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Keysight U1610/20A Handheld Digital Oscilloscope

KEYSIGHT TECHNOLOGIES

User's Guide

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Safety Information

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Safety Symbols

The following symbols on the instrument and in the documentation indicate precautions that must be taken to maintain safe operation of the instrument.

	Direct current (DC)		Equipment protected throughout by double insulation or reinforced insulation
	Alternating current (AC)		Earth (ground) terminal
	Both direct and alternating current	**CAT II**	Category II overvoltage protection
	Caution, risk of danger (refer to this manual for specific Warning or Caution information)	**CAT III**	Category III overvoltage protection
	Caution, risk of electric shock		

General Safety Information

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements.

WARNING

- Remove all unused scope (oscilloscope) probes, DMM (digital multimeter) test leads, or USB cable.
- Do not connect the DMM test leads and scope probes at the same time.
- Disconnect the scope probe from the instrument before using the DMM functions.
- Disconnect the DMM test leads from the instrument before using the scope functions.

WARNING

To avoid electrical shock or fire during battery replacement:

- Disconnect test leads, probes, power supply, and USB cable before opening case or battery cover.
- Do not operate the instrument with the battery cover open.
- Use only specified insulated probes and test leads.
- Use only the 10.8 V Li-Ion battery pack supplied with the instrument.

WARNING

To prevent fire or injury:

- Use only the designated AC/DC adapter and test leads supplied with the instrument.
- Observe all ratings and markings on the instrument before connecting to the instrument.
- When performing measurements, ensure that the right safety and performance ratings of instrument and accessories are used.

WARNING

- Plug the probe or test leads to the instrument before connecting to any active circuit for testing. Before disconnecting from the instrument, remove the probe or test leads from the active circuit.
- Do not connect the USB cable when not in use. Keep the USB cable away from any probe, test lead, or exposed circuitry.
- Do not expose the circuit or operate the instrument without its cover or while power is being supplied.
- Do not use exposed metal BNC or banana plug connectors. Use only the insulated voltage probes, test leads, and adapters supplied with the instrument.
- Do not supply any voltage when measuring resistance or capacitance in multimeter mode.
- Do not operate the instrument if it does not operate properly. Have the instrument inspected by qualified service personnel.
- Do not operate the instrument in wet or damp environments.
- Do not operate the instrument in any environment at risk of explosion. Do not operate the instrument in the presence of flammable gases or flames.
- Keep the instrument surface clean and dry. Keep the BNC connectors dry especially during high-voltage testing.

WARNING

Maximum Input Voltages

- Input CH1 and CH2 direct (1:1 probe) – CAT III 300 Vrms
- Input CH1 and CH2 via 10:1 probe – CAT III 600 Vrms[1], CAT II 1000 Vrms[1]
- Input CH1 and CH2 via 100:1 probe – CAT III 600 Vrms[1], CAT II 1000 Vrms[1],CAT I 3540 Vrms[1]
- Meter input – CAT III 600 Vrms, CAT II 1000 Vrms
- Scope input – CAT III 300 Vrms
- Voltage ratings are Vrms (50 – 60 Hz) for AC sine wave and VDC for DC applications.

Maximum Floating Voltage

- Meter input - From any terminal to earth ground - CAT III 600 Vrms
- Scope input - From any terminal to earth ground - CAT III 300 Vrms

---

[1] Refer to the respective probe's manual for more information on the specification.

CAUTION

- If the instrument is used in a manner not specified by the manufacturer, the instrument protection may be impaired.
- Always use a dry cloth to clean the instrument. Do not use ethyl alcohol or any other volatile liquid.
- It is recommended to use the instrument under ventilated conditions and in the upright position to ensure adequate airflow at the rear.
- Always cover the DC power inlet and the USB port by closing the lid when not in used.

CAUTION

Electrostatic discharge (ESD) can result in damage to the components in the instrument and accessories. To prevent electrostatic discharge (ESD):

- Select a static-free work location when installing and removing sensitive equipment.
- Handle sensitive components to the minimum extent possible. Do not allow contacts between components and exposed connector pins.
- Transport and store in ESD preventive bags or containers that protect sensitive components from static electricity.
- The battery (optional) must be properly recycled or disposed.

Measurement Category

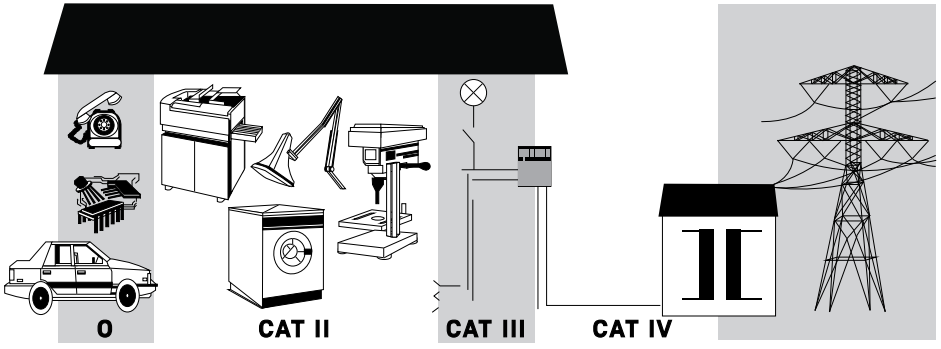
This instrument is intended to be used for measurement in Measurement Category II and III.

O Other circuits that are not directly connected to the mains.

Measurement CAT II Measurements performed on circuits directly connected to a low-voltage installation. Examples are measurements on household appliances, portable tools, and similar equipment.

Measurement CAT III Measurements performed in the building installation. Examples are measurements on distribution boards, circuit- breakers, wiring, including cables, bus-bars, junction boxes, switches, socket outlets in the fixed installation, and equipment for industrial use, and some other equipment including stationary motors with permanent connection to the fixed installation.

Measurement CAT IV Measurements performed at the source of the low-voltage installation. Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units.



Environmental Conditions

This instrument is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

Environmental conditions	Requirements
Temperature	Operating condition: – 0 °C to 50 °C (with battery only) – 0 °C to 40 °C (with power adapter) Storage condition: – -20 °C to 70 °C
Humidity	Operating condition: – Up to 80% RH (0 °C to 35 °C) (non-condensing) – Up to 50% RH (non-condensing) – 35 °C to 40 °C (with power adapter) – 35 °C to 50 °C (with battery only) Storage condition: – Up to 95% RH at 40 °C (non-condensing)
Altitude	Up to 2000 m
Pollution degree	2

NOTE

The U1610/20A Handheld Digital Oscilloscope complies with the following safety and EMC requirements:

- IEC 61010-1:2010/EN 61010-1:2010
  IEC 61010-2-030:2012/EN 61010-2-033:2012
- Canada: CAN/CSA-C22.2 No. 61010-1-12
  CAN/CSA-C22.2 No. 61010-2-030-12
  CAN/CSA-C22.2 No. 61010-2-033-12
- USA: ANSI/UL Std. No. 61010-1:2012
  ANSI/UL Std. No. 61010-2-030 (1st Edition)
  ANSI/UL Std. No. 61010-2-033 (1st Edition)
- IEC 61326-1:2012/EN 61326-1:2013
- Australia/New Zealand: AS/NZS CISPR 11:2011
- Canada: ICES/NMB-001: ISSUE 4, June 2006

Regulatory Markings

	The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives.		The RCM mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australia EMC Framework regulations under the terms of the Radio Communication Act of 1992.
	ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada. ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product.		This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.
	The CSA mark is a registered trademark of the Canadian Standards Association.		Product contains restricted substance(s) above maximum value, with a 40-year Environmental Protection Use Period.

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.

Do not dispose in domestic household waste.

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This chapter provides you the information to start using your handheld scope.

Introduction

The U1610/20A Handheld Digital Oscilloscope is a mobile high-performance troubleshooting tool for multi-industrial automation, process control, facility maintenance, and automotive-service industries.

The U1610A and U1620A models have 100 MHz and 200 MHz bandwidths with maximum real-time sample rates of 1 GSa/s and 2 GSa/s respectively.

With its 5.7-inch LCD color display, the U1610/20A oscilloscope is capable of clearly distinguishing waveforms from two channels. The U1610/20A allows you to perform up to 30 types of automatic measurements. Waveform math and Fast Fourier Transform (FFT) functions are available for performing quick waveform analyses in both time and frequency domains.

The U1610/20A can also function as a digital multimeter (DMM) and a data logger. The autorange function provided allows you to perform quick and accurate DMM measurements. Using the data logger function, you can perform automatic data logging for DMM and scope measurements.

Package Contents

When you receive your shipping container, unpack and inspect the container for damage.

If the shipping container is damaged or the cushioning materials show signs of stress, notify the carrier and your nearest Keysight Sales Office. Keep the damaged shipping container or cushioning material until you have inspected the contents of the shipment for completeness and have checked the handheld scope mechanically and electrically.

Verify that you have received the following items in the handheld scope packaging:

- ✔ 1 × Handheld scope
- ✔ 1 × Power cable
- ✔ 1 × Li-Ion battery pack, 10.8 V (included in the handheld scope)
- ✔ 1 × AC/DC adapter
- ✔ 2 × 10:1 CAT III 600 V scope probe
- ✔ 1 × BNC-to-probe adapter
- ✔ 1 × DMM test lead kit
- ✔ 1 × USB cable
- ✔ 1 × Hand strap (attached on the handheld scope)
- ✔ 1 × Neck strap
- ✔ 1 × Printed Quick Start Guide
- ✔ 1 × Certificate of Calibration

If anything is missing, contact your nearest Keysight Sales Office.

NOTE **The items above are available for purchase separately if you require more quantities.**

Inspect the handheld scope

If there is mechanical damage or a defect, or if the handheld scope does not operate properly or does not pass performance tests, notify your nearest Keysight Sales Office.

Optional Accessories

The following accessories are available for purchase separately.

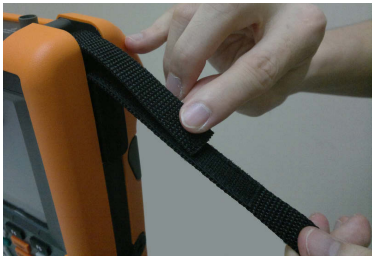
- 1:1 CAT III 300 V scope probe
- 100:1 CAT III 600 V scope probe
- Temperature module
- Desktop charger
- Soft carrying case

Adjust the Hand Strap

For better grip, peel open the strap and adjust the two velcro strips as shown below.

Install the Neck Strap

Thread the velcro strip through the strap hole. Adjust the strap to the maximum length and secure it as shown below.



Charge the Battery

NOTE **Unplug the power adapter when measuring signals to improve the common mode rejection.**

Before using the handheld scope for the first time or after a prolonged storage period, fully charge the battery for at least 3 hours, with the handheld scope turned off, using the AC/DC adapter provided. If the battery is fully discharged after subsequent use, charge the battery with the handheld scope turned on.

The power key will turn constant yellow when the battery is fully charged.

Tilt the Handheld Scope

For proper handling during operation, tilt the handheld scope as shown below.

Power On/Off the Handheld Scope

NOTE **Hook up all cables and accessories before applying power. You can connect/disconnect probes while the handheld scope is turned on.**

Press and hold ⏻ for approximately 3 seconds to power on the handheld scope. When the handheld scope display appears, the scope is ready for use.

Press and hold ⏻ for approximately 3 seconds to power off the handheld scope. The display will take some time to turn off.

Press and hold ⏻ for approximately 10 seconds to power cycle the handheld scope.

NOTE **If the handheld scope is not able to power cycle after pressing and holding ⏻ for approximately 10 seconds, remove and reinsert the battery.**

Use the Function Softkeys

Press the softkey (F1 to F5) that corresponds to the label shown above it on the display.

Access the Quick Help

Press any function key/softkey followed by Help to display its respective Help information. Use the ▲ or ▼ key to navigate within Help.

To view Help in another language, press User > System Settings > Language <English> and use the ◀▲▼▶ keys to select the language. Press Language <English> again to exit the selection menu.

To access information on using Help, press and hold Help for approximately 3 seconds.

Reset the Handheld Scope

Reset the handheld scope to its default settings by pressing Save/Recall > Default Settings. This removes all previous user-defined configurations.

NOTE

Before resetting the handheld scope, you may want to save the current configuration for later use by pressing Save/Recall > Save. See Chapter 3, "Save and Recall Controls" on page 85.

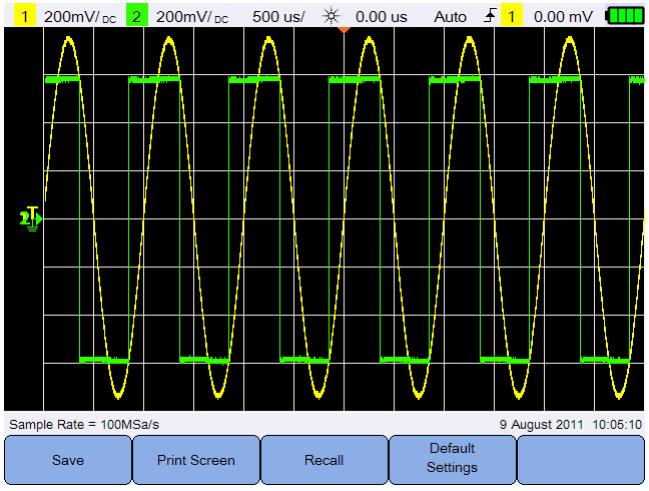


Figure 1-1 Default Settings function

Perform Self-Calibration

When performing self-calibration, no signal is injected into the handheld scope. During the self-calibration process, the firmware will perform zero, offset, and TDC calibration.

- For zero calibration, the firmware will acquire samples for a fixed period of time corresponding to the zero input condition. The acquired data contains channel noise and DC offset. The firmware determines this channel DC offset and upon completion of self-calibration, uses the determined DC offset to subtract from ADC samples, producing offset-compensated samples. This feature is useful for removing channel DC offset due to temperature changes and component aging, thus providing better accuracy.
- Offset calibration (performed after completion of the zero calibration) calibrates the system offset DAC for gain accuracy. During calibration, the firmware determines the offset DAC code settings required to offset the zero input signal trace to +4 divisions and –4 divisions (vertical). The codeword range for the offset DAC to move the zero input trace across ±4 division range will represent the offset DAC gain. This gain changes due to temperature variation and component aging. Offset calibration corrects for this drift in the offset DAC gain.
- TDC calibration calibrates and corrects for errors (due to temperature variation) in the time interval measurement performed by the TDC circuit.

Allow the handheld scope to warm up for at least 30 minutes before performing self-calibration. It is recommended that you perform self-calibration in the following situations:

- Every 12 months or after 2000 hours of operation.
- If the ambient temperature is >10 °C from the calibration temperature.
- To maximize the measurement accuracy.
- After experiencing abnormal operation.
- To verify proper operation after repairing.

WARNING **Disconnect all probe and meter connections to the input terminals of the handheld scope before performing self-calibration.**

Press User > Service > Self Cal to start self-calibration.

If you want to restore factory calibration constants, press Restore Cal Factor.

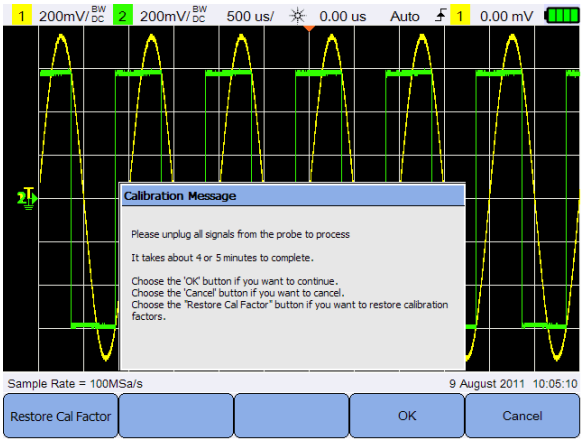


Figure 1-2 Self-Cal notification

Set the Date and Time and Language

Press User > System Settings to access the general system settings.

Press Set Date & Time to set the current date and time of day (24-hour format). Press any softkey and use the ▲ or ▼ key to set the year, month, day, hour, or minute.

NOTE

- **The real-time clock only allows selection of valid dates. If a day is selected and the month or year is changed so the day is invalid, the day is automatically adjusted.**
- **Set Date & Time is only accessible when in the Scope mode.**

Press Language <English> and use the ◀▲▼▶ keys to set any of the 10 languages (English, Spanish, French, Italian, German, Portuguese, Simplified Chinese, Traditional Chinese, Japanese or Korean). Press Language <English> again to exit the selection menu.

