



RIGOL

DG70000 Series

Arbitrary Waveform Generator

User Guide

Aug. 2023

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| Section | Description | Page |
|---------|--|------|
| | List of Figures..... | V |
| | List of Tables..... | VIII |
| 1 | Safety Requirement | 1 |
| 1.1 | General Safety Summary | 1 |
| 1.2 | Safety Notices and Symbols | 3 |
| 1.3 | Measurement Category | 3 |
| 1.4 | Ventilation Requirement | 4 |
| 1.5 | Working Environment | 4 |
| 1.6 | Care and Cleaning | 6 |
| 1.7 | Environmental Considerations | 6 |
| 1.8 | Keep Hands Clear | 7 |
| 2 | Product Features | 8 |
| 3 | Document Overview | 9 |
| 4 | Quick Start | 11 |
| 4.1 | General Inspection | 11 |
| 4.2 | Appearance and Dimensions | 12 |
| 4.3 | To Prepare for Use | 13 |
| 4.3.1 | To Connect to Power | 13 |
| 4.3.2 | Turn-on Checkout | 13 |
| 4.3.3 | Fuse Replacement | 14 |
| 4.3.4 | To Set the System Language | 14 |
| 4.4 | Product Overview | 15 |
| 4.4.1 | Front Panel Overview | 15 |
| 4.4.2 | Rear Panel Overview | 19 |
| 4.4.3 | User Interface Overview | 22 |
| 4.4.4 | 3.5-Inch High-definition Touch Screen Overview | 25 |
| 4.5 | Touch Screen Gestures | 28 |
| 4.5.1 | Tap | 28 |
| 4.5.2 | Pinch&Stretch | 29 |
| 4.5.3 | Drag | 30 |
| 4.6 | Parameter Setting Method | 30 |
| 4.7 | To Use the Built-in Help System | 34 |
| 4.8 | To View the Option Information and the Option Installation | 34 |

| | | |
|-------|--|----|
| 5 | Project Management | 36 |
| 6 | Waveform Editing and Management | 40 |
| 6.1 | Basic Waveform Editor | 41 |
| 6.2 | Table Editor | 44 |
| 6.2.1 | New Waveform | 45 |
| 6.2.2 | Table Management | 45 |
| 6.3 | Advanced Editor (Optional) | 47 |
| 6.4 | High Speed Serial Editor (Optional) | 50 |
| 6.4.1 | Pattern Setting | 51 |
| 6.4.2 | Transmitter | 56 |
| 6.4.3 | Channel Setting | 59 |
| 6.4.4 | Pre/De-Emphasis | 60 |
| 6.4.5 | Other Waveform Parameters | 60 |
| 6.5 | Marker | 61 |
| 6.6 | Waveform Management | 62 |
| 7 | Sequence Editing and Management (Optional) | 66 |
| 7.1 | New Sequence | 66 |
| 7.2 | Output Rules | 69 |
| 7.2.1 | Wait | 70 |
| 7.2.2 | Go To | 70 |
| 7.2.3 | Loop | 71 |
| 7.2.4 | Event Jump To | 71 |
| 7.2.5 | Force Jump | 72 |
| 7.3 | Pattern Jump | 73 |
| 7.4 | Viewing Sequence Editor | 75 |
| 7.5 | Sequence Editing Tools | 76 |
| 7.6 | Sequence Management | 76 |
| 8 | Modulation | 79 |
| 8.1 | Modulating Waveform | 79 |
| 8.2 | Modulated Waveform Management | 81 |
| 9 | Channel Management | 84 |
| 9.1 | Adding Resources to Channel | 84 |
| 9.2 | Run Mode and Trigger Source | 86 |
| 9.3 | Common Operations | 87 |
| 9.4 | Channel Output Control | 87 |
| 10 | Clock Setup | 89 |
| 10.1 | Clock and Reference Sources | 89 |

| | | |
|--------|---------------------------------|-----|
| 10.2 | Jitter Reduction | 91 |
| 10.3 | Sample Rate and Sample Clock | 92 |
| 10.4 | Clock Output | 93 |
| 11 | Channel Setup | 94 |
| 11.1 | Resolution | 96 |
| 11.2 | Real Waveform | 96 |
| 11.3 | IQ Waveform (Optional) | 98 |
| 11.4 | DAC Mode | 99 |
| 11.5 | Output Settings | 100 |
| 12 | Output Setup | 102 |
| 13 | Trigger Setup | 105 |
| 14 | Synchronization Setup | 107 |
| 15 | Skew Setup | 109 |
| 16 | IQ Impairment | 111 |
| 17 | Storage Management | 113 |
| 18 | Import/Export | 116 |
| 19 | System Utility Function Setting | 121 |
| 19.1 | I/O Setting | 121 |
| 19.2 | Basic Settings | 123 |
| 19.3 | About this Instrument | 125 |
| 19.4 | Screen Saver | 126 |
| 19.5 | Email | 126 |
| 19.6 | Screen Capture | 127 |
| 19.7 | Option | 127 |
| 20 | Upgrade | 128 |
| 21 | AFG Mode | 129 |
| 21.1 | Continuous Mode | 131 |
| 21.1.1 | Sine Wave | 131 |
| 21.1.2 | Square Wave | 133 |
| 21.1.3 | Ramp Wave | 134 |
| 21.1.4 | Pulse | 136 |
| 21.1.5 | Noise | 138 |
| 21.2 | Burst Mode | 139 |
| 21.2.1 | Burst Type | 139 |
| 21.2.2 | Burst Count | 140 |
| 21.2.3 | Burst Delay | 140 |
| 21.2.4 | Burst Phase | 141 |

| | | |
|--------|-------------------------------------|-----|
| 21.2.5 | Burst Period | 141 |
| 21.2.6 | Trigger Source | 141 |
| 21.2.7 | Burst Idle Level | 141 |
| 21.3 | Modulation Mode | 142 |
| 21.3.1 | Amplitude Modulation (AM) | 143 |
| 21.3.2 | Frequency Modulation (FM) | 144 |
| 21.3.3 | Phase Modulation (PM) | 145 |
| 21.3.4 | Amplitude Shift Keying (ASK) | 146 |
| 21.3.5 | Frequency Shift Keying (FSK) | 147 |
| 21.3.6 | Phase Shift Keying (PSK) | 148 |
| 21.4 | Sweep Mode | 149 |
| 21.4.1 | Sweep Type | 149 |
| 21.4.2 | Start Frequency and Stop Frequency | 151 |
| 21.4.3 | Center Frequency and Frequency Span | 151 |
| 21.4.4 | Sweep Time | 152 |
| 21.4.5 | Start/Stop Hold Time | 152 |
| 21.4.6 | Return Time | 153 |
| 21.4.7 | Sweep Trigger Source | 153 |
| 21.5 | Channel Setup | 153 |
| 21.6 | Clock Setup | 156 |
| 21.7 | AFG Storage Management | 156 |
| 21.8 | AFG Upgrade | 157 |
| 22 | Remote Control | 158 |
| 22.1 | Remote Control via USB | 159 |
| 22.2 | Remote Control via LAN | 159 |
| 22.3 | Remote Control via GPIB | 160 |
| 23 | Factory Defaults | 162 |
| 24 | Troubleshooting | 170 |
| 25 | Appendix | 172 |
| 25.1 | Appendix A: Options and Accessories | 172 |
| 25.2 | Appendix B: Warranty | 172 |

