis of SCL

D. Set the source of SDA. In the example above, SDA is connected to C4.

E. Set the threshold level of the SDA channel.

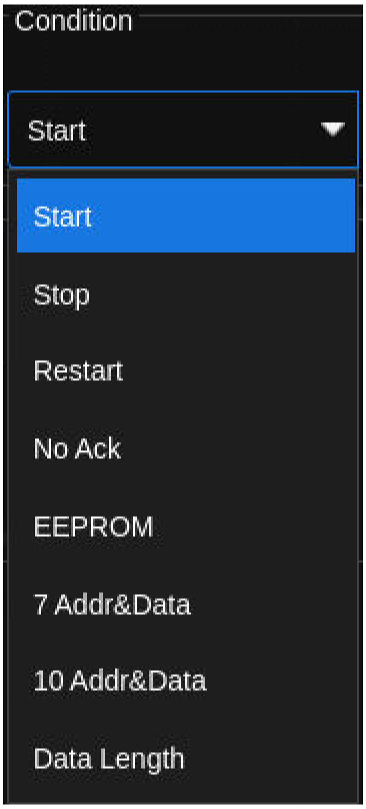
F. Set the hysteresis of SDA

G. Threshold level line. It only appears when adjusting the threshold level.

17.2.2 I2C Trigger

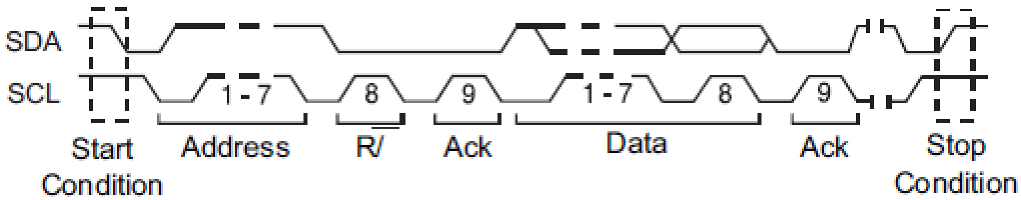
When the protocol is set to I2C, the following trigger conditions can be set: Start, Stop, Restart, No Ack, EEPROM, or an R/W frame with a specific device address and data value.

Switch to the *Setup* tab in the I2C trigger dialog box to select the trigger condition:



Start -- The oscilloscope will be triggered when the SDA line transitions from high to low while the SCL is high.

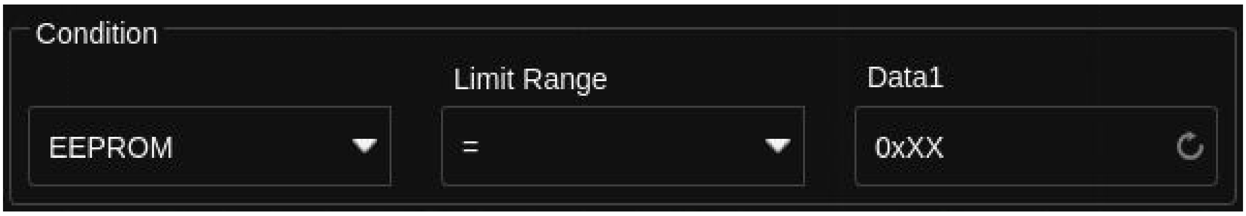
Stop -- The oscilloscope will be triggered when the SDA line transitions from low to high while the SCL is high.

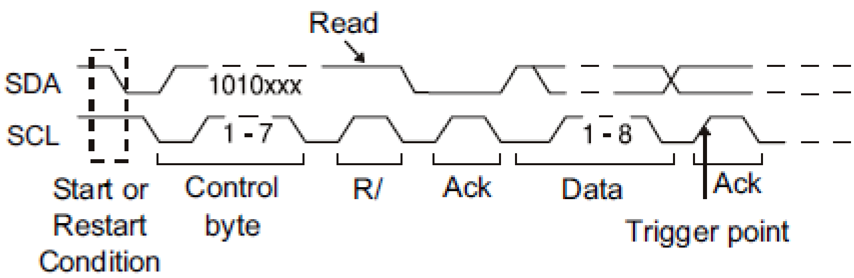


Restart -- The oscilloscope will be triggered when another “Start” occurs before a “Stop".

No Ack -- The oscilloscope will be triggered when the SDA line is high during any SCL’s ACK bit.

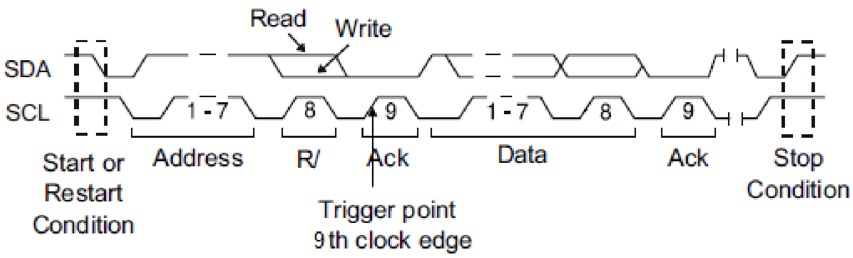
EEPROM -- The trigger searches for EEPROM control byte value 1010xxx on the SDA bus. And there is a Read bit and an ACK bit behind EEPROM. Set the data value and compare type according to *Data1* and *Limit Range* . If EEPROM’s data is greater than (less than, equal to) *Data1* , the oscilloscope will be triggered at the edge of the ACK bit behind the Data byte. The Data byte doesn’t need to follow the EEPROM.



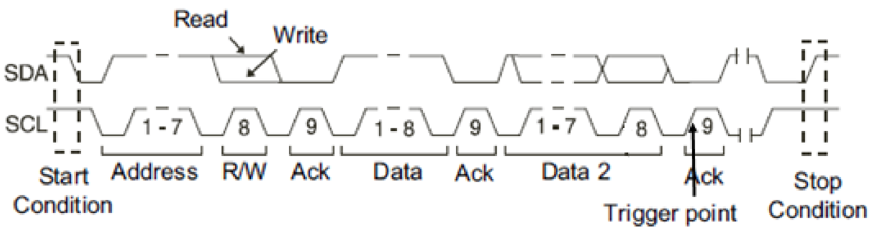


7 Address & Data -- the oscilloscope will be triggered on the read or write frame in 7-bit address mode.

Frame (Start: 7-bit address: R/W: Ack) -- Data1 and Data2 are set to “0xXX”. If all bits match, then trigger on the Ack bit followed by the R/W bit.

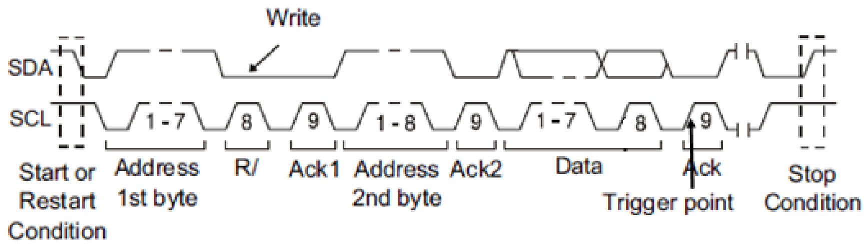


Frame (Start: 7-bit address: R/W: Ack: Data: Ack: Data2) -- If all bits match, then trigger on the Ack bit followed by the Data2.

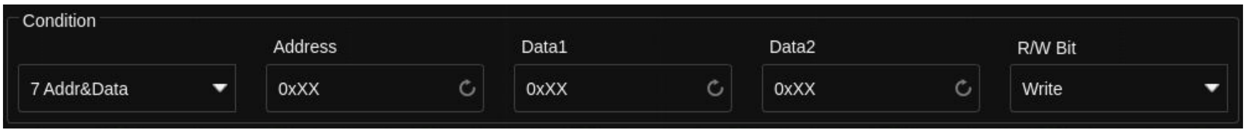


10 Address & Data -- If all bits match, then trigger on the Ack bit followed by the Data.

Frame (Start: Address 1st byte: R/W: Ack: Address 2nd byte: Ack: Data)



If you set the trigger condition to 7 address & data or 10 address & data:



Address can be selected in the hexadecimal range of 0x00 to 0x7F (7-bit) or 0x3FF (10-bit). If the address is selected as "0xXX (7-bit address)" or "0xXXX (10-bit address)", the address is ignored. It will always trigger on the Ack bit followed by the address.

Data1 and *Data2* can be selected in the hexadecimal range of 0x00 to 0xFF. If the data is selected as "0xXX", the data is ignored. It will always trigger on the Ack bit followed by the address.

R/W Bit can be specified as Write, Read, or Don't Care.

Data Length -- The data length range is 1 to 12 bytes. When the SDA data length is equal to the value of Data Length and address length is the same as the set value, the oscilloscope will be triggered.

- Click the *Address Length* to select "7-bits" or "10-bits" to match the address of the input signal.
- Click the *Data Length* and roll the mouse wheel or use the virtual keypad to set the data length to match the data length of the input signal.

17.2.3 I2C Serial Decode

The layout of the display when I2C decode is enabled is as follows:

A. The waveform display area shows the original waveforms of the bus signals

B. The bus display shows the decoding result of the bus. At most two buses can be decoded at the same time. Enable *On* to turn on or off the selected bus, and click *Format* in the *Display* tab to select the display type of decode result (Binary, Decimal, Hex, or ASCII).

C. List display area. The decode result of multiple frames can be displayed in the list, in which each row shows the time label and decode result of a frame. Switch to *Result List* tab to set the parameters of the list.

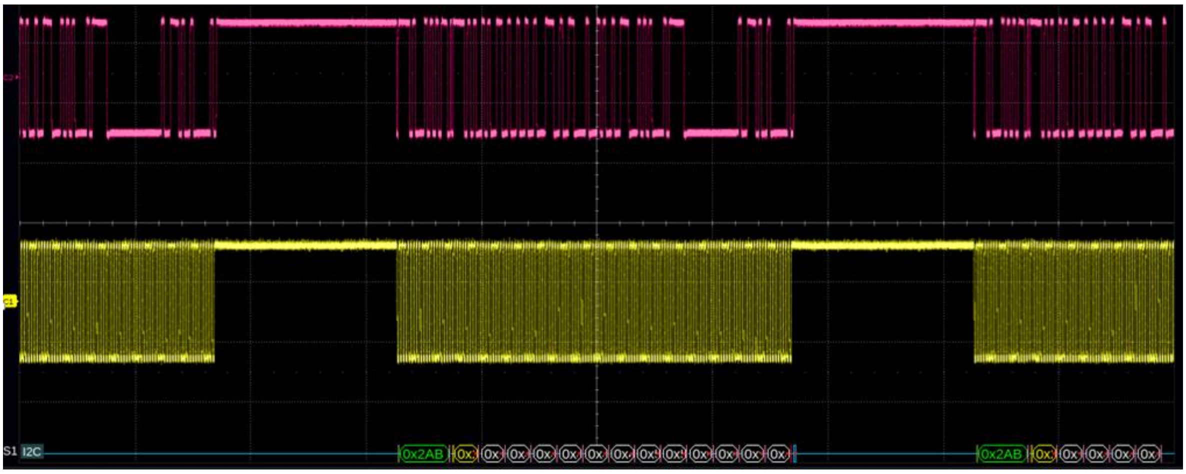
Bus

- The beginning of a frame, displayed in yellow green.
- The address value is displayed at the beginning of a frame. The write address is displayed in green and the read address is in yellow.
- W/R bit is represented by (W) and (R), followed by the address value.
- The 

after a data or address byte represents ACK (acknowledgment), and 

indicates no acknowledgment.
- The data value is displayed in white.
- The ending of a frame, displayed in blue.
- A red point at the end of a segment indicates there is not enough space on the display to show the complete content of a frame, and some content is hidden, such as 

.



- The position of the bus in the vertical direction can be adjusted by dragging with the mouse.

List

- TIME -- The horizontal offset of the current data frame head relative to the trigger position.
- Address -- Address value. For example, "0x50" means that address = 50 with no acknowledgement.
- R/W -- Read or write address.
- DATA -- Data bytes.

I2C	Time	Address	R/W	Data
1	762.400ns	0x2AB	W	
2	95.7640µs	0x2AB	R	0x53 49 47 4C 45 4E 54 5F 00 00 9D 40~A
3	1.00077ms	0x2AB	W	
4	1.09577ms	0x2AB	R	0x53 49 47 4C

Configuration

There is only one item *Include R/W Bit* in the protocol settings of the I2C decode. When it is disabled, the address is represented separately from the R/W bit, and when it is enabled, the R/W bit is represented together with the address.

For example, the address 0x50: Write: no Ack, is displayed as "0x50" when the R/W bit is not included and is displayed as "0xA1" when the R/W bit is included.

17.3 SPI Trigger and Serial Decode

This section covers triggering and decoding SPI signals. Please read the following for more details: "SPI Signal Settings", "SPI Trigger" and "SPI Serial Decode".

17.3.1 SPI Signal Settings

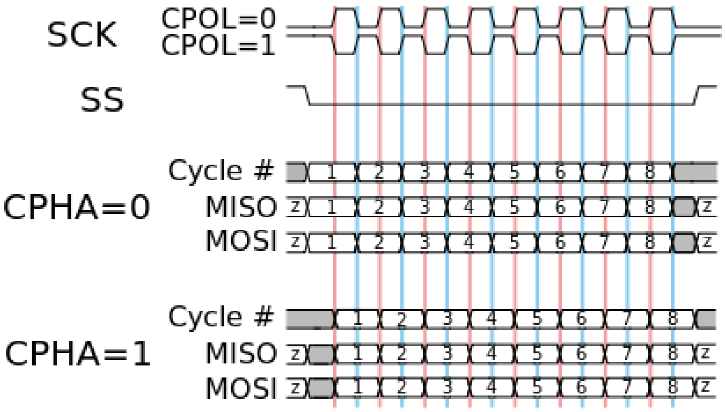
Connect the CLK, MOSI, MISO, and CS signals to the oscilloscope and set the mapping relation between channels and signals. Then set the threshold level of each signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

CLK

In addition to specifying the source and the threshold level, for the CLK signal, it is also necessary to specify the *Clock Edge* .

- Rising -- Data latched on the rising edge of the clock.
- Falling -- Data latched on the falling edge of the clock.

The user can select the edge according to the actual phase relationship between the clock and the data of the SPI bus. Referring to the following figure, when the falling edge of the clock is aligned with the data, the rising edge is selected to latch the data. When the rising edge of the clock is aligned with the data, the falling edge is selected to latch the data.



CS

The CS signal should be set to correct *CS Type* , including CS, ~CS, and Clock Timeout.

- CS -- Active high. The CS signal needs a complete rising edge in the screen to be regarded as active.
- ~CS -- Active low. The ~CS signal needs a complete falling edge in the screen to be regarded as active.
- Clock Timeout --It is not necessary to specify the source and the threshold level for the CS signal. The only parameter for the CS signal is the timeout Limit, which is the minimum time that the clock signal must be held idle before the oscilloscope acquires valid data. This setting is suitable for the case where the CS signal is not connected, or the number of oscilloscope channels is

insufficient (such as two-channel oscilloscopes).

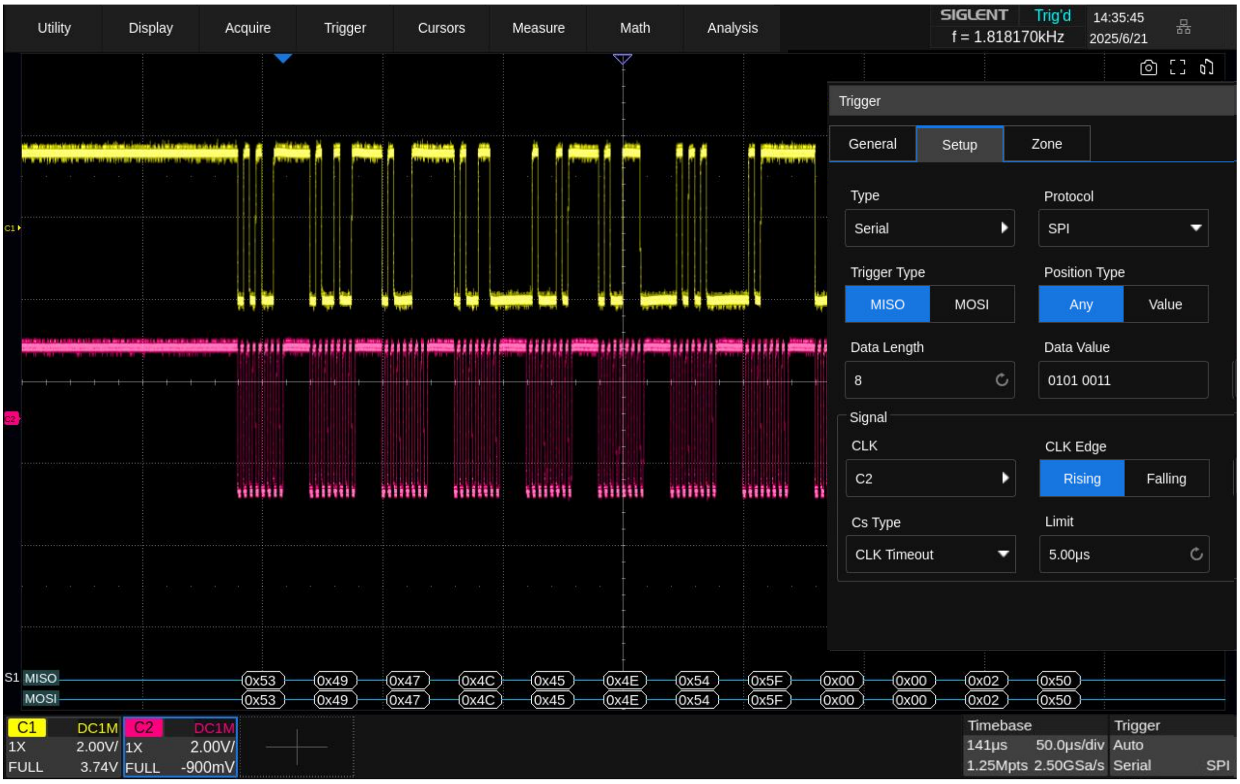
The method of copying settings is the same as I2C signal settings. See "I2C Signal Settings" for details.

Example:

Connect the data, CLK, and ~CS signals of an SPI bus respectively to C1, C2, and C3. Data width = 8-bit, Bit order = MSB, CS polarity = active low, and 12 data bytes are transmitted in one frame.

In the SPI trigger signal menu, set the source and threshold of CLK, MISO, and CS signals, then copy the trigger settings to decoding. Adjust the timebase, so that there is a falling edge on the CS signal shown on the screen:

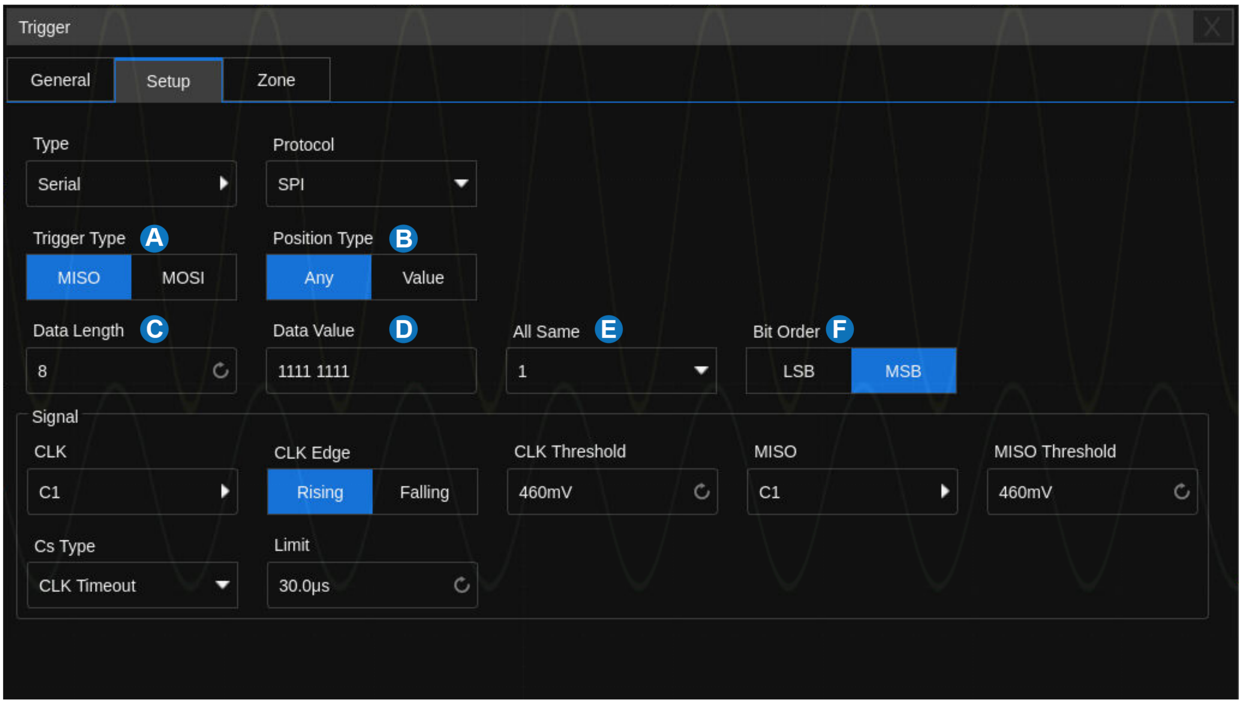
When the CS type is set to Clock Timeout, turn on Cursor, measure the clock idle time between frames as 150 us, and measure the interval between clock pulses as 1.28 us, then set the timeout to a value between 1.28 us and 150 us. In this example it is set to 5 us:



If the data width is set to be greater than 8 bits (such as 16 bits), measure the clock idle time between 8-bit data packets as 12 us, and then set the timeout time to a value between 12 and 150 us. In this example, it is set to 15 us:

17.3.2 SPI Trigger

The trigger condition for the SPI trigger is mainly about data. Switch to the *Setup* tab in the dialog box to set data:



A. Trigger Type: MISO or MOSI

B. Set the position type

C. Specify the data length for each SPI frame, with a range of 4-96 bit

D. Set to trigger on the specified data value. Click *Data Value* twice, and enter the value by the virtual keypad.

E. Set all bits to 0, 1, or ignored ("X")

F. Set the bit order to MSB or LSB

17.3.3 SPI Serial Decode

The configuration of SPI decoding is similar to I2C.

In the *Protocol Settings* menu, Data Length (4-32 bit) and Bit Order (LSB or MSB) are configurable.

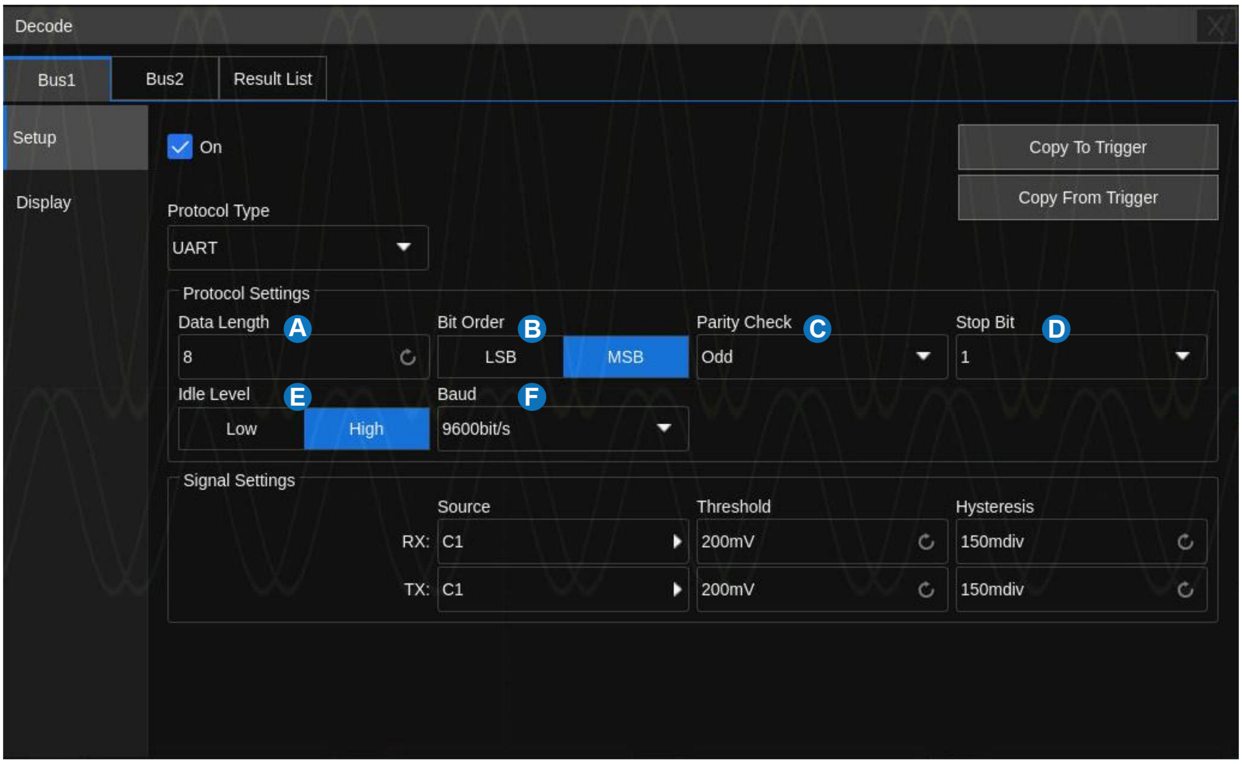
17.4 UART Trigger and Serial Decode

This section covers triggering and decoding UART signals. Please read the following for more details: "UART Signal Settings", "UART Trigger" and "UART Serial Decode".

17.4.1 UART Signal Settings

Connect the RX and TX signals to the oscilloscope, set the mapping relation between channels and signals, and then set the threshold level of each signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

In the *Setup* tab of the trigger or *Protocol Settings* menu of the decode , the following parameters are available:



A. Data Length: 5~8 bit

B. Set the bit order

C. Parity Check: None, Odd, Even, Mark, or Space. If the data is 9 bits, the 9th bit is treated as Mark parity or Space parity

D. Select the number of stop bits (1, 1.5, 2)

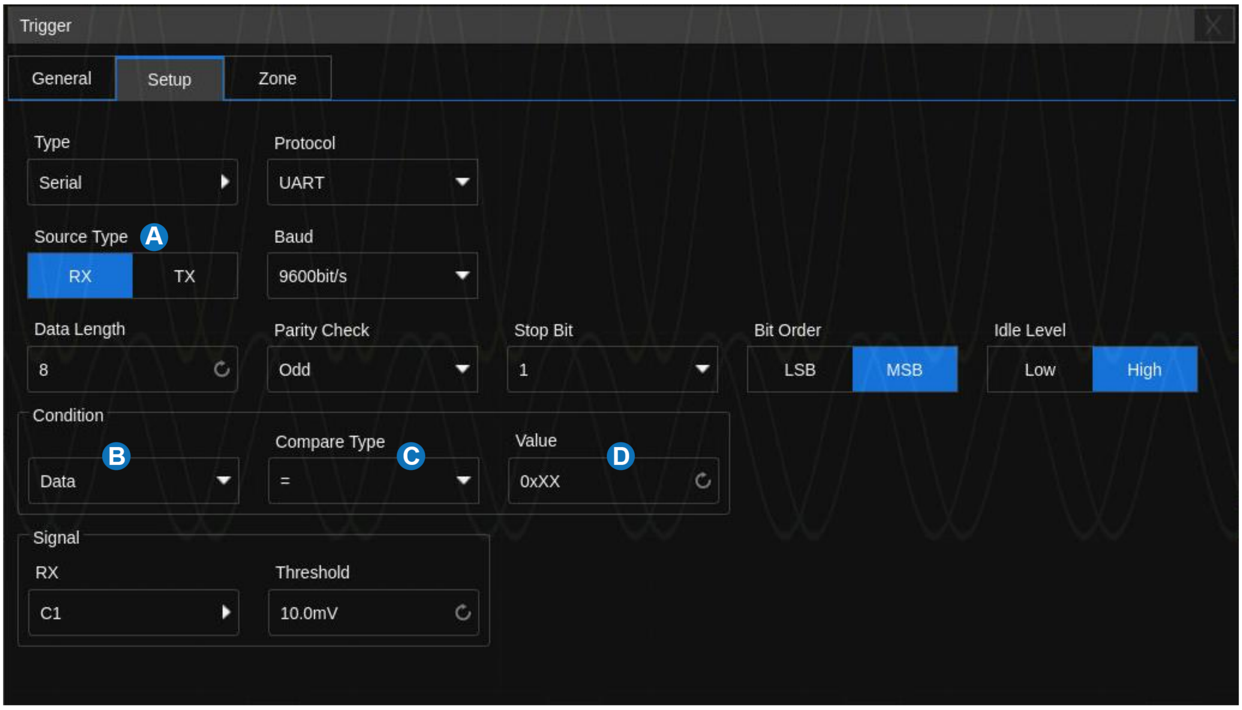
E. Set the idle level

F. Click to select the baud rate: 600,1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 b/s or Custom

The method of copying settings is the same as I2C signal settings. See "SPI Signal Settings" for details.

17.4.2 UART Trigger

Switch to the *Setup* tab in the dialog box to set the trigger condition:



A. Source Type: RX or TX

B. Trigger condition: Start, Stop, Data or Error

C. When the "trigger condition" is Data, set the compare type to =, >, <

D. When the "trigger condition" is Data, set the data value

Trigger Condition

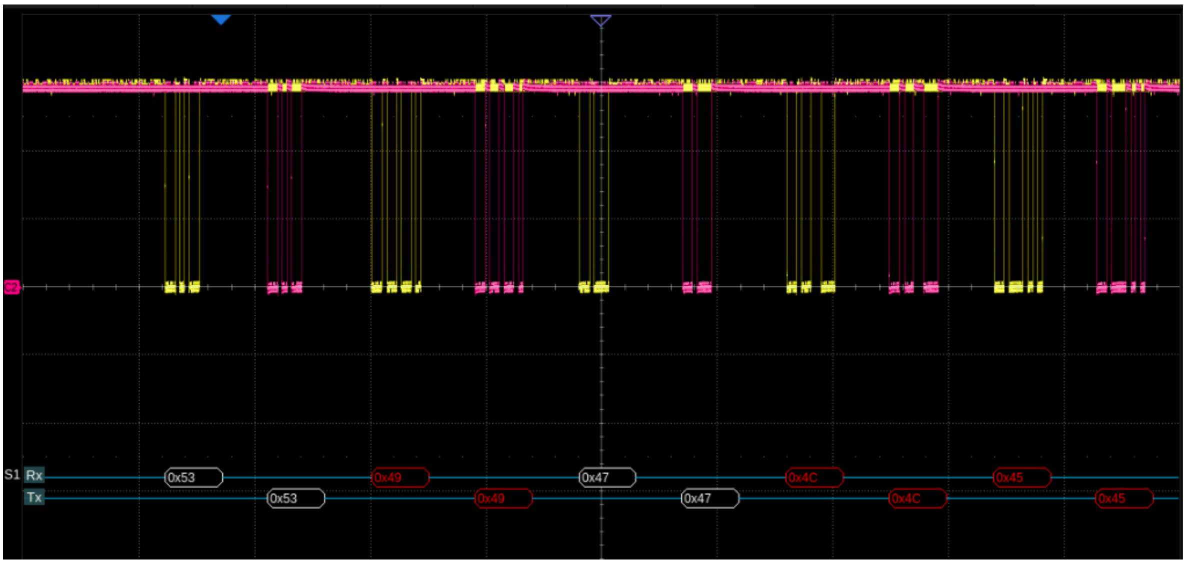
- **Start** -- The oscilloscope triggers when the start bit appears on the RX/TX.
- **Stop** -- The oscilloscope triggers when the stop bits appear on the RX/TX. It always triggers on the first stop bit.
- **Data** -- Trigger on data
  - Click *Compare Type* to select "=", ">" or "<".
  - Click *Value* to set the data value by the mouse wheel or virtual keypad. The range of data values is 0x00 to 0xff.
- **Error** -- The oscilloscope performs a parity check on the data according to the parity type set by the user, and triggers if the check value is incorrect.

17.4.3 UART Serial Decode

The configuration of UART decoding is similar to that of I2C decoding.

On the bus:

- DATA is displayed in frames and displayed in white.
- Check value errors will cause the associated data words to be displayed in red.
- The red point at the end of a segment indicates there is not enough space on the display to show the complete content of a frame and some content is hidden.



In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- RX -- Receive data.
- RX Err -- Receive error type.
- TX -- Send data.
- Data -- Send error type.

UART	Time	RX	RX Err	TX	TX Err
1	-24.2780us	0x53			
2	20.1392us			0x53	
3	65.3218us	0x49	Parity Err		
4	109.767us			0x49	Parity Err
5	154.861us	0x47			
6	199.305us			0x47	
7	244.460us	0x4C	Parity Err		

17.5 CAN Trigger and Serial Decode

This section covers triggering and decoding CAN signals. Please read the following for more details: "CAN Signal Settings", "CAN Trigger" and "CAN Serial Decode".

17.5.1 CAN Signal Settings

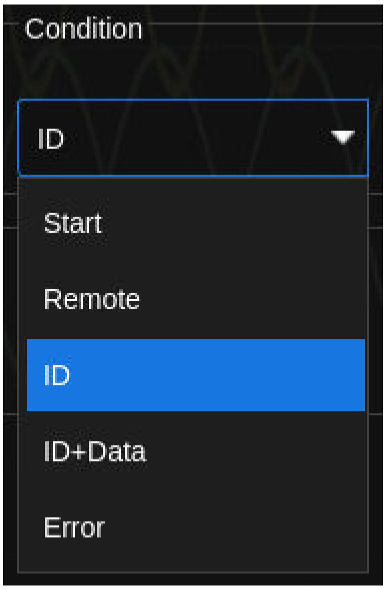
Connect the CAN_H and CAN_L signals to the oscilloscope, set the mapping relation between channels and signals, and then set the threshold level of each signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

In the *Setup* tab of the trigger or *Protocol Settings* menu of the decode , baud rate can be set to: 5 kb/s, 10 kb/s, 20 kb/s, 50 kb/s, 100 kb/s, 125 kb/s, 250 kb/s, 500 kb/s, 800 kb/s, 1 Mb/s or Custom.

The method of copying settings is the same as I2C signal settings. See "I2C Signal Settings" for details.

17.5.2 CAN Trigger

Switch to the *Setup* tab in the CAN trigger dialog box to set the trigger condition:



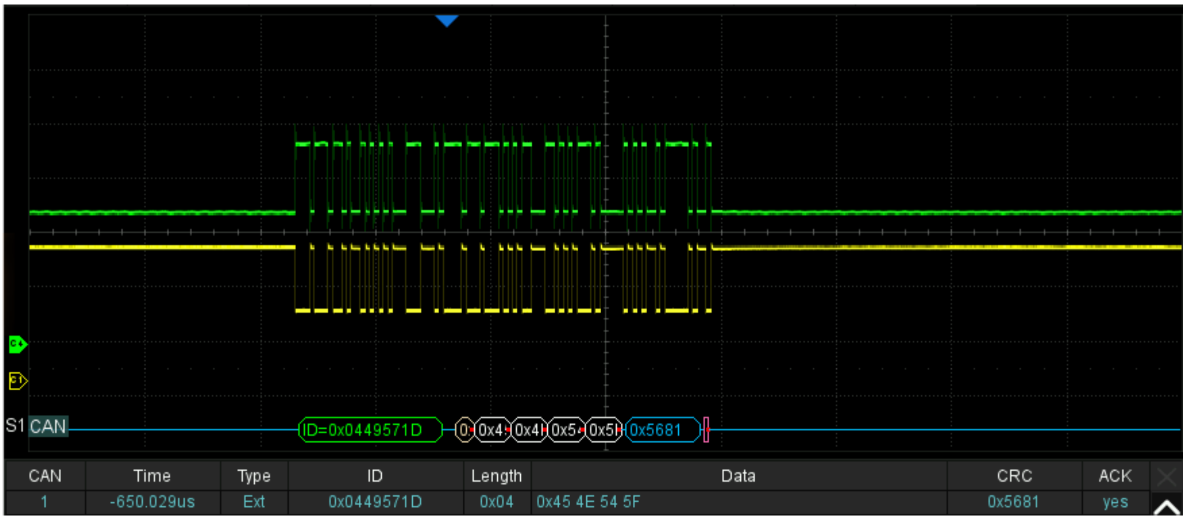
- **Start** -- The oscilloscope triggers at the beginning of the frame.
- **Remote** -- The oscilloscope triggers on a remote frame with a specified ID. ID, ID Bits (11-bit or 29-bit), and Curr ID Byte (1st, 2nd, 3rd, or 4th byte) can be set. Curr ID Byte is used to specify the byte to be adjusted when using the mouse wheel.
- **ID** -- The oscilloscope triggers on the data frame that matches the specified ID. ID, ID Bits (11-bit or 29-bit), and Curr ID Byte (1st, 2nd, 3rd, or 4th byte) can be set.
- **ID + Data** -- The oscilloscope triggers on the data frame that matches the specified ID and data.ID, ID Bits (11-bit or 29-bit), Curr ID Byte (1st, 2nd, 3rd, or 4th byte), Data1, and Data2 can be set.
- **Error** -- The oscilloscope triggers on the error frame.

17.5.3 CAN Serial Decode

The configuration of CAN decoding is similar to that of I2C decoding.

On the bus:

- ID is displayed in frames and displayed in green.
- LEN (data length) is displayed in frames and displayed in light yellow.
- DATA is displayed in frames and displayed in white.
- CRC is displayed in frames and displayed in blue.
- Ack is played in pink.
- The red point at the end of a segment indicates there is not enough space on the display to show the complete content of a frame and some content is hidden.



In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- Type -- Type of the frame. The Data frame is represented by "D" and the Remote frame is represented by "R".
- ID -- ID of the frame, 11-bits or 29-bits ID are automatically detected.
- Length -- Data length.
- Data -- Data values.
- CRC -- Cycle redundancy check.
- Ack -- Acknowledge bit.

CAN	Time	Type	ID	Length	Data	CRC	ACK
1	-24.1488ms	R	0x012F30DC	0		0x4BA5	yes
2	-19.9490ms	D	0x0449571D	4	0x45 4E 54 5F	0x5681	yes
3	-15.1293ms	R	0x056A7E0C	3		0x734E	yes
4	-10.9295ms	D	0x07819F51	8	0x53 49 47 4C 45 4E 54 5F	0x0C9B	yes
5	-5.44975ms	R	0x012F30DC	0		0x4BA5	yes
6	-1.24996ms	D	0x0449571D	4	0x45 4E 54 5F	0x5681	yes
7	3.56980ms	R	0x056A7E0C	3		0x734E	yes

17.6 LIN Trigger and Serial Decode

This section covers triggering and decoding LIN signals. Please read the following for more details: “LIN Signal Settings”, “LIN Trigger” and “LIN Serial Decode”.

17.6.1 LIN Signal Settings

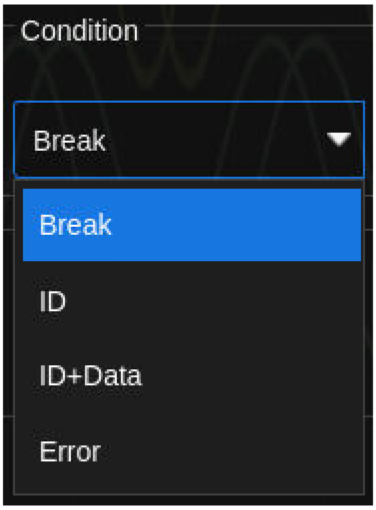
Connect the LIN signal to the oscilloscope, and then set the threshold level of the signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

In the *Setup* tab of the trigger or *Protocol Settings* menu of the decode, baud rate can be set to: 600 b/s,1200 b/s, 2400 b/s, 4800 b/s, 9600 b/s, 19200 b/s or Custom.

The method of copying settings is the same as I2C signal settings. See "I2C Signal Settings" for details.

17.6.2 LIN Trigger

Switch to the *Setup* tab in the LIN trigger dialog box to set the trigger conditions:



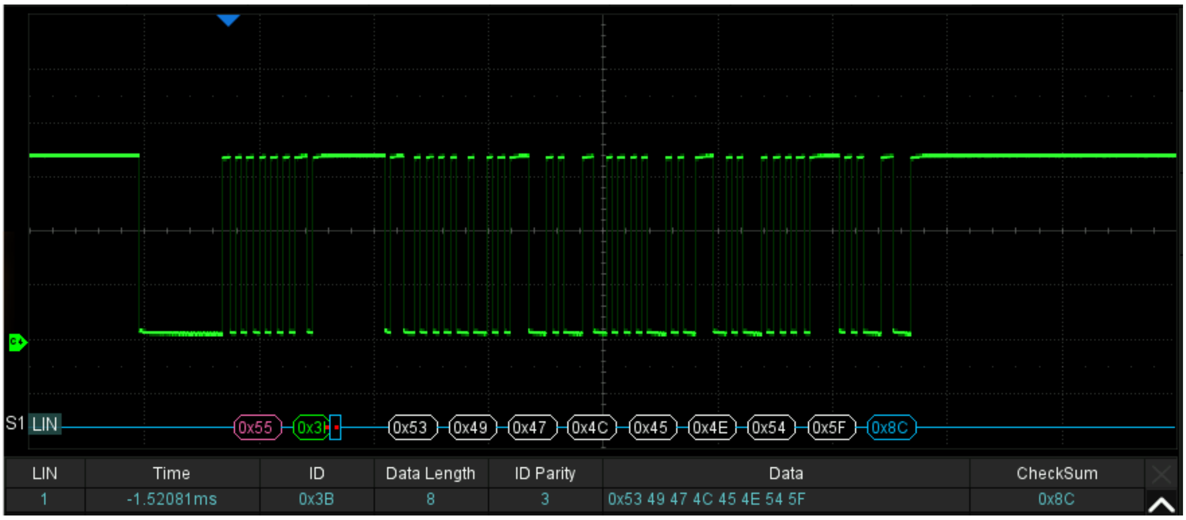
- **Break** -- The oscilloscope triggers at the beginning of the frame.
- **ID** -- The oscilloscope will trigger when it detects a frame with its ID equal to the set value, with a setting range of 0x00 to 0x3f
- **ID & Data** -- The oscilloscope will trigger when it detects a frame with its ID and data equal to the set value. You can set "ID", "Data1", and "Data2" respectively.
- **Data Error** -- The oscilloscope triggers on the error frame of the LIN signal.

17.6.3 LIN Serial Decode

The configuration of LIN decoding is similar to that of I2C decoding.

On the bus:

- ID is displayed in frames and displayed in green.
- LEN (data length) and CHK are displayed in frames and displayed in white.
- DATA are displayed in frames and displayed in blue.



In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- ID -- ID of the frame.
- Data length -- Data length.
- ID Parity -- ID parity check.
- Data -- Data values.
- Checksum -- Data checksum.

LIN	Time	ID	Data Length	ID Parity	Data	CheckSum
1	-39.8835ms	25H	4	00H	E N T _	93H
2	-3.63532ms	3BH	8	03H	S I G L E N T _	8CH
3	36.7793ms	06H	2	00H	T _	46H
4	70.9443ms	14H	2	00H	T _	38H
5	105.109ms	25H	4	00H	E N T _	93H

17.7 FlexRay Trigger and Serial Decode

This section covers triggering and decoding FlexRay signals. Please read the following for more details: "FlexRay Signal Settings", "FlexRay Trigger" and "FlexRay Serial Decode".

17.7.1 FlexRay Signal Settings

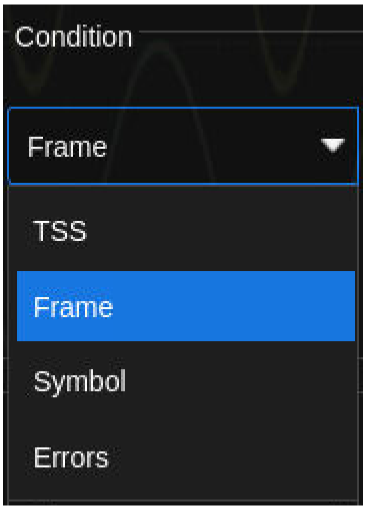
Connect the FlexRay signal to the oscilloscope, and then set the threshold level of the signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

In the *Setup* menu of the trigger or *Protocol Settings* menu of the decode, the baud rate can be set to: 2.5 Mb/s, 5.0 Mb/s, 10.0 Mb/s, or Custom.

The method of copying settings is the same as I2C signal settings. See "I2C Signal Settings" for details.

17.7.2 FlexRay Trigger

Switch to the *Setup* tab in the FlexRay trigger dialog box to set the trigger conditions:



- **TSS** -- The oscilloscope triggers on the transmission start sequence.
- **Frame** -- The oscilloscope triggers on the frame.
  - ➢ Set Frame header indicators: Payload preamble indicator, null frame indicator, sync frame indicator, startup frame indicator.
  - ➢ Click *ID* to set the frame ID by the mouse wheel or virtual keypad. The range of ID is 0x000 to 0x7ff.

- ➢ Click *Compare Type* to select "=", ">" or "<". When setting the *Compare Type* as "=", the *Repetition Factor* is also required.
- ➢ Click *Cycle* to set the cycle count by the mouse wheel or virtual keypad. The range of data values is 0 to 63.

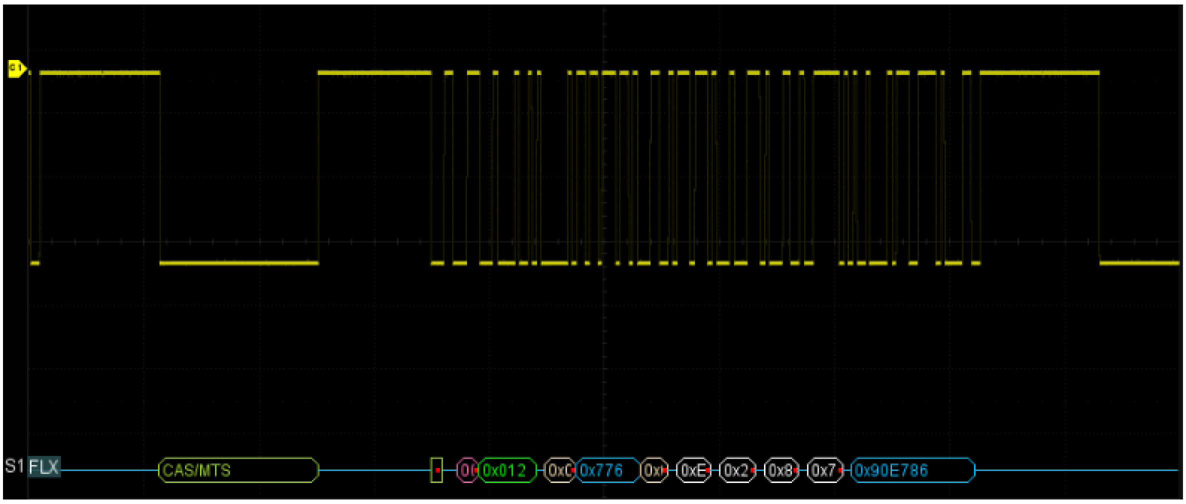
- **Symbol** -- The oscilloscope triggers on CAS/MTS (Conflict Avoidance Symbol/ Media access Test Symbol) or WUS (Wake-up Symbol)
- **Errors** -- The oscilloscope will trigger when a data error happens, including errors on FSS, BSS, FES, Header CRC, and Frame CRC.

17.7.3 FlexRay Serial Decode

The configuration of FlexRay decoding is similar to that of I2C decoding.

On the bus:

- The signatures (CAS/MTS, WUP) are displayed in yellow-green.
- TSS transmission start sequence, displayed in yellow-green. The null frame indicator, the Sync frame indicator, and the Startup frame indicator are displayed in the frame and displayed in pink.
- The ID is displayed in the frame and displayed in green.
- PL (Valid Data Length) is displayed in frames, in words, and in light yellow.
- HCRC (Head Check Code) is displayed in the frame and displayed in blue.
- CYC (cycle) is displayed in the frame and displayed in light yellow.
- D (data) is displayed in the frame and displayed in white.
- FCRC (Data Check Code) is displayed in the frame and displayed in blue.



In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- FID -- Frame ID, the symbol occupies a single line of the list.
- PL -- Valid Data Length
- HCRC -- Head Check Code
- CYC -- Cycle count
- Data -- Data values
- FCRC -- Data Check Code

FLX	Time	FID	PL	HCRC	CYC	Data	FCRC
1	-83.0406us	0x012	0x02	0x776	0x0C	0xEE 0x23 0x8C 0x7E	0x90E786
2	-25.0160us	CAS/MTS					
3	-1.40820us	0x012	0x02	0x776	0x0C	0xEE 0x23 0x8C 0x7E	0x90E786
4	56.6174us	CAS/MTS					
5	80.2240us	0x012	0x02	0x776			

17.8 CAN FD Trigger and Serial Decode

This section covers triggering and decoding CAN FD signals. Please read the following for more details: "CAN FD Signal Settings", "CAN FD Trigger" and "CAN FD Serial Decode".

17.8.1 CAN FD Signal Settings

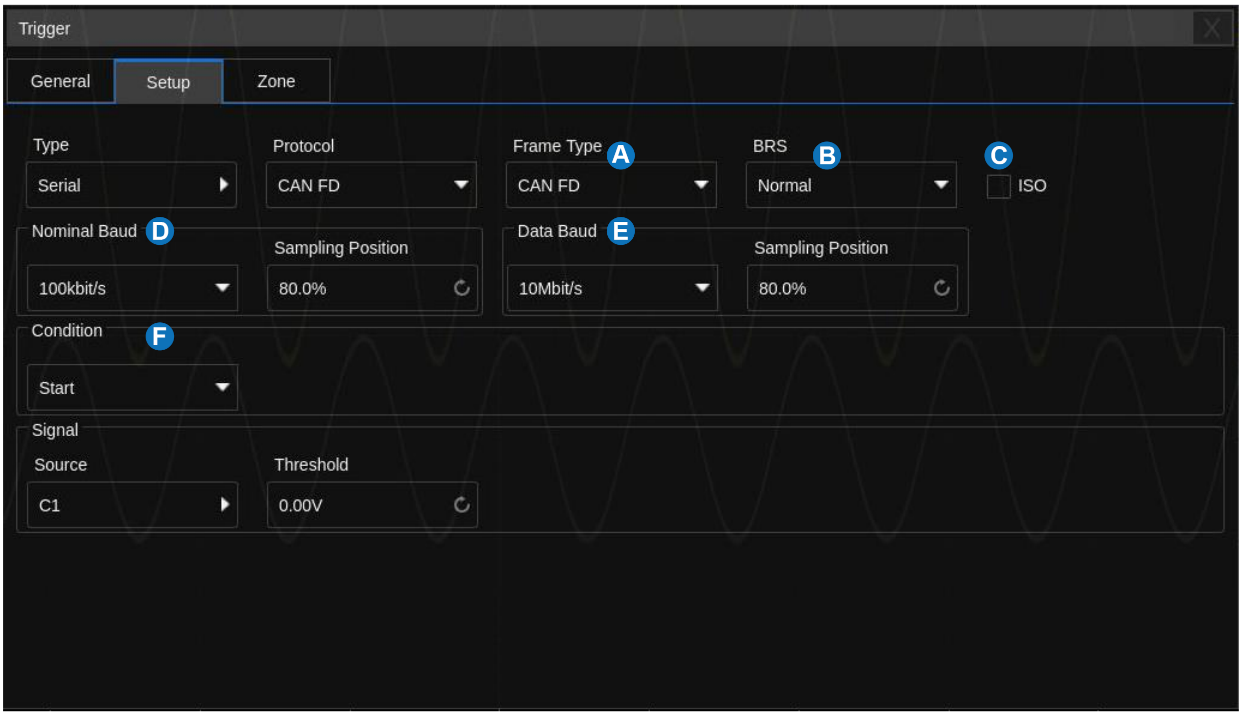
Connect the CAN FD signal to the oscilloscope, and then set the threshold level of the signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

In the *Setup* tab of the trigger or *Protocol Settings* menu of the decode, the nominal baud rate can be set to: 10 kb/s, 25 kb/s, 50 kb/s, 100 kb/s, 250 kb/s, 1 Mb/s or Custom. The data baud rate can be set to: 500 kb/s, 1 Mb/s, 2 Mb/s, 5 Mb/s, 8 Mb/s, 10 Mb/s or Custom.

The method of copying settings is the same as I2C signal settings. See "I2C Signal Settings" for details.

17.8.2 CAN FD Trigger

Switch to the *Setup* tab in the CAN FD trigger dialog box to set the trigger conditions:



A. Frame Type: Both, CAN, CAN FD

B. When the "Frame Type" is CAN FD, set the BRS (Bit Rate Switch) to Both, Normal or FD

C. When the "Frame Type" is CAN FD, turn on or off ISO

D. Set nominal baud rate and sampling position

E. Set data baud rate and sampling position

F. Trigger Condition: Start, Remote, ID, ID + Data, Error

Trigger Condition

- **Start** -- The oscilloscope triggers at the beginning of the frame.
- **Remote** -- The oscilloscope triggers on a remote frame with a specified ID. ID, ID Bits (11-bit or 29-bit), and Curr ID Byte (1st, 2nd, 3rd, or 4th byte) can be set. Curr ID Byte is used to specify the byte to be adjusted when using the mouse wheel.
- **ID** -- The oscilloscope triggers on the data frame that matches the specified ID. ID, ID Bits (11-bit or 29-bit), and Curr ID Byte (1st, 2nd, 3rd, or 4th byte) can be set.
- **ID + Data** -- The oscilloscope triggers on the data frame that matches the specified ID and data.ID, ID Bits (11-bit or 29-bit), Curr ID Byte (1st, 2nd, 3rd, or 4th byte), Data1, and Data2 can be set.
- **Error** -- The oscilloscope triggers on the error frame.
  - Error Frame
  - Stuff Bit Error
  - CRC Mismatch Error: The oscilloscope triggers when the calculated CRC does not match the

transmitted CRC.

- Stuff Bit Cnt Err: Effective only when ISO is turned on, the oscilloscope triggers when the stuff bit count is incorrect.
- Stuff Bit Cnt Par. Err: Effective only when ISO is turned on, the oscilloscope triggers when the polarity of the stuff bit count is incorrect.

17.8.3 CAN FD Serial Decode

The configuration of CAN FD decoding is similar to that of I2C decoding.

On the bus:

- ID is displayed in the frame and displayed in green.
- BRS (Bit Rate Switch) is displayed in the frame and displayed in light yellow.
- ESI (Error State Indicator) is displayed in the frame and displayed in blue.
- L (Data Length) is displayed in the frame and displayed in light yellow.
- D (Data) is displayed in the frame and displayed in white.
- CRC is displayed in the frame and displayed in blue.
- Ack is displayed in the frame and displayed in pink.
- The red point at the end of a segment indicates there is not enough space on the display to show the complete content of a frame and some content is hidden.

In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- Type -- Type of the frame. The Standard CAN frame is represented by "Std", CAN FD frame is represented by "FD", the extended frame is represented by "Ext" and the remote frame is represented by "RTR".
- ID -- Frame ID.
- Length -- Data length.
- Data -- Data bytes.
- CRC -- Cycle redundancy check.
- Ack -- Acknowledge bit.

CAN FD	Time	Type	ID	Length	Data	CRC	ACK
1	-190.506us	FD Std	0x66	0x08	0x0A 1B 2C 3D 4E 5F 60 71	0x9ADA	yes
2	-95.5054us	FD Std	0x66	0x08	0x0A 1B 2C 3D 4E 5F 60 71	0x9ADA	yes
3	-505.600ns	FD Std	0x66	0x08	0x0A 1B 2C 3D 4E 5F 60 71	0x9ADA	yes
4	94.4942us	FD Std	0x66	0x08	0x0A 1B 2C 3D 4E 5F 60 71	0x9ADA	yes
5	189.496us	FD Std	0x66	0x08	0x0A 1B 2C 3D 4E 5F 60 71	0x9ADA	yes

17.9 I2S Trigger and Serial Decode

This section covers triggering and decoding I2S signals. Please read the following for more details: "I2S Signal Settings", "I2S Trigger" and "I2S Serial Decode".

17.9.1 I2S Signal Settings

Connect the WS, BCLK, and Data signals to the oscilloscope, set the mapping relation between channels and signals, and then set the threshold level of each signal. The process of specifying the source and threshold is similar to "I2C Signal Settings" .

BCLK

In addition to specifying the source and the threshold level, BCLK signals also require the specification of the *BCLK Edge* .

Rising– Data latched on the rising edge of the clock.

Falling– Data latched on the falling edge of the clock.

WS

In addition to specifying the source and the threshold level, WS signals also require the specification of the *Left CH* .

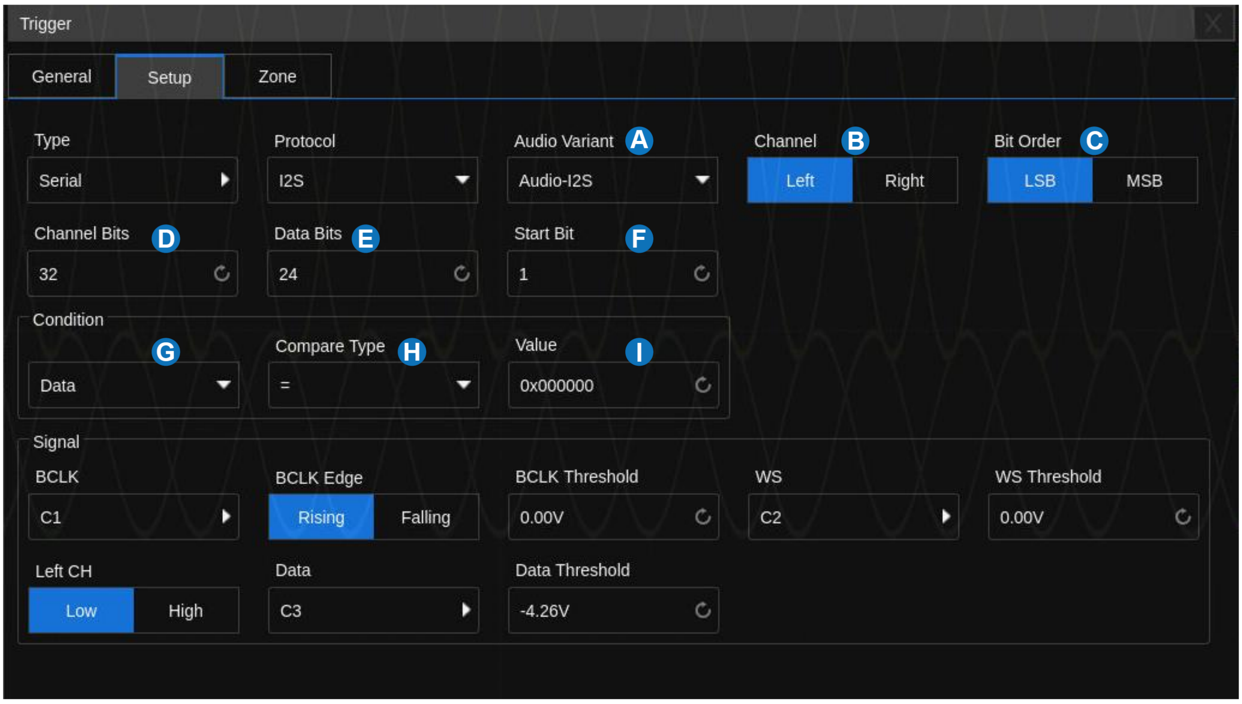
Low– Select the left channel when WS is low and the right channel when WS is high.

High– Select the right channel when WS is low and the left channel when WS is high.

The method of copying settings is the same as I2C signal settings. See "I2C Signal Settings" for details.

17.9.2 I2S Trigger

Switch to the *Setup* tab in the I2S trigger dialog box to set the trigger conditions:



A. Audio Variant: Audio-I2S, Audio-LJ, Audio-RJ

B. Channel: Set the channel to trigger, Left or Right

C. Set the bit order to MSB or LSB

D. Channel Bits: Specify the receiver word length. The length should be greater than or equal to the "Start bit+Data bits"

E. Data Bits: Specify the number of bits per word, ranging from 0 to 31

F. Start Bit: The start bit of data, ranging from 0 to 31

G. Trigger Condition: Data, Mute, Clip, Glitch, Rising Edge, Falling Edge

H. When the "Trigger Condition" is Data, set the compare type to =, >, <

I. When the "Trigger Condition" is Data, set the data value

Trigger Condition

- **Data** -- Trigger on data.
  - Click *Compare Type* to select "=", ">" or "<".
  - Click *Value* to set the data value by the virtual keypad. The range of data value is related to the number of Data Bits .
- **Mute** -- Trigger on the mute signal. Mute signal: Volume is less than the set value and duration reaches the set value.
  - Click *MNF* to set the mute threshold by the mouse wheel or virtual keypad. The range of values is related to the number of *Data Bits* .

  - ➢ Click *Duration* to set the value by the mouse wheel or virtual keypad. The range is 1-64 frames.
- **Clip** -- Trigger on the clipped signal. Clip signal: Volume is greater than the set value and duration reaches the set value.
  - ➢ Click *Clip Level* to set the clip threshold by the mouse wheel or virtual keypad. The range of values is related to the number of *Data Bits* .
  - ➢ Click *Duration* to set the value by the mouse wheel or virtual keypad. The range is 1-64 frames.
- **Glitch** -- Trigger on glitches within the audio signal.
  - ➢ Click *Threshold* to set the threshold by the mouse wheel or virtual keypad. The range of values is related to the number of *Data Bits* .
- **Rising Edge** -- Trigger on signals greater than the *Threshold* setting value.
  - ➢ Click *Threshold* to set the threshold by the mouse wheel or virtual keypad. The range of values is related to the number of *Data Bits* .
- **Falling Edge** -- Trigger on signals less than the *Threshold* setting value.
  - ➢ Click *Threshold* to set the threshold by the mouse wheel or virtual keypad. The range of values is related to the number of *Data Bits* .

17.9.3 I2S Serial Decode

The configuration of I2S decoding is similar to that of I2C decoding.

In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- Type -- Channel type, the left channel is represented by "Left CH" and the right channel is represented by "Right CH".
- Data -- Data bytes.
- Error – Error.

I2S	Time	Type	Data	Complemental Code	Error
1	-1.99274ms	Left CH	0x17	00010111	
2	-1.49276ms	Right CH	0x00	00000000	
3	-992.737us	Left CH	0x17	00010111	
4	-492.762us	Right CH	0x00	00000000	
5	7.26200us	Left CH	0x17	00010111	
6	507.237us	Right CH	0x00	00000000	
7	1.00726ms	Left CH	0x17	00010111	

17.10 MIL-STD-1553B Trigger and Serial Decode

This section covers triggering and decoding MIL-Standard 1553B signals. Please read the following for more details: "MIL-STD-1553B Signal Settings", "MIL-STD-1553B Serial Trigger" and "MIL-STD-1553B Serial Decode"

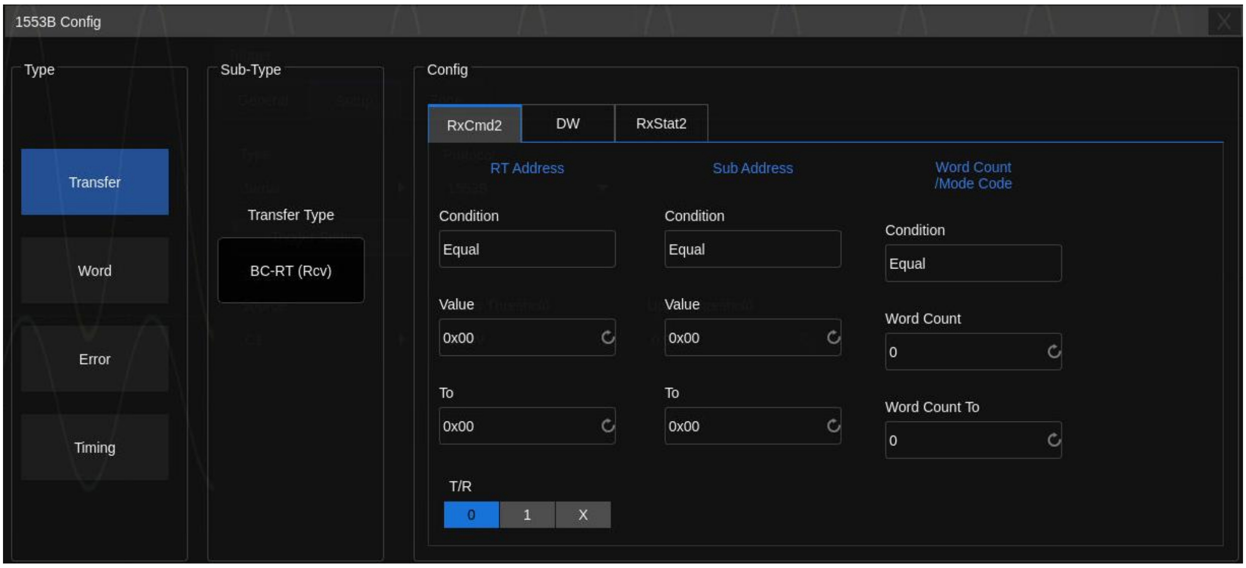
17.10.1 MIL-STD-1553B Signal Settings

Connect the MIL-STD-1553B signal to the oscilloscope, set the mapping relation between channels and signals, and then set the threshold level of each signal. The process of specifying the source and threshold is similar to "I2C Signal Settings" .

17.10.2 MIL-STD-1553B Serial Trigger

When the oscilloscope is set to capture MIL-STD-1553B signals, it can be triggered on Transfer, Word, Error, or triggered on frames that meet the specified message sending interval and response time.

Click *Trigger Setting...* in the dialog box to set the trigger conditions:



Trigger on Transfer:

- **All** -- Trigger at the end of the Sync pulse of any word.
- **BC-RT (Rcv)** -- Trigger on the specified transmission messages from bus controller to remote terminal. RxCmd + Word Count + DW, RxStat can be specified, and the response time should be less than 14us.
- **RT-BC (Xmit)** -- Trigger on the specified transmission messages from remote terminal to bus controller. TxCmd + Word Count, TxStat+ DW can be specified, and the response time should be

less than 14us.

- **RT-RT** -- Trigger on the specified transmission messages from remote terminal to remote terminal. RxCmd + Word Count, TxCmd + Word Count, TxStat + DW, RxStat can be specified, and the response time should be less than 14us.
- **Mode Command** -- Trigger on the specified mode command without DW. TxCmd + Mode Code, TxStat can be specified, and the response time should be less than 14us.
- **Mode Command_Data (Xmit)** -- Trigger on the specified mode command (transmit) with DW. TxCmd + Mode Code, TxStat + DW can be specified, and the response time should be less than 14us.
- **Mode Command_Data (Rcv)** -- Trigger on the specified mode command (receive) with DW. RxCmd + Mode Code + DW, RxStat can be specified, and the response time should be less than 14us.
- **BC-RT (S) (B'cast)** -- Trigger on the specified broadcast transmission messages from bus controller to each remote terminal. Rxcmd (The remote terminal address is 11111) + Word Count + DW can be specified.
- **RT-RT (S) (B'cast)** -- Trigger on the specified broadcast transmission messages from remote terminal to each remote terminal. RxCmd (The remote terminal address is 11111), TxCmd, TxStat + DW can be specified.
- **Mod Command (B'cast)** -- Trigger on the specified broadcast mode command without DW. TxCmd (The remote terminal address is 11111) + Mode Code can be specified.
- **Mod Command_Data (B'cast)** -- Trigger on the specified broadcast mode command with DW. TxCmd (The remote terminal address is 11111) + Mode Code + DW can be specified.

Trigger on Word:

- **All** -- Trigger at the end of the Sync pulse of any word.
- **Command** -- Trigger on the specified Cmd, and RT Address, T/R, Sub Address, Word Count/Mode Code can be specified.
- **Data** -- Trigger on the specified DW.
- **Status** -- Trigger on the specified status word, and RT Address, Error, Inst, SRQ, Bcast Rcvd, Busy, Sub Syst, Dyn Bus, and Term Flag can be specified.

Trigger on Error:

- **Invalid Sync** -- The oscilloscope triggers when an invalid Sync pulse is found. If the high and low level of sync pulse are less than 1.5 bit, it is considered invalid, with a tolerance of 10%.
- **Manchester Error** -- The oscilloscope triggers when a manchester code error is detected.

- **Idle Error** -- The oscilloscope triggers when the word length is incorrect. A word length less than 20 bits is considered an error.
- **Parity Error** -- The oscilloscope triggers when parity error occurs.
- **Bad Word Count** -- The oscilloscope triggers when the Word Count does not meet the definition of command word.
- **Address Mismatch** -- The oscilloscope triggers when the remote terminal address mismatch between status word and command word.
- **Non Contig. Data** -- The oscilloscope triggers when there is a gap between DW.
- **Sync Error** -- The oscilloscope triggers when the message format is not satisfied. When a command word or status word is expected to appear during message transmission, but a data word appears, it is considered an error.

Trigger on Timing:

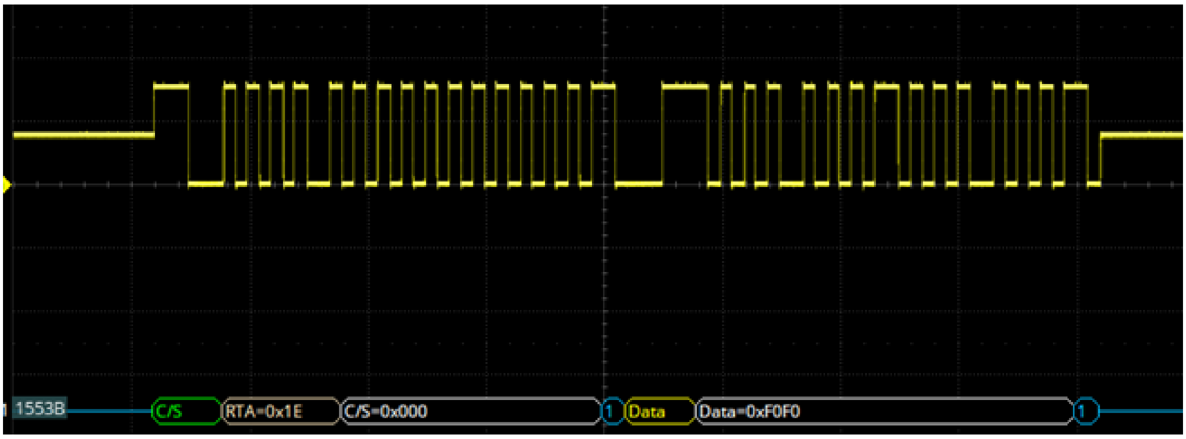
- **Response Time** -- Trigger on the status word that meets the response time requirement. The response time range is [4us, 12us].
- **Inter Message Gap** -- Trigger on the messages that meet the message interval requirement. The minimum message interval is 4us.

17.10.3 MIL-STD-1553B Serial Decode

The configuration of MIL-STD-1553B decoding is similar to that of I2C decoding.

On the bus:

- C/S is displayed in green.
- RTA is displayed in light yellow.
- The remaining data value of the C/S is displayed in white.
- Data is displayed in yellow, and the data value behind it is displayed in white.
- CRC is displayed after the data value and displayed in blue.



In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position
- RTA -- The RT address
- Type -- Type of the word
- Data -- Data values
- Error -- Error type

1553B	Time	RTA	Type	Data	Error
1	-2.99040us	0x1	Cmd/Status	0x631	
2	27.0088us	0x1	Cmd/Status	0x0	Parity
3	47.0402us		Data	0x8888	

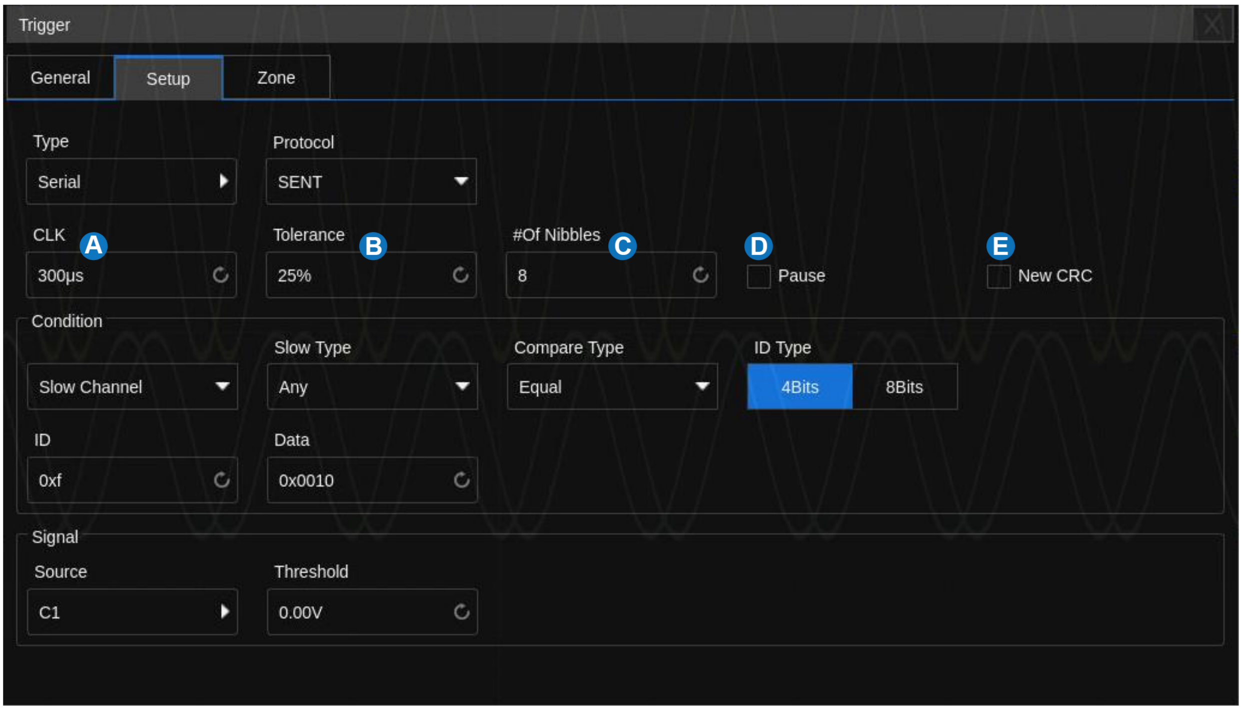
17.11 SENT Trigger and Serial Decode

This section covers triggering and decoding SENT signals. Please read the following for more details: "SENT Signal Settings", "SENT Trigger" and "SENT Serial Decode".

17.11.1 SENT Signal Settings

Connect the SENT signal to the oscilloscope, set the mapping relation between channels and signals, and then set the threshold level of each signal. The process of specifying the source and threshold is similar to "I2C Signal Settings" .

In the *Setup* tab of the trigger or *Protocol Settings* menu of the decode, the following parameters are available:



A. Click to specify the nominal clock period (tick) time

B. Set the percent tolerance to determine whether the sync pulse is valid for decoding the data

C. Set the number of nibbles in a Fast Channel Message

D. Specify whether there is a pause pulse between Fast Channel Messages

E. Set the CRC format that will be used in calculating the correctness of the CRCs. The New CRC selection uses the 2010 CRC format. If "NEW" is not selected, the CRC will use the 2008 format. Enhanced Serial Message CRCs are always calculated using the 2010 format, but for the Fast Channel Messages, and Short Serial Message CRCs, the chosen setting is used

17.11.2 SENT Trigger

When the protocol is set to SENT, the following trigger conditions can be set: Start, Slow Channel, Fast Channel, and Error.

Switch to the *Setup* tab in the SENT trigger dialog box to select the trigger condition:

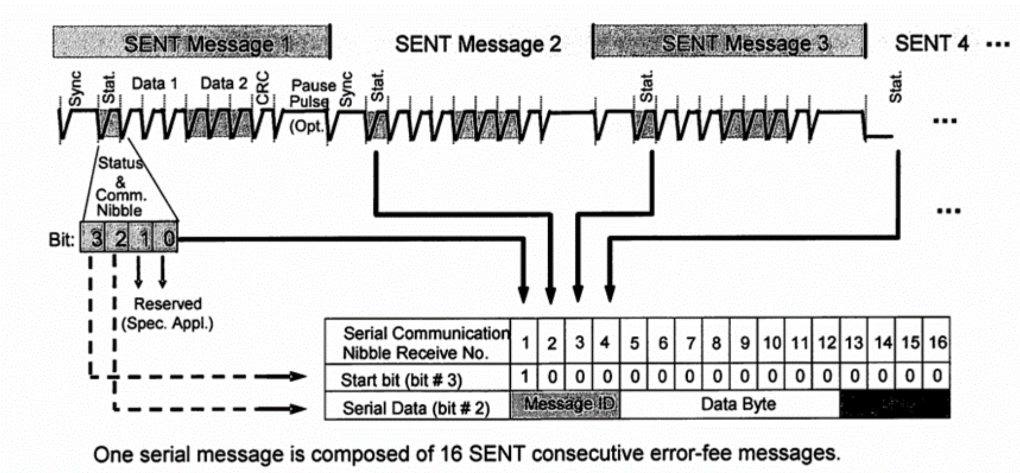
Start -- The oscilloscope will be triggered at the start of the message (after 56 Sync ticks). You can select the type of message: Fast Channel Message, Slow Channel Message, or any.

Fast Channel -- The oscilloscope will be triggered on a Fast Channel Message when the Status & Communication nibble and the data nibbles match the specified values.

- *Status* can be selected in the hexadecimal range of 0x0 to 0xF. If the value is selected as "0xX", the state is ignored.
- *Compare Type* can be specified as Equal, Not Equal, Less than, Less or Equal, Greater than, Greater or Equal, in Range of, or out of Range.
- *At Pos* determines the start position of the trigger data. If selected as Value, you need to set *Nibble Pos* in the decimal range of 0 to 5. If selected as Don't care, the oscilloscope will be triggered at the first data which matches the specified condition.
- *Nibble Len* can be selected in the decimal range of 1 to 6. It is associated with the *Nibble Pos* .
- *Data* can be selected in hex. The range is associated with the *Nibble Pos* . If the data is selected as "0xXX", the data is ignored.

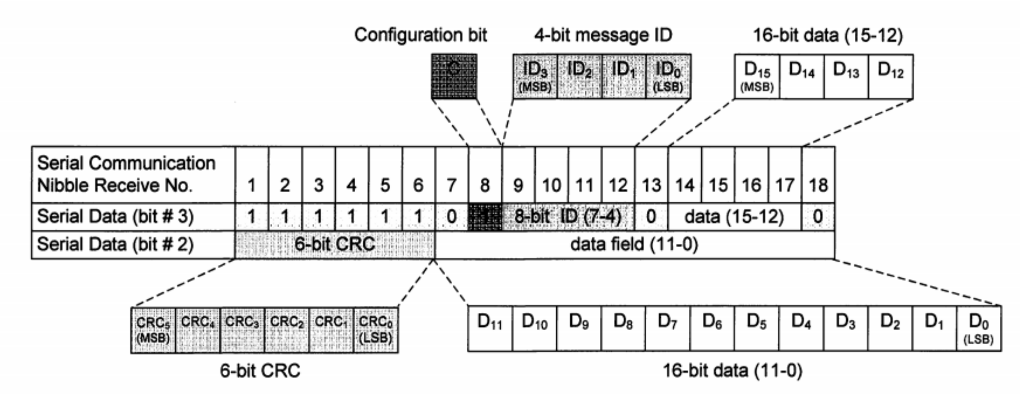
Slow Channel -- the oscilloscope will be triggered on a Slow Channel Message.

Frame (short serial message) -- The 16-bit message consists of a 4-bit Message ID nibble, 2 nibbles (1 byte) of data, and a CRC checksum nibble. If ID and data match, then trigger on the end of CRC bit.

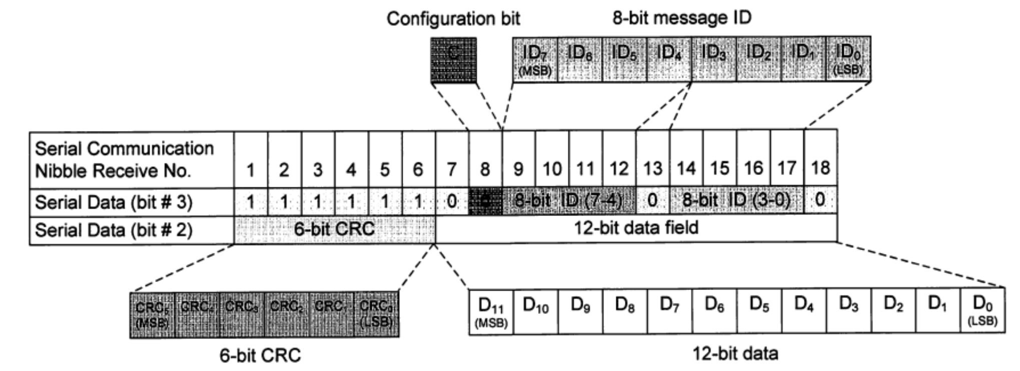


The serial message frame contains 21 bits of payload data. Two different configurations can be chosen and determined by the configuration bit (serial data bit #3, serial communication nibble No. 8):

Frame (enhanced serial message with 4bits ID) --16-bit data and 4-bit message ID, the configuration bit is 1.



Frame (enhanced serial message with 8bits ID) --12-bit data and 8-bit message ID, the configuration bit is 0.