Connect Probes to Oscilloscope Terminals

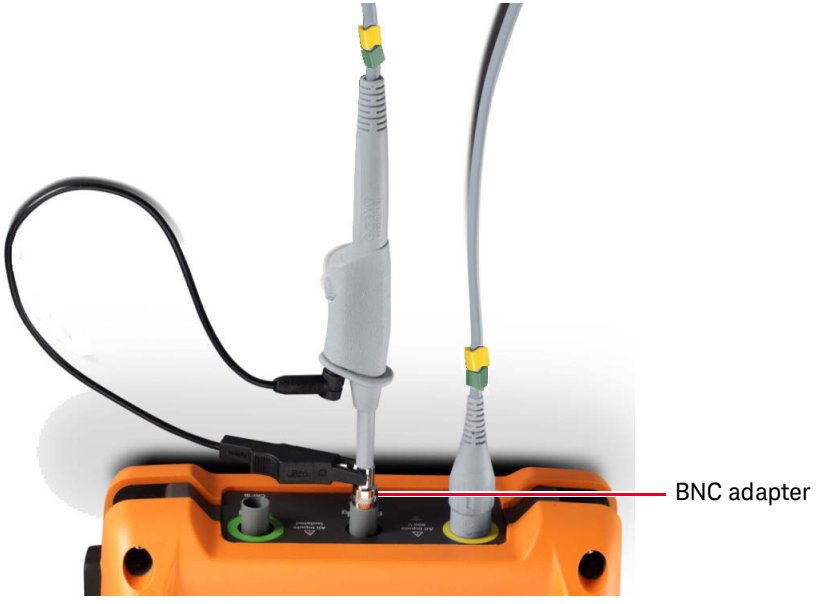
Connect the handheld scope in either single channel or dual channels with scope probes as shown below.

Compensate the Scope Probe

Perform scope probe compensation whenever you attach a passive scope probe to any input channel for the first time. This is important to match the probe characteristic to the handheld scope. A poorly compensated probe can introduce significant measurement errors.

To adjust the probe compensation for a channel:

1. Connect the passive probe to the channel terminal and the probe contact to the external trigger terminal using a BNC adapter as shown below.
2. Press Scope, then toggle Probe Comp <Off> to turn on the compensation signal for a channel.
3. Press Probe <1:1> repeatedly to set the probe attenuation factor.
4. The input signal is 5 Vpp, 1 kHz from the external trigger.



Use a nonmetallic tool to adjust the trimmer capacitor on the probe for the flattest pulse possible.

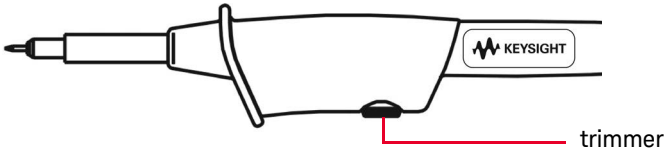


Figure 1-3 Trimmer capacitor

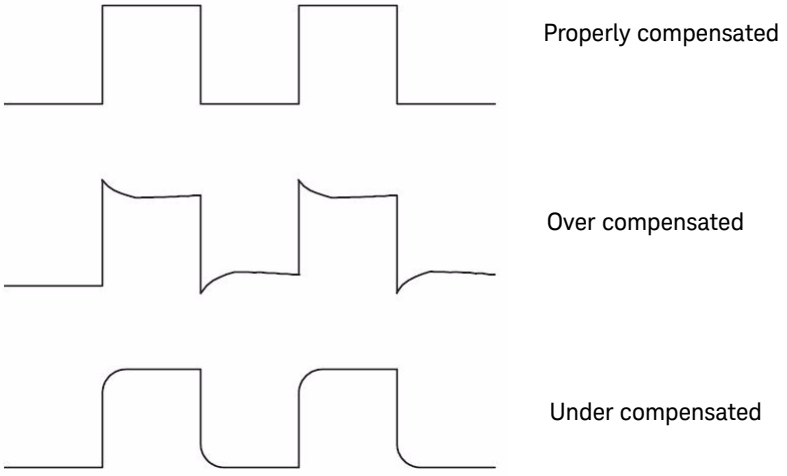


Figure 1-4 Pulse shape reference

Independently Isolated Scope Input Channels

There are two main categories of signal sources:

- Earth ground referenced signal—the voltage signals are referenced to a system ground, such as earth ground.
- Floating ground referenced signal—a floating signal in which the voltage signal is not referenced to earth ground.

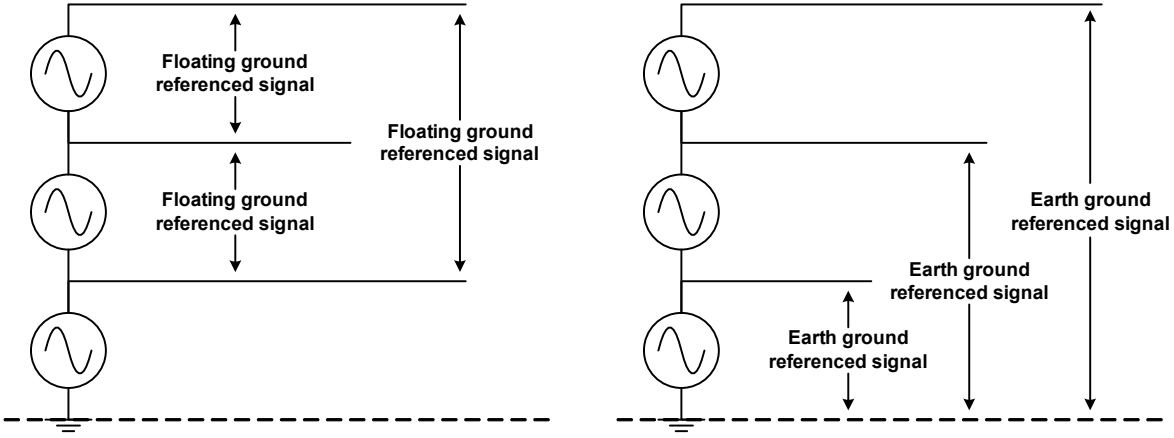


Figure 1-5 Floating ground reference signal and earth ground reference signal

When measuring floating signals with instruments that have multiple inputs, unwanted ground loops may occur. These ground loops can induce measurement errors and cause electrical shock or power surges. Ground loop occurs between the negative terminals of two inputs as shown in Figure 1-6.

Instruments with channel-to-channel isolation can be used to eliminate the ground loops. Isolated channels separate the two signal path effectively from each other by eliminating any potential common circuit path between the two inputs.

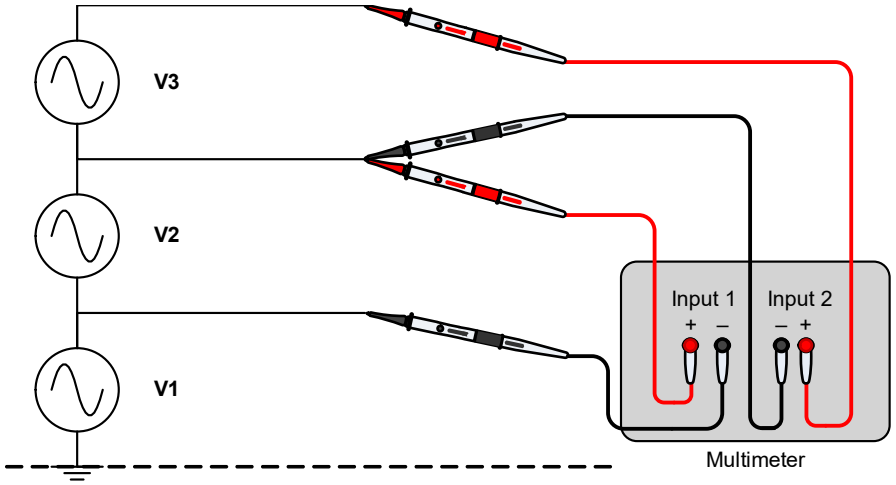


Figure 1-6 Ground loop

The handheld scope input channels, external trigger, USB, and AC/DC adapter are electrically isolated from each other. This level of isolation allows you to:

- measure floating signal between channels without any unwanted ground loops.
- latch trigger points freely on the circuit.
- connect to the PC using the USB port for monitoring as the port is isolated from the handheld scope.
- monitor your device-under-test while charging the handheld scope.

Figure 1-7 outlines the handheld scope channel isolation. The chassis and the controls of an isolated-input channel are designed with plastic, rubber, or other types of insulating material. Each input channel (CH1, CH2, and Ext. Trig) is isolated with Keysight isolation technology architecture and the ground leads are referred to any ground potential as shown in Figure 1-7.

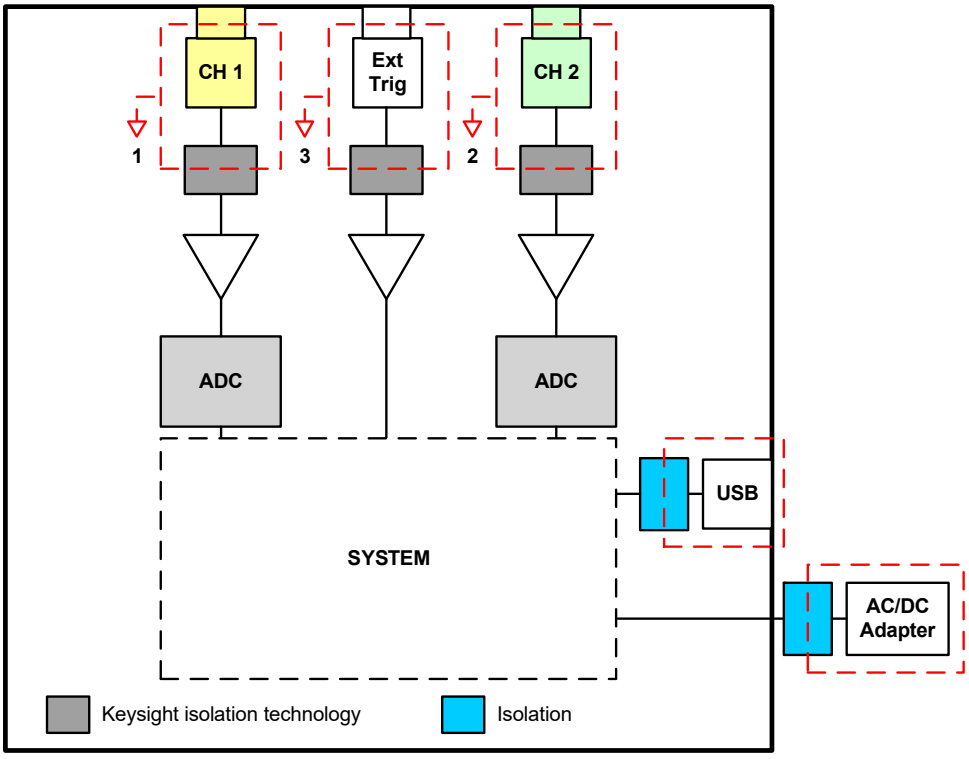


Figure 1-7 Channel isolation block diagram

As there are no direct connections between the measurement probes and the inputs to the scope, you are protected from the measured voltages. Each input is connected to its reference voltage point and not to the earth reference point.

The handheld scope input channels are fully isolated and provide channel-to-power line isolation, channel-to-USB connectivity isolation, and channel-to-keypad isolation. You can connect to signals with different voltage reference levels safely and obtain accurate measurements.

WARNING Connect the insulation cover over the probe tip when the hook clip is not used to prevent any electrical shock. This also helps to avoid unwanted interconnection between the two probes when both ground clips are connected.

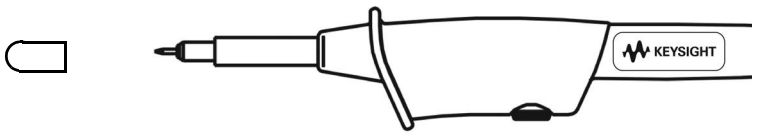


Figure 1-8 Insulation cover

An example of how a fully isolated input channels handheld scope monitors the output voltage of a PWM inverter drive and the gate control signals of an Insulated Gate Bipolar Transistor (IGBT) is shown in Figure 1-9. Channel 1 is connected to the output voltage of the PWM AC drive and Channel 2 is connected to the transistor input, where the signals come from the control board. For a complete floating measurement, the probe reference lead for each channel is connected to the circuitry.

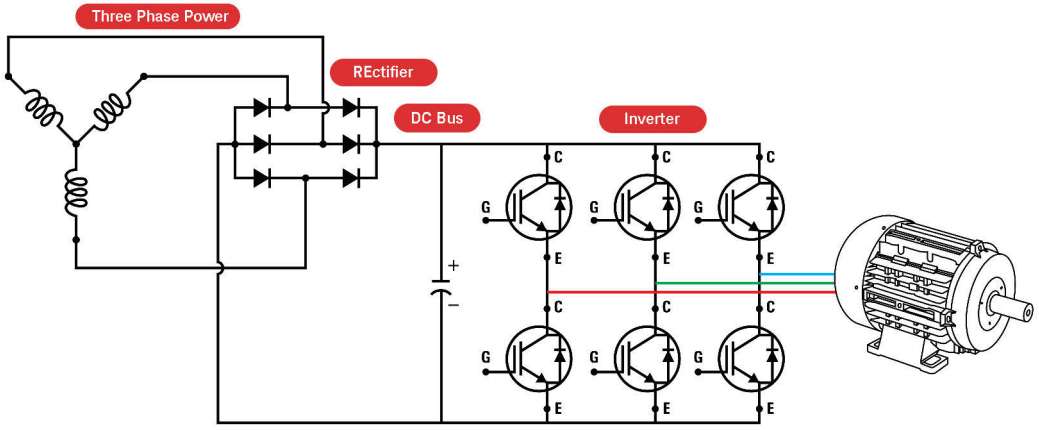


Figure 1-9 Probing the VFD IGBT control signal and IGBT output

Floating measurement with isolated probes at CAT III 600 V

NOTE Before performing floating measurements with the handheld scope, ensure that the measured signal is within the voltage range specified on the probe and input terminals, and the floating voltage from any terminal to ground as shown in Figure 1-10.

The differential signal in each channel is referenced to a reference point that is not connected to the earth ground. This helps in eliminating ground loop errors.

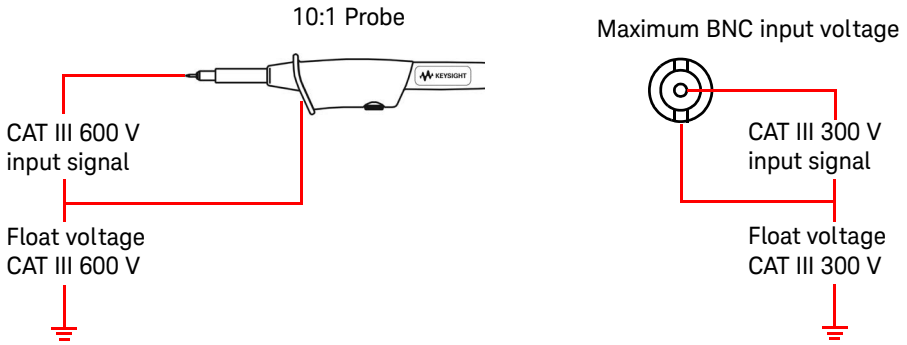


Figure 1-10 Channel-to-channel isolation at CAT III 300 V

The maximum input voltage on each BNC input is CAT III 300 V (referenced to non-earth grounding and referenced to earth-grounding). If you are measuring an input floating voltage of CAT III 600 V with a 10:1 probe, the signal will be attenuated 10 times. The actual voltage flow into the BNC input will be CAT III 60 V, which is within the maximum input voltage rating.

Derating curve

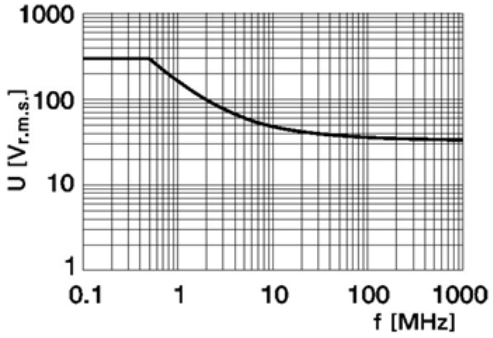


Figure 1-11 U1560A scope probe 1:1

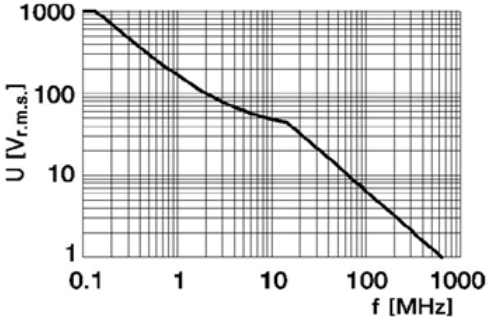


Figure 1-12 U1561A scope probe 10:1

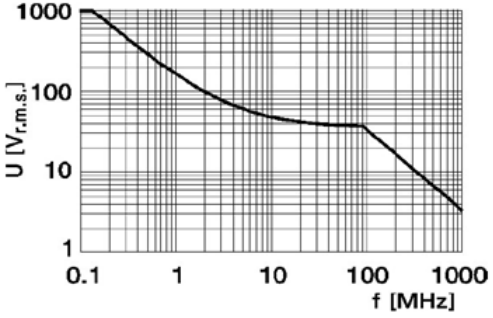


Figure 1-13 U1562A scope probe 100:1

Connect Test Leads to Meter Terminals

Connect the test leads to the meter terminals on the handheld scope as shown below.