List of Figures

| | |
|--|----|
| Figure 4.1 Front Elevation | 12 |
| Figure 4.2 Side Elevation | 12 |
| Figure 4.3 Connecting to Power | 13 |
| Figure 4.4 Fuse Replacement | 14 |
| Figure 4.5 Front Panel (4-channel Model) | 15 |
| Figure 4.6 Rear Panel (4-channel Model) | 19 |
| Figure 4.7 User Interface (4-channel Model) | 22 |
| Figure 4.8 User Interface (2-channel Model) | 23 |
| Figure 4.9 Smart and Quick-Responsive Keyboard Menu | 26 |
| Figure 4.10 Flip Screen Adjustment Interface | 27 |
| Figure 4.11 Tap Gesture | 29 |
| Figure 4.12 Pinch&Stretch Gesture | 29 |
| Figure 4.13 Drag Gesture | 30 |
| Figure 4.14 English Input Interface | 31 |
| Figure 4.15 Chinese Input Interface | 32 |
| Figure 4.16 Numeric Keypad | 33 |
| Figure 5.1 Project Interface | 36 |
| Figure 5.2 Waveform Preview Area | 38 |
| Figure 6.1 Waveform Editing and Management Interface | 40 |
| Figure 6.2 "Assign to channel" Menu | 41 |
| Figure 6.3 "Table Editor" Menu | 45 |
| Figure 6.4 "Generate New Waveform" Menu | 45 |
| Figure 6.5 "Table Editor" Menu | 46 |
| Figure 6.6 Advanced Editor Menu | 47 |
| Figure 6.7 High Speed Serial Editor Menu | 51 |
| Figure 6.8 Pattern Setting Menu | 51 |
| Figure 6.9 Encoding/Modulation Menu | 53 |

| | |
|--|-----|
| Figure 6.10 "Transmitter" Menu | 56 |
| Figure 6.11 Channel Setting Menu | 59 |
| Figure 6.12 Pre/De-Emphasis Menu | 60 |
| Figure 6.13 Waveform List | 62 |
| Figure 6.14 Resource List Menu | 64 |
| Figure 7.1 Sequence Editing and Management Interface | 66 |
| Figure 7.2 Creating an Empty Sequence | 67 |
| Figure 7.3 Creating a Track | 68 |
| Figure 7.4 Adding Resources to Track | 68 |
| Figure 7.5 "Rule Setting" Menu | 69 |
| Figure 7.6 "Sequence Setting" Menu | 72 |
| Figure 7.7 "Sequence Setting" Menu | 73 |
| Figure 7.8 Sequence Editor Default Style | 75 |
| Figure 7.9 Switching Display Style | 75 |
| Figure 7.10 Sequence List | 77 |
| Figure 8.1 Modulation Interface | 79 |
| Figure 8.2 Constellation diagram of 8PSK | 80 |
| Figure 8.3 Modulation List | 81 |
| Figure 9.1 CH1 Operation Interface | 84 |
| Figure 9.2 "Resource List" Menu | 85 |
| Figure 10.1 "Clock Setting" Menu | 89 |
| Figure 11.1 Channel Labels | 94 |
| Figure 11.2 "Channel Setting" Menu | 95 |
| Figure 12.1 "Output Option" Menu | 102 |
| Figure 13.1 Trigger Setting Menu | 105 |
| Figure 14.1 Sync Labels | 107 |
| Figure 14.2 Sync Setting Menu | 107 |
| Figure 14.3 All Channels Synchronized | 107 |
| Figure 15.1 Skew Setting Menu of Analog Outputs | 109 |

| | |
|--|-----|
| Figure 15.2 Skew Setting Menu of Marker Outputs | 110 |
| Figure 16.1 "IQ Impairment" Menu | 111 |
| Figure 17.1 "Storage" Menu | 113 |
| Figure 18.1 Import/Export Menu | 116 |
| Figure 18.2 Import Wave Menu | 117 |
| Figure 18.3 Import Sequence Menu | 118 |
| Figure 18.4 Export Waveform Menu | 119 |
| Figure 18.5 Export Sequence Menu | 119 |
| Figure 19.1 Screen Saver | 126 |
| Figure 21.1 AFG Mode Interface (4-channel Model) | 129 |
| Figure 21.2 AFG Mode Interface (2-channel Model) | 130 |
| Figure 21.3 Continuous Mode Interface | 131 |
| Figure 21.4 Burst Mode Interface | 139 |
| Figure 21.5 Modulation Mode Interface | 142 |
| Figure 21.6 Sweep Mode Interface | 149 |
| Figure 21.7 Linear Sweep | 150 |
| Figure 21.8 Logarithmic Sweep | 150 |
| Figure 21.9 Step Sweep | 151 |
| Figure 21.10 "Channel Setting" Menu | 154 |
| Figure 21.11 Channel Quick Setup Menu | 154 |
| Figure 21.12 "Storage" Menu | 157 |
| Figure 22.1 Search for the Available Device | 161 |
| Figure 22.2 Confirm the Available Device | 161 |

List of Tables

| | |
|--|-----|
| Table 11.1 Correspondence of Marker to Output Port | 96 |
| Table 23.1 Factory Settings | 162 |

1 Safety Requirement

1.1 General Safety Summary

Please review the following safety precautions carefully before putting the instrument into operation so as to avoid any personal injury or damage to the instrument and any product connected to it. To prevent potential hazards, please follow the instructions specified in this manual to use the instrument properly.

- **Use the SMA Output Connectors Properly.**

The front-panel SMA output connectors only allow signal output but unable to support signal input.

- **Use Proper Power Cord.**

Only the exclusive power cord designed for the instrument and authorized for use within the destination country could be used.

- **Ground the Instrument.**

The instrument is grounded through the Protective Earth lead of the power cord. To avoid electric shock, it is essential to connect the earth terminal of the power cord to the Protective Earth terminal before connecting any inputs or outputs.

- **Observe All Terminal Ratings.**

To avoid fire or shock hazard, observe all ratings and markers on the instrument and check your manual for more information about ratings before connecting the instrument.

- **Use Proper Overvoltage Protection.**

Ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the operator might be exposed to the danger of an electric shock.

- **Do Not Operate Without Covers.**

Do not operate the instrument with covers or panels removed.

- **Do Not Insert Objects into the Air Outlet.**

Do not insert objects into the air outlet, as doing so may cause damage to the instrument.

- **Use the Proper Fuse.**

Please use the specified fuses.

- **Avoid Circuit or Wire Exposure.**

Do not touch exposed junctions and components when the instrument is powered on.

- **Do Not Operate With Suspected Failures.**

If you suspect that any damage may occur to the instrument, have it inspected by RIGOL authorized personnel before further operations. Any maintenance, adjustment or replacement especially to circuits or accessories must be performed by RIGOL authorized personnel.

- **Provide Adequate Ventilation.**

Inadequate ventilation may cause an increase of temperature in the instrument, which would cause damage to the instrument. So please keep the instrument well ventilated and inspect the air outlet and the fan regularly.

- **Do Not Operate in Wet Conditions.**

To avoid short circuit inside the instrument or electric shock, never operate the instrument in a humid environment.

- **Do Not Operate in an Explosive Atmosphere.**

To avoid personal injuries or damage to the instrument, never operate the instrument in an explosive atmosphere.

- **Keep Instrument Surfaces Clean and Dry.**

To avoid dust or moisture from affecting the performance of the instrument, keep the surfaces of the instrument clean and dry.

- **Prevent Electrostatic Impact.**

Operate the instrument in an electrostatic discharge protective environment to avoid damage induced by static discharges. Always ground both the internal and external conductors of cables to release static before making connections.

- **Use the Battery Properly.**

Do not expose the battery (if available) to high temperature or fire. Keep it out of the reach of children. Improper change of a battery (lithium battery) may cause an explosion. Use the RIGOL specified battery only.

- **Handle with Caution.**

Please handle with care during transportation to avoid damage to keys, knobs, interfaces, and other parts on the panels.

**WARNING**

Equipment meeting Class A requirements may not offer adequate protection to broadcast services within residential environment.

1.2 Safety Notices and Symbols

Safety Notices in this Manual:



WARNING

Indicates a potentially hazardous situation or practice which, if not avoided, will result in serious injury or death.



CAUTION

Indicates a potentially hazardous situation or practice which, if not avoided, could result in damage to the product or loss of important data.

Safety Notices on the Product:

- **DANGER**

It calls attention to an operation, if not correctly performed, could result in injury or hazard immediately.

- **WARNING**

It calls attention to an operation, if not correctly performed, could result in potential injury or hazard.

- **CAUTION**

It calls attention to an operation, if not correctly performed, could result in damage to the product or other devices connected to the product.

Safety Symbols on the Product:



**Hazardous
Voltage**



Safety Warning



**Protective Earth
Terminal**



Chassis Ground



Test Ground

1.3 Measurement Category

Measurement Category

This instrument can make measurements in Measurement Category I.



WARNING

This instrument can only be used for measurements within its specified measurement categories.