If you set the trigger condition to Slow Channel:

- *ID* can be selected in the hexadecimal range of 0x0 to 0xF (short serial / enhanced serial with 4 bits ID) or 0x00 to 0xFF (enhanced serial with 8 bits ID). If it is selected as "0xXX", the ID is ignored.
- *Compare Type* can be specified as Equal, Not Equal, Less than, Less or Equal, Greater than, Greater or Equal, in Range of, or out of Range.
- *Data* can be selected in the hexadecimal range of 0x00 to 0xFF (short serial) or 0x0000 to 0xFFFF (enhanced serial with 4 bits ID) or 0x000 to 0Xfff (enhanced serial with 8 bits ID). If it is selected as "0xXX", the data is ignored.

Error -- The oscilloscope triggers on the error frame. Errors include Successive Sync Pulses Error, Pulse Period Error, Fast Channel CRC Error, Slow Channel CRC Error, All CRC Errors.

- Successive Sync Pulses Error: Triggers on a sync pulse whose width varies from the previous sync pulse's width by greater than 1/64 (1.5625%, as defined in the SENT specification).
- Pulse Period Error: Triggers if a nibble is either too wide or too narrow (for example, data nibble < 12 (11.5) or > 27 (27.5) ticks wide). Sync, S&C, data, or checksum pulse periods are checked.
- Fast Channel CRC Error: Triggers on any Fast Channel Message CRC error.
- Slow Channel CRC Error: Triggers on any Slow Channel Message CRC error.
- All CRC Errors: Triggers on any CRC error, Fast or Slow.

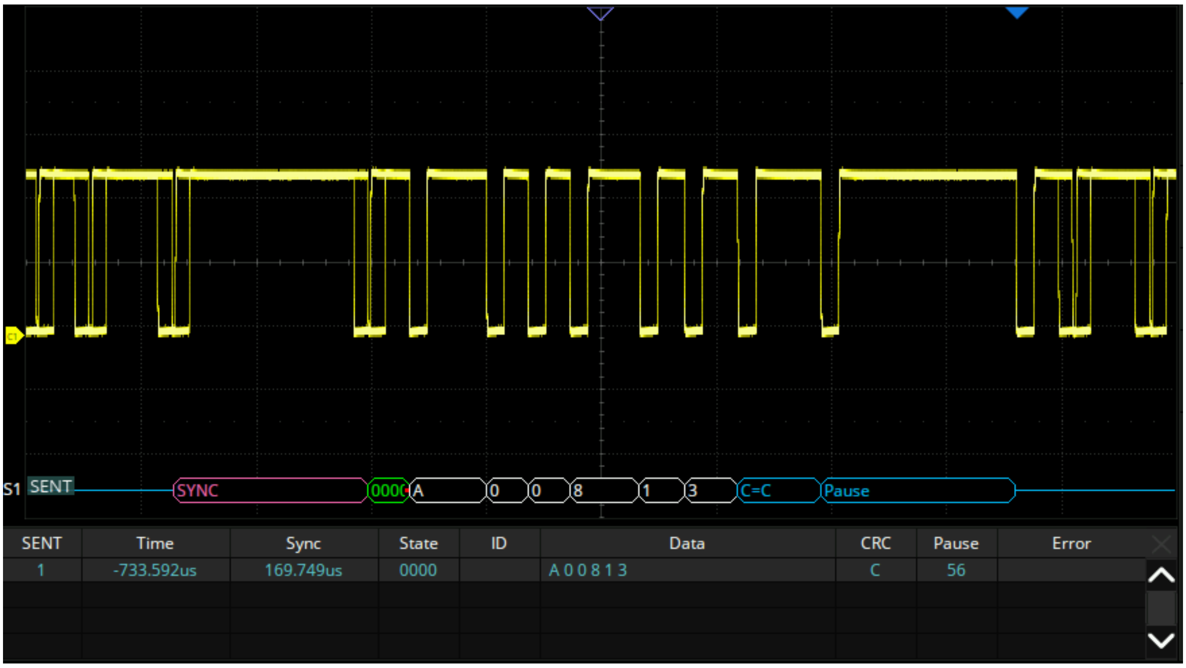
17.11.3 SENT Serial Decode

The configuration of SENT decoding is similar to that of I2C decoding.

On the bus:

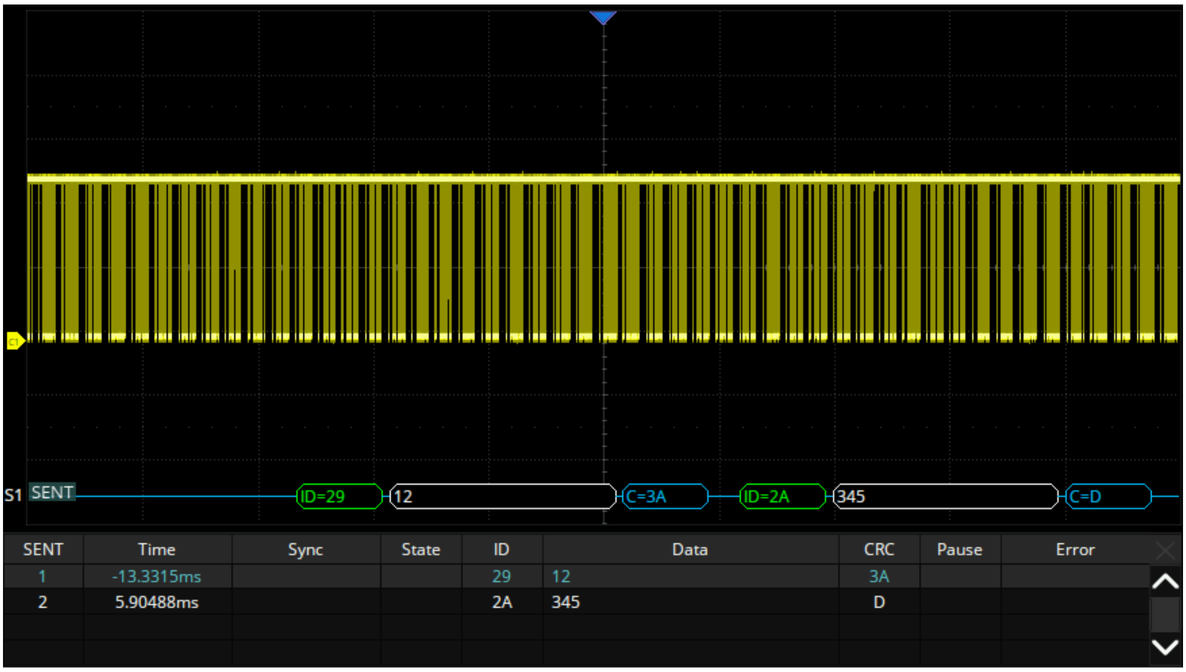
For Fast Channel:

- SYNC is displayed in pink
- STATE is displayed in green
- DATA is displayed in white
- CRC and Pause are displayed after the data and displayed in blue



For Slow Channel:

- ID is displayed in green
- DATA is displayed in white
- CRC is displayed in blue



In the list view:

- **Time** -- The horizontal offset of the current data frame head relative to the trigger position.
- **Sync** -- Sync pulse width (only fast channel)
- **State** -- Status & Communication nibble (only fast channel)
- **ID** -- ID of the frame (only slow channel).
- **Data** -- Data values
- **CRC** -- Cycle redundancy check
- **Pause** -- Pause ticks
- **Error** -- Error type

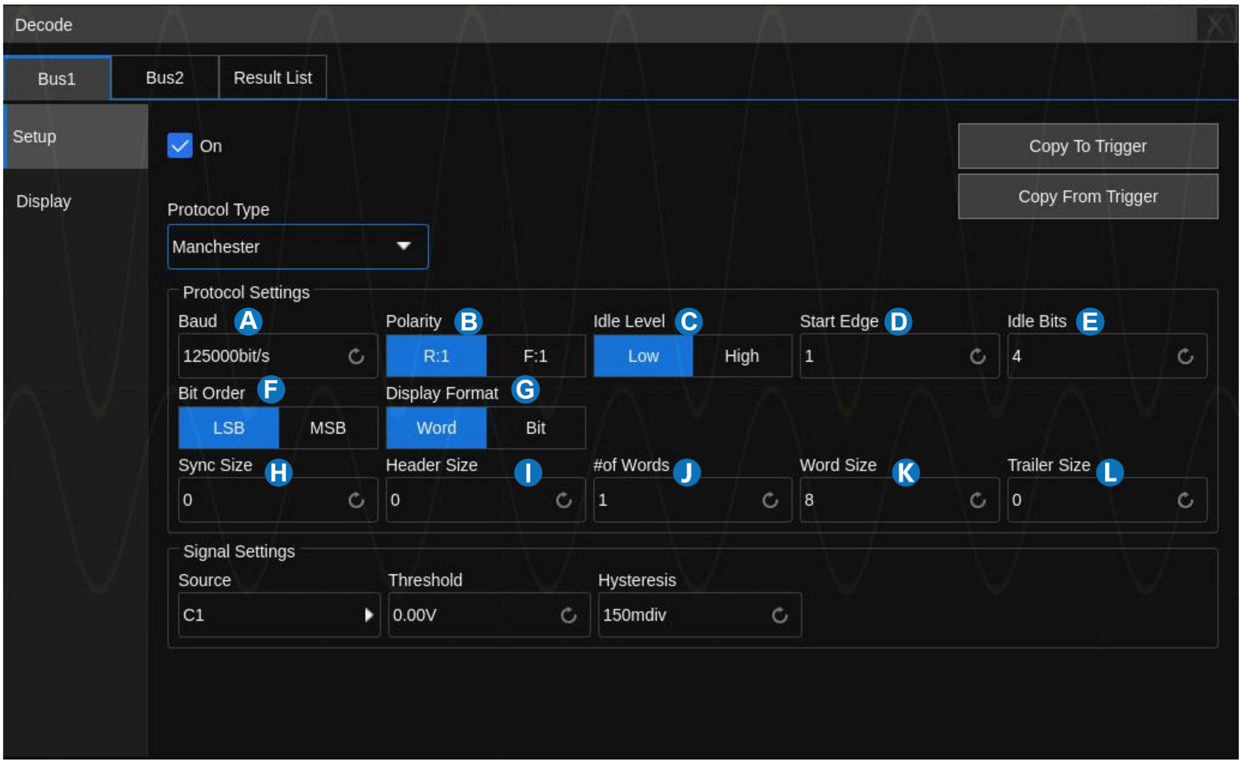
17.12 Manchester Serial Decode

This section covers decoding Manchester signals. Please read the following for more details: "Manchester Signal Settings" and "Manchester Serial Decode".

17.12.1 Manchester Signal Settings

Connect the Manchester signal to the oscilloscope, set the mapping relation between channels and signals, and then set the threshold level of the signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

In the *Protocol Settings* menu of decode, the following parameters are available:



A. Click to specify the baud rate, the range is 500 b/s to 5 Mb/s

B. Set the Manchester signal's logic type. R:1 indicates that the rising edge is used to encode a bit value of logic 1, and F:1 indicates that the falling edge is used to encode a bit value of logic 1

C. Set the idle level

D. Set the starting edge of the Manchester signal. The range is 1~32

E. Set the minimum idle time/inter-frame gap time of the Manchester bus in terms of the bit width

F. Set the bit order to MSB or LSB

G. Set the display format to Byte or Bit

H. Set the sync field size, from 0 to 32

I. Set the header size, from 0 to 32

J. Set the number of words in the data field, from 1 to 255

K. Set the data word size, from 2 to 8

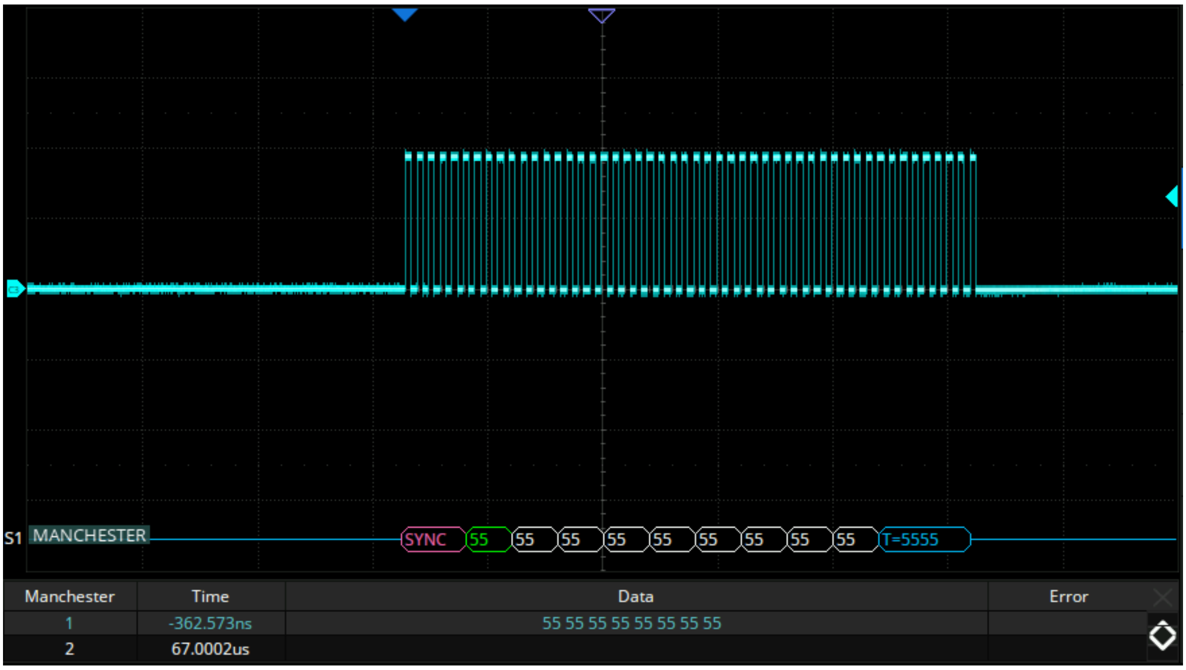
L. Set the trailer size, from 0 to 32

17.12.2 Manchester Serial Decode

The configuration of Manchester decoding is similar to that of I2C decoding.

On the bus:

- SYNC is displayed in pink
- The header is displayed in green
- DATA is displayed in white
- The trailer is displayed in blue



In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- Data -- Data words
- Error -- Error type

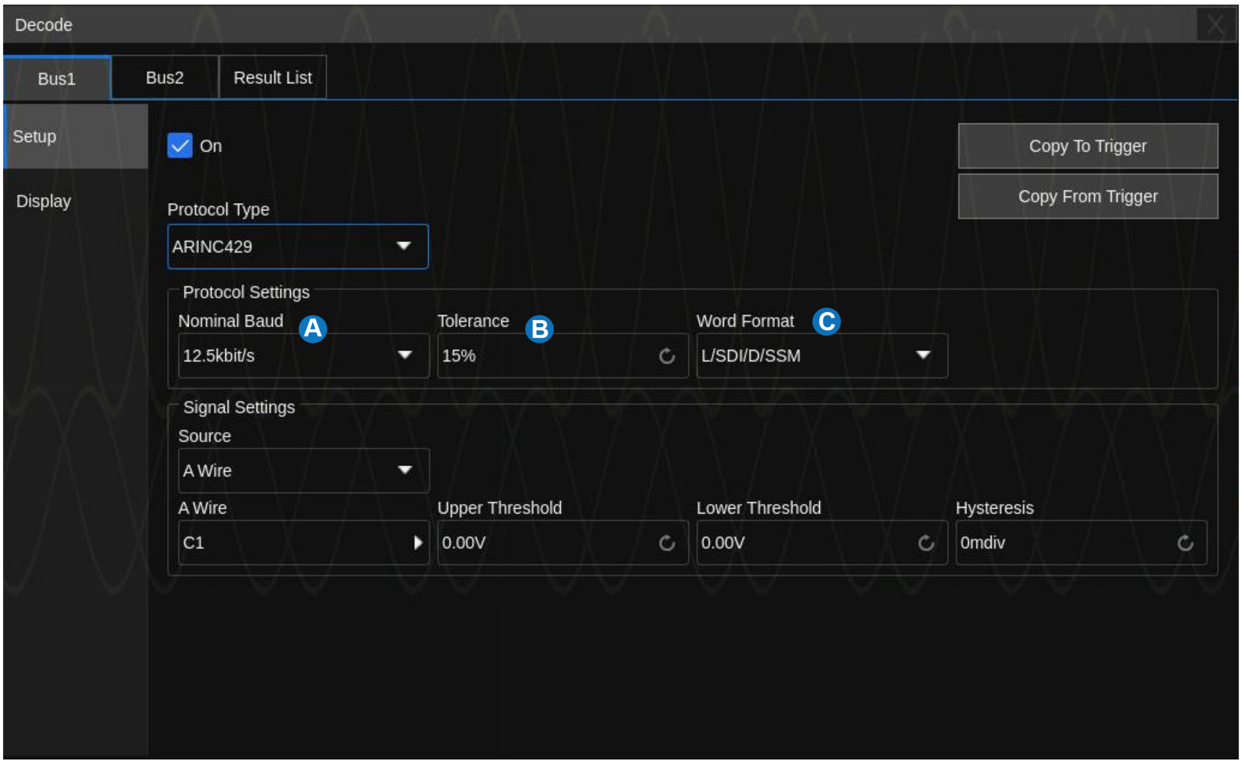
17.13 ARINC 429 Trigger and Serial Decode

This section covers triggering and decoding ARINC 429 signals. Please read the following for more details: "ARINC 429 Signal Settings", "ARINC 429 Trigger" and "ARINC 429 Serial Decode".

17.13.1 ARINC 429 Signal Settings

Connect the A-line signal and the B-line signal to the oscilloscope, set the threshold level of the signal, and specify the triggering or decoding signal source (A-line, B-line, or A-B). The process of specifying the source and threshold is similar to "I2C Signal Settings".

In the *Protocol Config* menu of decode, the following parameters are available:



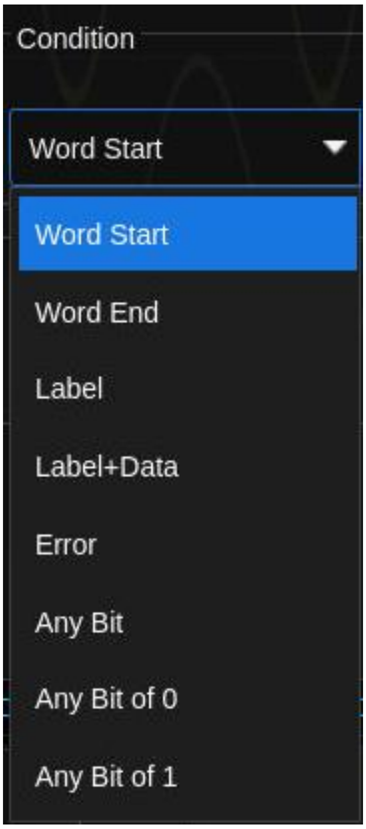
A. Click to specify the baud rate: 12.5kbit/s, 100 kbit /s or Custom

B. Set the Tolerance, the range is 1-20%

C. Select the Word Format: Label, SDI, Data or SSM

17.13.2 ARINC 429 Trigger

Switch to the *Setup* tab in the ARINC 429 trigger dialog box to set the trigger condition:



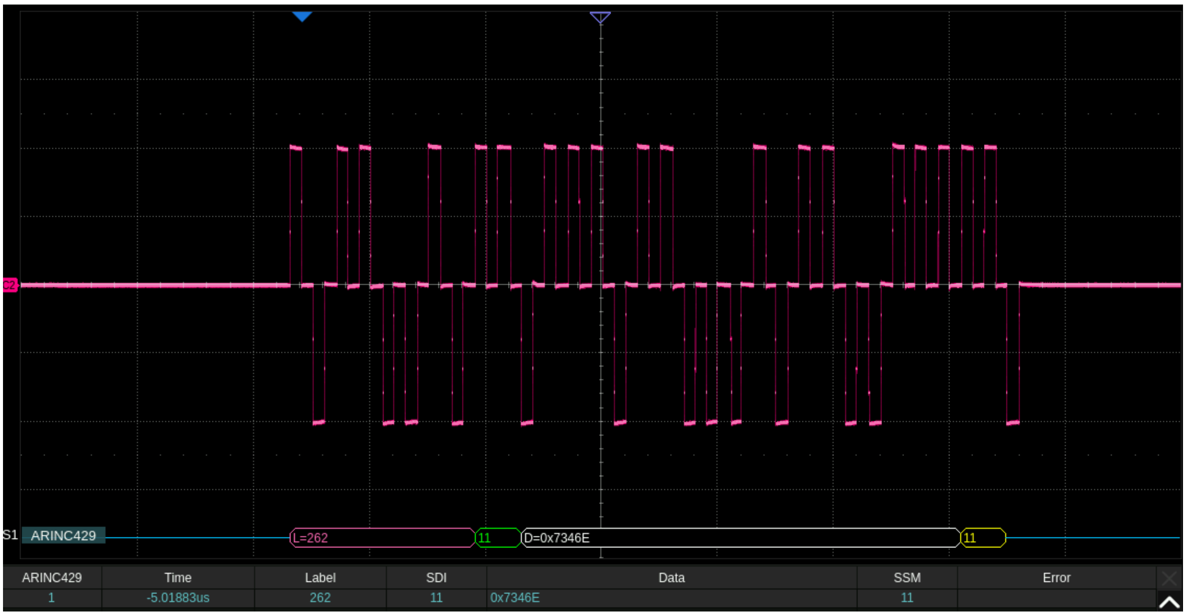
- **Word Start** -- The oscilloscope triggers at the start of the word.
- **Word End** -- The oscilloscope triggers at the end of the word.
- **Label** -- The oscilloscope triggers when the specified label value appears.
  - ➢ Click *Compare Type* to select: “=”, “>” or “<”
  - ➢ Click *Label(Octal)* to set the data value by the virtual keypad. The range of the data value is 0x00 to 0xff.
- **Label + Data** -- The oscilloscope triggers when the specified label value and other word fields appear. Label value, data value, SDI, and SSM can be set.
- **Error** -- The oscilloscope triggers on the error frame, include CRC Error, Byte Error, Gap Error, Byte Error or Gap Error, Any Error.
- **Any Bit** -- The oscilloscope triggers on the presence of any bit that forms an eye diagram.
- **Any Bit of 0** -- The oscilloscope triggers on the presence of any bit with a value of 0.
- **Any Bit of 1** -- The oscilloscope triggers on the presence of any bit with a value of 1.

17.13.3 ARINC 429 Serial Decode

The configuration of ARINC 429 decoding is similar to that of I2C decoding. In the ARINC 429 decoding dialog box, the *Protocol Settings* and *Signal Settings* can be synchronized with ARINC 429 triggering through *Copy From Trigger*.

On the bus:

- Label is displayed in frames and displayed in pink.
- SDI(Source/Destination Identifiers) is displayed in frames and displayed in green.
- DATA is displayed in frames and displayed in white.
- SSM(Signal/Status Matrix) is displayed in frames to describe the data properties of a transmission, and displayed in yellow.
- The red point at the end of a segment indicates there is not enough space on the display to show the complete content of a frame and some content is hidden.



In the list view:

- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- Label -- Octal format, used to indicate data type.
- SDI -- Indicate the origin/destination of data.
- Data -- Data values.
- SSM -- Describe the data properties of a transmission.
- Error -- Error type.

17.14 CAN XL Serial Decode

Please read the following for more details: "CAN XL Signal Settings" and "CAN XL Serial Decode "

17.14.1 CAN XL Signal Settings

Connect the CAN XL signal to the oscilloscope, and then set the threshold level of the signal. The process of specifying the source and threshold is similar to "I2C Signal Settings".

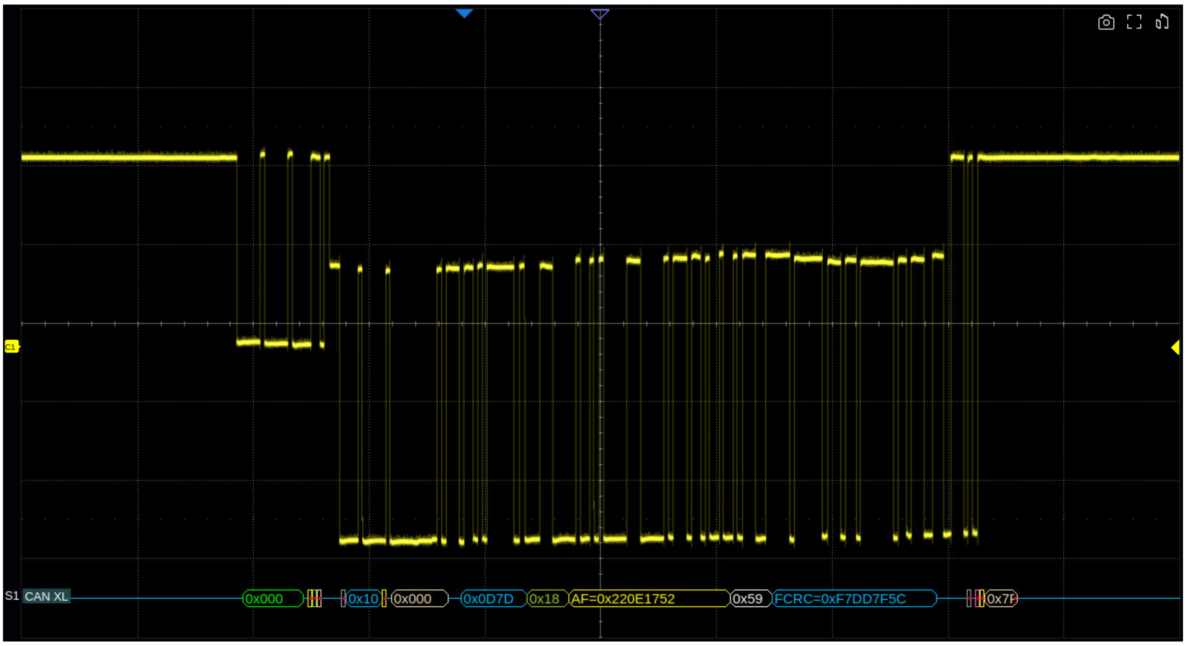
In the *Protocol Settings* menu of the decode, the bus mode can be set to SIC Mode or Fast Mode, he nominal baud rate can be set to: 10kb/s, 25kb/s, 50kb/s, 100kb/s, 250kb/s, 1Mb/s, 2Mb/s, 5Mb/s, 8Mb/s, 10Mb/s or Custom. The FD baud rate can be set to: 500kb/s, 1Mb/s, 2Mb/s, 5Mb/s, 8Mb/s, 10Mb/s or Custom. The XL baud rate can be set to: 500kb/s, 1Mb/s, 2Mb/s, 5Mb/s, 8Mb/s, 10Mb/s, 12Mb/s, 15Mb/s, 20Mb/s or Custom.

17.14.2 CAN XL Serial Decode

The configuration of CAN XL decoding is similar to that of I2C decoding

On the bus:

- ID is displayed in the frame and displayed in green.
- IDE, Identifier extension bit, displayed in yellow. CAN XL only supports 11 bit ID, this bit is always dominant
- FDF, CAN FD flag, displayed in yellow green
- XLF, CAN XL flag, displayed in light yellow. When both FDF and XLF bits are implicit, it is represented as a CAN XL frame
- DL1, the last bit of the ADS mode and rate switching fields, displaed in gray. Mode switching from SIC mode to FAST mode and the bit rate switches from arbitration to data phase
- SDT, Service Data Type, indicates the type of the data field, is similar to the Ethernet Type field, displayed in blue
- SEC, 1-bit to indicate if the CANXL data link layer security protocol is used to safeguard the frame, displayed in yellow
- DLC, 11-bit, data field length, displayed in light yellow
- PCRC, forward CRC check, including: arbitration field, reXEL, ADS, SDT, SEC, DLC and SBC; displayed in blue
- VCID, 8-bit Virtual CAN Identifier, allows to virtually separate CAN traffic that is physically on the same bus, displayed in yellow green
- AF, 32-bit Address Field, depends on SDT (e.g. when SDT=0x05, AF is the destination MAC address of Ethernet), displayed in yellow
- D, Data field(0-2048 Byte), displayed in white
- FCRC, Frame CRC, displayed in blue
- AL1, displayed in gray. Mode switching from FAST mode to SIC mode and the bit rate switching from data to arbitration phase
- Ack field (2 bits), used to confirm that the message has been successfully received, displayed in pink and yellow
- EOF, End Of Frame, displayed in light yellow
- The red point at the end of a segment indicates there is not enough space on the display to show the complete content of a frame and some content is hidden.



In the list view:

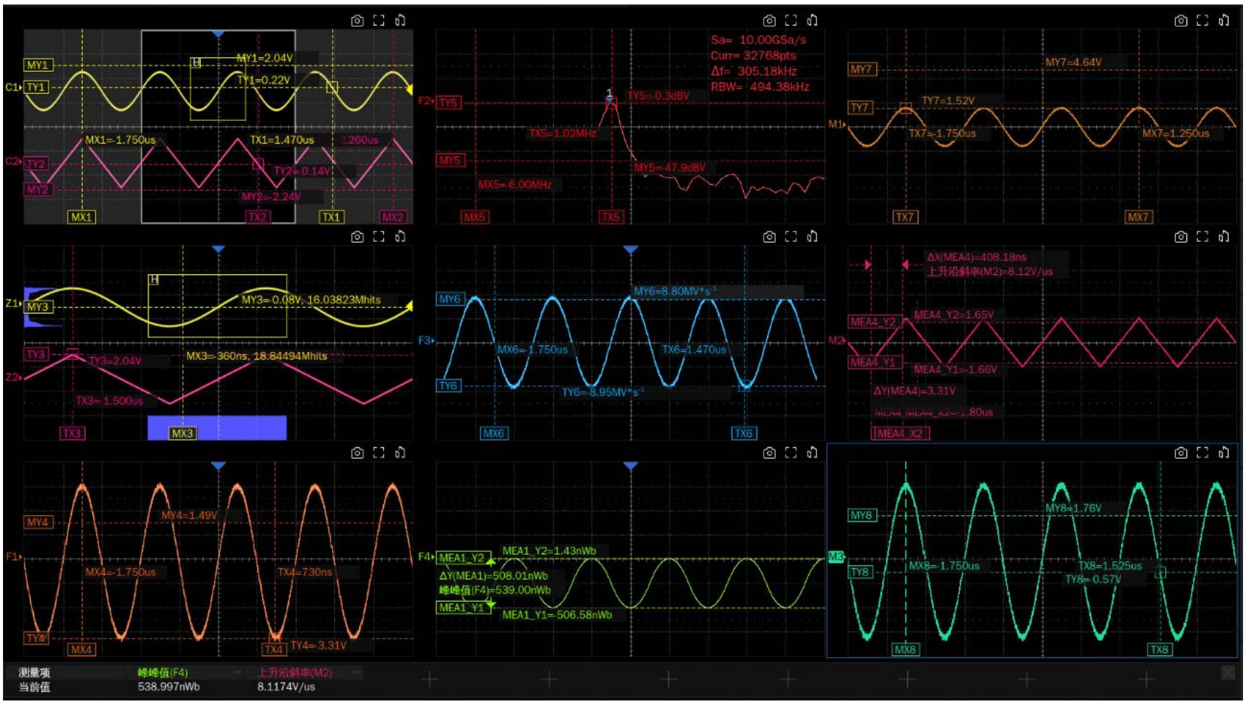
- Time -- The horizontal offset of the current data frame head relative to the trigger position.
- Type -- Type of the frame. The Standard CAN XL frame is represented by "XL Std"
- ID -- Frame ID.
- DLC -- Data length
- Data -- Data bytes.
- FCRC -- Frame cycle redundancy check
- Ack -- Acknowledge bit.

CAN XL	Time	Type	ID	DLC	Data	FCRC	ACK
1	-4.10489ms	XL Std	0x000	0x000	0x59	0xF7DD7F5C	yes
2	-3.10488ms	XL Std	0x000	0x000	0x59	0xF7DD7F5C	yes
3	-2.10487ms	XL Std	0x000	0x000	0x59	0xF7DD7F5C	yes
4	-1.10487ms	XL Std	0x000	0x000	0x59	0xF7DD7F5C	yes
5	-104.860µs	XL Std	0x000	0x000	0x59	0xF7DD7F5C	yes
6	895.147µs	XL Std	0x000	0x000	0x59	0xF7DD7F5C	yes
7	1.89515ms	XL Std	0x000	0x000	0x59	0xF7DD7F5C	yes

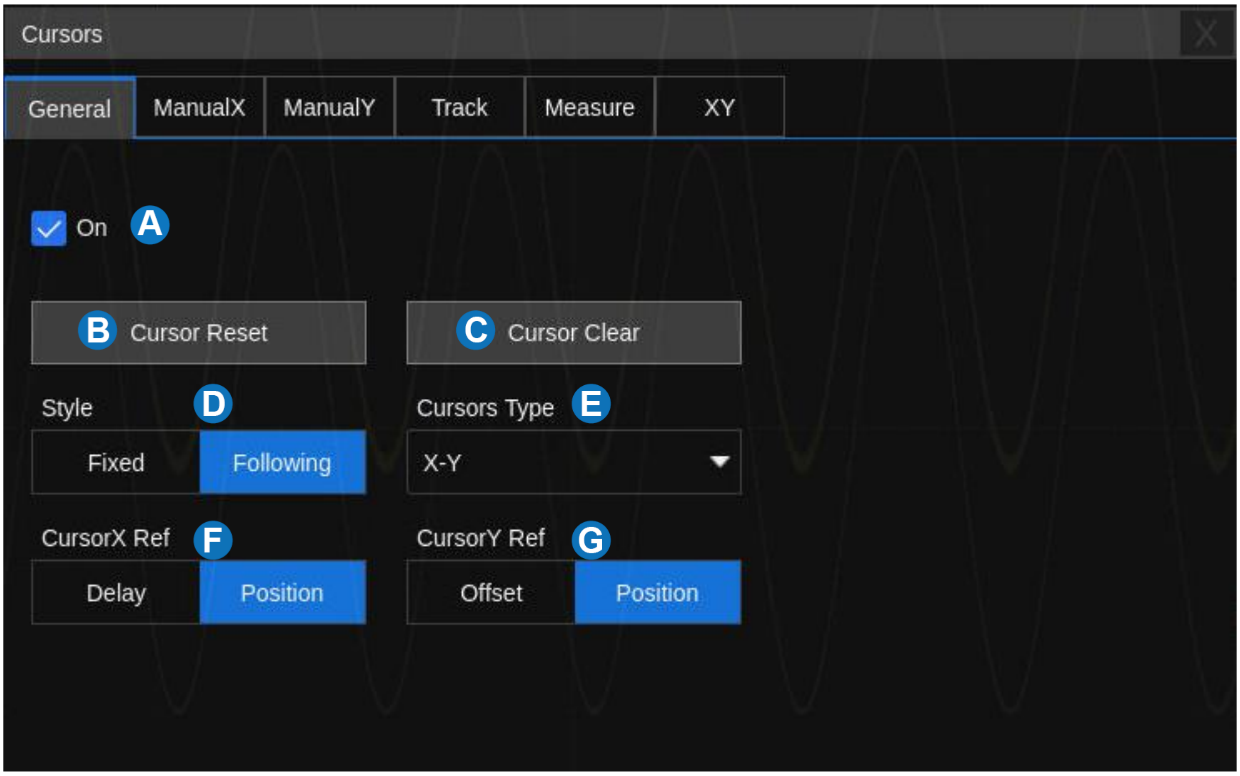
18 Cursors

18.1 Overview

Cursors are important tools when measuring signals. Rapid measurements can be performed using cursors in both horizontal and vertical directions. The cursor modes include Manual X, Manual Y, Track, Measure, and XY. Different modes support multiple cursors to indicate the X-axis values (time or frequency) and Y-axis values (voltage or current) on a selected waveform(C1~C8/ F1~F8/ RefA~RefH/ M1~M4/ Histogram).



Perform *Cursors* to open the cursors dialog box, set cursor general settings under the general tab:



A. Turn the cursor function on or off

B. Cursor reset. Restore all cursors to default setting

C. Cursor clear. Close the opened cursors

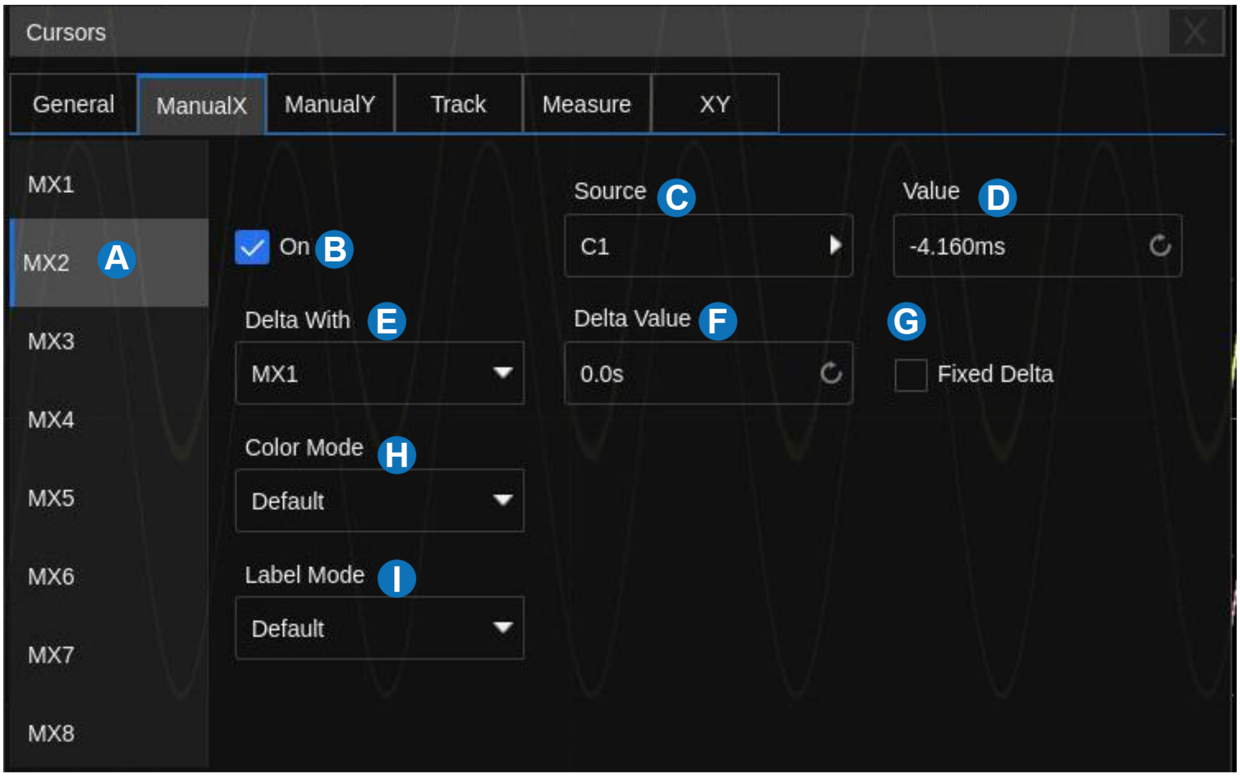
D. Display style of cursors text

E. Set cursor display switches in all directions (horizontal, vertical, horizontal + vertical). It only controls the cursor display and does not control the cursor switch

F. X cursor reference (Delay or Position). Delay measures the cursor position relative to the Horizontal Delay/Offset position. Position measures the cursor position relative to the horizontal center of the display

G. Y cursor reference (Offset or Position). Offset measures the cursor position relative to the Vertical/Offset position. Position measures the cursor position relative to the vertical center of the display

Switch to *ManualX* tab to set manual X cursors:



A. Select the cursor. Multiple cursors are supported in each cursors mode

B. Turn on/off the cursor

C. Select the source

D. Set the position of the specified cursor (by gestures, universal knob, or virtual keypad)

E. Set delta cursor. Relative relationships can be established between cursors in the same direction, such as between MX cursors, between MX cursor and TX cursor, between MY cursors, between XY_X cursors, and between XY_Y cursors. MEA cursor does not support.

F. Set the delta value between the cursors

G. Check the *Fixed Delta* box to move the delta cursor while moving the source cursor

H. Set the cursor color mode (Default, Follow or Custom)

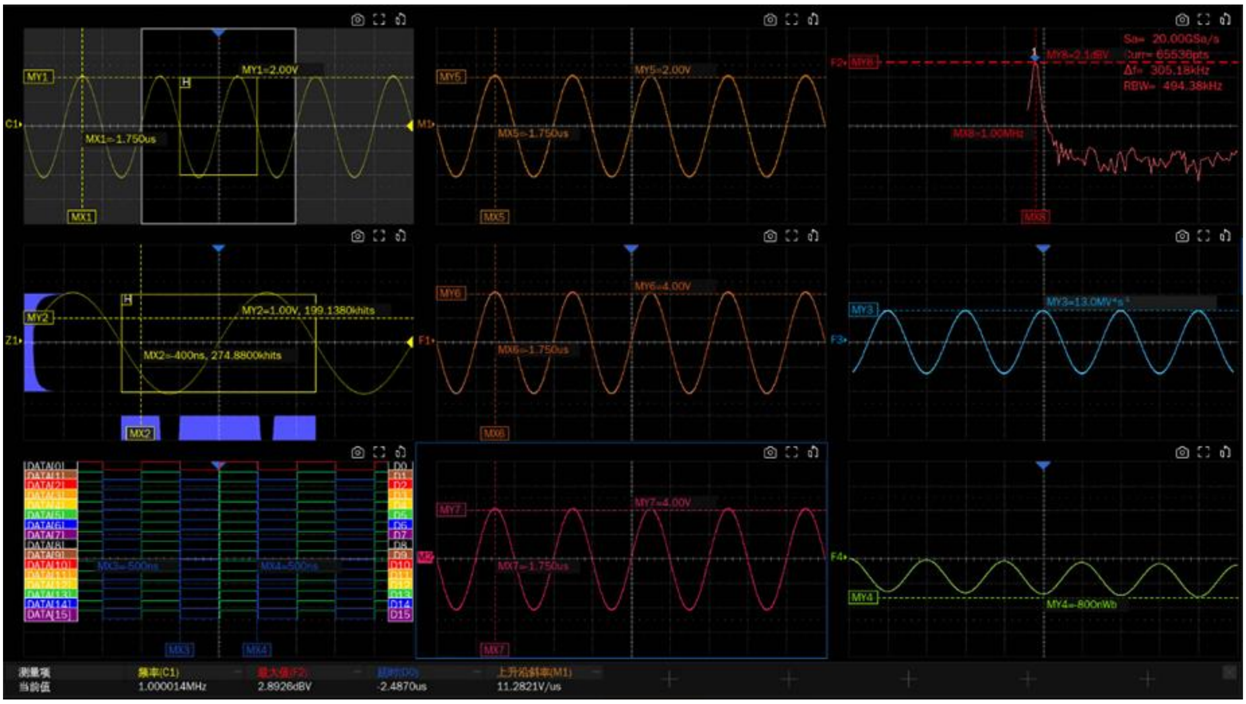
I. Set the cursor label mode (Default, Follow or Custom)

18.2 Cursors Mode

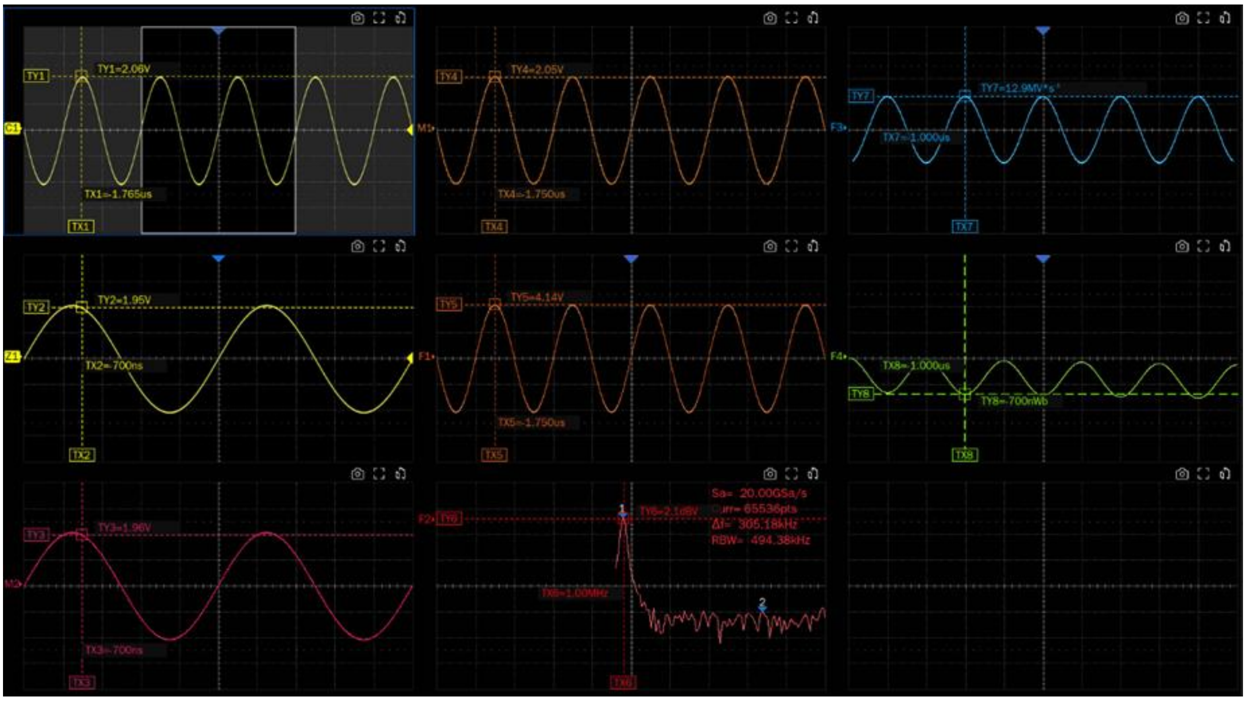
Multiple cursors are supported in each cursors mode. Each cursor is independently switchable and can be simultaneously displayed to measure different waveforms in different windows.

Manual X -- Manually set the position of the X cursors (vertical dashed lines) for measuring horizontal time. (When using the FFT math function as the source, the X cursors indicate frequency.) This mode supports 8 cursors (MX1 to MX8)

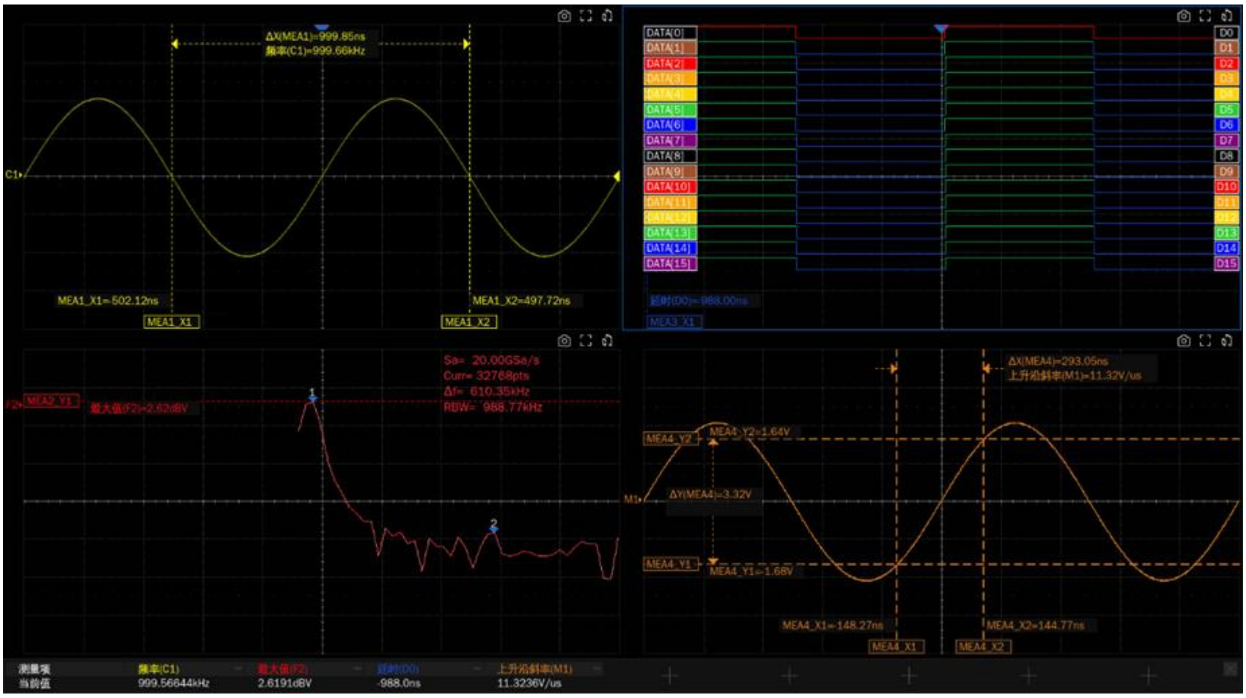
Manual Y -- Manually set the position of the Y cursors (horizontal dashed lines) for measuring vertical voltage or amperage (depending on the channel's unit settings). The measurement unit corresponds to the cursor source. This mode supports 8 cursors (MY1 to MY8).



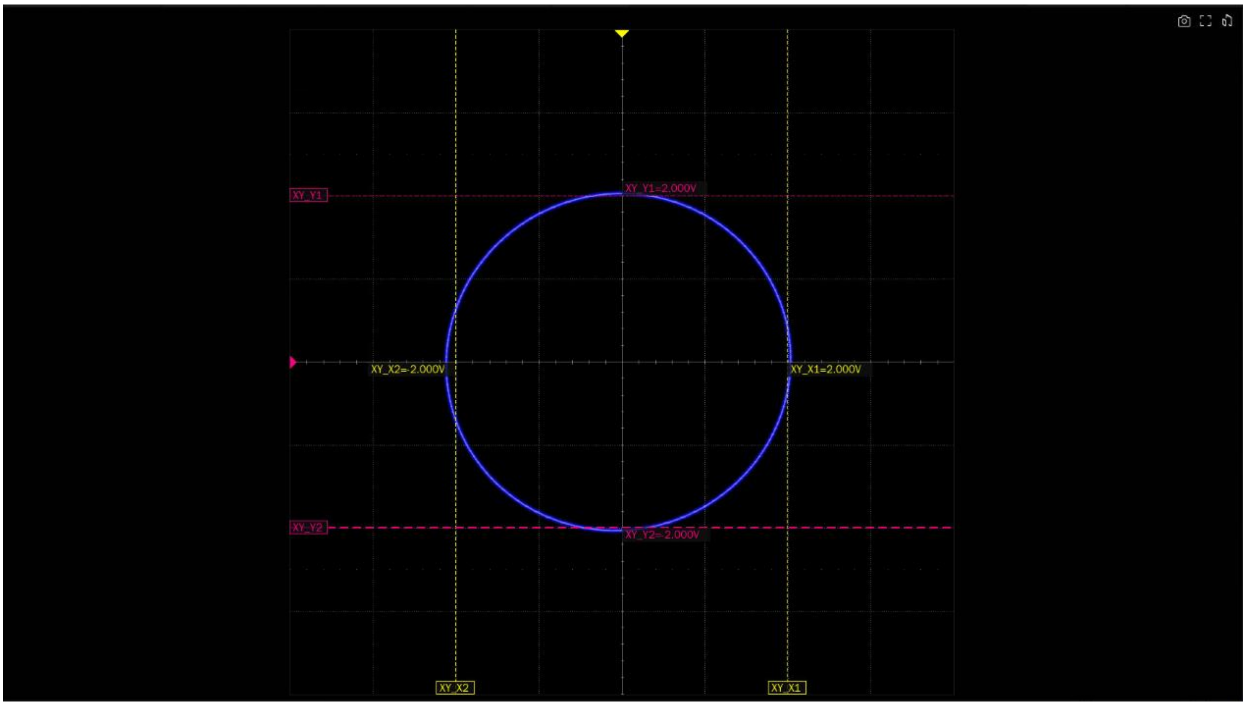
Track -- A set of track cursor contains two cursors. Only horizontal cursor TX is adjustable, while the vertical cursor TY automatically attach to the cross-point of the cursor and the source waveform. This mode supports 8 cursors (TX1 to TX8)



Measure -- Automatically indicates the measured item using cursors. and the measurement cursor cannot be adjusted . This mode supports 4 cursors (MEA1 to MEA4).



XY -- In XY mode, used to measure the vertical volts or amperes of source group C1-C2 (depending on the unit setting of the channel). This mode supports 4 cursors (XY_X1、XY_X2、XY_Y1、XY_Y2).

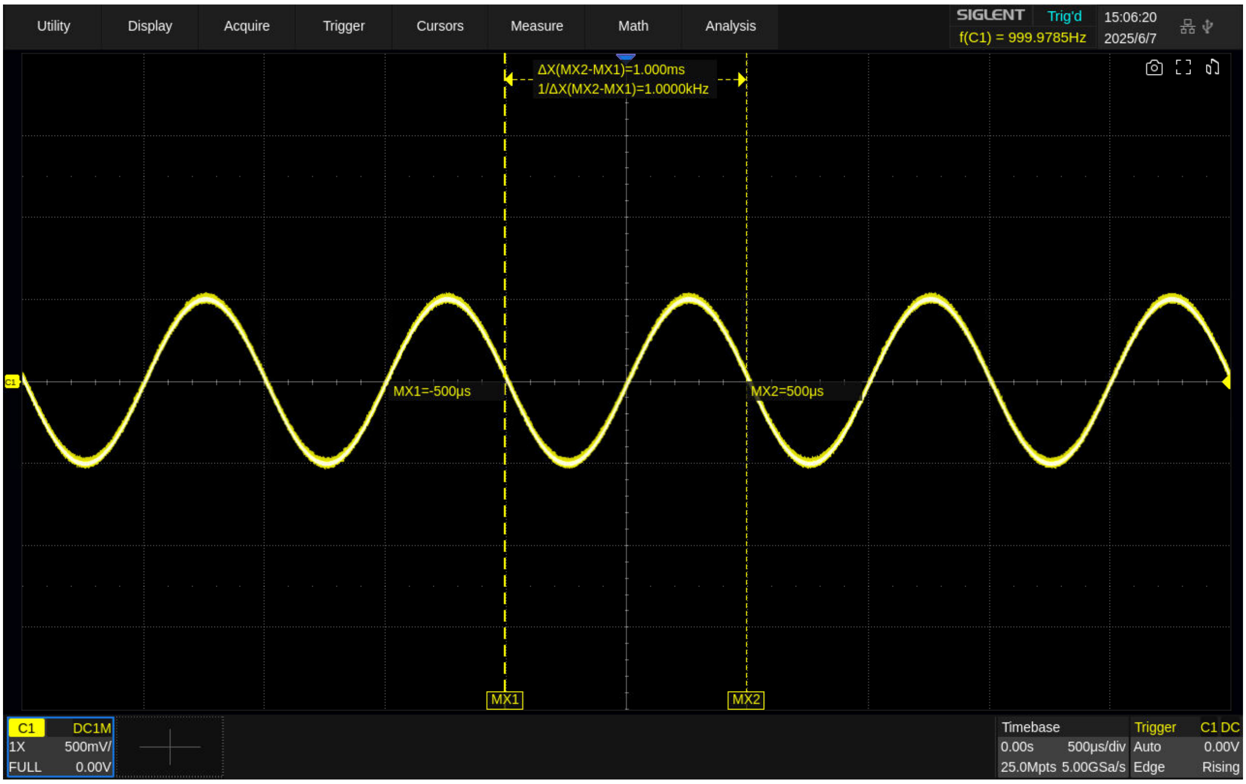


18.3 Delta Cursor

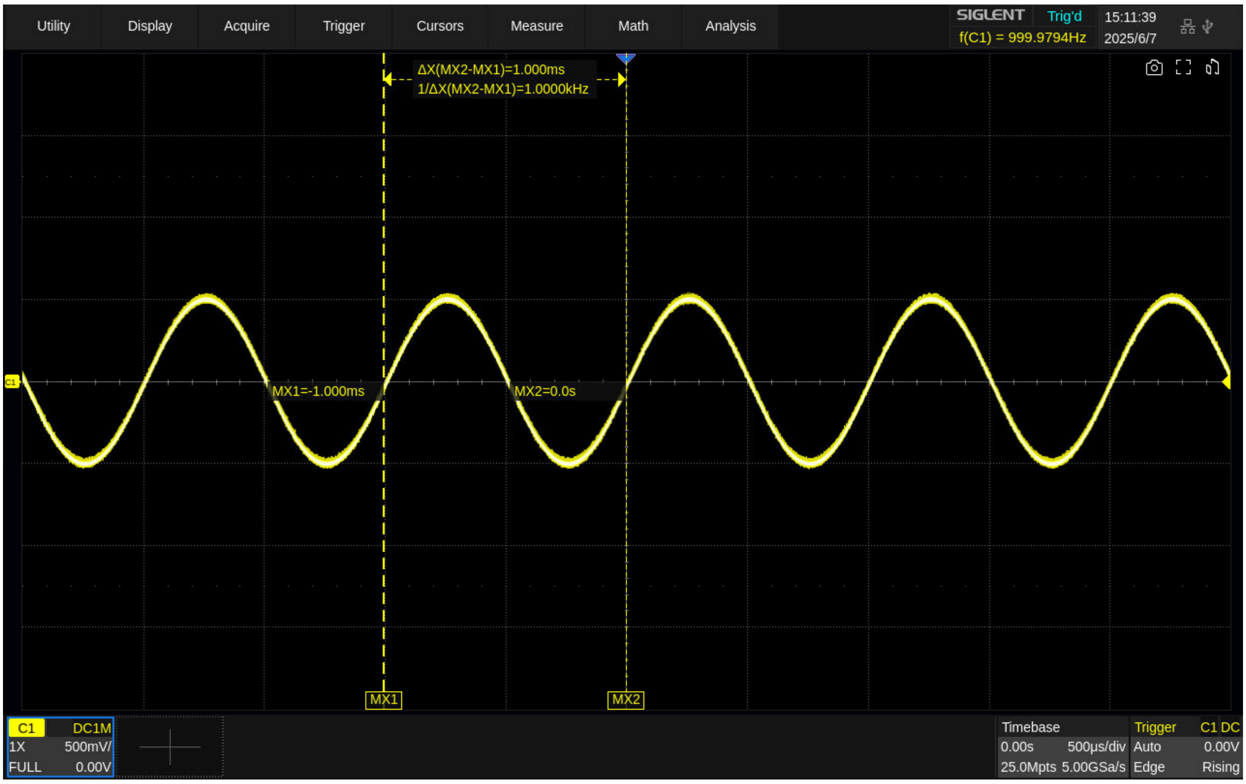
After establishing a relationship between the cursors, the relative information △X or △Y between the cursors will be displayed. Check the *Fixed Delta* box to move the delta cursor while moving the source cursor. Set the *Delta Value* to set the position of the source cursor with the delta cursor at zero position.

Relative relationships can be established between cursors in the same direction, such as between MX cursors, between MX cursor and TX cursor, between MY cursors, between XY_X cursors, and between XY_Y cursors. MEA cursor does not support.

The following is an example of using a manual X cursor, with MX2 setting the delta cursor to MX1, and the movement effect after enabling the fixed delta position:



Timebase =500μs/div， MX1=-500μs（1div）， MX2=500μs（-1div）， Delta Value =1ms



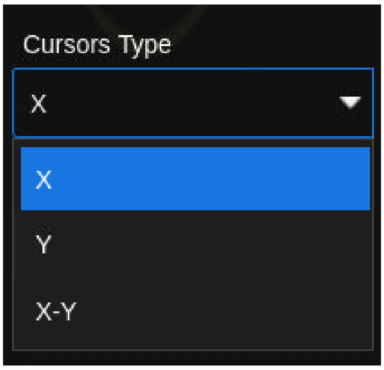
Move MX1 to the left 1div（MX1=-1ms），MX2 follow the left shift 1div（MX2=0s）

ℹ	**Note:** Reference relationships can only be established unidirectionally between the cursors.

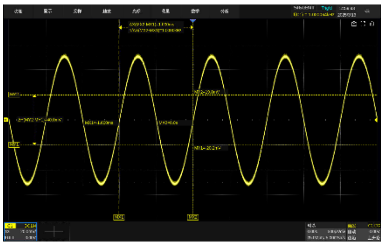
18.4 Cursors Display

Cursors Type

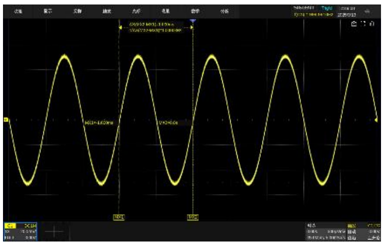
When there are many cursors turned on, use the cursor display switch to quickly hide cursor types of no interest. This switch only controls the cursor display and does not control the cursor switch. Click *General* > *Cursors Type* to set:



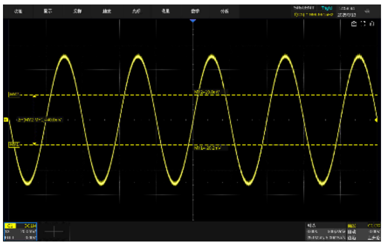
A. Only display X cursor, hide Y cursor and its information
B. Only display Y cursor, hide X cursor and its information
C. Simultaneously display X cursor and Y cursor



X-Y



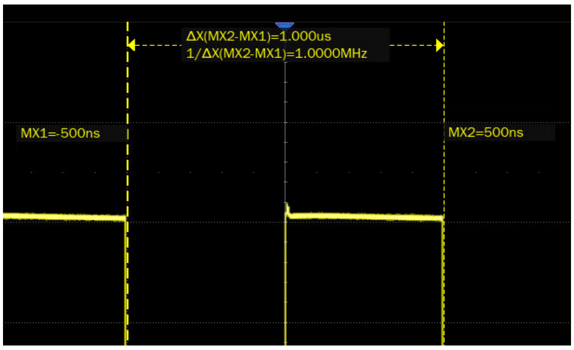
X



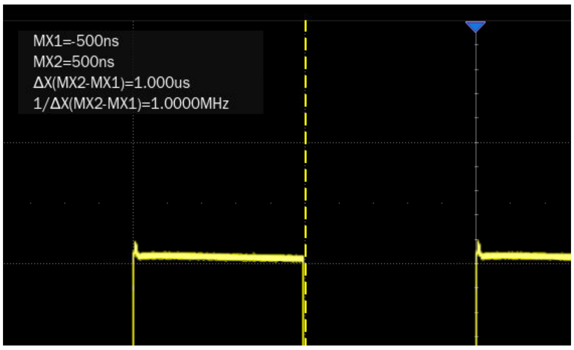
Y

Display Mode

The display mode of cursors:



Following mode



Fixed mode

Following -- The position information of each cursor is attached to the cursor, and the difference information is between the two cursors with arrows connected to the cursors. This mode is more intuitive.

Fixed -- The position information of each cursor and the difference between the cursors are displayed in a region on the screen. The region can be moved by dragging to avoid covering the waveform. This mode is relatively concise.

Cursors Reference

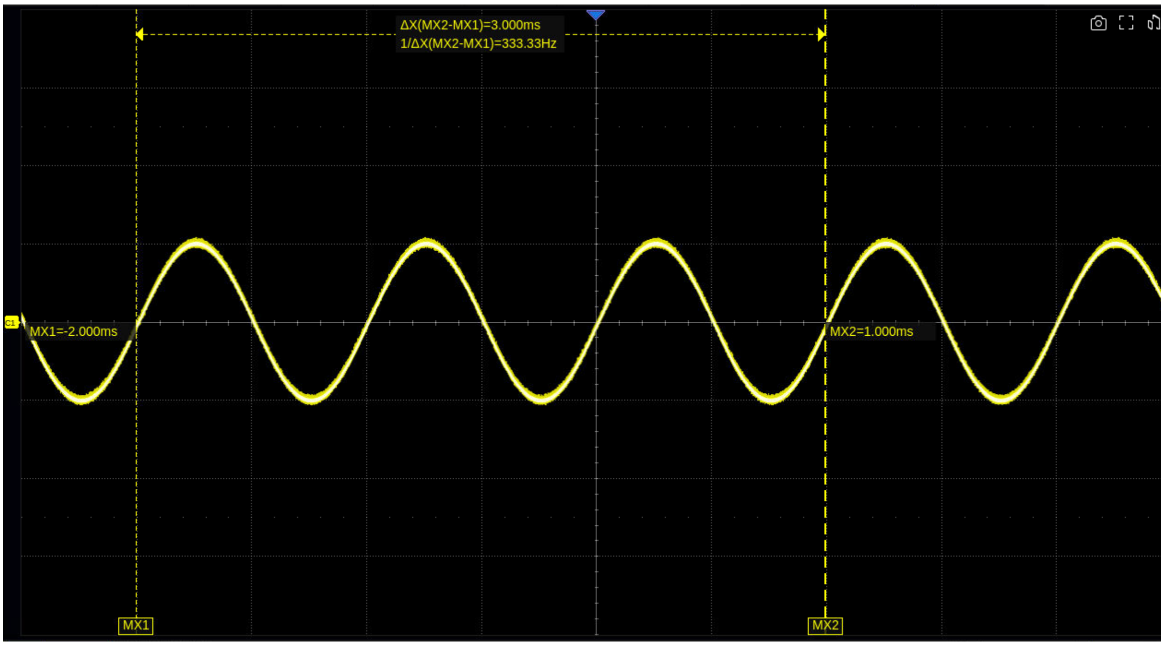
CursorX Ref:

- Delay- When the timebase is changed, the value of X cursors remains fixed.
- Position- When the timebase is changed, the X cursors remain fixed to the grid position on the display.

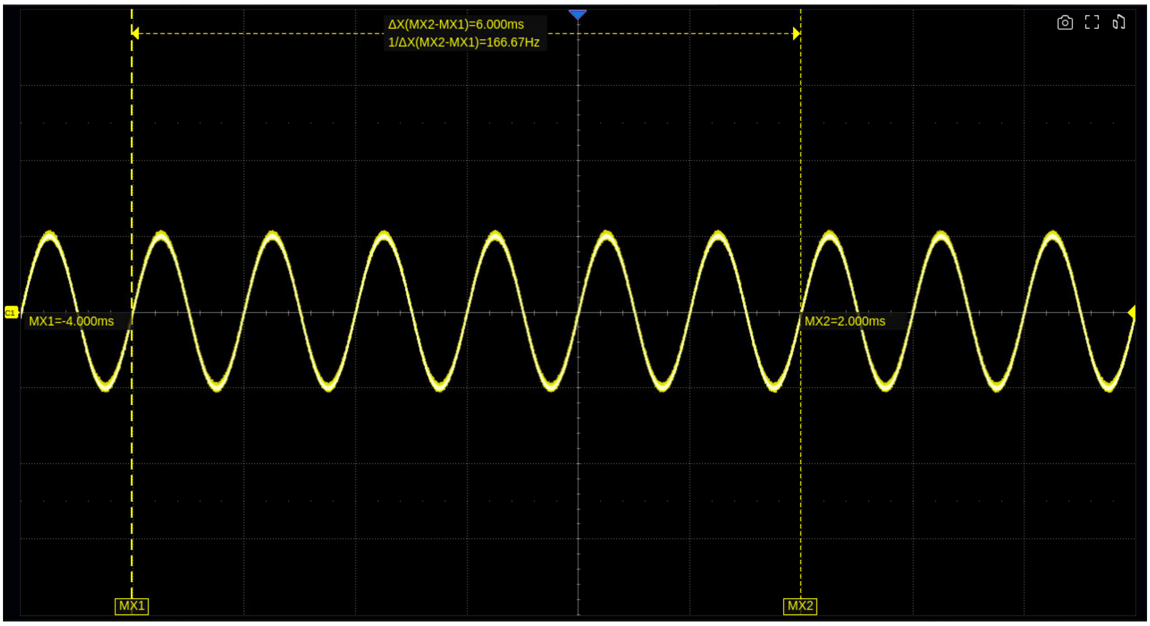
CursorY Ref:

- Offset – When the vertical scale is changed, the value of Y- cursors remain fixed.
- Position – When the vertical scale is changed, the Y-cursors remain fixed to the grid position on the display.

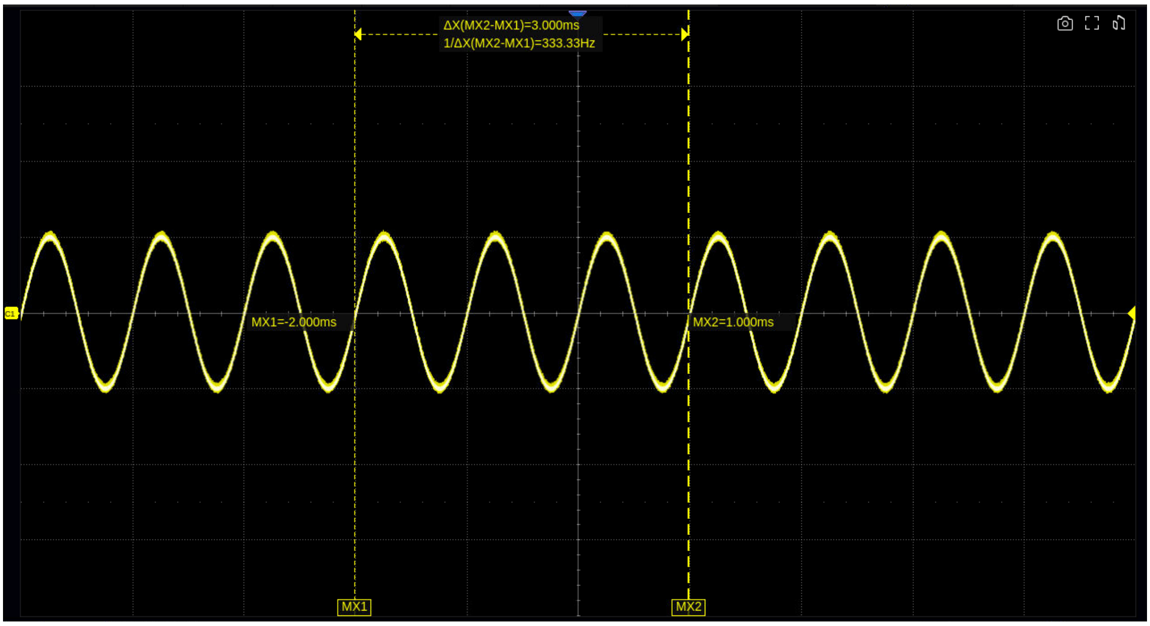
Take the cursorX reference as an example to demonstrate the scaling effect of different settings:



Timebase=500μs/div， MX1=-2ms (-4div)， MX2=1ms (2div)



Fixed position, timebase is changed to 1ms/div, the grid number of MX1 and MX2 cursors (-4div, 2div) remains fixed. The value of MX1 and MX2 is changed to -4ms , 2ms.



Fixed delay, timebase is changed to 100 ns/div, the value of MX1 and Mx2 cursors (-200 ns, 100 ns) remains fixed. The grid number of MX1 and Mx2 cursors is changed to -2div, 1div.

Cursors Label

This device supports setting cursor labels, with optional modes: default, follow, and custom.

Default -- Default value. MX, MY, and TX cursor labels default to empty, MEA cursor label defaults to "MEAn" (where n=1-4, representing cursor group number), XY cursor label defaults to "XY".

Follow -- Sync the labels of the delta cursor. Optional after setting the delta cursor.

Custom -- Custom label content. Click *Label Text* to pop up the label text input box, then click on the content area under the input box and enter custom content through the pop-up virtual keyboard. The tag length is limited to 20 characters, and characters exceeding the length will not be displayed.

Cursors Color

This device supports setting cursor color, with optional modes: default, follow, and custom.

Default -- Keep the cursor color consistent with the source color.

Follow -- Sync the color of the delta cursor. Optional after setting the delta cursor.

Custom -- Custom cursor color. Click on the color block to set it on the pop-up color palette page.

Cursors Reset

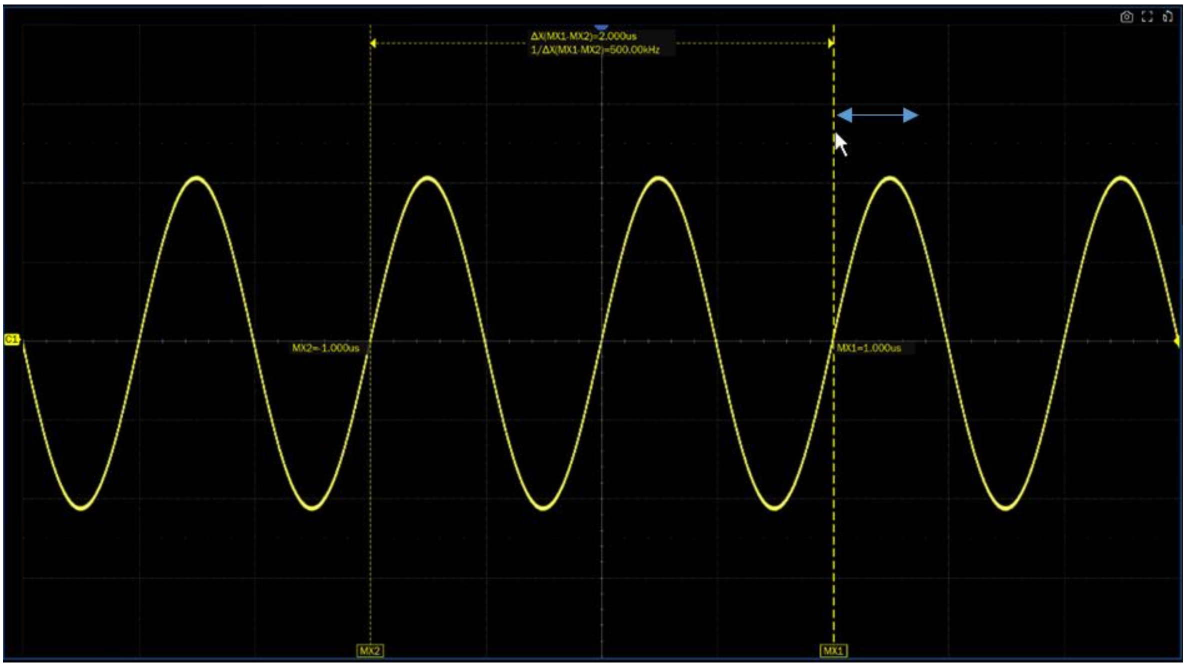
All cursors will be restored to default settings: MX1-MX2 will be activated with a reference relationship established, MY1-MY2 will be activated with a reference relationship established. Other cursors will be deactivated.

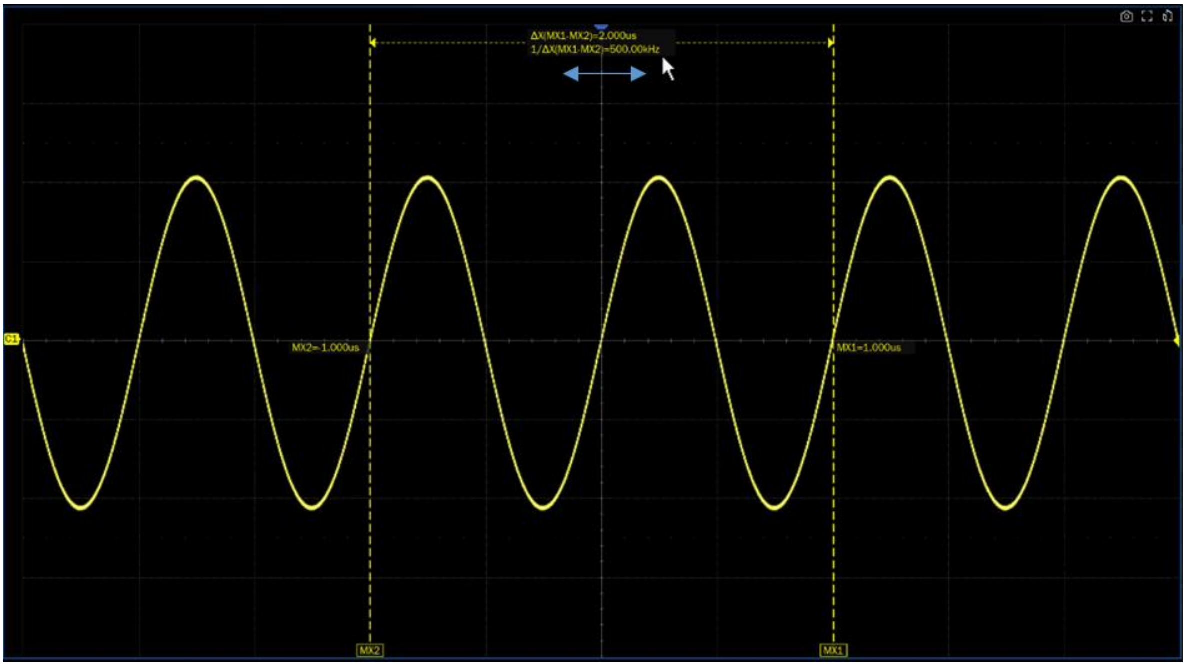
18.5 Select and Move Cursors

The cursors can be selected and moved directly by the mouse, in addition, they can be selected in the cursor's value dialog box.

Gesture or Mouse

Directly click the cursor and drag it, as shown below:





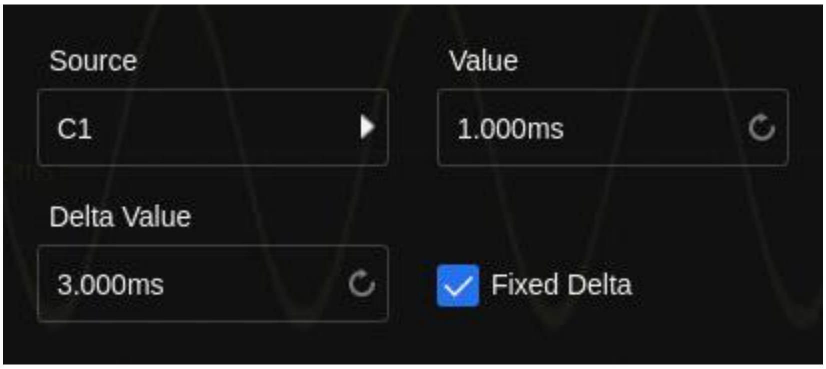
Knob

Move the cursor position through the knob in the front panel cursor area, press to select different cursors.

Gesture movement of the cursor is fast but not precise enough, and knob movement of the cursor is fine but not fast enough. It is recommended to combine two methods: first use gesture movement for coarse adjustment, and then rotate the multi-functional knob for fine adjustment to improve efficiency.

Dialog Box

Click the cursor value area of the dialog box, and then roll the mouse wheel to adjust the position, or set through the pop-up Virtual keyboard.

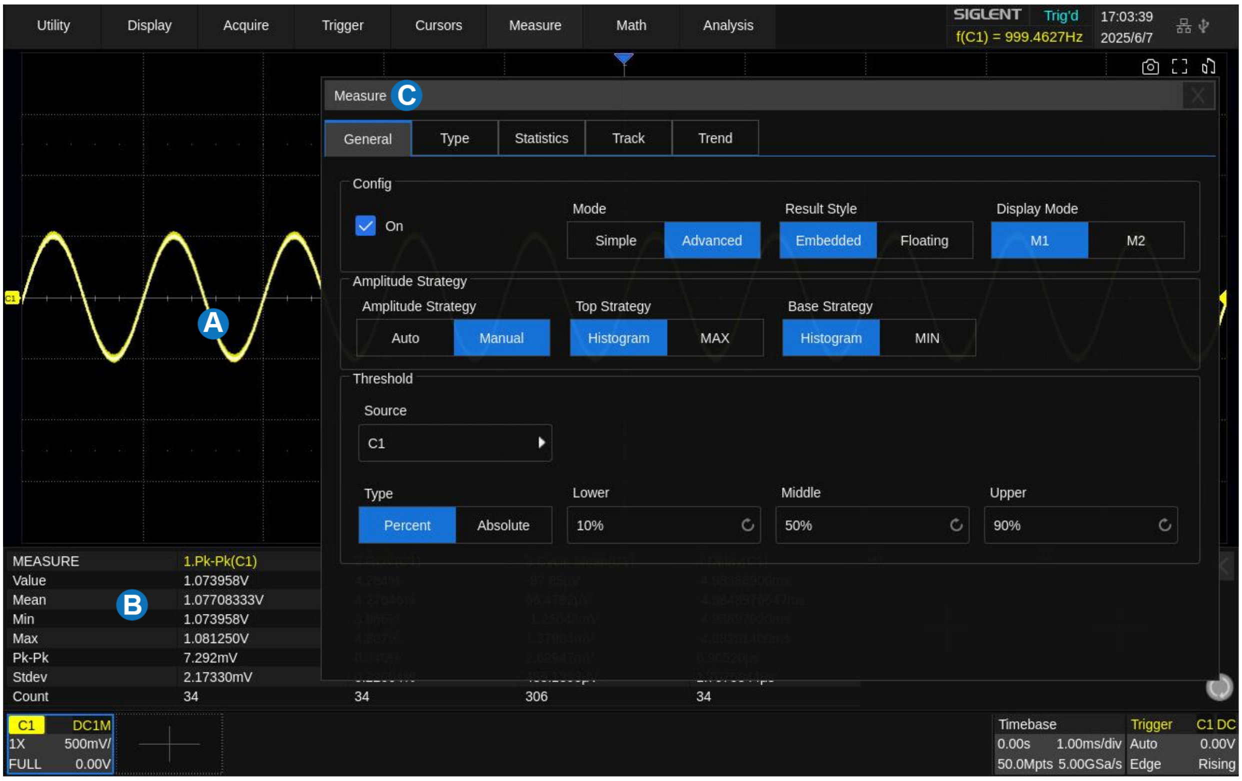


19 Measurement

19.1 Overview

The device features a strong automatic measurement list. These parameters can be automatically measured without cursors and include common measurements such as rise time, fall time, peak-peak, and period. The device can also measure multiple channels at the same time, showing up to 6 parameter measurements with statistics while in the M1 display mode and up to 12 parameters in the M2 mode. If you wish to view more parameters on a specified channel, then the "Simple" mode can be employed. For measuring waveform of interest in a time gate, the "Gate" function is suggested.