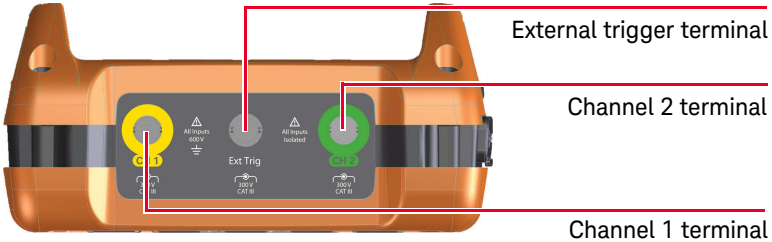
2 Product Outlook

Product at a Glance 38
Front Panel Key Overview 39
Oscilloscope Display Overview 41
Multimeter and Data Logger Display Overview 42

This chapter provides an overview of the handheld scope keys, panels, and display.

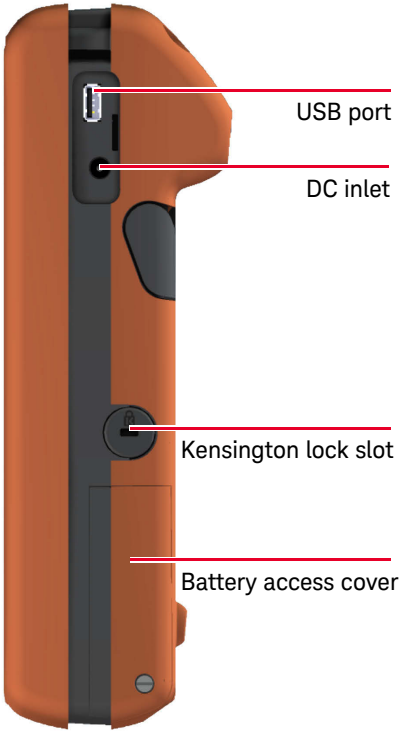
Product at a Glance

Top view



Front view

Side view

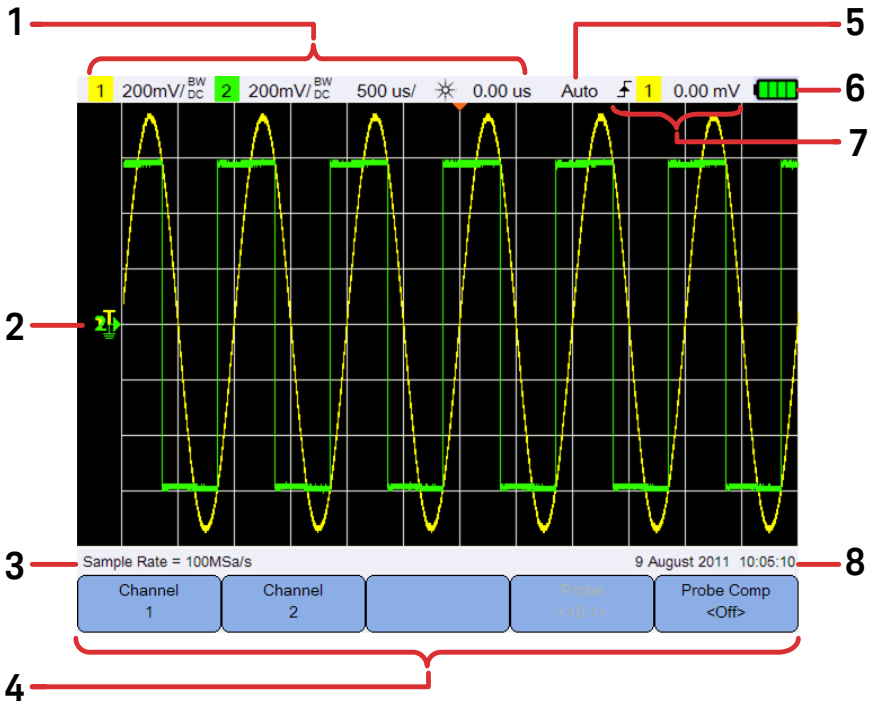


Front Panel Key Overview

Key	Description
F1 F2 F3 F4 F5	To access the submenus related to the main function when a main function key is pressed.
Trigger	To configure the trigger settings. Pressing and holding this key will change the triggering mode.
Acquire	To select the waveform acquisition mode.
Run/Stop	To toggle between continuous running mode or stopped mode. Pressing and holding this key will change the triggering mode to Single acquisition.
Autoscale	To perform autoscaling and configure the autoscale settings.
Meter	To access the multimeter mode.
Scope	To access the oscilloscope mode.
User	To access the system-related settings.
Help	To access the built-in quick help.
Logger	To access the data logger mode.
Analyzer	To perform mathematical operations and Fast Fourier Transform (FFT) function.
Save/Recall	To access the save and recall, print screen, and default settings functions. Pressing and holding this key will enable the quick print function.
Display	To configure the display settings.

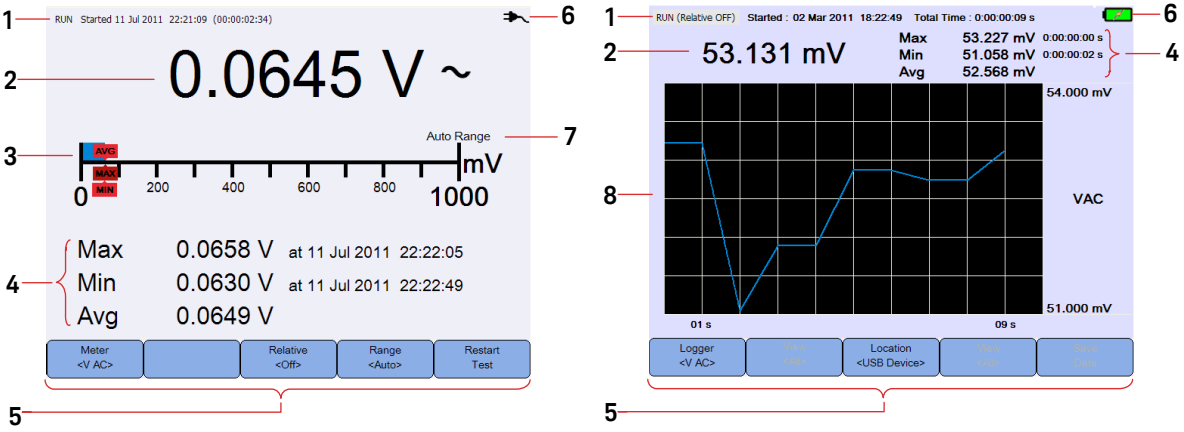
Key	Description
	To access the X or Y cursor functions.
	To select and perform automatic measurements.
	To select softkey functions and values.
	To adjust the vertical sensitivity (gain) in voltage per vertical division (volt/div).
	To adjust the waveform and ground level positions.
	To access the horizontal modes.
	To change the sweep speed in time per horizontal division (time/div).
	To set the delay time (horizontal position).
	Press and hold this key for: – ≈3 seconds to turn on the handheld scope. – ≈1 second to turn off the handheld scope. – ≈10 seconds to power cycle the handheld scope. During power-off battery charging, this key will show the following status: – blinking red (capacity <60%) – blinking yellow (60% < capacity < 90%) – constant yellow (90% – 100% capacity) During power-on battery charging, this key will always turn constant yellow. The charging status is indicated on the top right of the display.

Oscilloscope Display Overview



No.	Description
1	Displays the channel and timebase setup information.
2	Displays the channel input waveforms with channel identifiers and indicators for trigger level, signal ground level, analyzer waveforms, time reference, and trigger point.
3	Displays the sample rate.
4	Displays the function menus of the keys and softkeys.
5	Displays the signal acquisition mode.
6	Displays the battery status and AC connectivity for battery charging.
7	Displays the trigger type, source, and level.
8	Displays the date and time.

Multimeter and Data Logger Display Overview



No.	Description
1	Displays the acquisition, start date and time, and duration status.
2	Displays the measurement reading.
3	Displays the virtual measurement scale.
4	Displays the resulting average, maximum, and minimum readings.
5	Displays the function menus of the keys and softkeys.
6	Displays the battery status and AC connectivity for battery charging.
7	Indicates the auto or manual ranging mode.
8	Displays the logging graph.

3 Using the Oscilloscope

Vertical Controls 44
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Trigger Controls 54
Waveform Acquisition Controls 64
Display Controls 66
Automatic Measurements 68
Cursor Measurement Controls 76
Analyzer Controls 78
Autoscale and Run/Stop Controls 82
Save and Recall Controls 85

This chapter explains how to set up the oscilloscope functions.

Vertical Controls

Press Scope to access the vertical channel control menu.

Press Channel 1 / Channel 2 to access the respective channel submenu.

Channel selection for waveform display

You can enable either one channel or two channels simultaneously.

Turn on/off the channel by toggling Ch1 <On> / Ch2 <On>.

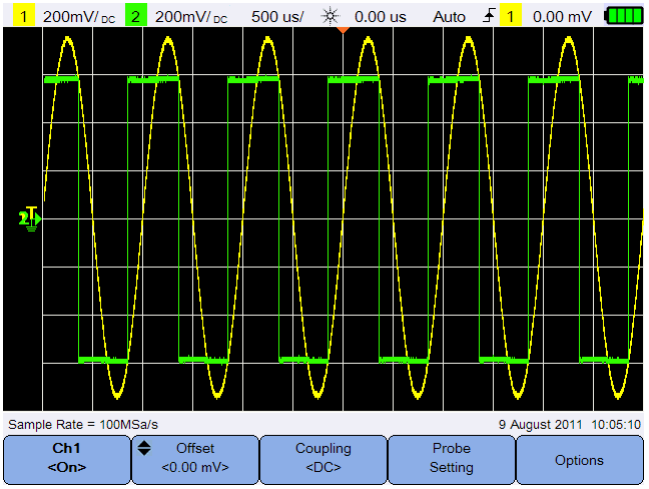
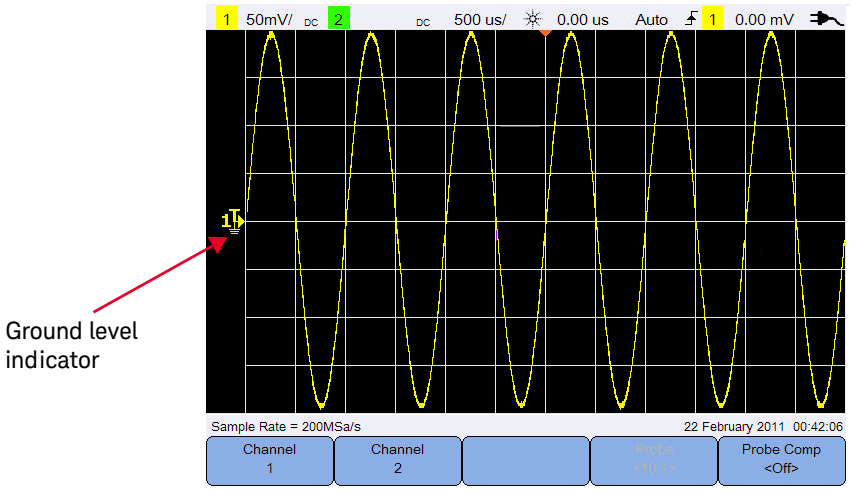


Figure 3-1 Channel 1 submenu

Vertical system setup

Adjust the ground level position

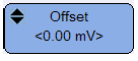
The signal ground level is identified by the position of the icon on the display.



Move both and the waveform vertically by:

– pressing

, or

– pressing 

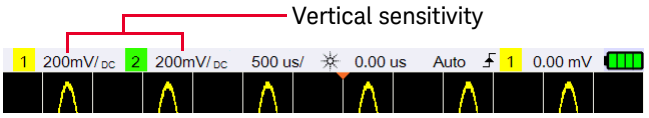
and using the ▲ or ▼ key.

Moving the waveform to the top offsets the waveform with a negative voltage value, while moving to the bottom offsets it with a positive voltage value.

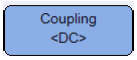
Adjust the vertical sensitivity

You can increase or decrease the vertical sensitivity (Volt/div) of a waveform by pressing

.



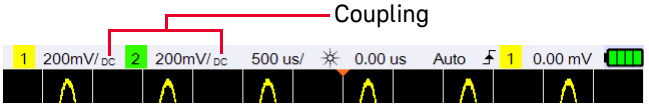
Channel coupling

Toggle 

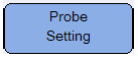
to set the channel coupling.

AC coupling blocks any DC component in the waveform and allows only the AC component of the signal to be viewed.

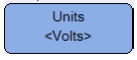
DC coupling allows both AC and DC components to pass into the handheld scope.



Probe setting

Press 

to access the probe setup submenu.

Toggle 

to set the Volts unit for a voltage probe or Amps for a current probe. Channel sensitivity and offset, trigger level, measurement results, and math functions will reflect the unit you have selected.

Press

repeatedly to set the attenuation factor/sensitivity for measuring voltage/current values with a voltage/current probe. The attenuation factor/sensitivity must be set according to the probe being used to ensure the measurement results reflect the actual voltage/current level.

AC current measurement

AC current measurement can be performed by using an AC current clamp. Keysight recommends the U1583B AC current clamp.

To measure AC current:

1 Connect the AC current clamp to channel 1 or channel 2.

2 Press Channel 1 / Channel 2 to access the connected channel submenu.

3 Press Probe Setting to access the probe setup submenu.

4 Toggle Units <Volts> to set the unit to Amps.

5 Press Probe <1:1> repeatedly to select the required V/A range for the AC current clamp.

Invert control

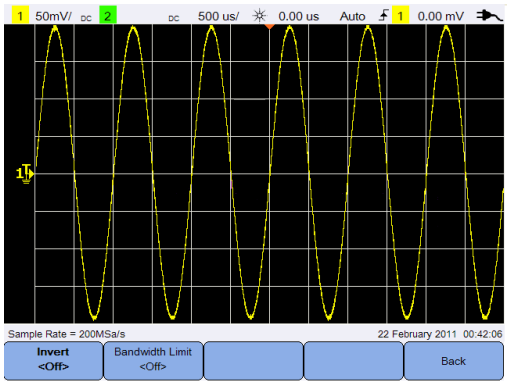
This control inverts the displayed waveform with respect to the ground level. Invert affects how a channel is displayed, but does not affect triggering. Inverting a channel also changes the result of any function selected in the Analyzer Controls menu.

To invert a channel waveform:

1 Press Options to access the invert and bandwidth limit control submenu.

2 Toggle Invert <Off>.

Before inversion



After inversion

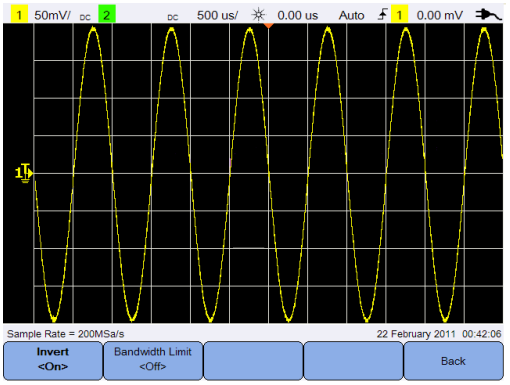
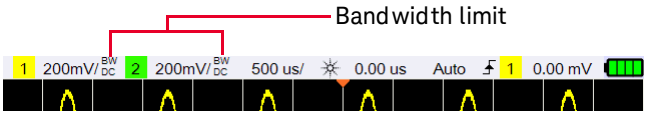


Figure 3-2 Waveform before and after inversion

Bandwidth limit control

Press Options and press Bandwidth Limit <Off> repeatedly to set the maximum bandwidth for a channel to 10 kHz or 20 MHz. For waveforms with frequencies below the bandwidth limit, turning on this control removes unwanted high-frequency noise from the waveform.



Return to zero

Press Save/Recall > Return to zero to return the vertical offset to zero for both channels.

Horizontal Controls

The horizontal controls adjust the horizontal scale and position of the waveforms.

Horizontal system setup

Select the time reference position

Time reference is the point on the display where the trigger point is referenced. Time reference can be set to one grid line from left to right or to the center of the display.

▼ at the top of the graticule marks the position of the time reference. When delay time is set to zero, the delay time indicator (▼) overlays the time reference indicator.