Measurement Category Definitions

- **Measurement category I** is for measurements performed on circuits not directly connected to MAINS. Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS derived circuits. In the latter case, transient stresses are variable. Thus, you must know the transient withstand capability of the equipment.
- **Measurement category II** is for measurements performed on circuits directly connected to low voltage installation. Examples are measurements on household appliances, portable tools and similar equipment.
- **Measurement category III** is for measurements performed in the building installation. Examples are measurements on distribution boards, circuit-breakers, wiring (including cables, bus-bars, junction boxes, switches and socket-outlets) in the fixed installation, and equipment for industrial use and some other equipment. For example, stationary motors with permanent connection to a fixed installation.
- **Measurement category IV** is for measurements performed at the source of a low-voltage installation. Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units.

1.4 Ventilation Requirement

This instrument uses a fan to force cooling. Please make sure that the air inlet and outlet areas are free from obstructions and have free air. When using the instrument in a bench-top or rack setting, provide at least 10 cm clearance beside, above and behind the instrument for adequate ventilation.



CAUTION

Inadequate ventilation may cause an increase of temperature in the instrument, which would cause damage to the instrument. So please keep the instrument well ventilated and inspect the air outlet and the fan regularly.

1.5 Working Environment

Temperature

Operating: 0°C to +50°C

Non-operating: -30°C to +70°C

Humidity

- **Operating:**
 - Below +30°C: ≤90% RH (without condensation)
 - +30°C to +40°C: ≤75% RH (without condensation)

+40°C to +50°C: ≤45% RH (without condensation)

- **Non-operating:**

Below +65°C: ≤90% RH (without condensation)



WARNING

To avoid short circuit inside the instrument or electric shock, never operate the instrument in a humid environment.

Altitude

- **Operating:** below 3 km
- **Non-operating:** below 15 km

Protection Level Against Electric Shock

ESD ±8kV

Installation (Overvoltage) Category

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



WARNING

Ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the operator might be exposed to the danger of an electric shock.

Installation (Overvoltage) Category Definitions

Installation (overvoltage) category I refers to signal level which is applicable to equipment measurement terminals connected to the source circuit. Among these terminals, precautions are done to limit the transient voltage to a low level.

Installation (overvoltage) category II refers to the local power distribution level which is applicable to equipment connected to the AC line (AC power).

Pollution Degree

Pollution Degree 2

Pollution Degree Definition

- **Pollution Degree 1:** No pollution or only dry, nonconductive pollution occurs. The pollution has no effect. For example, a clean room or air-conditioned office environment.
- **Pollution Degree 2:** Normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected. For example, indoor environment.
- **Pollution Degree 3:** Conductive pollution or dry nonconductive pollution that becomes conductive due to condensation occurs. To be found in industrial

environment or construction sites (harsh environments). For example, sheltered outdoor environment.

- **Pollution Degree 4:** The pollution generates persistent conductivity caused by conductive dust, rain, or snow. For example, outdoor areas.

Safety Class

Class 1 – Grounded Product

1.6 Care and Cleaning

Care

Do not store or leave the instrument where it may be exposed to direct sunlight for long periods of time.

Cleaning

Clean the instrument regularly according to its operating conditions.

1. Disconnect the instrument from all power sources.
2. Clean the external surfaces of the instrument with a soft cloth dampened with mild detergent or water. Avoid having any water or other objects into the chassis via the heat dissipation hole. When cleaning the LCD, take care to avoid scarifying it.

CAUTION

To avoid damage to the instrument, do not expose it to caustic liquids.

WARNING

To avoid short-circuit resulting from moisture or personal injuries, ensure that the instrument is completely dry before connecting it to the power supply.

1.7 Environmental Considerations

The following symbol indicates that this product complies with the WEEE Directive 2002/96/EC.



The equipment may contain substances that could be harmful to the environment or human health. To avoid the release of such substances into the environment and avoid harm to human health, we recommend you to recycle this product appropriately to ensure that most materials are reused or recycled properly. Please contact your local authorities for disposal or recycling information.

You can click on the following link <https://int.rigol.com/services/services/declaration> to download the latest version of the RoHS&WEEE certification file.

1.8 Keep Hands Clear



WARNING

While the main screen is opening or closing, keep hands clear from the inclination angle between the main screen and its instrument body to avoid being pinched.

2 Product Features

Product Features

- Up to 5 GSa/s sample rates (12 GSa/s interpolated)
- 4-channel synchronization for a single instrument (4-channel models only)
- -70 dBc SFDR
- 16-bit vertical resolution
- 1.5 GSample waveform memory depth per channel
- Direct generation of signals with carriers up to 5 GHz
- Generate arbitrary waveforms point by point; recover the signal without distortion
- Total jitter low as 10 ps_{p-p}, random jitter low as 350 fs_{rms}
- Sample rates adjustable from 100 Sa/s to 12 GSa/s
- High-precision synchronization with channel-to-channel skew repeatability low as ±10 ps
- Support advanced sequence to define outputs of various complex waveforms
- Multiple interfaces available: LAN, USB3.0, HDMI
- Support the import of external waveform files
- 15.6-inch angle-adjustable display

Built on its unique SiFi III technical platform and Android operating system, the DG70000 series Arbitrary Waveform Generator (AWG) has the following advantages: accurate and adjustable sample rates; generate arbitrary waveforms point by point; recover the signal without distortion; etc. This series is customer-oriented with a variety of functions suitable for practical applications. For example, the creation of advanced sequences enables you to self-define long complex waveforms. The multi-channel high-precision synchronization, high-bandwidth and low-jitter waveform output make it ready for applications in a variety of industrial and communications fields. Equipped with a 15.6-inch angle-adjustable touch screen supporting multi-pane windowing, it brings a brand new UI design and extraordinary user experience. Multiple standard interfaces provide you with more solutions in connectivity, making it simple to control the instrument remotely.

3 Document Overview

This manual gives you a quick overview of the front and rear panel, user interface as well as basic operation methods of DG70000 series.



TIP

For the newest version of this manual, download it from RIGOL official website (www.rigol.com).

Publication Number

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Format Conventions in this Manual

1. Key

The front panel key is denoted by the menu key icon. For example, indicates the "Default" key.

Default


2. Menu

The menu item is denoted by the format of "Menu Name (Bold) + Character Shading" in the manual, for example, **Setup**.





3. Operation Procedures

The next step of the operation is denoted by ">" in the manual. For example,



> **Storage** indicates first clicking or tapping the icon  and then clicking or tapping **Storage**.

4. Knob

| Label | Knob | Label | Knob |
|--|----------------|---|--|
|  Channel | Channel ON/OFF |  Trigger Interval/Screen Tilt | Trigger Interval/Screen Tilt Adjustment Knob |
|  Amplitude | Amplitude Knob |  Offset | Offset Knob |

Content Conventions in this Manual

DG70000 series Arbitrary Waveform Generator (AWG) includes the following models. Unless otherwise specified, this manual takes DG70004 as an example to illustrate the functions and operation methods of DG70000 series.

| Model | Number of Channels | Max. Output Frequency |
|---------|--------------------|-----------------------|
| DG70002 | 2 | 5 GHz |
| DG70004 | 4 | 5 GHz |

4 Quick Start

4.1 General Inspection

1. Inspect the packaging

If the packaging has been damaged, do not dispose the damaged packaging or cushioning materials until the shipment has been checked for completeness and has passed both electrical and mechanical tests.

The consigner or carrier shall be liable for the damage to the instrument resulting from shipment. RIGOL would not be responsible for free maintenance/rework or replacement of the instrument.

2. Inspect the instrument

In case of any mechanical damage, missing parts, or failure in passing the electrical and mechanical tests, contact your RIGOL sales representative.

3. Check the accessories

Please check the accessories according to the packing lists. If the accessories are damaged or incomplete, please contact your RIGOL sales representative.

Recommended Calibration Interval

RIGOL suggests that the instrument should be calibrated every 12 months.