Some parameter measurements (such as the mean) may be a value generated by all the data in a frame. Some parameter measurements (such as period) accumulate all measurements in a frame, but the displayed value is always the first value. If you want to know the distribution of multiple parameters in one frame, you should use the statistics function.

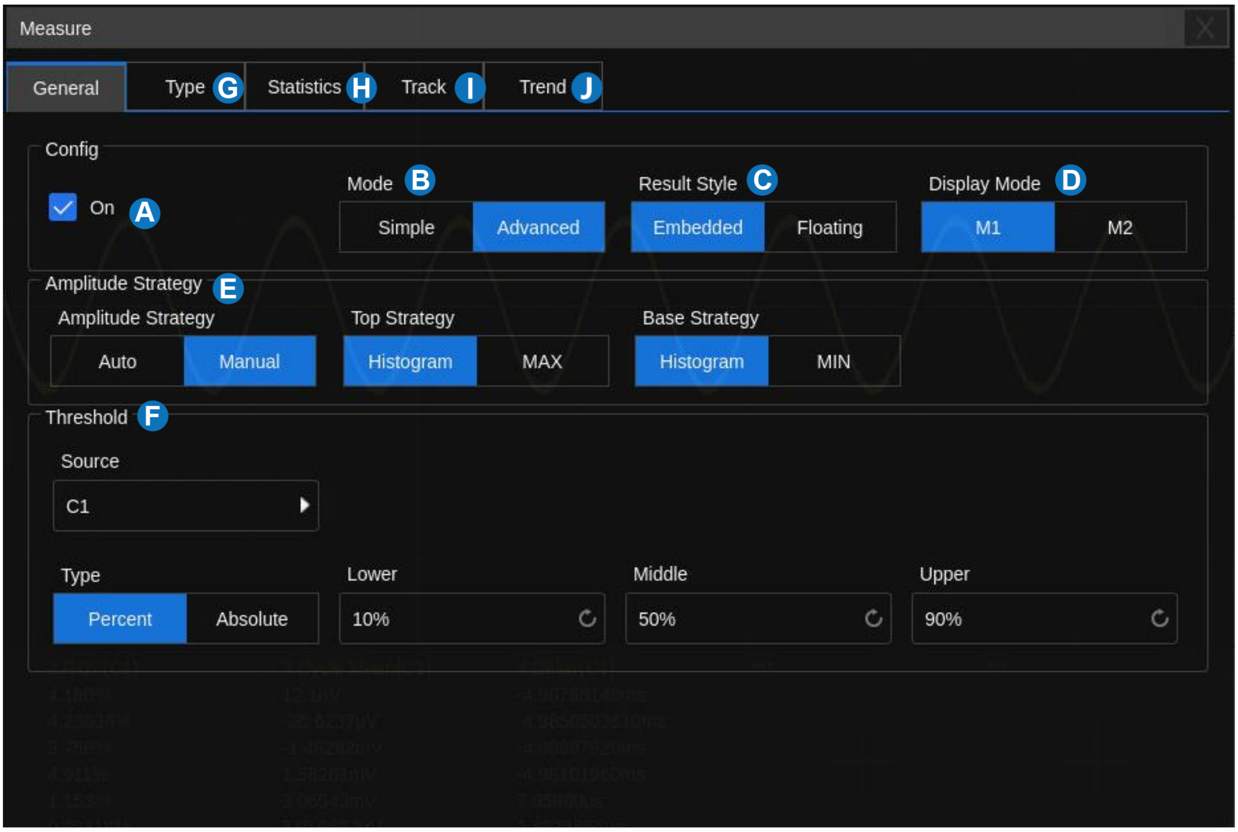


A. The waveform display area automatically compresses when the other windows are displayed

B. Measurement parameters and statistics display area. If select the mode as “Simple”, the "Simple" parameter area is displayed

C. Measure dialog box

Perform Measure , or click *Measure* to open the dialog box.



A. Enable/disable measure

B. Set the mode of measure: Simple or Advanced. "Simple" shows the specified basic measurement parameters of the selected channel. In "Advanced" mode, the measurement parameters can be added one by one as needed.

C. Set the result style : Embedded or Floating.

D. Set the display mode.

E. Set the amplitude strategy

F. Threshold level setting area

G. Select measurement parameters

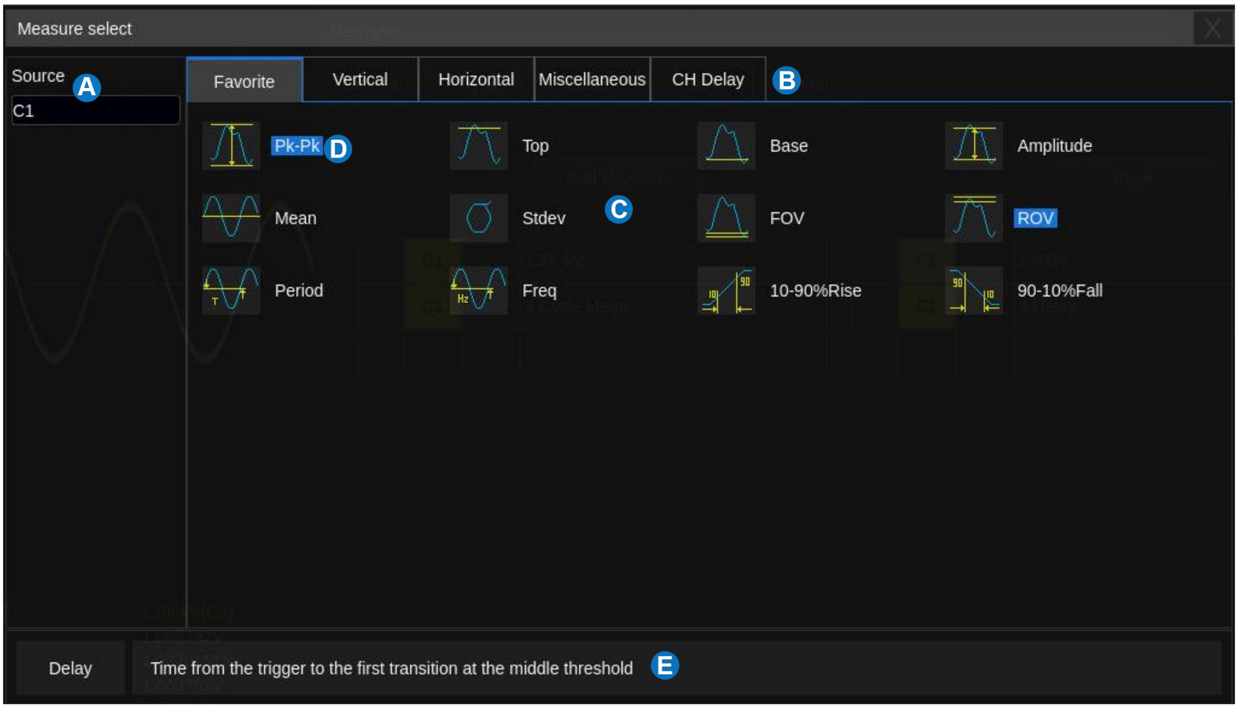
H. Set measurement and statistical parameters. This item is not displayed under “Simple” mode

I. Set up a measurement trajectory diagram. This item is not displayed under “Simple” mode

J. Set up a measurement trend chart. This item is not displayed under “Simple” mode

19.2 Set Parameters

Click *Type* > *Add Measure* in the measure dialog box, or click *+* in the measurement parameters and statistics display area to open the parameter selection window:



A. Set the source of the current setting.

B. Measurement parameter classification tabs, including Favorite, Vertical, Horizontal, Miscellaneous, and CH Delay. Click a tab and the C area will display the corresponding parameters

C. Parameters area. Click the parameter to be measured to activate it, and click it again to close the parameter.

D. Background highlighted parameters represent it is activated. In the figure above, "Pk-Pk" and "ROV" are activated.

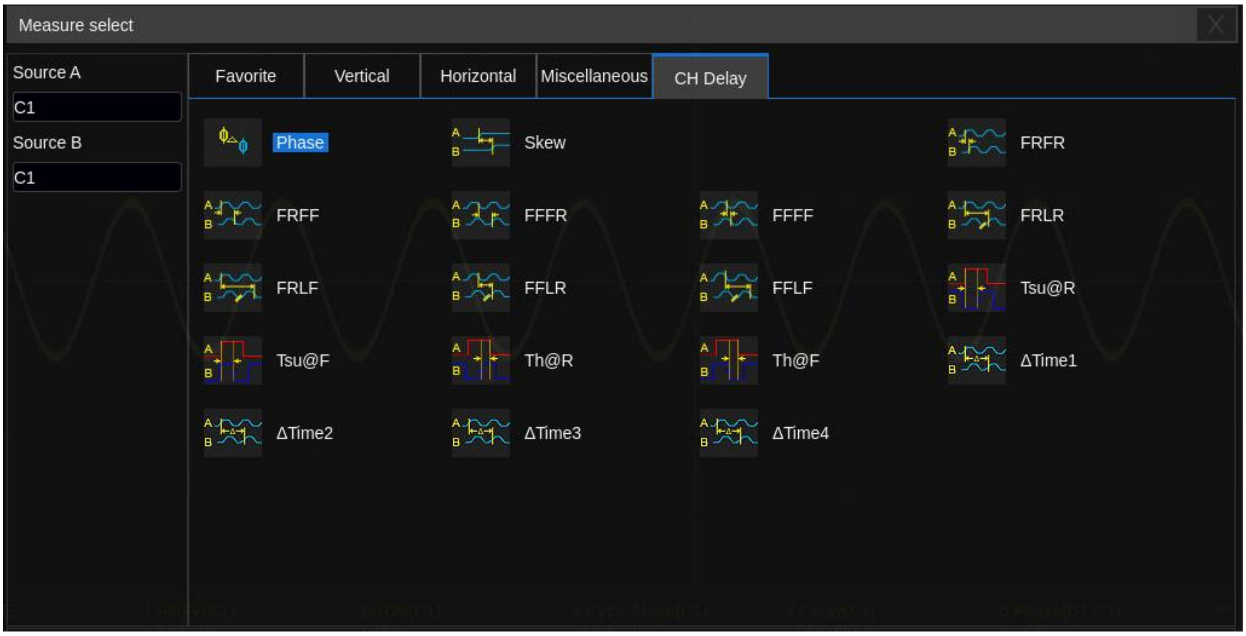
E. Description of the last selected parameter.

The correct steps to add a measurement parameter are to select the source in the A area and then select the parameter in the C area. For example, to add Pk-Pk measurements for C1 and Period measurements for C2, follow the steps below:

Source > *C1* > *Vertical* > *Pk-Pk*

Source > *C2* > *Horizontal* > *Period*

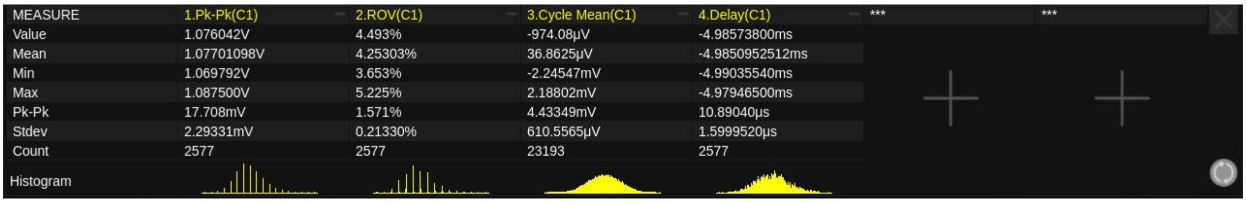
For the channel delay (CH Delay) measurement, because the number of sources involved is greater than 1, the steps to specify the source are different:



In the parameter selection area, the channel corresponding to *Source A* is specified first, and then the channel corresponding to *Source B*. Finally, the measurement parameter is selected. For example, to activate the skew between C1 and C2, you can follow the following steps:

Source A > *C1* > *Source B* > *C2* > *Skew*

Once a parameter is selected, it will appear in the parameter and statistical display area below the grid:



Click *+* in the blank area to add a parameter.

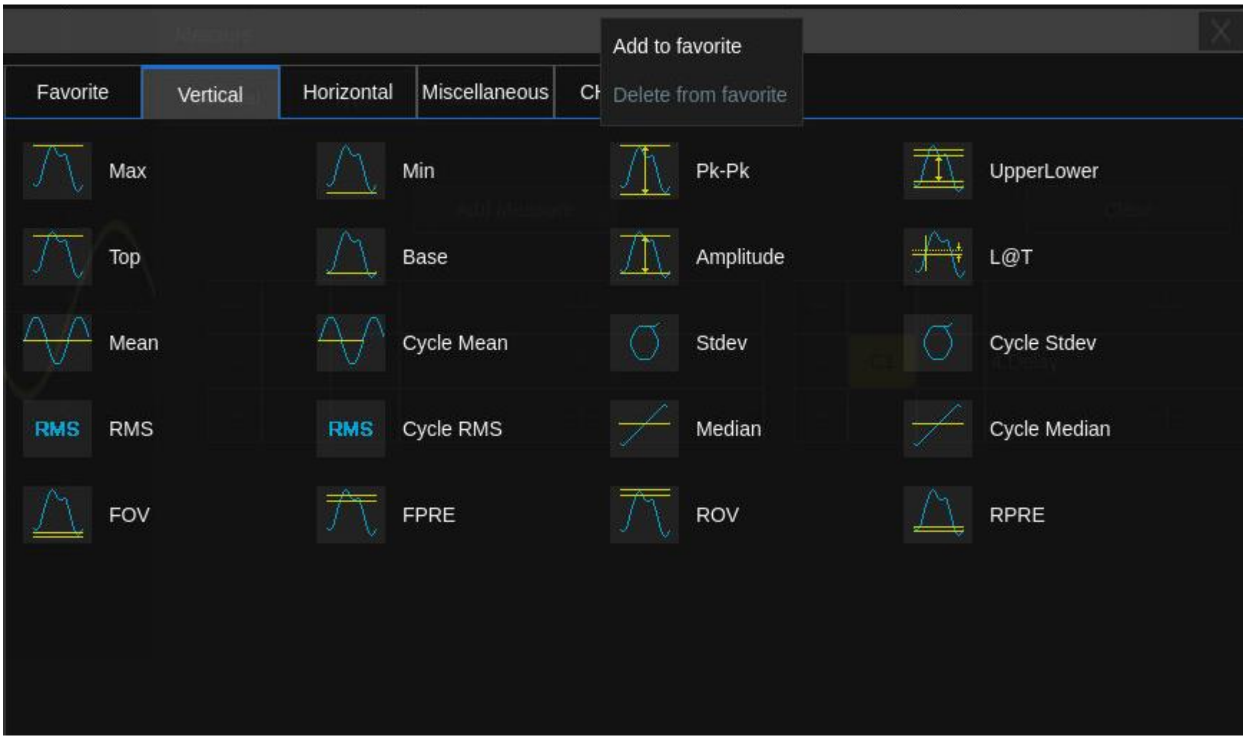
Click *−* in the upper right corner of each parameter to close the parameter.

Click *×* in the upper right corner of the area to close the measurement.

Click *Clear* in the dialog box to close all parameters.

The "Favorite" tab is used to store frequently used items. You can customize this tab. Up to 20 items can be stored in it. Long-click an item to add or remove it from the "Favorite" tab. For example, to add Pk-Pk to the "Favorite" tab:

Advanced > *Type* > *Vertical* > *Pk-Pk* > *Add to favorite*



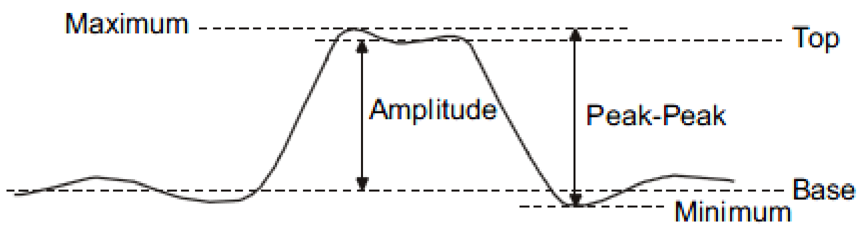
To remove Period from the "Favorite" tab:

Advanced > *Type* > *Favorite* > *Period* > *Delete from favorite*

19.3 Type of Measurement

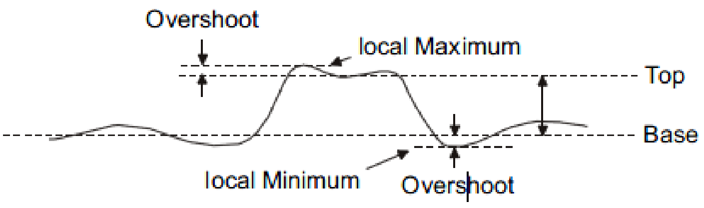
19.3.1 Vertical Measurement

Vertical measurement includes parameters:



- **Max:** Highest value in the input waveform
- **Min:** Lowest value in the input waveform
- **Pk-Pk:** Difference between maximum and minimum data values
- **UpperLower:** The value between the threshold upper and lower
- **Top:** Value of most probable higher state in a bimodal waveform
- **Base:** Value of most probable lower state in a bimodal waveform
- **Amplitude:** Difference between top and base in a bimodal waveform. If not bimodal, the difference between max and min
- **Mean:** Average of data values
- **Cycle Mean:** Average of data values in the first cycle
- **Stdev:** Standard deviation of the data
- **Cycle Stdev:** Standard deviation of the data in the first cycle
- **RMS:** Root mean square of the data

- **Cycle RMS:** Root mean square of the data in the first cycle
- **Median:** Value at which 50% of the measurements are above and 50% are below
- **Cycle Median:** Median of the first cycle
- **Overshoot (FOV):** Overshoot following a falling edge; 100%* (min- base)/amplitude
- **Overshoot (ROV):** Overshoot following a rising edge; 100%*(max-top)/amplitude



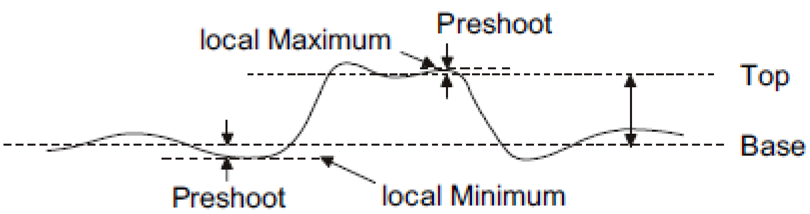
$$Rising\ Edge\ Overshoot = \frac{Maximum - Top}{Amplitude} \times 100\%$$

$$Falling\ Edge\ Overshoot = \frac{Minimum - Base}{Amplitude} \times 100\%$$

- **Preshoot (FPRE):** Overshoot before a falling edge.

  Equal to 100 %*(max-top)/amplitude.
- **Preshoot (RPRE):** Overshoot before a rising edge.

  Equal to 100 %*(min- base)/amplitude.



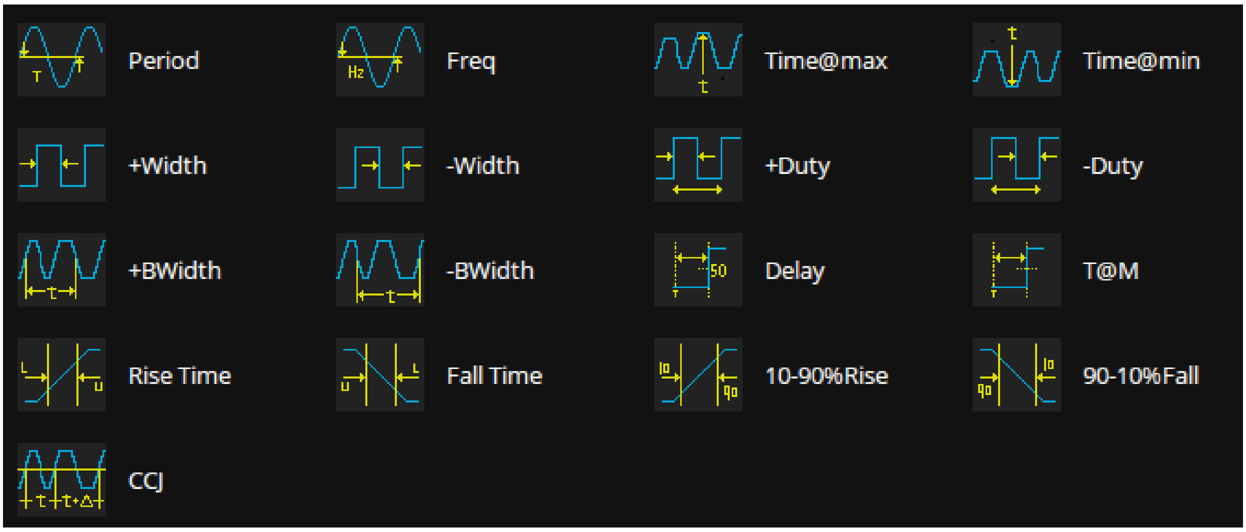
$$Falling\ Edge\ Preshoot = \frac{Maximum - Top}{Amplitude} \times 100\%$$

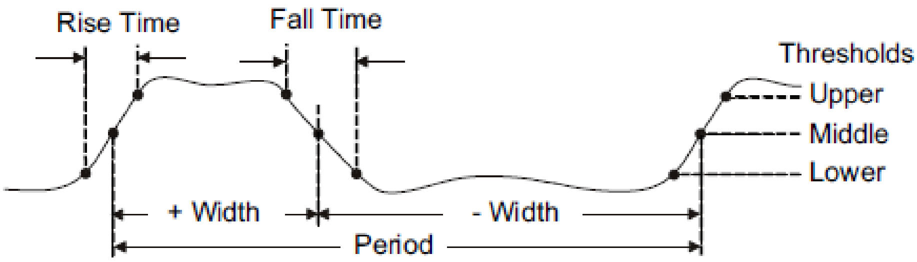
$$Rising\ Edge\ Preshoot = \frac{Minimum - Base}{Amplitude} \times 100\%$$

- **L@T:** Level measured at trigger position

19.3.2 Horizontal Measurement

Horizontal measurement includes parameters:



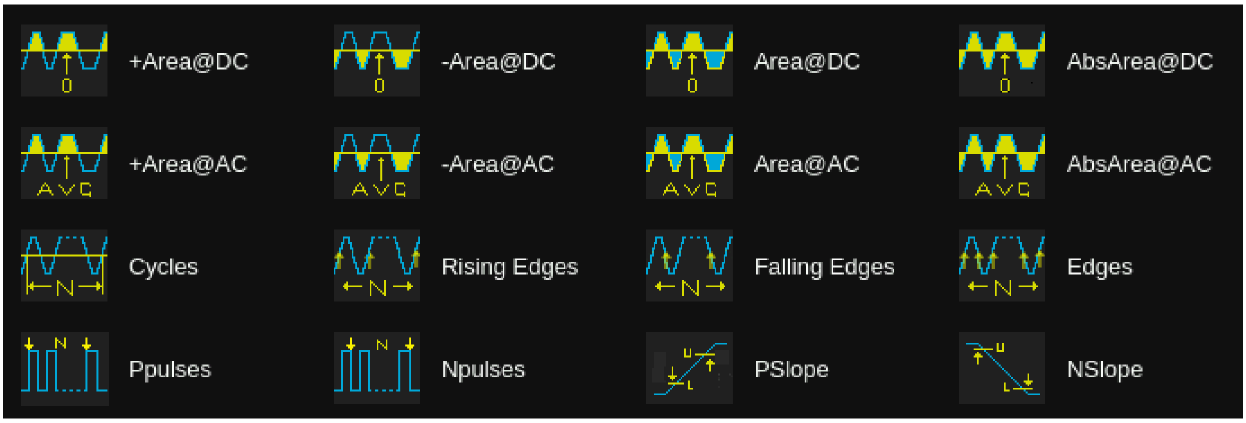


- **Period:** Time between the middle threshold points of two consecutive like-polarity edges.
- **Freq:** Reciprocal of the period
- **Time@max:** First time of maximum value
- **Time@min:** First time of minimum value
- **+Width:** Time difference between the middle threshold of a rising edge to the middle threshold of the next falling edge of the pulse
- **-Width:** Time difference between the middle threshold of a falling edge to the middle threshold of the next rising edge of the pulse
- **+Duty:** Positive Duty Cycle. The ratio of positive width to period
- **-Duty:** Negative Duty Cycle. The ratio of negative width to period
- **+BWidth:** Time from the first rising edge to the last falling edge at the middle threshold
- **-BWidth:** Time from the first falling edge to the last rising edge at the middle threshold

- **Delay:** Time from the trigger to the first transition at the middle threshold
- **T@M:** Time from the trigger to each rising edge at the middle threshold
- **Rise Time:** Duration of rising edge from lower threshold to upper threshold
- **Fall Time:** Duration of falling edge from upper threshold to lower threshold
- **10-90%Rise:** Duration of rising edge from 10-90%
- **90-10%Fall:** Duration of falling edge from 90-10%
- **CCJ:** The difference between two continuous periods

19.3.3 Miscellaneous Measurements

The Miscellaneous measurements tab includes parameters:

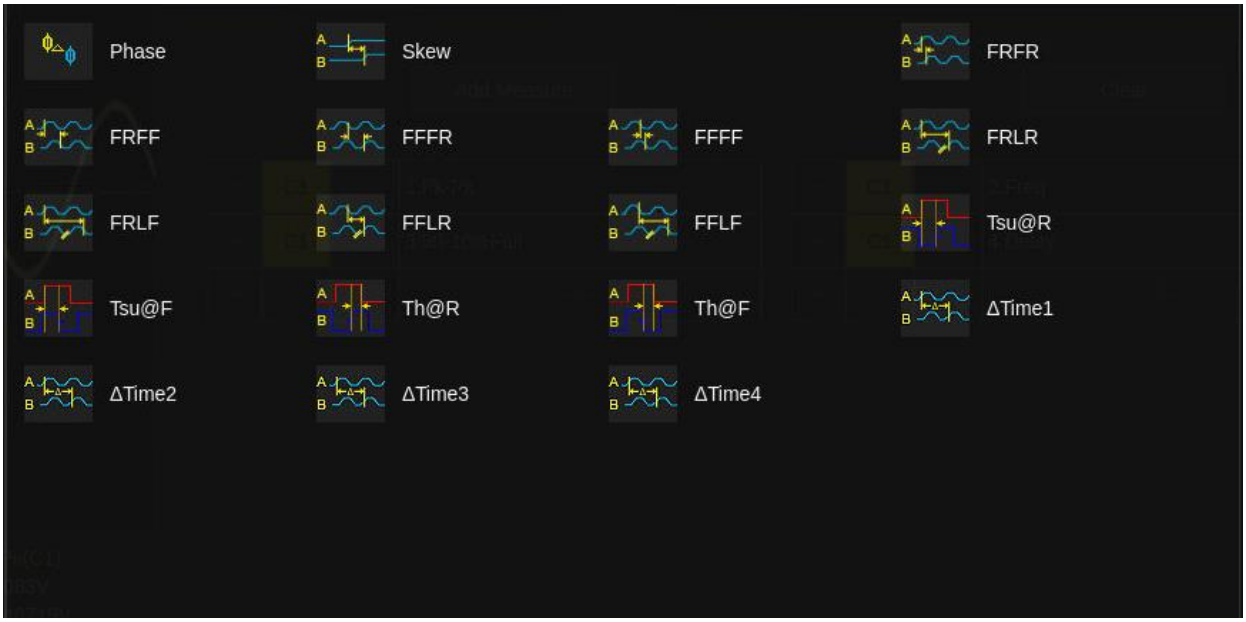


- **+Area@DC:** Area of the waveform above zero
- **-Area@DC:** Area of the waveform below zero
- **Area@DC:** Area of the waveform
- **AbsArea@DC:** Absolute area of the waveform
- **+Area@AC:** Area of the waveform above average
- **-Area@AC:** Area of the waveform below average
- **Area@AC:** Area of the waveform above the average minus the area of the waveform below average
- **AbsArea@AC:** Area of the waveform above the average plus the area of the waveform below the average
- **Cycles:** Number of cycles in a periodic waveform
- **Rising Edges:** Number of rising edges in a waveform
- **Falling Edges:** Number of falling edges in a waveform

- **Edges:** Number of edges in a waveform
- **Ppulses:** Number of positive pulses in a waveform
- **Npulses:** Number of negative pulses in a waveform
- **PSlope:** The slope of the rising edge
- **NSlope:** The slope of the falling edge

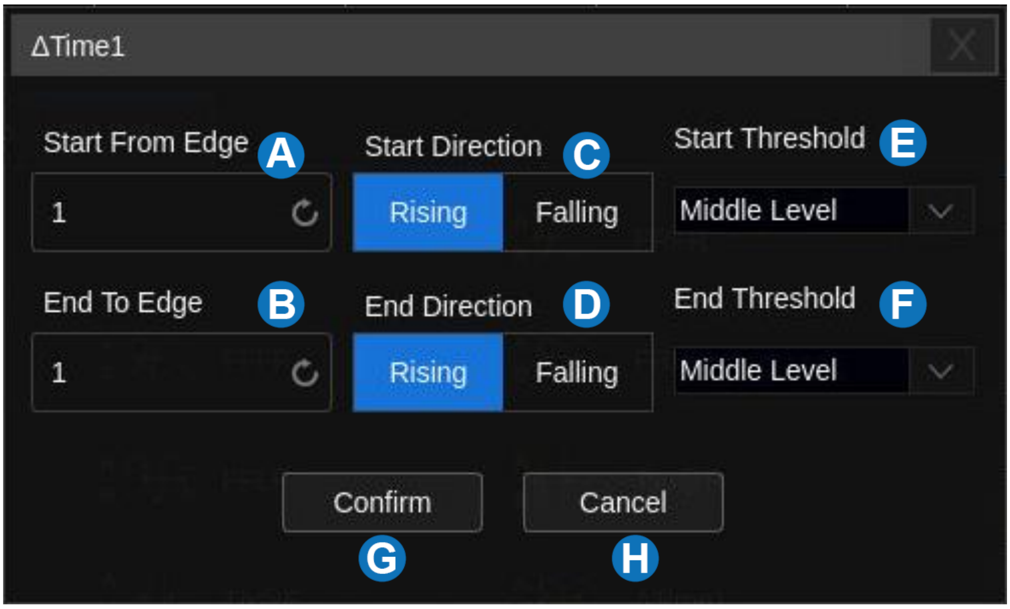
19.3.4 Delay Measurement

Delay measurement measures the time difference between two channels. It includes delay parameters:



- **Phase:** Phase difference between source A and source B. This parameter is only valid when the complete cycle of channel A can be measured
- **Skew:** Time of source A edge minus time of nearest source B edge
- **FRFR:** The time between the first rising edge of source A and the following first rising edge of source B at the middle threshold
- **FRFF:** The time between the first rising edge of source A and the following first falling edge of source B at the middle threshold
- **FFFR:** The time between the first falling edge of source A and the following first rising edge of source B at the middle threshold
- **FFFF:** The time between the first falling edge of source A and the following first falling edge of source B at the middle threshold

- **FRLR:** The time between the first rising edge of source A and the last rising edge of source B at the middle threshold
- **FRLF:** The time between the first rising edge of source A and the last falling edge of source B at the middle threshold
- **FFLR:** The time between the first falling edge of source A and the last rising edge of source B at the middle threshold
- **FFLF:** The time between the first falling edge of source A and the last falling edge of source B at the middle threshold
- **Tsu@R:** Data setup time before the clock rising edge
- **Tsu@F:** Data setup time before the clock falling edge
- **Th@R:** Data hold time after the clock rising edge
- **Th@F:** Data hold time after the clock falling edge
- **△Time1-4:** The time between two edges of △Time. Click to add measurement parameters to bring up the △Time settings window. Click on the added △Time item under the type page, and the △Time parameter will also be displayed.



A. Set the sequence number of the starting from edge (source A).

B. Set the sequence number of the end to edge (source B).

C. Set the start type, rising edge or falling edge

D. Set the end type, rising edge or falling edge

E. Set the start threshold, which can be selected as high, medium, or low value. Threshold level setting, see the section "Threshold" for details

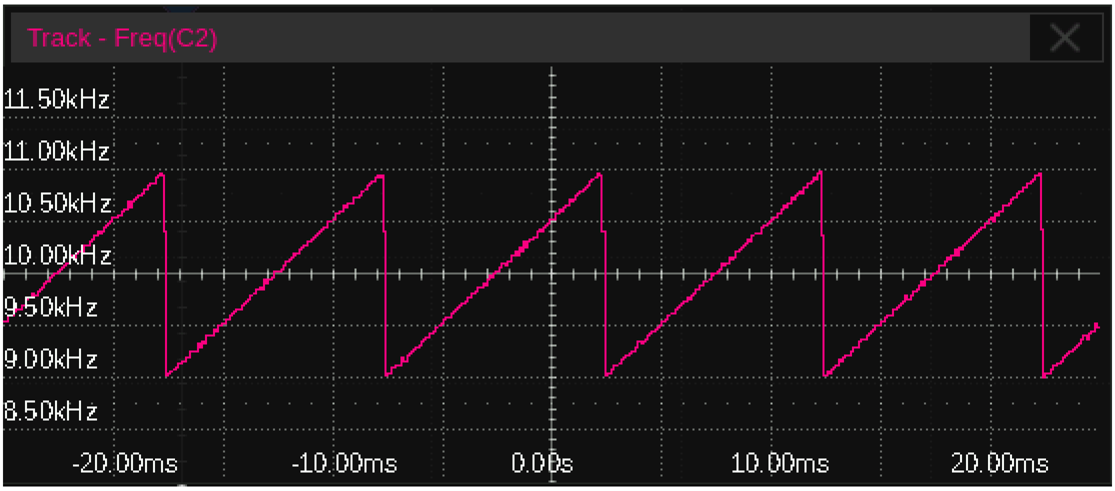
F. Set the end threshold, which can be selected as high, medium, or low value. Threshold level setting, see the section "Threshold" for details

G. Click "Confirm" to complete the setup and add measurement parameters. If you need to modify the settings, please set them through the dialog box

H. Click "Cancel" to cancel adding the parameter, and the window will close

19.4 Track

The measure values VS. time plot of a horizontal parameter (e.g. frequency, rise time) in one frame can be observed when the Track is enabled.



The upper limit of the statistic number in a frame is set in *Measure* > *Statistics* > *Config* > *AIM Limit* , which means the values exceeding the limit will not be shown in the track plot. The upper limit is 1,000 by default and can be set to up to 100,000.

19.5 Trend

After adding a measurement parameter, a Trend can be used to observe the long-term change of the selected measurement value over time.

Click on the *Trend* to open the trend dialog box

A. Record model

B. Max record num. Range 250 ~ 1,000,000， Default value 10,000

C. Select the trend source, only supports measurement items in advanced measurement mode

D. Scale mode. Auto or Manual.

E. Set the vertical scale and vertical position. Only manual mode is Manual

F. Set the horizontal scale and horizontal position. Only manual mode is Manual

G. Reset statistics

H. Trend plot display area

I. Trend chart statistical information.

J. Reset statistics

Press the Clear Sweeps button on the front panel, or click *Reset Statistics* in the measure dialog box, or click the symbol in the statistics display area to clear and restart statistics.

Record mode

By Sequnce -- according to the number of measurements taken. When the maximum number of records is reached, the recorded data will be overwritten in sequence.

By Interval -- Record at intervals, with a setting range of 0.5 to 1000 seconds.

Scale mode

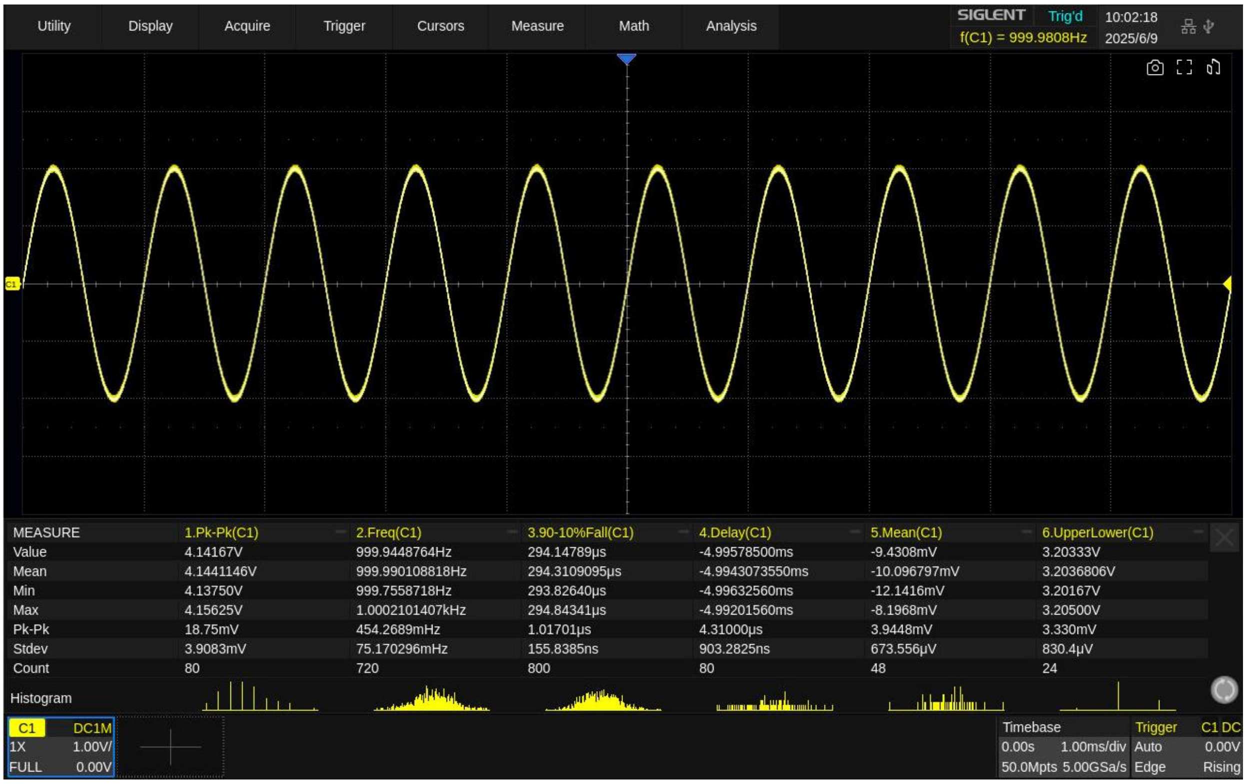
Auto mode -- Automatically sets the vertical and horizontal parameters of the trend chart based on the measured values.

Manual mode -- Customizable vertical and horizontal levels and offsets for trend charts. Its horizontal parameters are constrained by the maximum number of records, and its vertical gear is constrained by the automatic mode vertical gear.

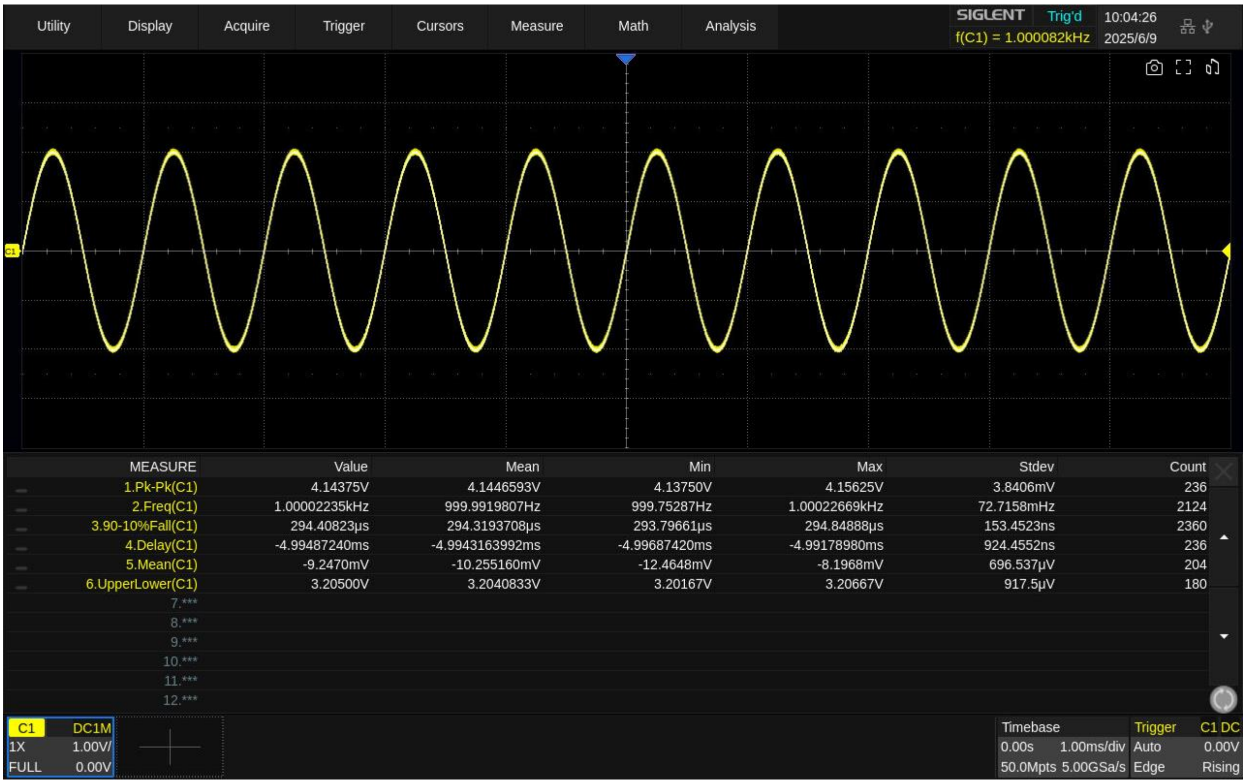
19.6 Display Mode

In advanced measurement mode, two display modes are supported: M1 and M2. Set through *Config* > *Display Mode*.

In M1 mode, up to 6 parameter measurements are displayed at a time. When statistics are enabled, they are listed under the measurement items. Click a column to add or replace a measurement.

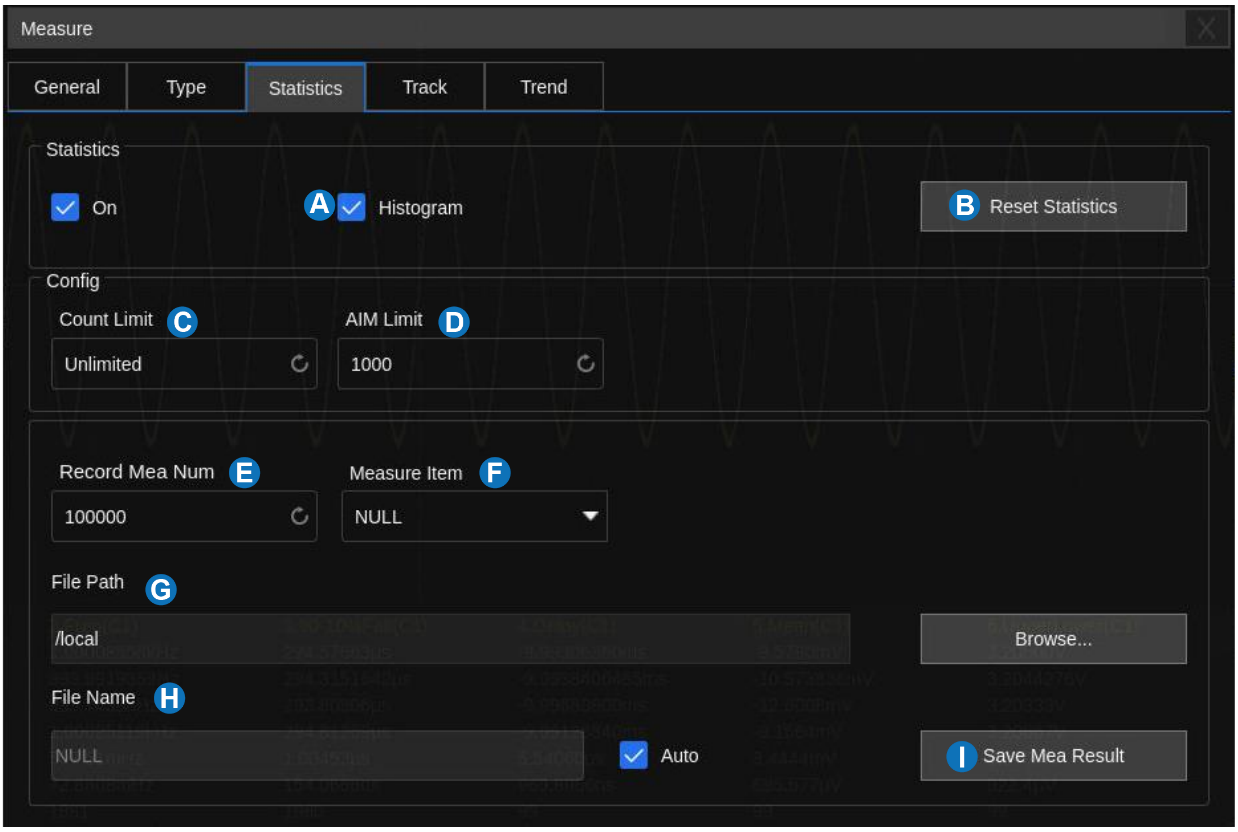


In M2 mode, up to 12 parameter measurements are displayed at a time. When statistics are enabled, they are distributed on the right side of the measurement item. Click a row to add or replace a measurement.



19.7 Measurement Statistics

Measurement statistics are based on the total number of captured waveforms. In Roll mode, measurement statistics increase over time. Click *Statistics Setting* in the measure dialog box to recall the Statistics Config dialog box:



A. Turn on /off the histogram

B. Clear and restart the statistics

C. Set the maximum number of samples for the statistics function. The setting range is 0 ~ 1024, or unlimited. If there is no limit, the number of statistics will be accumulated. If there is a limit, when the maximum number of statistics N is reached, only the latest N measurements will be counted. When the count is limited, only the first period measurement value of each frame is counted

D. Set the upper limit of the statistic number in a frame. Valid only when the count limit is set to "Unlimited". The setting range is 1 ~ 100000

E. Set the record mea num.

F. Selection measurement item.

G. Set the file path for saving measurement results

H. Set the file name for saving measurement results. The default name is "Measurement Item Time". After selecting *Auto* , the file name will be automatically updated based on the save time

I. Save measurement results

Enable the *Statistics* function to observe the distribution of the measured values of every selected parameter.

MEASURE	1.Pk-Pk(C1)	2.Freq(C1)	3.90-10%Fall(C1)	4.Delay(C1)	5.Mean(C1)	6.UpperLower(C1)
Value	4.15000V	1.00006353kHz	294.20052μs	-9.99312200ms	-10.4750mV	3.20500V
Mean	4.1477183V	999.9920686Hz	294.2930586μs	-9.9936995859ms	-10.071984mV	3.2042567V
Min	4.13958V	999.66828Hz	292.90727μs	-9.99680900ms	-13.1756mV	3.19333V
Max	4.16250V	1.00028747kHz	294.92435μs	-9.99086760ms	-6.5295mV	3.20667V
Pk-Pk	22.92mV	619.19mHz	2.01708μs	5.94140μs	6.6461mV	13.34mV
Stdev	3.4856mV	73.4778mHz	163.2800ns	906.4048ns	848.933μV	974.0μV
Count	2583	49077	51660	2583	2583	2583

- **Value** -- The current measurement
- **Mean** -- Average of all historical measurements
- **Min** -- The minimum of all historical measurements
- **Max** -- The maximum of all historical measurements
- **Stdev** -- Standard deviation of all historical measurements
- **Count** -- The number of historical measurements

Click *Reset Statistics* in the statistics setting dialog box, or click the symbol in the statistics display area to clear and restart statistics.

When the oscilloscope detects the trace under test is clipped, an extra overflow indicator will appear after the measurement value:

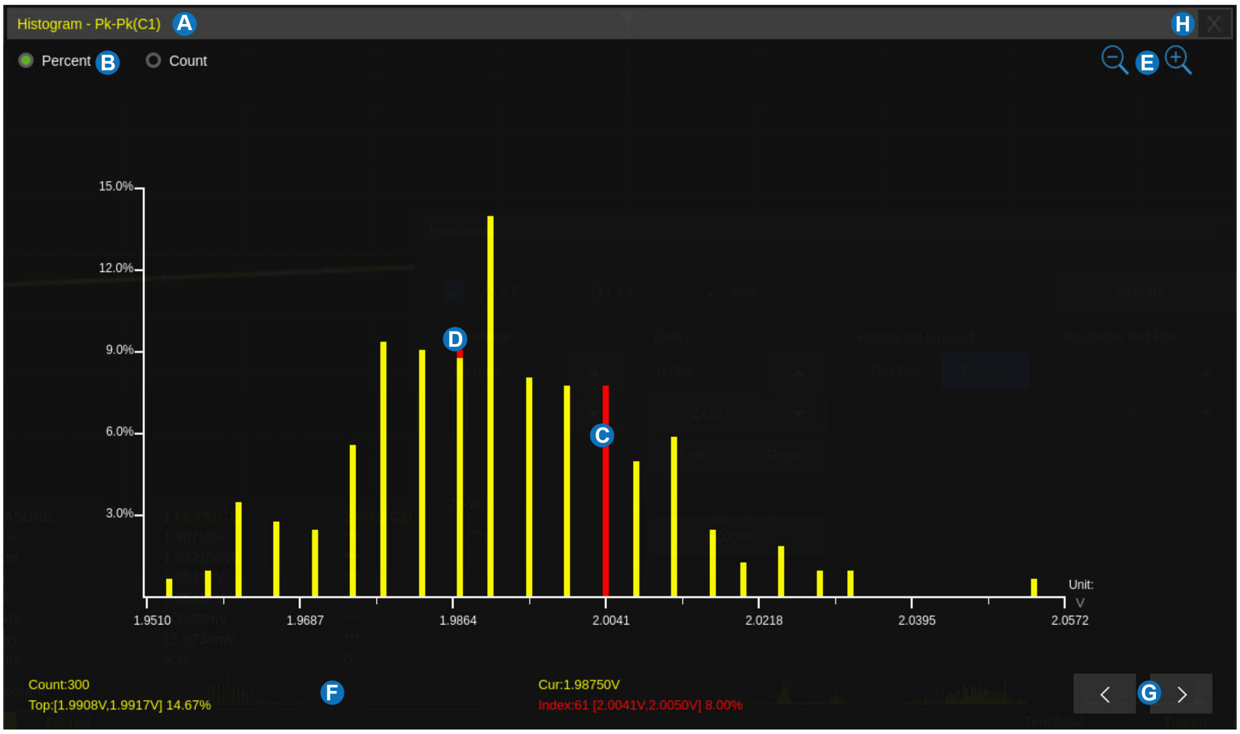
>2.02353V(↑)	Waveform clipped at the top, the actual value is greater than the current displayed value
>2.02353V(↓)	Waveform clipped at the bottom, the actual value is greater than the current displayed value
>1.922353V(↕)	Waveform clipped at both top and bottom, the actual value is greater than the current displayed value

19.8 Statistics Histogram

After enabling statistics on a selected measurement, you can also activate a statistical histogram. The histogram appears at the bottom of the statistics area. This enables users to quickly view the probability distribution of the measured parameters. The color of the histogram is consistent with the measurement source.

MEASURE	1.Pk-Pk(C1)	2.Freq(C1)	3.90-10%Fall(C1)	4.Delay(C1)	5.Mean(C1)	6.UpperLower(C1)
Value	4.15000V	1.00014253kHz	294.36226μs	-9.99377220ms	-7.7301mV	3.20500V
Mean	4.1477072V	999.9920649Hz	294.2926985μs	-9.9936993600ms	-10.047815mV	3.2042548V
Min	4.13750V	999.66828Hz	292.87531μs	-9.99680900ms	-13.1756mV	3.19333V
Max	4.16250V	1.00028747kHz	294.92435μs	-9.99086760ms	-6.5295mV	3.20667V
Pk-Pk	25.00mV	619.19mHz	2.04904μs	5.94140μs	6.6461mV	13.34mV
Stdev	3.4856mV	73.5470mHz	165.8897ns	907.2149ns	856.231μV	1.0021mV
Count	2695	51205	53900	2695	2695	2695
Histogram						

Click the histogram area of a parameter to enlarge it for details. You can move the large histogram window position around the display by dragging. Click the histogram of another parameter to switch to the corresponding enlarged histogram.



A. Parameter

B. Statistical representation of measurement results: percent or count

C. Histogram display area. The X-axis represents measured values and Y-axis represents the probability

D. Current measurement point. Different measurement sources may indicate different colors of indicator points

E. Enlarge/shrink the histogram area. Click multiple times to continuously zoom in/out

F. Histogram information display area. The displayed information includes: the number of measurement statistics, the current measurement value, the interval and probability of the maximum measurement value, and the interval and probability of the current index measurement value (only displayed after zooming in)

G. Adjust the current index value (only displayed after zooming in)

H. Close histogram

19.9 Simple Measurements

Enabling Simple Measurement displays all selected measurement parameters of the specified channel at the same time. The font color of the measurement parameters is consistent with the color of the specified source.

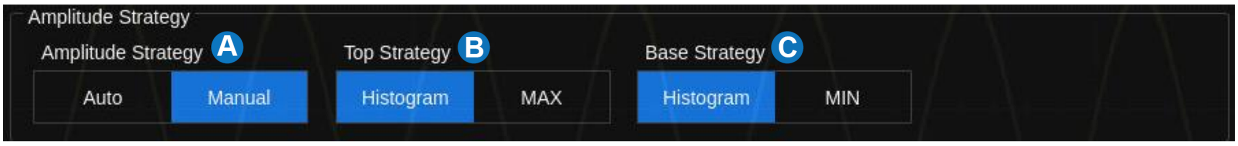
19.10 Gate

Sometimes the user may want to measure parameters for a certain specified time range of the signal and ignore signal parts that lie outside of that range. In this case, the Gate function can be helpful. See "Analysis Gate" for details.

19.11 Amplitude Strategy

According to different types of input signals, users can choose the corresponding amplitude calculation strategy which can measure top and bottom values with more accuracy.

Perform *General* in the measure dialog box to recall the amplitude strategy dialog box:



A. Set the amplitude calculation strategy. When set to Auto, the amplitude calculation strategy will be selected automatically according to the input signal to ensure the accuracy of the measured value

B. Set the top value calculation strategy. When set to Histogram, the value at the upper half of the waveform will be counted, and the value with the maximum probability will be identified as the top value; when set to max, the maximum value of the waveform will be identified as the top value

C. Set the base value calculation strategy. When set to Histogram, the value at the lower half of the waveform will be counted, and the value with the maximum probability will be identified as the base value; when set to min, the minimum value of the waveform will be identified as the base value

19.12 Threshold

Measurement thresholds can be defined by the user. Changing the default threshold may change the measurement results of relevant measurement items, such as Period, frequency, +width, -width, +duty, -duty, +BWidth, -BWidth, delay, T@M, rise time, fall time, CCJ, cycles, rising edges, falling edges, edges, Ppulses, Npulses, and delay measurement.

Perform *General* in the measure dialog box to recall the threshold dialog box:

A. Set measurement threshold source

B. Set the type of threshold

C. Set the upper value

D. Set the middle value

E. Set the lower value

Threshold Type

Percent: Set according to the percentage of the waveform. The setting range of lower value and upper value is 1% ~ 99%, and the low value shall not be greater than the middle value and high value.

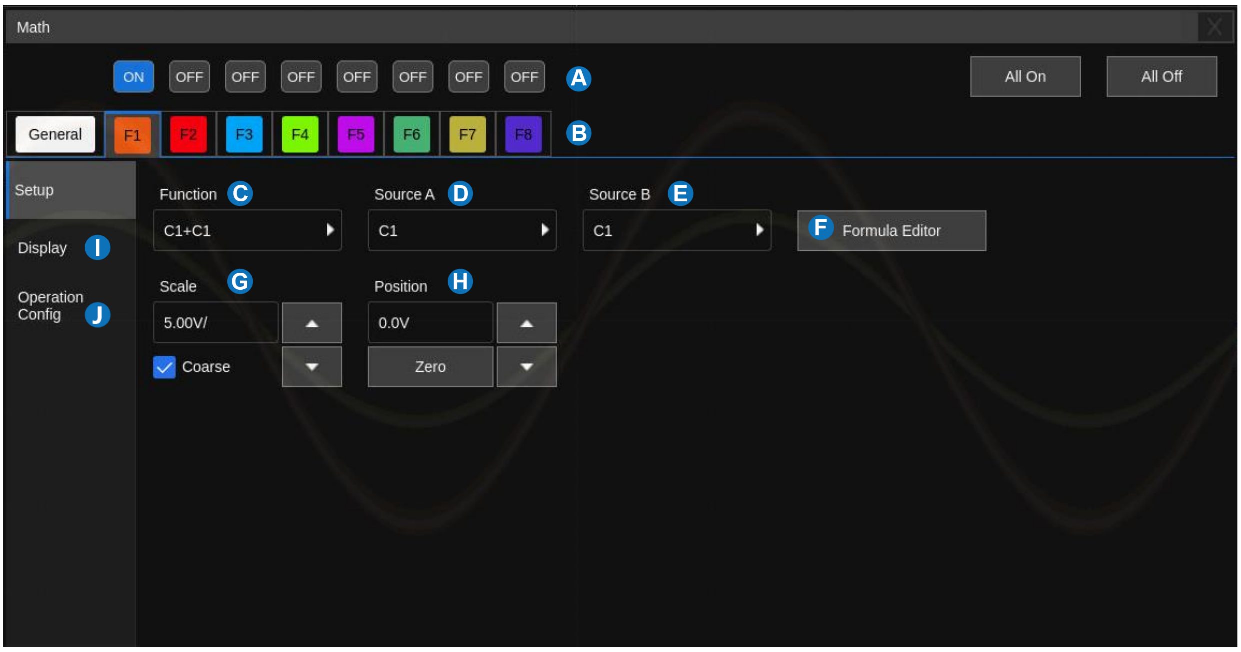
Absolute: Set according to the vertical range. The absolute threshold value depends on the vertical scale, offset and probe attenuation. These values should be set before setting absolute thresholds. Lower and upper values are limited to the range of the screen. If any absolute threshold is greater or less than the minimum or maximum waveform value, the measurement may be invalid.

20 Math

20.1 Overview

The device supports 8 math traces and multiple operators. Arithmetic operators: Addition (+), subtraction (-), multiplication (x), division (/), average, ERES, identity, negation, maxhold, minhold. Algebra operators: differential (d/dt), integral (∫dt), square root (√), absolute (|y|), sign, exp, ln, interpolate; and FFT, Filter, as well as a formula editor. The math traces are labeled with icons "F1 ~ F8" and can be measured by the cursors or as the source of auto measurement.

Click the *Math* menu bar at the top of the screen, or click *+* in the channel descriptor box region and select *Fx* , and then the math dialog box pops up.



A. Turn on/off the math trace. Click All On / All Off to turn on/off all math traces

B. Tabs

C. Select operator

D. Select source A

E. Select source B

F. Open the formula editor

G. Click the region to set the vertical scale with the mouse wheel or virtual keypad. ▲ to increase the vertical scale and ▼ to decrease. The SDS5000X HD can also be set through the vertical scale knob. Check the Coarse box to coarsely adjust the vertical scale and uncheck to enable fine adjustment.

H. Click the region to set the offset with the mouse wheel or virtual keypad. ▲ to increase the offset and ▼ to decrease. The SDS5000X HD can also be set through the vertical Position knob; Click *Zero* to set the offset to zero.

I. Display settings for math trace. Set labels and trace visible/hidden

J. Operator related settings

Units for Math Waveform

Different operations have different dimensions. Therefore, the specific units displayed in *Scale* depend on the operation:

Math Operation	Unit
Addition (+) or Subtraction (-)	V, A, or U* *(used when the units of two sources are not consistent)
Multiplication (x)	V^2, A^2, or W
Division (/)	None, Ω (Resistance unit Ohms), S (conductance unit Siemens)
Identity (y) or Negation (-y)	V, A
FFT	dBVrms, Vrms, dBArms, Arms, dBm
d/dt	V/s (Volt/second) or A/s (A/second)
∫dt	VS (Volt*second) or AS (A*second)
√	V^1/2 or A^1/2
lyl	V, A
Sign	V, A
Exp or Exp10	V, A
Ln or lg	V, A
intrp	V, A

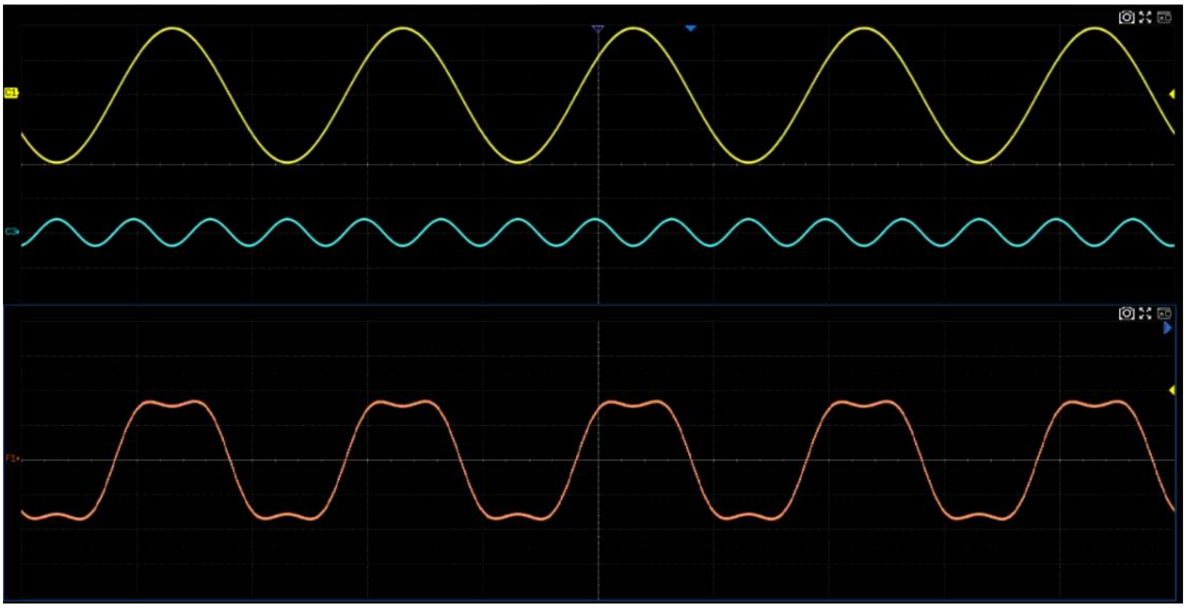
20.2 Arithmetic

The device supports Addition (+), Subtraction (-), Multiplication (x), Division (/), Identity (y), Negation (-y), Average, ERES, Max-hold, Min-hold and Envelope.

20.2.1 Addition / Subtraction / Multiplication / Division

The device can perform arithmetic operations including addition, subtraction, multiplication, or division on any two analog input channels, and the values of Source A and Source B are computed point-by-point.

The following figure shows an example of F1 = C1 + C3:



20.2.2 Identity / Negation

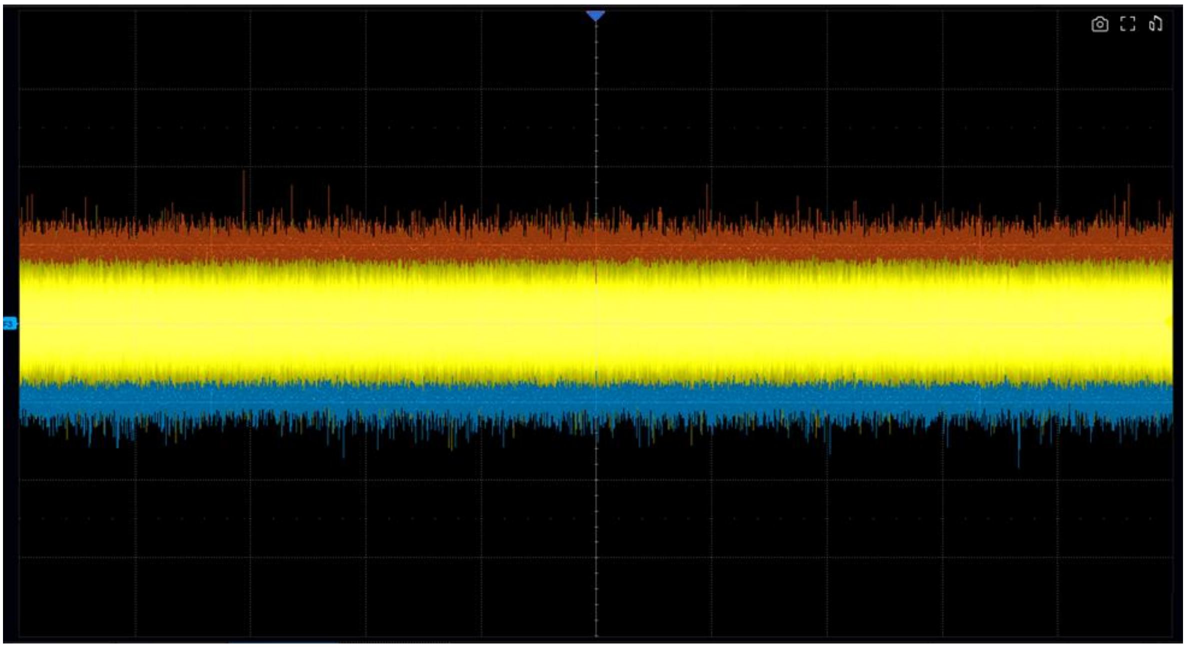
The values of Source A are computed point-by-point when an identity or negation operation is chosen in any analog channel. The following figure shows an example of F1 = -C1:

20.2.3 Average / ERES

Average/ERES can be set in acquisition mode and arithmetic function as well, but with different computing methods. Average and ERES in acquisition mode are computed by hardware with a higher speed than if they were computed by software in the arithmetic mode. Average and ERES in acquisition mode can only be based on data from analog channels, while the Average/ERES arithmetic function can use analog channels, zoom traces, math, and memory traces as the source.

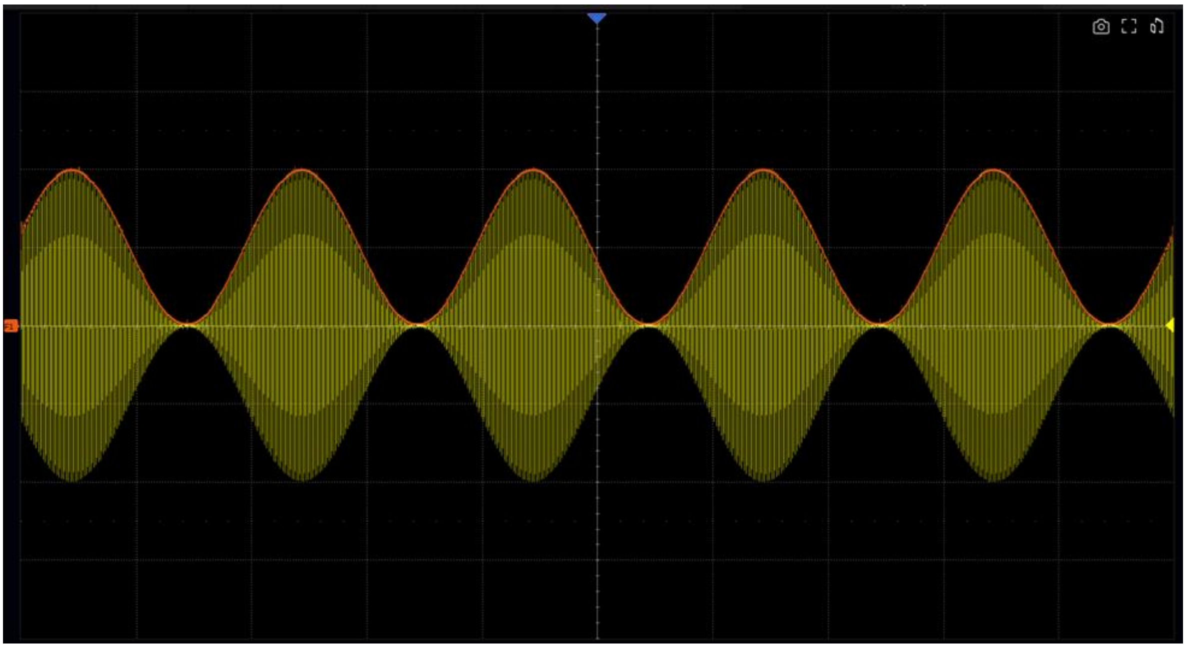
20.2.4 Max-hold / Min-hold

The value of Max-hold and Min-hold are based on statistical calculations from multiple frames. The following figure shows the Max-hold result and Min-hold result.



20.2.5 Envelope

Display the amplitude envelope of the amplitude modulation (AM) signal, implement Hilbert transform based on FFT, and obtain the demodulated envelope waveform.



20.3 Algebra

The device can perform algebraic operations including differential (d/dt), integral (∫dt), square root (√), absolute(|x|), sign, exp(e^x), exp10 (10^x), ln, lg, interpolate (Intrp), Tan and Atan.

20.3.1 Differential

The differential (d/dt) operator is used to calculate the derivative of the selected source. It is always used to measure the instantaneous slope of the waveform, such as the slew rate of an operational amplifier.

The differential equation is:

$$di = \frac{y(i + dx) - y(i)}{dx}$$

Where:

d = Differential result

y = Values of source data

i = Data point index

dx = Differential interval

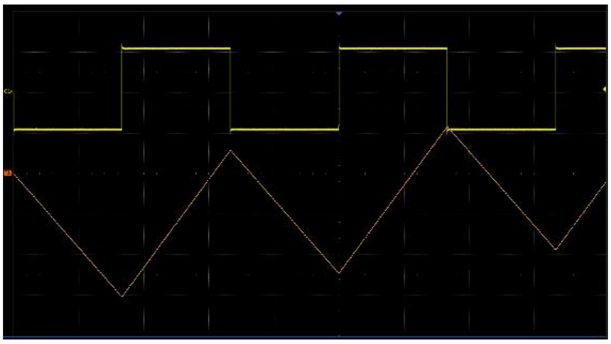
The range of “dx” in the d/dt menu is 1~ number of samples pts.

	Note: Differentiation is sensitive to noise. It is helpful to set the acquisition mode to "Average" or "Hi-Res" to help minimize the visible effects of additional noise.

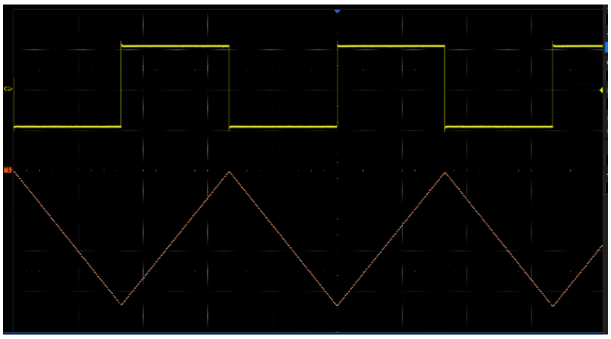
20.3.2 Integral

Integral operation integrates the waveforms on the screen or within the specified gate.

Setting *Offset* in the integral menu provides an approach to correct the DC offset of the source. Small DC offsets in the input signal (or even small offset errors of the oscilloscope itself) may cause the integral output waveform to "ramp" up or down, as shown below:

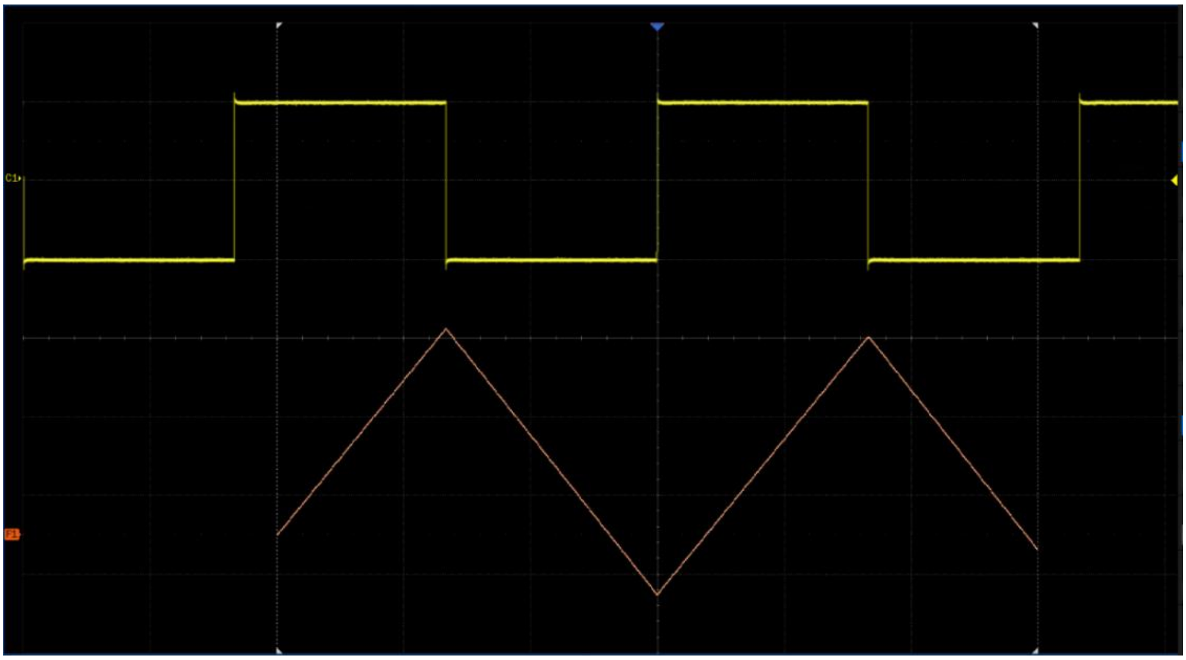


Integral without Offset



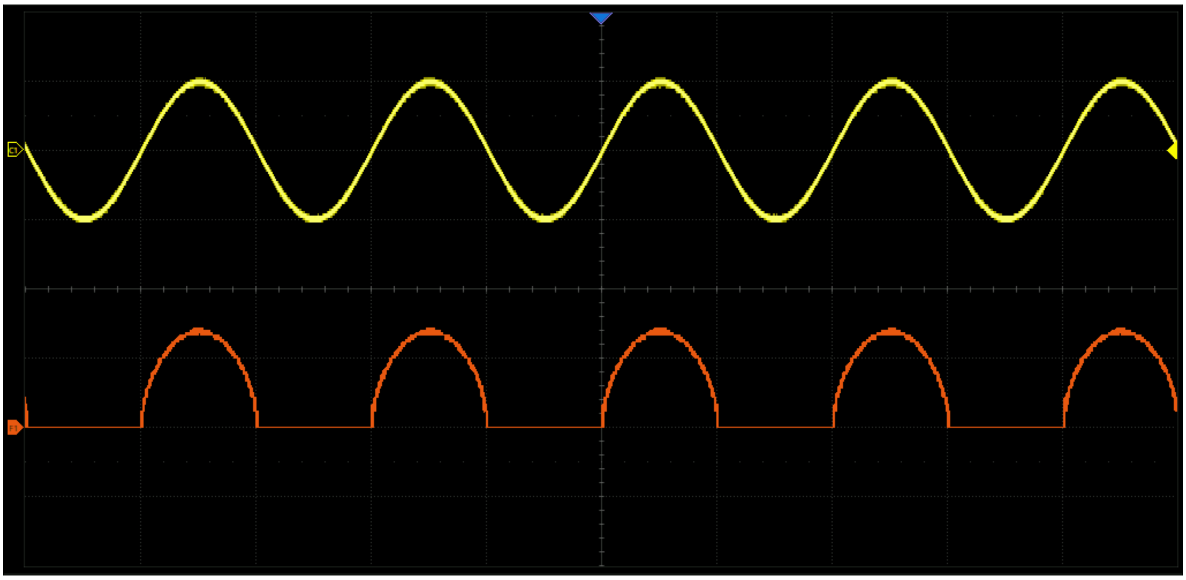
Integral with Offset

In addition, the integral operation can be performed within a specified gate. Click *Analysis* > *Analysis Gate* to enable the gate function, then set *Gate A* and *Gate B* to define the gate. See "Analysis Gate" for details.



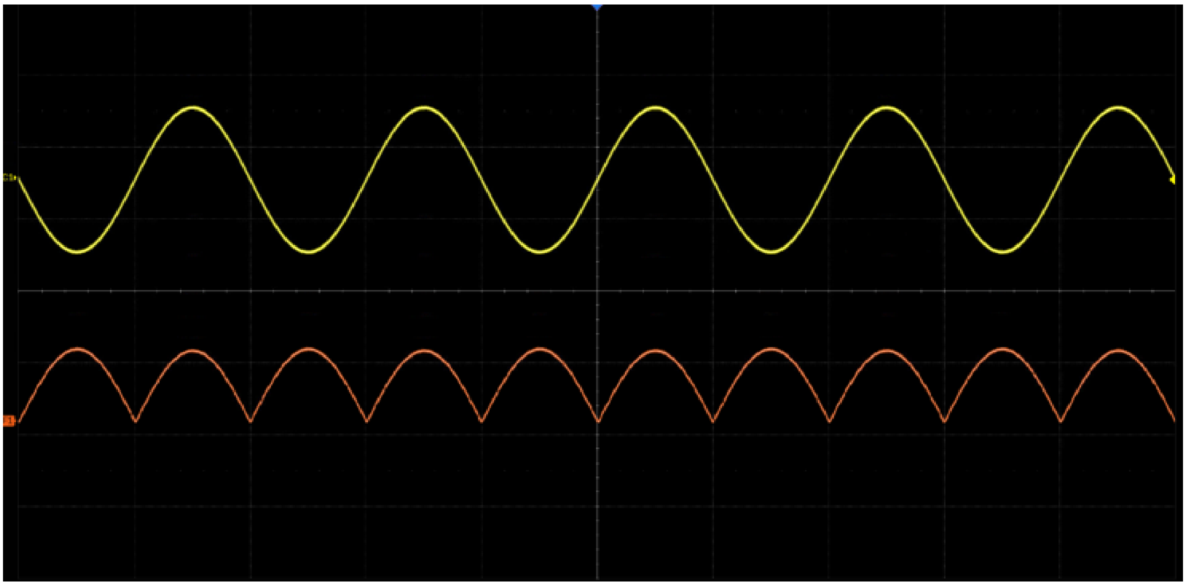
20.3.3 Square Root

Square root (√) calculates the square root of the selected source. If the waveform value is negative (the waveform is below the ground level), the result is displayed as zero.



20.3.4 Absolute

Absolute (|x|) calculates the absolute value of the selected trace.



20.3.5 Sign

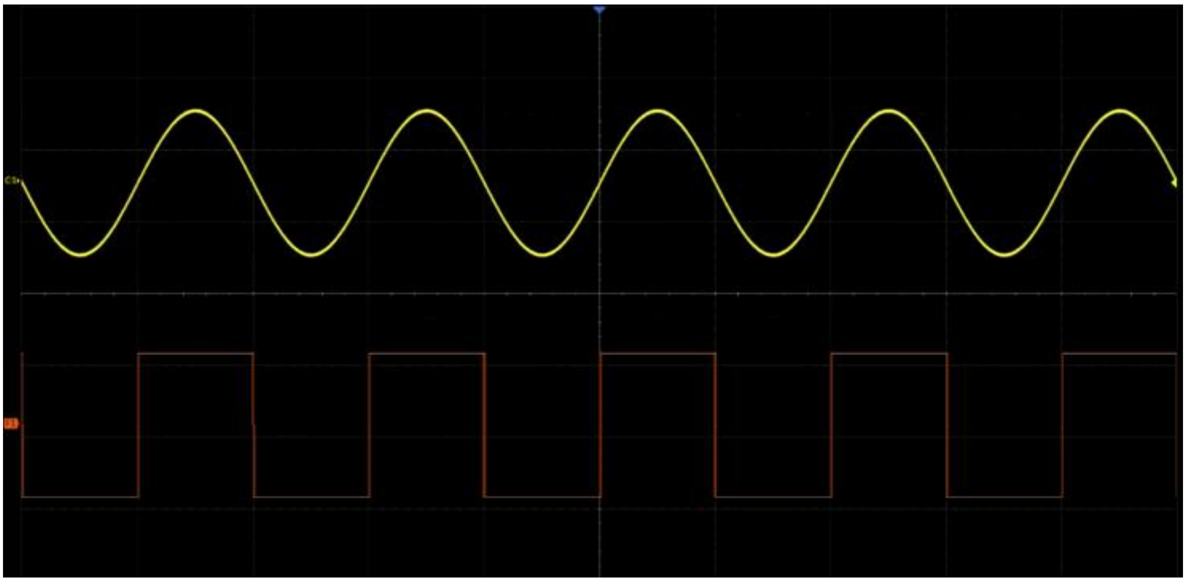
In mathematics, the sign function or signum function (from signum, Latin for "sign") is an odd mathematical function that extracts the sign of a real number.