Set the time reference position by pressing Menu/Zoom and pressing Time Ref <Center> repeatedly.

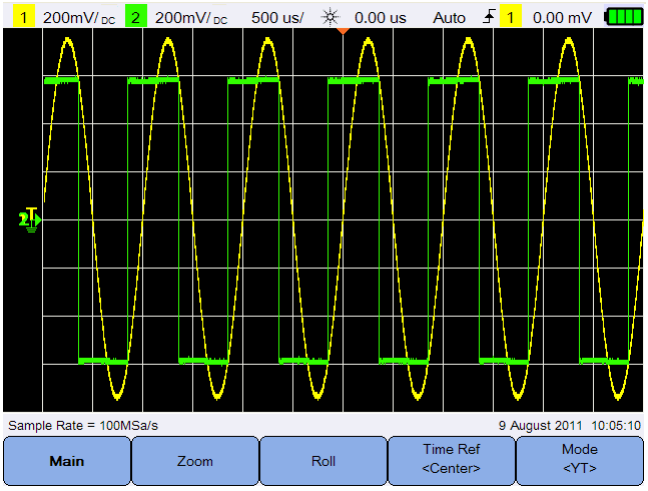
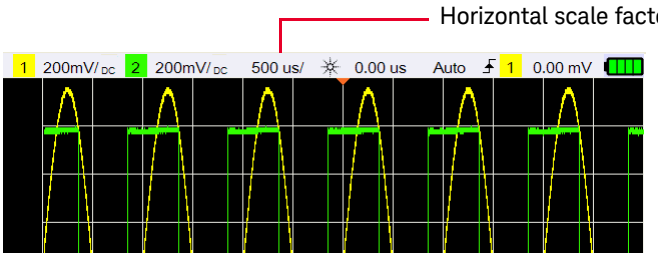


Figure 3-3 Time reference position setting

Adjust the horizontal scale factor (time/div)

You can increase or decrease the horizontal scale factor or sweep speed of a waveform by pressing

.



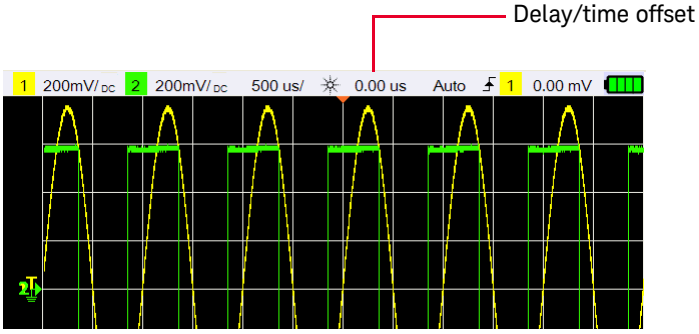
Set the waveform delay

The delay setting sets the specific location of the trigger event with respect to the time reference position.

You can move the delay time indicator (▼) by pressing

.

Negative delay values indicate that you are looking at a portion of the waveform before the trigger event, and positive values indicate that you are looking at the waveform after the trigger event.



Horizontal modes

Press Menu/Zoom to access the horizontal mode menu.

Main mode

Press Main to access the Main mode, which is the normal viewing mode for the oscilloscope.

Zoom mode

Press Zoom to access the Zoom mode, which is a horizontally expanded version of the normal display. When Zoom is enabled, the display divides in half, where the top half shows the normal sweep and the bottom half displays the zoom sweep.

The area of the normal display that is expanded is outlined with a box.

Timebase Range controls the size of the box and Timebase Position sets the position of the zoom sweep.

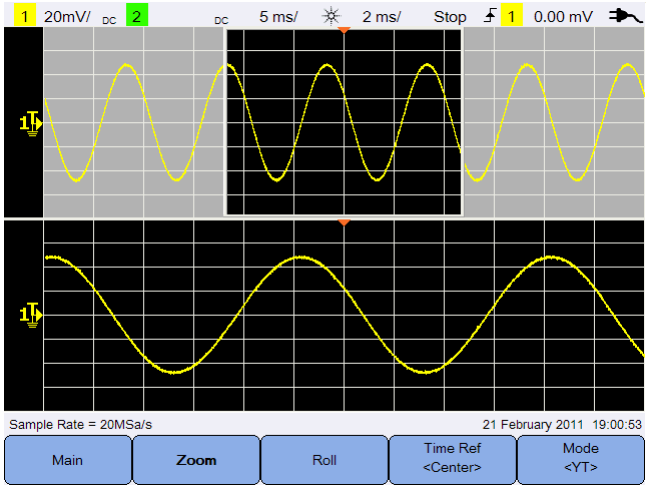


Figure 3-4 Zoom mode

Roll mode

Press Roll to access the Roll mode, which causes the waveform to roll across the display from right to left. To pause the display, press Run/Stop. To clear the display and restart an acquisition, press Run/Stop again.

XY mode

Press Mode <YT> to access the XY mode, which changes the display from a volts-versus-time display to a volts-versus-volts display. The timebase is turned off and Channel 1 amplitude is plotted on the X-axis and Channel 2 amplitude is plotted on the Y-axis. The Z-axis input (Ext Trigger) turns the trace on and off. When Z is low (<1.4 V), Y versus X is displayed; when Z is high (>1.4 V), the trace is turned off.

You can use XY mode to compare frequency and phase relationships between two signals.

Recording length

Time/div	Single Channel on		Two Channel on	
	U1610A	U1620A	U1610A	U1620A
50 s	60 k	600 k	120 k	1.2 M
20 s	60 k	600 k	120 k	1.2 M
10 s	60 k	600 k	120 k	1.2 M
5 s	60 k	600 k	120 k	1.2 M
2 s	60 k	600 k	120 k	1.2 M
1 s	60 k	600 k	120 k	1.2 M
500 ms	60 k	600 k	120 k	1.2 M
200 ms	60 k	600 k	120 k	1.2 M
100 ms	60 k	600 k	120 k	1.2 M
50 ms	60 k	600 k	120 k	1.2 M

Time/div	Single Channel on		Two Channel on	
	U1610A	U1620A	U1610A	U1620A
20 ms	60 k	1 M	120 k	2 M
10 ms	60 k	1 M	120 k	2 M
5 ms	60 k	1 M	120 k	2 M
2 ms	60 k	1 M	120 k	2 M
1 ms	60 k	1 M	120 k	2 M
500 µs	60 k	1 M	120 k	2 M
200 µs	60 k	1 M	120 k	2 M
100 µs	60 k	1 M	120 k	2 M
50 µs	60 k	2 M	120 k	2 M
20 µs	60 k	2 M	120 k	2 M
10 µs	60 k	2 M	120 k	2 M
5 µs	60 k	2 M	120 k	2 M
2 µs	60 k	2 M	120 k	2 M
1 µs	60 k	2 M	120 k	2 M
500 ns	60 k	2 M	120 k	2 M
200 ns	60 k	2 M	120 k	2 M
100 ns	60 k	2 M	120 k	2 M
50 ns	60 k	2 M	120 k	2 M
20 ns	60 k	2 M	120 k	2 M
10 ns	60 k	2 M	120 k	2 M
5 ns	60 k	2 M	120 k	2 M
2 ns	60 k	2 M	120 k	2 M

Trigger Controls

Press Trigger to access the trigger function, which determines when the oscilloscope starts to acquire data and display a waveform. A triggered waveform is one in which the oscilloscope begins tracing the waveform, from the left side of the display to the right, each time a particular trigger condition is met.

Trigger types

You can select the trigger type by pressing Trig. Setting and pressing Type <Edge> repeatedly.

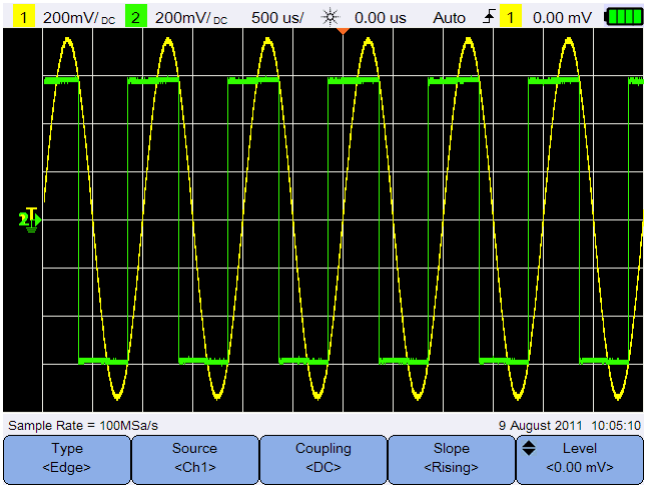


Figure 3-5 Trigger type and settings submenu

The icon on the left of the display indicates the position of the trigger level for the analog channel.

Edge trigger

The Edge trigger identifies a trigger by looking for a specified edge (slope) and voltage level on a waveform.

Source

Press Source <Ch1> repeatedly to select the trigger source.

Coupling

Press Coupling <DC> repeatedly to select either:

- DC coupling – allows DC and AC signals into the trigger path.
- AC coupling – removes any DC offset voltage from the trigger waveform.
- LF (low frequency) reject coupling – removes any unwanted low-frequency components from the trigger waveform.
- HF (high frequency) reject coupling – removes high-frequency components from the trigger waveform.

Slope

Press Slope <Rising> repeatedly to select the Rising ( ) edge, Falling ( ) edge, Alternate ( ) edges, or Either ( ) edge.

All modes operate up to the oscilloscope bandwidth except the Either edge mode, which has a limitation. The Either edge mode will trigger on constant wave signals up to 100 MHz, but can trigger on isolated pulses down to 1/(2 × oscilloscope bandwidth).

Level

Press Level <0.00 mV> and use the ▲ or ▼ key to set the trigger level.

Glitch trigger

A glitch is a rapid change in the waveform that is usually narrow as compared to the waveform. The Peak Detect mode can be used to more easily view glitches or narrow pulses.

Source

See "Source" on page 55.

Polarity

Toggle Polarity <Positive> to select the positive (⎍) polarity or negative (⎎) polarity for the glitch you want to capture.

Level

See "Level" on page 55.

Qualifier

The time qualifier sets the oscilloscope to trigger on a channel pattern whose time duration is:

- less than a time value (<)
- greater than a time value (>)
- within a range of time values (><)
- outside a range of time values (<>)

To select the qualifier:

1 Press More Settings to access more trigger parameters.

2 Press Qualifier > repeatedly.

Minimum and Maximum values

Press More Settings > Min Value <1.00us> / Max Value <N/A> and use the ▲ or ▼ key to set the minimum or maximum time value respectively for the selected qualifier.

Coupling

See "Coupling" on page 55.

TV trigger

TV triggering can be used to capture the complicated waveforms of most standard and high-definition analog video signals.

Source

See "Source" on page 55.

Standard

Press Standard <NTSC> repeatedly to select the NTSC, SECAM, PAL, PAL-M, HDTV 720p, HDTV 1080p, or HDTV 1080i standard.

NTSC, SECAM, PAL, and PAL-M are broadcast standards used throughout the world. HDTV is a high-definition TV standard.

Mode

Press Mode <Odd> repeatedly to select the portion of the video signal to trigger on:

- All Field – triggers on the rising edge of the first pulse in the vertical sync interval.
- All Line – triggers on all horizontal sync pulses.
- Line – triggers on the selected line # (HDTV standard only).
- Odd – triggers on the rising edge of the first serration pulse of the odd field.
- Even – triggers on the rising edge of the first serration pulse of the even field.
- Line:Odd – triggers on the selected line # in the odd field.
- Line:Even – triggers on the selected line # in the even field.

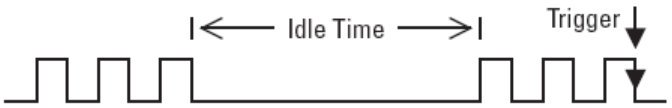
Not all of the above modes are available for all standards. The mode selection changes according to the standard you select.

Custom Line

Press Custom Line <N/A> and use the ▲ or ▼ key to select the line number on which you want to trigger. This is only applicable for the Line trigger mode.

Nth Edge trigger

The Nth Edge trigger allows you to trigger on the Nth edge of a burst that occurs after a specified idle time.



Source

See "Source" on page 55.

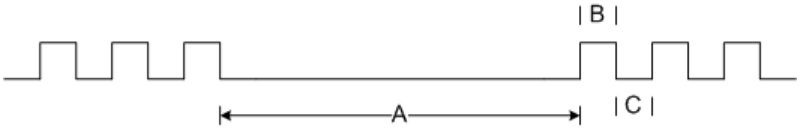
Slope

Toggle Slope <Rising> to select the Rising ( ) edge or Falling ( ) edge to make the oscilloscope count the waveform rising or falling edges. The oscilloscope will trigger when the Nth edge has been detected after the idle time has been satisfied.

Idle time

Press Idle <60ns> and use the ▲ or ▼ key to set an idle time, which must be greater than the largest width of the burst, and smaller than the longest idle time (high or low).

In the example below, the idle time must be less than A and greater than B or C. The idle time is considered whether it is low (as shown) or high.



Edge

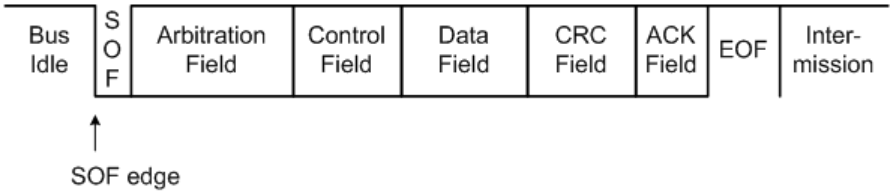
Press More Settings > Edge <1> and use the ▲ or ▼ key to set the edge count from 1 to 65535.

Level

See "Level" on page 55.

CAN trigger

The Controller Area Network (CAN) trigger allows triggering on CAN version 2.0A and 2.0B signals. The basic CAN trigger will trigger on the Start of Frame (SOF) bit of a Data frame. A CAN message frame in the CAN_L signal type is shown below:



Source

See "Source" on page 55.

Signal

Press Signal <Differential> repeatedly to set the type and polarity of the CAN signal. This also automatically sets the channel label for the source channel that can be connected as follows:

- CAN_H – actual CAN_H differential bus signal.

Dominant low signals:

- CAN_L – actual CAN_L differential bus signal.
- Rx – Receive signal from the CAN bus transceiver.
- Tx – Transmit signal from the CAN bus transceiver.
- Differential – CAN differential bus signals connected to an analog source channel using a differential probe.

Level

See “Level” on page 55.

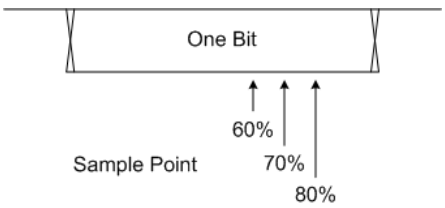
Baud rate

Press More Settings and press Baud <125kb/s> repeatedly to set the baud rate to match the bus signal.

If the selected baud rate does not match the system baud rate, false triggers may occur.

Sample point

Press More Settings and press Smpl Pt <75%> repeatedly to set the sample point, which represents the percentage of time between the beginning of the bit time to the end of the bit time.



Standard

Press More Settings and toggle Standard <CAN2.0A> to select Standard CAN (2.0A) or Extended CAN (2.0B).

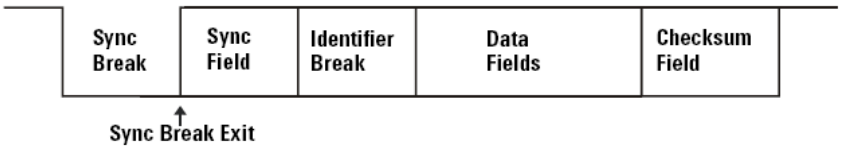
Standard CAN has an 11-bit long identifier while Extended CAN has a 29-bit long identifier.

Trigger

Press More Settings > Trigger <SOF> to trigger on the SOF bit of a Data frame.

LIN trigger

Local Interconnect Network (LIN) triggering will trigger on the rising edge at the Sync Break exit of the LIN single-wire bus signal that marks the beginning of the message frame.



Source

See "Source" on page 55.

Sync break

Press Sync Break >= 13 repeatedly to select the minimum number of clocks that define a sync break in the LIN signal.

Level

See "Level" on page 55.

Baud rate

See "Baud rate" on page 60.

Sample point

See "Sample point" on page 60.

Standard

Press More Settings and press Standard <LIN 1.3> repeatedly to select the LIN standard of 1.3, 2.0, or 2.1.

Trigger

Press More Settings > Trigger <Sync Break> to trigger on the rising edge at the Sync Break exit of the LIN single-wire bus signal that marks the beginning of the message frame.

Trigger modes

Press Trig. Mode <Auto> repeatedly to select the trigger mode, which affects the way the oscilloscope searches for the trigger.