4.2 Appearance and Dimensions

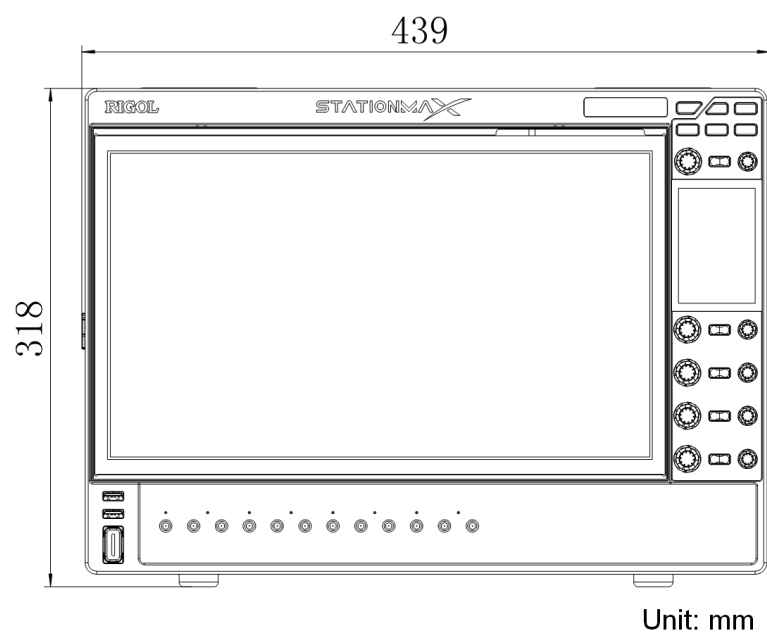


Figure 4.1 Front Elevation

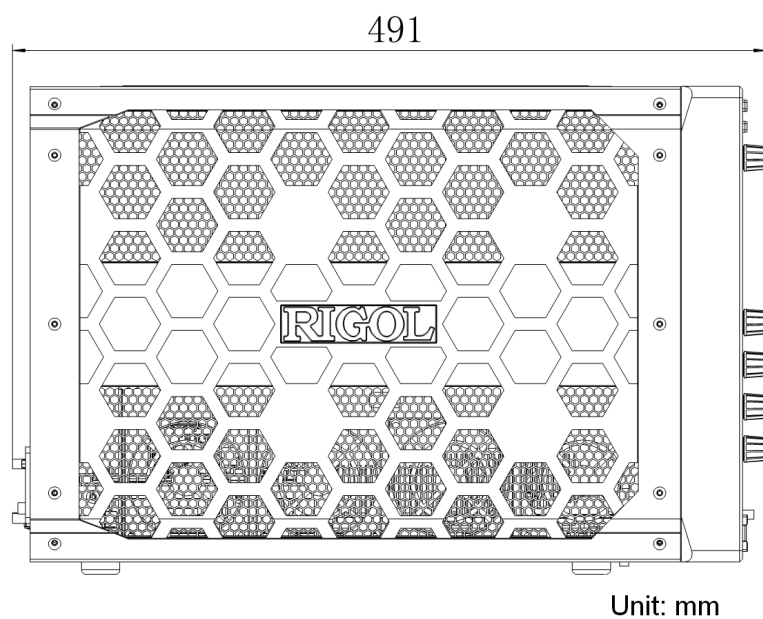
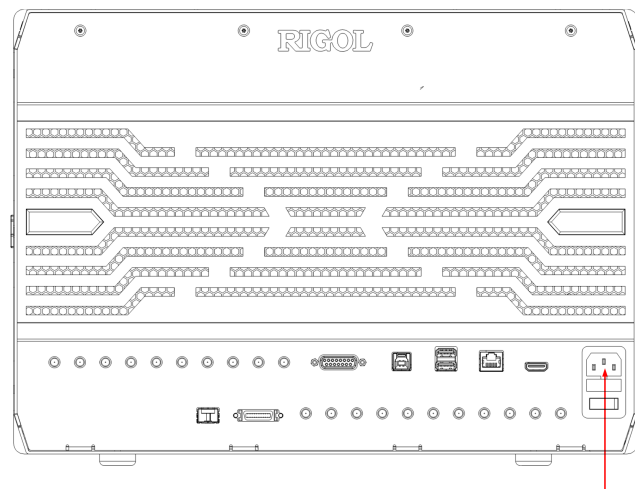


Figure 4.2 Side Elevation

4.3 To Prepare for Use

4.3.1 To Connect to Power

Please use the power cord provided in the accessories to connect the generator to the AC power source, as shown in [Figure 4.3](#). The power requirements of the generator are 100 V to 240 V, 45 Hz to 440 Hz. The maximum input power is no more than 500 W. When the generator is connected to AC power through the power cord, it will be automatically adjusted to the correct voltage range without the need for manual selection.



Power Cord Connector


Figure 4.3 Connecting to Power





WARNING

To avoid electric shock, please ensure that the instrument is correctly grounded.

4.3.2 Turn-on Checkout

After the instrument is connected to the power source, press the power key  at the lower-left corner of the front panel to power on the instrument. During the start-up process, the instrument performs a series of self-tests. After the self-test, the splash screen is displayed.

- **Restart:** Click or tap the function navigation icon  at the lower-left corner of the screen to open the function navigation. Click or tap the **Restart** icon, then a prompt message "Are you sure to reboot?" is displayed. Click or tap **OK** to restart the instrument.

- Shutdown:** Click or tap the function navigation icon  at the lower-left corner of the screen to open the function navigation. Click or tap the **Shutdown** icon, then a prompt message "Are you sure to shutdown?" is displayed. Click or tap **OK** to shut down the instrument. You can also press the Power key at the lower-left corner of the instrument to turn off the instrument.

4.3.3 Fuse Replacement

If you need to replace the fuse, use only the specified fuse (AC 250V, T3.15A; 5.2 mm×20 mm) and perform the following operations (as shown in *Figure 4.4*):

1. Turn off the instrument, cut off the power, and remove the power cord.
2. Use a small straight slotted screwdriver to pry out the fuse holder.
3. Take out the fuse holder.
4. Replace the old fuse with a specified fuse.
5. Install the fuse holder.

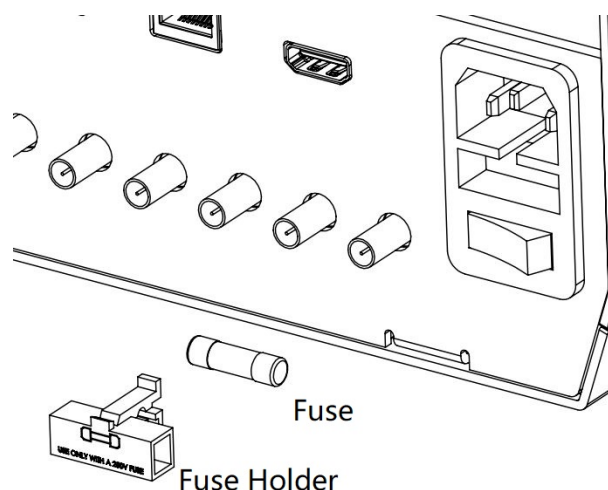



Figure 4.4 Fuse Replacement



WARNING

To avoid electric shock, please ensure that the instrument has been turned off, the power source has been cut off, and the fuse to be used conforms to the fuse rating.

4.3.4 To Set the System Language

This instrument supports multiple languages. You can click or tap  > **Utility** > **Setup** > **Language** to set the system language.

4.4 Product Overview

This section introduces the front and rear panel as well as the user interfaces of DG70000 series.