The sign function of a real number x is defined as follows:

Sign(x) = −1 if x < 0,

Sign(x) = 0 if x = 0,

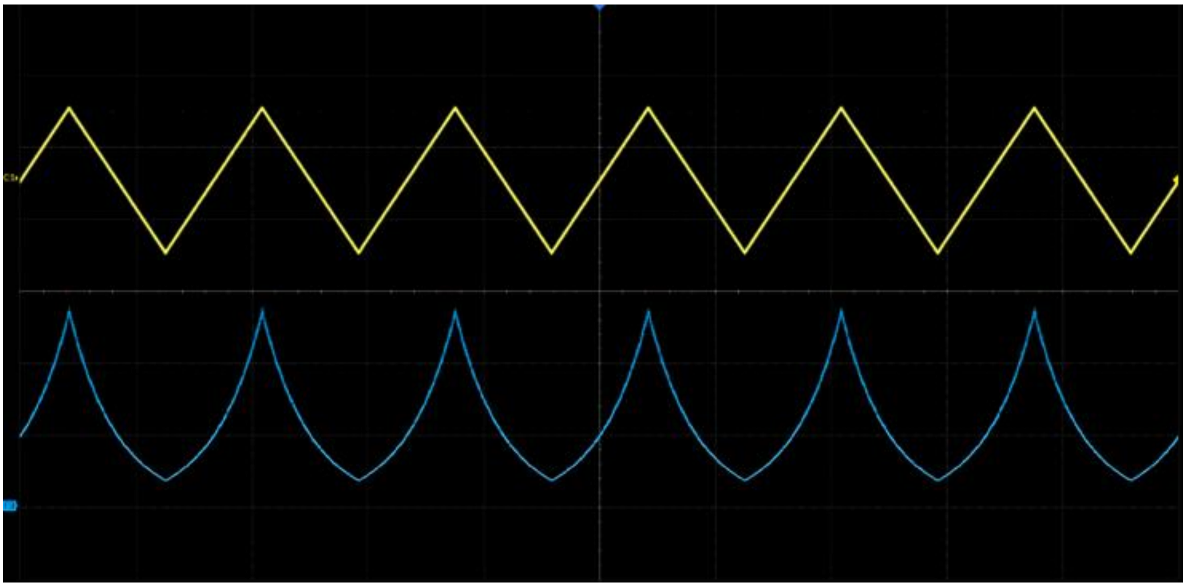
Sign(x) = 1 if x > 0.



20.3.6 exp/exp10

The exponential operation includes the exponential operation e^x based on constant e and the exponential operation 10^x based on 10.

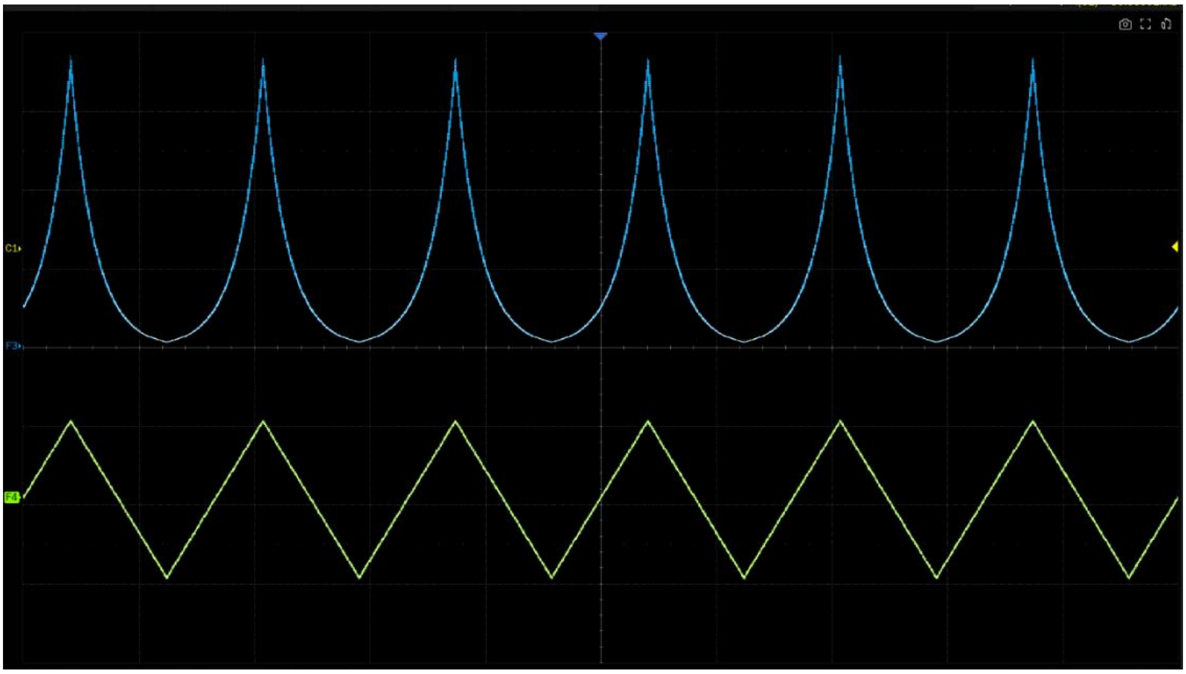
For example: y(x) = e^x.



20.3.7 ln/lg

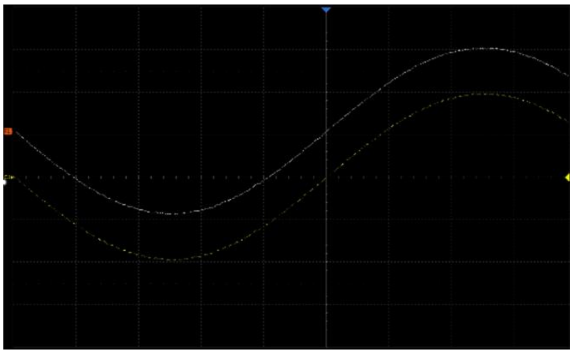
Logarithmic operation includes natural logarithm base e (ln) and common logarithm base 10 (lg). In logarithmic operation, if the waveform value is negative (the waveform is below the ground level), the result is displayed as zero.

For example, F3= e^x, where x is the trigonometric wave function. F4= ln (F3).

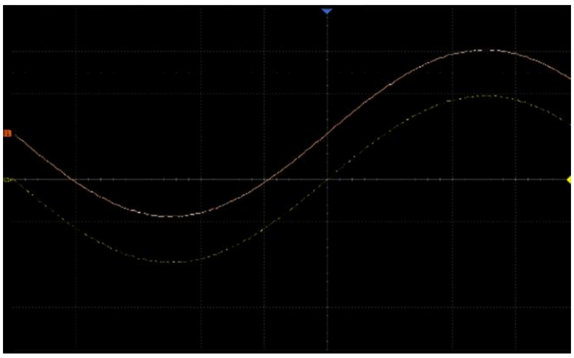


20.3.8 Interpolate

Between the adjacent sampling points, the waveform is interpolated according to the selected interpolation method and interpolation coefficient. Click *Acquire* > *Interpolation* to set the interpolation method, and the upsample coef can be set to 2, 5, 10, or 20.



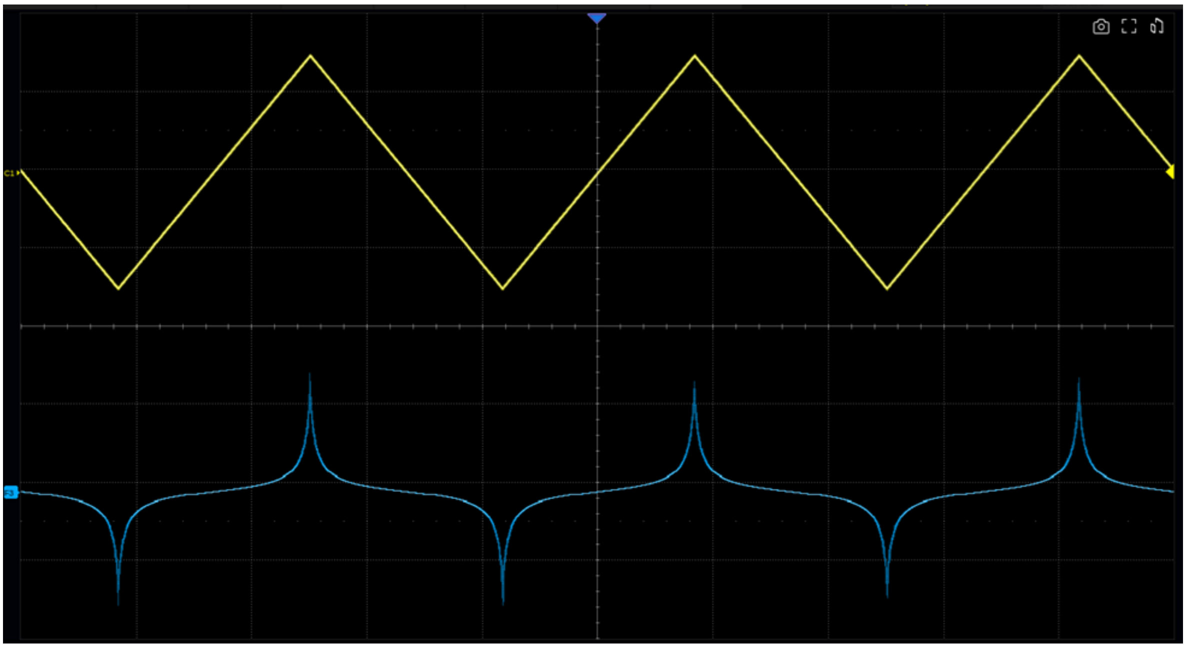
coefficient = 2



coefficient = 20

20.3.9 Tan

Perform trigonometric tangent operation on the waveform, default calculation in radian.



20.3.10 Atan

Perform anti-trigonometric tangent operation on two waveforms, and the unit of the operation result can be selected as radian or degree. The judgment of the Atan (srcA, srcB) quadrant is as follows:

srcB>0 : arctan(srcA/srcB);

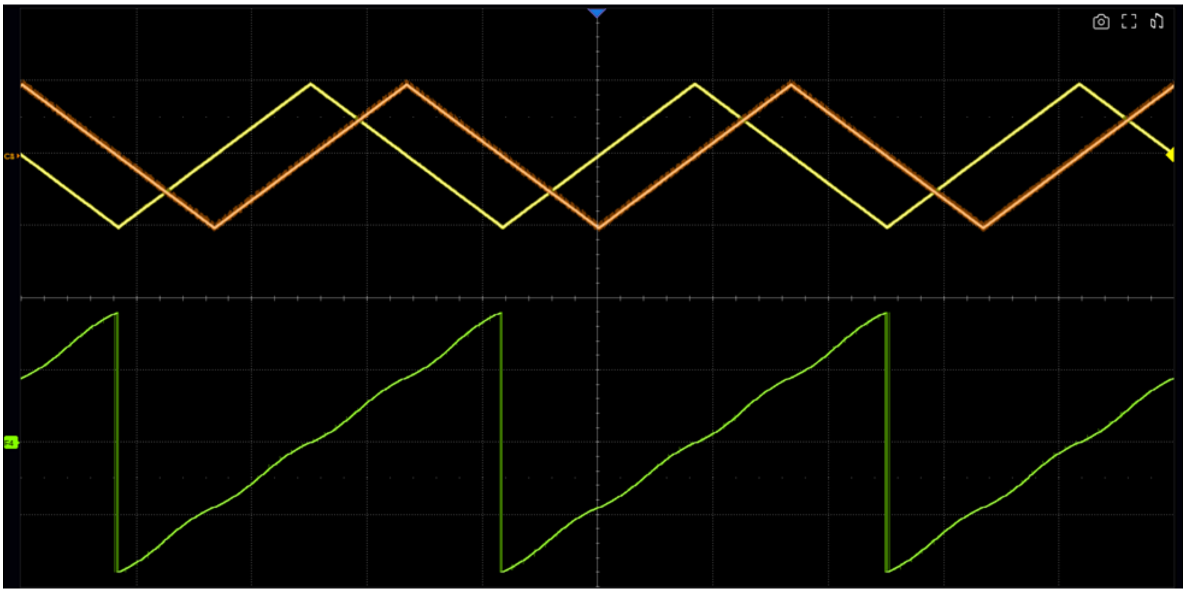
srcB<0 , srcA>=0 : arctan(srcA/srcB)+π;

srcB<0 , srcA <0 : arctan(srcA/srcB)-π;

srcB=0 , srcA>0 : π/2;

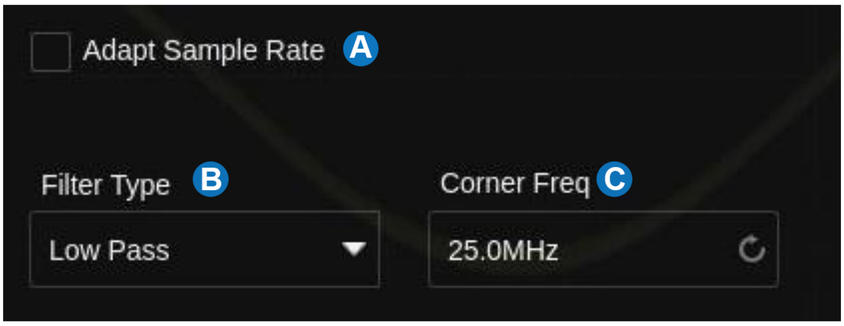
srcB=0 , srcA<0 : -π/2;

srcB=0 , srcA=0 : Invalid res.



20.4 Filter

The filter operation in the device provides FIR (Finite Impulse Response) filtering with the following types: Low pass, High pass, Bandpass, and Band Reject. The filters have up to 200 taps which can reach roll-off as fast as 0.01*fs. Users just need to set the filter type and corner frequency(s), then the instrument will automatically calculate the coefficients needed for the filtering.



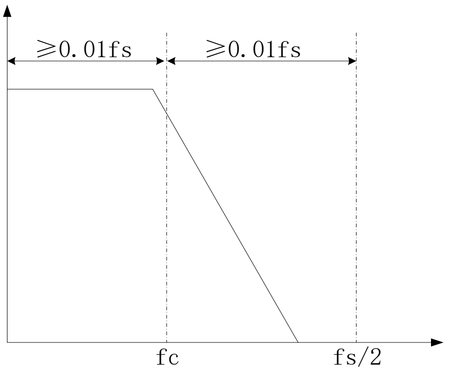
A. Choose to let the oscilloscope set the sample rate automatically according to the filter setting or not. See below for details

B. Filter type: Low pass, High pass, Bandpass, and Band Reject

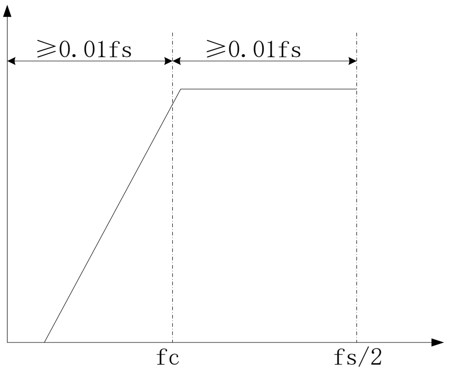
C. Corner frequency. For Bandpass and Band Reject there are two corner frequencies, separately named Lower Frequency and Upper Frequency. The attenuation at the corner frequency is around 3 dB

Adapt Sample Rate

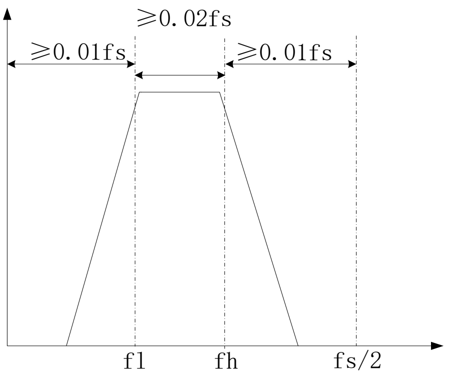
Unlike an ideal “brick wall” filter, the actual FIR filters have their roll-off from the passband to the stopband because of the limited number of taps. The 200-tap FIRs applied in the device provide roll-off as fast as 0.01*fs (where fs is the sample rate), this means some limitations in the setting of corner frequency at a specified sample rate. The figures below show the limitations in detail:



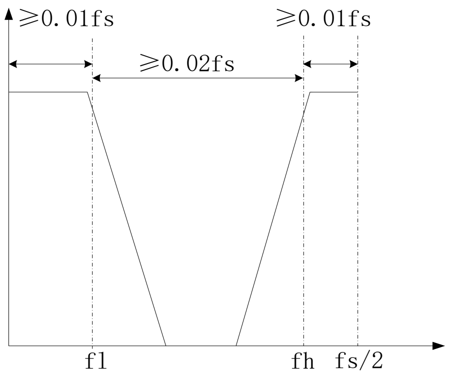
Low pass



High pass



Bandpass



Band reject

Take a Low pass filter as an example. It requires that the corner frequency (fc) is not less than 0.01*fs (i.e. fc ≥ 0.01*fs), and the 0.01*fs wide roll-off does not exceed the 1st Nyquist zone (i.e. (fs/2) - fc ≥ 0.01fs). If fs = 5 GSa/s, then the legal range of the corner frequency (fc) is 50 MHz~2.45 GHz

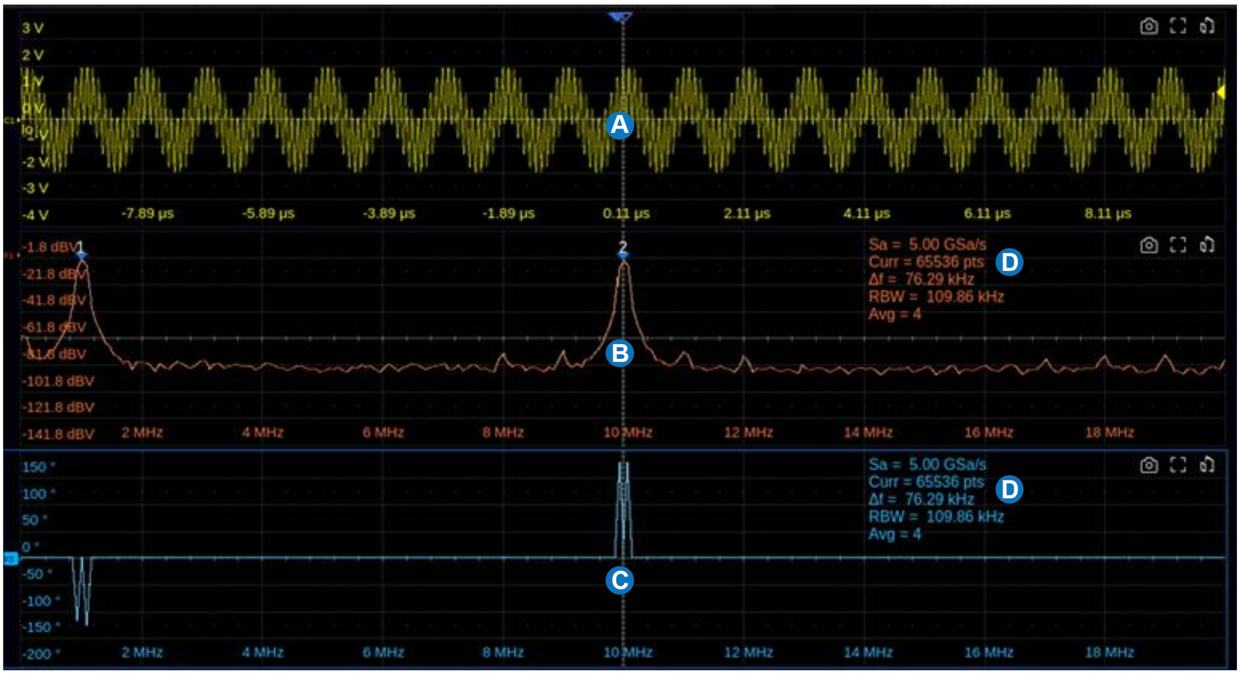
If the expected fc is out of the legal range at some sample rate, then the sample rate needs to be changed. For instance, when fs = 5 GSa/s, the setting fc = 20 MHz is illegal, so we must lower fs to 1.25 GSa/s to satisfy the limitation (fc ≥ 0.01*fs).

Professional users who have prior knowledge of FIR filters and are familiar with the operation of this instrument are encouraged to change the sample rate for the corner frequency of interest. Otherwise, we recommend using the “Adapt Sample Rate” option. In this mode, the scope forces the Memory Management Mode to be “Fixed Sample Rate” and automatically adjusts the sample rate to adapt to the corner frequency setting. For details of the Memory Management Mode refer to the section “Memory Management”.

	Note: Be aware that when the corner frequency is set very low the sample rate may not satisfy the Nyquist Theorem (i.e. fs is no longer greater than or equal to twice the highest frequency of the input). Keep the sample rate reasonable at all times.

20.5 Frequency Analysis

The result of FFT (Fast Fourier Transform) calculations is the frequency spectrum of the source signal. The operation result of FFT amplitude spectrum is the frequency amplitude relationship of the input signal, and the operation result of FFT phase spectrum is the frequency phase relationship of the input signal. The horizontal axis of the FFT display is labeled using frequency (Hz) units instead of time (seconds). In addition, the vertical axis provides the option of logarithmic scaling (dBVrms/dBArms or dBm). For FFT phase, the vertical axis provides the option of degree, radian, or second.



A. Time-domain waveform display area

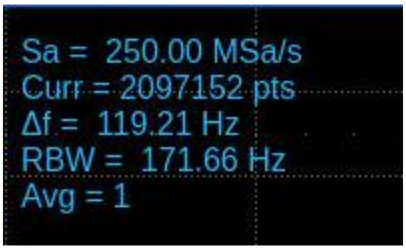
B. Amplitude (FFT) waveform display area

C. Phase (FFT) waveform display area

D. FFT parameter display area

Parameter Display Area

The FFT parameters are displayed in the upper right of the spectrum waveform display area:



FFT sample rate (Sa): FFT operation results present the first Nyquist zone (DC ~ Sa/2) of the frequency spectrum. Be aware that the FFT sample rate may be inconsistent with the sample rate in the time domain. Assuming the max points value is set to 2 Mpts:

- When the number of points in the time domain, N, is less than 2 Mpts, the FFT takes the number which is an integer power of 2 closest to N. In this case, FFT sample rate = sample rate in the time domain.
- When N is greater than 2 Mpts, FFT first decimates N by D and then takes the first 2 Mpts for the calculation. In this case, FFT sample rate = sample rate in time domain/D.

  For example, in the case of sample rate in the time domain is 5 GSa/s and the number of samples is 5 Mpts, the FFT first decimates the samples by 2, to 2.5 Mpts, and then takes the first 2 Mpts to calculate the spectrum. In this example, FFT sample rate = 5 GSa/s ÷ 2 = 2.5 GSa/s.

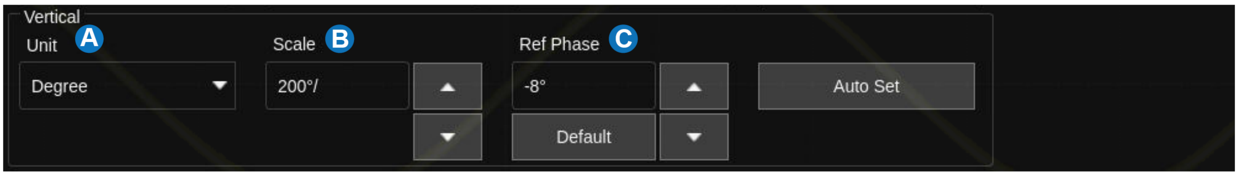
FFT points (Curr): The current FFT points, which is an integer power of 2. The device supports up to 8 M points (8,388,608, to be exact).

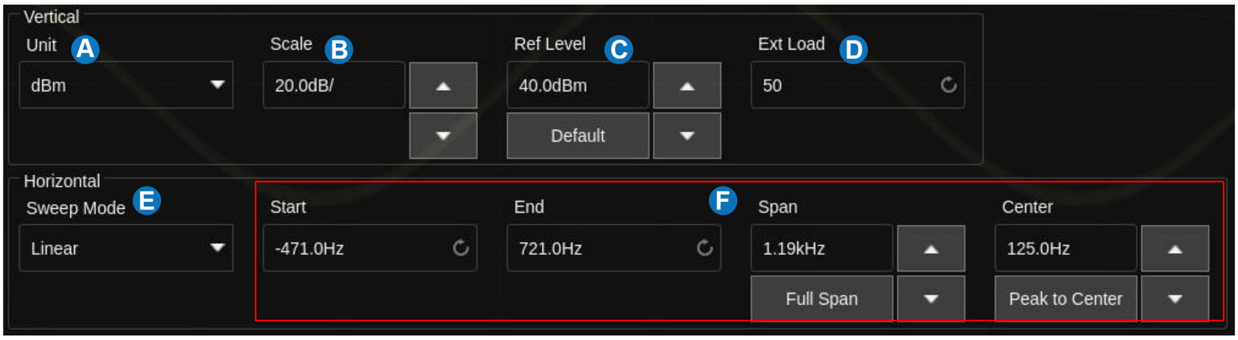
Frequency interval (△f): The frequency interval between two adjacent points in the FFT sequence, which is proportional to the frequency resolution.

RBW: Equivalent resolution bandwidth, related to windowing. For different window functions, Δ f and RBW have different proportional relationships

Average count of FFT (Avg): Displayed only when the FFT mode is set to "Average", indicating the completed average count.

Select operation as FFT function in the math dialog box , to open the FFT dialog box





A. Set the vertical unit of FFT waveform. For amplitude spectra, dBVrms, Vrms, and dBm can be set, where dBm is the power unit. The oscilloscope will D calculate the dBm value based on the load; For phase spectra, Degree, Radian, and Second can be set

B. Set the FFT waveform vertical scale

C. Set the FFT waveform reference level and phase

D. Set the external load value of the amplitude spectrum to calculate the correct dBm result

E. Set the FFT sweep mode

F. Set the FFT waveform start frequency, end frequency, frequency span, and center frequency

Unit

The unit of the vertical axis can be set to dBm, dBVrms, or Vrms. dBVrms and Vrms respectively using either logarithmic or linear scaling. dBVrms is recommended to show larger dynamic ranges. dBm is a power unit, the correct result can be obtained only if the value of *Ext Load* is set to be consistent with the load impedance of the actual measured signal.

Vertical control

Click the *Ref level* or *Ref Phase* to set the reference level or reference phase of the FFT waveform using the up/down keys or the virtual keypad.

Click *Scale* to set the vertical scale of the FFT waveform by the mouse wheel or the virtual keypad. The reference point for vertical scale scaling is the reference level.

Horizontal control

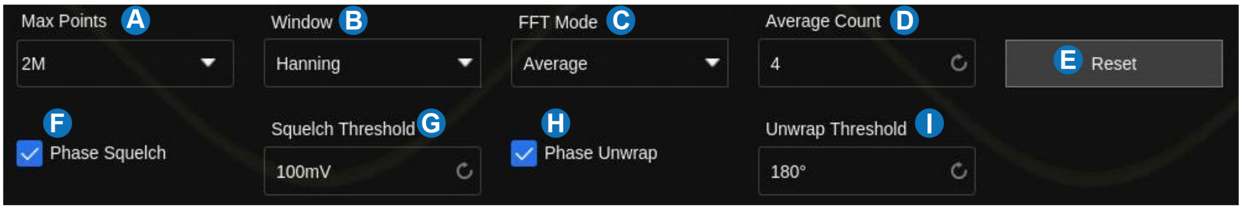
Click *Center* to set the center frequency by the mouse wheel or the virtual keypad.

Click *Span* to set the frequency span with the center frequency as the center by the mouse wheel or the virtual keypad.

Click *Start* to set the start frequency by the mouse wheel or the virtual keypad.

Click *End* to set the end frequency by the mouse wheel or the virtual keypad.

Click *Operation Config* in the math dialog box to recall the FFT configuration dialog box:



A. Set the maximum points (2n, n = 10 ~ 23)

B. Set the window type (Rectangle, Blackman, Hanning, Hamming, Flattop , Blackman - Harris and Gaussian)

C. Select the FFT mode (Normal, Average, and Max-Hold)

D. Set the average count in average mode

E. Reset average

F. Enable noise phase suppression of phase spectrum to obtain effective phase information

G. Set the squelch threshold, frequency points with amplitude spectrum Vrms values less than this threshold, their phase values will be considered as 0

H. Activate phase unwrapping, continuously accumulate phase angles, eliminate phase jumps, and make it a linearly changing phase

I. Set the unwrap threshold, and if the difference between adjacent phases exceeds this threshold, it is considered that a phase jump has occurred.

Windows

Spectral leakage in FFTs can be considerably decreased when a window is used. The device provides windows that have different characteristics and apply to different scenarios.

For example, for a two-tone signal with a very close frequency interval, it is suitable to use a Rectangle window with the best frequency resolution. For the case where the accuracy of amplitude measurement is critical, it is recommended to select the Flattop window with the best amplitude resolution.

Window	Characteristics	Main lobe width	Side lobe suppression	Maximum amplitude error
Rectangle	The best frequency resolution The worst amplitude resolution It is equivalent to the case of no window	4π/N	-13 dB	3.9 dB
Hanning	Better frequency resolution Poor amplitude resolution	8π/N	-32 dB	1.4 dB
Hamming	Better frequency resolution Poor amplitude resolution	8π/N	-43 dB	1.8 dB
Blackman	Poor frequency resolution Better amplitude resolution	12π/N	-58 dB	1.1 dB
Flattop	The worst frequency resolution The best amplitude resolution	23π/N	-93 dB	< 0.1dB
Blackman - Harris	Better frequency resolution Better amplitude resolution	6.0π/N	-42dB	1.69 dB
Gaussian	Better frequency resolution Better amplitude resolution	8π/N	-92dB	0.83 dB

FFT Mode

Normal: Displays the FFT result of each frame directly.

Max-Hold: Holds the maximum value in the historic frame on the display until cleared. This mode is suitable for detecting discontinuous waves, such as sporadic pulse signals, or frequency hopping signals. Click *Reset* in the dialog box to clear the max-hold waveform.

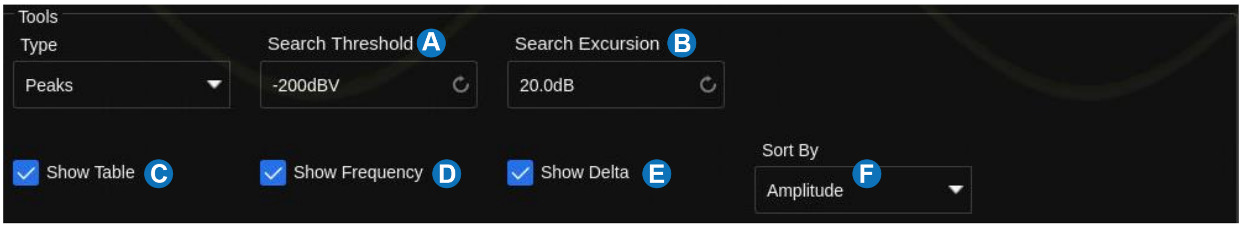
Average: Reduces the effect of the superimposed random noise on the signal. After the FFT mode is set as Average, *Average* will appear under *FFT Mode* . The average count can be set here, ranging from 4 to 1024. Click *Reset* in the dialog box to restart the average counter.

FFT Tools

The device provides two tools for the FFT waveform: Peaks and Markers. The peaks tool can automatically search the qualified peak points and mark them on the FFT waveform. Up to 10 peaks are supported. Based on the peak tool, the markers tool can automatically search the qualified harmonics, and users can control the position of each marker. Up to 8 markers are supported.

Click *Operation Config* in the math dialog box to recall the FFT tools dialog box:

When the FFT tool peaks is selected, the dialog box is as follows:



A. Set the search threshold. Only peaks larger than the limit are shown

B. Set the difference between the peak value and the minimum amplitude on both sides. The difference should be greater than the search excursion

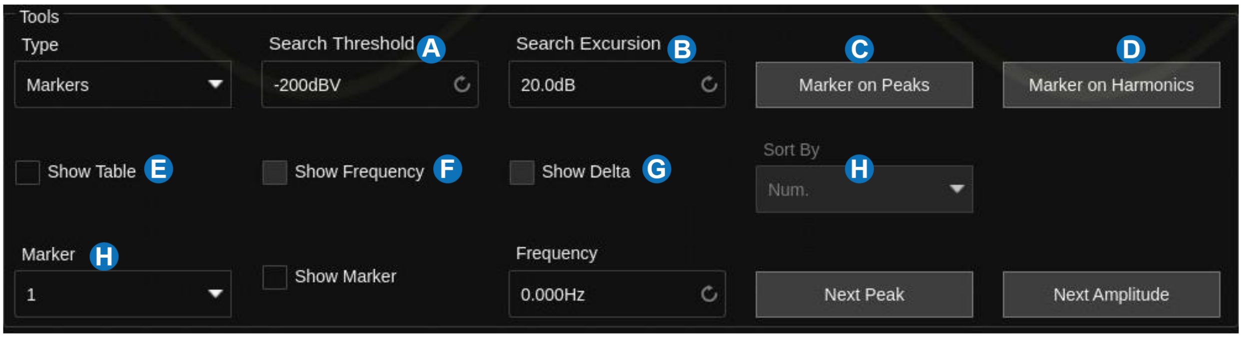
C. Turn on / off the table. Turn on the table, the peaks searched with the limit of *Search Threshold* and *Search Excursion* will be displayed in a table

D. Turn on / off the display of peak frequency in the table

E. Turn on / off the delta display

F. Sort peaks by amplitude or frequency

When the FFT tool markers is selected, the dialog box is as follows:



A. Set the search threshold. Only peaks larger than the peak limit can be judged as peaks.

B. Set the difference between the peak value and the minimum amplitude on both sides. The difference should be greater than the search excursion, which can be determined as the peak.

C. Marker on peaks. It will automatically mark the peak that meets the conditions of *Search Threshold* and *Search Excursion* .

D. Marker on harmonics. It will automatically mark each harmonic of the FFT waveform.

E. Turn on or off the table

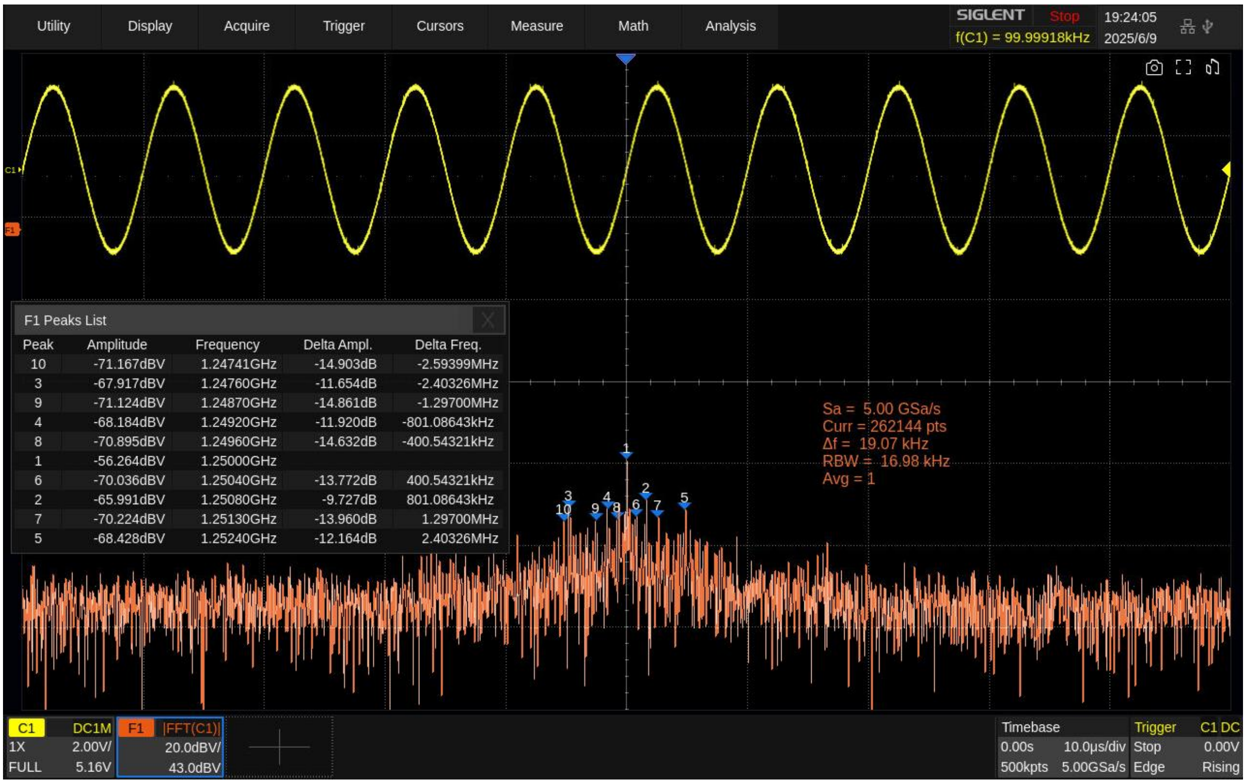
F. Turn on / off the display of peak frequency in the table

G. Turn on / off the delta display

H. Sort peaks by amplitude or frequency

I. Control Marker. Select the tag number, check the display status, click the *frequency* area, set the tag frequency by scrolling the middle wheel of the mouse or using the virtual numeric keypad, and click on the *Next Peak* or *Next Amplitude* to quickly set the tag position.

The following screenshot shows the peaks of the FFT waveform:



Measure the FFT waveform

Turn on the cursor function, and then specify the source as "F1". Measure the difference between the FFT waveform frequency value and two frequency values using the MX1 and MX2 cursors （ΔX) ; MY1 and MY2 cursors measure amplitude (in dB or Vrms) and amplitude difference （ΔY) .

Only the “maximum” parameter of the FFT is supported in automatic measurement.

	Note: DC components in the signal may show a large amplitude near 0 Hz. If your application does not require measurement of the DC component, it is recommended to set the coupling mode of the source channel to "AC".

20.6 Formula Editor

Click *Formula Editor* in the operation setting tab to recall the editor:

A. Formula display text box

B. Text box operation area, which can clear and modify the entered formula

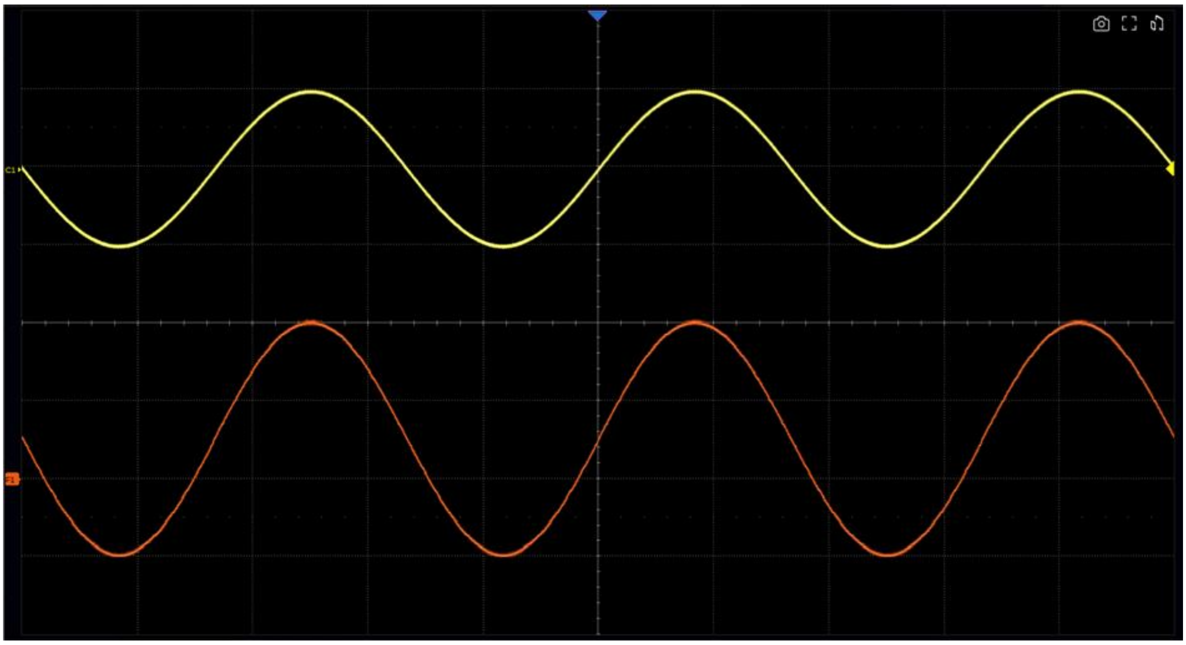
C. Special operators

D. Operation source

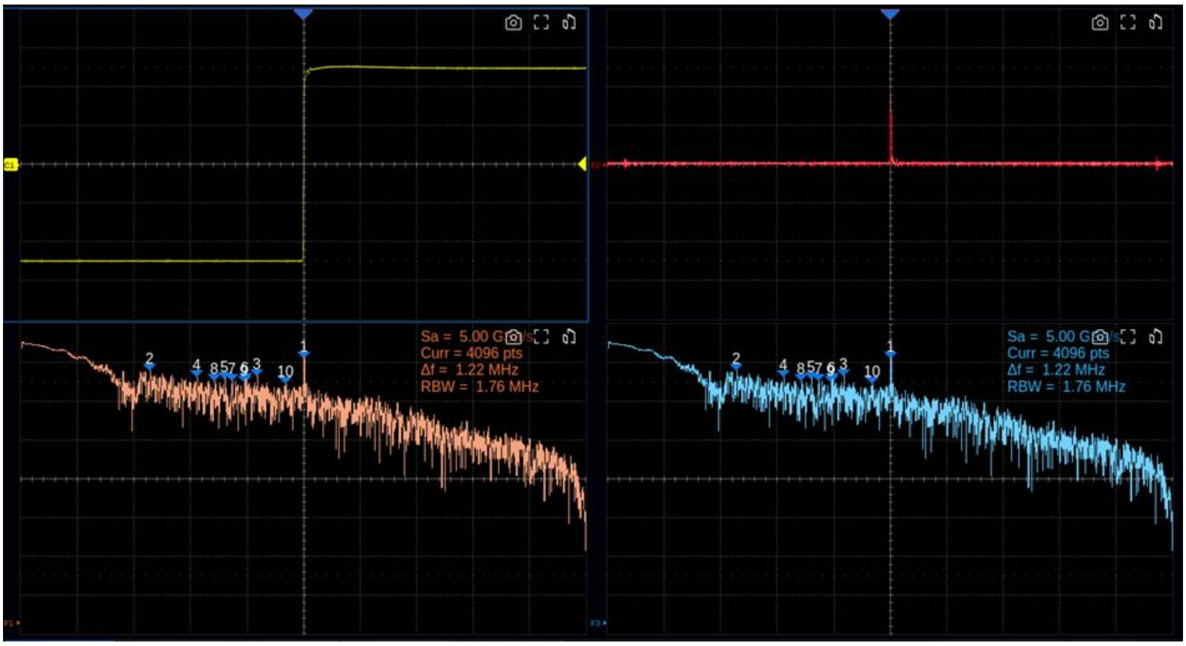
E. The Keyboard area contains the basic arithmetic operators addition (+), subtraction (-), multiplication (*), division (/)

F. Confirm button. After the formula is input, press the button to apply it

The following is an example of F1 = (3*C1) + 1V through the formula editor:



The following is an example of implementing nested operations among operators through the formula editor:



This example uses two nested operations to achieve FFT analysis of the differential operation results of C1 waveform:

1. Use nested operations between mathematical waveforms: F2=d(C1)/dt, F3=FFT(F2)
2. Use the formula editor to directly input the formula F1=FFT(d(C1)/dt)

From the comparison of the results of F1 and F3 in the above figure, it can be seen that they are equivalent.

21 Reference

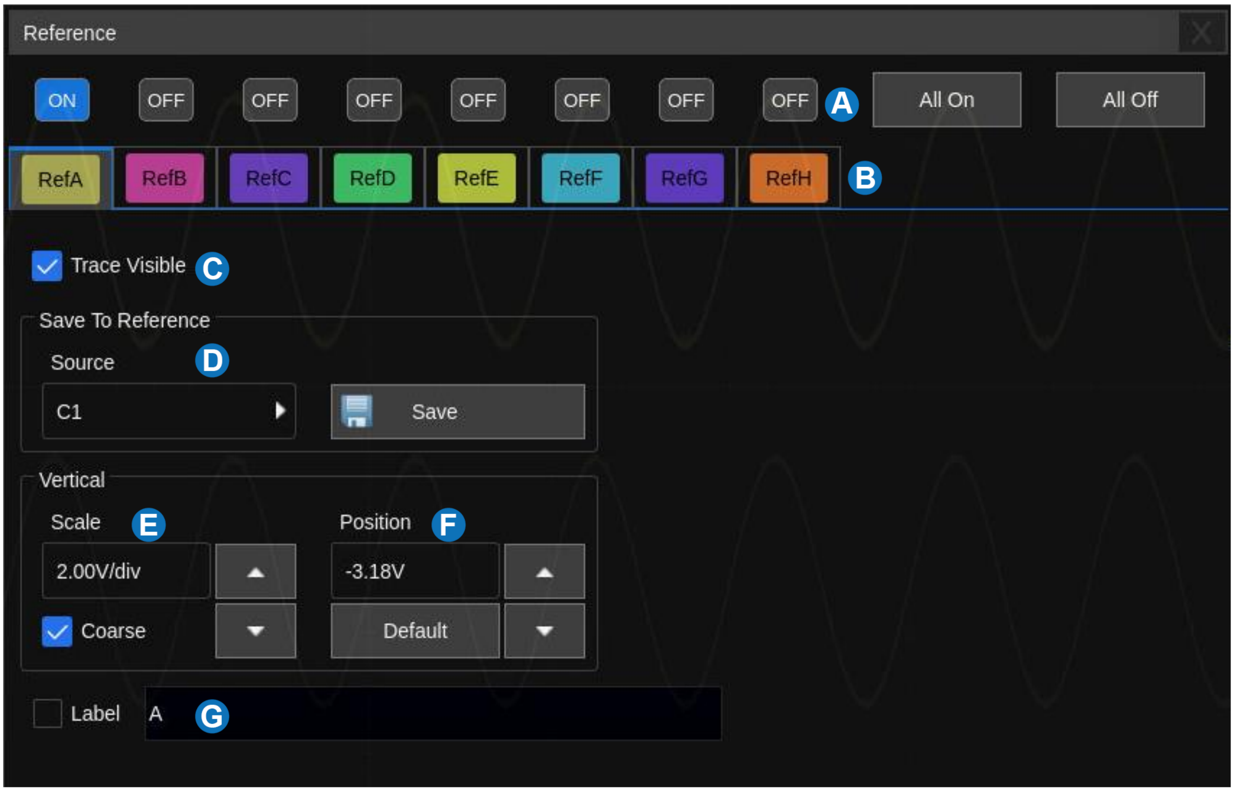
The reference waveform function of this device allows saving waveforms from analog channels (Cx) or math functions (Fx) into the oscilloscope's reference waveform slots (RefA, RefB, RefC, RefD, RefE, RefF, RefG, and RefH). The stored reference waveforms can then be displayed and compared with other waveforms to analyze and identify anomalies. Reference waveforms are non-volatile, meaning they remain saved even after power cycling or performing a default reset.

A. Channel waveform

B. Reference Waveform

C. The Reference dialog box

Press the Ref button on the front panel, or tap the + icon in the channel parameter area and select *Reference Waveform* to enable the reference waveform function. To access the reference waveform settings dialog, simply tap the reference waveform parameter area at the bottom of the display.



A. Turn on/off the reference waveform. Click *All On/All Off* to turn on/off all reference waveforms

B. Switch dialog box tabs. Set corresponding reference waveform

C. Set the reference waveform to be visible/hidden

D. Select the source (C1 ~ C8, F1 ~ F8), Click *Save* Save the source waveform to reference waveform.

E. Set the vertical gear. Click the region to set the vertical scale with the mouse wheel or virtual keypad. ▲ to increase the vertical scale and ▼ to decrease. The SDS5000X HD can also be set through the vertical gear knob. Check to coarsely adjust the vertical scale and uncheck to enable fine adjustment.

F. Set vertical Position. Click the region to set the offset with the mouse wheel or virtual keypad. ▲ to increase the offset and ▼ to decrease. The SDS5000X HD can also be set through the vertical Position knob; Click Default set the vertical position at the import time.

G. Set the label text of the reference trace

22 Memory

Analog channels (Cx), zoom (Zx), math (Fx), memory waveforms (Mx), and waveforms in files can be imported to available memory waveforms (M1/M2/M3/M4) and displayed on the screen for comparison with the current waveforms. Differing from reference traces which are displayed data, the memory traces are in the format of raw data, which can be used as the source of Math and Decoding functions and can provide more accurate measurements than a reference waveform.

A. Channel waveform

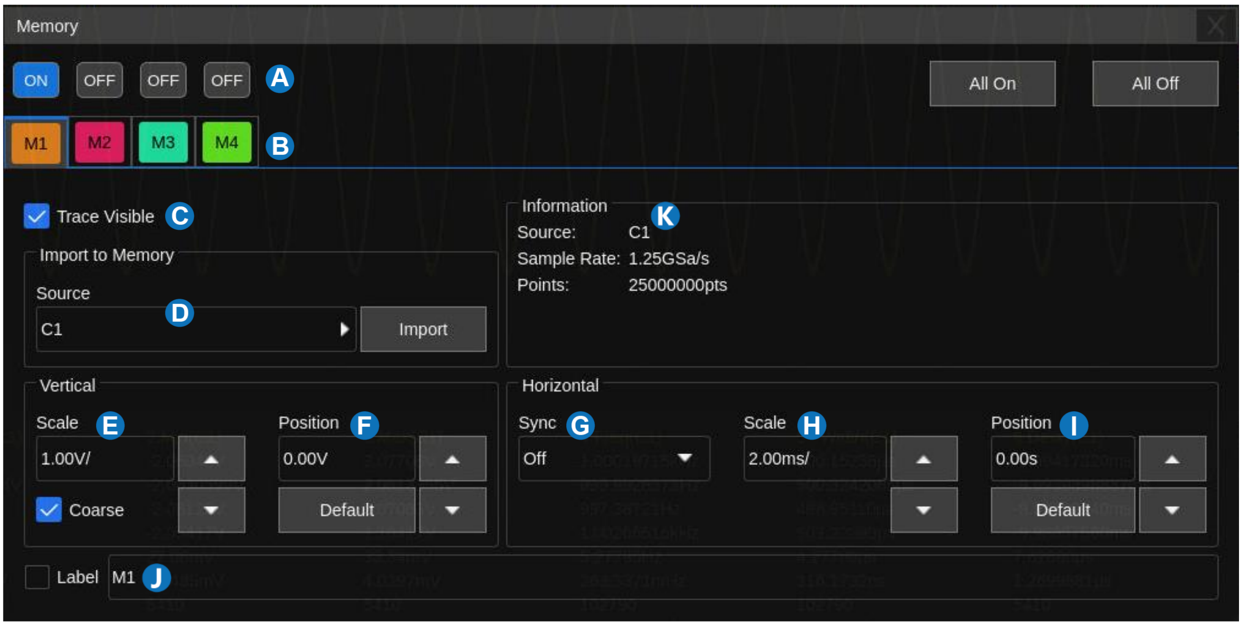
B. Memory Waveform

C. The Memory dialog box

There are multiple ways to import waveforms to memory. To enter the memory dialog box in any of the following ways:

- Click *+* at the channel parameter area and select *M1* ~ *M4* on the memory waveform.
- Click the menu *Utility* > *Save/Recall* to open the Save/Recall dialog box, select Mode as "Recall", Type as "Waveform", and then import the file to memory.

Details of the dialog box are as below.



A. Turn on/off the memory trace. Click *All On/All Off* to turn on/off all memory traces

B. Switch dialog box tabs to set memory traces

C. Set the memory trace to be visible/hidden

D. Select the source (Channel / Zoom / Math / Memory / File). Click *Import* to save the trace of the selected source to the memory location

E. Click the region to set the vertical scale with the mouse wheel or virtual keypad. ▲ to increase the vertical scale and ▼ to decrease. The SDS5000X HD can also be set through the vertical scale knob. Check to coarsely adjust the vertical scale and uncheck to enable fine adjustment

F. Click the region to set the offset with the mouse wheel or virtual keypad. ▲ to increase the offset and ▼ to decrease. The SDS5000X HD can also be set through the vertical position knob. Click *Default* to set the vertical position as the value at the import time

G. Synchronize the horizontal parameters. When adjusting the horizontal scale or position of the source, memory trace will remain consistent

H. Click the region to set the horizontal scale with the mouse wheel or virtual keypad. ▲ to increase the scale and ▼ to decrease. The SDS5000X HD can also be set through the horizontal scale knob

I. Click the region to set the horizontal position with the mouse wheel or virtual keypad. ▲ to increase the position and ▼ to decrease. SDS5000X HD can also be set through the horizontal position knob. Click *Default* to set the horizontal position as the value at the import time

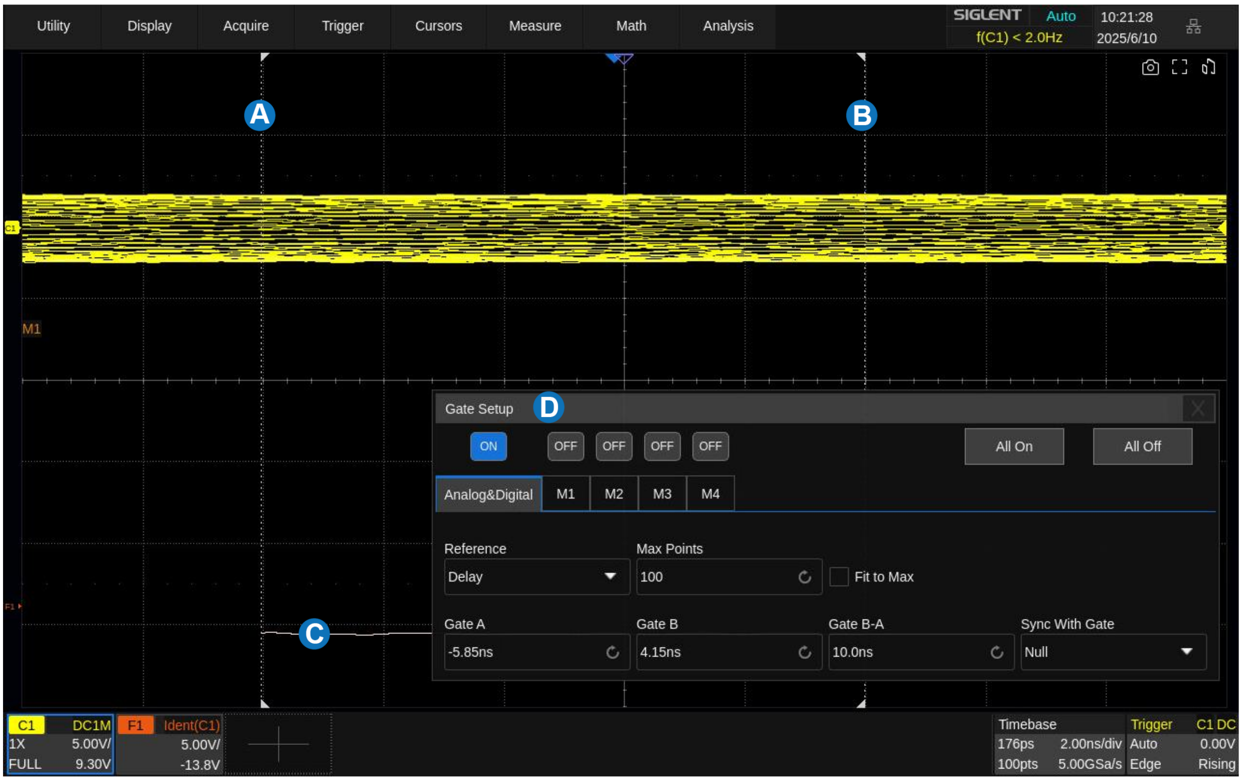
J. Set the label text of the memory trace

K. Display the memory information, including source, vertical and horizontal parameters, sampling rate, and length

ℹ	**Note:** When the memory waveform is saved in the device's RAM, it will be lost after the device is powered off or restarted. If you want to save the waveform as non volatile data, please use the operation of storing data files to store the data in the specified storage path (see chapter "Save/Recall" for details). The saved binary files (*. bin) can be imported into the memory waveform.

23 Analysis Gate

The Device supports analysis gate and can perform measurement, mathematical operations, decoding, and other analysis functions on waveforms within the gate. Users can manually open the analysis gate based on actual testing scenarios. It should be noted that when the storage depth is greater than 100Mpts, the analysis gate will be automatically opened and cannot be manually closed at this time.



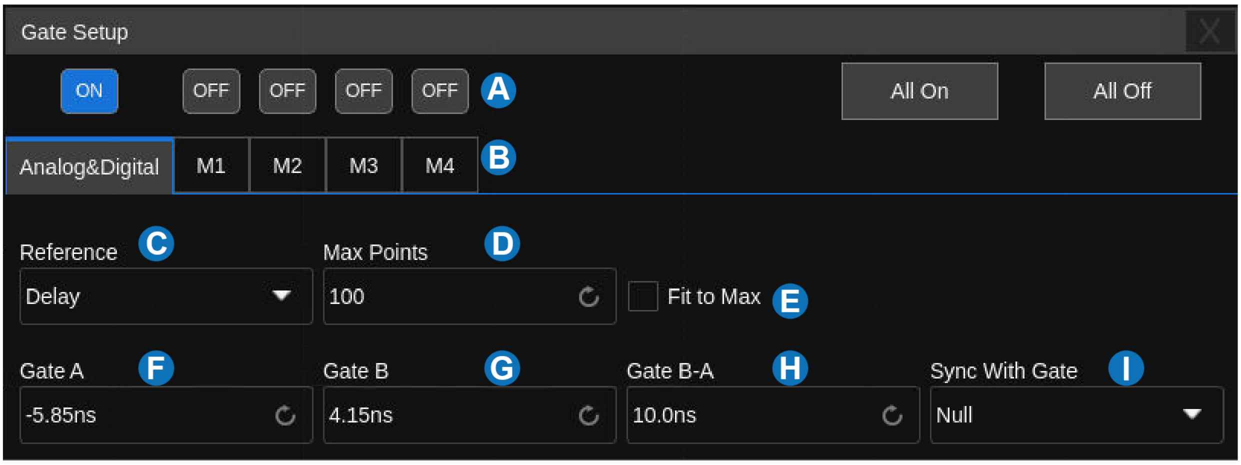
A. Analysis gate cursor A. The cursor name is displayed after the gate is switched or moved, and it will be automatically hidden if there is no action after 3 seconds

B. Analysis gate cursor B

C. The result of analysis gate. The figure takes mathematical operation and decoding as an example

D. Analysis gate dialog box

The descriptions of the analysis gate dialog box are as follows:



A. Turn on/off the Gate Setup. Click *All On/All Off* to turn on/off all Gate Setup.

B. Switch dialog box tabs to set Gate Setup

C. Set the reference position type of gate cursors (Delay or Position)

D. The maximum number of points in the waveform used for analysis, used to limit the range of analysis gate

E. Fit the maximum number of points. When the function is switched on, the gate range is set to the maximum number of points centered on the current range

F. Set the reference position of the gate cursor A

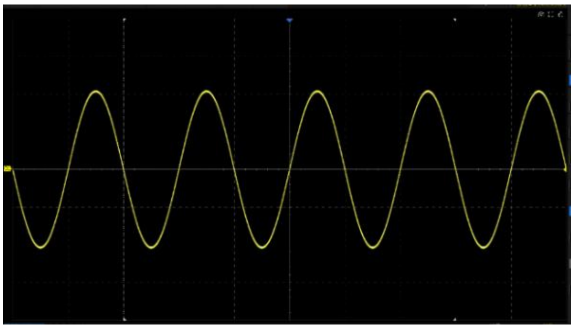
G. Set the reference position of the gate cursor B

H. Move the gate cursor A and cursor B simultaneously

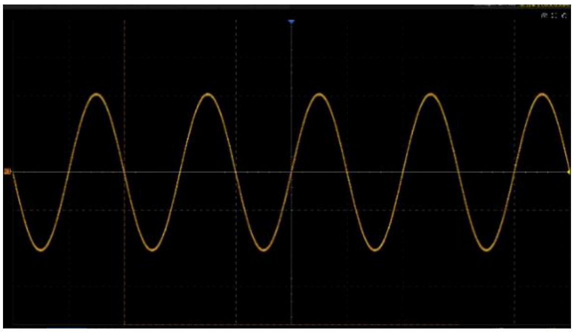
I. Synchronize gate with other sources, and the gate positiosn of the them will remain consistent. When the current source gate range is less than the Sync source, it will be synchronized to its maximum gate position and marked with a warning

Gate Select

The Analysis Gate function can be used in analog channels, digital channels and memory waveforms (M1-M4), and the gates of each source are independent of each other. Gates of analog and digital channels are displayed as dashed white lines, and gates of memory waveforms are displayed as dashed rectangular boxes in the same color as their waveforms, as shown below:



analog and digital channels



memory waveform

Gate Reference

Delay -- When the horizontal scale is changed, the gate cursor value remains fixed

Screen position -- When the horizontal scale is changed, the gate cursor remains fixed to the grid position on the display

24 Search

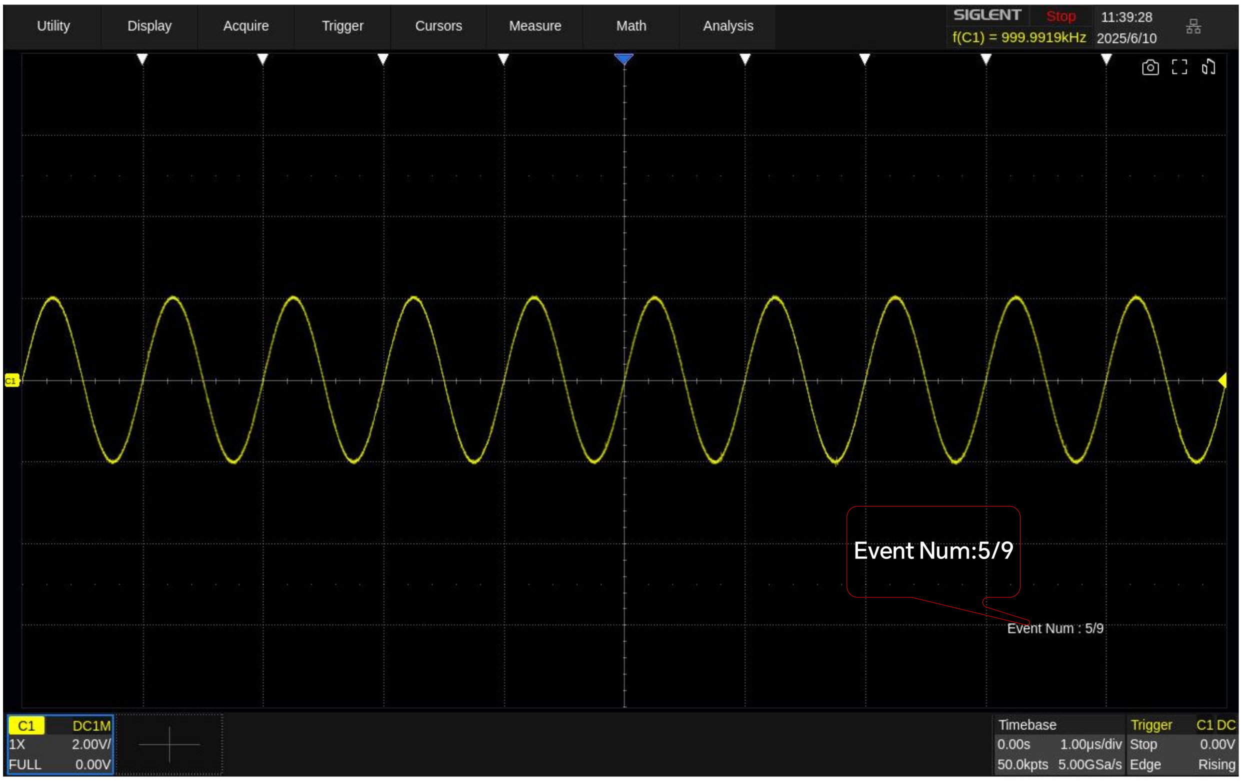
The device can search for the specified events in a frame. The location of the events is displayed with white triangle indicators. In YT mode or Roll mode with the acquisition stopped, up to 1000 events are supported. In Roll mode with the acquisition running, the number of search events is unlimited. The waveform can be zoomed in when the search function is enabled.

A. Search event indicator, white triangle indicators, marking the time point of an event

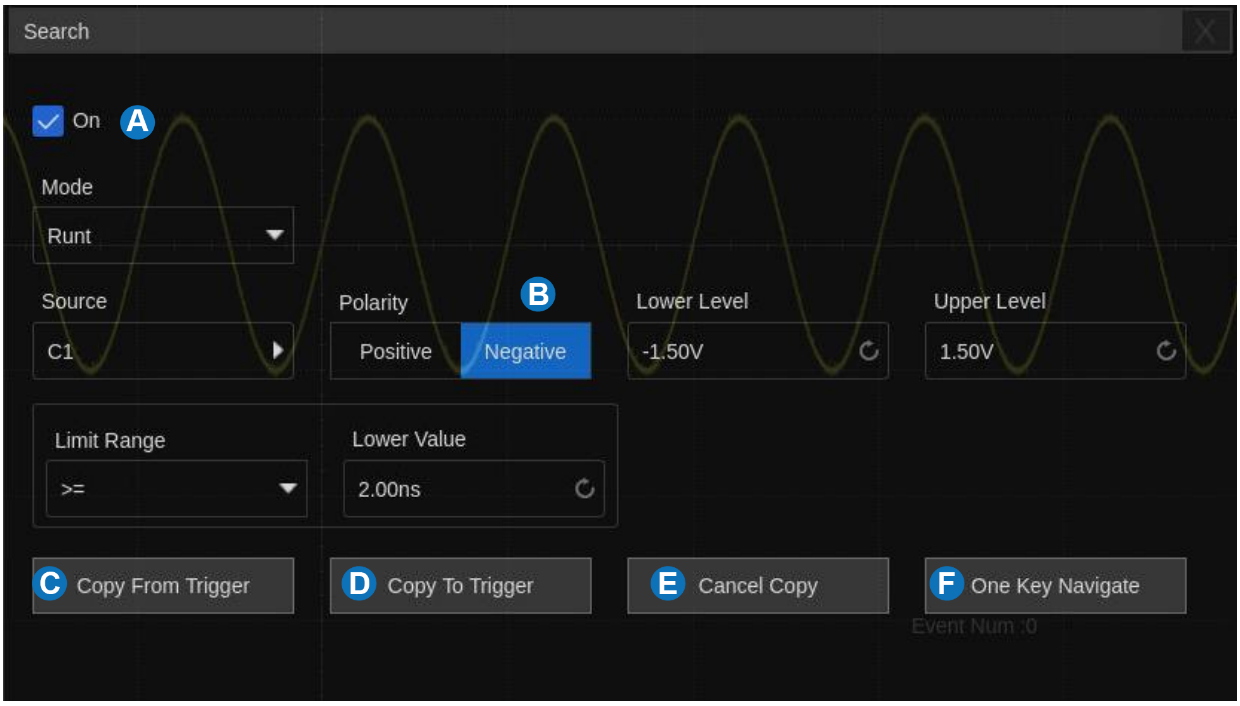
B. Total number of events marked on the display, here is 9 in this example

C. The search dialog box

In the stop state, the area B shows the index of the current event/total number of events. The current event is the one in the center of the display.



Click the menu *Analysis* > *Search* to recall the search dialog box and turn it on.



A. Turn on/off the search function

B. Go to the Setup Menu

C. Synchronize the current trigger settings to the search settings.

D. Synchronize the current search settings to the trigger settings

E. Cancel the last synchronization and restore the settings before it.

F. Enable the search event navigation with one key

Setup Menu

Select and set the search type in the Model . The device provides five search conditions: Edge, Slope, Pulse, Interval, and Runt.

Search Type	Setup Description
Edge	Slope: Rising, Falling, or Either
Slope	Slope: Rising, Falling Limit Range setting is available
Pulse	Polarity: Positive, Negative Limit Range setting is available
Interval	Slope: Rising, Falling Limit Range setting is available
Runt	Polarity: Positive, Negative Limit Range setting is available

Search setup is similar to the corresponding trigger type. See the sections “Edge Trigger”, “Slope Trigger”, ”Pulse Trigger”, ”Interval Trigger” and ”Runt Trigger” for details.

Copy

The device supports replication between search settings and trigger settings.

Copy from Trigger: Synchronize the current trigger settings to the search settings.

Copy to Trigger: Synchronize the current search settings to the trigger settings.

Cancel Copy: Cancel the last synchronization and restore the settings before it.

Note:
When copying from the trigger, if the trigger type is not supported by search, the operation is invalid.

25 Navigate

Click the menu *Analysis* > *Navigate* to recall the navigate dialog box. The device provides three navigate types: Search Event, Time, and History Frame.

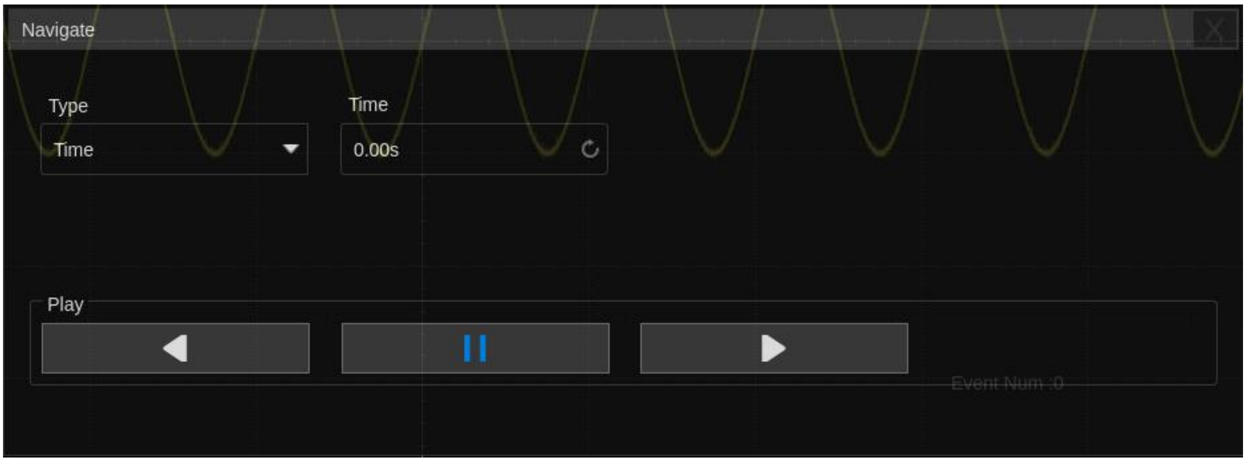
Navigate by Time

The oscilloscope automatically adjusts the trigger delay according to the direction set by the user.

Click *Type* in the navigate dialog box to select the navigate type as “Time”. There are two ways to navigate by time:

Click the *Time* area to set the time value by the mouse wheel or the virtual keypad.

Click the navigation buttons ◂, ||, or ▸ on the menu to play backward, stop, or play forward the waveform. Click the ◂ or ▸ buttons multiple times to speed up the playing. Three replay speed levels are supported: Low, Medium , and High Speed.



Navigate by Search Event

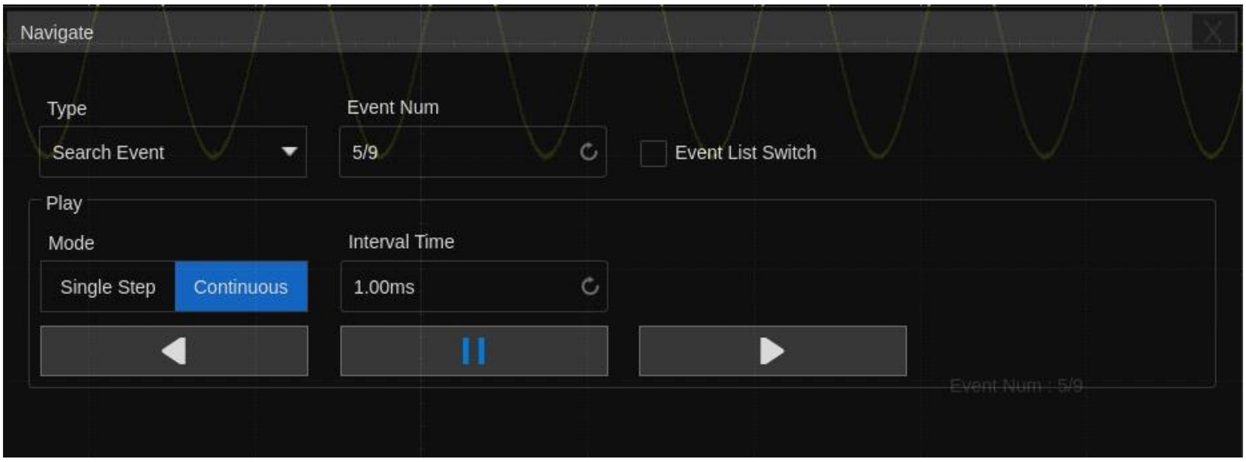
When the Search function is turned on and the acquisition is stopped, Navigate is usable to find search events (see the chapter “Search” for the search function).

Click *Type* in the navigate dialog box to select the navigate type as “Search Event”.

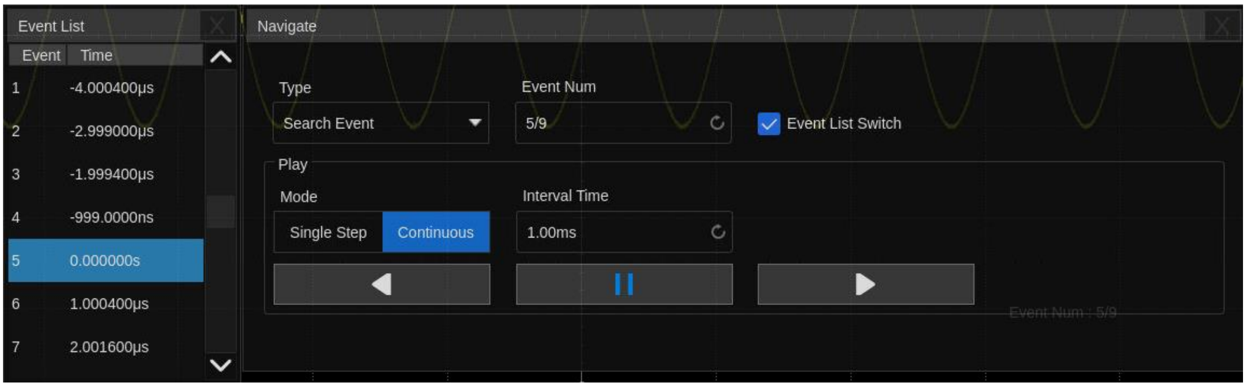
Click *Event Num* to set the event number by the mouse wheel or the virtual keypad. Click the navigation buttons ◂ or ▸ on the front panel to go to the previous or next search event.

Click *Playing Mode* to set the search event playing mode.

Click *Interval Time* to set the playing interval by the mouse wheel or the virtual keypad.



Click the *Event List Switch* area to turn the list on or off. The list contains time labels for each event. Clicking a row in the list automatically jumps to the corresponding event. This operation is equivalent to specifying an event in the *Event Num* area.



Navigate by History Frame

When the history function is turned on, Navigate can be used to play history frames (see the chapter "History" for details of the history function).

Click *Type* in the navigate dialog box to select the navigate type as "History Frame".

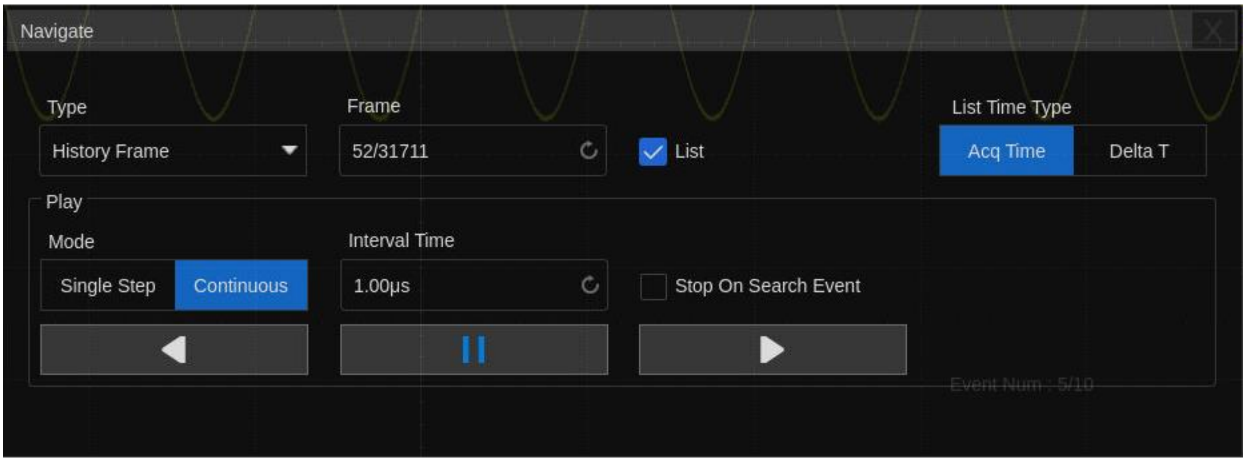
Click *Frame* to set the frame number by the mouse wheel or the virtual keypad. Click the navigation buttons ◂, ||, or ▸ on the menu to play backward, stop, or play forward.

Click the *List* area to turn on the list of history frames

Click *Playing Mode* to set the search event playing mode. When set to a single frame, each jump to the event stops; When set to continuous, jump to the first or last event before stopping.

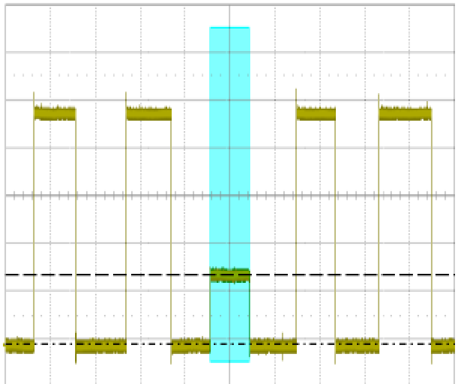
Click *Interval Time* to set the playing interval by the mouse wheel or the virtual keypad.

Click *Stop On Search Event* to set the stop play condition: stop when the event is searched. This setting is only valid when the search function is on.

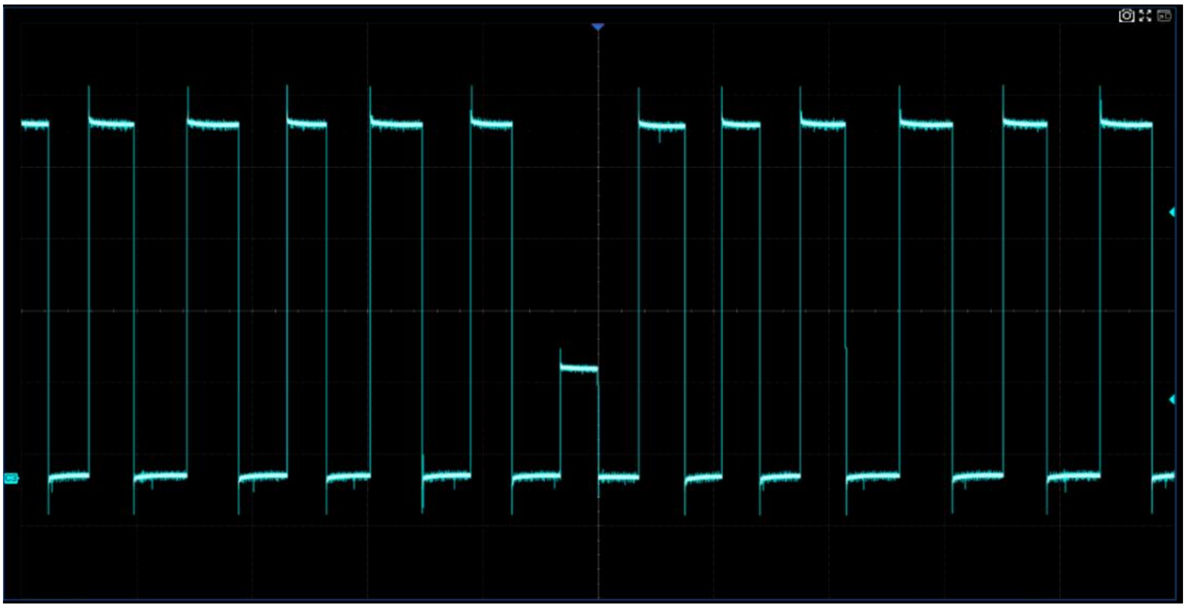


The following is an example of an occasional runt signal to demonstrate how to quickly locate and find events of interest by using the combination of Search and Navigate:

The input signal is a 5 V periodic square wave, in which every 200 ms there is a runt pulse with a height of 1/3 of the normal amplitude.