- Normal – displays a waveform when the trigger conditions are met, otherwise the oscilloscope does not trigger and the display is not updated. “Trig’d” is shown on the status line when this trigger mode is set and a trigger is found. “Trig’d (blinking)” is shown when a trigger has not been found.
- Auto – displays a waveform when the trigger conditions are met. If the trigger conditions are not met, it forces the oscilloscope to trigger anyway. “Auto” is shown on the status line when this trigger mode is set and a trigger is found. “Auto (blinking)” is shown when a trigger has not been found.
- Single – displays single-shot events without subsequent waveform data overwriting the display. When the oscilloscope triggers, the single acquisition is displayed and the oscilloscope is stopped (“Stop” is shown on the status line). Press Run/Stop again to acquire another waveform.

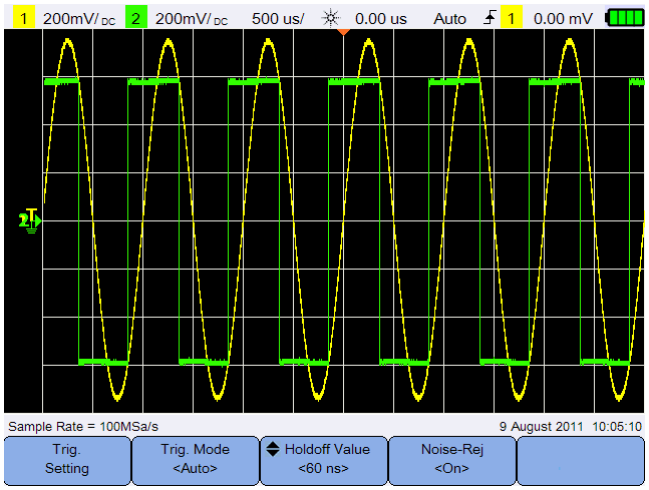
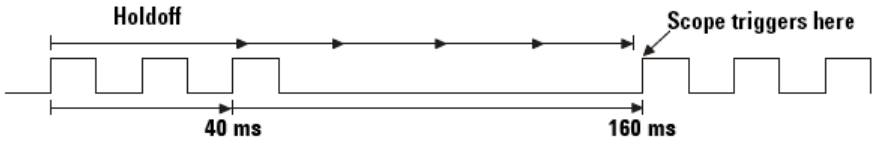


Figure 3-6 Auto trigger mode

Trigger holdoff

Press Holdoff Value <60 ns> and use the ▲ or ▼ key to set the amount of time that the oscilloscope waits before re-arming the trigger circuitry.

To get a stable trigger on the pulse burst shown below, set the holdoff time to be >40 ms but <160 ms.



Noise rejection

Toggle Noise-Rej <On> to turn on/off noise rejection, which adds additional hysteresis to the trigger circuitry and reduces the possibility of triggering on noise.

Waveform Acquisition Controls

The real-time sampling of the handheld scope can be used with either repetitive signals or single-shot signals. This means the waveform display is produced from samples collected during one trigger event and all samples from previous trigger events are erased.

Press Acquire to access the acquisition mode menu.

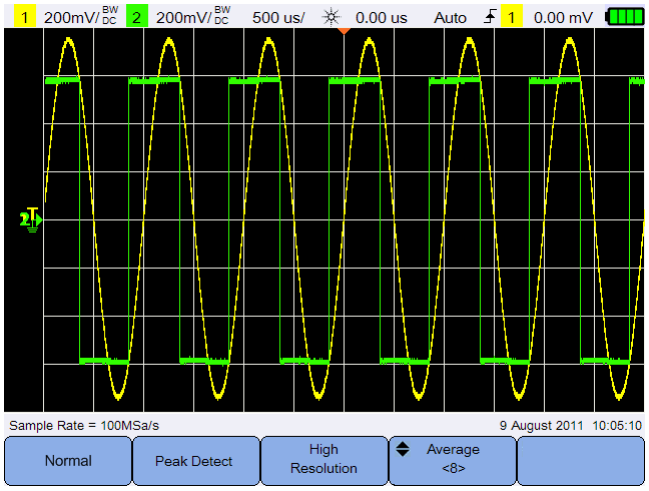


Figure 3-7 Acquire menu

– Normal mode

  Used for most waveforms with normal decimating and no averaging. This mode provides the best display for most waveforms. You are allowed to capture up to 1.2 kpts of data in the CSV format.

– Peak Detect mode

  Evaluates all sample points at the maximum sample rate, selects the minimum and maximum points, and stores them into memory. This ensures that narrow glitches will always be displayed regardless of sweep speed. You are allowed to capture up to 1.2 kpts of data in the CSV format.

– High Resolution mode

  Averages extra samples at slower sweep speeds to reduce random noise, produce a smoother trace, and effectively increase vertical resolution. You are allowed to capture up to 12 kpts of data in the CSV format.

– Average mode

  Averages multiple acquisitions to reduce random noise and increase vertical resolution. The average numbers can be set from 2 to 8192 in powers-of-2 increments using the ▲ or ▼ key. You are allowed to capture up to 1.2 kpts of data in the CSV format.

Display Controls

Press Display to access the display control menu.

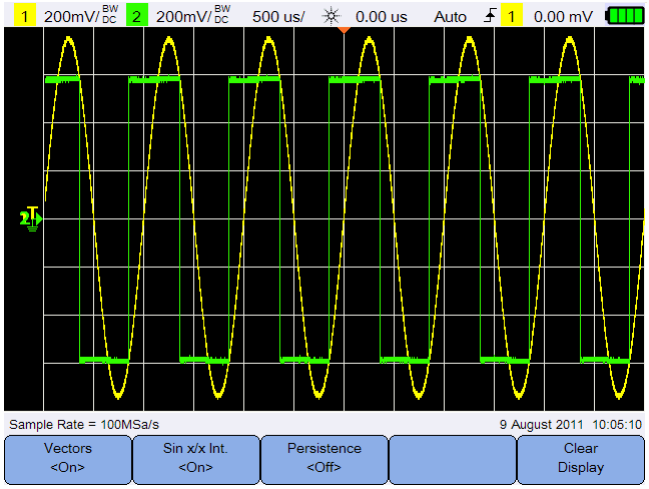


Figure 3-8 Display control menu

Vectors display

Toggle Vectors <On> to enable the vectors mode, which draws a line between consecutive waveform data points. This mode produces the most insightful waveforms for most situations.

Sin x/x interpolation

Toggle Sin x/x Int. <On> to enable sin x/x interpolation, which reproduces the exact waveform as displayed on the oscilloscope. You can use this process to reaffirm the behavior of a signal between samples.

Infinite persistence

Toggle Persistence <Off> to enable infinite persistence, which updates the display with new acquisitions, but does not erase the results of previous acquisitions. This can be used to measure noise and jitter, observe the worst case of a varying waveform, look for timing violations, and capture events that occur irregularly.

To erase previous acquisitions, press Clear Display. The display will start to accumulate acquisitions again if the oscilloscope is running. Turn off Persistence <Off>, then press Clear Display to return to the normal display mode.

Automatic Measurements

You can perform up to 30 automatic measurements (time, voltage, and power) on any channel source or running math function.

To make a quick measurement:

1 Press Measure to access the measurement function menu.

2 Press Source <Ch1> repeatedly to select a channel or math source. The math source is applicable only when Analyzer Controls are enabled.

3 Press Select <Delay> and use the ◀▲▼▶ keys to select a measurement type.
Press Select <Delay> again to exit the selection menu.

4 Press Measure <Delay> to make the selected measurement.

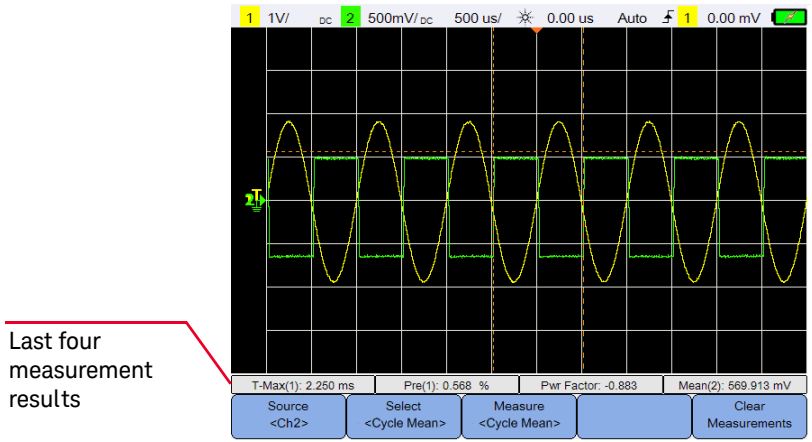


Figure 3-9 Measurement function menu

Cursors are turned on to show the portion of the waveform being measured for the most recently selected measurement.

If a portion of the waveform required for a measurement is not displayed or does not display enough resolution to make the measurement, the result will be displayed as no signal, no edges, greater than a value, or less than a value.

If you select the delay or phase shift measurement, press Setting to select the source channels or running math functions. Press Source 1 <Ch1> and Source 2 <Ch2> repeatedly to select the first and second sources respectively.

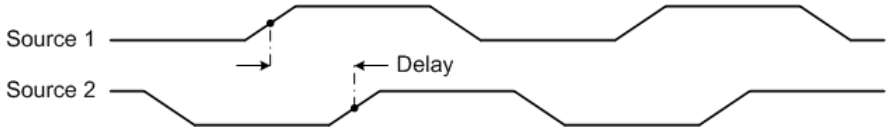
If you select any power measurement, press Sensitivity to set the channel input and probe attenuation factor or sensitivity. Toggle Volt/Amp. <Ch1/Ch2> to assign channel 1 or 2 as the voltage input or current input. Press Volt Probe <1:1> or Sensitivity <1.00V/A> repeatedly to set the attenuation factor or sensitivity for the connected voltage or current probe respectively. Changing the attenuation or sensitivity will also change the vertical scale of the assigned channel.

To clear all measurements, press Clear Measurements.

Time measurements

Delay

Delay measures the time difference from the selected edge on Source 1 and the selected edge on Source 2 closest to the trigger reference point at the middle threshold points on the waveforms.



Duty Cycle (–), Duty Cycle (+), Fall Time, Rise Time, Frequency, Period, Width (–), Width (+)

The duty cycle (–) and (+) of a repetitive pulse train are expressed as follows:

$$Duty\ Cycle\ (-) = \frac{-\ Width}{Period} \times 100 \qquad Duty\ Cycle\ (+) = \frac{+\ Width}{Period} \times 100$$

The fall time is the time difference between the crossing of the upper threshold and the crossing of the lower threshold for a negative-going edge.

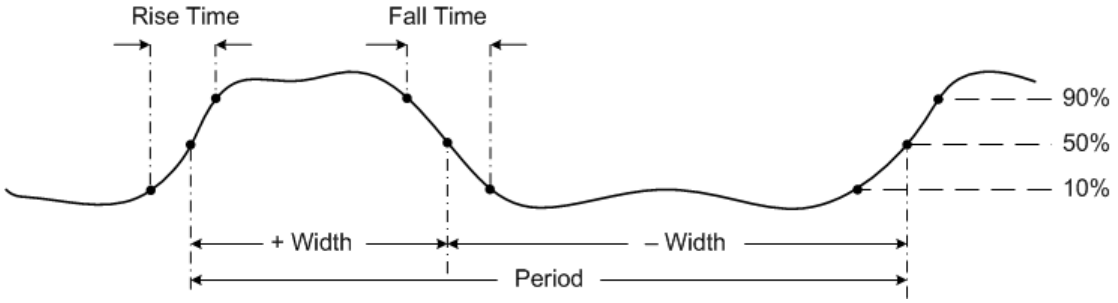
The rise time is the time difference between the crossing of the lower threshold and the crossing of the upper threshold for a positive-going edge.

Frequency is defined as 1/Period.

Period is the time period of the complete waveform cycle.

Width (–) is the time from the middle threshold of the falling edge to the middle threshold of the next rising edge.

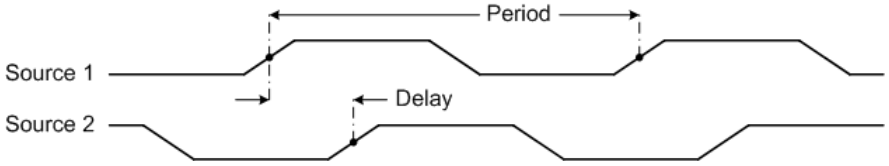
Width (+) is the time from the middle threshold of the rising edge to the middle threshold of the next falling edge.



Phase Shift

Phase shift is expressed as follows:

$$Phase\ Shift = \frac{Delay}{Source\ 1\ Period} \times 360$$



T-Max and T-Min

T-Max and T-Min are x-axis time values at the first displayed occurrence of the waveform maximum and minimum respectively, starting from the left side of the display.

Voltage measurements

Amplitude, Base, Maximum, Minimum, Peak to Peak, Top

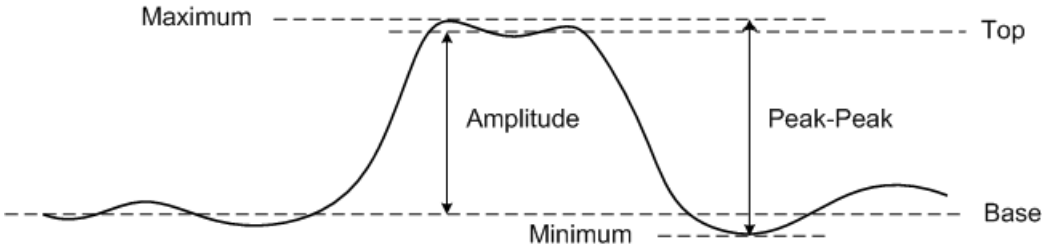
The amplitude of a waveform is the difference between its top and base values.

The base is the mode (most common value) of the lower part of the waveform, or if the mode is not well defined, the base is the same as minimum.

Maximum and minimum are the highest and lowest values in the waveform display respectively.

The peak-to-peak value is the difference between maximum and minimum values.

The top is the mode of the upper part of the waveform, or if the mode is not well defined, the top is the same as maximum.



Average

Average is the sum of the levels of the waveform samples divided by the number of samples over one or more full periods.

$$Average = \frac{\sum x_i}{n}$$

CREST

The crest factor is computed by dividing the peak amplitude of a waveform by the waveform RMS value.

$$C = \frac{|X|_{peak}}{|X|_{rms}}$$

Cycle Mean

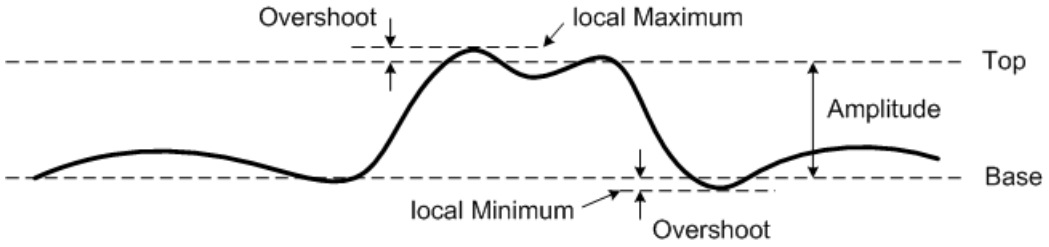
The mean cycle value is the statistical average of the measurement within a cycle period.

Overshoot

Overshoot is distortion that follows a major edge transition expressed as a percentage of amplitude.

$$Rising\ edge\ overshoot = \frac{local\ Minimum - Top}{Amplitude} \times 100$$

$$Falling\ edge\ overshoot = \frac{Base - local\ Minimum}{Amplitude} \times 100$$

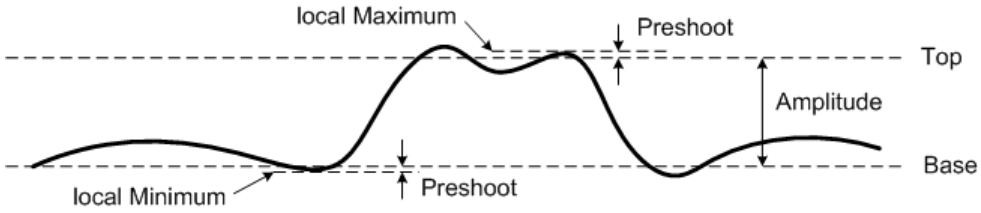


Preshoot

Preshoot is distortion that precedes a major edge transition expressed as a percentage of amplitude.

$$\textit{Rising edge preshoot} = \frac{\textit{Base - local Minimum}}{\textit{Amplitude}} \times 100$$

$$\textit{Falling edge preshoot} = \frac{\textit{local Maximum - Top}}{\textit{Amplitude}} \times 100$$



Std Deviation

The standard deviation (σ) of a data collection is the amount that the data varies from the mean value.

$$\sigma = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{N - 1}}$$

RMS (AC)

AC voltage is normally expressed as a root-mean-square (RMS) value, represented as Vrms. For a sinusoidal voltage, Vrms is equivalent to Vpeak/√2.