4.4.1 Front Panel Overview

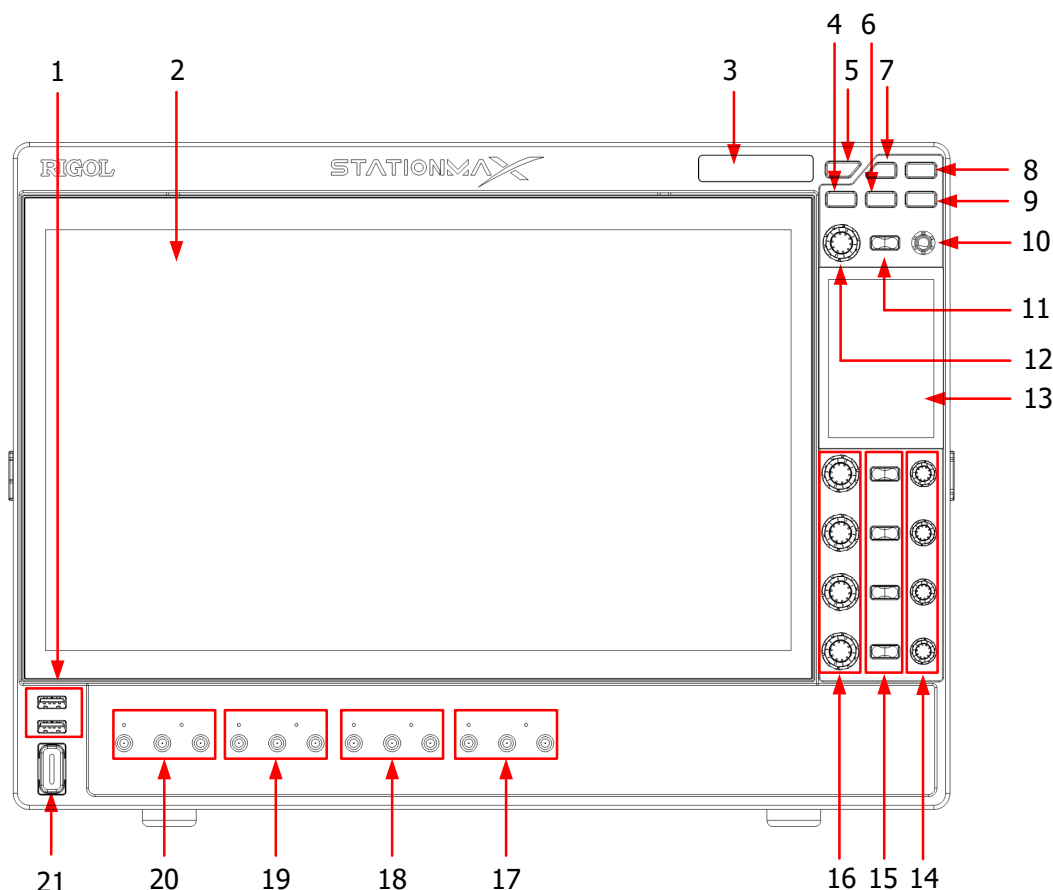


Figure 4.5 Front Panel (4-channel Model)

1. USB HOST Interface

Supports USB storage device (FAT32/NTFS format) and USB-GPIB interface module.

- **USB storage device:** reads the waveform or sequence files stored in the USB storage device; saves the edited waveform and sequence data into the USB, or saves the content displayed on the screen to the USB in the format of a captured image.
- **USB-GPIB interface module:** extends the GPIB interface for RIGOL instruments that integrates the USB HOST interface but no GPIB interface.

2. High-Definition Touch Screen with One Button Electronic Tilt

15.6-inch high-definition touch screen, with its tilt angle available to be adjusted electronically. It displays the menu labels and parameter settings of the current function, system state, and prompt messages and other information. For details, please refer to [User Interface Overview](#).

3. Electronic Label

The electronic label displays the product model and its main parameters, sustaining its contents up to 20 years even at power-off state. The parameters will be updated automatically after upgrade to keep the information displayed on the electronic label consistent with that of the current instrument.

4. Screen Tilt Adjustment Lock Key

Controls whether to adjust the tilt angle of the 15.6-inch high-definition touch screen.

5. RUN/STOP Key

Controls the run state of the channel output signal.

6. Default Key

Pressing this key can restore the instrument to its default settings.

7. Import/Export Function Key

Pressing this key can pop up the import/export menu for you to import files to the instrument or export files stored in the instrument to internal memory/external storage device.

8. Screen Capture Key

An shortcut key for screen capture.

9. Local Key

Pressing this key can restore the instrument to local operation from remote control.

10. Trigger Interval/Screen Tilt Adjustment Knob

- You can use the knob to set the time interval of the internal trigger signal. Rotating the knob can modify the time interval of the internal trigger signal in [Trigger Setup](#). Pressing the knob can set the interval to default (10 μ s).
- You can also use the knob to adjust the touch screen tilt angle. Rotating the knob can adjust the degree to which the main screen surface tilts. Pressing the knob can reset the degree to zero.

11. Touch Lock Key

Pressing the key can enable or disable the touch screen function.

12. Sample Rate Knob

You can use the knob to adjust the channel sample rate. Rotating the knob can modify the sample rate in *Clock Setup* menu. Pressing the knob can toggle between coarse and fine adjustment.

13. 3.5-Inch High-Definition Touch Screen

Allows you to operate the instrument with the function icons available on the small screen. After pressing the screen tilt adjustment lock key, you can adjust the tilt angle of the main screen using this screen.

14. Channel Offset Knobs

The knobs are used to modify the output offset of CH1, CH2, CH3, and CH4 respectively. Rotating the knob can modify the offset value in channel *Output Settings*. Pressing the knob can reset the offset to zero.

NOTE

As DG70002 is a two-channel model, it only provides the offset knobs for two channels (CH1 and CH2).

15. Channel ON/OFF Keys

Pressing the corresponding channel on/off key can enable or disable the specified channel (CH1~CH4).

NOTE

As DG70002 is a two-channel model, it only provides the channel on/off keys for two channels (CH1 and CH2).

16. Channel Amplitude Knobs

The knobs are used to modify the output waveform amplitude of CH1, CH2, CH3, and CH4 respectively. Rotating the knob can modify the amplitude value in channel *Output Settings*. Pressing the knob can toggle between coarse and fine adjustment.

NOTE

As DG70002 is a two-channel model, it only provides the amplitude knobs for two channels (CH1 and CH2).

17. CH4 Output Connectors (4-channel Models Only)

SMA type connectors with 50 Ω nominal output impedance. When the CH4 output is enabled, its channel label is illuminated. Output coupling modes include AC coupling and DC coupling. The DC outputs supply differential analog signals.

- **AC:** Single-ended AC connector.
- **DC+:** Analog + differential output connector.
- **DC-:** Analog - differential output connector.

18. CH3 Output Connectors (4-channel Models Only)

SMA type connectors with 50 Ω nominal output impedance. When the CH3 output is enabled, its channel label is illuminated. Output coupling modes include AC coupling and DC coupling. The DC outputs supply differential analog signals.

- **AC:** Single-ended AC connector.
- **DC+:** Analog + differential output connector.
- **DC-:** Analog - differential output connector.

19. CH2 Output Connectors

SMA type connectors with 50 Ω nominal output impedance. When the CH2 output is enabled, its channel label is illuminated. Output coupling modes include AC coupling and DC coupling. The DC outputs supply differential analog signals.

- **AC:** Single-ended AC connector.
- **DC+:** Analog + differential output connector.
- **DC-:** Analog - differential output connector.

20. CH1 Output Connectors

SMA type connectors with 50 Ω nominal output impedance. When the CH1 output is enabled, its channel label is illuminated. Output coupling modes include AC coupling and DC coupling. The DC outputs supply differential analog signals.

- **AC:** Single-ended AC connector.
- **DC+:** Analog + differential output connector.
- **DC-:** Analog - differential output connector.

21. Power Key

Powers the signal generator on or off.

4.4.2 Rear Panel Overview

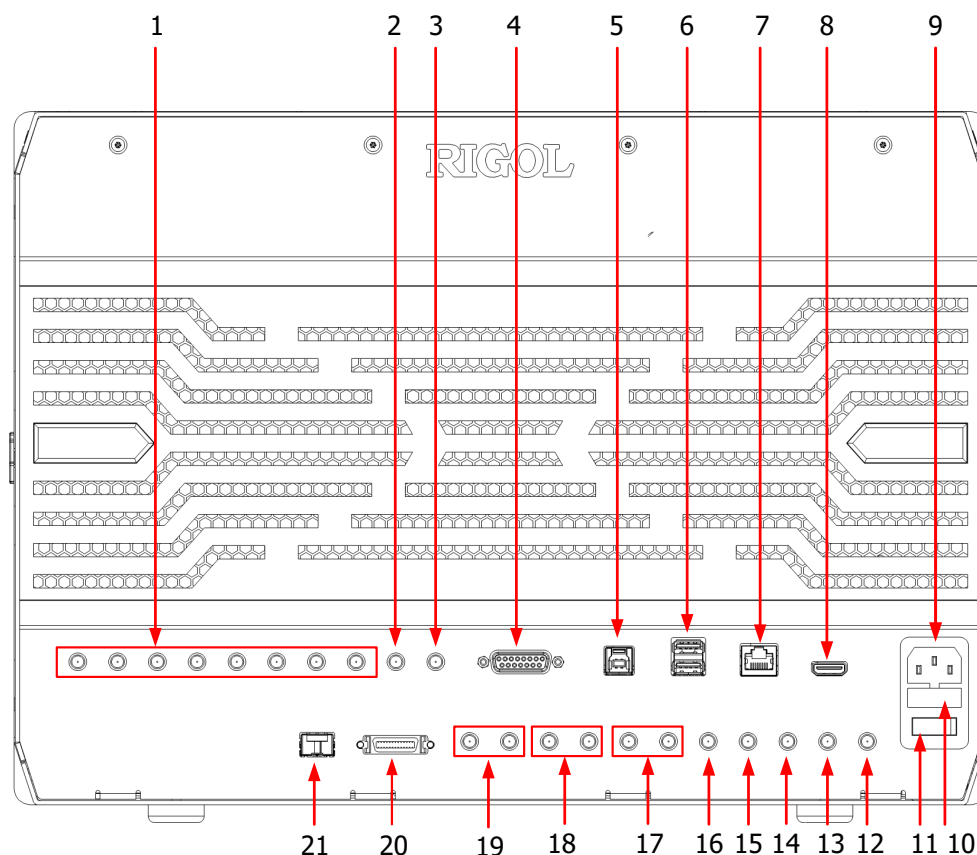


Figure 4.6 Rear Panel (4-channel Model)

1. CH 1:1 ~ CH 4:2

SMA type connectors. The 8 connectors are the output connectors of Marker1 and Marker2 for 4 channels (CH1~CH4). For details, please refer to [Resolution](#).