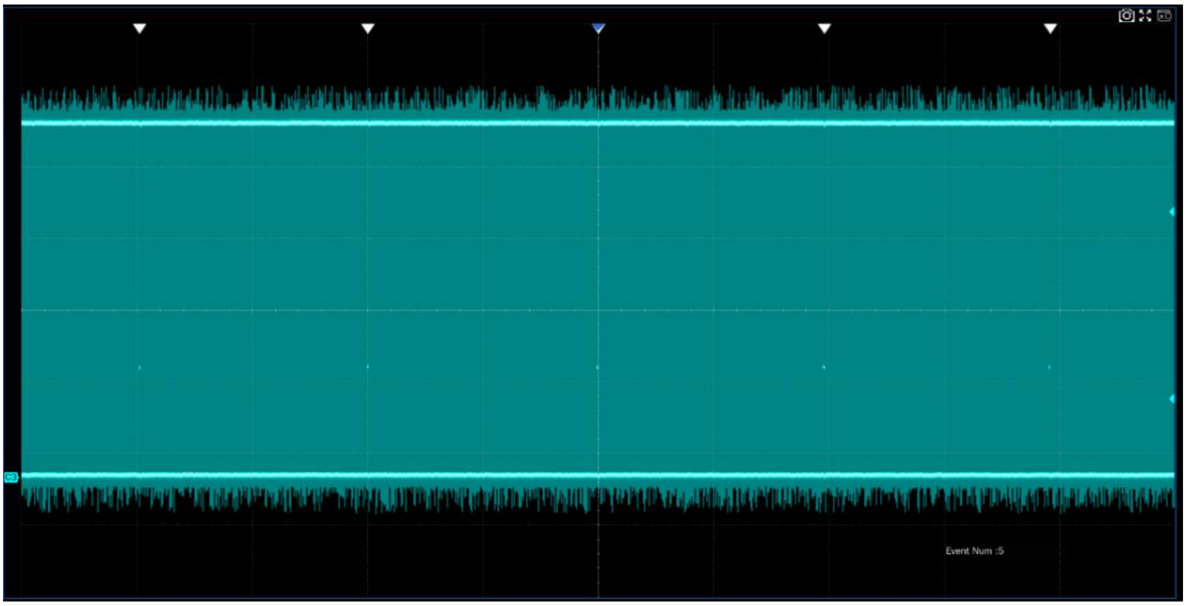


First, set the trigger type to Runt to trigger on the runt pulse. See the section "Runt Trigger" for details.

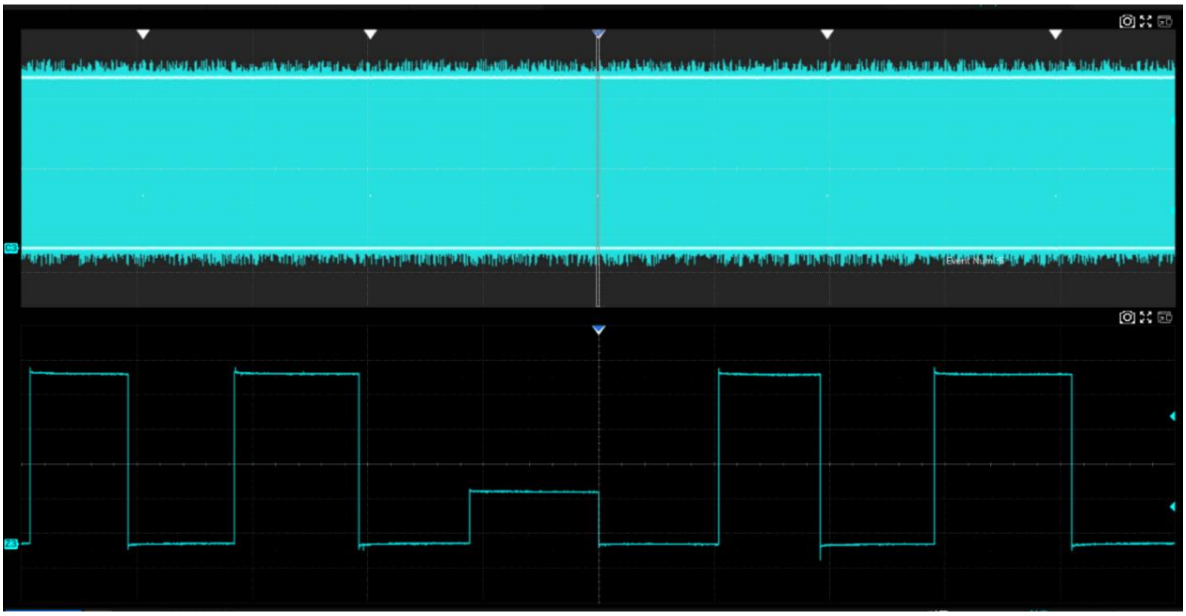


Then turn on the Search function and operate *Copy from Trigger* in the search dialog box so that the oscilloscope searches for the dwarf pulses according to the same setting as the trigger.

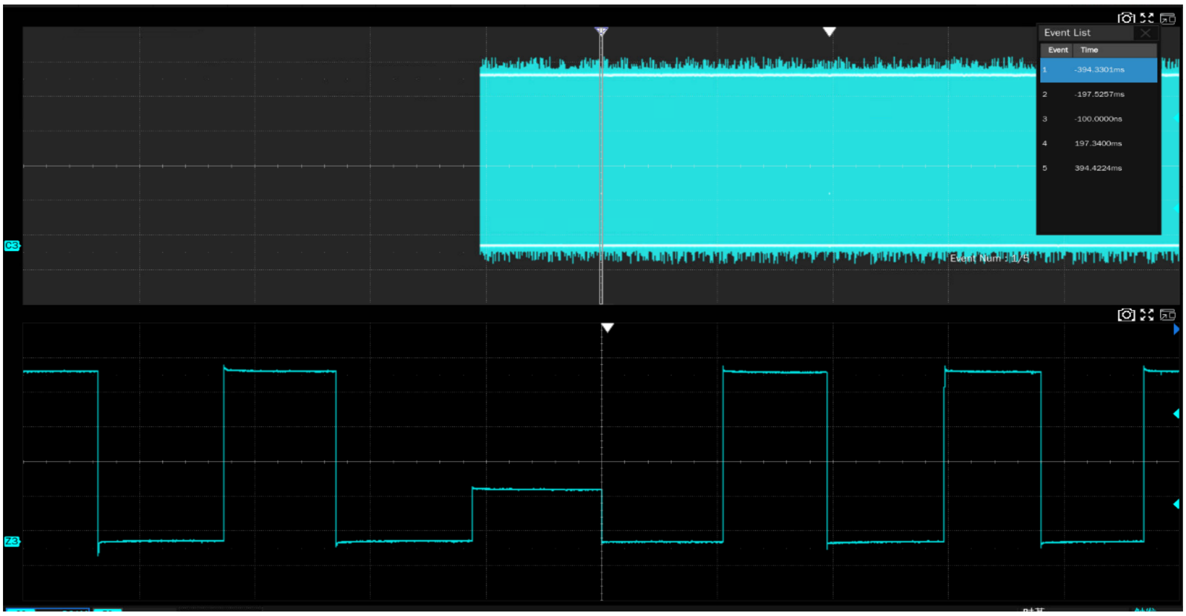
Set the horizontal scale to 100 ms/div, then 5 markers with 200 ms interval are shown on the display, indicating that a total of 5 dwarf pulses were found in the full screen of 1 second time range:



Turn on the Zoom function to observe the full view of the frame and the detail of the third dwarf pulse at the same time:



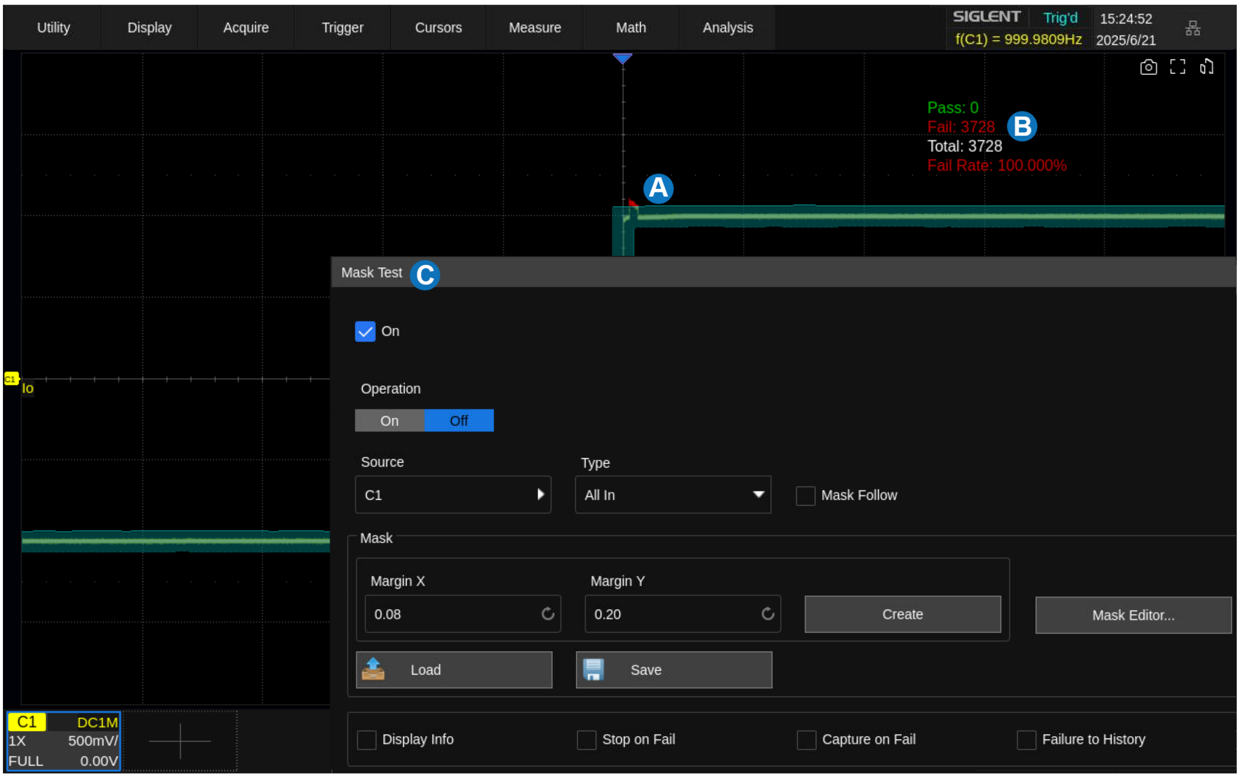
Perform *Acquire* > *Run/Stop* to stop the acquisition, and then follow the steps *Analysis* > *Navigate* > *Type* to select "Search Event". The following figure shows the first dwarf pulse. In this example, the list is enabled and the time labels of each event are shown in the list.


Event List
Event
Time
1
-394.3301ms
2
-197.5257ms
3
-100.0000ns
4
197.3400ms
5
394.4224ms
C3
Z3

26 Mask Test

26.1 Overview

Users can create masks and define the rule used to evaluate Pass/Fail operations. An event violating the rule is defined as a failure and a pulse can be generated from the "Aux Out" port on the back panel. This is very useful to find and quantify anomalies in production tests or similar batch measurements. When Pass/Fail is enabled, the signal output from the Aux Out is automatically switched to Pass/Fail pulse.

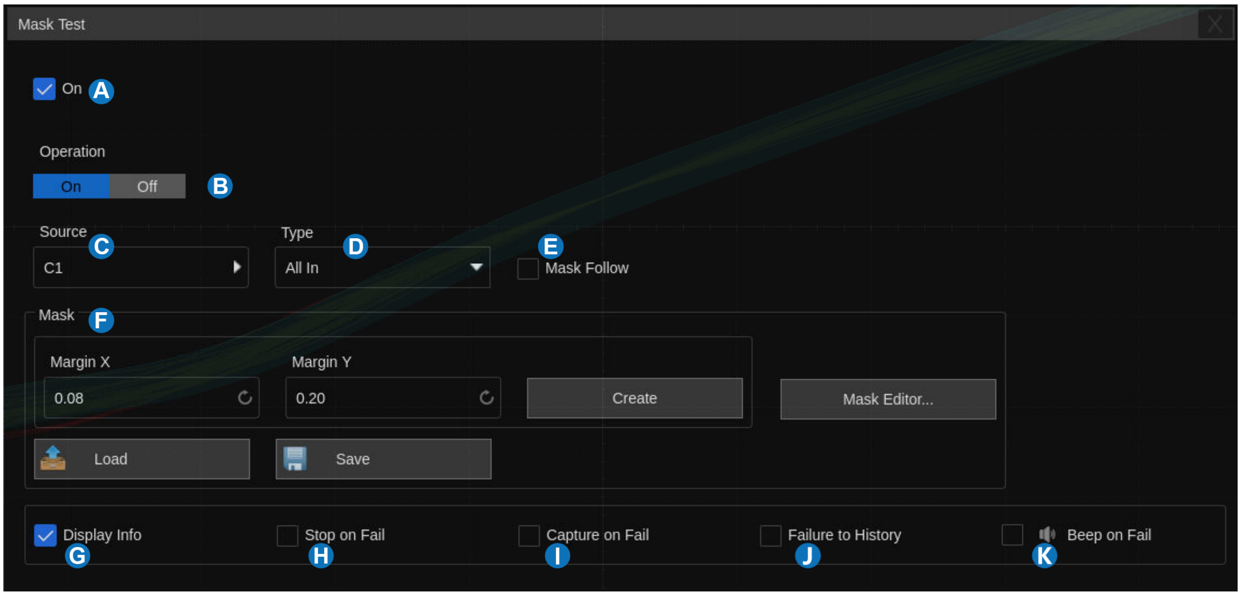


A. Mask area in green. Any dot violating the rule is highlighted in red, instead of the normal waveform color.

B. Pass/Fail information display area, including the count of the passed frames, failed frames, total frames, and the fail rate.

C. Dialog box

Perform *Analysis* > *Mask Test* to open the Mask Test dialog box:



A. Turn on/off the test

B. Turn on/off the operation. Change the state of the Pass/Fail operation. Turning off the operation when the test is in progress will stop the test immediately, and the counters in the information display area will stop. Turning the test back on will re-start the test and clear the counters.

C. Select the source (C1 ~ C8 , F1 ~ F8 , M1 ~ M4)

D. Select the rule (All In, All Out, Any In, and Any Out)

E. Turn on/off the mask follow

F. Set the mask

G. Turn on/off the information display

H. Turn on/off stop on fail. When it is "on", the oscilloscope stops the acquisition once it detects a failure

I. Turn on/off capture on fail. When it is "on", the failure waveform is detected, and the screenshot with the failure frame will be stored in the external U disk.

J. Turn on/off failure to history. When it is "on", the failure frame will be stored internally and can be viewed through the history function

K. Turn on/off the sound prompt when a failure occurs.

26.2 Mask Setup

Click *Mask Setup* in the Mask Test dialog box to set the mask. There are two methods to create a mask, one is by setting horizontal and vertical values, and the other is by drawing a polygon mask.

26.2.1 Create Mask

The mask can be created based on an existing waveform trace.

A. Set the spacing of the mask to the trace horizontal

B. Set the spacing of the mask to the trace vertical

C. Create the mask based on settings in A and B

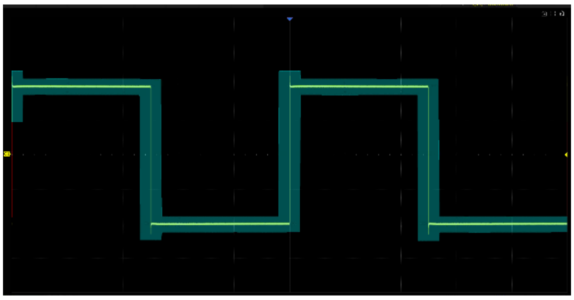
D. Load the mask

E. Save the mask

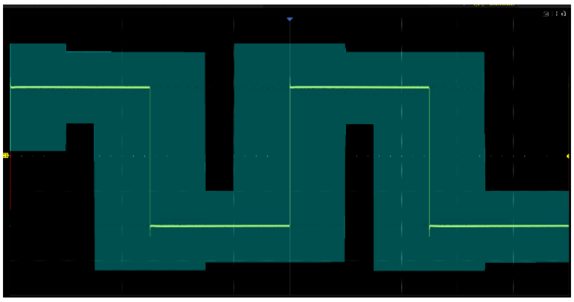
Under mask testing, the user detects signal changes by creating specific rules for the signal to be detected (including setting the horizontal and vertical adjustment range of the signal), and then observing whether the signal is outside the rule range.

Create a signal rule as follows:

Set the values for *Mask X* and *Mask Y* (in divisions of the display graticule), and then perform *Create* to generate the mask. The horizontal and vertical adjustment range is 0.08~4.00 div.



X = 0.2 div, Y = 0.2 div

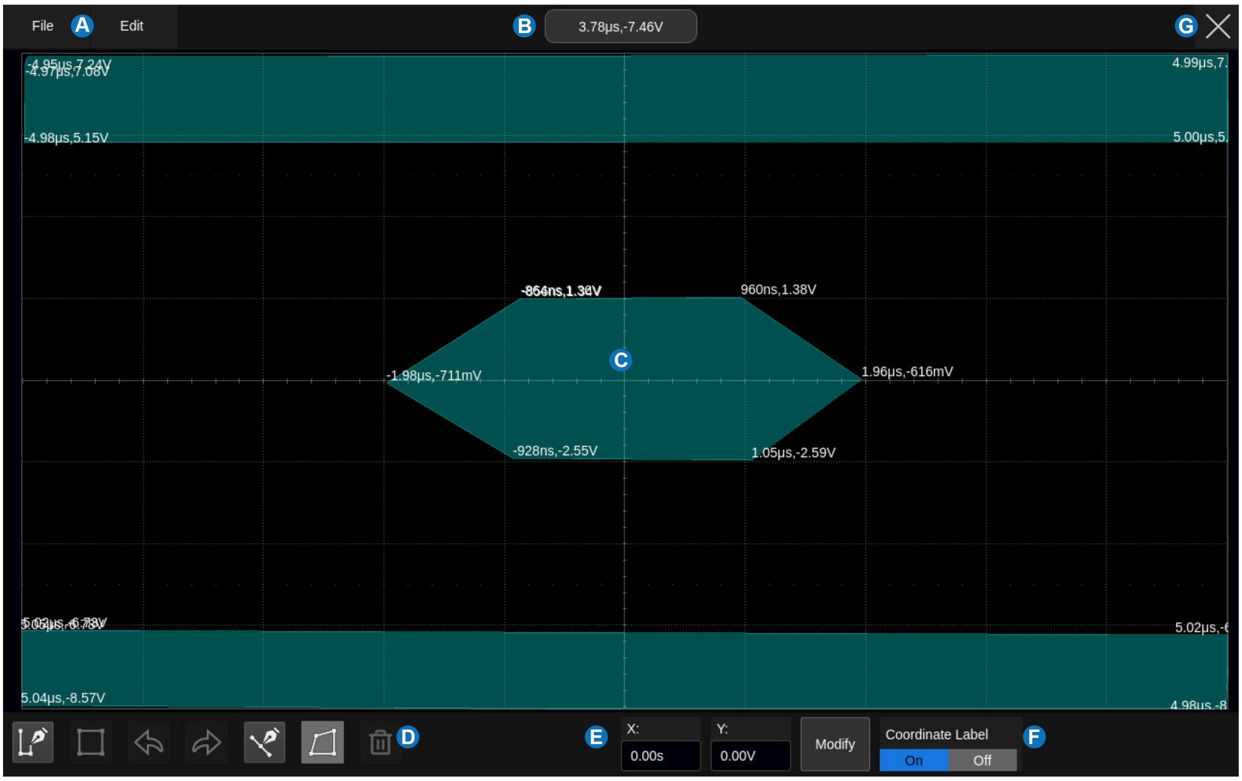


X = 1 div, Y = 1 div

Saving and recalling mask files (*.smsk) is similar to the operation of setup files, see the chapter "Save/Recall".

26.2.2 Mask Editor

The Mask Editor is a built-in tool that provides an approach to create custom masks. Below is its layout:



A. Menu bar

B. Coordinate the latest selected point on the display

C. Mask edit area, which is equivalent to the grid area. In this example, a hexagon has been created as a part of the mask

D. Toolbar

E. Coordinate edit area. Set the X ordinate and Y ordinate by the virtual keypad and then click the “Set point” button the perform the ordinate update

F. Display or hide the coordinates of the polygon vertices on the display

G. Exit the tool

Menu bar

There are 2 menus on the menu bar. The File menu includes ordinary file operations such as:

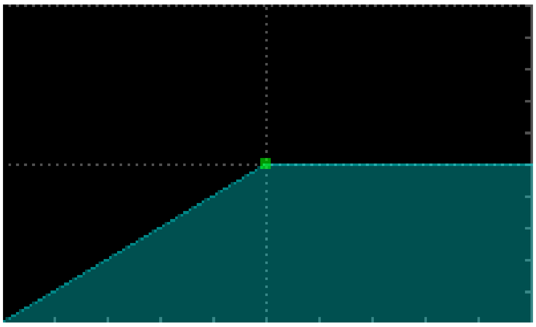
- **New:** Create a new mask file
- **Open:** Open an existing mask file
- **Save:** Save the current mask file
- **Save As**
- **Exit:** Exit the Mask Editor tool

The contents of the Edit menu are equivalent to the Toolbar.

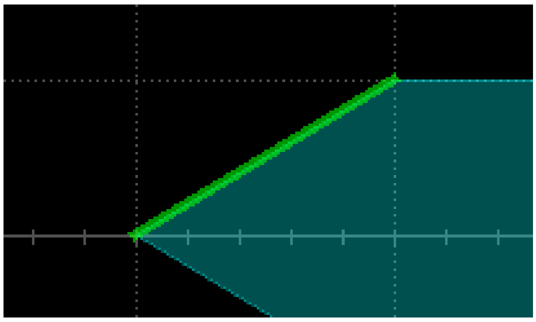
Toolbar

- Draw: Creates vertices of a polygon by clicking the display or entering values in E coordinate edit area
- Create Polygon: Creates a polygon based on the drawn vertices by the operation Draw
- Undo
- Redo
- Insert Point: Inserts a vertex on a selected side
- Edit Polygon: Edits a polygon. Vertices, sides, and the polygon are all editable object
- Delete Polygon: Deletes selected polygon

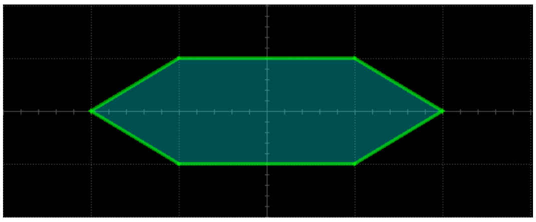
To edit a vertex, side, or polygon object, select it first, and then move it by mouse or by entering the desired value in E coordinate edit area. For a side, the value is for its middle point. For a polygon, the ordinate is for its geometric center.



Select a vertex (point)



Select a side (line segment)



Select a polygon

26.3 Pass/Fail Rule

The Pass / Fail rule is specified at the *Type* region in the Mask Test dialog box.

All In: All data points must be inside the mask to pass the test. Even a single point outside the mask will cause a failure.

All Out: All data points must be outside the mask to pass the test. Even a single point inside the mask will cause a failure.

Any In: Any data point inside the mask will be recognized as a pass. All data points outside the mask will cause a failure.

Any Out: Any data point outside the mask will be recognized as a pass. All data points inside the mask will cause a failure.

26.4 Operation

Stopping the operation during testing, the test will be terminated and parameter values in the count will stop immediately; Reopening the operation will restart the test, clearing all parameter values in the information box and resetting the counters.

Pressing the Clear Sweeps button on the front panel can also reset statistical values and restart the counting process.

27 DVM

27.1 Overview

The DVM (Digital Voltage Meter) function can be used to measure parameters such as DC and AC amplitudes. The device measures the specified parameter of the input signal and can display it in various formats, including Bar, Histogram, and Trend. DVM is asynchronous to the acquisition system of the oscilloscope. Sources of DVM and Measurement can be different, and DVM can work well even if the acquisition of the oscilloscope is stopped.

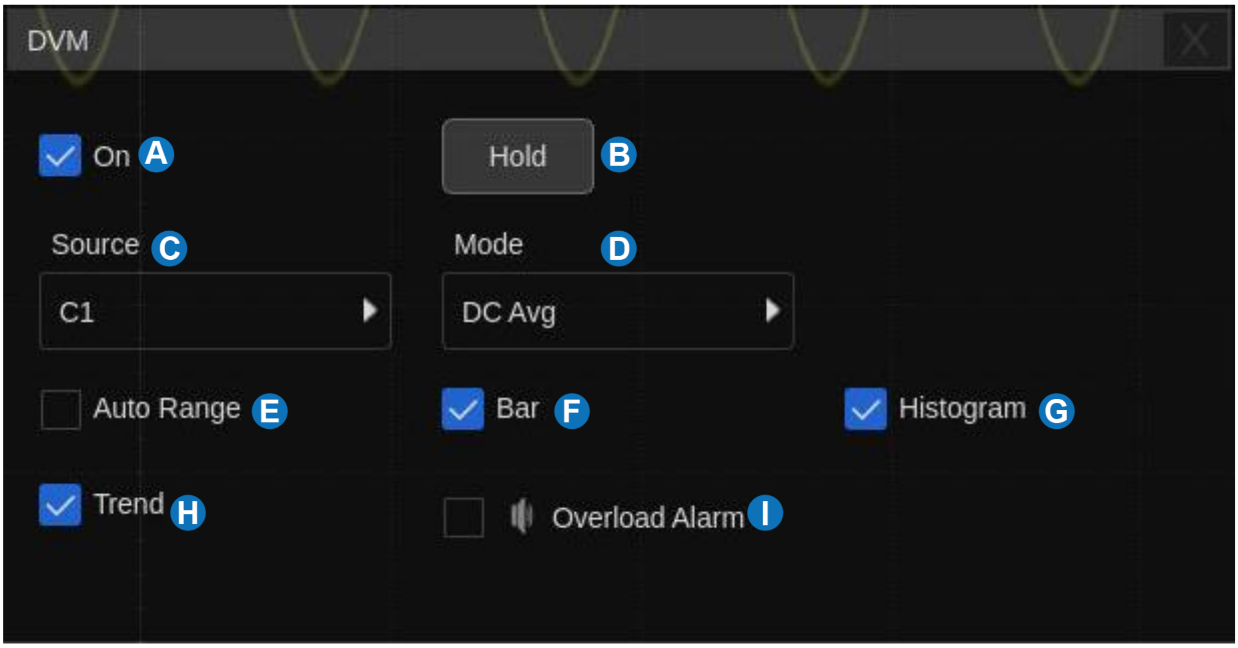
A. Bar display area

B. Histogram display area

C. Trend display area

D. DVM dialog box

Click the menu *Analysis* > *DVM* to open the DVM dialog box:



A. Turn on or off the DVM

B. Turn on or off Hold. DVM stops acquisition in Hold mode

C. Select the source (C1 ~ C8)

D. Select the mode: DC Mean, DC RMS, AC RMS, Peak-Peak, or Amplitude

E. Turn on or off the Auto Range

F. Turn on or off the bar diagram

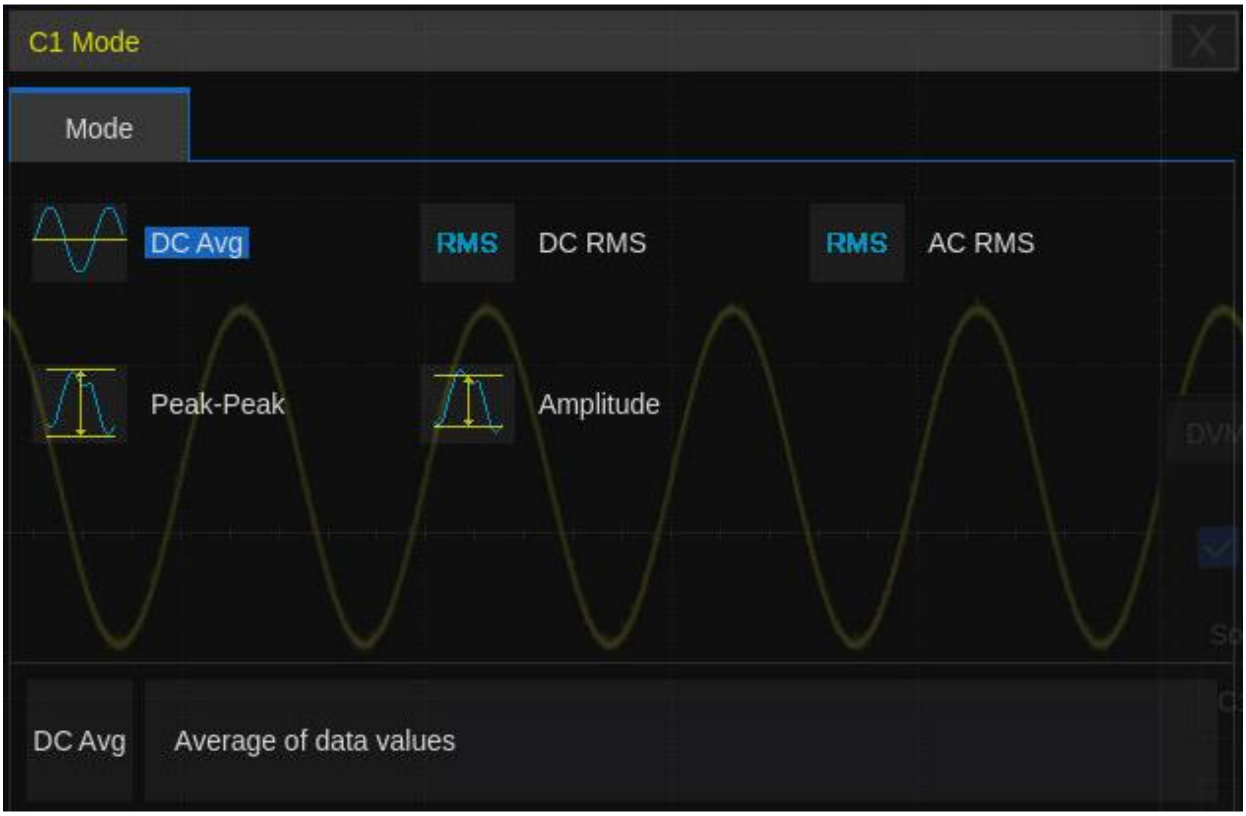
G. Turn on or off the histogram diagram

H. Turn on or off the trend plot

I. Turn on the overload alarm, an alarm will sound when the signal is out of range

27.2 Mode

DVM provides 5 modes. Click *Mode* in the DVM dialog box to open the mode selection window:



DC Avg: Average of data values

DC RMS: Root mean square of the data at DC coupling

AC RMS: Root mean square of the data at AC coupling

Peak-Peak: Difference between maximum and minimum data value

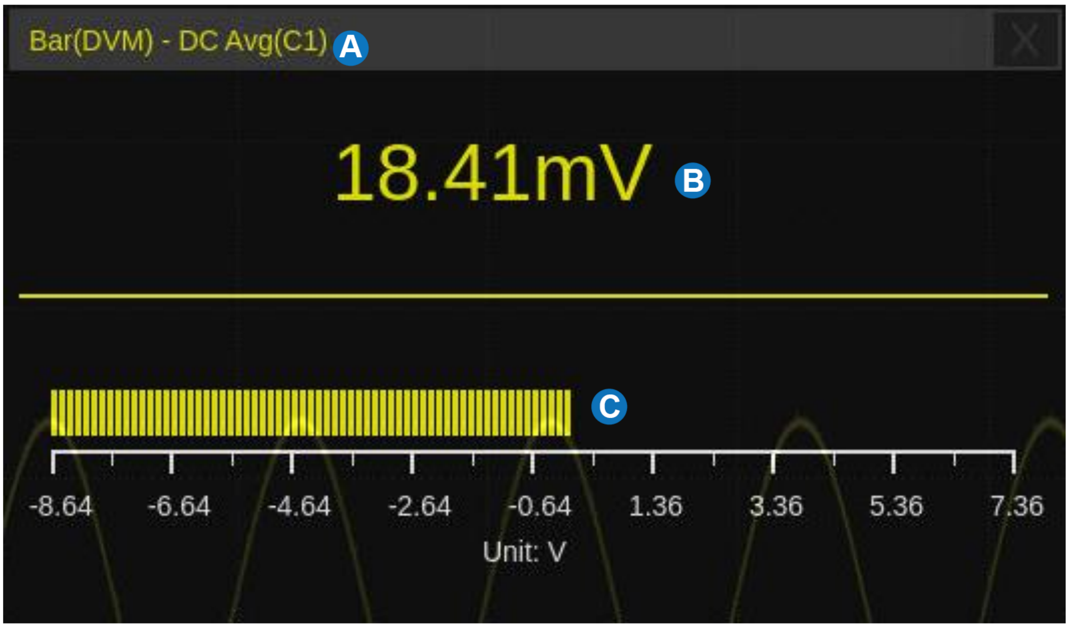
Amplitude: Difference between top and base in a bimodal waveform. If not bimodal, the difference between max and min

27.3 Diagrams

After selecting the mode, users can click the screen to open the state diagrams: bar, histogram, and trend. The color of the data in the diagrams is consistent with the color of the source.

Bar

The bar diagram accurately displays the current measured value. Click *Bar* in the DVM dialog box to display it.



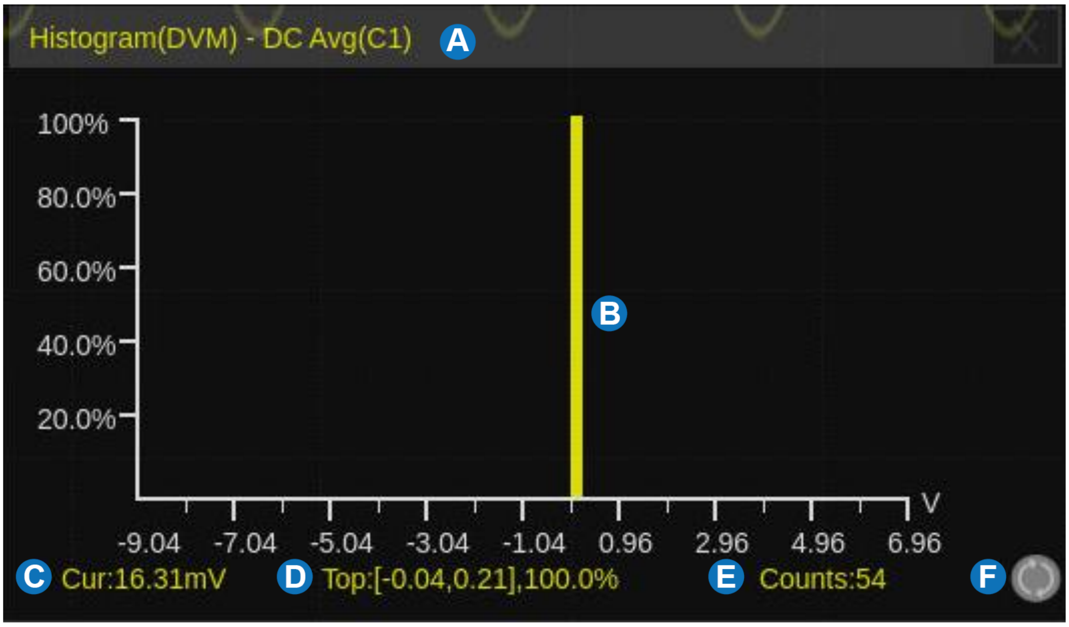
A. Mode

B. Current value

C. Bar corresponding to the current value

Histogram

A histogram visually indicates the probability distribution of the measured values. Click *Histogram* in the DVM dialog box to display it.



A. Mode

B. Histogram display area

C. Current value

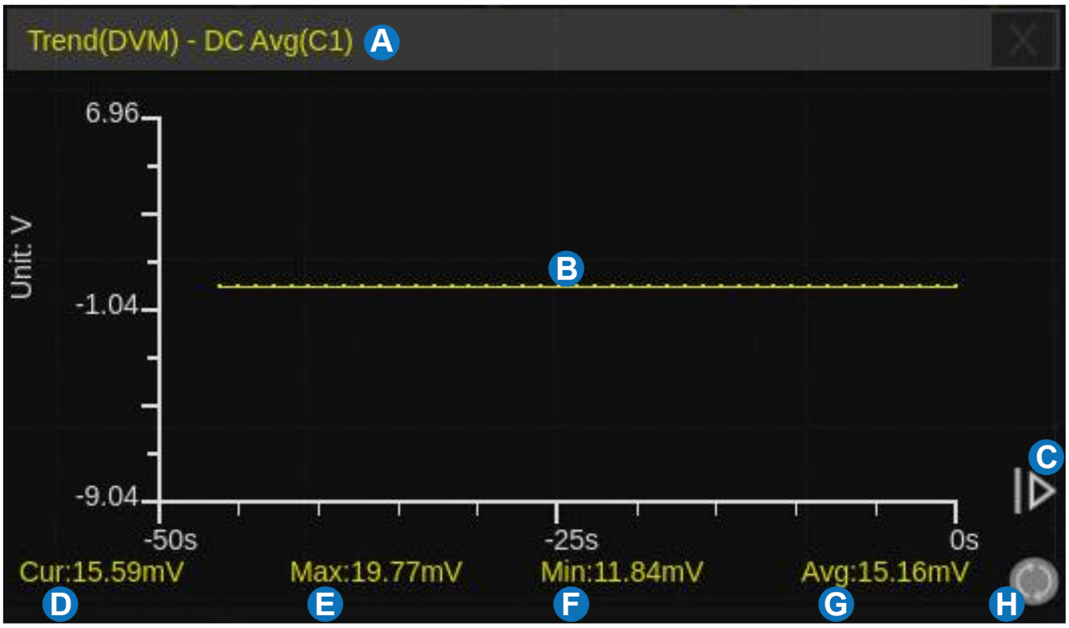
D. The bin includes the maximum value and probability with which values fall into it

E. Statistics counts

F. Reset statistics

Trend

The trend diagram indicates the trend of the measured values over time. Click *Trend* in the DVM dialog box to display it.



A. Mode

B. Trend display area

C. Extend the range of time. Click it to expand the time range

D. Current value

E. Maximum value

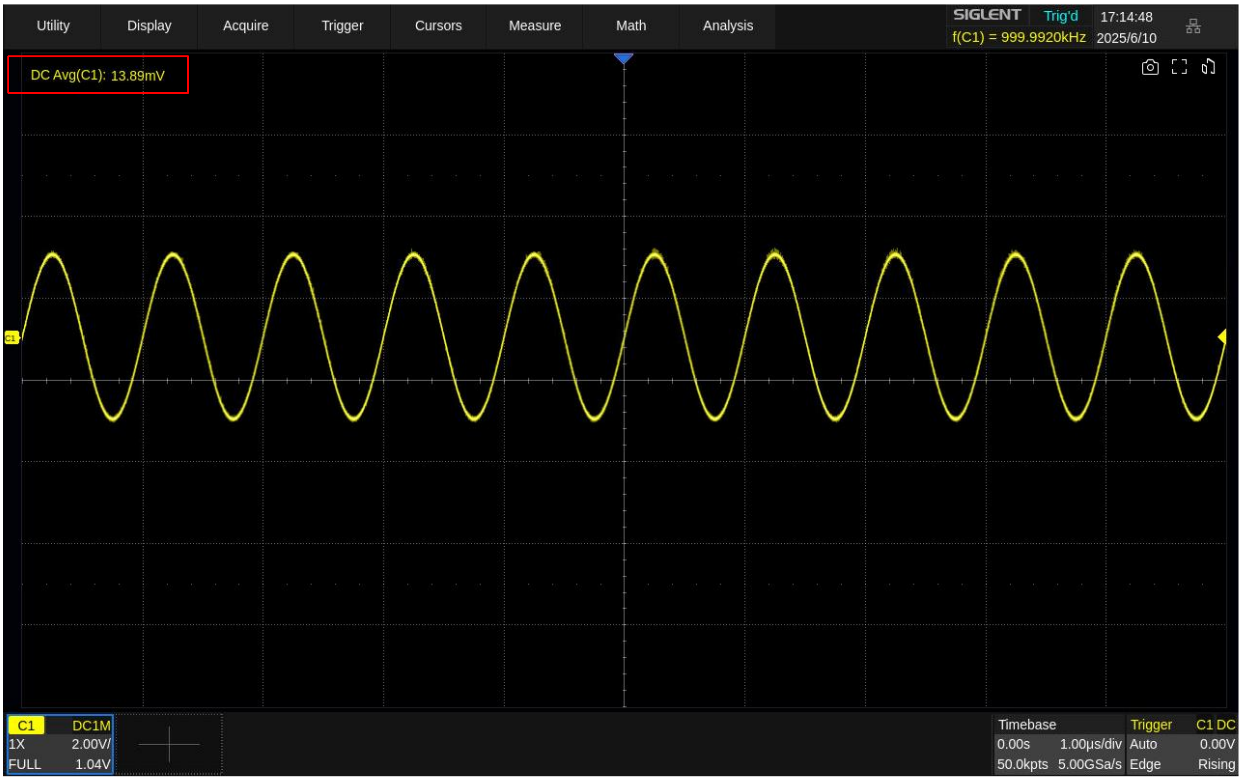
F. Minimum value

G. Average value

H. Reset statistics

Click the symbol  in the histogram and trend display areas to restart statistics.

When all the 3 diagrams are closed, there is a simple information bar on the top-left of the waveform display area to show the current value of the DVM:

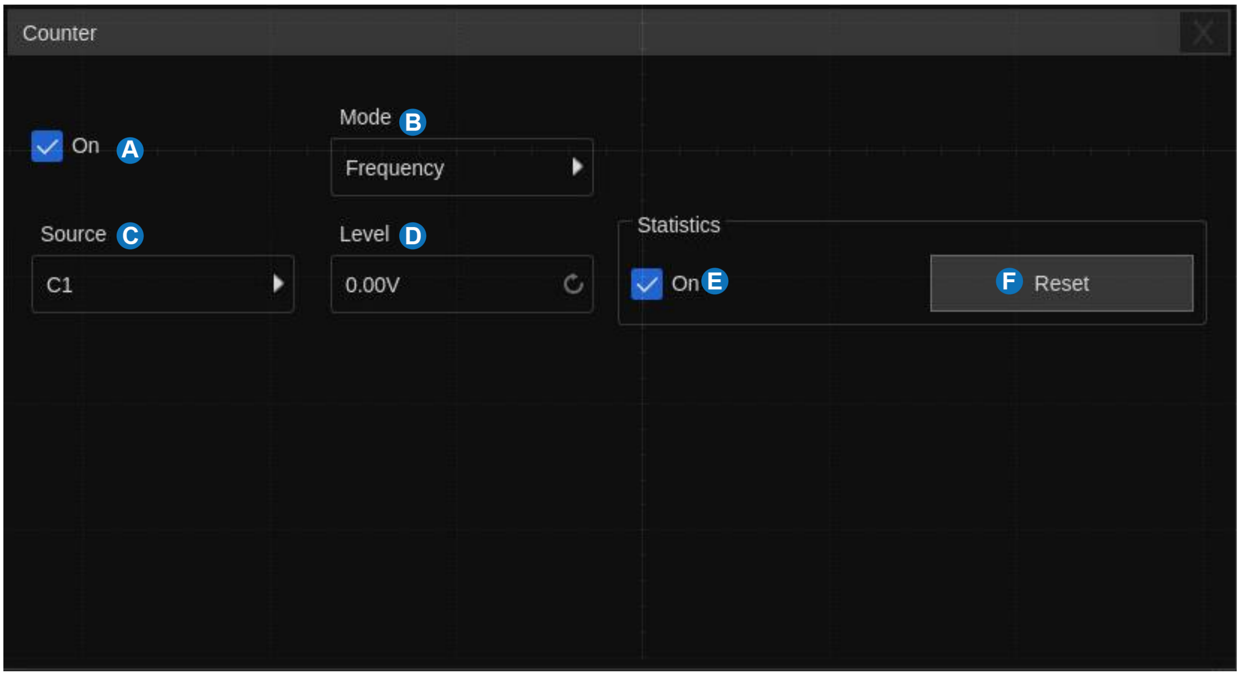

Utility
Display
Acquire
Trigger
Cursors
Measure
Math
Analysis
SIGLENT
Trig'd
17:14:48
f(C1) = 999.9920kHz
2025/6/10
DC Avg(C1): 13.89mV
C1
DC1M
1X
2.00V/
FULL
1.04V
Timebase
0.00s
1.00µs/div
50.0kpts
5.00GSa/s
Trigger
C1 DC
Auto
0.00V
Edge
Rising

28 Counter

28.1 Overview

The counter is used to measure the frequency and period of a signal or count the events happening within it. The counter is asynchronous to the acquisition system of the oscilloscope. It can work well even if the acquisition of the oscilloscope is stopped.

Click the menu *Analysis* > *Counter* to open the counter dialog box:



A. Turn on or off Counter

B. Select the mode: Frequency, Period, and Totalizer

C. Select the source (C1~C8)

D. Set the level of the counter

E. Turn on or off statistics

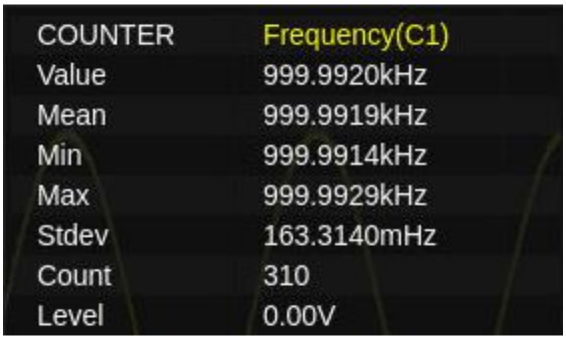
F. Clear and restart the statistics.

Mode

See the section "Mode" for details.

Statistics

When statistics are enabled, the counter will increment the data and display the statistics results on the screen.



COUNTER	Frequency(C1)
Value	999.9920kHz
Mean	999.9919kHz
Min	999.9914kHz
Max	999.9929kHz
Stdev	163.3140mHz
Count	310
Level	0.00V

Value -- The latest count

Mean -- The average of all historical counts

Min -- The minimum of all historical counts

Max -- The maximum of all historical counts

Stdev -- The standard deviation of all historical counts, used to judge the distribution of historical count parameters

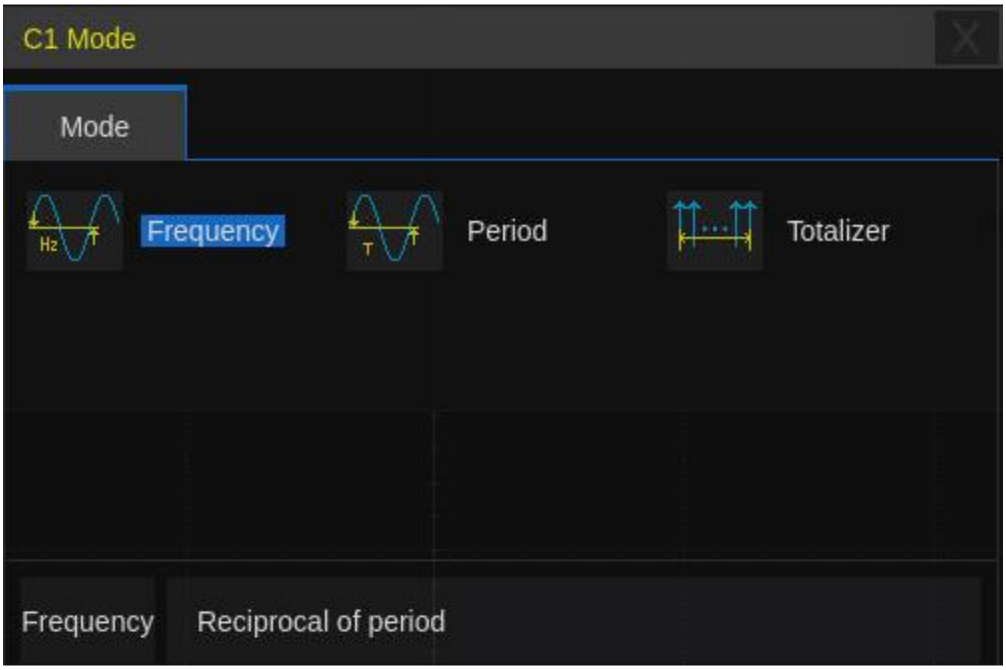
Count -- Number of counts obtained

Level -- Counter level

Click *Reset* in the measure dialog box to clear and restart statistics.

28.2 Mode

The counter provides 3 modes. Click *Mode* in the counter dialog box to open the mode selection window:



Frequency: Average frequency over a set period

Period: The reciprocal of the average frequency over a set period

Totalizer: Cumulative count

When the mode is set to totalizer, the edge of the counting source needs to be set. When the counting gate is turned on, the counter can count only when the gate-source meets the specified conditions. Click *Gate Setting* to recall the gate setting dialog box:

A. Turn on or off the gate

B. Select the gate type: Level or After Edge

C. Gate source display area. C1 and C2 are gate sources of each other, C3 and C4 are gate sources of each other, C5 and C6 are gate sources of each other , C7 and C8 are gate sources of each other

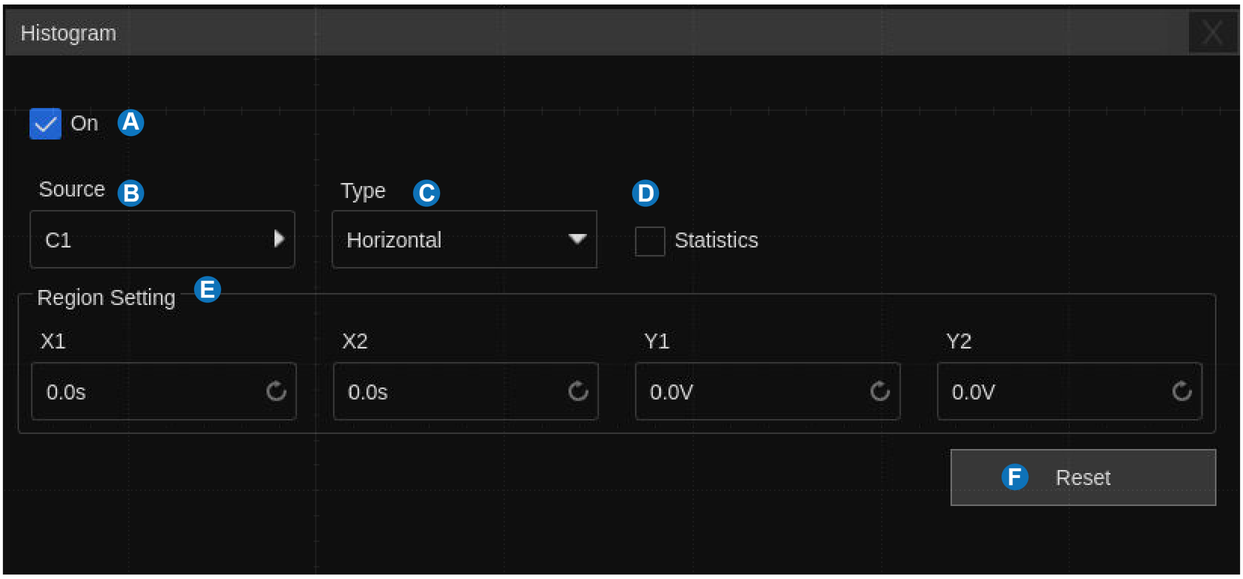
D. When the gate type is level, set the polarity (Positive or Negative) of the gate source. When the gate type is edge, set the slope (Rising or Falling edge) of the gate source.

E. Set the gate level

29 Histogram

29.1 Overview

The device supports waveform histograms for observing probability distributions of the waveform in the specified region. The statistics can be performed in both horizontal and vertical directions. The histogram continues to update as long as the acquisition is active.



A. Turn on / off the histogram

B. Select the source of the histogram: C1~C8 (When Zoom is turned on, the source selection is automatically switched to Z1-Z8) , F1 ~ F8 , M1 ~ M4

C. Set the type of histogram: Horizontal, Vertical or Both

D. Turn on or off histogram statistics

E. Set the region of the histogram. The setting range is within the waveform area

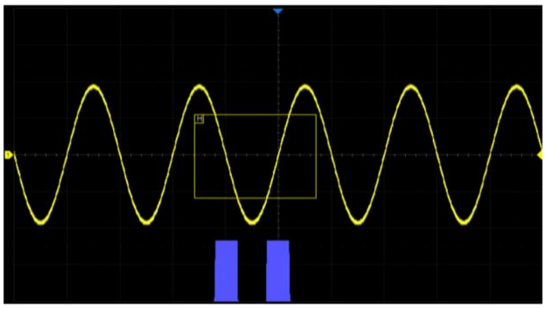
F. Clear and restart the histogram statistics

Type

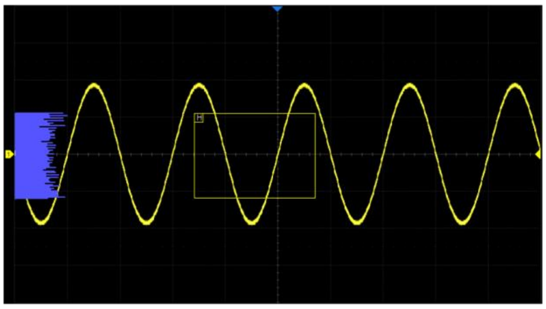
Horizontal -- Displays the histogram in the horizontal direction. The oscilloscope counts waveform data falling into every horizontal (time) bin defined by the histogram region and shows the histogram at the bottom of the waveform area.

Vertical -- Displays histogram in the vertical direction. The oscilloscope counts waveform data falling into every vertical (amplitude) bin defined by the histogram region and shows the histogram at the left of the waveform area.

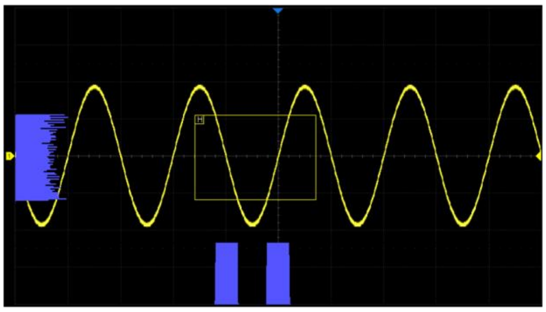
Both -- Displays both horizontal and vertical histograms.



Horizontal



Vertical



Both

Region Setting

See the section "Region Setting" for details.

Histogram Statistics

When histogram statistics is turned on, the oscilloscope will show the statistical parameters of the histogram on the display.

Histogram Statistics		
Type	Horizontal	Vertical
Sum	26.20698Mhits	26.20698Mhits
Peak	650.0000khits	4.247084Mhits
Max	425.0000us	833.33mV
Min	-80.00000us	-1.0000V
Pk-Pk	505.0000us	1.8333V
Mean	88.50526us	67.912mV
Median	40.00000us	166.67mV
Mode	-25.00000us	833.33mV
Bin Width	5.000000us	166.67mV
Sigma	150.8381us	615.12mV

Sum -- Total samples falling in the histogram region

Peak -- Samples in the highest bin

Max -- Maximum value of the samples

Min -- Minimum value of the samples

Pk-Pk -- Maximum - Minimum

Mean -- Mathematical expectation (or average) value of the samples

Median -- The value separating the higher half from the lower half of the histogram

Mode --The value that appears most often

Bin Width -- The width of each bin

Sigma -- Standard deviation of the samples (σ)

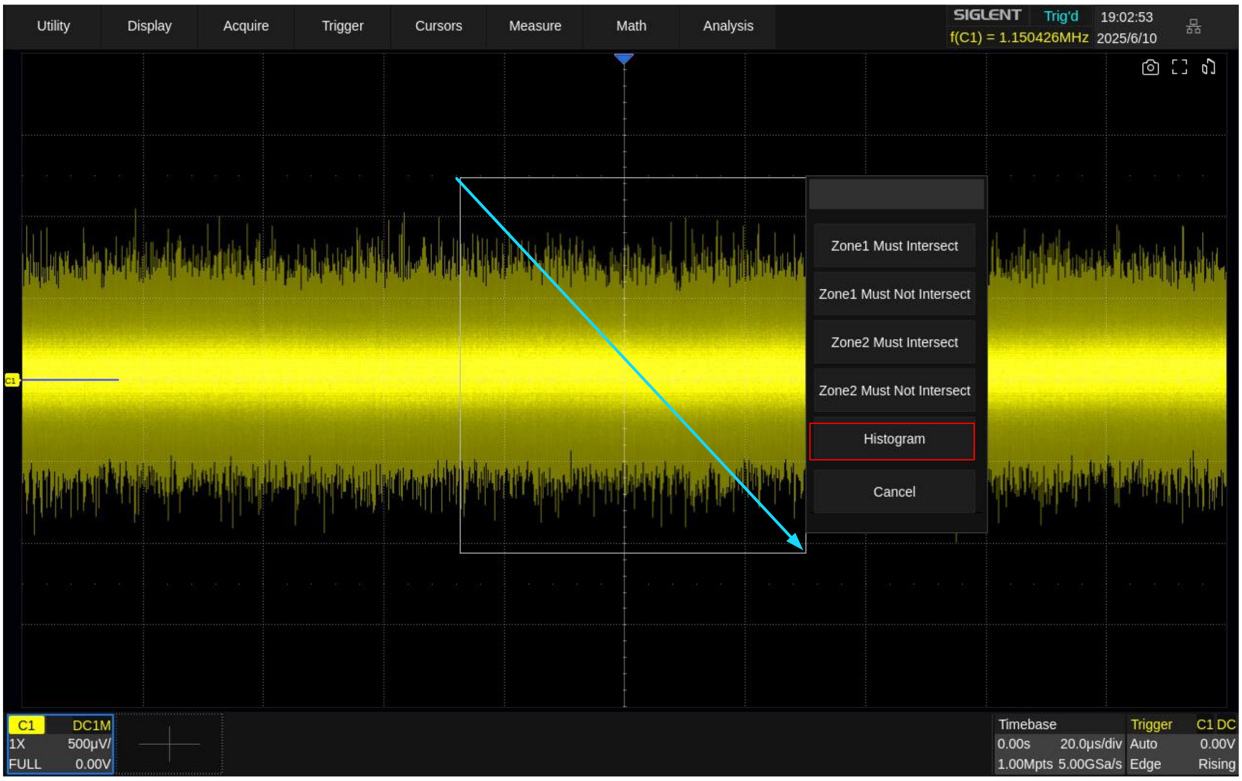
Click *Reset* in the histogram dialog box to clear and restart the statistics.

29.2 Region Setting

Histogram region can be created and moved directly by the mouse or by setting Histogram > Region Setting in the dialog box. The border color of the histogram region is consistent with the color of the specified source.

By the Mouse

Click any position of the waveform area and draw a rectangular box, as follow:

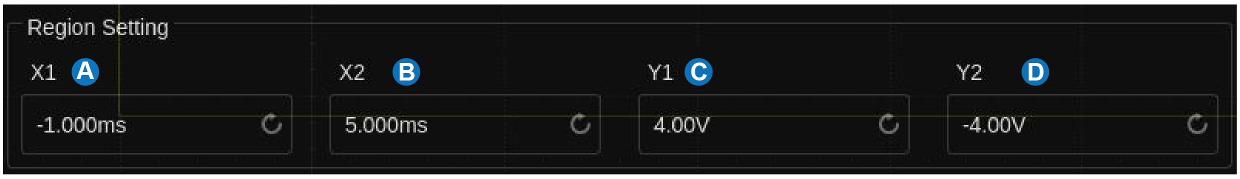


A menu pops up at the end of the drawing action. Select "Histogram" in the menu:

After the region is created, it can be moved by dragging action.

Dialog Box

Click *Histogram* > *Region Setting* to recall the dialog box.



A. Set the left border of the histogram region

B. Set the right border of the histogram region

C. Set the top border of the histogram region

D. Set the bottom border of the histogram region

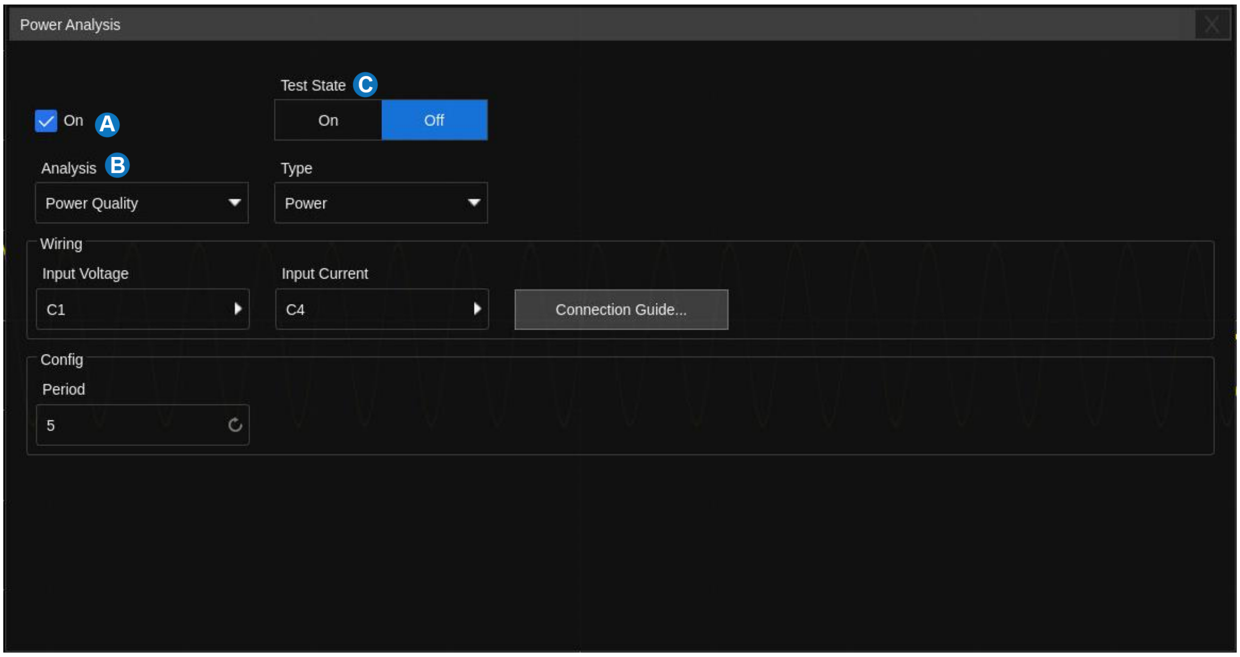
Click the area above to set the value by the mouse wheel or the virtual keypad.

30 Power Analysis

30.1 Overview

The device supports a power analysis function. Power analysis can help users quickly and easily analyze and debug switching power supply design. It automatically calculates Power Quality, Current Harmonics, Inrush Current, Switching Loss, Slew Rate, Modulation, Output Ripple, Turn On/Turn Off, Transient Response, PSRR, Efficiency, SOA, etc. Full use of the Power analysis requires a differential voltage probe like the SIGLENT DPB series, a current probe like the SIGLENT CP series, the SIGLENT DF2001A deskew fixture, Install the software option part number SDS5000HD-PA . For installation of options, see section "Install Options".

Click *Analysis* > *Power Analysis* to recall the power analysis dialog box:



A. Enable/Disable the test

B. Select the analysis item (Power Quality, Current Harmonics, Inrush Current, Switching Loss, Slew Rate, Modulation, Output Ripple, Turn On/Turn Off, Transient Response, PSRR, Efficiency, etc.)

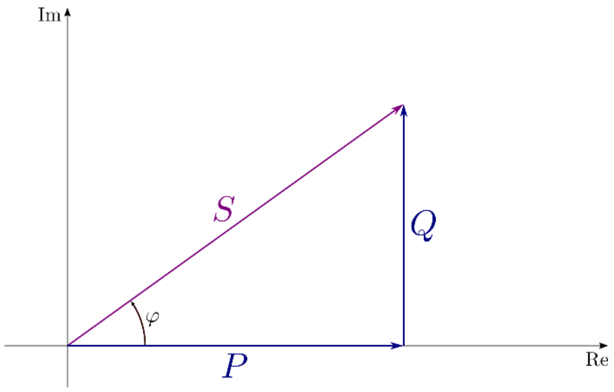
C. Turn on/off the state of the analysis item

30.2 Power Quality

The specific measurement parameters of power quality analysis include real power, apparent power, reactive power, power factor, power phase angle, voltage effective value, current effective value, voltage crest factor, and current crest factor of power input of a switching power supply.

Type

Power -- Includes all the items to describe energy flow in a system: real power, reactive power, apparent power, power factor, and power phase angle.



The various power-related parameters and their respective units are as follows:

P: Real Power = $\frac{1}{N} * \sum_{i=0}^{N-1} Vi * Ii$

S: Apparent Power = Vrms * Irms

Q: Reactive Power =$\sqrt{\text{Apparent Power}^2 - \text{Real Power}^2}$

φ: Power Phase Angle: Phase difference between voltage and current

$\cos\varphi$: Power Factor, which is the ratio of real power and apparent power.

Voltage Crest -- Voltage parameters of the power input include voltage crest, voltage effective value, and voltage crest factor.

Vrms = $\frac{1}{N} * \sqrt{\sum_{i=0}^{N-1} Vi^2}$

V_Crest = Vpeak / Vrms

Current Crest -- Current parameters of the power input include current crest, current effective value, and current crest factor.

Irms = $\frac{1}{N} * \sqrt{\sum_{i=0}^{N-1} Ii^2}$

I_Crest = Ipeak / Irms

Signal Settings

Click *Analysis* to recall input setup dialog box:

A. Set the input voltage source

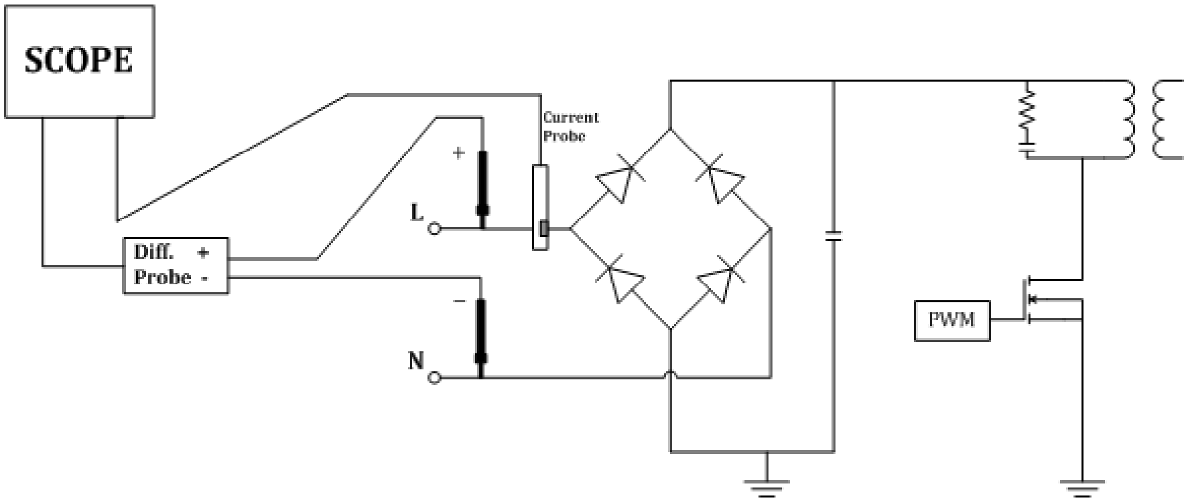
B. Set the input current source

C. Set the periods displayed

D. View the connection guide

Connection Guide

Click *Connection Guide* to recall the connection guide of power quality, as shown in the figure below. Please follow the instructions in this figure for correct connections. Click the icon on the top right of the guide to close.

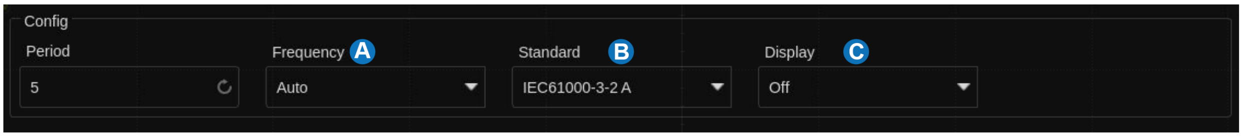


30.3 Current Harmonics

Current harmonics are used to analyze the input current harmonics. An FFT of the selected channel is performed to get the harmonic components. The signal settings and connection guide are the same as the power quality test.

Configuration

Click *Config* to recall the configuration dialog box:



A. Set the frequency of the line (Auto, 50 Hz, 60 Hz, or 400 Hz)

B. Set the standard type (IEC61000-3-2 A, IEC61000-3-2 B, IEC61000-3-2 C or IEC61000-3-2 D)

C. Set the display type (Off, Bar Chart, or Table)

Standard

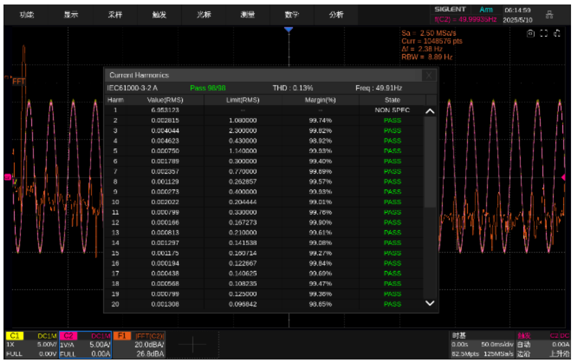
IEC 61000-3-2 is an international standard that limits mains voltage distortion by prescribing the maximum value for harmonic currents from the second harmonic up to and including the 40th harmonic current. There are 4 different classes in the EN 61000-3-2 that have different limit values:

- Class A: Balanced 3-phase equipment, household appliances excluding equipment identified as class D, tools, excluding portable tools, dimmers for incandescent lamps, audio equipment, and all other equipment, except that stated in one of the following classes.
- Class B: Portable tools, arc welding equipment which is not professional equipment
- Class C: Lighting equipment.
- Class D: PC, PC monitors, radio, or TV receivers. Input power P ≤ 600 W.I

Parameter Description

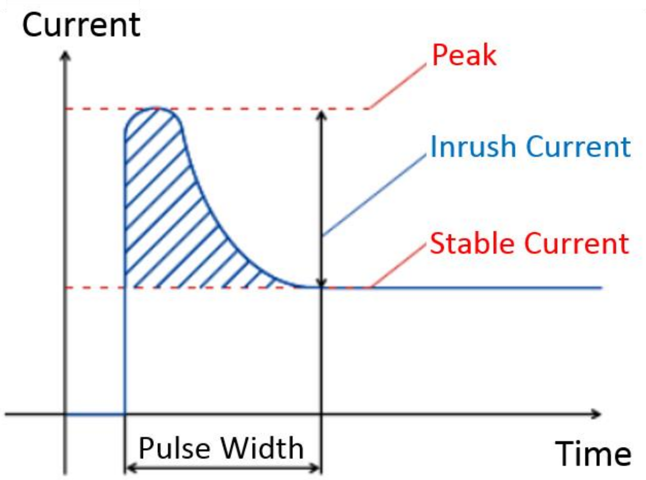
For the first 40 harmonics, the following values are displayed:

- Measured Value (RMS) -- The measured value displayed in the unit specified by the harmonic unit parameter
- Limit Value (RMS) -- Limits specified by the selected standard
- Margin (%) --The margin specified by selected standard parameters. The margin value is (standard value - measured value) / standard value * 100%
- Pass/Fail State -- Determine whether the measured value is passed or failed according to the selected standard. The rows in the table or the bars in the bar chart are rendered in different colors based on the pass / fail state. When the value is greater than 85% of the limit but less than 100% of the limit, it is defined as a critical state.
- Total Harmonic Distortion (THD) $= 100\% * \frac{\sqrt{X_2^2+X_3^2+\cdots+X_n^2}}{X_1}$, where Xn is the nth harmonic, and X1 is the basic component.



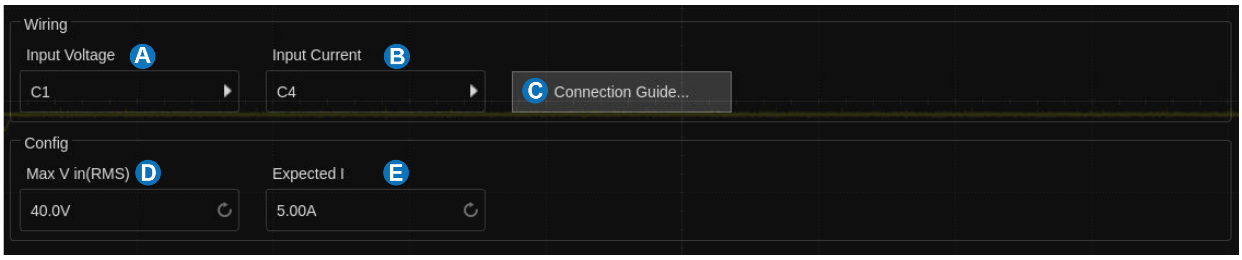
30.4 Inrush Current

A large current far greater than the stable current may flow through at the moment of switching on a power supply. The large current is called the inrush current. The current waveform when switching on is shown in the figure below:



Signal Settings

Click *Analysis* to recall input setup dialog box:



A. Set the input voltage source

B. Set the input current source

C. View the connection guide

D. Set the maximum effective input voltage (Vrms), the range is 1 V ~ 1 kV. The oscilloscope will set the vertical scale of the voltage channel to maximum input voltage/6

E. Set the expected current value, the range is 100 mA ~ 500 A. The oscilloscope will set the trigger level to an expected current/20 and the vertical scale of the current channel to an expected current/3

30.5 Switching Loss

Switch loss analysis can be used to calculate the power dissipated in the switching period.

Deskew Calibration

A relatively small skew can cause a large measurement error of switching loss, especially during the on phase when the voltage is close to zero and the non-on phase when the current is close to zero. This is a typical oscilloscope dynamic range limitation when trying to measure weak voltage and (or) current in the presence of relatively large switching voltage and (or) current.

To correct the skew between the oscilloscope channels or probes, the deskew procedure should be performed once initially, and re-run when any part of the hardware setup changes (for example, a different probe, different oscilloscope channel, etc.) or when the ambient temperature changes. The deskew procedures by using the DF2001A deskew fixture are as follows:

A. Demagnetize and zero-adjust the current probe

B. Set up connections to the DF2001A deskew fixture

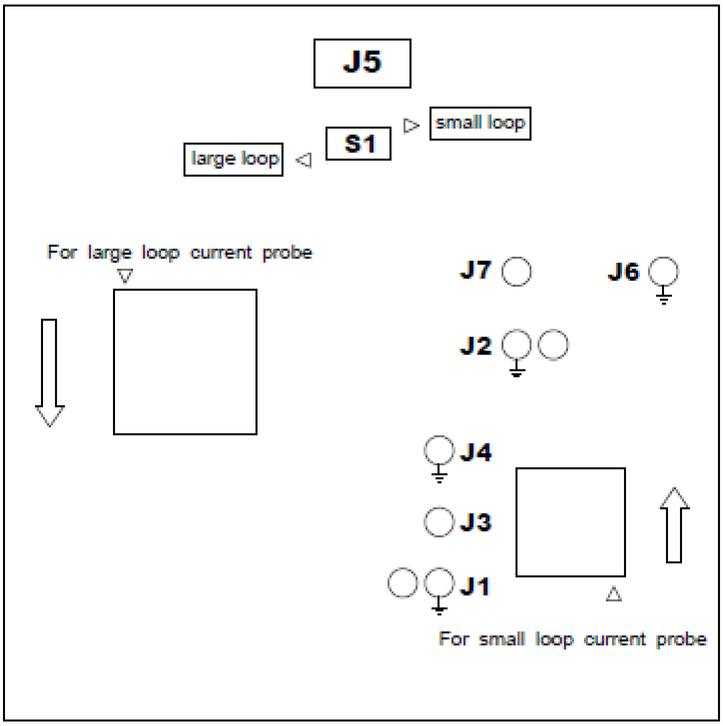
	Small Loop	Large Loop
Available current probes	CP4020 (100 kHz, 20 Arms) CP4050 (1 MHz, 50 Arms) CP4070 (150 kHz, 70 Arms) CP4070A (300 kHz, 70 Arms) CP5030 (50 MHz, 30 Arms) CP5030 (100 MHz, 30 Arms)	CP5150 (12 MHz, 150 Arms) CP5500 (5 MHz, 500 Arms)
High-voltage differential probe sense points	J7: signal terminal J6: earth terminal	J3: signal terminal J4: earth terminal

a) Connect D+ and D- of the high-voltage differential probe to J7 and J6

b) Connect the current probe to the loop with the direction of the arrow indicating the direction of the current flow

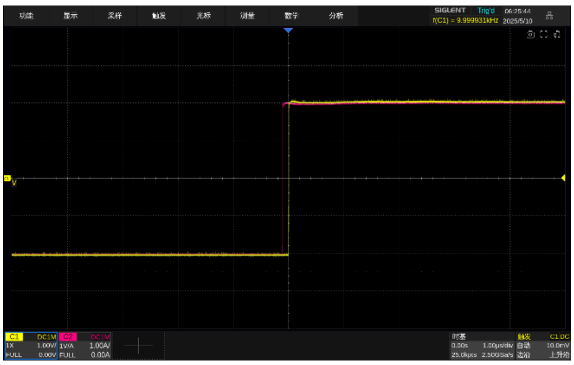
c) Make sure the switch S1 on the deskew fixture is set to the appropriate side of the fixture (either “small loop” or “large loop”)

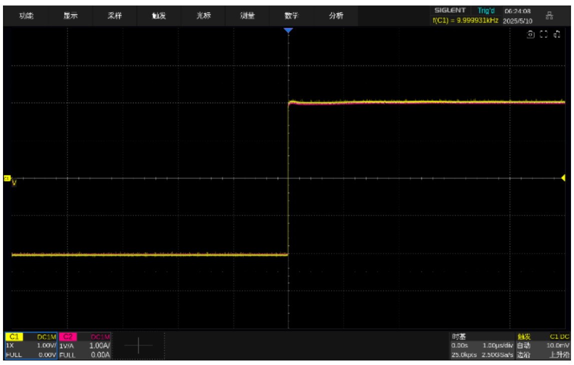
d) Connect the deskew fixture to a USB port on your oscilloscope or a PC using a USB cable. The USB port supplies power to the deskew fixture



C. Connect the voltage and current probes to the oscilloscope input channel

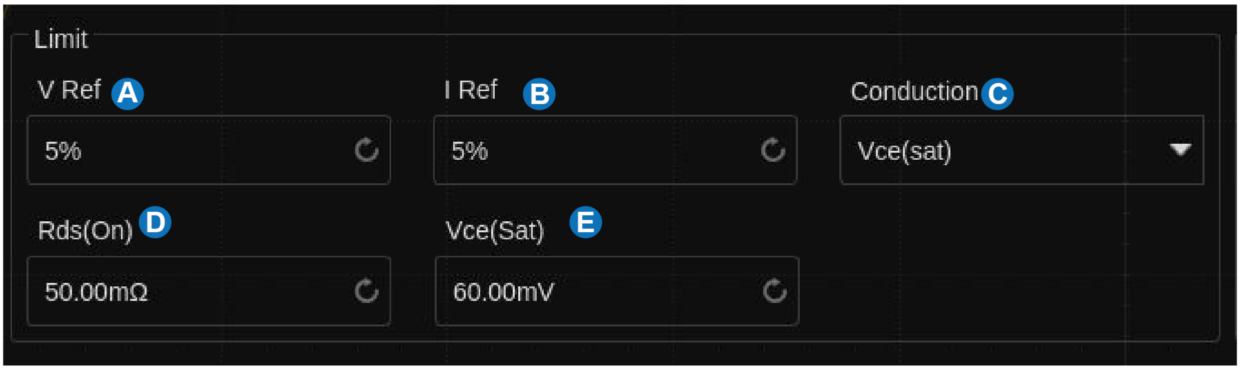
D. Click *Analysis* to enter the Switching loss setting menu. Select the corresponding input channel, and then click *Auto Deskew* to perform the calibration. When the process completes, a message will pop up indicating whether the deskew operation was successful or not.


Before deskew calibration


After deskew calibration

Configuration

Click *Analysis* to recall the configuration dialog box:



A. Set the voltage reference, i.e. the switch level at the edge of the input switch. This value is a percentage of the maximum switching voltage. Adjusting the value to ignore background noise. This value is used to determine the threshold hysteresis of the switch edge

B. Set the current reference, i.e. the switch level at the beginning of the input switch edge. This value is the percentage of the maximum switching current. This value can be adjusted to ignore background noise or invalid offset that is difficult to eliminate in the current probe. This value is used to determine the threshold hysteresis of the switch edge

C. Set the conduction type (Waveform, Rds(on) or Vce(sat))

D. Set Rds(on) resistance

E. Set Vce voltage

Conduction Type

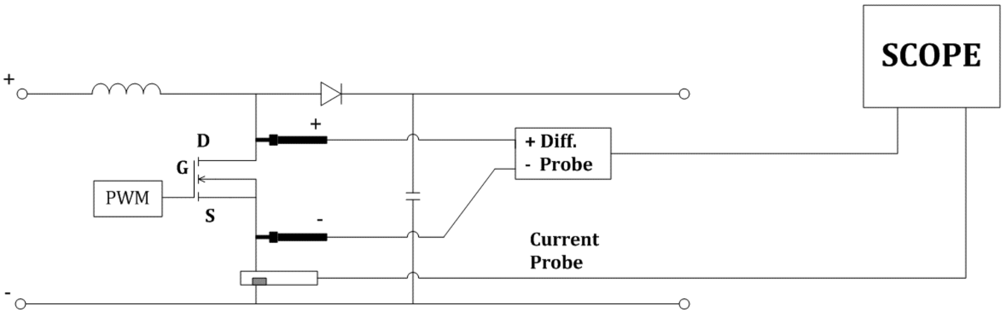
Waveform -- The power waveform uses the original data, and the calculation formula is P = V * I, E = P * T.

Rds(on) -- In the on area (where the voltage level is lower than the voltage reference (adjustable)), the power calculation formula is $P = I^2$ * Rds(on). In the off area (where the current level is lower than the current reference (adjustable)), the power calculation formula is P = 0 watt.

Vce(sat) -- In the on area (where the voltage level is lower than the voltage reference (adjustable)), the power calculation formula is P = Vce(sat) * I. In the off area (where the current level is lower than the current reference (adjustable)), the power calculation formula is P = 0 watt.