RMS (DC)

VRMS (DC) is the RMS value of the waveform over one or more full periods.

$$VRMS\ (DC) = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n}}$$

Power measurements

Power measurement is a point-by-point multiplication of the voltage and current waveforms measured by the voltage and current probes.

The U1610/20A is designed to measure power factor, active power, reactive power, and apparent power in the electrical power distribution system in factories or commercial and residential areas. It is ideally suited to measure power in the 50 Hz or 60 Hz cycle commonly found in the power distribution system.

For higher frequency applications such as those found in switch mode power supplies, a deskewing mechanism is needed in order to compensate for the time delay between the voltage and current probes.

This is important as a small offset in the timing of the high frequency voltage and current traces can cause a large error in the instantaneous power reading. The U1610/20A is not able to support this high frequency power measurement application.

NOTE **Ensure that the correct attenuation factor/sensitivity is set for the connected voltage/current probe respectively. Refer to page 69 for more information in setting up the probes.**

Active Pwr

Active power (real or true power) is measured in watts (W) by averaging a portion of power over a complete cycle of the AC waveform which produces a nett transfer of energy in one direction. It is the power drawn by the electrical resistance of a system.

Apparent Pwr

Apparent power is measured in volt-amperes (VA) and by the vector sum of the active and reactive power. It is the voltage on an AC system multiplied by all the current that flows in it.

Reactive Pwr

Reactive power is measured in volt-amperes reactive (VAR) and is the portion of power stored and discharged by inductive motors, transformers, and solenoids.

Pwr Factor

Power factor is a measurement of how effectively the electrical power is being used. A high power factor (near 1.0), indicates the efficient utilization of the electrical power, while a low power factor indicates the poor utilization of the electrical power. If the power factor falls below 0.90, some utility companies charge a power factor penalty. Power factor is the ratio of real power (watts) and the apparent power (volt-amperes). It is calculated by dividing the real power with the apparent power.

NOTE Keysight recommends the U1583B AC current clamp for the power measurement.

Cursor Measurement Controls

Cursors are horizontal and vertical markers that indicate x-axis values for timebase measurements and y-axis values for voltage measurements respectively. You can use cursors to make custom voltage or time measurements on oscilloscope signals.

Press Cursors to access the cursor function menu.

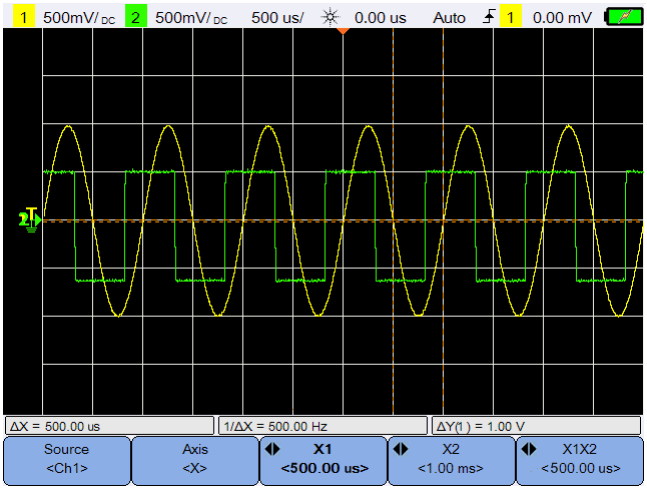
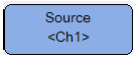


Figure 3-10 Cursor function menu

The X-cursor measurement places two vertical lines across the displayed waveform, which adjust horizontally and indicate time relative to the trigger point for all sources except math FFT (frequency is indicated).

The Y-cursor measurement places two horizontal lines across the displayed waveform, which adjust vertically and indicate values relative to the waveform ground point.

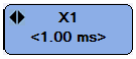
To set up the cursor measurement:

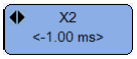
1 Press 

repeatedly to select a channel or analyzer source or to turn off the cursors. The analyzer source is applicable only when Analyzer Controls are enabled.

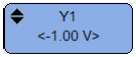
2 Toggle

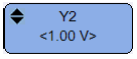
to select the X or Y cursor.

3 Press 

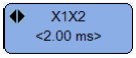
or 

and use the ◀ or ▶ key to adjust the X1 or X2 cursor respectively. The X1 cursor is displayed as a short-dashed vertical line while the X2 cursor is displayed as a long-dashed vertical line.

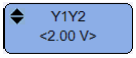
Press 

or 

and use the ▲ or ▼ key to adjust the Y1 or Y2 cursor respectively. The Y1 cursor is displayed as a short-dashed horizontal line while the Y2 cursor is displayed as a long-dashed horizontal line.

4 Press 

and use the ◀ or ▶ key to adjust the X1 and X2 cursors together.

Press 

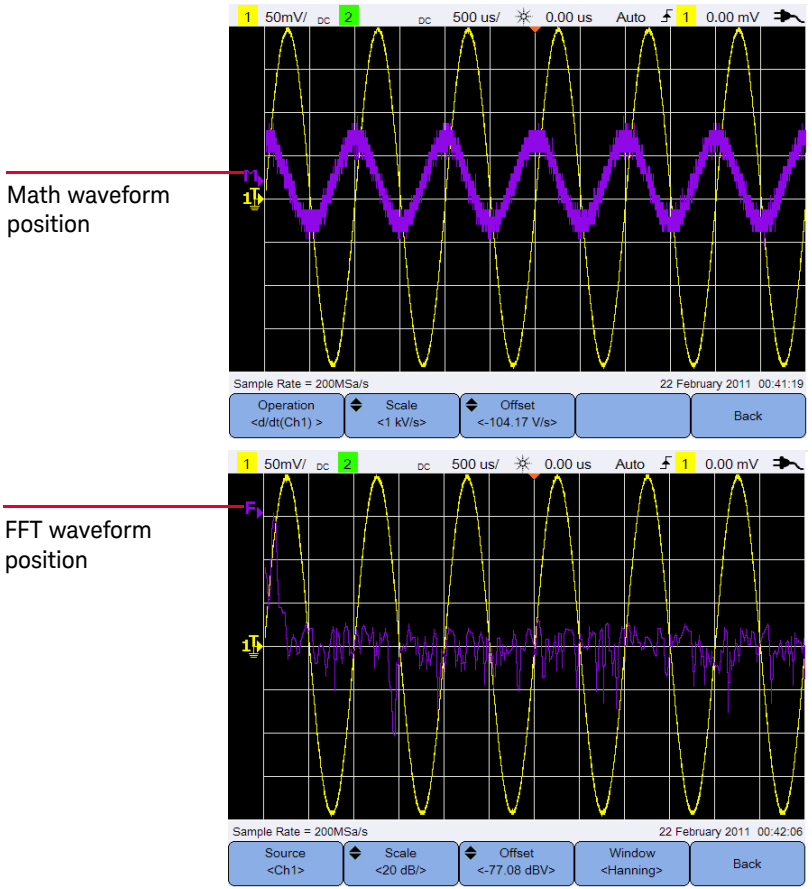
and use the ▲ or ▼ keys to adjust the Y1 and Y2 cursors together.

Analyzer Controls

Press Analyzer > Math / FFT to perform mathematical operations or Fast Fourier Transform (FFT) function on the waveforms.

Press Analyzer > Display Channel <Both> repeatedly to display either channel 1, channel 2, both channels 1 and 2, or turn off all the channels waveform on the screen.

The resulting math and FFT waveforms are displayed in purple.



To turn off the analyzer functions, press Turn Off Analyzer.

Math functions

Press Math to perform math functions on analog channels.

Select the math operations

Press Operation <d/dt(Ch1) > and use the ◀▲▼▶ keys to select a math operation.

Ch1 + Ch2	Adds channel 2 voltage values to channel 1 voltage values point by point.
Ch1 – Ch2 or **Ch2 – Ch1**	Subtracts channel 2/channel 1 voltage values from channel 1/channel 2 voltage values point by point.
Ch1 * Ch2	Multiplies channel 1 and channel 2 voltage values, point by point.
Ch1/Ch2 or **Ch2/Ch1**	Divides channel 2/channel 1 voltage values by channel 1/ channel 2 voltage values point by point.
d/dt(Ch1) or **d/dt(Ch2)**	Calculates the discrete time derivative of channel 1 or channel 2.
∫(Ch1)dt or **∫(Ch2)dt**	Calculates the integral of channel 1 or channel 2.

Press Operation <d/dt(Ch1) > again to exit the selection menu.

Adjust the math waveform scale or offset

Press Scale <1V/> / Offset <2.31 V> and use the ▲ or ▼ key to set the scale factor (unit/division) or offset respectively for the selected math operation. Set the Volts or Amps unit for the scale/offset via Probe setting (Scope menu). The units are:

Ch1 + Ch2 : V or A

Ch1 – Ch2 : V or A

Ch2 – Ch1 :	V or A
Ch1 * Ch2 :	V^2, A^2, or W
Ch1/Ch2 :	-
Ch2/Ch1 :	-
d/dt :	V/sec or A/sec
∫dt :	Vsec or Asec

A unit of U (undefined) will be displayed for Ch1 + Ch2, Ch1 – Ch2, and Ch2 – Ch1 if the channels are set to dissimilar units.

FFT function

Press Analyzer > FFT to access the FFT function, which converts a time-domain waveform into a frequency-domain waveform.

Select the source

Press Source <Ch1> and use the ◀▲▼▶ keys to select any analog channel or math operation as the FFT source. Press Source <Ch1> again to exit the selection menu.

Adjust the FFT waveform scale or offset

Press Scale <20 dB/> / Offset <-77.08 dBV> and use the ▲ or ▼ key to set the scale factor (dB/division) or offset (dB or dBV) respectively.

Select the window function

Press Window <Hanning> repeatedly to select a window function to apply to your FFT input signal based on the signal characteristics and measurement priorities.

– Hanning – used for making accurate frequency measurements or for resolving two frequencies that are close together.

- Rectangular – provides good frequency resolution and amplitude accuracy, but can be used only where there will be no leakage effects.
- Hamming – provides better frequency resolution but less amplitude accuracy compared to the Rectangular window. The Hamming window has a slightly better frequency resolution than the Hanning window.
- B. Harris – reduces time resolution compared to the Rectangular window, but improves the capacity to detect smaller impulses due to lower secondary lobes.
- Flattop – used for making accurate amplitude measurements of frequency peaks.

Autoscale and Run/Stop Controls

Autoscale

Pressing [Autoscale] automatically configures the handheld scope to best display the input signals by analyzing any waveforms present at each channel and at the external trigger input.

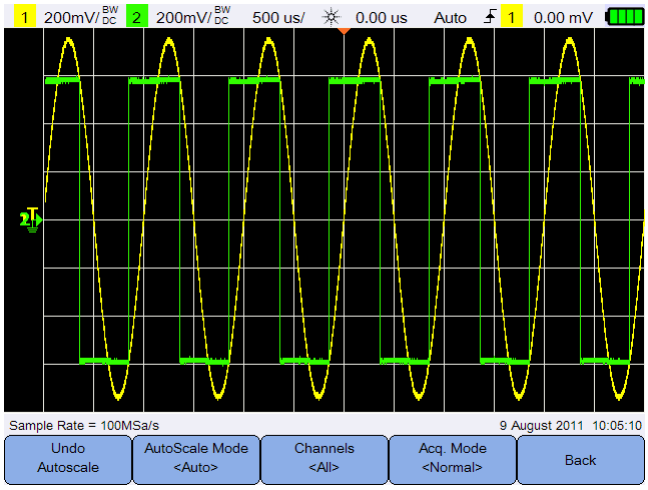


Figure 3-11 Autoscale function menu

Undo autoscale

Press [Undo Autoscale] to return to the settings that existed before pressing [Autoscale]. This is useful if you have unintentionally pressed [Autoscale] or do not like the settings Autoscale has selected and want to return to your previous settings.

Select the autoscale mode

Toggle [AutoScale Mode <Auto>] to select between the auto or manual range mode to apply on the waveforms.

Specify the channels displayed after autoscale

Toggle

to set which channels will be displayed on subsequent autoscales.

- All

  The next time you press

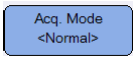
, all channels that meet the autoscale requirements will be displayed.

- Displayed Ch.

  The next time you press

, only the channels that are turned on will be examined for signal activity.

Preserve the acquisition mode during autoscale

Toggle 

to choose whether to allow the acquisition mode to be switched to Normal or left unchanged when autoscale is performed.

- Normal

  The handheld scope will switch to the Normal acquisition mode whenever

is pressed.

- Preserve

  The handheld scope will remain in the acquisition mode you have chosen when

is pressed.

Return to the previous menu

Press

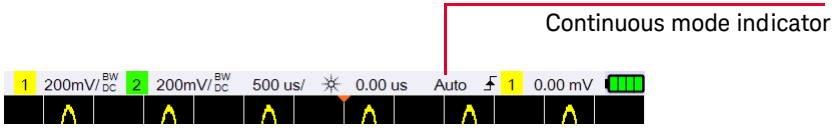
to return to the previous menu.

Run/Stop

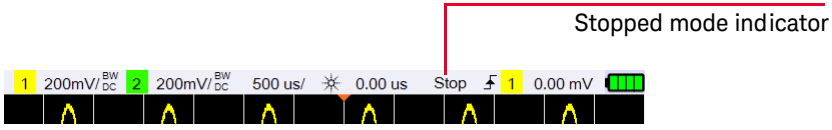
Press

to toggle between continuous running mode or stopped mode.

- Continuous mode – You are viewing multiple acquisitions of the same signal similar to the way an analog oscilloscope displays waveforms. “Trig'd” is indicated on the status line if the triggering mode is set to the Normal or Single acquisition.



– Stopped mode – You can pan and zoom the stored waveform by pressing the horizontal and vertical control keys. The stopped display may contain several triggers worth of information, but only the last trigger acquisition is available for pan and zoom. To ensure the display does not change, change the triggering mode to the Single acquisition to be sure you have acquired only one trigger. Pressing and holding Run/Stop also allows you to change to the Single acquisition.



Save and Recall Controls

Pressing Save/Recall allows you to perform save, recall, print screen, default settings, and return to zero functions.

NOTE Save/Recall **is only accessible when in the Scope mode.**

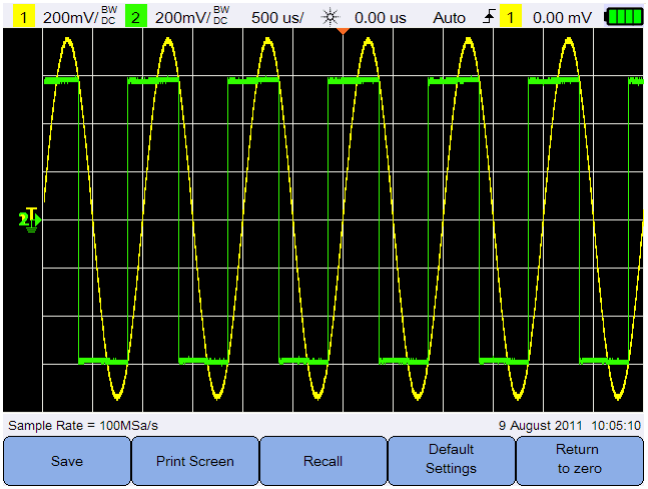


Figure 3-12 Save/Recall menu

Save control

Press Save to access the save functions.

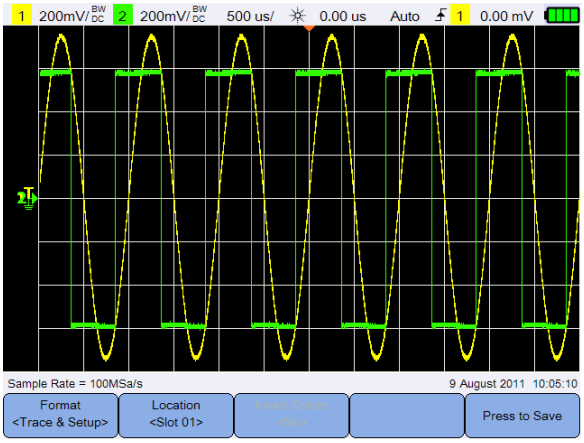


Figure 3-13 Save submenu

Select the save file format

Press Format <Trace & Setup> repeatedly to select the file format to save. The waveform trace and setup is saved to the handheld scope internal memory, while the rest of the formats are saved to a connected USB storage device.