NOTE

As DG70002 is a two-channel model, it only supports output interfaces of Marker1 and Marker2 for CH1 and CH2.

2. 10MHz OUT

SMA type connector to provide a 10 MHz reference signal.

3. EXT REF IN

SMA type input connector for an external reference signal (a fixed 10 MHz or variable from 35 MHz to 150 MHz). For how to use the connector, please refer to [Clock Setup](#).

4. Pattern Jump In

Pattern jump input connector to trigger sequence jump with the use of input signal. For details, please refer to [Pattern Jump](#).

5. USB DEVICE

USB Device connector to connect the instrument to PC. The instrument can be controlled through sending the SCPI commands via PC software Ultra Scope or user-defined programming.

6. USB HOST

USB Host connector to connect USB compatible storage device to the instrument, supporting USB storage device (FAT32/NTFS format) and USB-GPIB interface converter.

- **USB Storage:** reads the waveform or state files stored in USB; saves the current instrument state or the edited waveform data into USB; or saves the content displayed on the screen to the USB in the format of a captured image.
- **USB-GPIB interface module:** extends the GPIB interface for RIGOL instruments that integrates the USB HOST interface but no GPIB interface.

7. LAN

Connects the instrument to network. The instrument conforms to LXI CORE 2011 DEVICE instrument standard. Its test system can be built quickly. Then you can control the instrument through using Web Control or sending the SCPI commands via PC software Ultra Scope or user-defined programming. When update is available, you can perform online upgrading for the system software of the instrument via the LAN interface.

8. HDMI

You can connect the instrument to an external display that has the HDMI port (e.g. monitor or projector) via this interface to have a clear view of the instrument's display. Meanwhile, you can still operate on the instrument's touch screen.

9. AC Power Socket

The power requirements of the instrument are 100 V to 240 V, 45 Hz to 440 Hz. The maximum input power is no more than 500 W. Please use the power cord provided in the accessories to connect the instrument to the AC power source.

10. Fuse

If you need to replace the fuse, use only the specified fuse.

11. Power Switch

12. SCLK IN

SMA type connector. Sample clock input interface. For how to use the interface, please refer to *Clock Setup*.

13. SCLK OUT

SMA type connector. Sample clock output interface. For how to use the interface, please refer to *Clock Setup*.

14. SYNC OUT

SMA type connector. Sync output interface. For how to use the interface, please refer to *Clock Setup*.

15. CAL IN

SMA type connector. Calibration input interface.

16. CAL OUT

SMA type connector. Calibration output interface.

17. MOD IN2

SMA type connector. Input interface of external modulated IQ signal 2.

18. MOD IN1

SMA type connector. Input interface of external modulated IQ signal 1. ([MOD IN1] is not supported for now.)

19. TRIG A/B

SMA type connector for external trigger signal A/B. For how to use the interface, please refer to *Trigger Setup*.

20. SYNC Control IN/OUT

Sync input and output connector. MDR-26 type connector to synchronize multiple devices.

21. SFP+ (not used)

Small Form Factor Pluggable (SFP+) interface is a hot-pluggable interface that converts the optical light pulse signals to electronic signals. The instrument can support a data transmission rate of 10 Gbit/s with this interface.

4.4.3 User Interface Overview

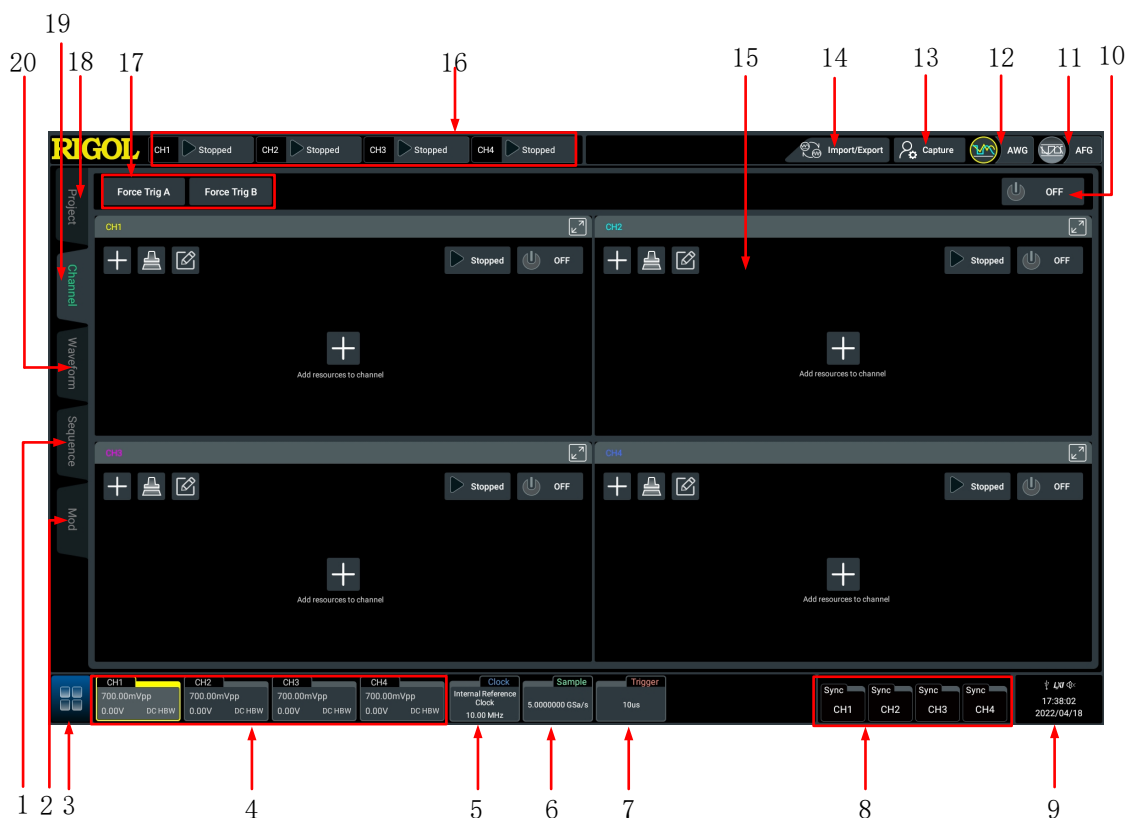


Figure 4.7 User Interface (4-channel Model)