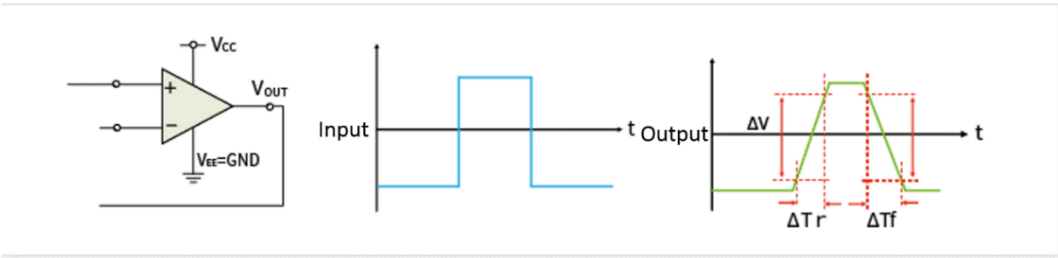
Connection Guide

Click *Connection Guide* to recall the connection guide of switching loss, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.



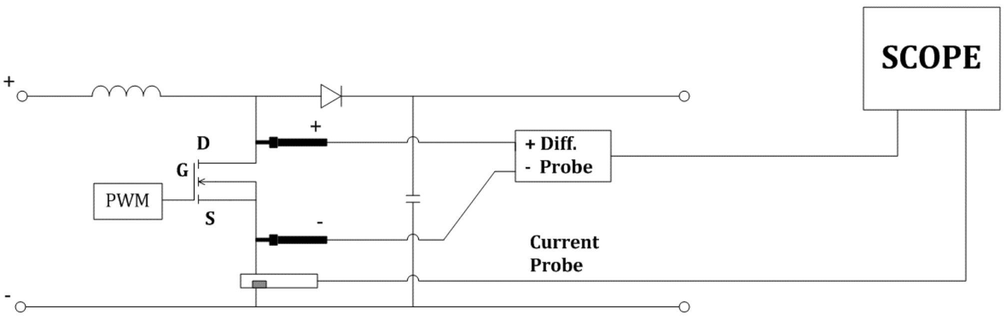
30.6 Slew Rate

When a rectangular pulse with steep rise and fall edges is applied to the input, it characterizes the maximum rate of output voltage variation per unit time. The following diagram provides the formal definition of slew rate.



Connection Guide

Click *Connection Guide* to recall the connection guide of the slew rate, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.

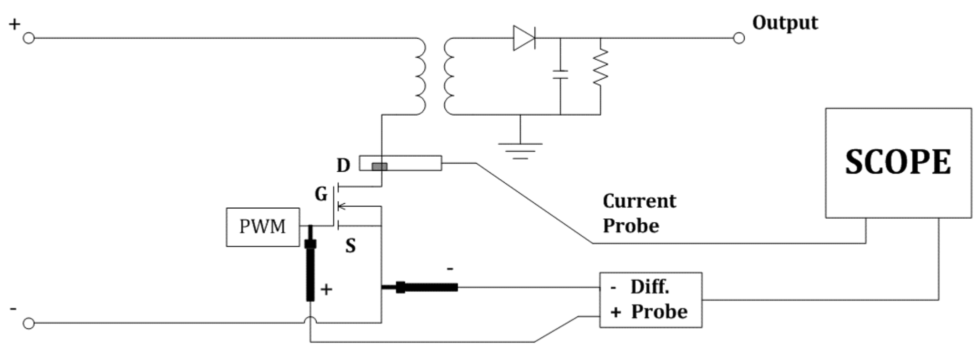


30.7 Modulation

Modulation analysis measures the control pulse signal of the switching device (MOSFET) and observes the pulse width, duty, period, frequency, and other trends of the control pulse signal in response to different events.

Connection Guide

Click *Connection Guide* to recall the connection guide of modulation, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.

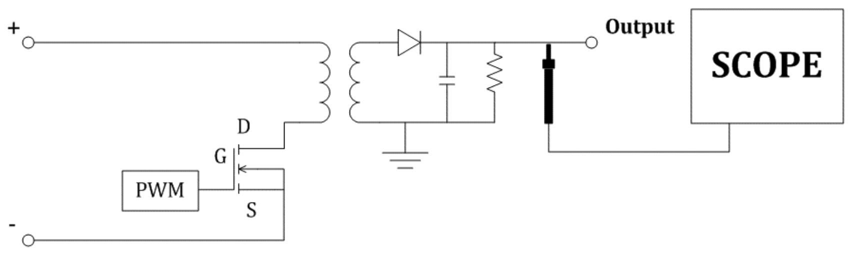


30.8 Output Ripple

Power supply ripple is an important parameter to evaluate DC power supply, which represents the quality of output DC voltage. Ripple analysis can measure the current value, average value, minimum value, maximum value, standard deviation, and count of the power supply output ripple.

Connection Guide

Click *Connection Guide* to recall the connection guide of output ripple, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.

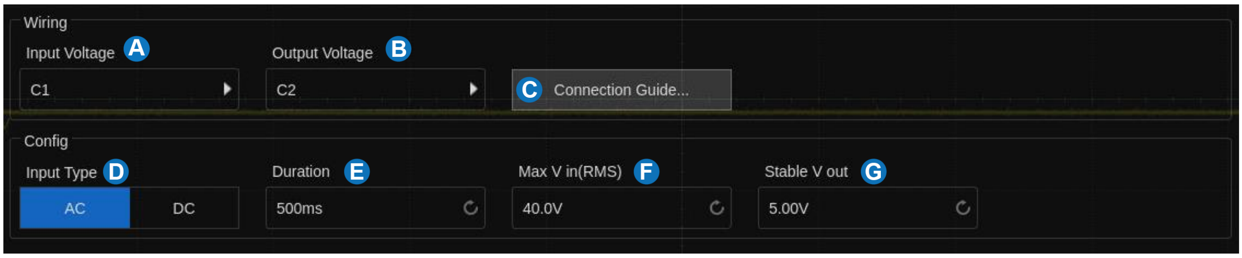


30.9 Turn On/Turn Off

Turn-on analysis determines the time taken for the power supply to reach 90% of its steady-state output. Turn-off analysis determines the time taken for the power supply to fall to 10% of its maximum output voltage.

Signal Settings

Click *Analysis* Input Setup to input setup dialog box:



A. Set the input voltage source

B. Set the output voltage source

C. View the connection guide

D. Set the input type (AC or DC).

E. Set the duration, the range is 5 ns ~ 20 s. The oscilloscope will set the timebase according to the value (duration / 14)

F. Set the maximum effective input voltage Vrms, the range is 1 V ~ 1 kV. The oscilloscope will set the vertical scale of the voltage channel to maximum input voltage / 7 and the trigger level to maximum input voltage / 10.

G. Set the stable output voltage value, the range is -30 V ~ 30 V. The oscilloscope will set the vertical scale of the output voltage channel to stable output voltage / 6

Testing Conditions

Turn On -- Determines the time taken for the power to reach a certain percentage of its steady-state output. The turn on time is between T2 and T1, where:

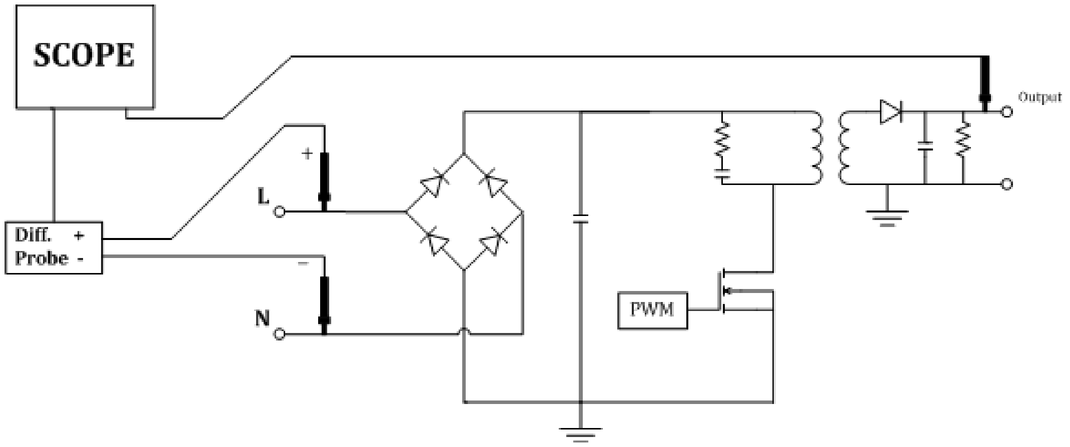
- T1 = When the input voltage first rises to a certain percentage (usually 10%) of its maximum amplitude
- T2 = When the output DC voltage rises to a certain percentage (usually 90%) of its maximum amplitude

Turn Off -- Determines the time it has taken for the power supply to be turned off to fall to a certain percentage of its maximum output voltage. The turn off time is between T2 and T1, where:

- T1 = When the input voltage finally falls to a certain percentage (usually 10%) of its maximum amplitude
- T2 = When the output DC voltage finally falls to a certain percentage (usually 10%) of its maximum amplitude

Connection Guide

Click Connection Guide to recall the connection guide of turn on/turn off, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.



30.10 Transient Response

Transient response analysis can determine the response speed of the output voltage of the power supply to the change of the output load. This time starts from the first time that the output voltage exits the stable band and ends at the last time that the output voltage enters the stable band.

Signal Settings

Click Analysis to recall input setup dialog box:

A. Set the output voltage source

B. Set the output current source

C. View the connection guide

D. Set the overshoot percentage of output voltage, which can be used to determine the stable band value of transient response and adjust the vertical scale of the oscilloscope

E. Set the input low current value. This is the expected low current value before or after the load change

F. Set the input high current value. This is the expected high current value before or after the load change

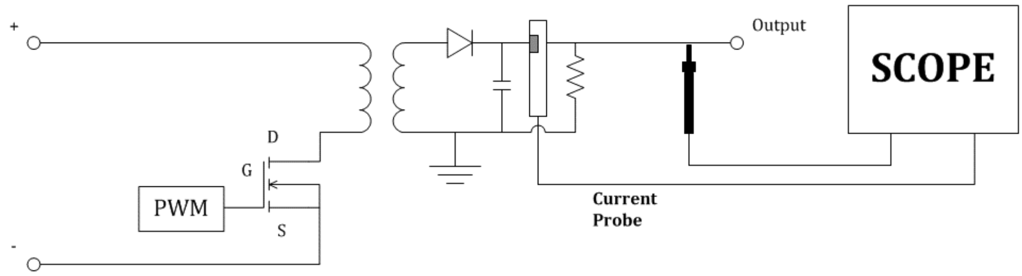
G. Set the duration. The oscilloscope will set the appropriate time base according to the duration

H. Set the stable output voltage, i.e. the expected output DC voltage of the power supply in a stable state

	Note: The low and high current values are used to calculate the trigger level and adjust the oscilloscope vertical scale. After the load changes, the current value changes from low to high (or from high to low), and the oscilloscope triggers and performs to measure the transient response stability time.

Connection Guide

Click *Connection Guide* to recall the connection guide of transient response, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.

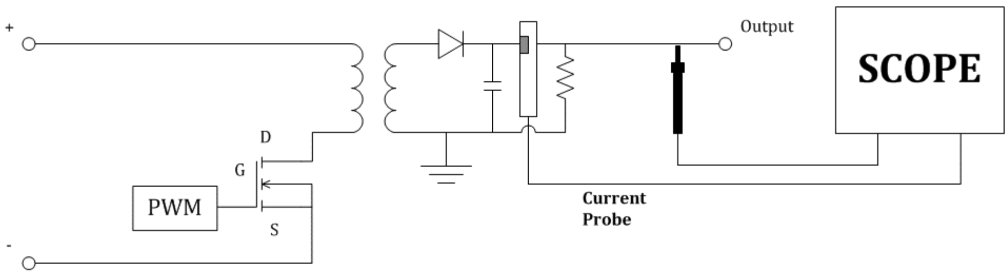


30.11 PSRR

The power supply rejection ratio (PSRR) test is used to determine how the regulator suppresses ripple noise in different frequency ranges. The oscilloscope controls the arbitrary waveform/function generator to output a sweep signal, which is used to introduce ripple into the DC voltage transmitted to the voltage regulator. Measure the AC RMS ratio of input to output, and plot the relationship between the ratio and frequency. The background noise of the oscilloscope is higher than that of the network analyzer, and the sensitivity is lower than that of the network analyzer, so the PSRR measured by the oscilloscope is difficult to exceed -60 dB. The PSRR test is generally acceptable for sampling the overall PSRR behavior of the power supply under test.

Connection Guide

Click *Connection Guide* to recall the connection guide of PSRR, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.

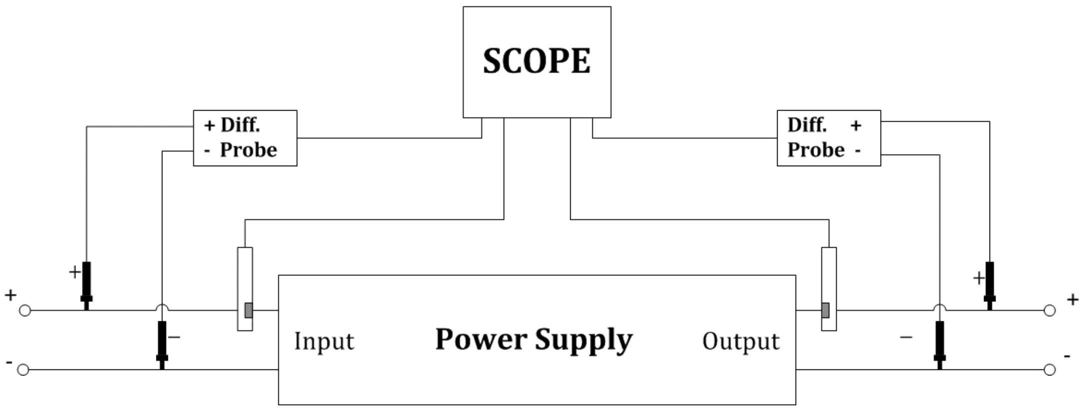


30.12 Power Efficiency

Power efficiency analysis can test the overall efficiency of the power supply by measuring the output power and input power.

Connection Guide

Click *Connection Guide* to recall the connection guide of power efficiency, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.

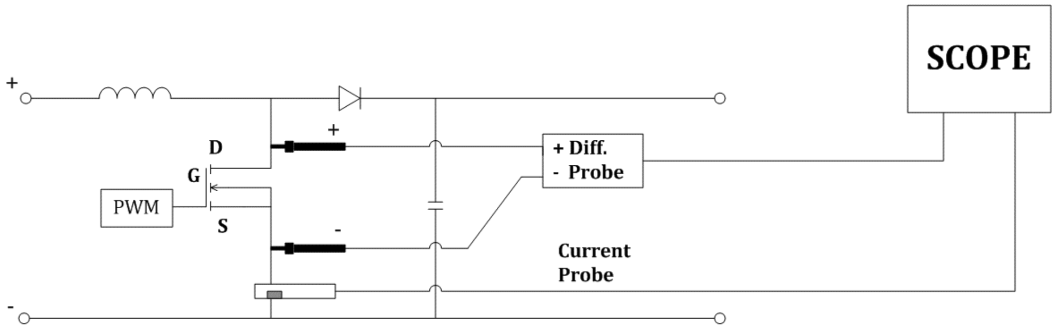


30.13 SOA

The safe operating area (SOA) of MOSFETs defines the voltage, current, and power consumption conditions over which the device can be expected to operate without self-damage. The oscilloscope can automatically generate the SOA according to the *Voltage Limit* , *Current Limit* , and *Power Limit* parameters set in the *Config* menu, and judge if the stress on the MOSFET is beyond the SOA or not. This helps designers quickly find a problem or latent risk in the circuit.

Connection Guide

Click *Input Setup* > *Connection Guide* to recall the connection guide of power efficiency, as shown in the figure below. Please follow the instructions in this figure for connection. Click the icon on the top right of the guide to close.

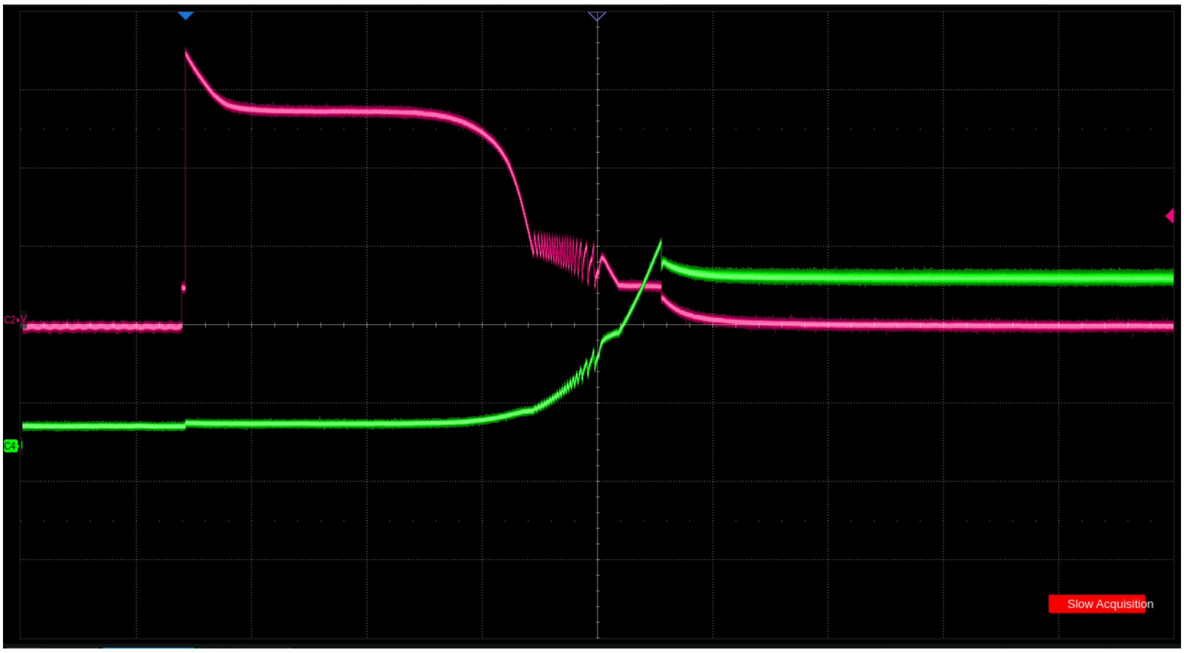


	Note: Perform a Deskew operation between the voltage and current input channels before the test. See the section "Switching Loss" for more details on deskewing.

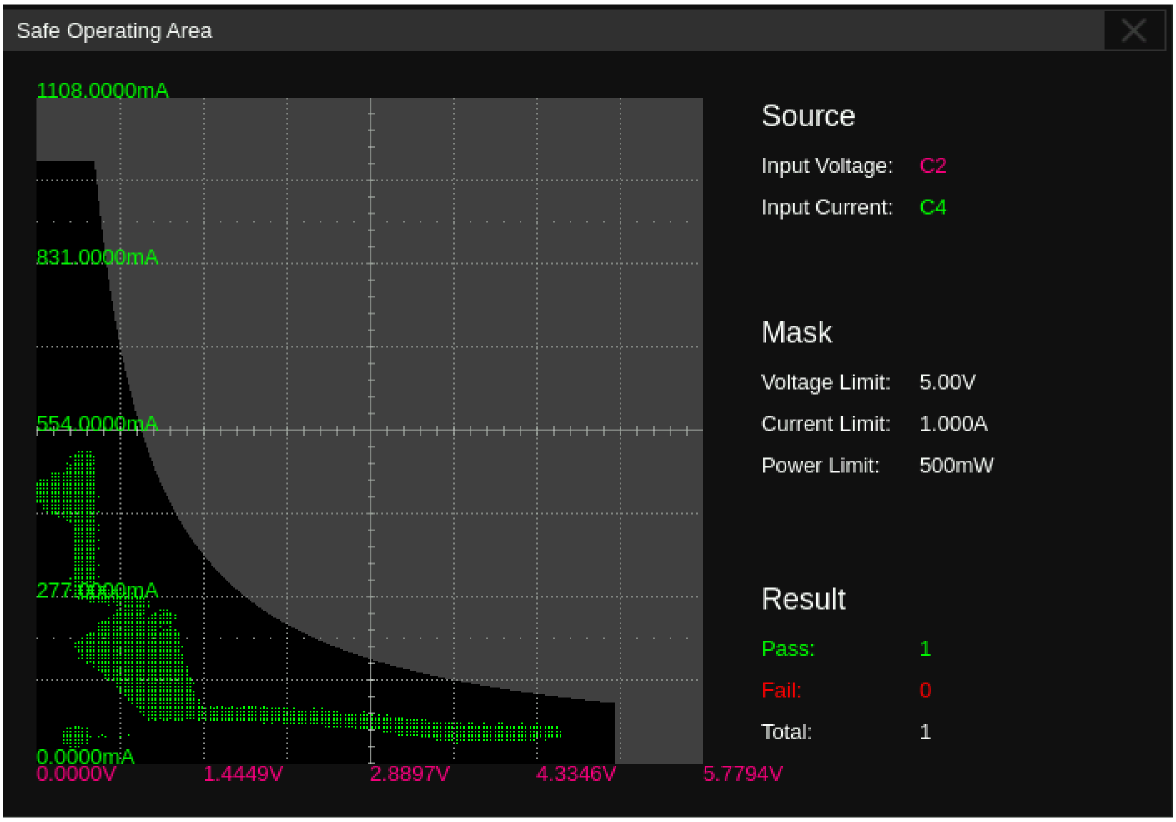
The test steps are as followed:

1. In the Wiring menu, assign the correct channels to *Input Voltage* and *Input Current*. Set *Duration* as the expected observed duration, then the oscilloscope will automatically set the timebase according to it.
2. In the *Config* menu set *Voltage Limit* , *Current Limit* , and *Power Limit* parameters according to the datasheet of the MOSFET device under test, then the oscilloscope will automatically generate the SOA and the vertical scale of the Input Voltage and Input Current channels according to them.
3. Turn on *Test State* . The oscilloscope will begin to acquire the voltage and current waveforms, and display the SOA measurement, showing if the measured stresses are in the SOA or not.
4. Users can adjust horizontal, vertical, and trigger settings during the test for the best observation.
5. Real-time adjustments to horizontal scale, vertical gain, and trigger conditions are permitted during operation to enhance signal analysis

Below is an example of testing the power-up stresses on a MOSFET and judging if the stresses are safe for the MOSFET using the SOA:



Voltage and current waveforms on the MOSFET at power-up



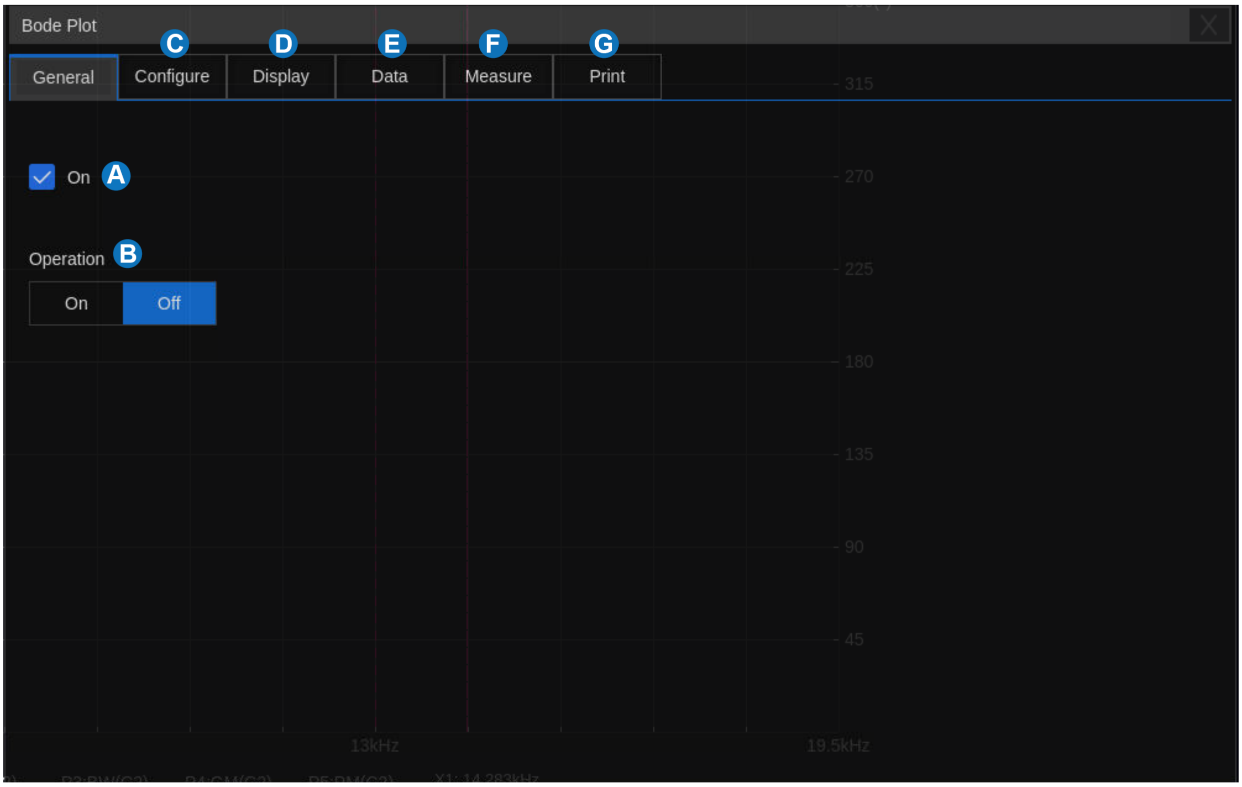
SOA, in which the mask is created according to the voltage limit, current limit, and power limit. The result shows “Pass” because all the stresses are within the mask.

31 Bode Plot

31.1 Overview

The device supports an automatic Bode plot function. This function provides a frequency response curve of the device-under-test as well as the interface for output sweep parameter control and data display settings. At this time, either the built-in waveform generator or one of the SIGLENT SDG series arbitrary function generators are supported. During the sweep, the oscilloscope configures the generator output frequency and amplitude and then compares the input signal to the output of the DUT. Gain (G) and phase (P) are measured at each frequency and plotted on the frequency response Bode plot. When the loop response analysis is complete, you can move the markers on the chart to see the gain and phase values measured at each frequency point. You can also adjust the scale and offset settings for the amplitude and phase plots.

Click *Analysis* > *Bode Plot* to recall the Bode plot dialog box:



A. Turn on/off the Bode plot

B. Turn on/off the operation

C. Configure the Bode plot (DUT, AWG connection, sweep parameters)

D. Set display parameters, including coordinate axis, trace visibility, and cursors

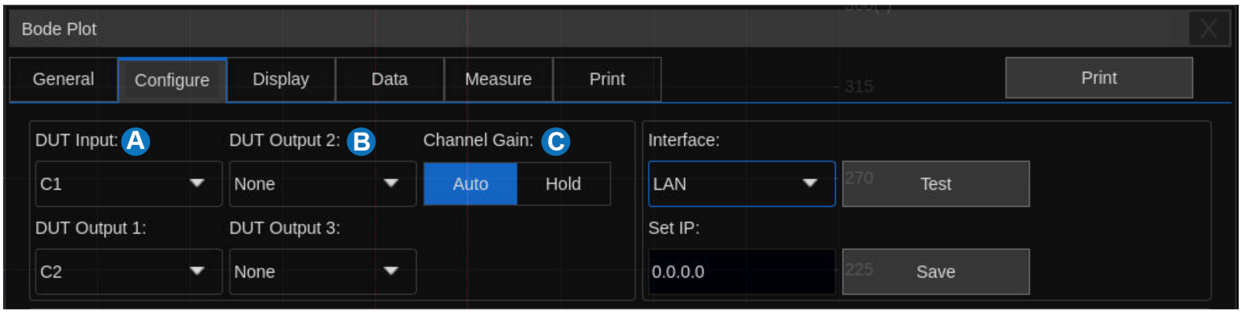
E. Data list. Open the data list of the Bode plot to view the curve data, save the data results to a U-disk or recall it from a U-disk

F. Set the measurement parameters. Parameter measurement of the scanning curve includes upper cut-off frequency (UF), lower cut-off frequency (LF), bandwidth (BW), gain margin (GM), and phase margin (PM)

G. Quickly print the specified Bode Plot waveform area to the storage

31.2 Configuration

31.2.1 Connection



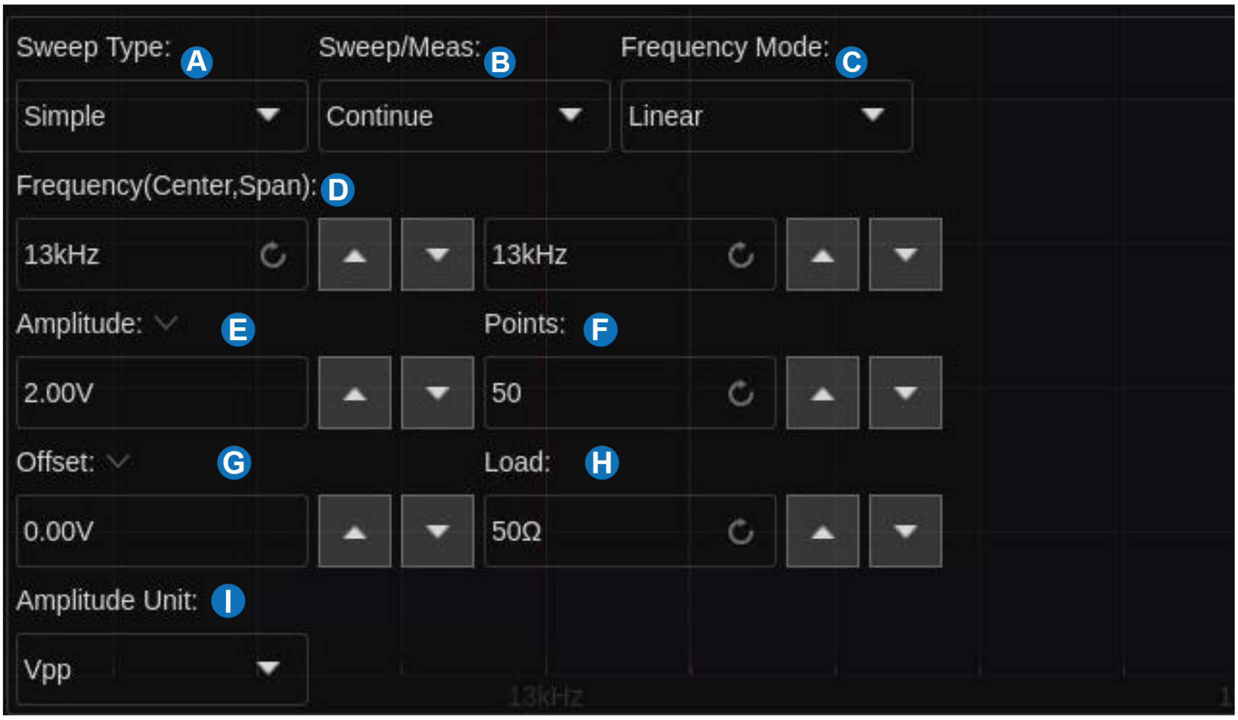
A. DUT input and output channels

B. Channel gain. When it is set to Auto, the oscilloscope will automatically adapt the vertical scale according to the signal amplitude; when it is set to Hold, it will always keep the vertical scale before the test operation

C. Arbitrary waveform generator connection settings. Click *Interface* to select the connection type. When selecting LAN, it needs to *Set IP* and *Save* it. Click *Test* to confirm whether the arbitrary waveform generator is connected correctly

31.2.2 Sweep

Click *Configure* to select the sweep type. There are two types: Simple and Variable level.



A. Set the sweep type

B. Set the sweep/meas as continue or single

C. Set the sweep frequency. The frequency mode can be linear or logarithmic. When it is set to linear, the corresponding center frequency and span frequency need to be set; when it is set to a logarithmic, the corresponding start frequency and stop frequency need to be set

D. Set the scanning signal frequency

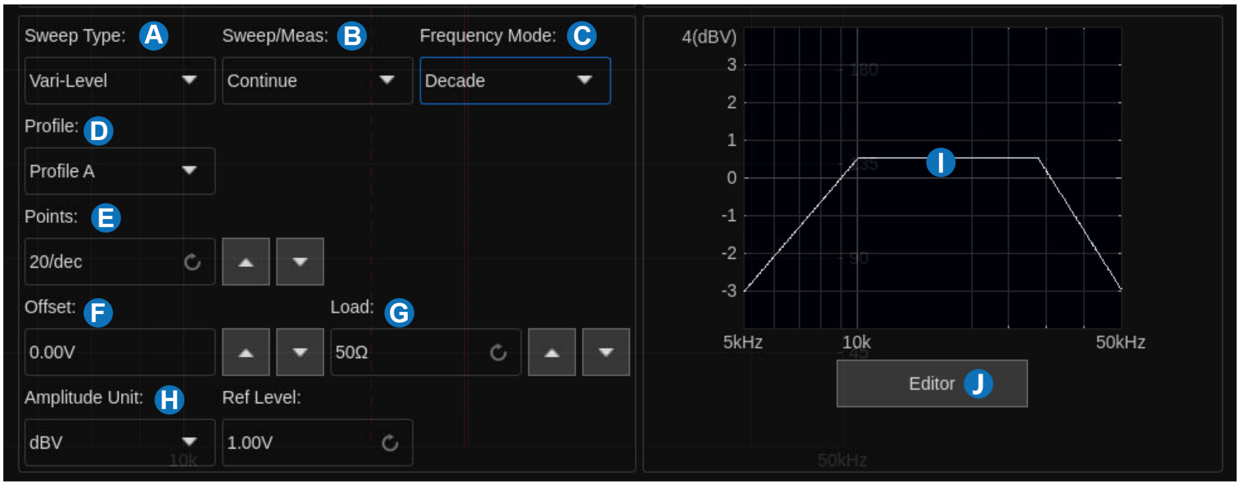
E. Set the amplitude of the sweep signal

F. Set the number of sweep points. The larger the number of points, the higher the sweep resolution

G. Set the offset of the sweep signal

H. Set the load

I. Set the signal amplitude unit. When it is set to dB, the reference level and load need to be set



A. Set the sweep type to Vari-Level

B. Set the sweep/meas as Continue or Single

C. Set the frequency mode

D. Select a profile. Up to 4 profiles can be edited

E. Set the number of sweep points

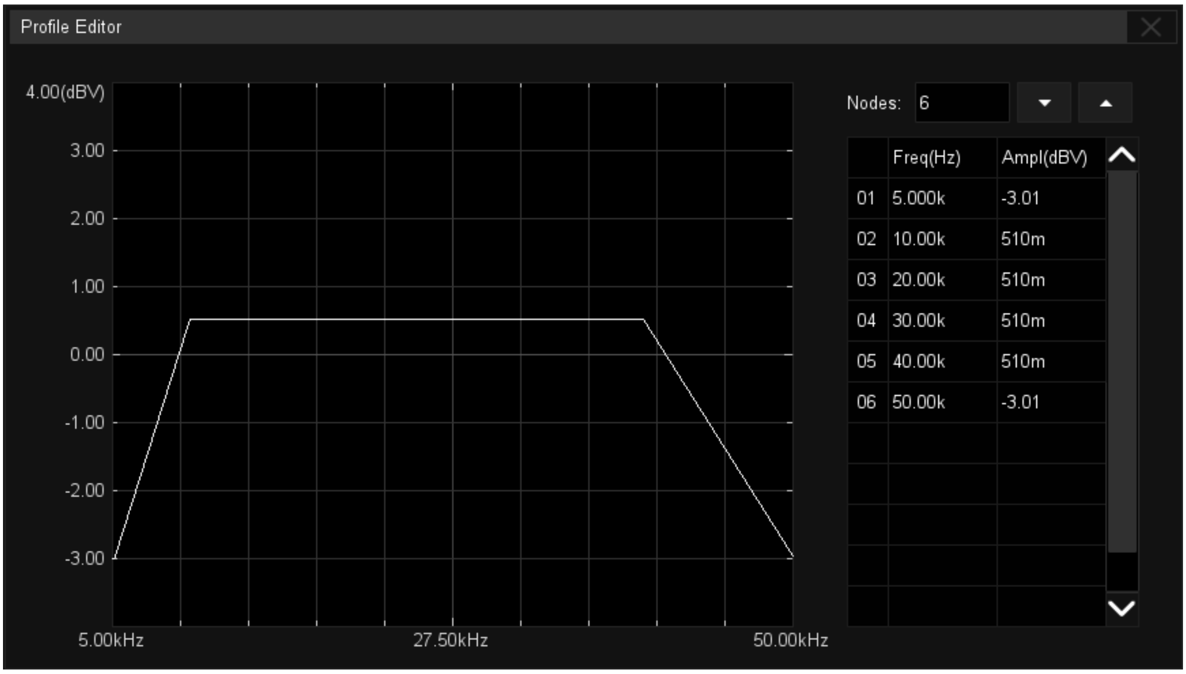
F. Set the offset of the sweep signal

G. Set the load

H. Set the signal amplitude unit. When it is set to dB, the reference level and load need to be set

I. Variable level signal display area

J. Click *Editor* to turn on the profile editor



Click *Nodes* to set the signal node number through the mouse wheel, or click ▲ to increase the nodes and ▼ to decrease.

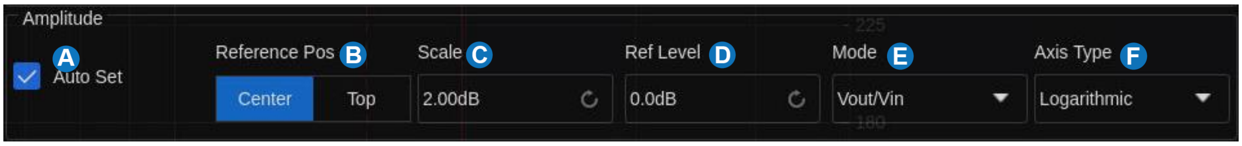
Click the cell in the table area to set the frequency and amplitude of the corresponding node. Click to activate the cell, adjust the value through the mouse wheel, or click the cell again to call up the virtual keypad for setting.

31.3 Display

Bode plot display settings include amplitude, phase, cursors, and trace visibility.

Amplitude

Set the amplitude coordinate axis of the Bode plot. Click *Display* > *Amplitude* to recall the amplitude setting dialog box:



A. Auto-Set. According to the output signal amplitude curve, the oscilloscope automatically sets the scale and reference level

B. Set the reference position to the center or top

C. Set the scale of the amplitude coordinate axis

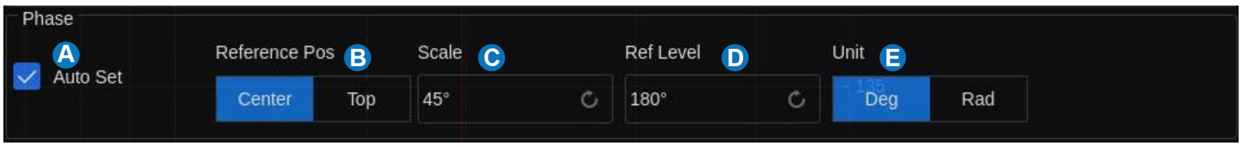
D. Set the reference level, the max value of the amplitude coordinate axis

E. Set the amplitude mode. Set to Vout to display the amplitude value of the output signal; set to Vout/Vin to display the amplitude ratio of the output signal to the input signal

F. When the mode is Vout, it needs to set the unit (Vpp, Vrms, dBV, dBu, dBm, or Arbitrary dB); when the mode is Vout/Vin, it needs to set the amplitude axis type (Linear or Logarithmic).

Phase

Set the phase coordinate axis of the Bode plot. Click *Display* > *Phase* to recall the phase setting dialog box:



A. Auto Set. According to the output signal phase curve, the oscilloscope automatically sets the scale and reference level

B. Set the reference position to the center or top

C. Set the scale of the phase coordinate axis

D. Set the reference level, the max value of the phase coordinate axis

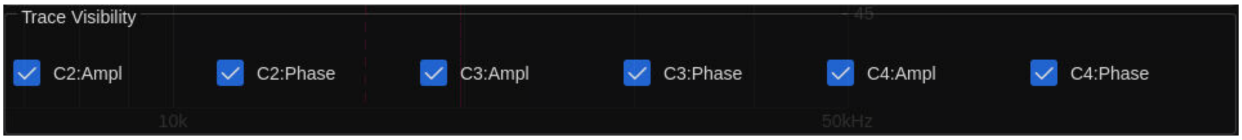
E. Set the phase unit (Degree or Rad)

Cursors

The device can use the cursor to measure the Bode plot curve. The cursor of the Bode plot is similar to the ordinary cursor, see the chapter "Cursors" for details. Click *Display* > *Cursors* to recall the cursor setting dialog box.

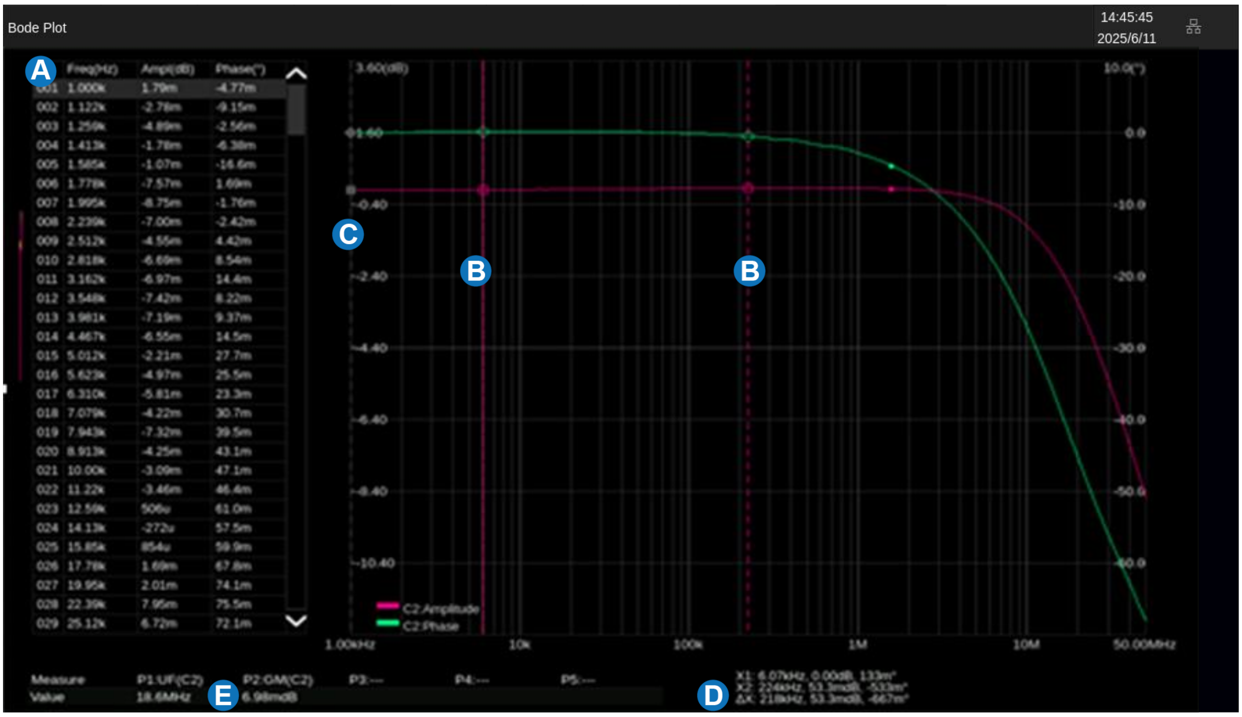
Trace Visibility

When multiple output signals are connected, the Bode plot interface will display the amplitude and phase curves of all output signals at the same time. Users can turn on/off other scanning curves to observe the details of specific curves. Click *Display* > *Trace Visibility* to recall the setting dialog box.



31.4 Data Analysis

With the data list, cursor measurement, and automatic measurement functions, the Bode plot curve can be analyzed in detail. The data list provides the raw values for each point. The cursors can be used to flexibly measure the change of each position of the curve. The automatic measurement function can be used to measure the five parameters of the Bode plot curve: upper cut-off frequency (UF), lower cut-off frequency (LF), bandwidth (BW), gain margin (GM), and phase margin (PM).



A. Data list display area

B. Cursors

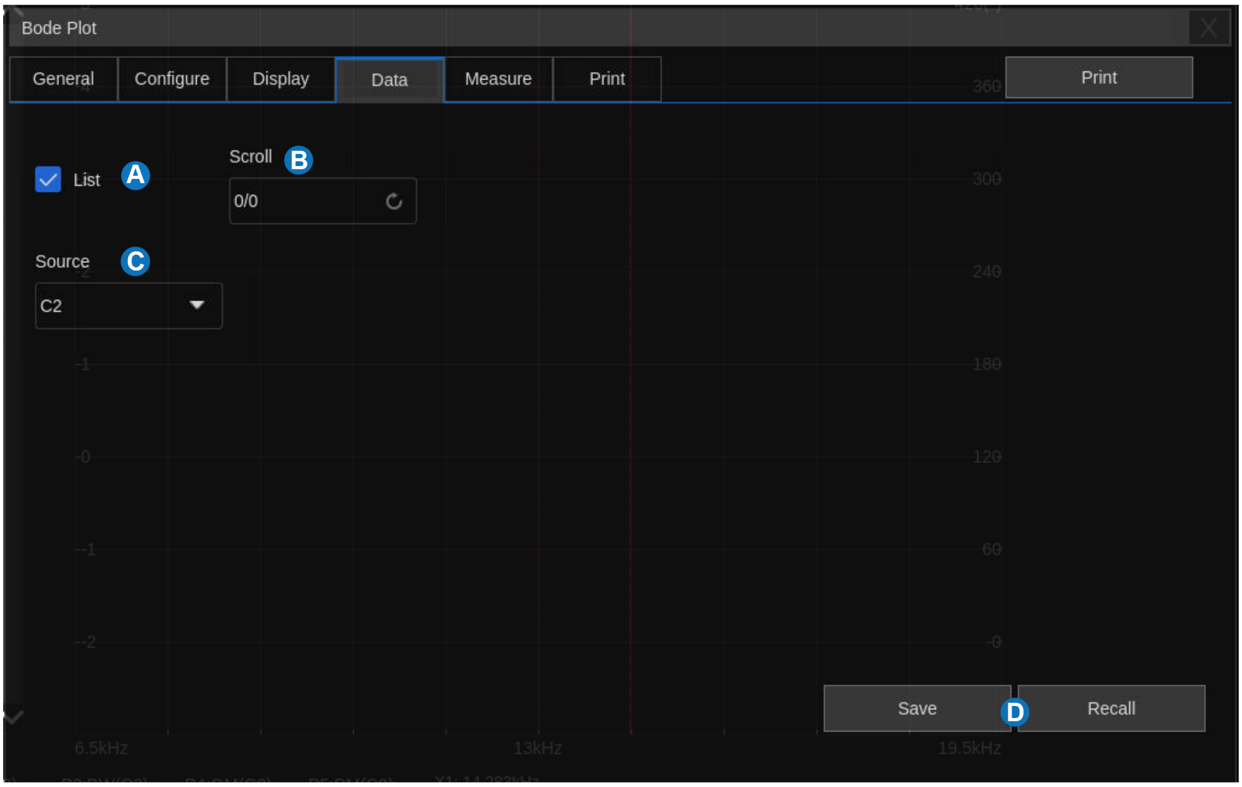
C. Data point location line

D. Cursor information display area

E. Measurement parameters display area

Data List

Click *Data* to recall the data setting dialog box:



A. Turn on/off the data list

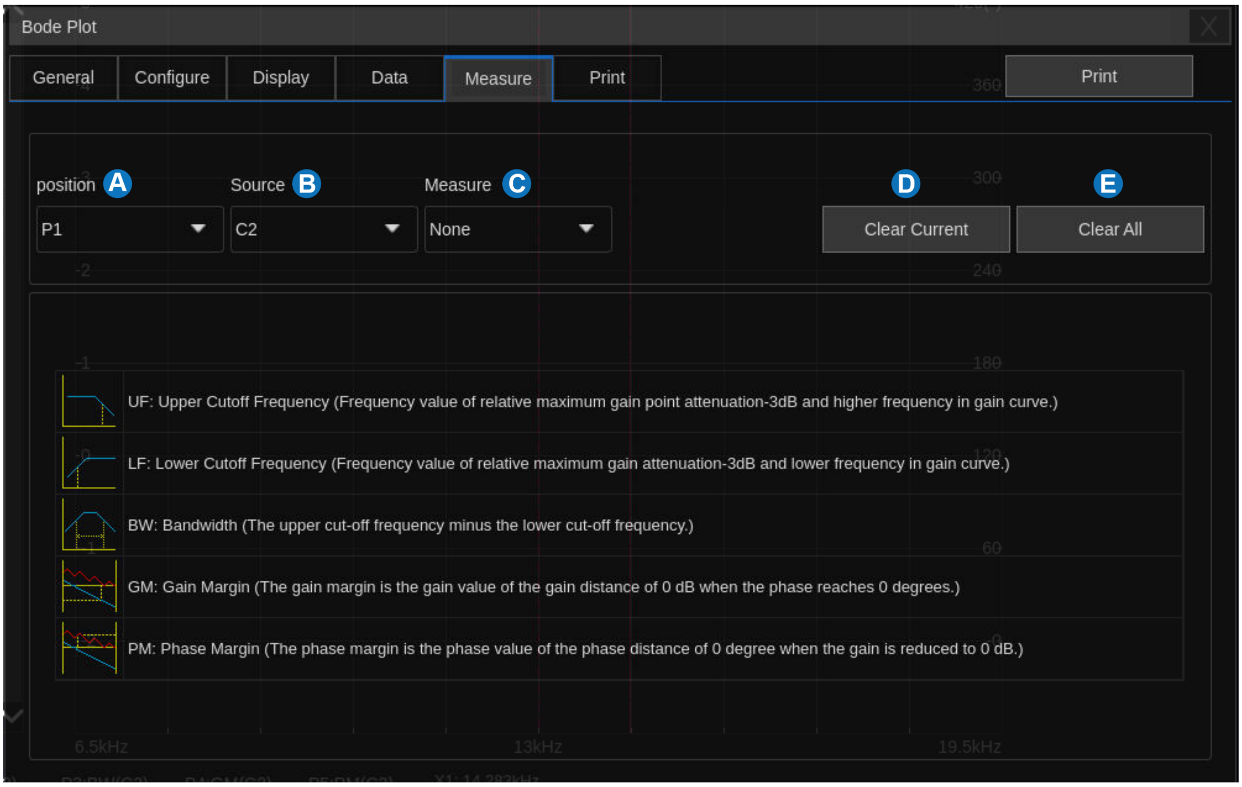
B. Set the selected row in the list. Adjust the mouse wheel to set, or directly click the list display area to select a specific line

C. Set the data source

D. Save/Recall the data. Saving and recalling the Bode plot data (*.csv) is similar to the operation of setup files, see the chapter "Save/Recall" for details

Measure

Click *Measure* to recall the measure setting dialog box:



A. Set the position of measurement items, and support 5 measurement items at most

B. Set the measurement source

C. Measurement parameter area. Click each parameter area to activate the measurement parameter. In the figure above, "UF" is activated

D. Clear the current measurement

E. Clear all measurements

For example, to add UF measurements for C2 and GM measurements for C3, follow the steps below:

Measure > *Position* > *Source* > *UF*

Measure > *Position* > *Source* > *GM*

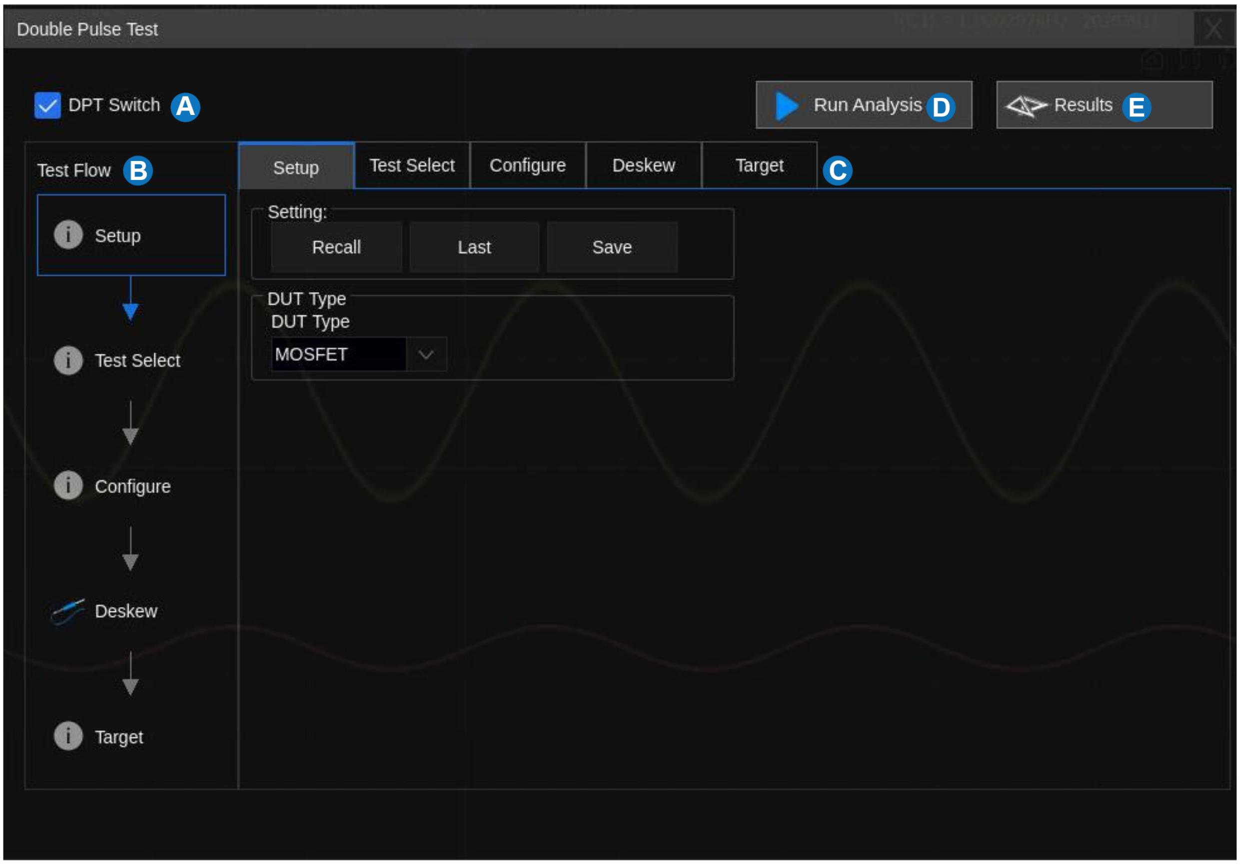
32 Double Pulse Test

32.1 Overview

The Double Pulse Test is a commonly used method for analyzing the dynamic characteristics of power switching devices such as MOSFETs and IGBTs. Through this test, the performance of power devices can be conveniently evaluated, key parameters during steady-state and dynamic processes can be obtained, and device performance can be better assessed to optimize drive design, among other applications. To perform the double pulse test, the following equipment is required:

- **High-voltage power supply (SPS6000X series):** A programmable switching DC power supply with a wide range of single output and constant power features. The feature rated output voltages and currents of 200 V / 25 A, with a maximum output power of 1500 W.
- **DC power supply for gate drive circuit (SPD4000X series):** This series consists of three models with up to four independent outputs with rated output voltage values of 32V, 12V, or 30V and the total output power of 240W, 285W or 400W. The minimum resolution can be set to 1mV/1mA.
- **Double Pulse Generator for gate drive circuit (SDG1000X Plus series):** Equipped with multi-pulse output, it can generate at least two different pulse widths. These pulses can be output as drive signals to the gate of the driver circuit to trigger power devices.
- **High-voltage differential probe (Siglent DPB series):** Used to measure high-side or low-side Vds. The DPB5000 series high voltage differential probes are designed for the measurement of high voltage differential signal, to meet the demand for floating measurement. The bandwidth can be as high as 100MHz, meeting the demand for majority of measurement systems.
- **Current probe (Siglent CP series):** Used to measure high-side or low-side Id and high-side Irr. The CP5000 series uses a combination of Hall effect and transformer technology which enables measurements to be made on DC, AC and impulse currents. It's key features include highly accurate current measurements, wide bandwidth, easy current measurements,DC/AC measure, over-current protected and indication(buzzer and LED indicator), double ranges selection,low current measurements, degauss and auto zero function.
- **Passive probe:** Used to measure high-side or low-side Vgs.
- **Siglent DF2001A deskew fixture:** Used to correct the skew between the oscilloscope channels or probes

Perform *Analysis* > *Double Pulse Test...* to recall the dialog box:



A. Turn on/off the DPT function

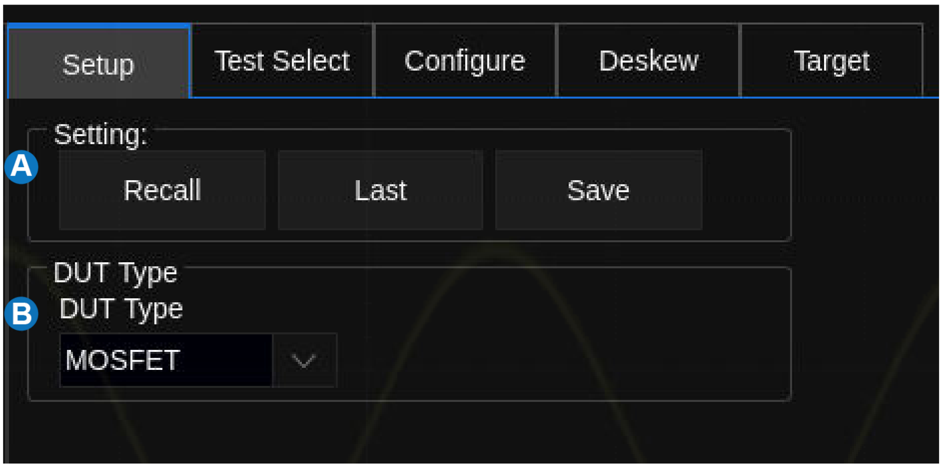
B. Test flow, click on each step to enter the corresponding settings menu

C. Test configuration tab

D. After setting the configuration, click to execute the analysis

E. View result and generate a report saved to internal or external storage

Switch to *Setup* tab to open the setup dialog box

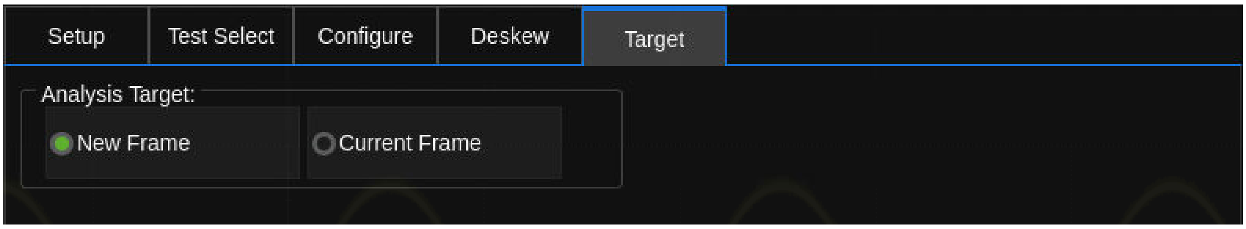


A. Recall or Save settings, including: DUT type, selected items, and configuration for each item. Click

Recall to enter the file manager and select a saved setting to load. Click *Last* to directly recall the settings from the previous analysis execution. Click *Save* to store the current setting to internal or external storage.

B. Select the type of switching device under test (DUT): MOSFET or IGBT.

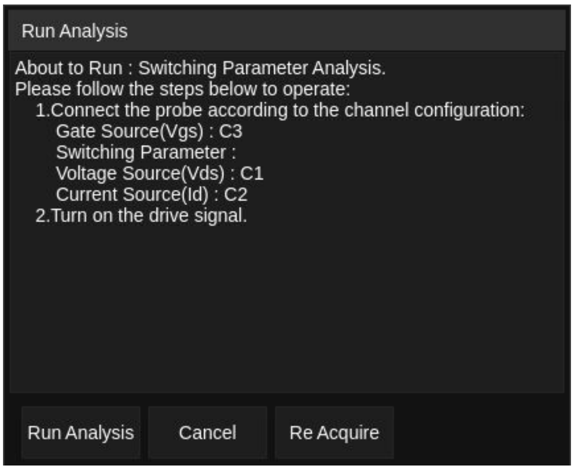
After completing the test selection and configuration in the "Test Item Configuration" section, switch to *Target* tab to set the analysis waveform frame:



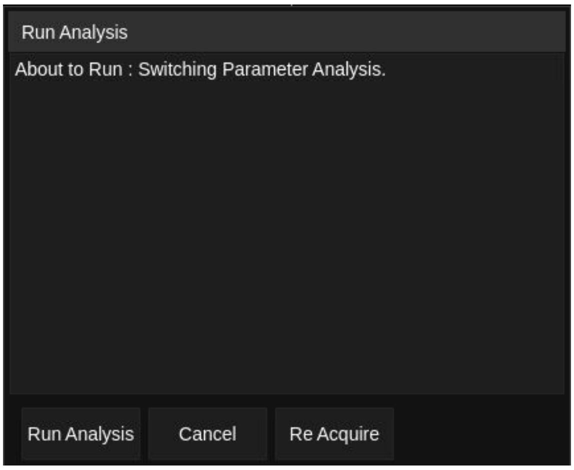
New frame: The oscilloscope automatically sets up to capture waveforms based on the selected item configuration, and then performs analysis.

Current frame: The user manually captures waveforms based on the selected item configuration, and then performs analysis.

Click *Run Analysis* , please follow the prompts step by step to operate:



Analysis “New Frame”

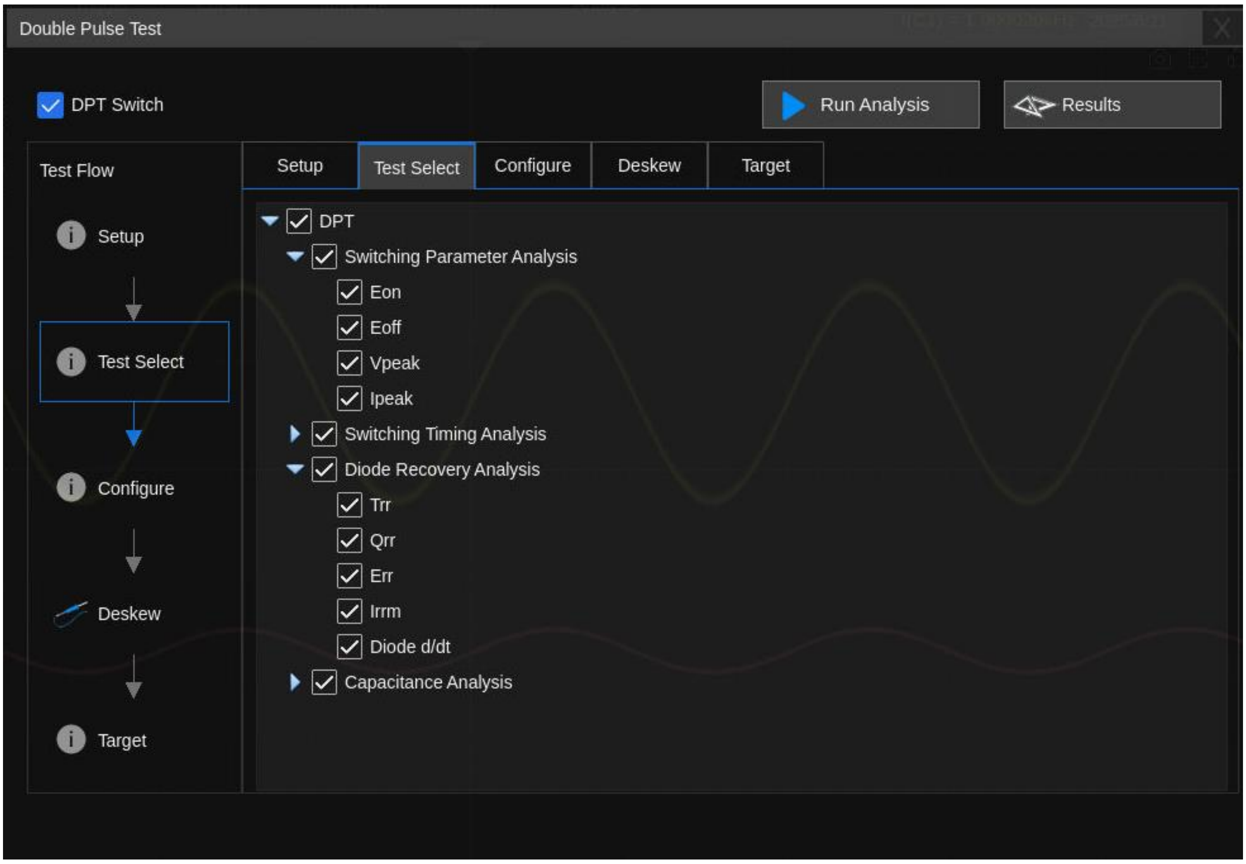


Analysis “Current Frame”

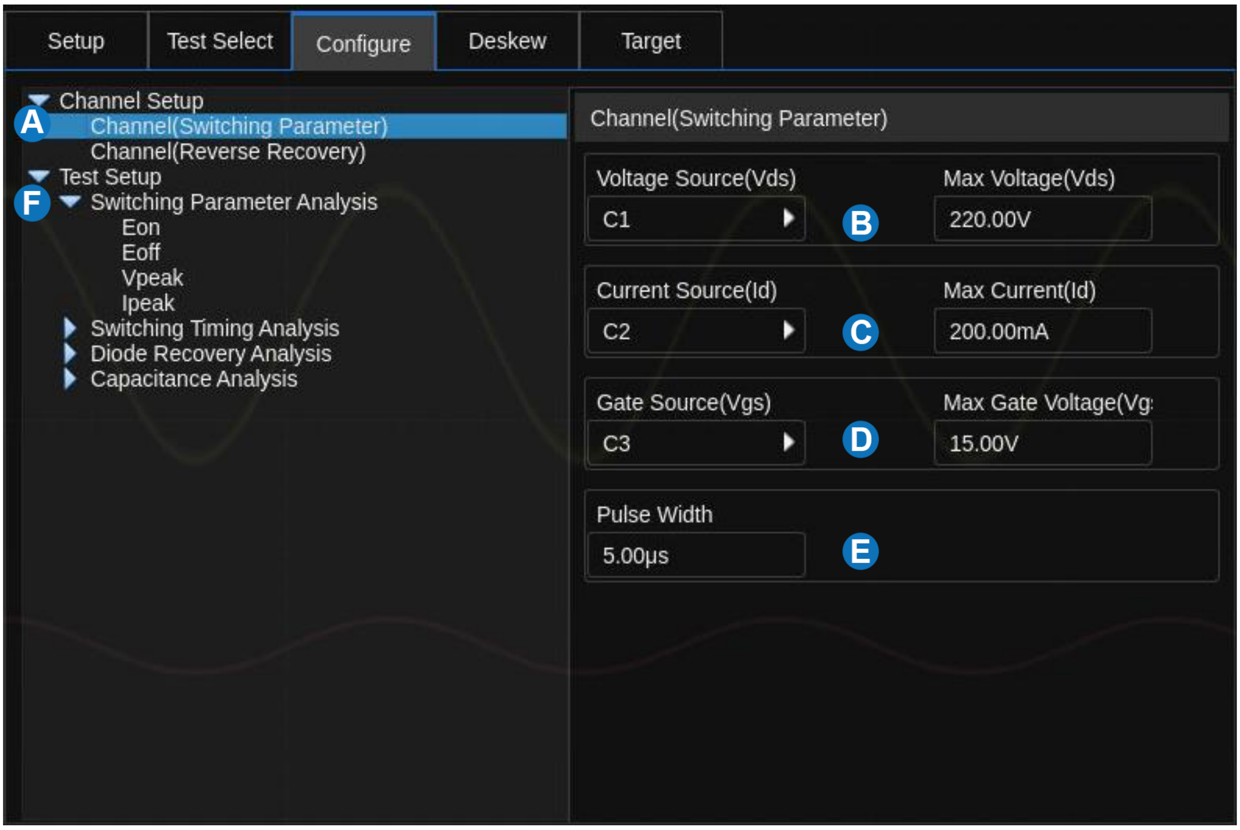
32.2 Test Item Configuration

The double pulse test supports the following test items: switching parameters, switching timing, diode recovery, and capacitance.

Switch to *Test Select* tab and check the test items.



Switch to *Configure* tab, and then click *Channel Setup* to open the channel setup dialog:



A. Channel setup. The oscilloscope will perform automatic measurements based on these settings. Only single-side switching parameter analysis is supported. Adjust the test wiring as needed.

B. Set drain-source voltage(Vds) channel and the maximum Vds. When the analysis target is "New Frame", the oscilloscope will adjust the vertical parameters of the Vds channel based on the maximum Vds.

C. Set drain current(Id) channel and the maximum Id. When the analysis target is "New Frame", the oscilloscope will adjust the vertical parameters of the Id channel based on the maximum Id.

D. Set gate-source voltage(Vgs) channel and the maximum Vgs. When the analysis target is "New Frame", the oscilloscope will adjust the vertical and trigger parameters of the Vgs channel based on the maximum Vgs.

E. Set drive signal pulse width. When the analysis target is "New Frame", the oscilloscope will adjust the horizontal timebase based on the pulse width setting.

F. Selected test items will be highlighted here. Click to configure measurement parameters. Different test items may require different configurations, refer to the following sections for details.

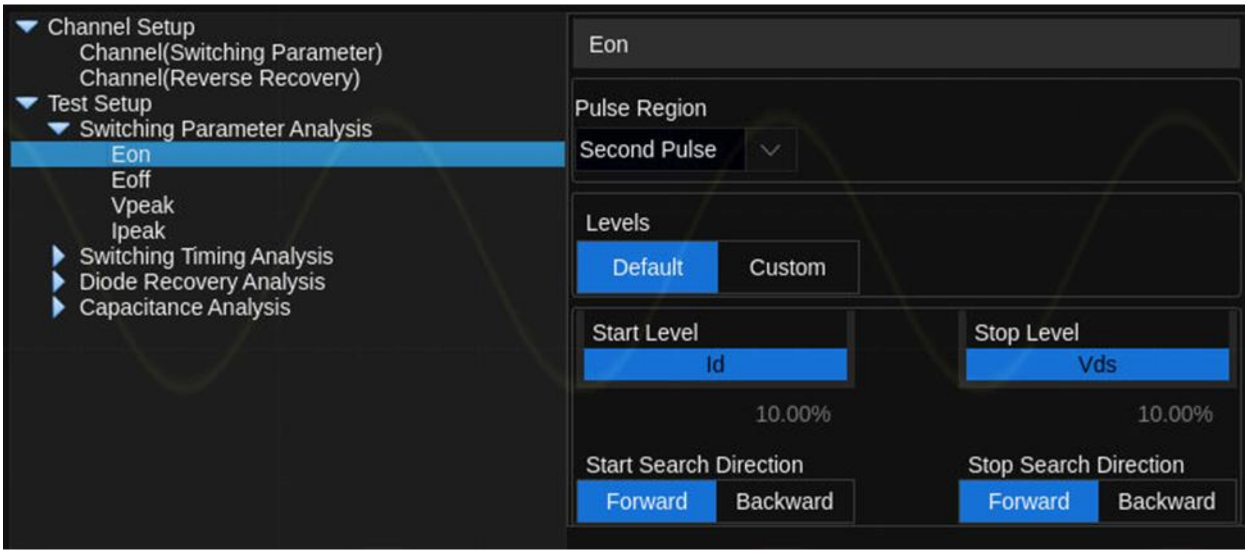
32.2.1 Switching Parameter Analysis

Includes the following measurement items:

Eon -- Measures the energy dissipated by the power device during turn-on. By default, measured on the second pulse width as defined by the standard.

MOSFET Eon: Integral of the power waveform calculated from 10% of Id to 10% of Vds under turn-on conditions or specified levels.

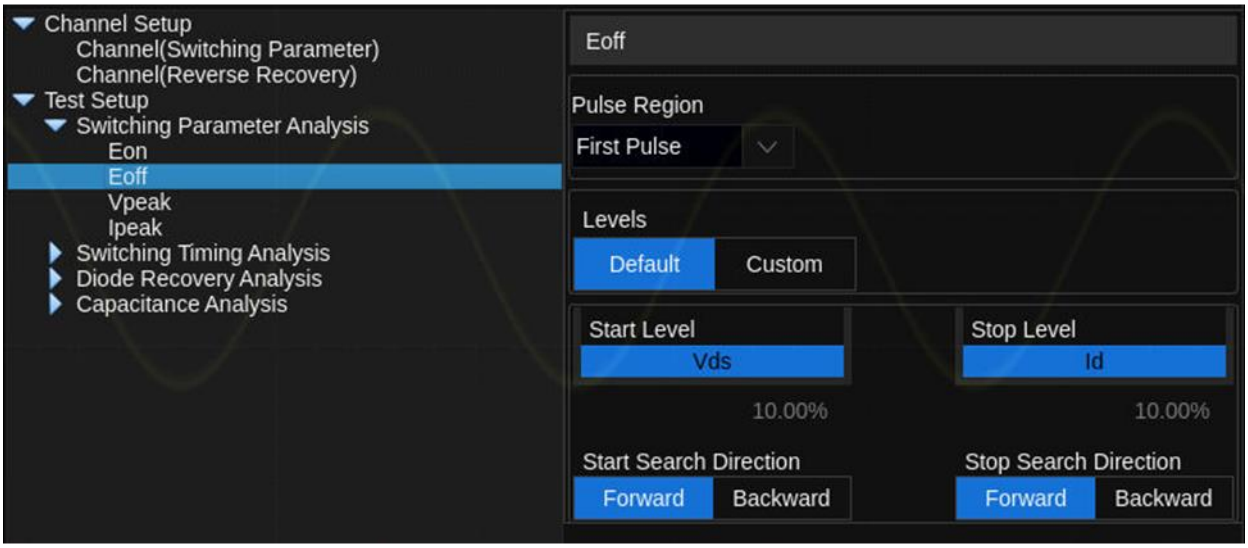
IGBT Eon: Integral of the power waveform calculated from 10% of Vge to 2% of Vce under turn-on conditions or specified levels.



Eoff -- Measures the energy dissipated by the power device during turn-off. By default, measured on the first pulse width as defined by the standard.

MOSFET Eoff: Integral of the power waveform calculated from 10% of Vds to 10% of Id under turn-off conditions or specified levels.

IGBT Eoff: Integral of the power waveform calculated from 90% of Vge to 2% of Ic under turn-off conditions or specified levels.



Vpeak -- Measures the peak voltage during turn-off. Configuration is the same as Eoff.

Ipeak -- Measures the peak current during turn-on. Configuration is the same as Eon.

32.2.2 Switching Timing Analysis

Includes the following measurement items:

Td(on) -- Measures the turn-on delay time of the power device. Configuration is the same as Eon.

MOSFET Td(on): Time interval between Vgs increasing to 10% and Vds decreasing to 90% under turn-on conditions.

IGBT Td(on): Time interval between Vge increasing to 10% and Ic increasing to 10% under turn-on conditions.

Td(off) -- Measures the turn-off delay time of the power device. Configuration is the same as Eoff.

MOSFET Td(off): Time interval between Vgs decreasing to 90% and Vds increasing to 90% under turn-off conditions.

IGBT Td(off): Time interval between Vge decreasing to 90% and Ic increasing to 90% under turn-off conditions.

Tr -- Measures the rise time during turn-on. Configuration is the same as Eon.

MOSFET Tr: Time interval between 90% and 10% of Vds under turn-on conditions.

IGBT Tr: Time interval between 10% and 90% of Ic under turn-on conditions.

Tf -- Measures the fall time during turn-off. Configuration is the same as Eoff.

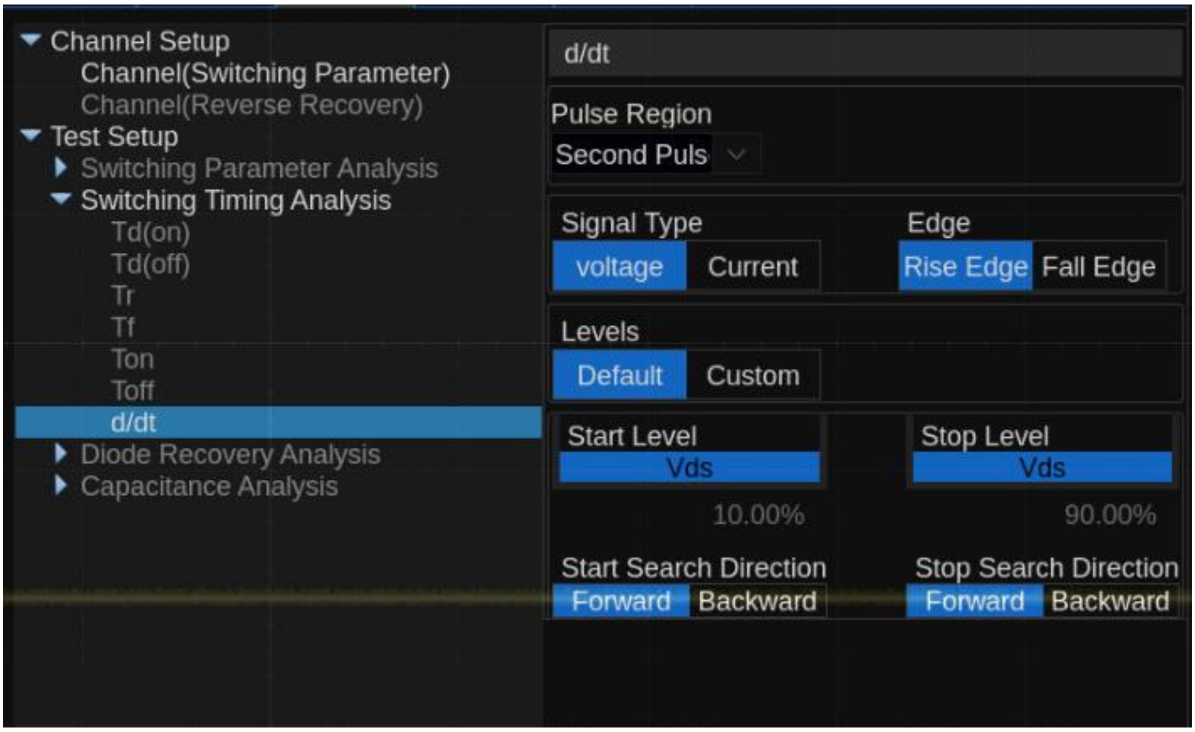
MOSFET Tf: Time interval between 10% and 90% of Vds under turn-off conditions.

IGBT Tf: Time interval between 90% and 10% of Ic under turn-off conditions.

Ton -- Measures the total turn-on time: Ton = Td(on) + Tr. Configuration is the same as Eon.

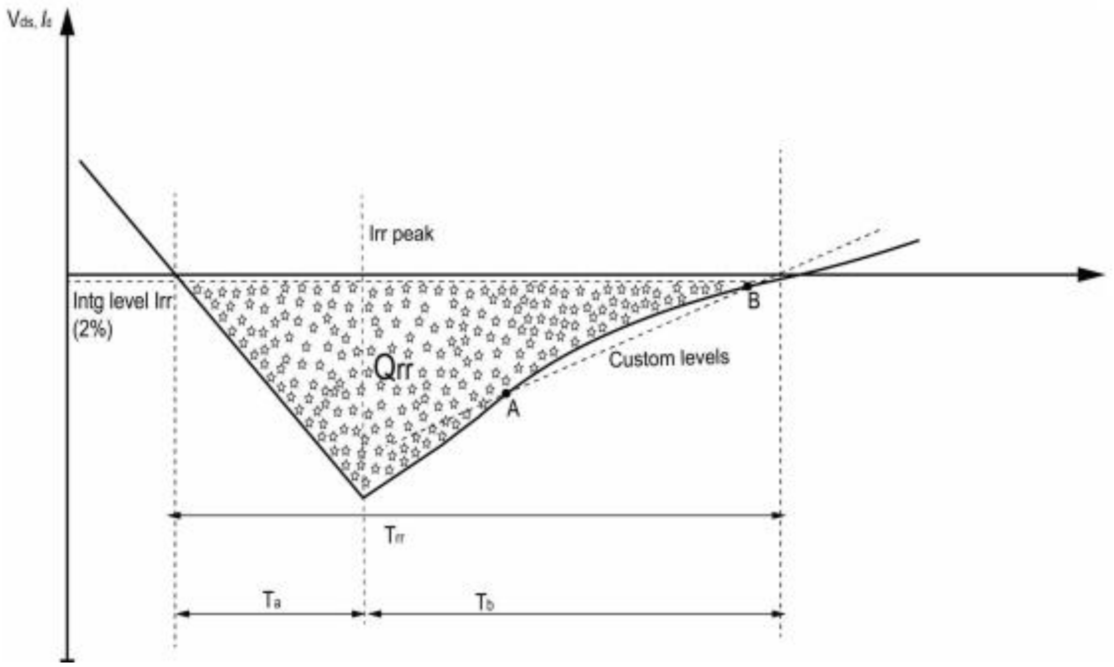
Toff -- Measures the total turn-off time: Toff = Td(off) + Tf. Configuration is the same as Eoff.

d/dt -- Measures the slew rate of Vds or Id between specified levels.



32.2.3 Diode Recovery Analysis

Includes the following measurement items:



Trr -- Measures the reverse recovery time using configured levels.