- Trace & Setup – save the waveform image and setup file.
- csv data – save the data points in the CSV format.
- bmp (8-bit) – save the waveform image in the BMP (8-bit) format.
- bmp (24-bit) – save the waveform image in the BMP (24-bit) format.
- png (24-bit) – save the waveform image in the PNG (24-bit) format.
- RAW – save the waveform image in the raw format.

Select the save location

Press Location <Slot 01> and use the ◀▲▼▶ keys to select any of the internal memory slots (for the trace and setup format) or any location in your connected USB storage device (for other file formats) to save to.

Press Location <Slot 01> again to exit the selection menu.

For USB, you need to first ensure that your USB storage device is connected to the handheld scope. Then, press User > System Settings. Press USB <Client> repeatedly to select **<Host>** for the handheld scope to detect the USB device.

Invert image colors

Toggle Invert Colors <No> to invert all colors on the screen image you want to save. This is only applicable for image formats.

Save the file

Press Press to Save to save the selected file format into the selected memory location.

Recall control

Press Recall to access the recall functions.

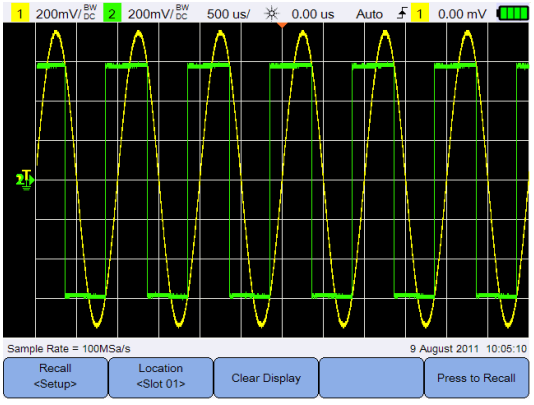


Figure 3-14 Recall submenu

Select the recall file format

Press Recall <Setup> repeatedly to select the waveform trace, setup, or both to recall from the internal memory.

Select the recall location

Press Location <Slot 01> and use the ◀▲▼▶ keys to select an internal memory location to recall a saved file. Press Location <Slot 01> again to exit the selection menu.

Clear the display

Press Clear Display to clear the current displayed waveform from the screen. If the handheld scope is running, the display will begin to accumulate waveform data again.

Recall the file

Press Press to Recall to recall the saved file from the selected memory location.

Print screen control

Press Print Screen to print a hardcopy of the current screen image via a supported USB printer connected to the handheld scope. You can also perform a quick print by pressing and holding Save/Recall.

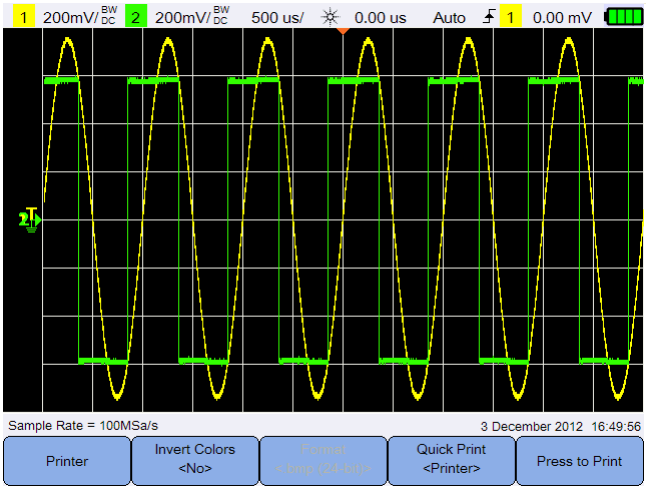


Figure 3-15 Print screen submenu

Invert image colors

Toggle Invert Colors <No> to invert all colors on the screen image you want to print.

Print the screen image

Press Press to Print to print the current screen image via a supported USB printer connected to the handheld scope.

Press Quick Print <Printer> repeatedly to set the quick print option to the printer, USB, or internal storage.

Press Format <.bmp (24-bit)> repeatedly to select the print screen file format for the USB or internal storage quick print option.

- bmp (8-bit) – save the waveform image in the BMP (8-bit) format.
- bmp (24-bit) – save the waveform image in the BMP (24-bit) format.
- png (24-bit) – save the waveform image in the PNG (24-bit) format.

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4 Using the Digital Multimeter

Introduction 92
Voltage Measurements 93
Resistance Measurement 94
Capacitance Measurement 95
Diode Test 96
Continuity Test 97
Temperature Measurement 98
Frequency Measurement 99
Relative Measurement 100
Range 100
Restart Measurements 100

This chapter explains how to configure and perform multimeter measurements.

Introduction

Press Meter to select and perform multimeter measurements.

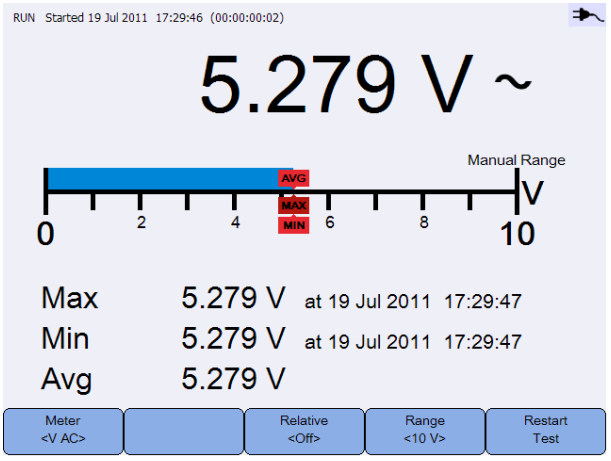


Figure 4-1 Multimeter display

To run or stop multimeter measurements, press Run/Stop.

To select the measurement function, press Meter <V AC> and use the ◀▲▼▶ keys.

Press Meter <V AC> again to exit the selection menu.

When you measure voltage, the AC (~), DC (⎓), or AC+DC (≂) indicator is displayed. A voltage warning sign (⚠) will appear whenever a potentially hazardous voltage is being measured.

The virtual scale indicates the measured value and the average, maximum, and minimum values. This allows you to quickly estimate different attributes of the input, such as variability (difference between min and max) and stability (average reading versus current reading).

If there is an input overload, OVERLOAD will be shown and no readings will be displayed.

NOTE **For accurate measurement results, allow the multimeter to warm up for 30 minutes.**

Voltage Measurements

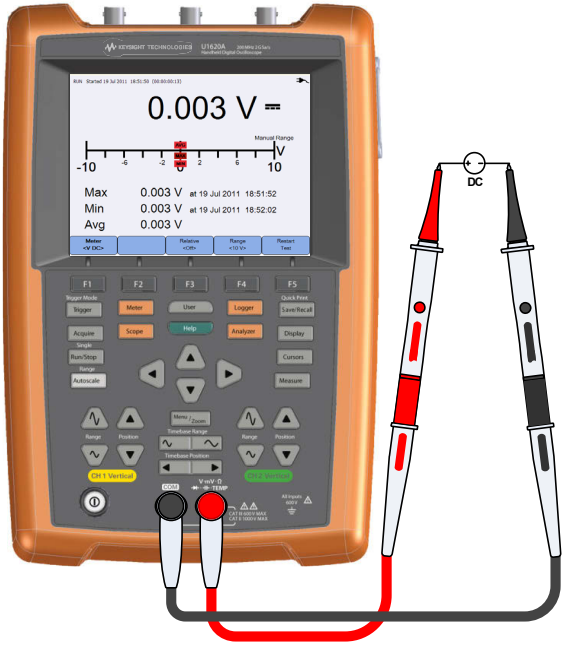
WARNING **Ensure that the probe tips are in contact with the metal contacts inside the outlet. Improper contact may lead to inaccurate voltage measurement. Poor contact will cause inaccurate readings and poses a risk of electrocution.**

Voltage measurements consist of:

- V AC – Measurements are returned as true RMS readings, which are accurate for sine waves and other waveforms (with no DC offset).
- V DC – Measurements are returned with their polarity.
- V AC+DC – Both AC and DC signal components are measured as one AC+DC (RMS) value combined.

To measure voltage:

1 Press Meter <V AC> and use the ◀▲▼▶ keys to select the voltage measurement function. Set up the following connections:



2 Read the voltage reading from the display.

3 See "Relative Measurement", "Range", and "Restart Measurements" for the respective functions.

Resistance Measurement

WARNING **Disconnect power to the device-under-test and discharge all high voltage capacitors to avoid electric shock and damage to the handheld scope or device-under-test while taking resistance measurement.**

Resistance (Ω) is measured by sending a small current out through the test leads to the device or circuit-under-test.

To measure resistance:

1 Press Meter <V AC> and use the ◀▲▼▶ keys to select the resistance measurement function. Set up the following connections:

2 Read the resistance reading from the display.

3 See "Relative Measurement", "Range", and "Restart Measurements" for the respective functions.

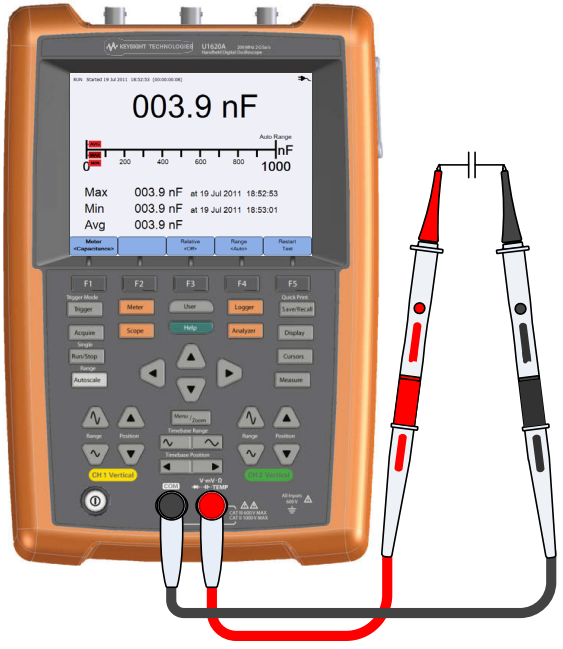
Capacitance Measurement

WARNING **Disconnect circuit power and discharge all high voltage capacitors before performing capacitance measurement to avoid electric shock and damage to the handheld scope. Use the V DC function to confirm that the capacitor is fully discharged.**

Capacitance is measured by charging the capacitor with a known current for a known period of time, measuring the resulting voltage, and then calculating the capacitance.

To measure capacitance:

1 Press Meter <V AC> and use the ◀▲▼▶ keys to select the capacitance measurement function. Set up the following connections:



2 Read the capacitance reading from the display.

3 See "Relative Measurement", "Range", and "Restart Measurements" for the respective functions.

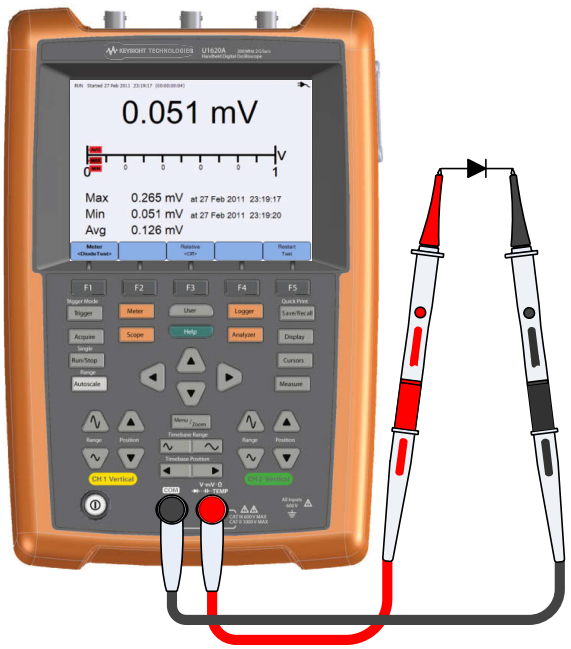
Diode Test

WARNING **Disconnect circuit power and discharge all high voltage capacitors before performing diode test to avoid electric shock and damage to the handheld scope.**

The diode test sends a current through a semiconductor junction, and then measures the junction voltage drop.

To perform the diode test:

1 Press Meter <V AC> and use the ◀▲▼▶ keys to select the diode test function. Set up the following connections:



2 Read the voltage reading from the display.

3 Reverse the polarity of the probes and measure the voltage across the diode again. Read the voltage reading from the display.

4 See "Relative Measurement" and "Restart Measurements" for the respective functions.

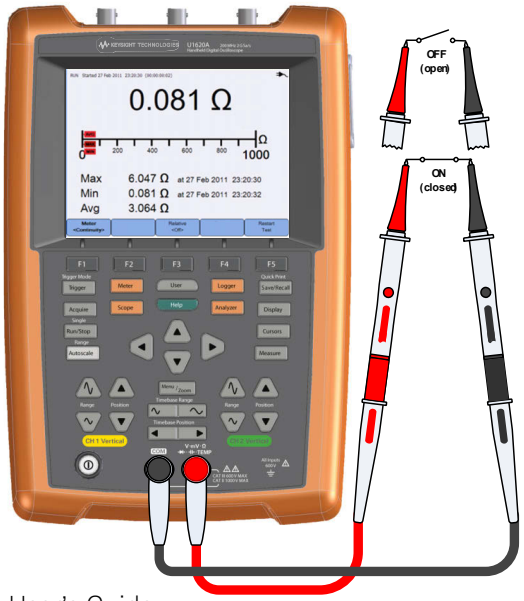
Continuity Test

WARNING **Disconnect circuit power and discharge all high voltage capacitors before measuring continuity on circuits or wires to avoid electric shock and damage to the handheld scope.**

The continuity test emits a continuous beep (press User > Sound Settings > Buzzer <Off> to enable the beeper) when a circuit is complete; otherwise the circuit is broken.

To perform the continuity test:

1 Press Meter <V AC> and use the ◀▲▼▶ keys to select the continuity test function. Set up the following connections:



2 Read the resistance reading from the display.

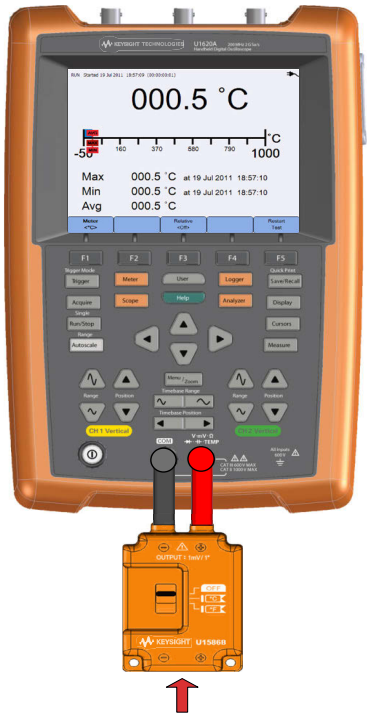
3 See "Relative Measurement" and "Restart Measurements" for the respective functions.

Temperature Measurement

The temperature measurement works in the autorange mode with a temperature module. Keysight recommends using the U1586B temperature adapter.

To measure temperature:

1 Press Meter <V AC> and use the ◀▲▼▶ keys to select the °C or °F temperature measurement function. Set up the following connections:



K-type thermocouple probe

2 Touch the material-under-test with the thermocouple probe tip.

3 Read the temperature reading from the display.

4 See "Relative Measurement" and "Restart Measurements" for the respective functions.

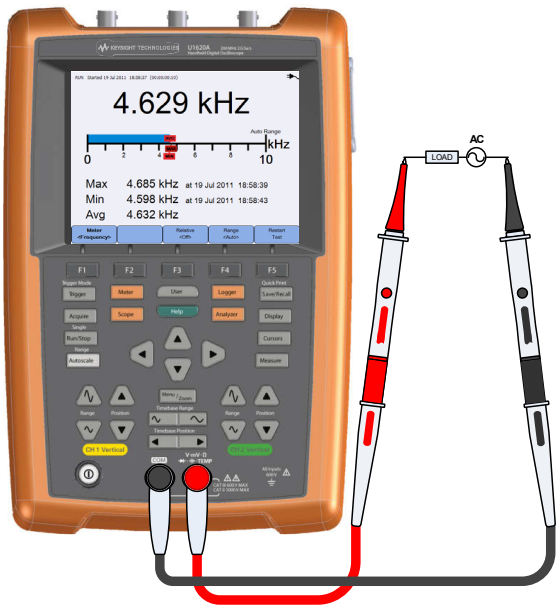
WARNING **Do not connect the thermocouple to electrically live circuits to avoid fire or electric shock.**

Frequency Measurement

Frequency of a signal is measured by counting the number of times the signal crosses a threshold level within a specified period of time.

To measure frequency:

1 Press Meter <V AC> and use the ◀▲▼▶ keys to select the frequency measurement function. Set up the following connections:



2 Read the frequency reading from the display.

3 See "Relative Measurement", "Range", and "Restart Measurements" for the respective functions.

Relative Measurement

Toggle [Relative <Off>] to enable the relative function.