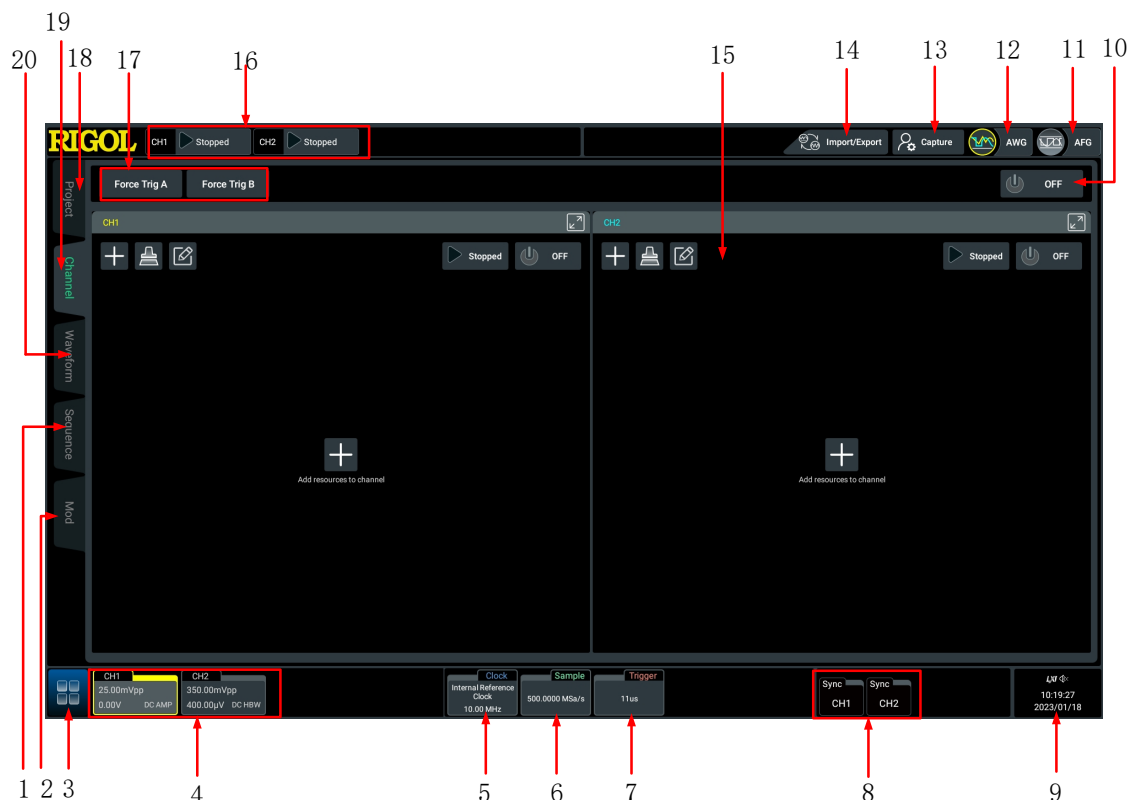


Figure 4.8 User Interface (2-channel Model)

1. Sequence Setup Function Label

Click or tap the label to enter the sequence editing and management interface and create your desired sequence signal. For details, please refer to *Sequence Editing and Management (Optional)*.

2. Modulation Setup Function Label

Click or tap the label to enter the modulation interface to create modulated signals as required. For details, please refer to *Modulation*.

3. Function Navigation Icon

Tap this icon on the touch screen to open the function navigation menu.

4. Channel Labels

- Display the on/off state of channels.
- Display the peak-to-peak amplitude of the corresponding channel.
- Display the offset value of the corresponding channel.
- Display the output mode of the corresponding channel.

- Click or tap the channel label for a pop-up "Channel Setting" menu to set parameters of the corresponding channel. For more details, please refer to [Channel Setup](#).

5. Clock Label

- Displays the current clock source of the system.
- Displays the current clock frequency of the system.
- Click or tap the channel label for a pop-up "Clock Setting" menu to set clock parameters. For more details, please refer to [Clock Setup](#).

6. Sample Label

Displays the current sample rate of the system.

7. Trigger Label





- Displays the trigger interval of the system.
- Click or tap the trigger label for a pop-up "Trigger Setting" menu to set trigger parameters. For more details, please refer to [Trigger Setup](#).

8. Sync Labels

- Display the current sync state of four analog output channels.
- Click or tap the label for multi-channel synchronization setting. For more details, please refer to [Synchronization Setup](#).

9. Notification Area

Displays the sound icon, USB icon, time, and LAN icon.

- Sound icon: In the "Utility" menu, click or tap **Setup** > **Beeper** to enable or disable the sound. When on,  will be displayed; when off,  will be displayed.
- USB storage device icon: When a USB storage device is detected,  will be displayed.
- Time: Displays the system time. To configure the system time, refer to descriptions in [Date and Time](#).
- LAN connection icon: When the LAN interface is successfully connected,  is displayed.

10. Channel All On/Off

One global on/off button to enable or disable all outputs.

11. AFG Mode Key

Click or tap the key to switch to AFG working mode.

12. AWG Mode Key

Click or tap the key to switch to AWG working mode.

13. Capture Function Key

Click or tap this key to capture the current screen and save the picture to internal memory or external storage device.

14. Import/Export Function Key

Click or tap this function key to import files to the instrument or export files stored in the instrument to internal memory or external storage device.

15. Channel Operation Area

In the corresponding channel operation area, you can add the specified signal and control its run state. For details, please refer to [Channel Management](#).

16. Channel Operating State Labels

Display the run state of four channels.

17. Force Trigger Function Keys

Click or tap the key for trigger signal A/B.

18. Project Management Function Label

Click or tap the label to enter the project management interface to create and manage project files. For details, please refer to [Project Management](#).

19. Channel Management Function Label

Click or tap the label to enter the channel output management interface. You can control the run state and output signal of each channel. For details, please refer to [Channel Management](#).

20. Waveform Setup Function Label

Click or tap the label to enter the waveform editing and management area and create your desired waveforms. For details, please refer to [Waveform Editing and Management](#).

4.4.4 3.5-Inch High-definition Touch Screen Overview

At the right side of the front panel, the 3.5-inch small screen is called a secondary touch screen. You can tap the specified function key on the secondary screen to enter the configuration menu of the corresponding function or directly enable the specified function. You can also adjust the tilt angle of the main screen.

Smart and Quick-Responsive Keyboard Menu

DG70000 series arbitrary waveform generator enables you to operate the instrument on both the main and secondary touch screens.

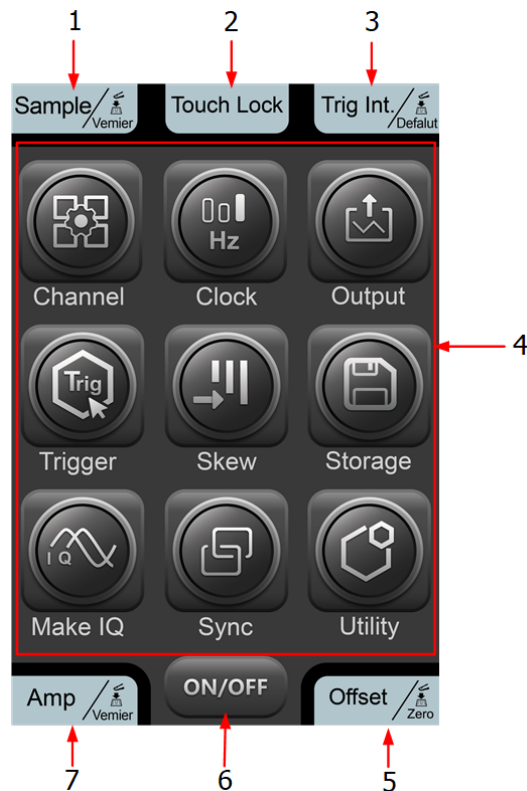


Figure 4.9 Smart and Quick-Responsive Keyboard Menu

1. Sample Rate Knob Operation Icon

The icon displays the function and the adjustment mode of the sample rate knob at the upper-left of the secondary screen. You can rotate the knob to modify the sample rate or press the knob to toggle between coarse adjustment and fine adjustment.

2. Touch Lock Switch Key Operation Icon

The icon displays the on/off state of the lock switch key right above the secondary screen. Pressing the key can disable the touch screen function.

3. Trigger Interval/Screen Tilt Adjustment Knob Operation Icon

The icon displays the current function of the trigger interval/screen tilt adjustment knob, as is shown in [Figure 4.9](#). You can rotate the knob to modify the time interval of the internal trigger signal or press the knob to set the interval to the default value.

4. Smart and Quick-Responsive Keyboard

Tap the specified function key on the secondary screen to enter the configuration menu of the corresponding function or directly enable the specified function.

5. Channel Offset Knob Operation Icon

The icon displays the functions of the channel offset knobs at the lower-right of the secondary screen. You can rotate the knob corresponding to the specified channel to modify the offset value or press the knob to reset the offset to zero.




6. Channel ON/OFF Keys

You can tap the key to enable or disable all outputs.

7. Channel Amplitude Knob Operation Icon

The icon displays the function and the adjustment mode of the channel amplitude knob at the lower-left of the secondary screen. You can rotate the knob to modify the waveform amplitude of the corresponding channel or press the knob to toggle between coarse adjustment and fine adjustment.