Trr as the time interval between the instant when the current passes through zero when chaging from the forward deirection to the reverse direction and the instant when extrapolated reverse current between A and B points reaches zero. Composed of two intervals, Ta (the reverse recovery current from zero to maximum reverse peak IRM) and Tb (reverse recovery current (or extrapolated current) return to zero from the reverse peak value).

Qrr -- Measures the total recovered charge using configured voltage levels.

Qrr as the total charge recovered when the power device switches from a specified forward current to a reverse voltage condition with forward-biased gate.

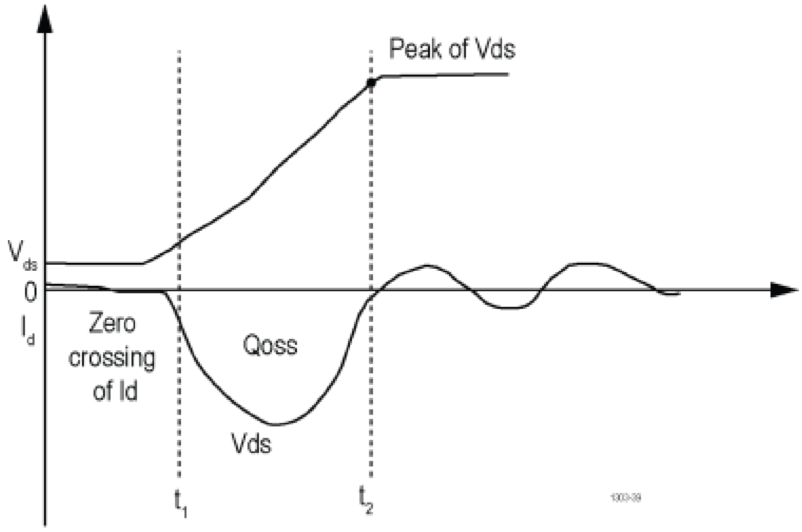
Err -- Measures the energy dissipated during reverse recovery using configured voltage levels.

Irrm -- The maximum reverse current during the reverse recovery interval.

Diode d/dt – Measures the slew rate of reverse recovery voltage or current between specified levels The diode d/dt can be measured during the rising or falling edge period.

32.2.4 Capacitance Analysis

Qoss -- Measures the charge required to supply the parasitic output capacitance of the power device per switching cycle.



$$Qoss = -\int_{t_1}^{t_2} i_r(t)dt$$

t1: The instant when current crosses zero.

t2: Specified time interval (preferably when Vds reaches 90% of peak voltage).

32.3 Deskew Calibration

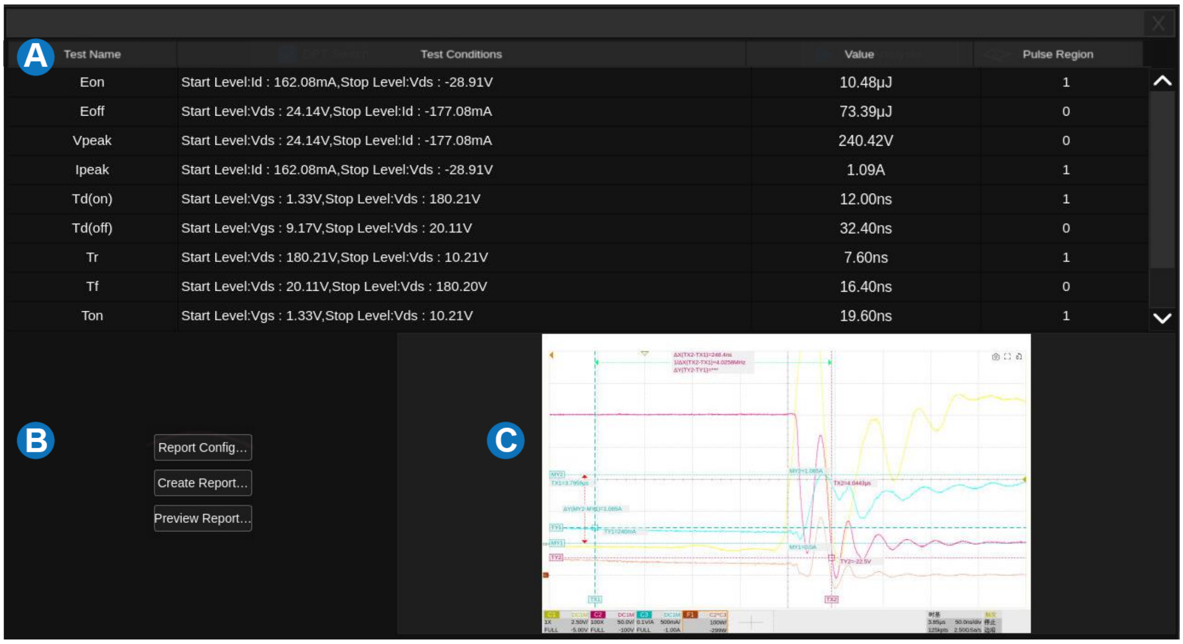
A relatively small skew can cause a large measurement error of switching loss. To correct the skew between the oscilloscope channels or probes, the deskew procedure should be performed once initially, and re-run when any part of the hardware setup changes (for example, a different probe, different oscilloscope channel, etc.) or when the ambient temperature changes.

For MOSFETs, calibrate skew between Vds channel and Id channel. For IGBTs, calibrate skew between Vce channel and Ic channel.

Use the DF2001A deskew fixture for deskew procedures. Refer to the "Switching Loss" section for detailed.

32.4 Results View

After completing the test analysis, click *Results* in the dialog to check the test data.



A. Test Item Display Area. Provides an overview of test conditions, values, and test pulse regions.

B. Report Settings Configure report generation options.

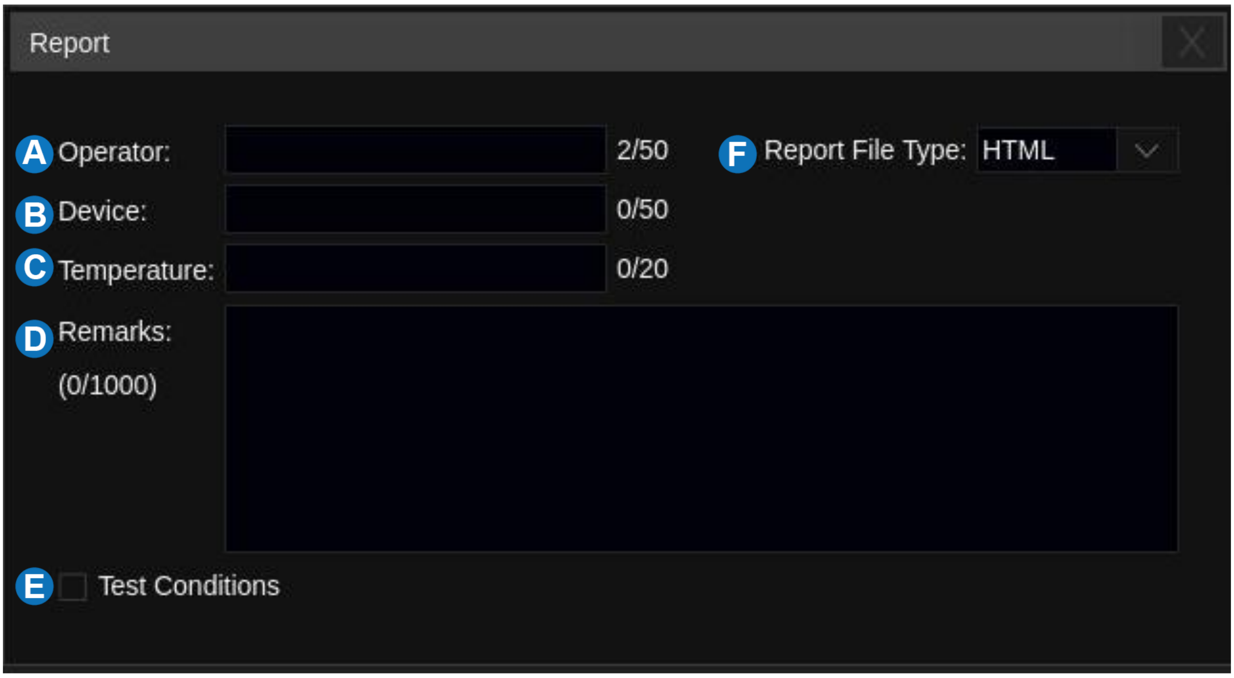
C. Screenshot Display Area . Click a test item to view its waveform screenshot. Click the image to zoom in for detailed inspection.

Each new analysis overwrites previous results. To save results, generate a report:

Click *Report Config...* then edit test information in the dialog.

Click *Greate Report...* to select a save path.

Click *Preview Report...* to view the full report on the oscilloscope.



A. Enter the tester name.

B. Enter the device under test (DUT) information.

C. Enter the temperature of testing environment.

D. Enter additional notes.

E. Check test conditions to display them in the report.

F. Select report format (HTML or XML). Saving as HTML generates both an .html file and a folder (*.files). Both must be copied together for proper viewing.

The test report includes a summary table of all test items. Click the test item name to jump to its detailed page (includes waveform screenshots). Click *Top* in the upper-right corner to return to the summary table.

Double Pulse Test Reoprt

Overall Result: Pass

Operator:	SIGLENT
Test Date:	2025-03-30 13:37:55
Device:	MOSFET
Temperature:	20
Remarks:	This is a test demo.
Oscilloscope Name:	SDS5108X HD
Oscilloscope Serial Number:	TESTRB11
Oscilloscope Scope ID:	80af-2c01-0293-45f0
Oscilloscope Firmware Version:	2.3.7.1.1.3.1

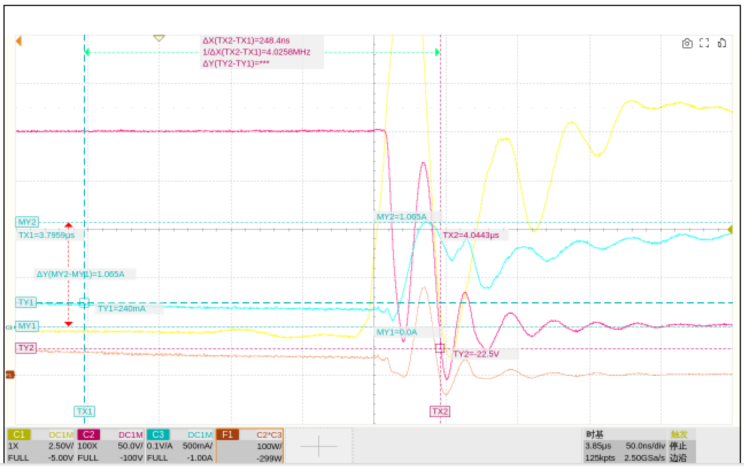
Summary

Measure name	Value	Test Conditions	Pusle Index
Eon			2
Eoff	0.0J	Start Level:Vds : 67.33V,Stop Level:Id : 2.13A	1
Vpeak	67.33V	Start Level:Vds : 67.33V,Stop Level:Id : 2.13A	1
Ipeak			2
Td(on)			2
Td(off)	***	Start Level:Vgs : 9.01V,Stop Level:Vds : 67.33V	1
Tr			2
Tf	0.0s	Start Level:Vds : 67.33V,Stop Level:Vds : 67.33V	1
Ton			2
Toff	***	Start Level:Vgs : 9.01V,Stop Level:Vds : 67.33V	1
d/dt			2

Details

[Top]

Eon	
Measure name	Eon
Value	
Test Conditions	
Pusle Index	2

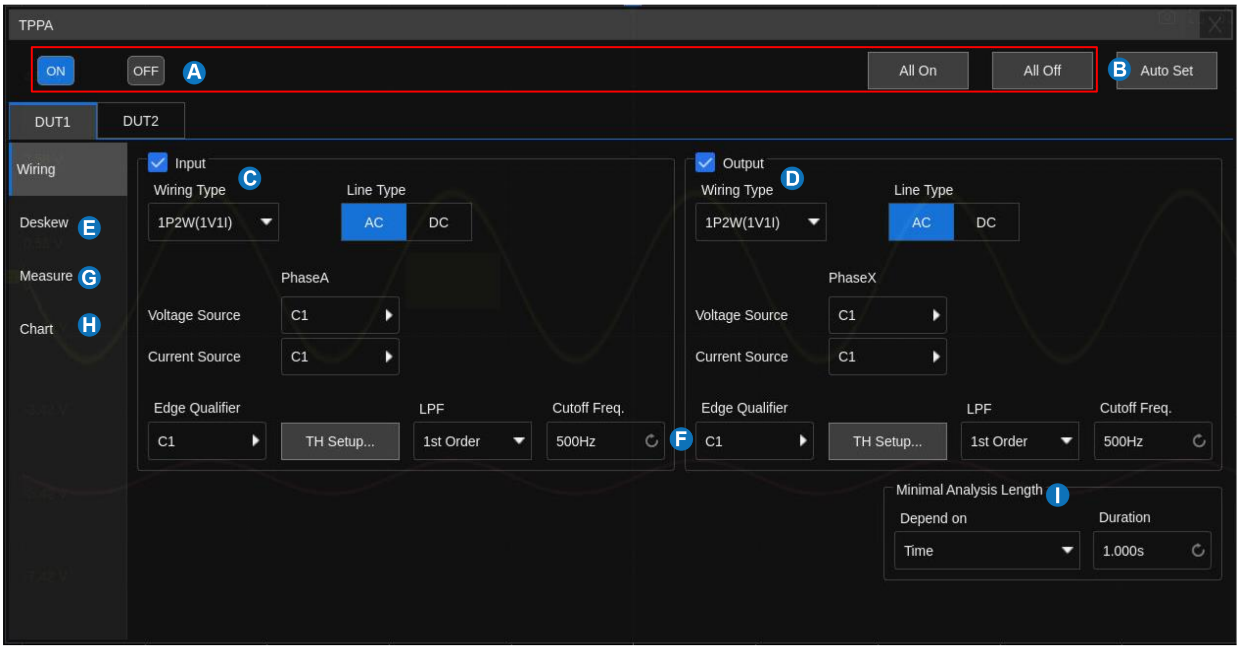


33 Three Phase Power Analysis

33.1 Overview

This device supports three phase power analysis function (TPPA). TPPA can help users to quickly and easily analyze key parameters of three-phase power supplies, AC converters, and loads. Supported measurements and analyses include: Power quality , Ripple analysis , Voltage harmonics , Current harmonics , Efficiency analysis. Full use of the three phase power analysis requires a differential voltage probe like the SIGLENT DPB series, a current probe like the SIGLENT CP series, Install the software option part number SDS5000HD-PA3. For installation of options, see section "Install Options".

Click *Analysis* > *TPPA* to open the configuration dialog:



A. Trun on /off DUT. Click on All On/All Off to enable or disable all DUT.

B. Automatically configure acquisition parameters according to the minimum analysis length setting of the enabled DUTs .

C. Set input signal wiring Type

D. Set output signal wiring Type

E. Deskew calibration. Compensate for inter channel shew (adjustable range: ±100 ns).

F. Set *Edge Qualifier* , *LPF* , *Cutoff Freq* , set the low-pass filter cutoff frequency, the edge quelifier also used as a reference channel for deskew calibration calibration .

G. Measurement Item Setup

H. Graphical Results Display. Select measurement items and configure chart outputs.

I. Set signal analysis length

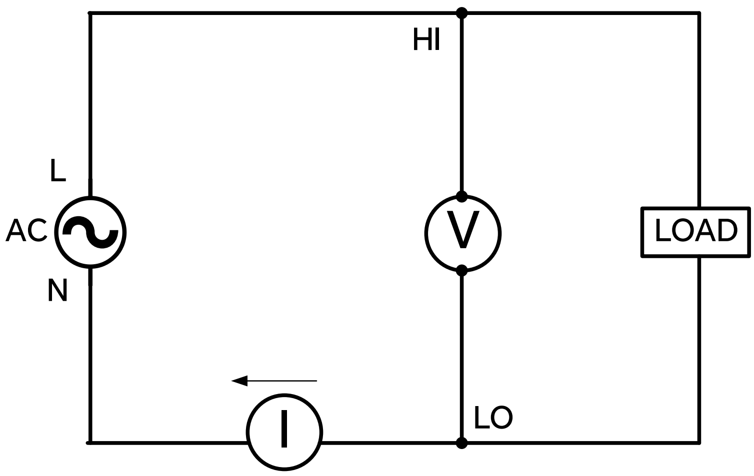
Note:

Since the neutral line in the three-phase power supply and distribution system is not always grounded,you cannot use the ground clip of the non-isolated voltage probe to directly connect the neutral line when measuring voltage ,otherwise there is a risk of electric shock and burning of instruments!

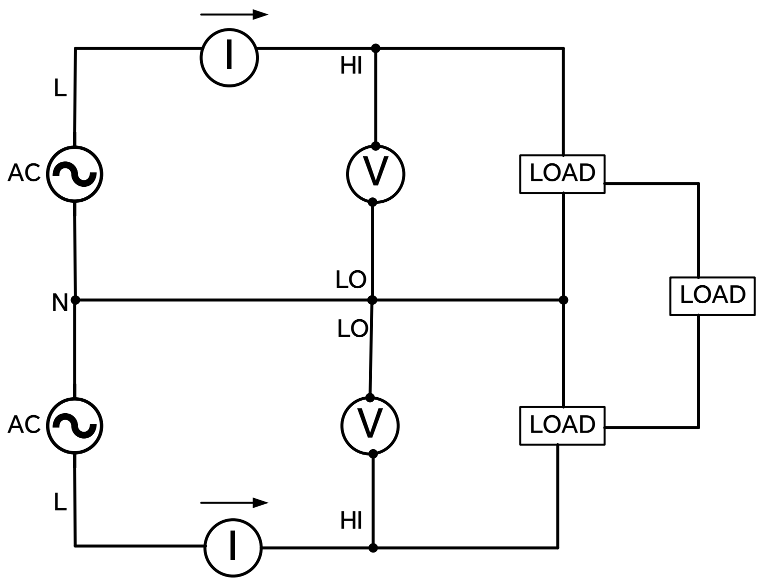
Wiring Type

Supported configurations:

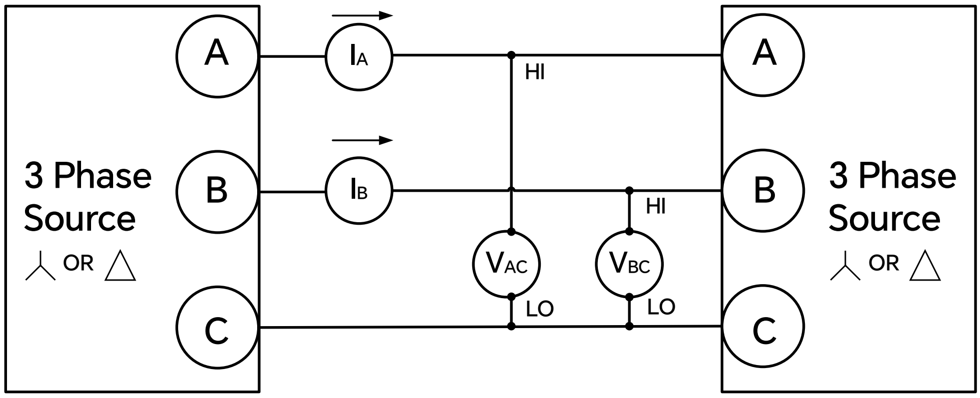
Single-Phase, Two-Wire (1P2W): 1V1I

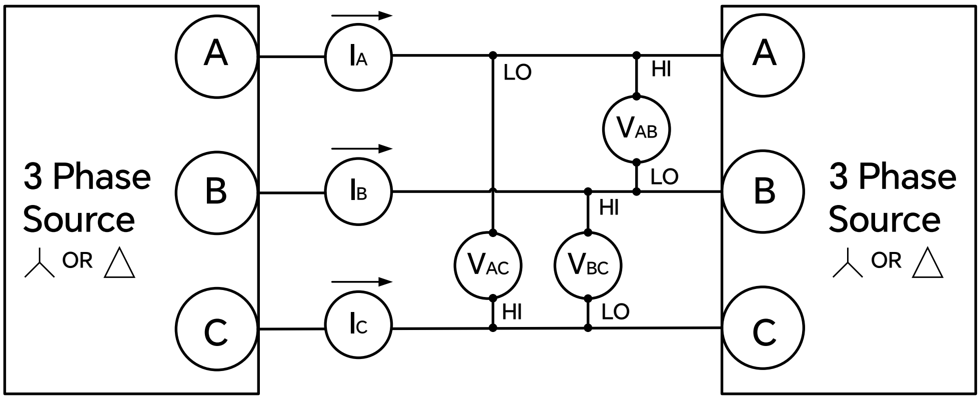


Two-Phase, Three-Wire (2P3W): 2V2I

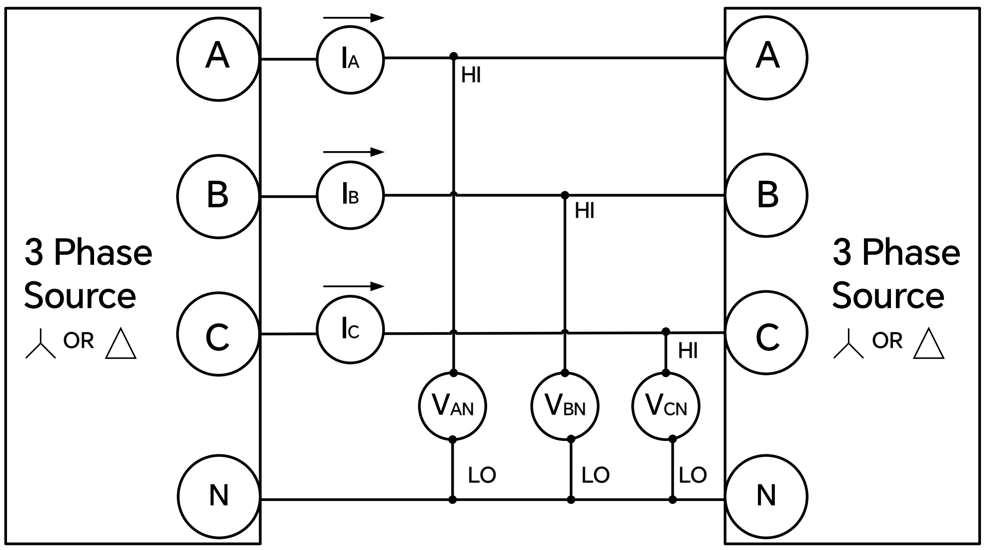


Three-Phase, Three-Wire (3P3W): 2V2I or 3V3I





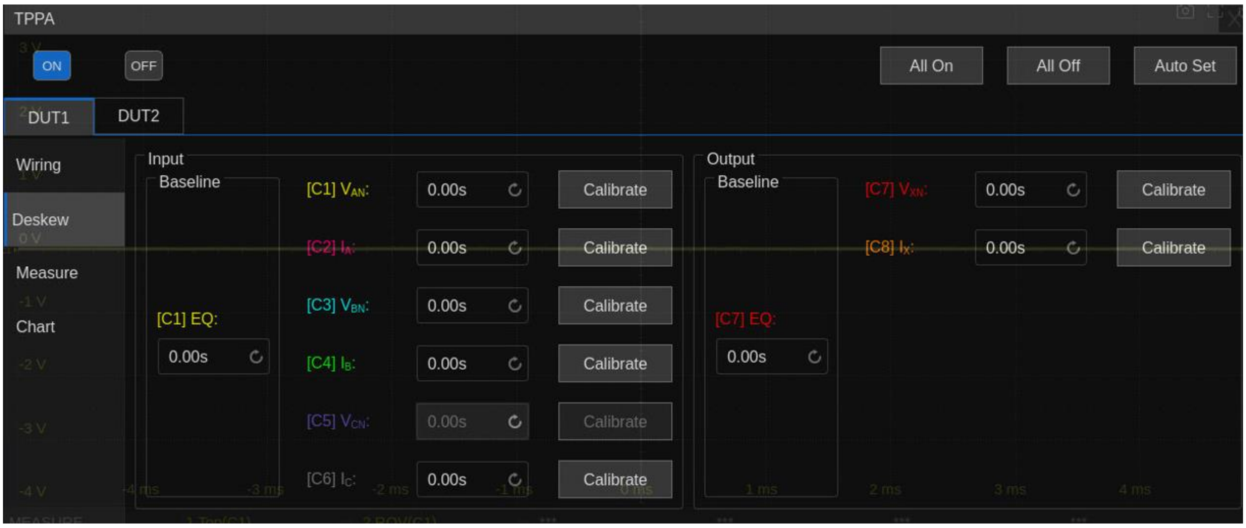
Three-Phase, Four-Wire (3P4W): 3V3I



33.2 Deskew Calibration

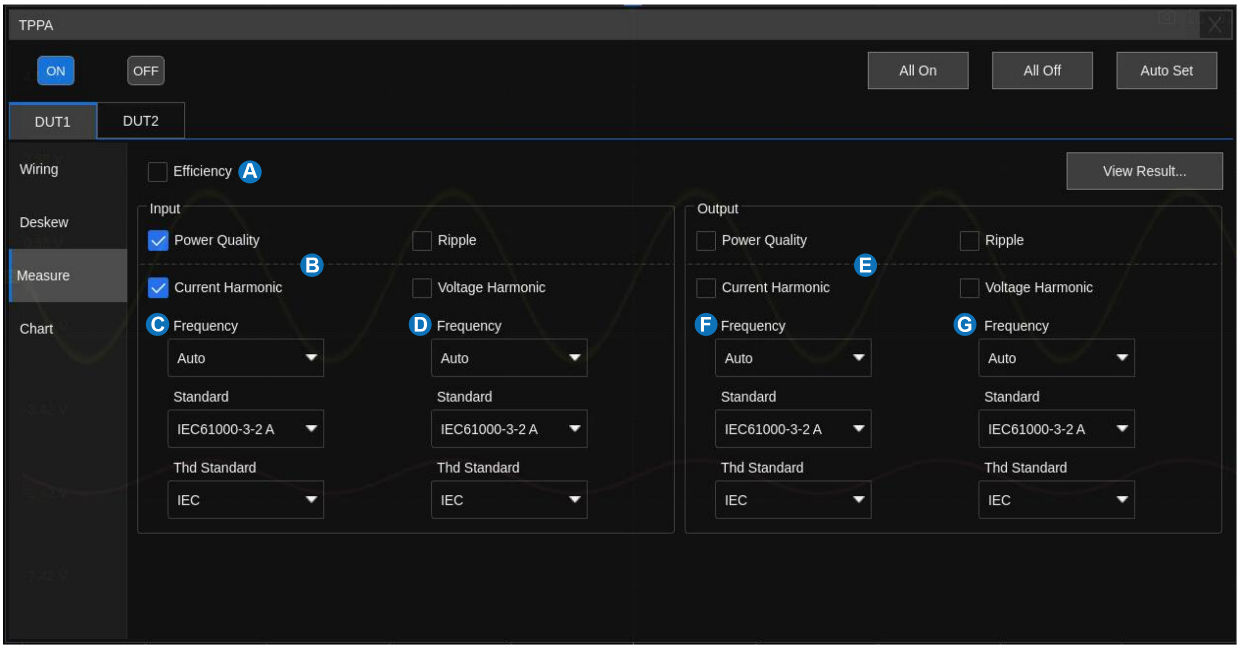
Ensures accurate relative timing among input channels . To correct the skew between the oscilloscope channels or probes, the deskew procedure should be performed once initially, and re-run when any part of the hardware setup changes (for example, a different probe, different oscilloscope channel, etc.) or when the ambient temperature changes. Use the DF2001A deskew fixture for deskew procedures. Refer to the "Switching Loss" section for detailed.

Set the edge qualified channel as the baseline, adjusting the valule of each channel for manual calibration, or clicking *Calibrate* for automatic calibration. When automatic calibration fails, the button will be displayed in red font.



33.3 Measure Setup

Click *Measure* on the DUT tab to configure:



A. Efficiency Analysis for input/ output signal

B. Set input signal measure items

C. Set the input signal current frequency and harmonic analysis standard

D. Set the input signal voltage frequency and harmonic analysis standard

E. Set output signal measure items

F. Set the output signal Current frequency and harmonic analysis standard

G. Set the output signal Voltage frequency and harmonic analysis standard

33.3.1 Power Quality

The measurements include: RMS value of voltage and current, magnitude of voltage and current, crest factor of voltage and current, real power, reactive power, apparent power and phase of each circuit.

Vrms: The RMS value of the phase voltage measured during all analysis periods. The number of phase voltages varies with the wiring configuration.

Vmag: The magnitude of the phase voltage measured at the fundamental frequency of the voltage signal.

Irms: The RMS value of the phase current measured during all analysis periods. The number of phase current varies with the wiring configuration.

Imag: The magnitude of the phase current measured at the fundamental frequency of the current signal.

Voltage crest factor : The ratio of Vmag to Vrms.

Current crest factor: The ratio of Imag to Irms.

Real Power (P): The average value of the power generated or consumed by an AC circuit per unit time, with watts (W) as the unit, calculated by the formula: P=Vrms*Irms.

Apparent Power (S): The product of Vrms and Irms , characterize the capacity of a circuit system, calculated by the formula: S=U*I

Reactive Power (Q): Reactive power is the maximum rate at which energy is exchanged between the power source and reactive components (such as capacitors and inductors) in an AC circuit containing reactance, calculated by the formula: Q=(S^2-P^2)^0.5.

Power Factor: The ratio of real Power to apparent Power.

33.3.2 Ripple Analysis

Measures RMS and peak-to-peak values on DC lines and switching semiconductors, corresponding to AC voltage frequency.

33.3.3 Harmonic Analysis

Harmonic measurement decomposes voltage or current waveforms into their sinusoidal components, plots the signal magnitude of the fundamental frequency and its harmonics, and measures the effective value and total harmonic distortion of the signal. The measurement results can be evaluated according to the IEC 61000-3-2 standard, with reference to the "Current Harmonics" section in power analysis for standard types.

Total Harmonic Distortion Standard

Total harmonic distortion refers to the proportion of each harmonic to the original waveform. It supports users to choose between IEC and CSA algorithm standards. The IEC standard defines it as the ratio of all harmonic energy to the fundamental energy, and the CSA standard defines it as the ratio of all harmonic energy to the fundamental plus the harmonics. Taking current harmonics as an example, the calculation differences are as follows.

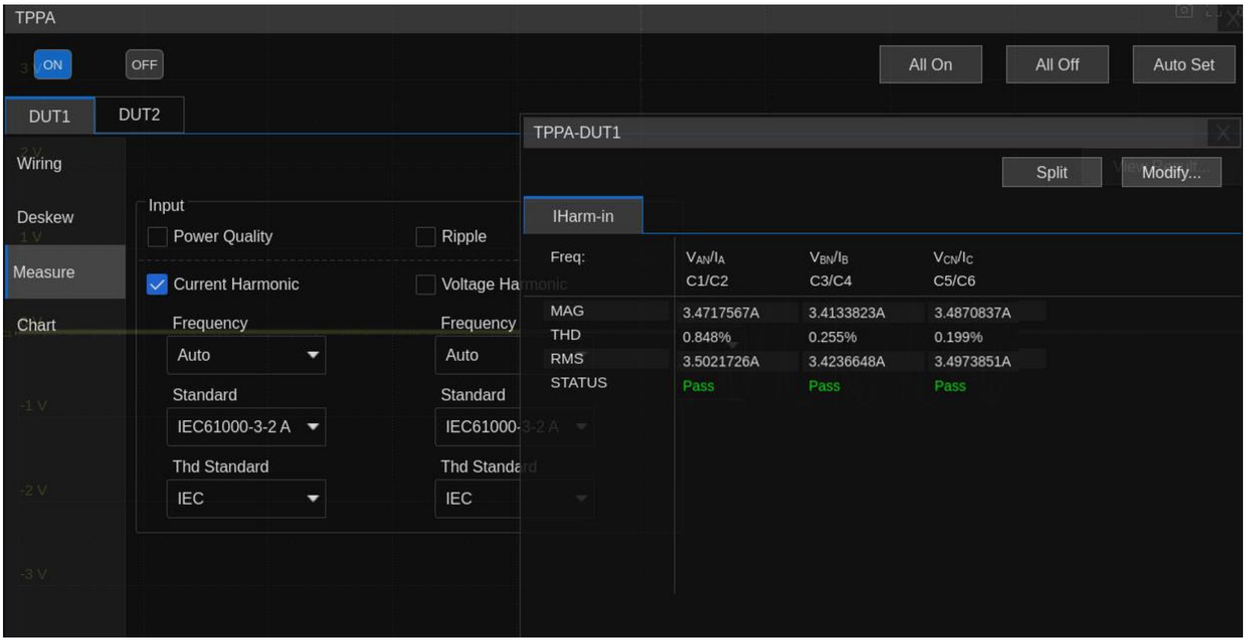
IEC Calculated as:

$$\mathrm{THD} = \frac{\sqrt{\sum_{i=2}^{N} I_i^2}}{I_1}$$

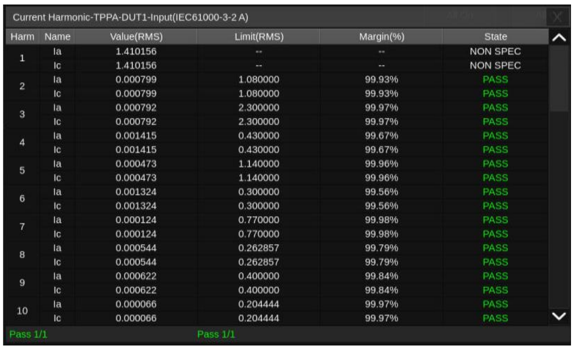
CSA Calculated as:

$$\mathrm{THD} = \frac{\sqrt{\sum_{i=2}^{N} I_i^2}}{\sqrt{\sum_{i=1}^{N} I_i^2}}$$

The calculation results of each phase of harmonic analysis are shown in the figure below:



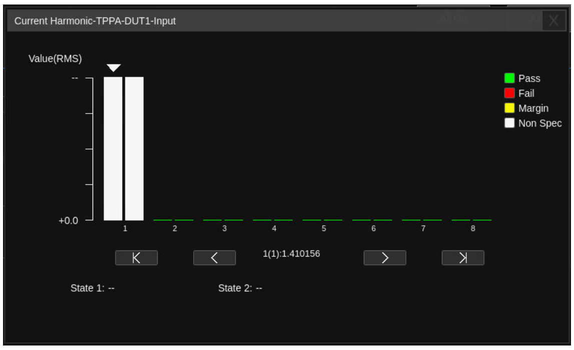
In the chart dialog box, check the table or bar chart to view the details of each phase harmonic, including harmonic effective value, standard, tolerance, and judgment results. In the bar chart, harmonic results are highlighted in green under passing conditions and in red when exceeding test limits.



Current Harmonic-TPPA-DUT1-Input(IEC61000-3-2 A)

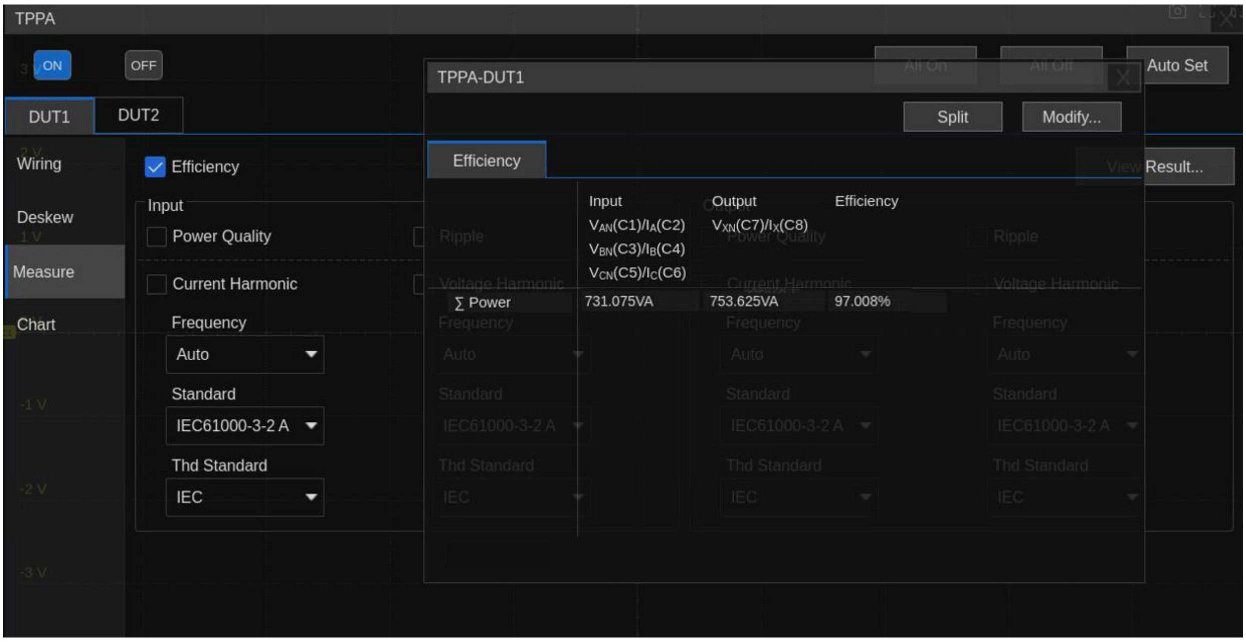
Harm	Name	Value(RMS)	Limit(RMS)	Margin(%)	State
1	Ia	1.410156	--	--	NON SPEC
	Ic	1.410156	--	--	NON SPEC
2	Ia	0.000799	1.080000	99.93%	PASS
	Ic	0.000799	1.080000	99.93%	PASS
3	Ia	0.000792	2.300000	99.97%	PASS
	Ic	0.000792	2.300000	99.97%	PASS
4	Ia	0.001415	0.430000	99.67%	PASS
	Ic	0.001415	0.430000	99.67%	PASS
5	Ia	0.000473	1.140000	99.96%	PASS
	Ic	0.000473	1.140000	99.96%	PASS
6	Ia	0.001324	0.300000	99.56%	PASS
	Ic	0.001324	0.300000	99.56%	PASS
7	Ia	0.000124	0.770000	99.98%	PASS
	Ic	0.000124	0.770000	99.98%	PASS
8	Ia	0.000544	0.262857	99.79%	PASS
	Ic	0.000544	0.262857	99.79%	PASS
9	Ia	0.000622	0.400000	99.84%	PASS
	Ic	0.000622	0.400000	99.84%	PASS
10	Ia	0.000066	0.204444	99.97%	PASS
	Ic	0.000066	0.204444	99.97%	PASS

Pass 1/1 Pass 1/1



33.3.4 Efficiency Analysis

Efficiency analysis calculates the ratio of output power to input power , supporting efficiency analysis of three-phase AC rectifiers and inverters. When measuring the efficiency of a frequency converter or motor drive using three-phase AC power, you can use 8 oscilloscope channels to measure the three-phase efficiency. Both the input and output should be configured as 3P3W (2V2I), with 2 voltage channels and 2 current channels for the input signal and 2 voltage channels and 2 current channels for the output signal. When measuring the efficiency of an inverter or rectifier, the input and output signals can be configured using 1V1I with 2V2I or 3V3I depending on the DUT.

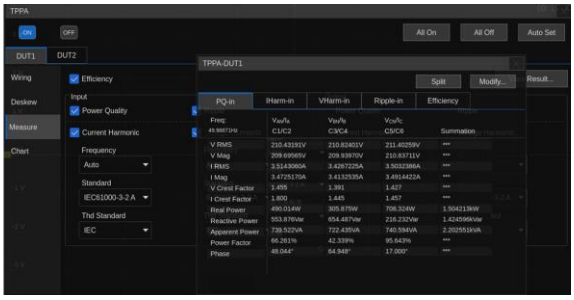


33.4 Results View

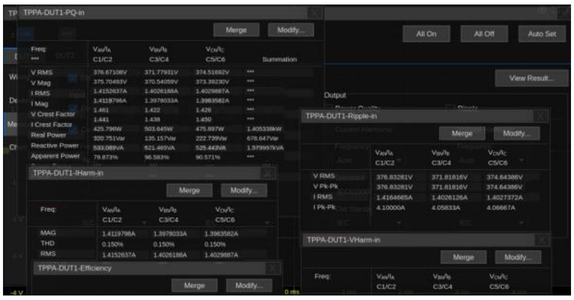
Results are displayed in multiple formats (default display is in table form). Each measurement item supports custom chart types.

Table

Click *Measure* > *View Result...* to show all results in a paginated dialog. Click *Split* to display each item in individual dialogs. Click *Modify...* to return to the main dialog.



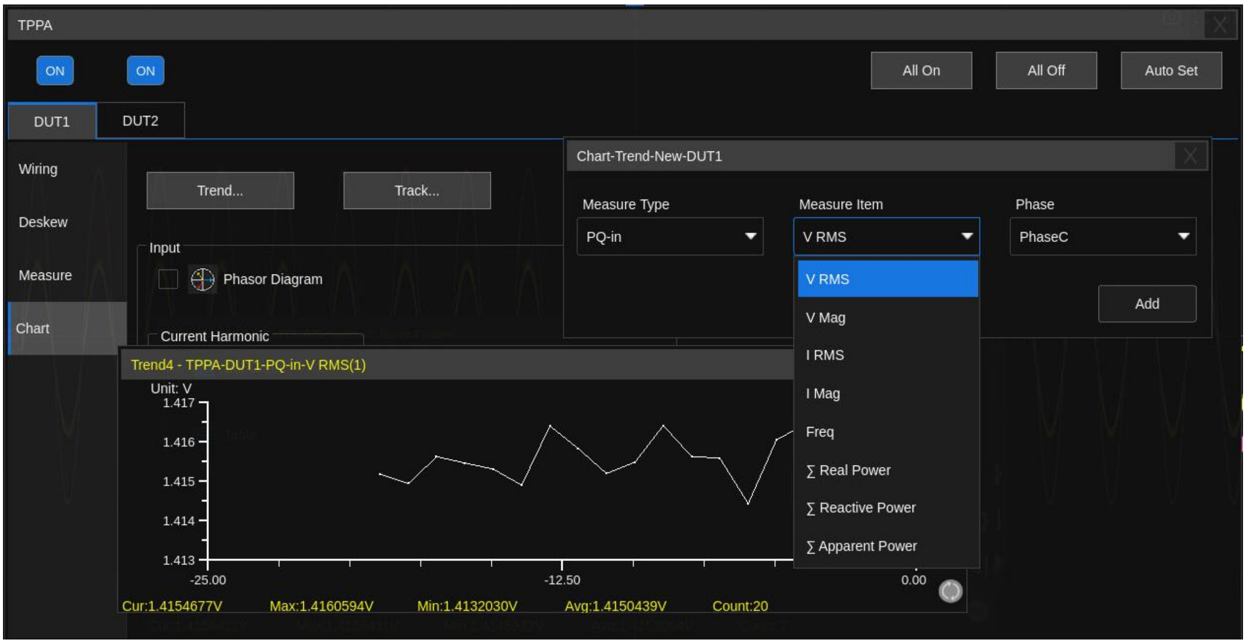
Merge display



Split display

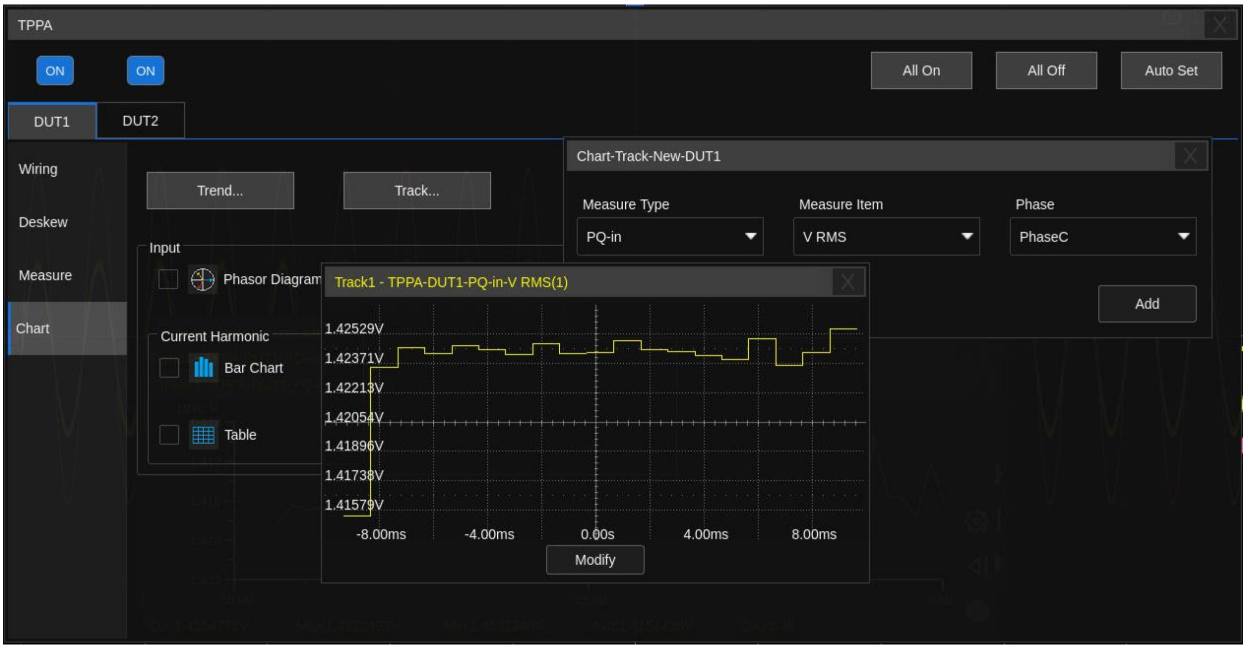
Trend Chart

Click *Chart* > *Trend...* to observe the long-term change of the selected measurement value over time. See the chapter "Trend" for more information.



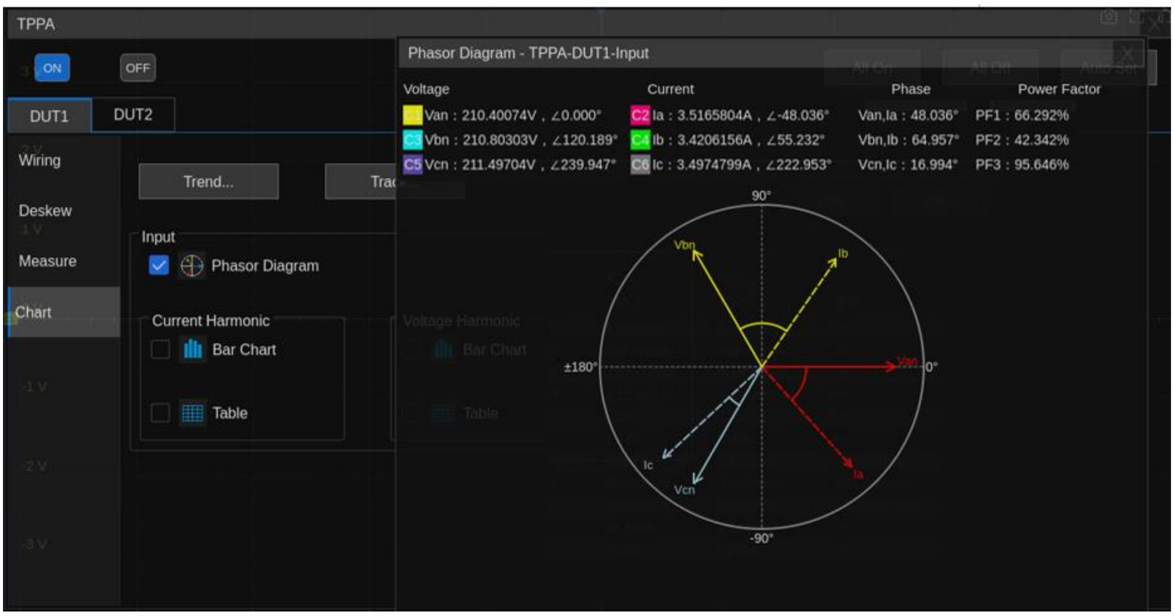
Track Chart

Click *Chart* > *Track...* to observe the measure values VS. time plot of a horizontal parameter in one frame. See the section "Track" for more information.



Phasor Diagram

Enable Phasor Diagram to display vector relationships between voltage and current.


TPPA
ON
OFF
DUT1
DUT2
Wiring
Deskew
Measure
Chart
Trend...
Input
Phasor Diagram
Current Harmonic
Bar Chart
Table
Phasor Diagram - TPPA-DUT1-Input
Voltage
Current
Phase
Power Factor
Van : 210.40074V , ∠0.000°
C2 Ia : 3.5165804A , ∠-48.036°
Van,Ia : 48.036°
PF1 : 66.292%
Vbn : 210.80303V , ∠120.189°
C4 Ib : 3.4206156A , ∠55.232°
Vbn,Ib : 64.957°
PF2 : 42.342%
C5 Vcn : 211.49704V , ∠239.947°
C6 Ic : 3.4974799A , ∠222.953°
Vcn,Ic : 16.994°
PF3 : 95.646%
90°
±180°
0°
-90°
Vbn
Ib
Van
Ia
Ic
Vcn

34 Waveform Generator

34.1 Overview

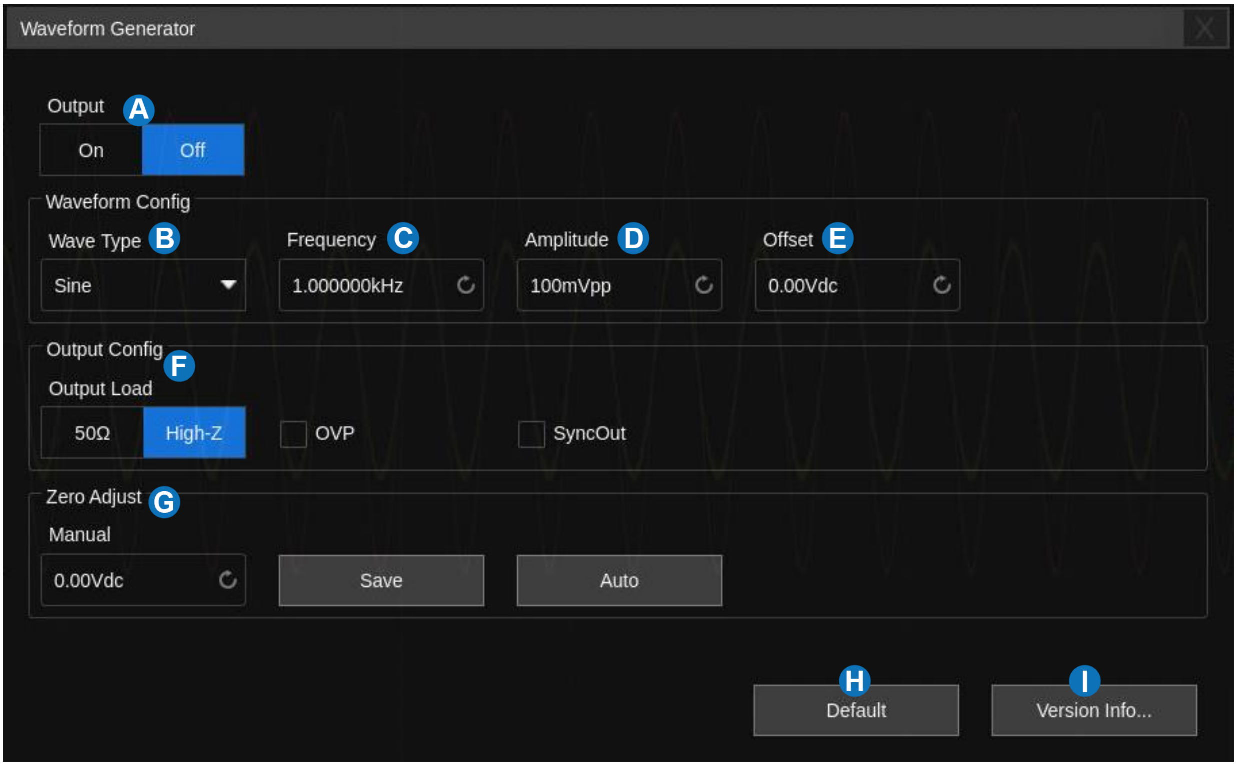
This device supports an external waveform generator option, which can conveniently and quickly provide users with multiple input signals. The options include SAG1021I function/arbitrary waveform generator module, etc.

The AWG functions include:

- 6 basic waveforms: Sine, Square, Ramp, Pulse, Noise, and DC
- 45 built-in arbitrary waveforms
- Output frequency up to 50 MHz
- -3V ~ +3V output amplitude range

Refer to the datasheet for the detailed specifications of the AWG.

Click the menu *Utility* > *Wave Gen* to recall the AWG dialog box.



A. Turn on/off the output of AWG

B. Select the waveform type (Sine, Square, Ramp, Pulse, Noise, DC, and Arb)

C. Set the frequency

D. Set the amplitude

E. Set the offset

F. Output config: output load, ovp and syncout

G. Zero adjust

H. Default

I. AWG version information and firmware upgrade

34.2 Wave Type

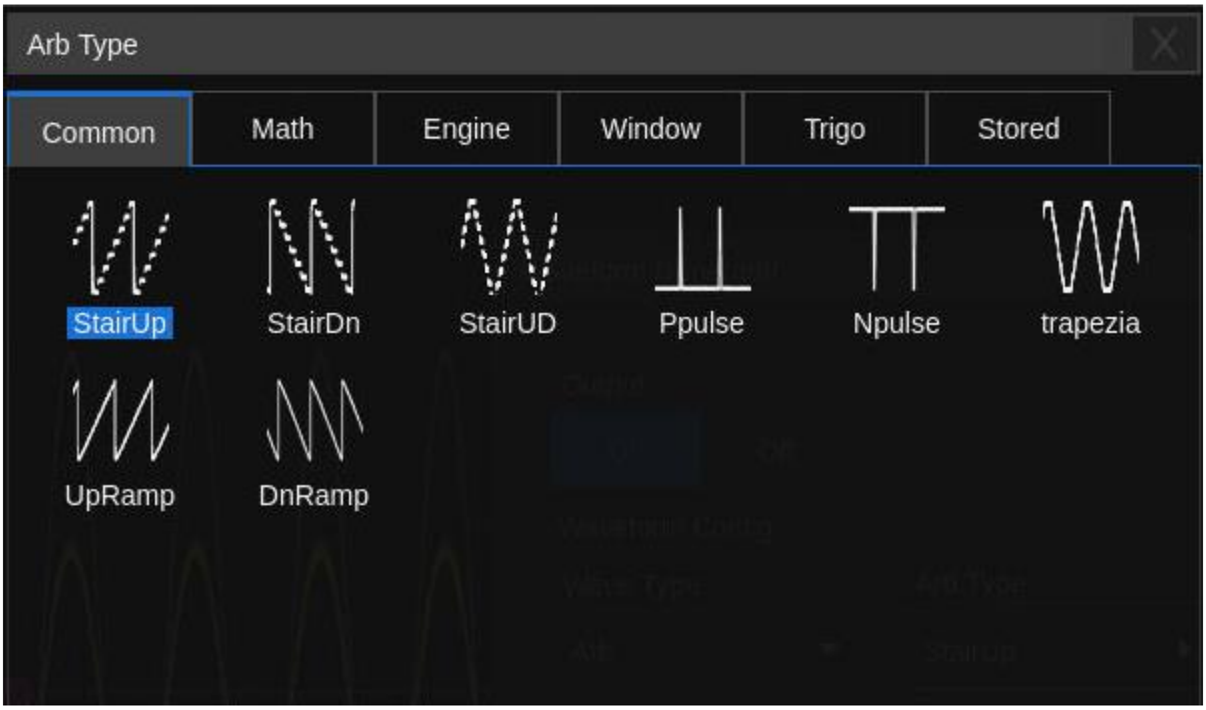
The AWG function provides six standard waveforms and multiple arbitrary waveforms. The standard waveforms are Sine, Square, Ramp, Pulse, Noise, and DC.

The following table shows all waveform types and corresponding parameters.

Wave Type	Parameters
Sine	Frequency, Amplitude, Offset
Square	Frequency, Amplitude, Offset, Duty
Ramp	Frequency, Amplitude, Offset, Symmetry
Pulse	Frequency, Amplitude, Offset, Duty
DC	Offset
Noise	Stdev, Mean
Arb	Frequency, Amplitude, Offset, Arb Type

The Arbitrary waveforms consist of two types: built-in waveforms and stored waveforms.

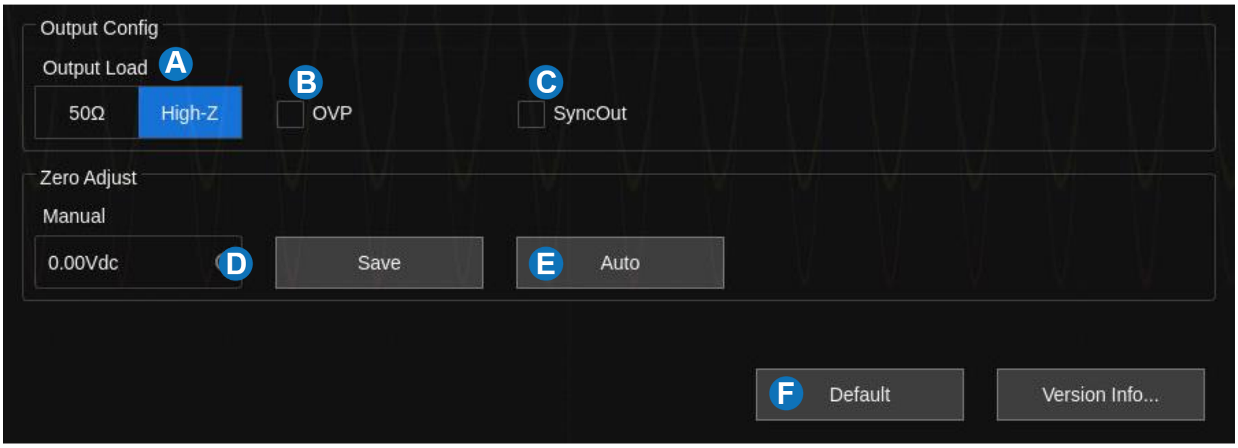
Click *Arb Type* in the AWG dialog box, and select the arbitrary in the pop-up window:



There are 6 tabs in the window. Under each tab, a catalog of waveforms is listed. Built-in waveforms are stored in Common, Math, Engine, Window, and Trigo. Stored waveforms are located in the Stored menu.

Users can edit arbitrary waveforms using SIGLENT EasyWaveX PC software, send the stored waveforms to the instrument through the remote interface, or import the stored waveforms through a U disk.

34.3 Other Setting



A. Select the output load

B. Turn on/off the OVP (Over Voltage Protection)

C. Turn on/off the Syncout

D. Manual zero adjust

E. Auto zero adjust

F. Set to default

Output Load

The selected output load value must match the load impedance. Otherwise, the amplitude and offset of the output waveform of AWG will be incorrect.

OVP

When OVP is enabled, the output will be turned off automatically once the protection condition is met. The protection condition is when the absolute value on the output port is higher than 4 V ± 0.5 V. At the same time, a warning message is displayed, and the function generator output is closed..

Synchoutput

When the synchoutput is turned on, the Aux In/Out port of the function generator can output a CMOS signal with the same frequency as the basic waveform (except for Noise and DC), any waveform, and a maximum frequency of 10MHz.

Zero Adjust

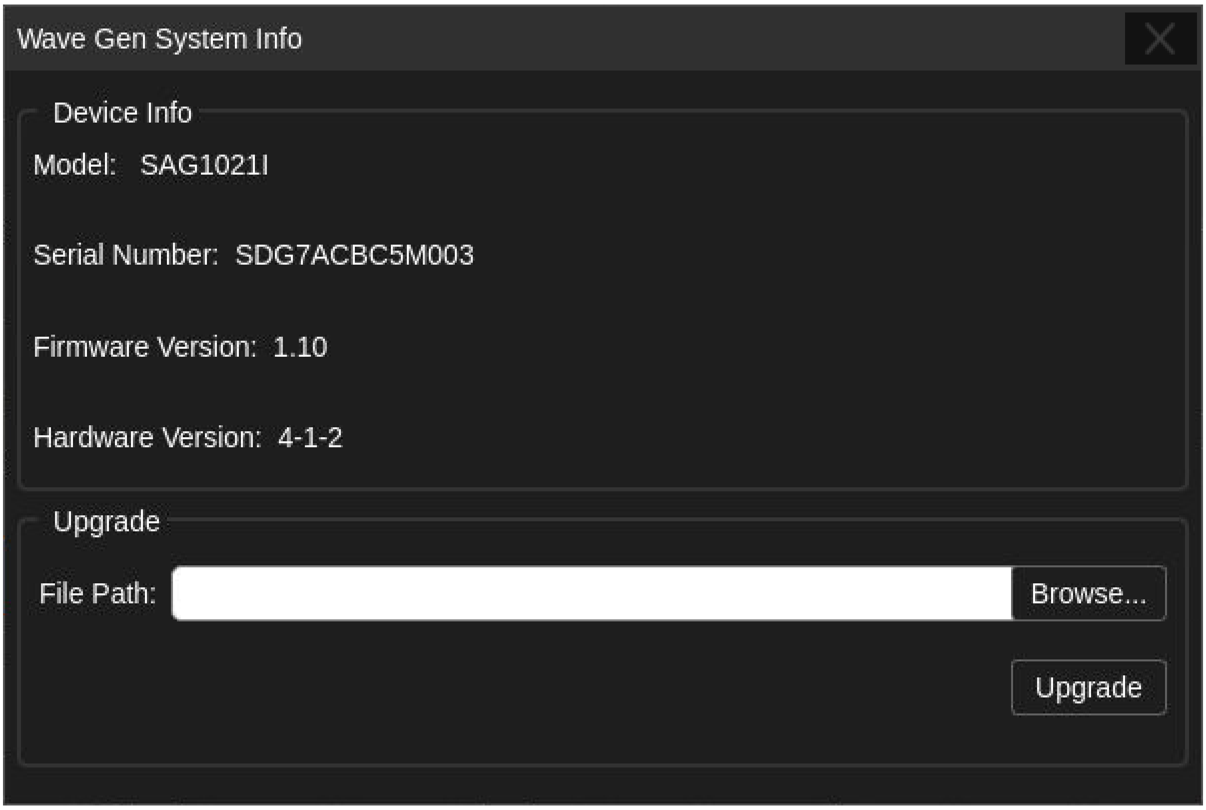
The output zero error of the AWG can be calibrated by using auto mode or manual mode. The object of the Zero Adjust is: when AWG outputs a 0 V DC signal, the measured mean value of the corresponding channel is within ± 1mV.

Auto Steps: In this mode, the adjustment can only be performed with C1 of the oscilloscope. Connect the output of AWG to C1 of the oscilloscope, click *Auto* , and the AWG will start to automatically adjust. The scope will display “Zero adjust completed!” when the adjustment is done.

Manual Steps: The AWG can be manually calibrated through any channel on the oscilloscope. Take C2 as an example:

1. Connect the output of AWG to C2, open C2, set it to DC coupling, turn on the bandwidth limit, and set the probe attenuation to 1X.
2. Set the vertical scale of C2 to a small scale such as 1 mV/div. Turn on the measure and set the parameter to the Mean of C2.
3. Click *Manual* and roll the mouse wheel to adjust the compensation value, until the mean value of C2 is within ±1 mV, and then click *Save* . The scope will display “Zero adjust completed!”.

34.4 System



Device Info -- Includes Model, Serial Number, Firmware Version, and Hardware Version of the AWG module.

Upgrade

The firmware here refers to the firmware of the built-in AWG module. The device supports firmware and configuration file upgrades for the AWG via a U disk. Follow the steps below:

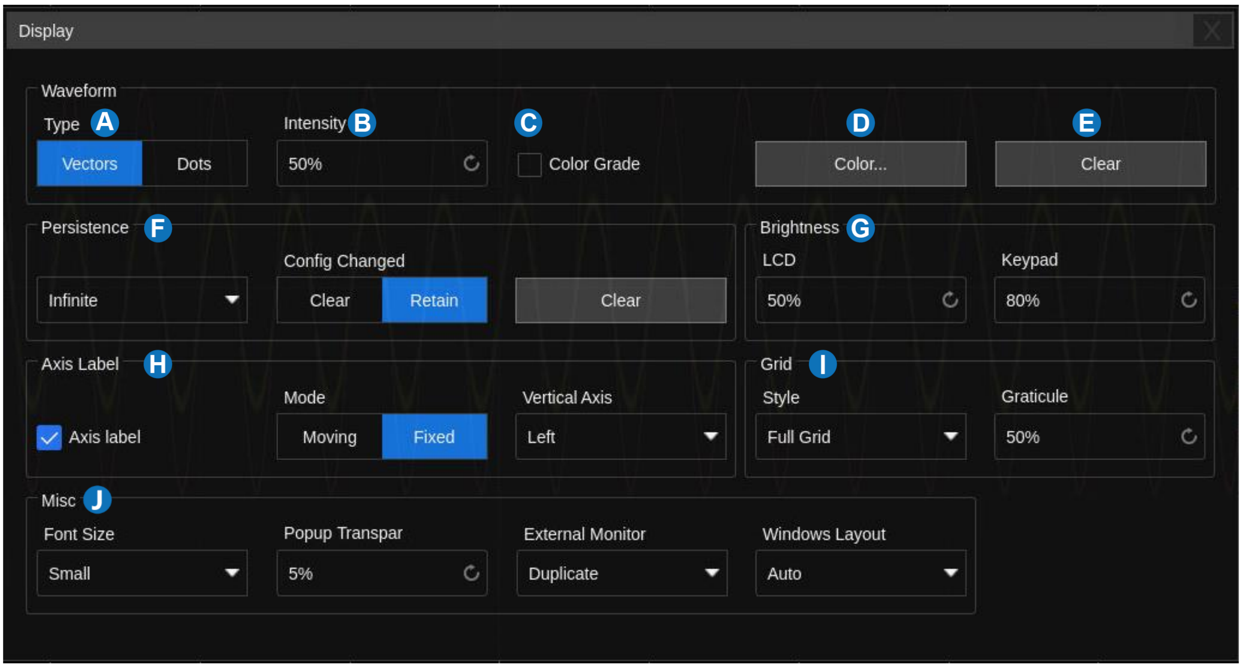
1. Copy the upgrade file (*.ADS) to the U disk.
2. Insert the U disk into one of the USB host ports of the oscilloscope.
3. Click *Browse...* to select the path of the upgrade file. See the chapter "Save/Recall"for the detailed operation.
4. Click *Upgrade* to start the upgrade progress. A progress bar shows the percentage finished.
5. After the upgrade, reboot the oscilloscope.
6. Enter the *System* dialog box again to check if the upgraded hardware version number is consistent with the target version.

⚠	**Warning:** Don't cut off the power during the upgrade !

35 Display

Display settings include display type of waveform, color, persistence, grid type, trace brightness, graticule brightness, etc.

Click the menu *Display* to recall the display dialog box.



A. Switch the waveform display type to Vectors (line display) or Dots

B. Set the wavwform brightness (0~100%, default 50%)

C. Turn on or off the color grade

D. Set the channel color

E. Clear display. The operation clears all waveforms displaying on the screen and clears persist

F. Set persistence

G. Set the LCD brightness (0~100%, default 80%) and keypad brightness (10~100%, default 80%)

H. Display the axis labels

I. Select the grid type (Full Grid, Light Grid, and No Grid)

J. Set the misc : font size (small , middle orlarge) , popup transpar (0~100%, default 20%) , external monitor (duplicate or extend) and windows layout.

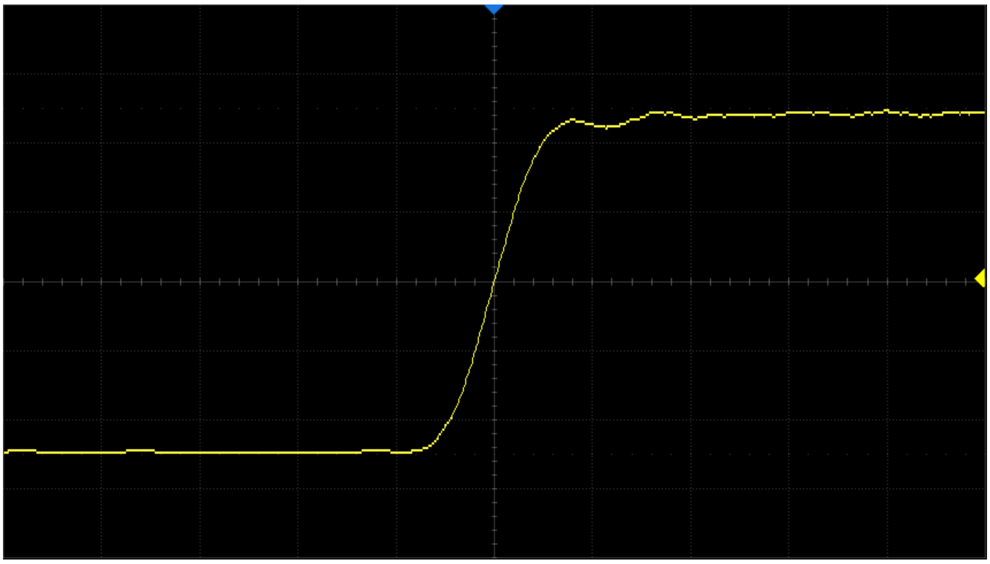
i	**Note:** SDS5000L has no display screen, does not support setting "screen brightness" and "button light brightness"

35.1 Display Type

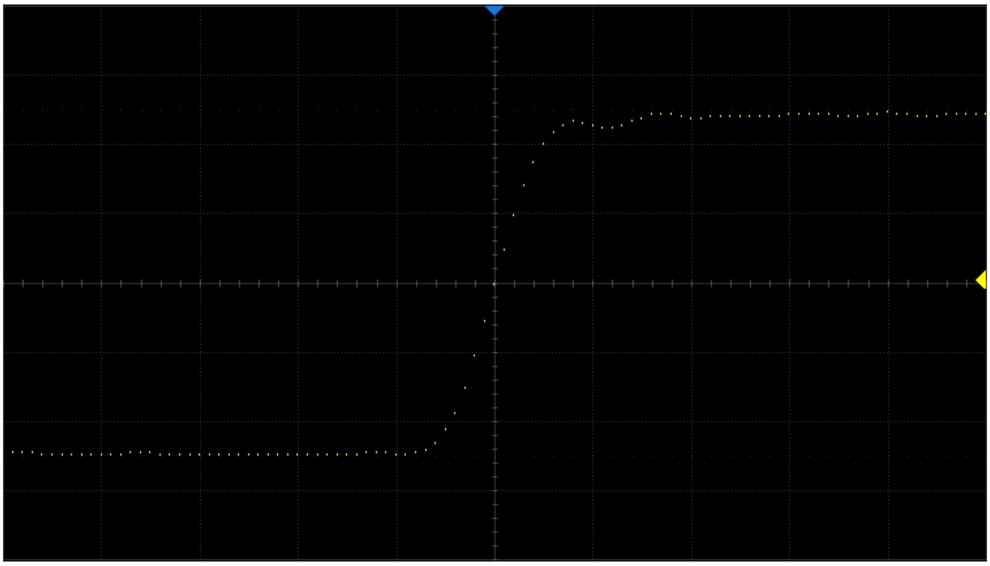
There is no difference between the vector and dot display types when the number of waveform points on the screen is large, but there will be differences when the number of waveform points on the screen is less than the number of pixel points in the waveform display area.

Vectors: The samples are connected by lines (i.e. interpolated) and displayed. The interpolation methods include linear interpolation and sin(x)/x interpolation. See the section of "Acquisition Setup" for details of interpolation.

Dots: Displays the raw samples directly. You can visually see each sampling point and use the cursor to measure the X and Y values of that point.

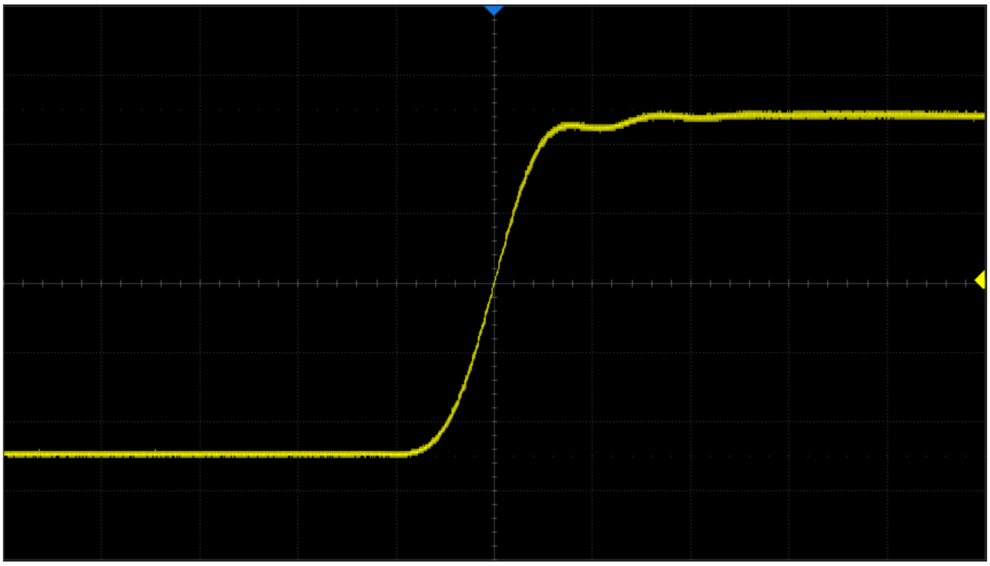


Vector Display



Dot Display

	Note: In the Run state, due to the high waveform update rate of the oscilloscope, the waveform displayed is the superposition of multiple frames. Therefore, what is seen using the dots display is not the discrete sampling points, but the display effect similar to equivalent sampling. Stop the acquisition to view the original samples of each frame separately.

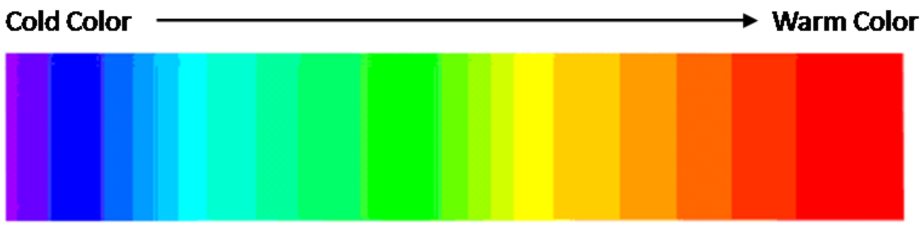


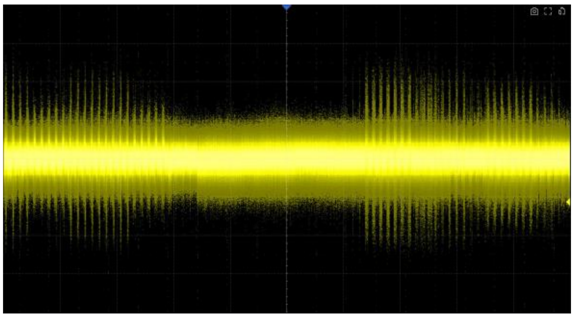
Dots display in Run state

35.2 Color Grade

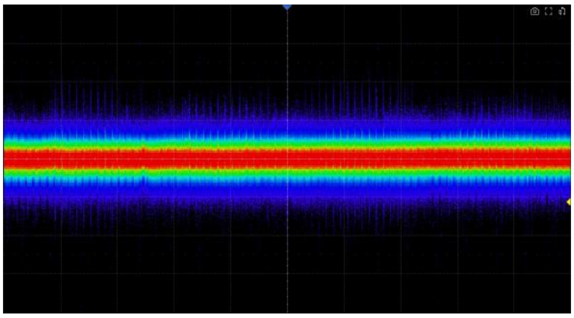
Color grade uses color temperature to map the probability of the waveforms. The greater the probability that the waveform appears in a pixel, the warmer the color of the pixel. The smaller probability, the colder the color temperature of that pixel.

The picture below shows the change of color from cold to warm.





Color grade off



Color grade on

35.3 Color Setting

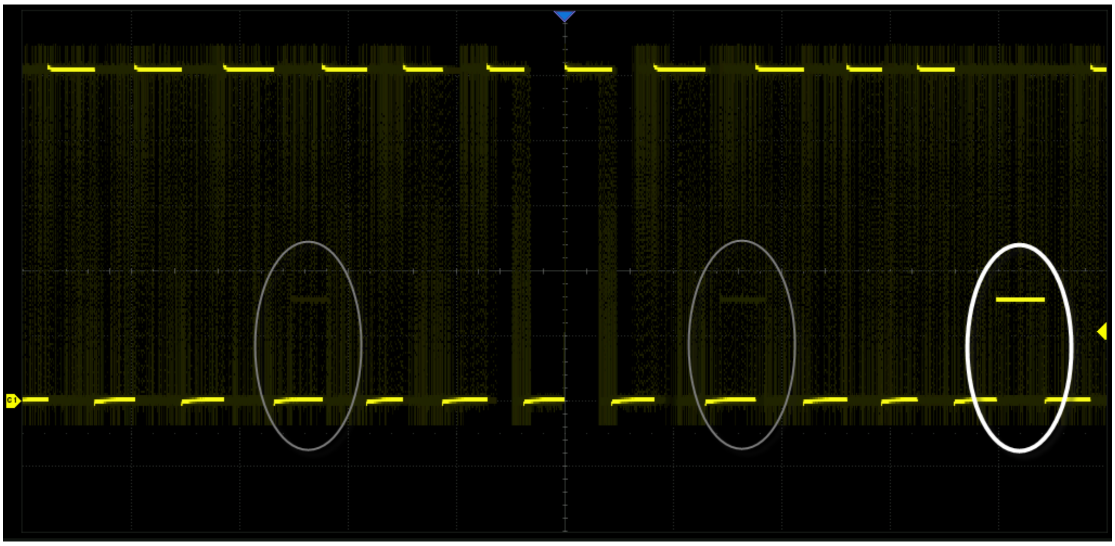
The color setting supports user-defined trace colors. Click the color rectangle box to set in the pop-up palette page. Click the *Default* area to restore the default color for all channels.

Select a color directly on the palette and preview its hue, saturation, light, and RGB values or directly modify the color parameters to customize the color. After the change, click *OK* to confirm.

After successfully setting the custom channel color, to restore the default color settings of the channel, click *Default* to restore the default settings.

35.4 Set Persist

With persistence, the oscilloscope updates the display with new acquisitions but does not erase the results of previous acquisitions in the specified period. All previous acquisitions are displayed with reduced intensity. New acquisitions are shown in their normal color with normal intensity. In combination with the device high waveform update rate and persist function, in some cases anomalies in the waveform can be found in a short time without complex trigger settings to improve test efficiency. Below is an example to display glitches in a data sequence with infinite persistence.



When the display dialog box and persist are off, performing *Display* > *Persistence* can turn on persist.

Click *Persist* in the display dialog box to set the persistence time.

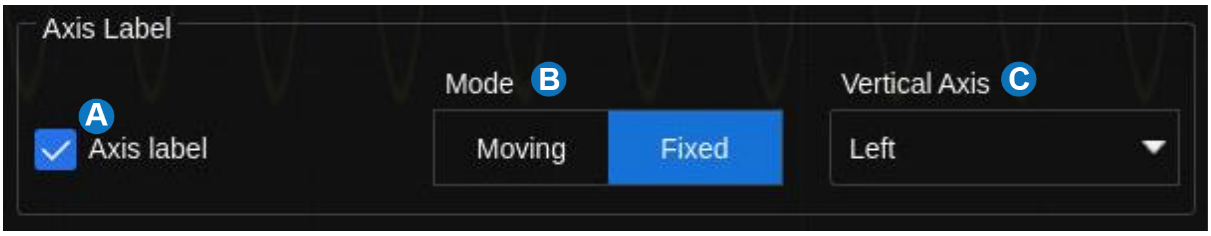
- **Off** -- Turn off persist.
- **Variable persist time (100ms, 200ms, 500ms, 1s, 5s, 10s, 30s)** -- Choose different persist times. The oscilloscope updates with the newly acquired waveform display. Acquired waveforms will be cleared after the corresponding time has expired.
- **Infinite** -- Select "Infinite", the oscilloscope never clears the collected waveform. Using infinite afterglow to measure noise and jitter, capturing occasional events.

To clear the collected waveform from the current display when the afterglow is on, click *Clear* . The afterglow state during configuration changes can also be set to:

- **Clear** -- Change the vertical and horizontal settings, and the afterglow will be automatically cleared.
- **Reserved** -- Change the vertical and horizontal settings, do not clear the afterglow. To clear, click *Clear* .