Relative value = Measured value – Reference value.

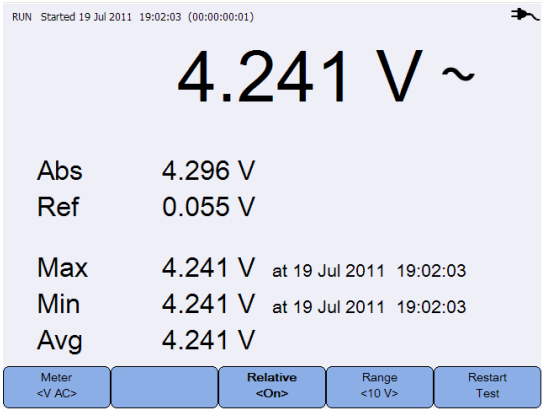


Figure 4-2 Relative measurement display

Range

Press [Range <Auto>] repeatedly to let the meter select the best range (Auto range) for the current reading, or select your own range to work with.

You can also activate Auto range by pressing [Autoscale].

Range is only applicable for the voltmeter, resistance, capacitance, and frequency functions.

NOTE **Frequency measurement works in the autorange mode, and the range that you select applies for V AC.**

Restart Measurements

Press [Restart Test] to restart and retest measurement functions.

5 Using the Data Logger

Introduction 102
Scope Logger 103
Meter Logger 106

This chapter describes how to perform scope and meter data logging.

Introduction

Press Logger to access the data logger functions for scope and multimeter measurements.

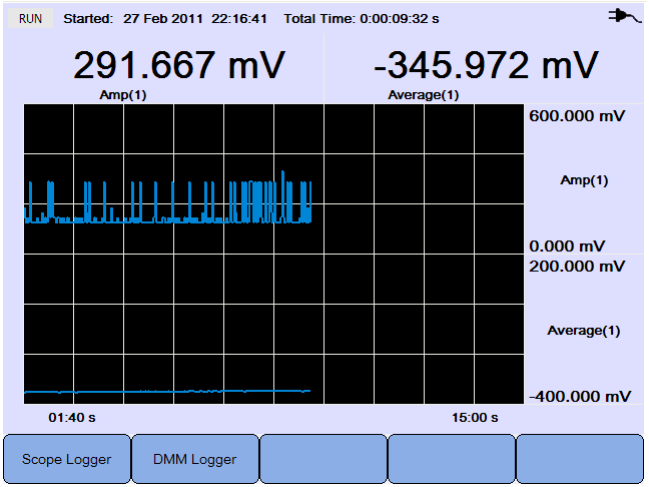


Figure 5-1 Data logger menu

Once the data logger function is activated, it takes measurements at a fixed rate of 1 reading/second. All the measured samples are stored into a buffer memory. The buffer memory can hold up to 691200 samples. At the rate of 1 reading/second, this is equivalent to a continuous measurement of up to 8 days. Once the buffer memory is full, the logger will stop.

The data logger function provides an on-screen chart, which plots the selected measurement parameter (for example, VDC or VAC). The chart is updated every second as a new sample arrives. Once the number of accumulated samples is more than the number of horizontal screen pixels on the chart area, the data logger will change the horizontal axis (time) scale while the measurement and chart updating process continues uninterrupted.

To start or stop the data recording, press Run/Stop.

When the data logger is stopped, you can zoom in to the graph. The zoom bar operates the same way as for the scope. See "Zoom mode" on page 51.

Scope Logger

Press Scope Logger to access the scope logger, which logs the first two scope measurement results.

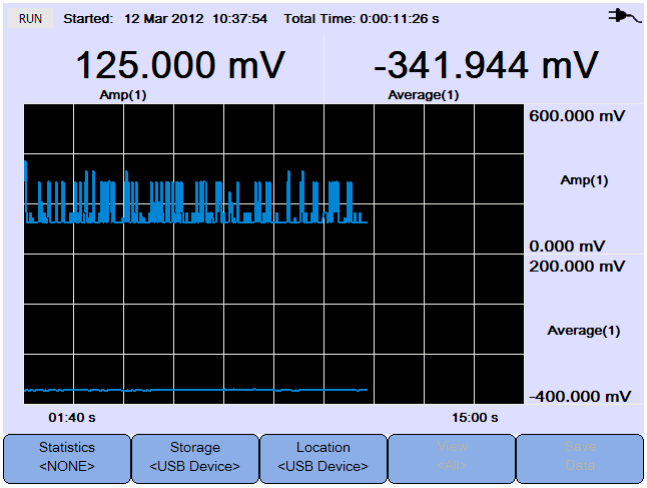


Figure 5-2 Scope logger display

Each measurement reading has a label below it indicating “measurement (channel number)”.

The upper half of the logging graph contains the logged graph for the first measurement, and the lower half contains the logged graph for the second measurement.

Measurement statistics

Press Statistics <NONE> repeatedly to display the maximum, minimum, and average measurements for the first or second scope measurement.

If there is only one scope measurement selected, Statistics <NONE> automatically selects that measurement.

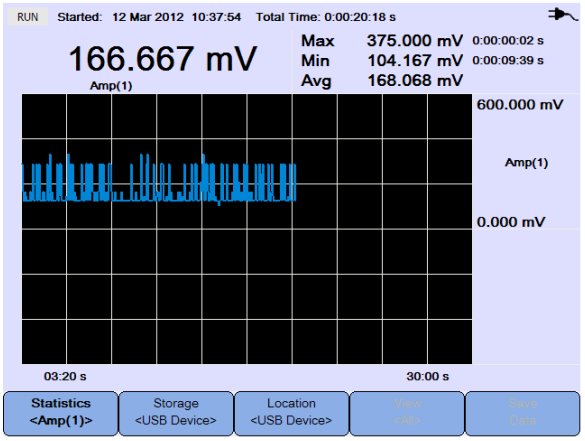


Figure 5-3 Statistics display

Graphing mode

When the logger is stopped, toggle View <All> to select the graphing mode.

- View Latest

  Only the latest 12 data points are shown. After that, new data is added to the right and previous data is moved to the left. This gives a clear view of the recent input.

- View All

  Allows you to view all the plotted data since the logger was started/restarted. All the data is compressed into the grid, allowing you to view long-term trends.

Saving the recorded data

When the logger is stopped, press Storage <USB Device> to select either the USB storage device or internal memory as the storage location. Press Location <USB Device> and use the ◀▲▼▶ keys to select the USB location or the internal memory slot to save the recorded data to. Ensure that your USB storage device is connected and ready for use (see "Select the save location" on page 86).

Press Save Data to save the recorded data.

Erasing the saved recorded data

When the logger is stopped, press Storage <Erase> repeatedly to select the erase function. Press Location <Slot 01> and use the ◀▲▼▶ keys to select the internal memory slot to be erased.

Press Save Data to erase the recorded data in the selected memory slot.

Transferring the saved recorded data

When the logger is stopped, press Storage <Transfer> repeatedly to select the transfer function. Press Location <Slot 01> and use the ◀▲▼▶ keys to select the internal memory slot to be transferred to the USB storage device. The USB location will be the previous location selected.

Press Transfer to transfer the selected recorded data to the USB storage device.

Meter Logger

Press DMM Logger to access the meter logger, which logs the multimeter measurement results. This allows you to notice trends over a long period of time.

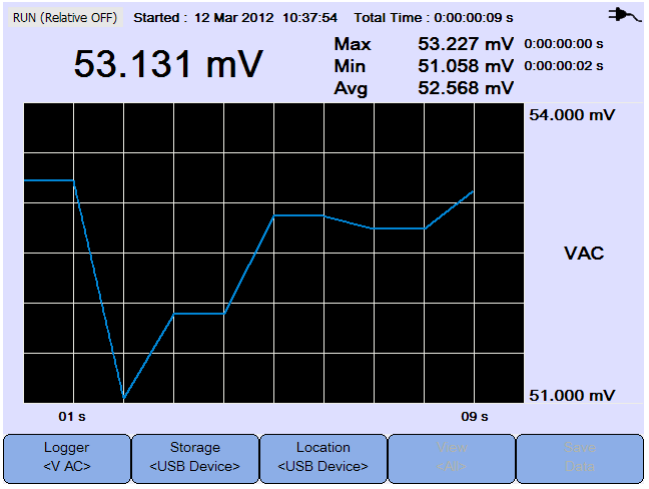


Figure 5-4 Meter logger display

Measurement selection

Press Logger <V AC> and use the ◀▲▼▶ keys to select a multimeter measurement function to be logged. Press Logger <V AC> again to exit the selection menu.

Graphing mode

See “Graphing mode” on page 104.

Saving the recorded data

See “Saving the recorded data” on page 105.

Erasing the saved recorded data

See “Erasing the saved recorded data” on page 105.

Transferring the saved recorded data

See “Transferring the saved recorded data” on page 105.

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6 Using the System-Related Functions

Introduction 110
General System Settings 110
Display Settings 112
Sound Settings 113
Service Functions 114
System Information 115

This chapter explains how to set up system-related settings and perform service functions.

Introduction

Press User to access the system configurations and functions.

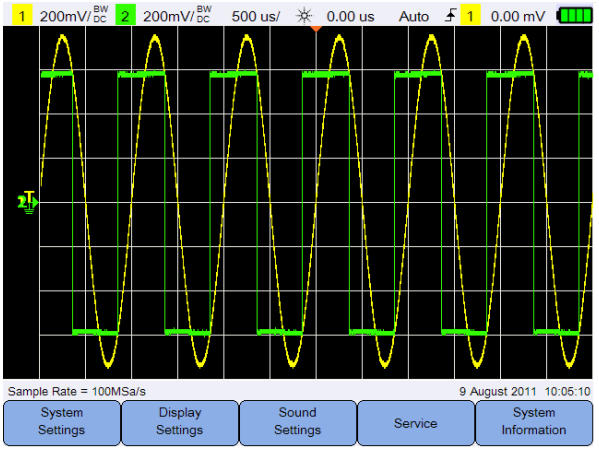


Figure 6-1 User function menu

General System Settings

Press System Settings to access the general system settings.

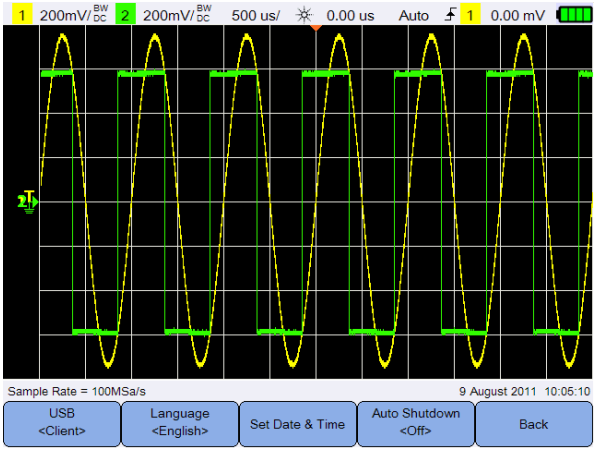


Figure 6-2 General system settings submenu

USB connectivity

Press

repeatedly to select the USB connectivity type when you connect a USB device to the handheld scope. Select **‹Host›** when a USB storage device is connected to the handheld scope, or **‹Client›** when the handheld scope is connected to the PC.

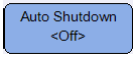
Set the language

See “Set the Date and Time and Language” on page 26.

Set the date and time

See “Set the Date and Time and Language” on page 26.

Set auto-shutdown

Press 

repeatedly to adjust the length of time the display can be left idle before the handheld scope is powered down automatically. Enabling this option helps you save the battery life of your handheld scope.

Display Settings

Press Display Settings to configure the handheld scope display.

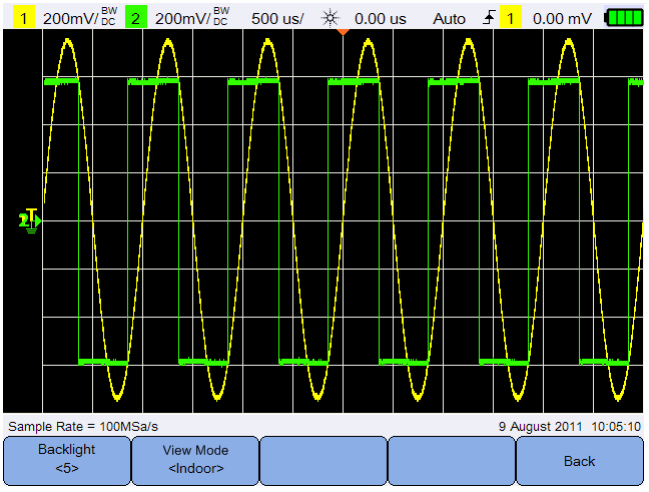


Figure 6-3 Display settings submenu

Backlight intensity

Press Backlight <5> repeatedly to increase/decrease the backlight brightness.

View mode

Press View Mode <Indoor> repeatedly to select a suitable view mode for the display to obtain the best views in different environments.

Sound Settings

Press Sound Settings to configure the buzzer and key sounds.

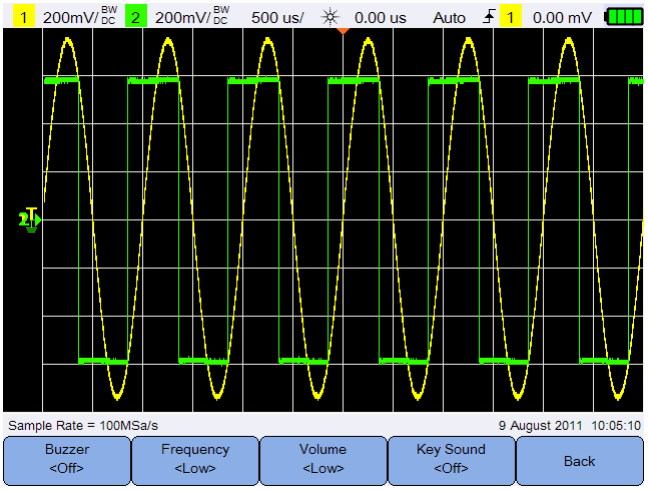


Figure 6-4 Sound settings submenu

Toggle Buzzer <Off> to turn on/off the buzzer, which emits a beep for warnings and alerts.

Toggle Key Sound <Off> to turn on/off the key sound, which produces the sound for the keypad when any of the keys is pressed.

Press Frequency <Low> or Volume <Low> repeatedly to set the sound frequency or volume level respectively.

Service Functions

Press Service to access the service functions.

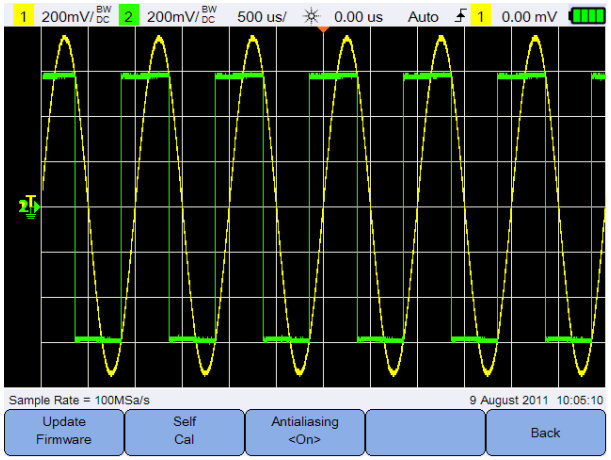


Figure 6-5 Service function submenu

Firmware update

NOTE **From time to time Keysight releases software and firmware updates for the U1610/20A.**

Use the following procedure to update the firmware:

1. Download the firmware update file from the Web page
2. Save the firmware file to the root directory on your USB storage device.
3. On the handheld scope, press User > System Settings and press USB <Client> repeatedly to select **<Host>**.
4. Connect your USB storage device to the handheld scope.

5 Press Back > Service > Update Firmware > OK to start updating the firmware.

6 Once completed, the handheld scope will automatically restart for the firmware updating to take effect.

Self-calibration

Press Self Cal to perform self-calibration. (See "Perform Self-Calibration" on page 25).

Antialiasing

Aliasing can occur when the oscilloscope sampling rate is not at least twice as fast as the highest frequency component in the sampled waveform. When the antialiasing function is turned on, the handheld scope randomizes the time between the samples at a low sweep rate. This prevents the high frequency aliased signals to be misinterpreted as low frequency signals when displayed on the screen.

Toggle Antialiasing <On> to turn on/off antialiasing.

System Information

Press System Information to view the current system information of the handheld scope.

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7 Characteristics and Specifications

For the characteristics and specifications of the U1610/20A Handheld Digital Oscilloscope, refer to the datasheet at http://literature.cdn.keysight.com/litweb/pdf/5990-9523EN.pdf.

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This information is subject to change without notice. Always refer to the Keysight website for the latest revision.

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