35.5 Axis Label Setting

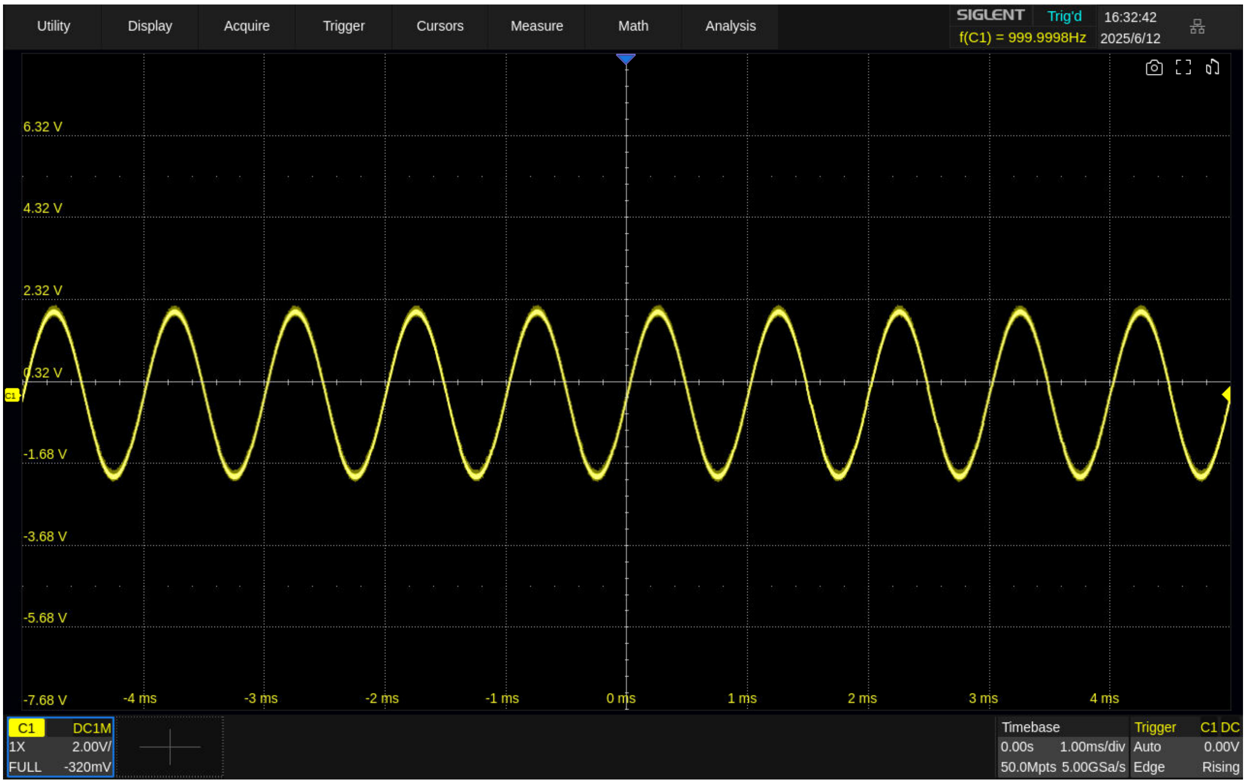
Click *Axis label* to recall axis label setting dialog box.



A. Turn on/off axis label. The opened axis labels will be displayed on the horizontal and vertical axes of the grid area

B. Set axis label mode : (moving mode or fixed mode). “Moving mode”, When moving the waveform, the position of the axes moves with the waveform, while the coordinates remain fixed. “Fixed mode” The position of the axes remains fixed, while the coordinates update as the waveform is moving.

C. Set vertical axis (left , middle or right)



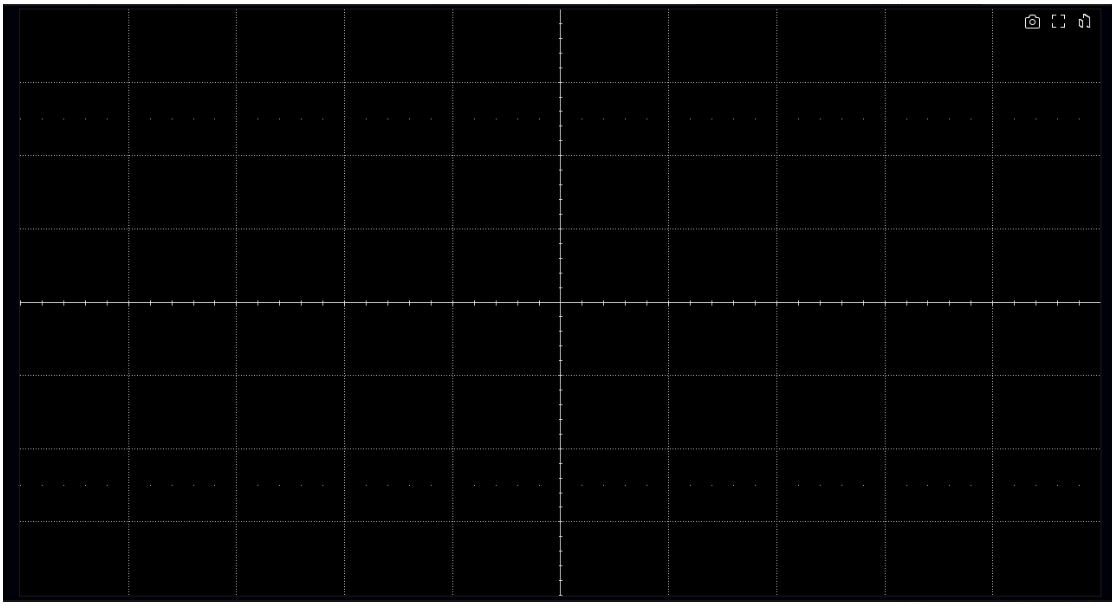
Enable axis label display, the axis label is located on the left side of the screen.

35.6 Set Grid

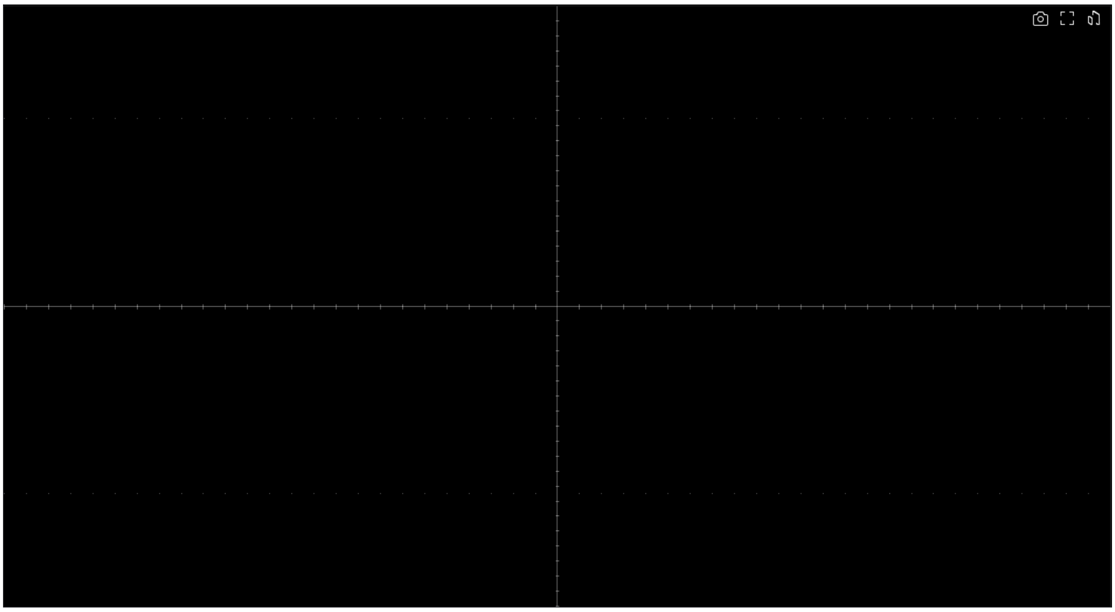
Full Grid -- Display 8*10 grid

Light Grid -- Display 2*2 grid

No Grid -- Display without grid



Full Grid



Light Grid

No Grid

35.7 Font Size Setting

SDS5000X HD provide users with three font sizes: large, medium, and small, and they can choose the font size according to their own needs.

35.8 Multiple Displays Setting

SDS5000X HD has three display interfaces, all of which can be used to connect external monitors. The external monitors must support high-definition resolution (1280x800). Multi-monitor settings are set in the following steps:

Display > *Multiple Displays*

Similar to computers, SDS5000X HD has two multi-display modes: Duplicate or Extend. When the display mode is " Duplicate ", the external monitor displays the same content as the oscilloscope. When the display mode is "Extend", the external monitor acts as an extension of the oscilloscope's main dispaly and a window in the main display can be dragged to the external monitor.

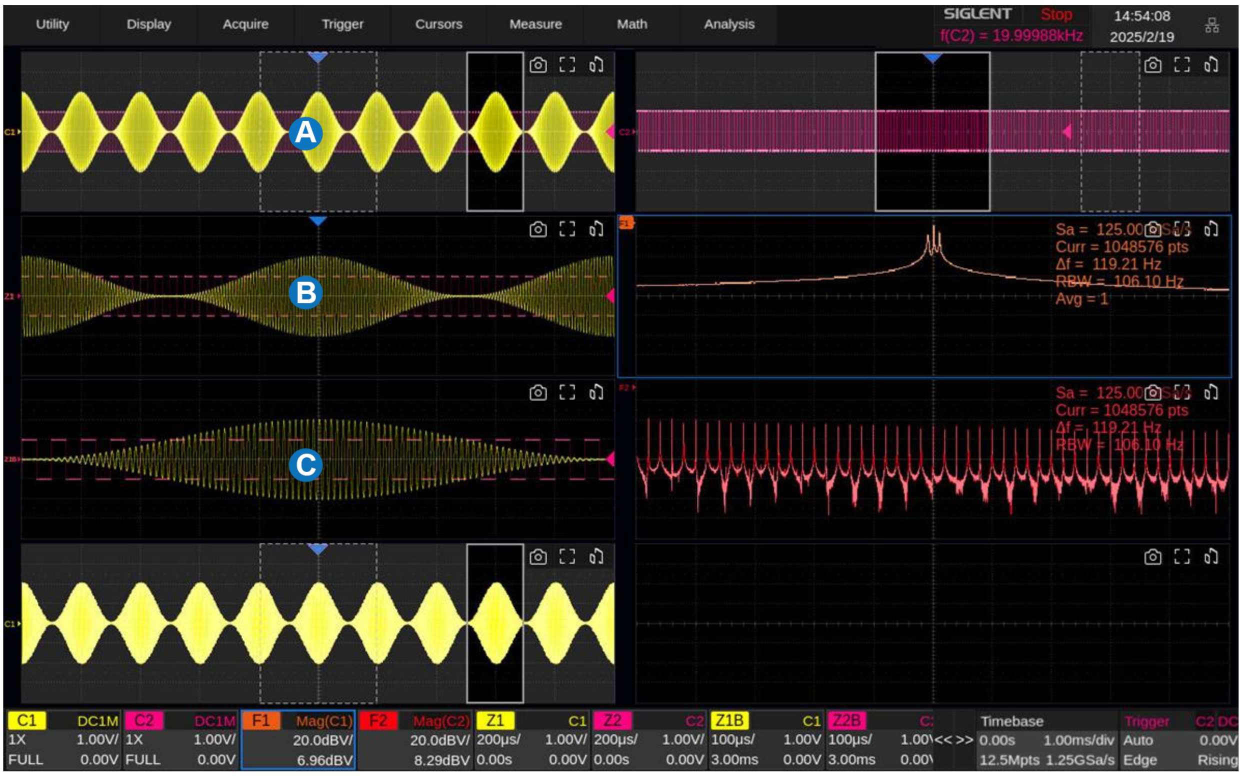
35.9 Window Layout Setting

SDS5000X HD has a 1280*800 pixel high-definition resolution display, which can display more content on the screen. SDS5000X HD supports up to 9 windows. The window layout schemes supported by the device include automatic, 2x1, 3x1, 4x1, 1x2, 2x2, 4x2 and 3x3. There are several ways to set up multiple windows:

1. Perform Display > *Window Layout* .
2. lick the right mouse button or long press the blank part of the menu area on the touch screen to select the window layout scheme from the popped-up menu.

Of all the windows in the window matrix, window (1,1) always serves as the main window. The fast refresh waveform of analog channel (i.e. the waveform mapped by hardware) can only be displayed in the main window, other waveforms besides the Zoom waveform can also be displayed in the main window.

When the Zoom is open, the window (2,1) (window (1,2) when the window layout scheme is 1x2) will be fixed as the Zoom window (refer to the chapter "Zoom" for details). Window (3,1) will be fixed as used to display ZoomB traces.The fast-refreshed Zoom waveform can only be displayed in the Zoom window. In addition to the fast-refreshed Zoom waveform, the amplified waveforms of other waveforms (ZF1~ZF4, ZM1~ZM4, etc.) can also be displayed in this window.

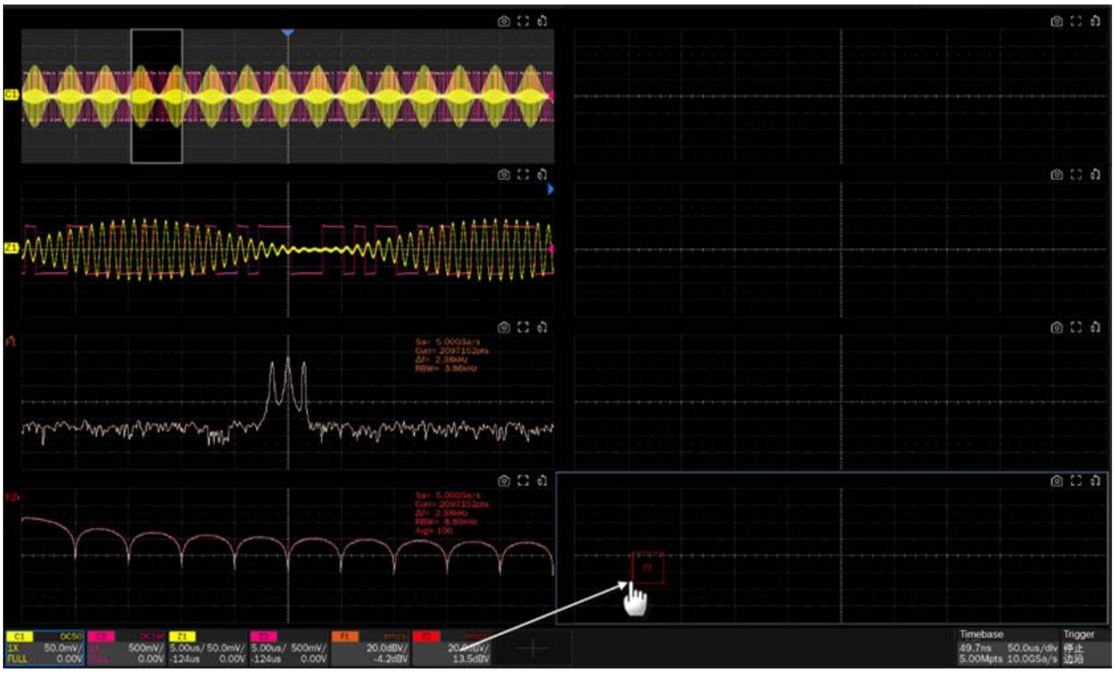


A. Main window
B. Zoom window
C. ZoomB window

When the window layout scheme is "Auto", if Zoom is closed, only one default window will be displayed;

If Zoom is open, two windows will be displayed in 2x1 mode, with the main window at the top and the Zoom window at the bottom.

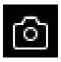
The device will automatically allocate the window where the waveform is displayed according to the window layout scheme and the opened waveform. If manual adjustment is needed, just drag the icon in the parameter area of the target waveform to the corresponding window. As shown in the following figure, F2 was originally assigned to be displayed in window (4,1). If it is desired to be displayed in window (4,2), just drag the parameter area icon of F2 to window (4,2):



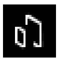
After adjustment, the display is as follows:

Window Operation

There are three icons in the upper right corner of each window, which have the following functions:

 To take a screenshot of this window.

 Show the window in full screen. In full-screen display mode, the icon changes to  , and click again can restore the icon.

 Floating the window. In floating mode, the icon changes to  , and click again can restore the icon. The floating window can be dragged and dropped to any position in the screen, or to the extended screen.

36 Save/Recall

The device supports saving setups, screenshots, and waveform data files to internal storage, external USB storage devices (e.g. U disk), or network storage. Saved setups and waveforms can be recalled as needed.

For details on network storage, refer to the section "SMB File Share".

36.1 Save Type

The device supports save types: Setup, Image (*.bmp/*.jpg/*.png), Waveform Data (binary / CSV / MATLAB), and correction data. It also supports saving the current setup as the default setting. Here are brief descriptions of save types:

Setup

The default save type of the oscilloscope. The setup is saved with the *.xml file extension.

BMP

Save the screenshot in *.bmp format.

JPG

Save the screenshot in *.jpg format.

PNG

Save the screenshot in *.png format.

Reference

The reference waveform data are saved with the *.ref file extension. The saved file contains the reference waveform data and its setup information such as the vertical scale, vertical position, and timebase.

Binary Data

Save the waveform data in binary (*.bin) format.

CSV Data

Save the waveform data in ".csv" format. After selecting this type, After selecting this type, you can click *save* option to turn on or off the parameter save function. The available sources include C1 ~ C8, F1 ~ F8 , Z1~ Z8 and M1 ~ M4.

Matlab Data

Saves the waveform data in *.mat format.

To Default Key

The oscilloscope provides two options for the default setting: Factory and Current.

FileConverter

The mini tool is used to convert stored binary files to CSV format for viewing with a spreadsheet program. This is ideal when collecting large datasets. For a waveform frame with deep memory (Greater than 10 Mpts), saving directly as a CSV file will take a long time and will occupy a large amount of memory on a USB storage device. It's recommended to save the data as a binary file and then convert it to a CSV file on a computer.

Project

Save the waveform data of enabled analog channels(C1~C8), current oscilloscope settings, screen images, and other information as a project. By loading the project, users can quickly restore channel waveform data and settings, enabling offline analysis without the need to reconnect signal sources.

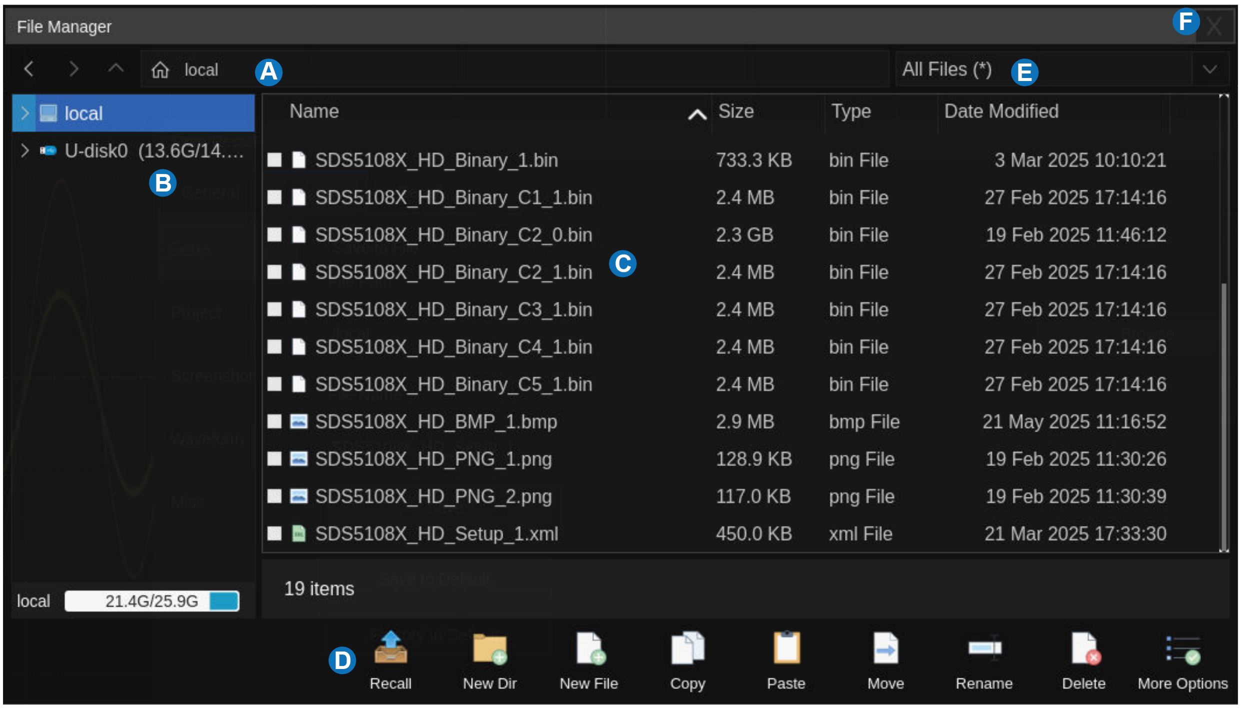
The following table shows the relationship between the save types and save/recall operations.

Type	Save to External	Recall
Setup	√	√
BMP	√	×
JPG	√	×
PNG	√	×
Reference	√	√
Binary Data	√	×
CSV Data	√	×
Matlab Data	√	×
FileConverter	√	×

Project	√	√

36.2 File Manager

The device file manager has a similar style and operation to the Windows© operating systems.



A. Address bar, displays the path where the current file list is located. It includes some shortcut operations on paths, as shown in Table below.

B. Navigation pane. The description of local memory size (remaining memory size/total memory size) is at the bottom.

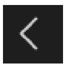
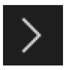
C. File list

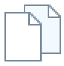
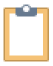
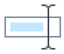
D. Toolbar. The description of each icon is shown in the table below.

E. File type

F. Close the file manager

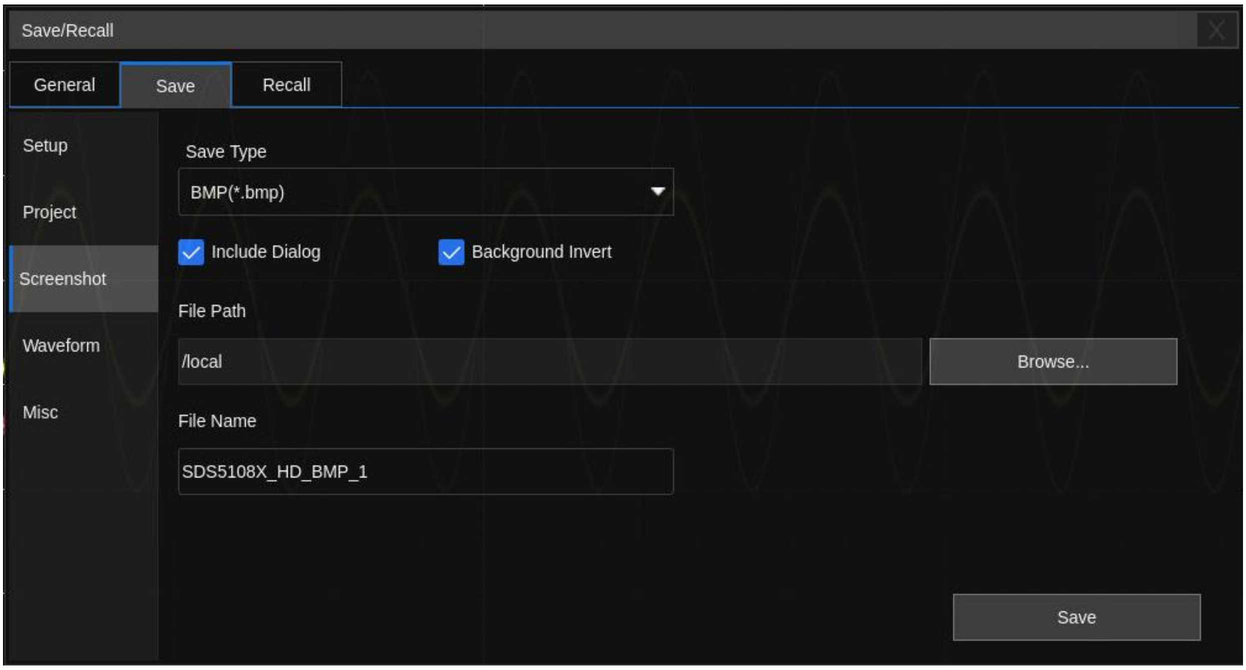
Table 36-1 Description of icons in the file manager

Icon	Description	Icon	Description
	Back		Forward
	Up level		Root directory

	Recall		New directory
	New file		Copy
	Paste		Rename
	Delete		

36.3 Save and Recall Instances

1. Save the screenshot to the path “Udisk0\SDS5X\” in the format of BMP



Step 1, Insert the U disk.

Step 2, Set the parameters of the Save operation:

Click *General* tab, select the Path Tips. "Hoid" the path prompt displayed on the screen after saving the file ; "Fade" the path prompt after storing the file is displayed for a period of time (default is 3 s, can also be customized) and then hidden; Do not display path prompts after “Hiding” stored files.

Click *Save* tab, Select left "Screenshot"

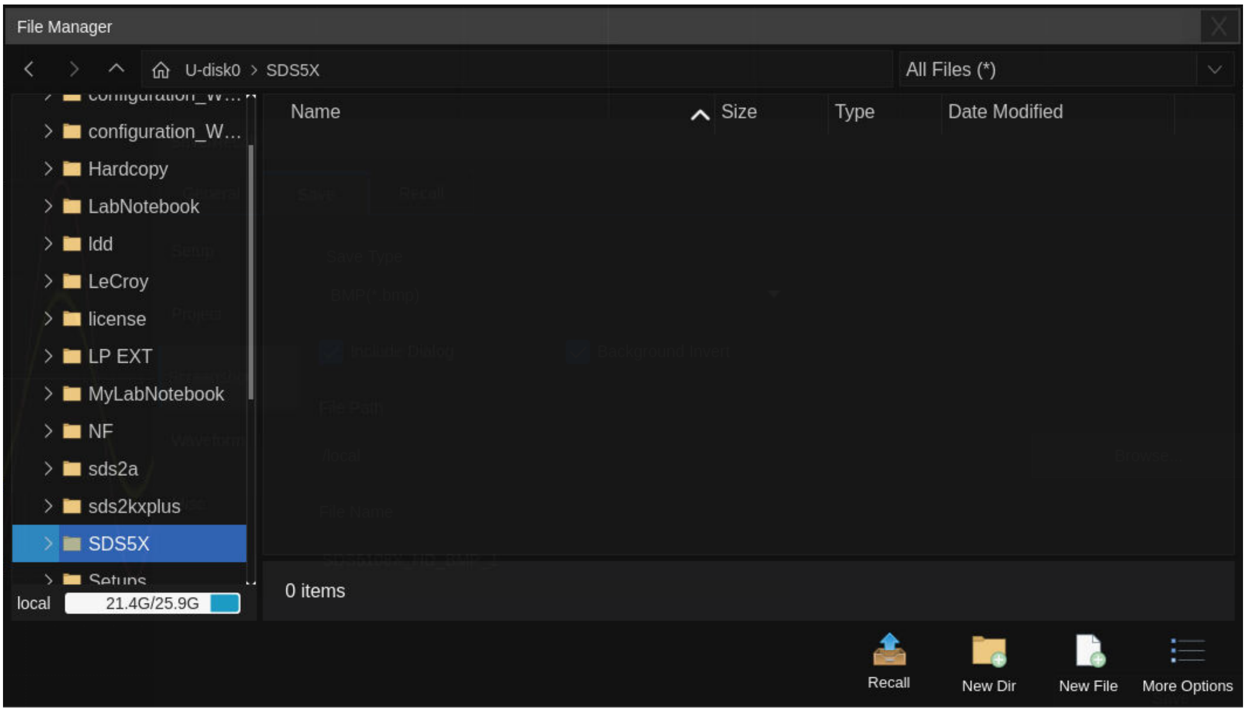
Select *Save Type* as "BMP"

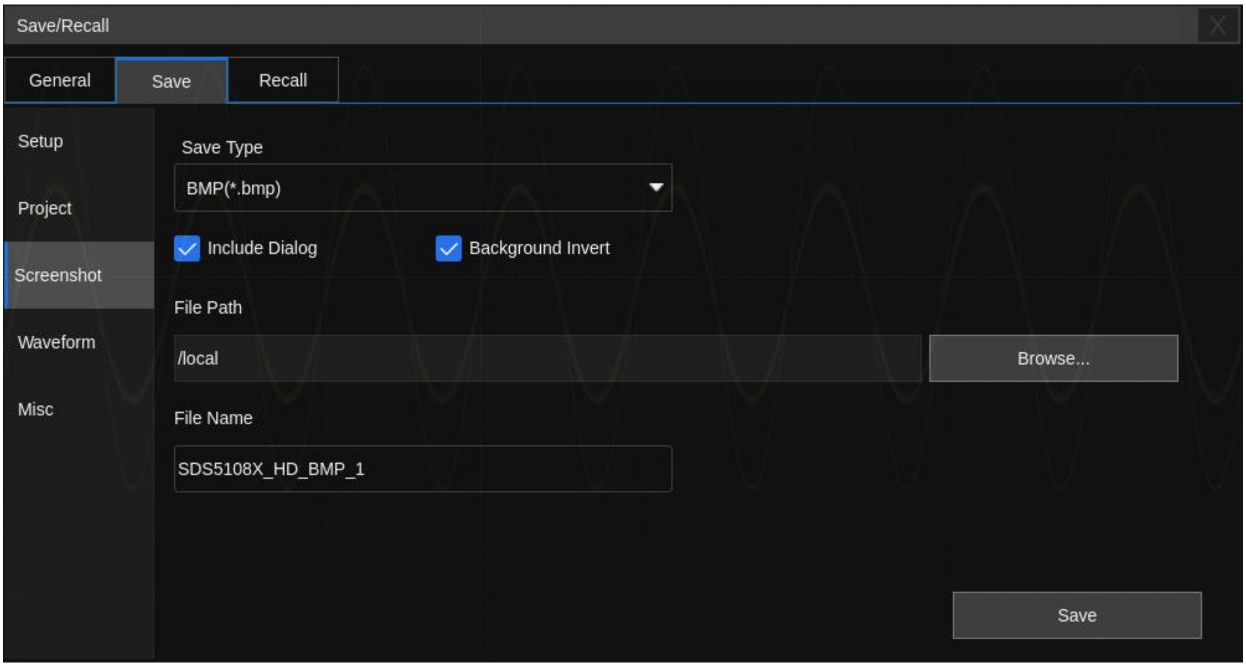
Select to *Include Dialog* the menu in the Print Area or not. "No" only saves the grid area and descriptor boxes; "Yes" saves the whole display

Select the *Background Invert* . "Normal" saves images with the same color of the display; "Inverted" saves images with a white background color to save ink during printing

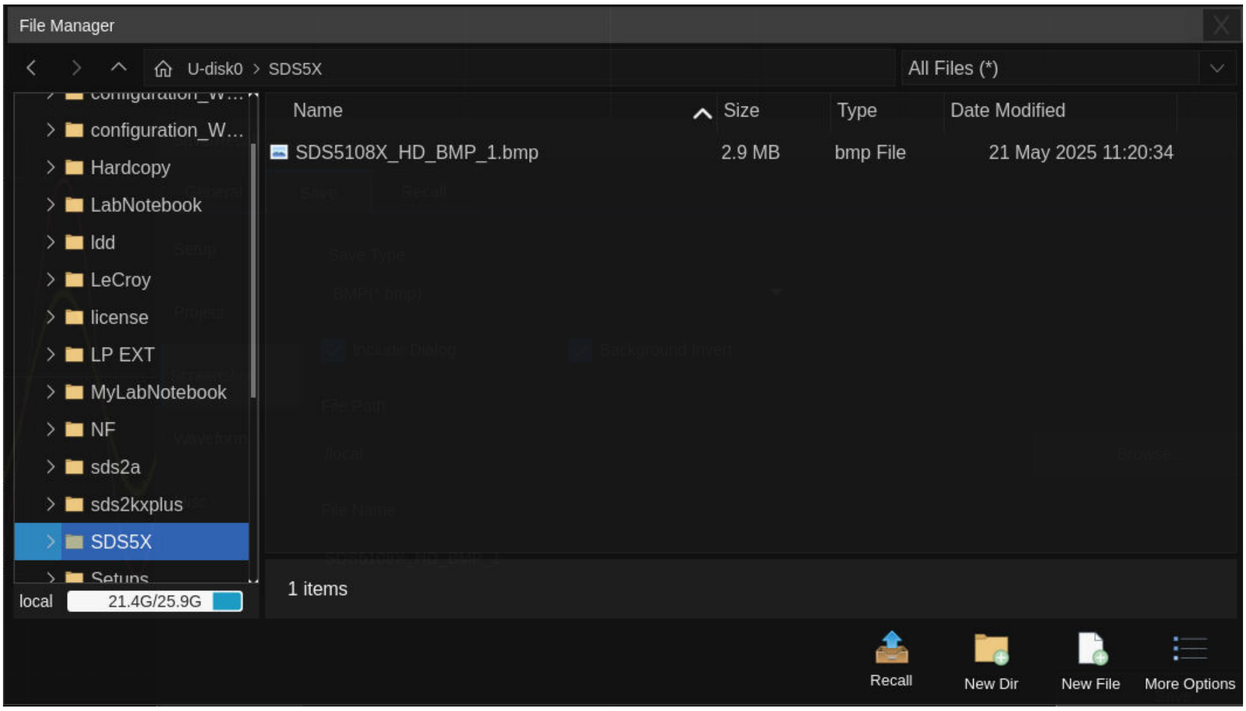
Step 3, Select the "Udisk0\SDS5X\" directory in the file manager.

Click *Browse...* to bring up the file manager, click *Recall* , change the file path to/U-disk0/SDS5X

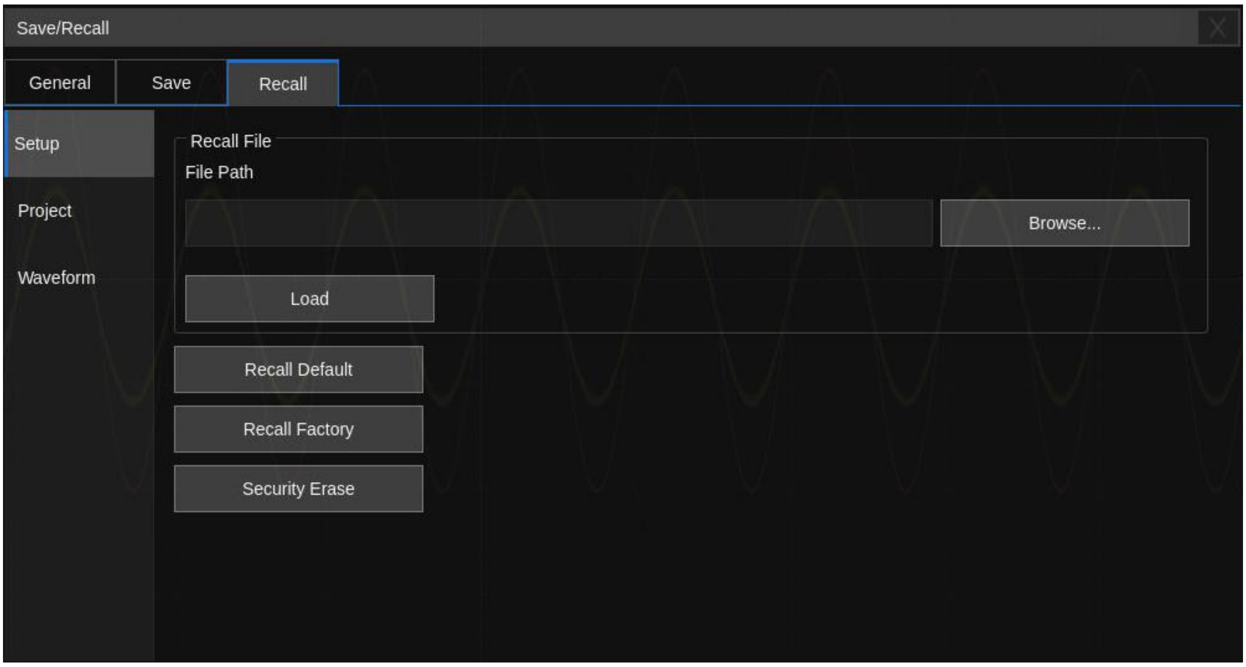




Step 4, click on the file name text box to bring up the virtual keyboard, enter the file name you want to save, and then click save. After saving, you can see the newly added BMP file in the file manager:



2. Call the settings file track.xml saved in the \ SDS5X \ directory on the USB drive



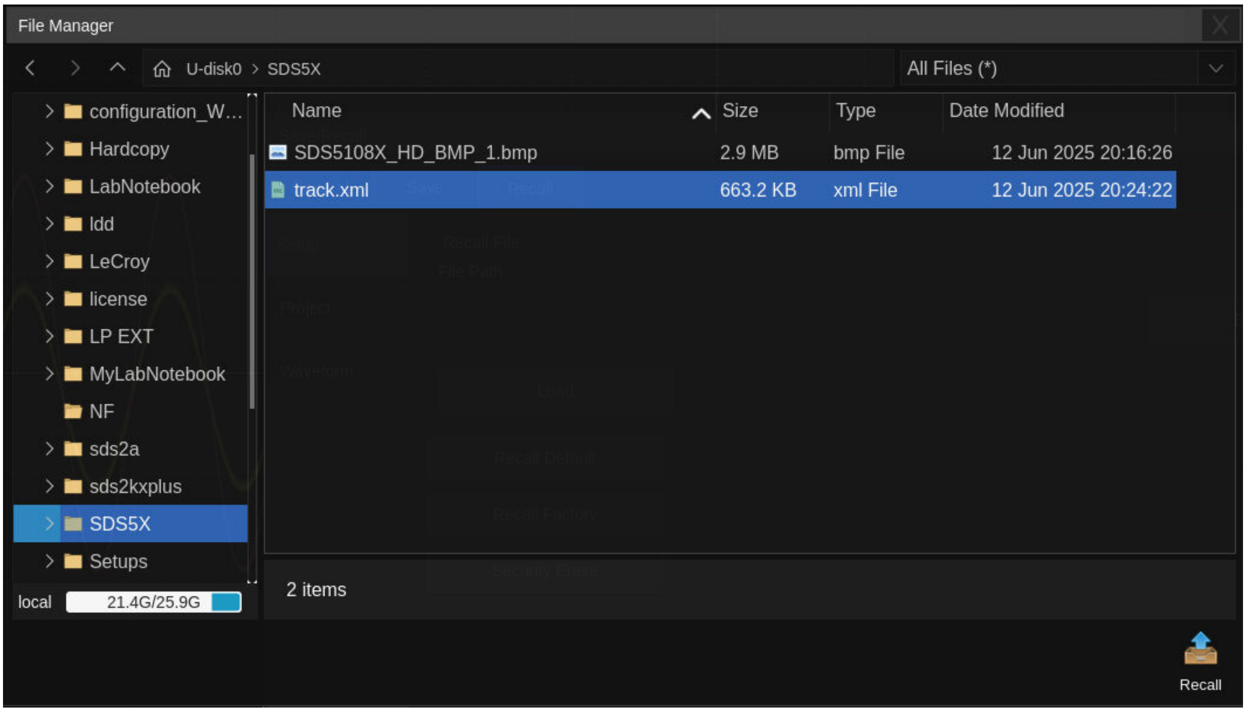
Step 1, Insert the U disk, which should contain the necessary setup files for this example.

Step 2, Set the parameters for recall:

Click *Recall* tab

Click *Browse* and recall the file manager

Step 3 , Select \ Udisk0 \ SDS5X in the file manager, then select the settings file "track. xml", and click to bring up the icon



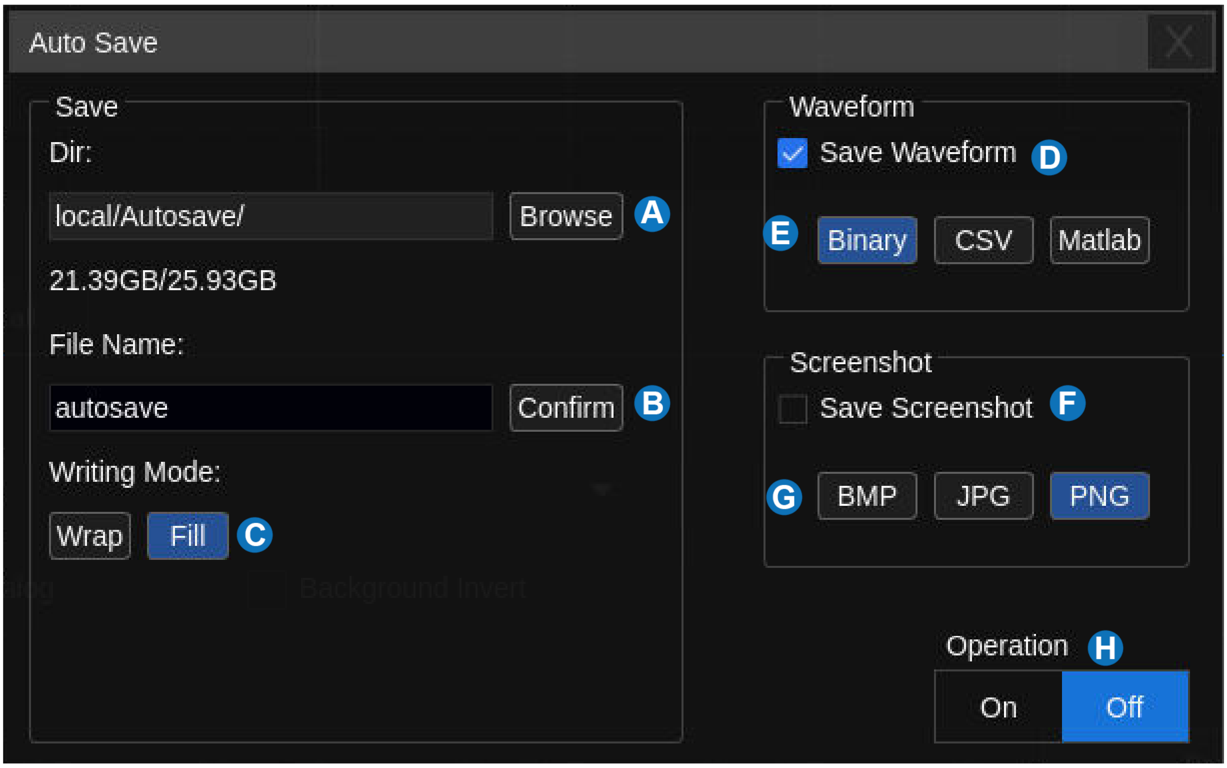
Step 4 , click *Load* and wait for the oscilloscope to be set up.

36.4 Quick Save and Screenshot

For simple screenshot requirements, perform *Utility* > *Bcreenshot* to quickly save screenshots, or directly click the icon at the top right of the window to take a screenshot for the specified window.

36.5 Auto Save

During automatic save operation, a waveform data save or screenshot will be automatically executed for each completed frame of waveform acquisition. Open the trigger settings dialog box through the top menu bar or bottom trigger parameter area, click *General* > *Auto Save* , open the Auto Save dialog box:



A. Directory, specify the path to save, default to internal memory; Display memory size description under the directory text box (remaining memory size/total memory size)

B. File name, default file name is autosave

C. Write mode, selecting overwrite will overwrite and save with the specified file name; Choose to fill up and save in ascending order according to the specified file name. When there is insufficient memory, automatic save will stop running

D. Turn on/off waveform data saving

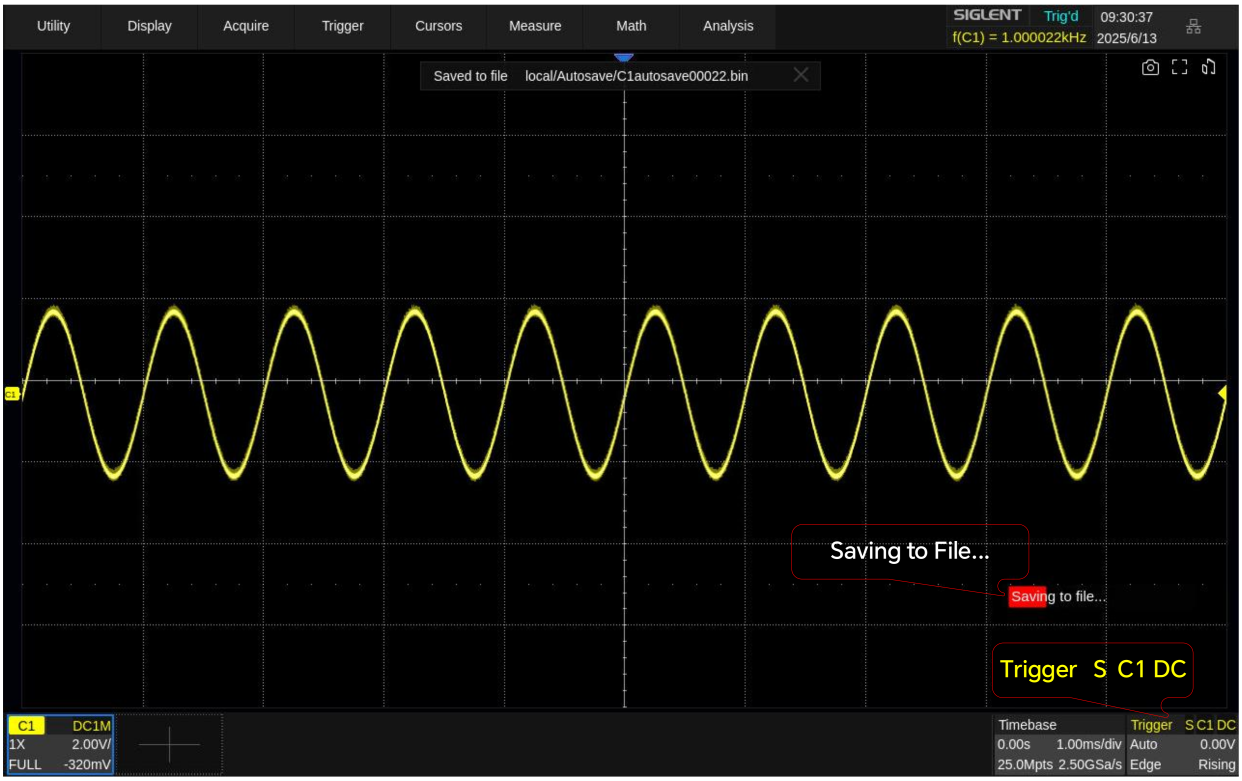
E. Set the waveform data type, and in the pop-up save dialog box, set the waveform parameters for saving

F. Turn on/off screenshot

G. Set the image format, and in the pop-up save dialog box, set the parameters for saving screenshots

H. Turn on/off operation.

When automatically saving and running, the parameter area will display a save indicator, and during the save process, there will be a status prompt in the lower right corner of the waveform display area:



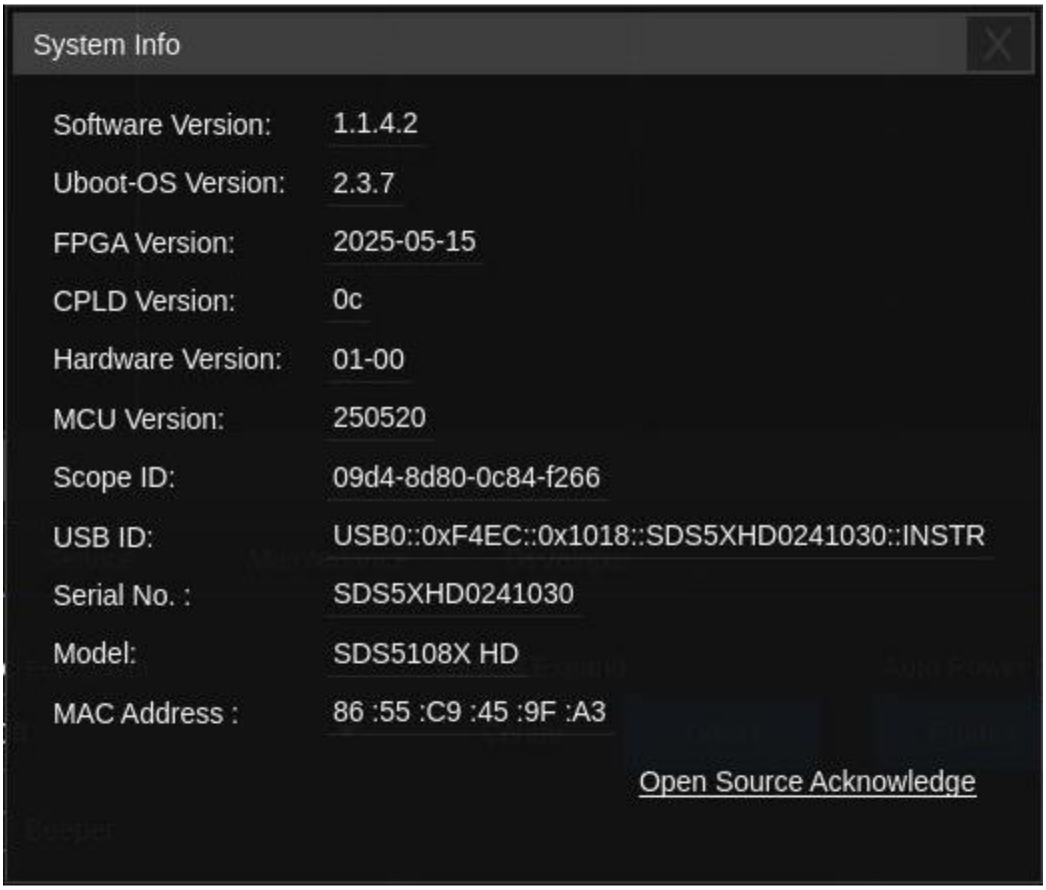
	Note: Auto save cannot modify save parameters during runtime. If you need to modify them, please exit the running state. The file manager cannot be opened during auto save operation. If it is enabled, it will prompt that the operation will exit auto save.

37 Utility

This function module supports the auxiliary functions of oscilloscope, such as viewing system status, setting interface language and sound, and some advanced settings, such as performing self-calibration, upgrading software version and setting interface communication.

37.1 System Information

Operate *Utility* > *Menu* > *System Info* to check the system status. System information includes the contents shown below.



37.2 System Setting

37.2.1 Language

The device supports multiple languages, including Simplified Chinese, Traditional Chinese, English, French, Japanese, German, Spanish, Russian, Italian, Portuguese, and so on.

Operate *Utility* > *Menu* > *System* > *Language* , and select the language in the list.

37.2.2 Screen Saver

The screen saver will be activated if the oscilloscope has not been operated for a period. At this time the output of the display is cut off to save power consumption.

Operate *Utility* > *Menu* > *System* > *Screen Saver* to specify the period before the screen saver activates, or select "Off" to disable the screen saver. Screen saver period can be selected as 1 minute, 5 minutes, 10 minutes, 30 minutes and 1 hour.

After the screen saver takes effect, touching or mouse operation on the oscilloscope can make the oscilloscope exit the screen saver.

37.2.3 Expand Strategy

The expansion strategy of this device is used to set reference points for horizontal and vertical scaling, to adapt to different horizontal and vertical scaling requirements.

Set horizontal expand, see the "Timebase Setup" section for details.

Set vertical expand, operate *Utility* > *Menu* > *System* > *Vertical Expand* , or set it in the Channel Settings dialog box. See the "Channel Setup" section for details.

37.2.4 Power On

Set through *Utility* > *Menu* > *System* > *Auto Power On* .

37.2.5 Screen Saver

The screen saver will be activated if the oscilloscope has not been operated for a period. At this time the output of the display is cut off to save power consumption.

Operate *Utility* > *Menu* > *System* > *Screen Saver* to specify the period before the screen saver activates, or select "Off" to disable the screen saver. Screen saver period can be selected as 1 minute, 5 minutes, 10 minutes, 30 minutes and 1 hour.

After the screen saver takes effect, touching or mouse operation on the oscilloscope can make the oscilloscope exit the screen saver.

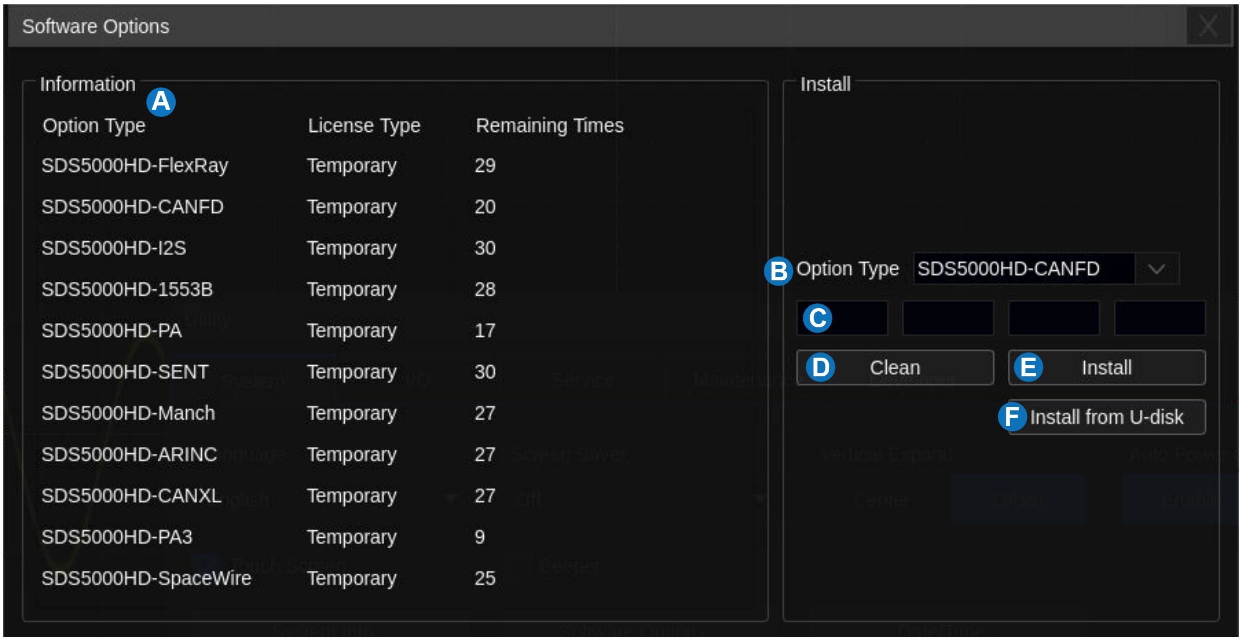
37.2.6 Sound

Follow the steps *Utility* > *Menu* > *System* > *Beeper* to enable or disable the audible buzzer.

37.2.7 Install Options

The device provides a few options to enhance its functionality. Contact your local SIGLENT sales representative or SIGLENT technical support to get the corresponding option key.

Perform the following steps to install the option: *Uility* > *Menu* > *Software Options*



A. Option information display area. When the option is not activated, the license type is displayed as "Temporary" and can be tried up to 30 times.

B. Select the option to install.

C. The option key input area, click the text box, and enter the key by the virtual keyboard.

D. Clear the characters in the key input area.

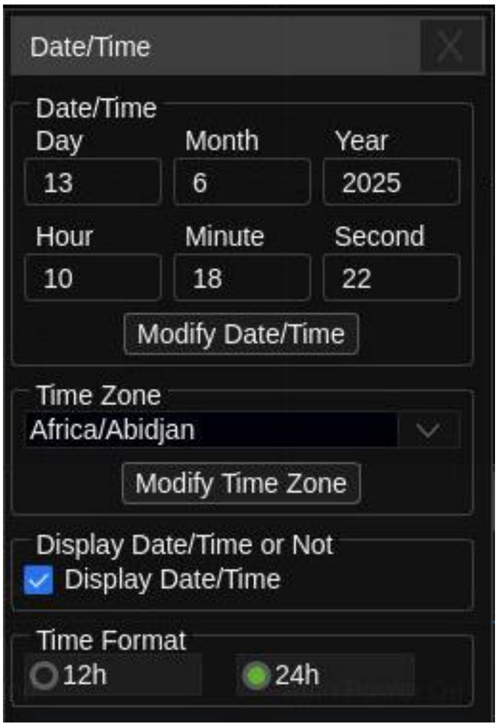
E. After entering the option key, click *Install* to perform the installation.

F. Use the U-disk to automatically install the option, the license must be stored in the root directory of the U-disk.

37.2.8 Date/Time

The SDS5000L has an RTC clock, which helps to record absolute time information for screenshots, history frames, and so on.

Operate *Utility* > *Menu* > *System* > *Date/Time* to open the Date/Time dialog box:



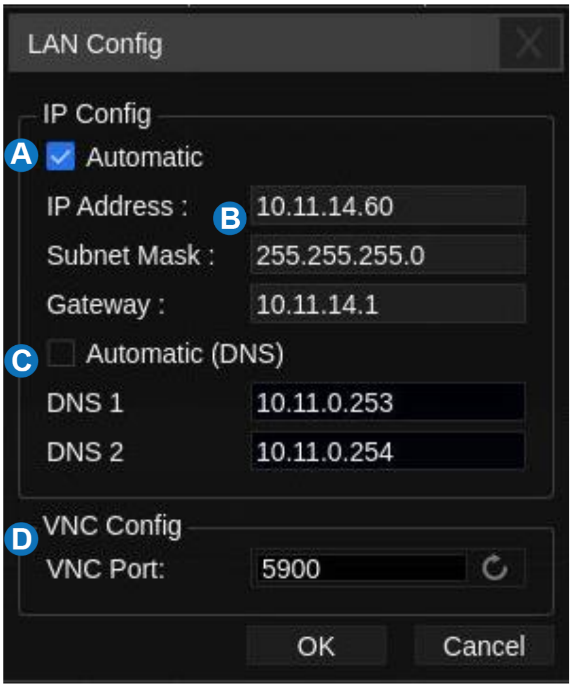
- Click the text box of Hour, Minute, Second, Day, Month, and Year to edit these fields.
- Click the text box of Time Format to select the event format.
- Click the *Modify Date/ Time* button to perform the change.
- Click the text box of Time Zone to select the time zone.
- Click the *Modify Time Zone* button to perform the change.
- Click display date/time or not display

37.3 I/O Setting

37.3.1 LAN

Operate the following steps to set the LAN port:

Perform *Utility* > *Menu* > *I/O* > *LAN Config* to enter the System Settings interface.



A. Check *Automatic* to enable dynamic IP. In this case, the oscilloscope must be connected to the local area network with a DHCP server. Contact your network administrator to confirm the relevant information.

B. When B is not checked, the oscilloscope uses static IP. Set the static IP address, subnet mask, and gateway separately

C. Check *Automatic(DNS)* to enable .

D. When accessing more than two SIGLENT instruments through the web browser, it is necessary to set a different VNC port number for each instrument. The range is from 5900 to 5999.

37.3.2 GPIB

Connect through USB-GPIB adapter. Perform the following steps:

1. Connect the device. Connect the USB end of the USB-GPIB adapter to the USB Host interface on the front panel of the device, and connect the GPIB end to the GPIB card port of the computer.
2. Install GPIB card driver program on the computer. Please install the GPIB card driver correctly to connect to the computer.
3. Set the GPIB port address of the device. Perform *Utility* > *Menu* > *I/O* > *GPIB* , complete numerical input in the pop-up virtual keyboard. Setting range: 1~30.

37.3.3 Clock Source

The clock source of the device can be set to "Internal" or "External". When the clock source is set to "external", the device receives the 10 MHz clock from the "10 MHz In" port on the rear panel and uses it as a reference to generate the sampling clock of the system. Both “internal" and "external" clock sources can be output from the 10 MHz Out port for synchronizing other instruments.

When the clock source is set to "External", an icon indicating an external clock will appear in the lower right corner of the display:

 The clock source is external.

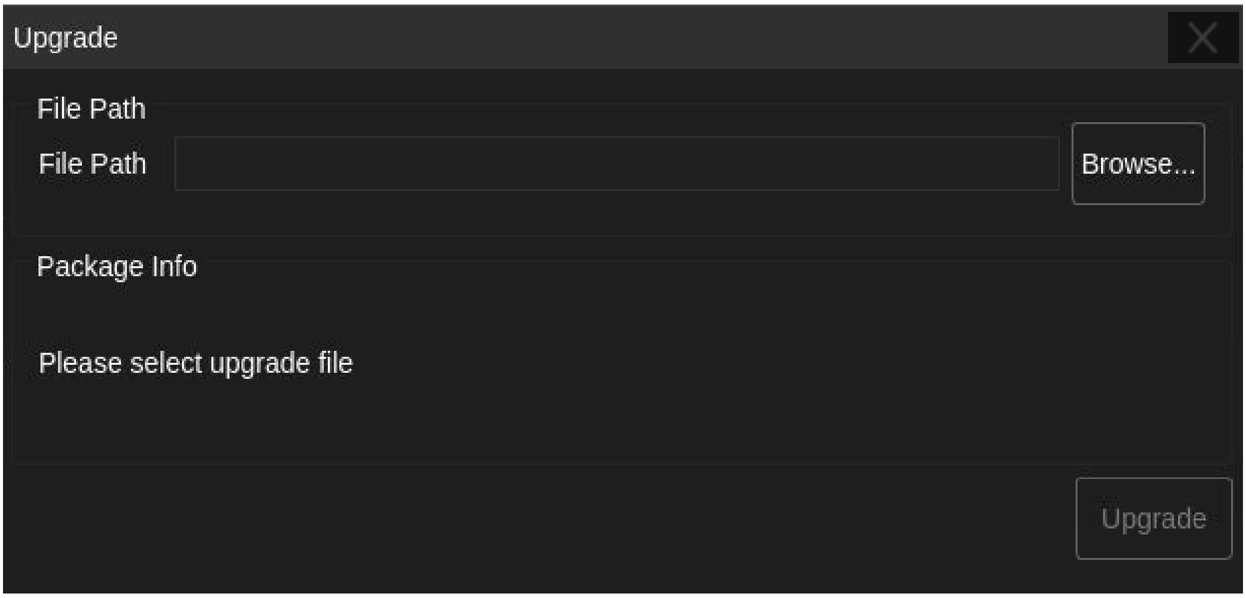
 The clock source is external, but no valid external clock is detected.

37.4 Maintenance

37.4.1 Upgrade

The firmware is upgradeable through an external USB memory device/U disk. Make sure the U disk contains the correct upgrade file (*.ads) and is connected to the oscilloscope before performing the upgrade.

Operate *Utility* > *Menu* > *Maintenance* > *Upgrade* to recall the upgrade dialog box:



Click *Browse* to open the file manager, select the correct upgrade file and click the Recall icon  .

Click *Upgrade* in the upgrade dialog box to start the upgrade. The oscilloscope first copies the upgrade file (*.ads) to the local memory and parses it. If the parse succeeds, it will show the following dialog. Users can choose *Cancel* to cancel the upgrade or *Reboot* to restart the oscilloscope immediately and continue the upgrade. Otherwise, the oscilloscope will restart automatically to finish the upgrade.

After the reboot, check if the version number is in the "System Information".

⚠	**Warning:** Do not turn off the power during upgrading. Otherwise, the oscilloscope may not boot up!

37.4.2 Self-Calibration

The self-calibration program can quickly calibrate the oscilloscope to reach the best working state and the most precise measurement. It is recommended to perform a self-calibration if the change of ambient temperature is more than 5℃.

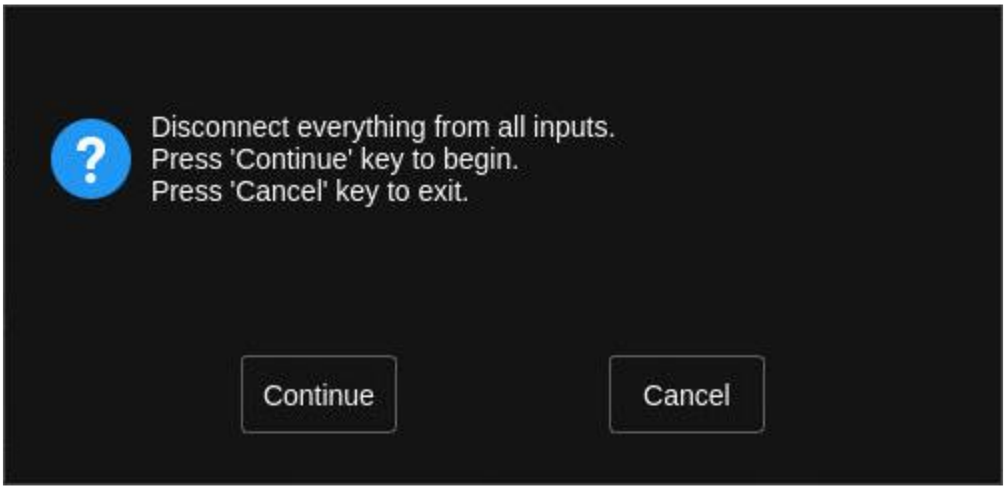
Note:

Make sure the oscilloscope has been warmed up or operated for more than 30 minutes before the self-calibration.

Please do the self-calibration as follows:

Disconnect everything from all inputs.

Operate *Utility* > *Menu* > *Maintenance* > *Self Calibration* , and the following dialog box appears. Select *Continue* to start the self-cal program.



The oscilloscope will not respond to any operation until the self-cal is finished. After the self-cal is completed, click the screen to exit.

37.4.3 Self Test

The Self Test includes screen, keyboard, and LED tests. It is used to check whether the oscilloscope has any electrical or mechanical problems with the user interface such as color distortion, and the sensitivity of buttons and knobs.

Screen Test

The screen test is used to find out whether the oscilloscope display has serious color distortion, bad pixels, or screen scratches.

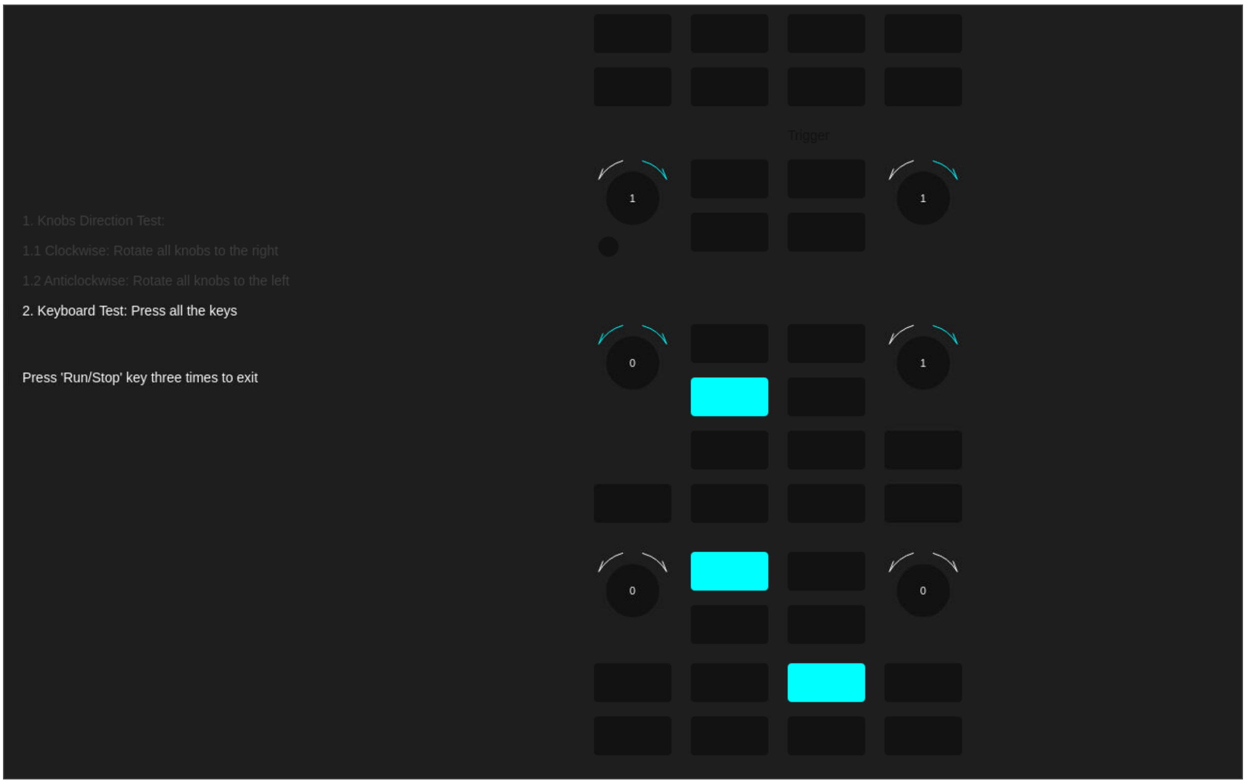
Perform *Utility* > *Menu* > *Maintenance* > *Self Test* > *Screen Test* , and the oscilloscope will enter the screen test interface as shown below. The screen displays in pure red at first.

Press the Single button to switch to green and blue display mode. Observe whether there is any color distortion, bad pixels, or scratches on the screen. Press the Run/Stop button to exit the screen test mode.

Keyboard Test

The keyboard test is used to check whether the oscilloscope front panel buttons or knobs are responsive or sensitive.

Perform *Utility* > *Menu* > *Maintenance* > *Self Test* > *Keyboard Test* to enter the keyboard test interface shown below:



Knob test -- Turn each knob clockwise, counter-clockwise, and press down. Observe whether the value on the corresponding knob (default 0) on the screen increases or decreases in real-time and whether the knob lights up when it is pressed.

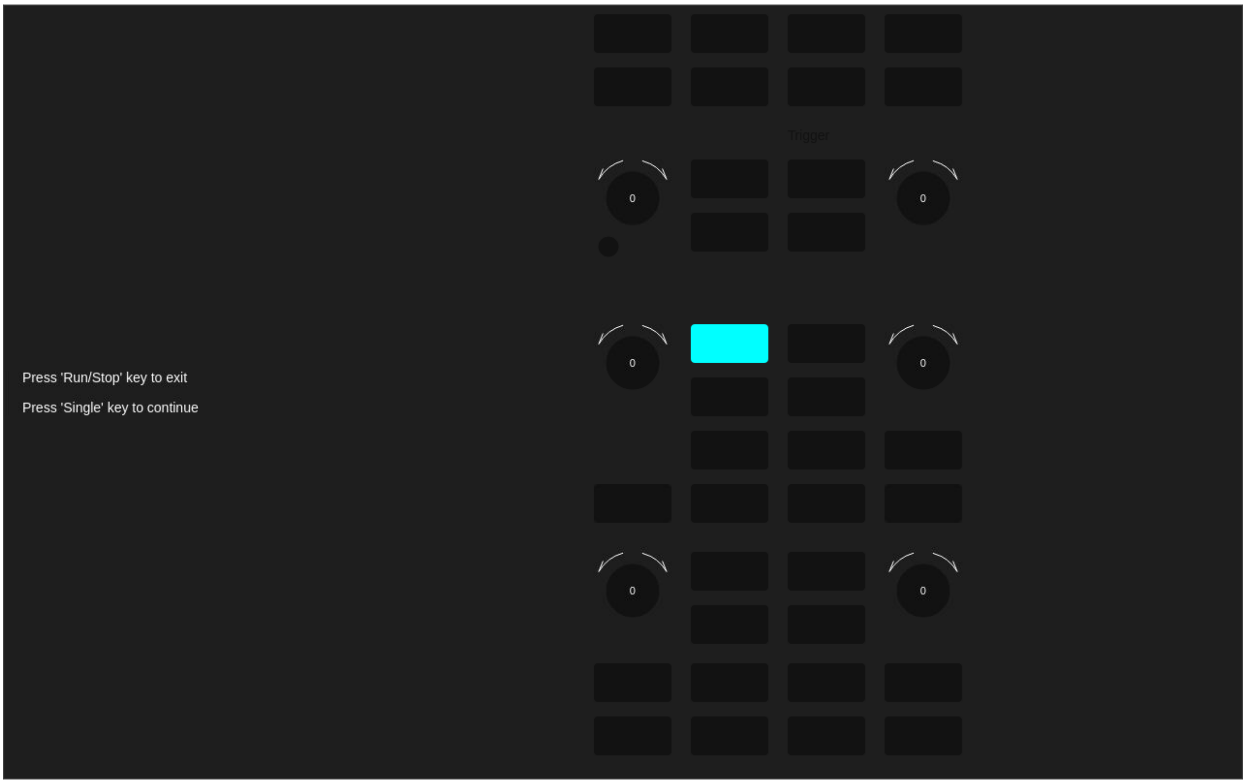
Button test -- Press each button and check whether the corresponding button icon on the screen lights up in real-time.

After all knobs and buttons have been tested, press the Run/Stop button three times continuously to exit the keyboard test.

LED Test

The LED test is used to check whether the button backlight on the front panel is functional.

Perform *Utility* > *Menu* > *Maintenance* > *Self Test* > *Keyboard Test* to enter the LED test interface shown below:



Press Single button and the first LED on the front panel will light. The corresponding position of the key on the screen will also change color. Press the Single button to check the next button.

Press the Single button consecutively until all the backlights are tested. Press the Run/Stop button to exit the LED test.

37.5 Developer Options

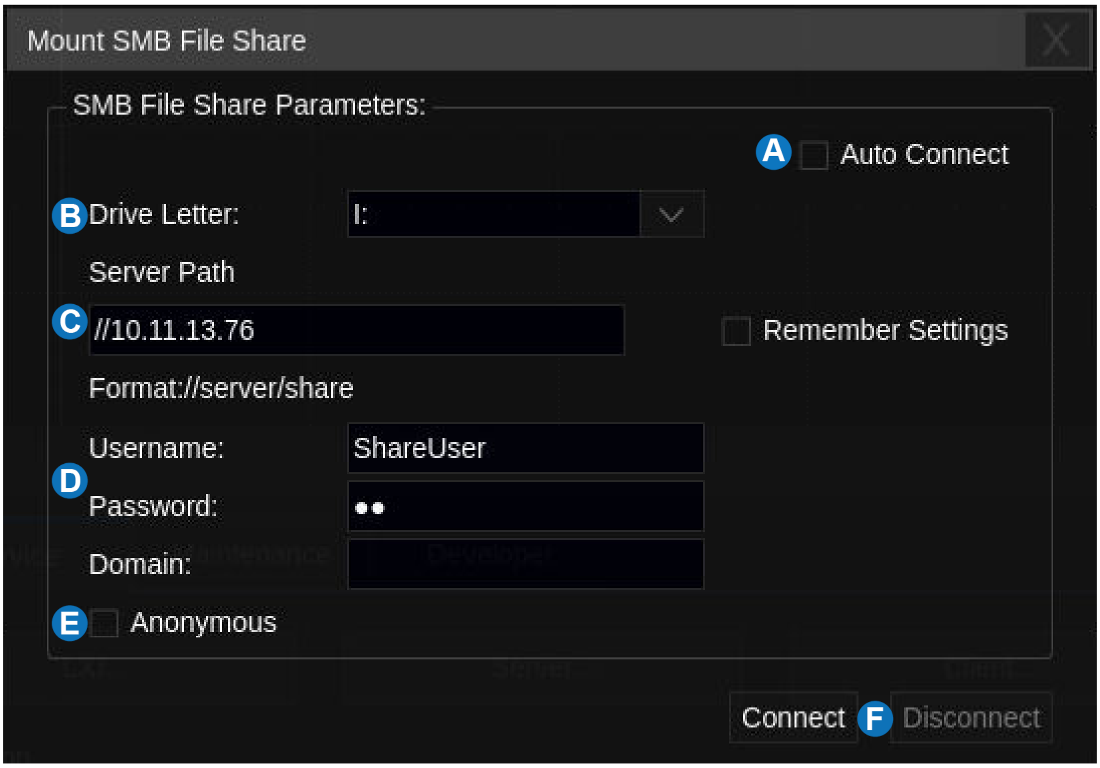
This function is used for internal development by SIGLENT.

37.6 Service

37.6.1 SMB File Share

Perform *Unity* > *Menu* > *Services* > *SMB file share* to enter the "Mount SMB File Share" interface. The device supports two types of SMB settings: Client and Server.

When the device serves as Client, set the network storage path and the content related to access permissions, the can store or recall files on the specified path. When the device being accessed in network access serves as Server, set up a shared directory and access permissions on the server, and then set up network storage on device.



A. Select "Auto Connect" to automatically connect to the server after each startup.

B. Select the drive letter.

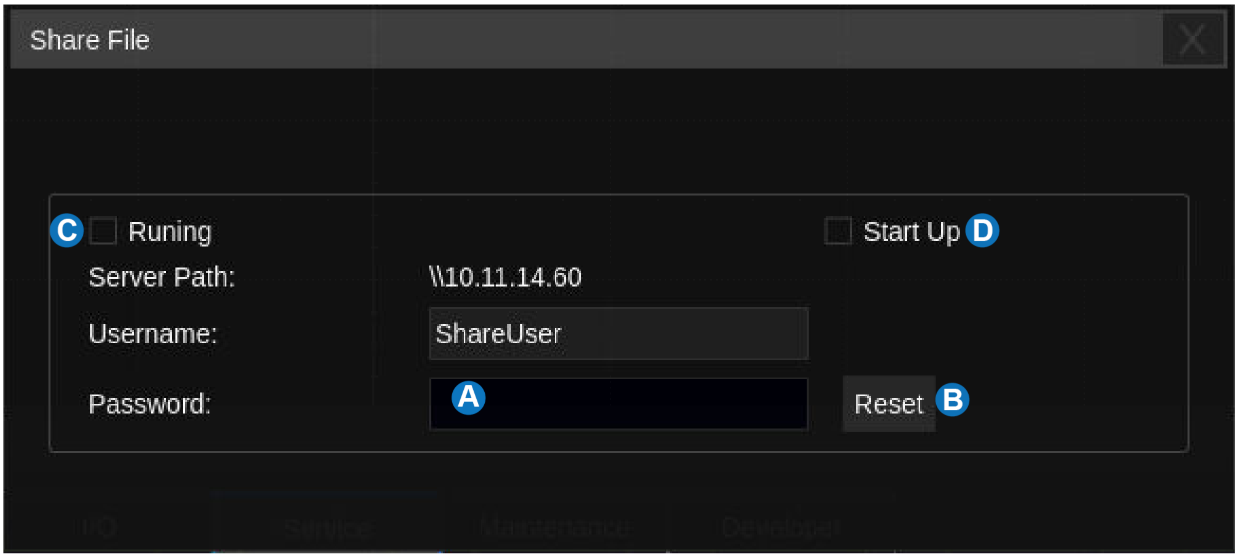
C. Set the server path. Enter the path in the text box, and select “Remember Settings” to save the path.

D. Enter user name and password in the text box.

E. Select "Anonymous" to access the specified path in the default guest mode (username: Guest, password: none), and it needs to be set on the server to allow anonymous access.

F. Manually connect or disconnect.

As Server, the IP address of the deviceis automatically imported from the IP address obtained from LAN settings, and the username is fixed as "ShareUser", and user only needs to set the password and confirm the settings to access it.



A. Password setting area.

B. Reset the password.

C. When selected, file share service will take effect, otherwise it will not take effect.

D. Check to automatically start up the share file at every power on.

37.6.2 Web

The device includes a web server function, you can access and control the oscilloscope using a web browser. See the section "Web Browser" for details about remote control.

37.6.3 Emulation

When the "Emulation" option is set to "Tektronix", the SCPI command set of the instrument is changed to be compatible with Tek. This setting can help the user switch from a Tek scope with minimum changes to the existing code.

38 Troubleshooting

The commonly encountered failures and their solutions are listed below. When you encounter those problems, please solve them using the corresponding steps. If the problem remains, please contact SIGLENT as soon as possible.

1. The screen is still dark (no display) after power on:
   1) Check whether the power is correctly connected.
   2) Check whether the power switch is on.
   3) Check whether the fuse is burned out. If the fuse needs to be changed, please contact SIGLENT timely and return the instrument to the factory for replacement by the maintenance personnel authorized by SIGLENT.
   4) Restart the instrument after finishing the above inspections.
   5) If it still does not work correctly, please contact SIGLENT.

Note:
It takes up to 1 minute from power on to display an image on an external monitor.

2. The signal is sampled but no waveform of the signal is displayed:
   1) Check whether the probe is correctly connected to the signal connecting wire.
   2) Check whether the signal connecting wire is correctly connected to the BNC (namely channel connector).
   3) Check whether the probe is correctly connected to the item to be tested.
   4) Check whether there are signals generated from the item to be tested.
   5) Resample the signal.

3. The tested voltage amplitude is greater or lower than the actual value (Note that this problem usually occurs when the probe is used):
   1) Check whether the attenuation coefficient of the channel complies with the attenuation ratio of the physical probe.
   2) Disconnect the oscilloscope from the external signal and do a self-cal.

4. There is a waveform display but not stable:

1) Check the trigger signal source: check whether the source item at the trigger panel complies with the signal channel used.

2) Check whether it is a "false wave": when the signal frequency is very large (more than half of the sample rate), it is easy to appear as a "false wave". At this point, a small timebase should be set to make the sample rate more than 2 times the signal frequency.

3) Check the trigger type: general signals should use the "Edge" trigger and video signals should use the "Video" trigger. Only when the proper trigger type is used, can the waveform be displayed stably.

4) Change the trigger holdoff setting.

5. No display after performing *Acquire* > *Run* :

   Check whether the mode at the trigger panel (TRIGGER) is on "Normal" or "Single" and whether the trigger level exceeds the waveform range. If yes, set the trigger level to the middle or set the mode to "Auto".

6. The USB storage device cannot be recognized:

   1) Check whether the USB storage device can work normally.

   2) Make sure the USB interface can work normally.

   3) Make sure that the USB storage device being used is a flash storage type. This oscilloscope does not support hardware storage type.

   4) Make sure that the U disk system format is FAT32.

   5) Restart the instrument and then insert the USB storage device to check it.

   6) If the USB storage device still cannot be used normally, please contact SIGLENT.

SIGLENT®

About SIGLENT

SIGLENT is an international high-tech company, concentrating on R&D, sales, production and services of electronic test & measurement instruments.

SIGLENT first began developing digital oscilloscopes independently in 2002. After more than a decade of continuous development, SIGLENT has extended its product line to include digital oscilloscopes, isolated handheld oscilloscopes, function/arbitrary waveform generators, RF/MW signal generators, spectrum analyzers, vector network analyzers, digital multimeters, DC power supplies, electronic loads and other general purpose test instrumentation. Since its first oscilloscope was launched in 2005, SIGLENT has become the fastest growing manufacturer of digital oscilloscopes. We firmly believe that today SIGLENT is the best value in electronic test & measurement.

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