Flip Screen Adjustment Interface

The main display of the DG70000 series can be adjusted with one-button electronic tilt. You can tilt the main display on the secondary touch screen. Press  at the upper-right side of the front panel to enter the tilt adjustment interface for the main display, as is shown in [Figure 4.10](#). Press  again or tap  at the lower-right corner to go back to the quick-responsive keyboard menu.

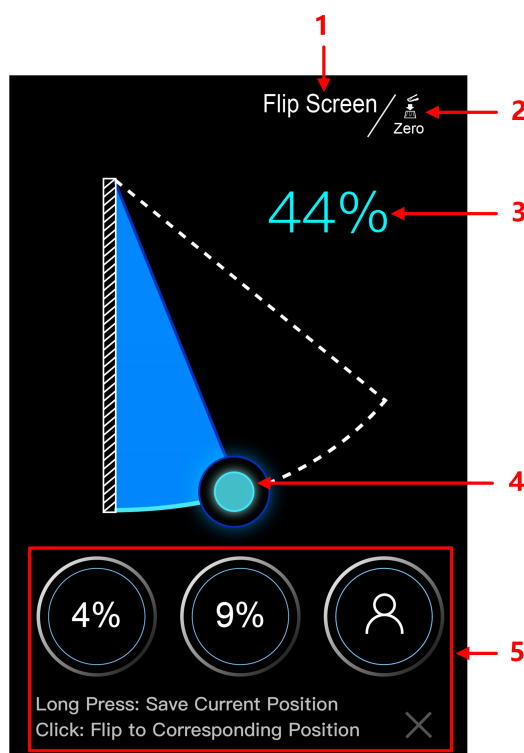



Figure 4.10 Flip Screen Adjustment Interface

1. Current Interface Operation

The "Flip Screen" indicates the function of the current interface. You can adjust the tilt angle of the main display.

2. Trigger Interval/Screen Tilt Adjustment Knob Operation Icon

The icon displays the current function of  **Trigger Interval/Screen Tilt** adjustment knob at the upper-right side of the secondary screen. You can rotate the knob to adjust the tilt angle or press the knob to reset the angle to zero.

3. Screen Angle Percentage

Indicates the current tilt percentage to the max. tilt angle available for the main display.

4. Tilt Adjustment Icon

Tap and drag the icon to adjust the tilt angle of the main display.

5. Saved Tilt Angle

This instrument allows you to save three commonly used tilt angle values for the main display. The operation procedures are as follows:

- a. Drag the "tilt adjustment icon" to adjust the main display to a desired tilt angle.
- b. Long press the "saved tilt angle icon" to save the current tilt angle of the main display. After completing setting a tilt angle for the main display, the tilt percentage will be shown on the icon.
- c. For future use, you just need to tap the icon with a saved tilt angle on it to directly reach the specified tilt for the main display.



CAUTION

During adjusting the tilt of the main display, keep hands clear of the flip screen to avoid being pinched.

4.5 Touch Screen Gestures

The instrument provides a super large capacitive touch screen, which is convenient for users to operate and make configurations. It has strong waveform display capability and excellent user experience. It features great convenience, high flexibility, and great sensitivity. The actions supported by the touch screen controls include tapping, pinching&stretching, dragging, and rectangle drawing.

4.5.1 Tap

Use one finger to tap the symbol or characters on the screen slightly, as shown in *Figure 4.11*. With the Tap gesture, you can perform the following operations:

- Tap the menu displayed on the screen to operate on the menu.
- Tap the function navigation icon at the lower-left corner of the touch screen to enable the function navigation.
- Tap the displayed numeric keypad to set the parameters.
- Tap the virtual keypad to set the filename.
- Tap the close button at the upper-right corner of the message box to close the prompt window.
- Tap other windows on the touch screen and operate on the windows.



Figure 4.11 Tap Gesture

4.5.2 Pinch&Stretch

Pinch or stretch two points on the screen with two fingers to zoom in or out the waveform. To zoom in the waveform, first pinch two fingers and then stretch the fingers; to zoom out the waveform, first stretch two fingers, and then pinch the fingers together, as shown in the *Figure 4.12*.



Figure 4.12 Pinch&Stretch Gesture

4.5.3 Drag

Use one finger to select the object, and then drag the object to a destination place, as shown in *Figure 4.13*. With the drag gesture, you can perform the following operation:

- Drag the window controls to change the position of the window (e.g. numeric keypad).
- Drag a waveform or subsequence to the sequence editor.



Figure 4.13 Drag Gesture

4.6 Parameter Setting Method

For this instrument, you can use the knob and touch screen to set parameters. The common parameter setting methods are as follows:

- **Method 1:** Some parameters can be adjusted by rotating the knob on the front panel.
- **Method 2:** Click or tap the input field of a specified parameter, then a virtual keypad is displayed. Complete the parameter setting with the keypad.

Input Chinese and English Characters

When naming a label, this instrument supports Chinese/English input method. The following part introduces how to input Chinese and English characters with the Chinese/English input method.

- **Input English Characters**

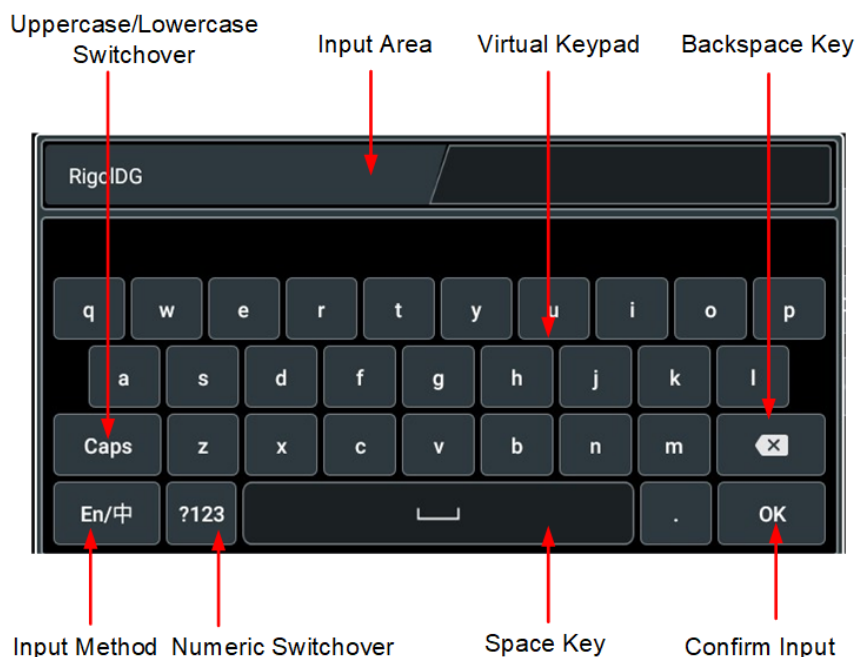


Figure 4.14 English Input Interface

1. Select English input method

First check the input method type. If it shows "En/中", then go to Step 2; if it shows "中/En", click or tap the input method switchover key to switch to "En/中" (English input method).

2. Clear the name input area

If there is no character in the "Name Input Area", please go to the next step. If there are characters in the "Name Input Area", click or tap the Backspace key to delete all the characters from the "Name Input Area" in order.

3. Input the upper-case letter

If you want to input an upper-case letter, use the Caps key to toggle between the upper-case and lower-case mode. If the Caps key is selected, input the upper-case letter with the virtual keypad. If not, first click or tap the Caps key to ensure it is selected, then input the upper-case letter. All the input letters will be displayed in the "Name Input Area".

4. Input the lower-case letter

Refer to the operation specified in the previous step. If the Caps key is not selected, directly input the lower-case letter.

5. Input numbers or symbols

If the letter keypad is displayed, you need to click or tap the numeric switchover key to switch to the numeric keypad, and input numbers or symbols with the numeric keypad. All the inputs will be displayed in the "Name Input Area".

6. Modify or delete the unwanted characters that have been input

During the name input process, you can modify or delete the unwanted character if necessary. To delete the characters that have been input, click or tap the Backspace key in the virtual keypad to delete the characters. To modify the characters that have been input, delete the unwanted characters first and then input the new characters.

You can directly move the cursor to the character to be modified or deleted, delete the desired character or input the new characters after deleting the unwanted character.

7. Confirm the input

After completing the input operation, click or tap "OK".

- **Input Chinese Characters**



Figure 4.15 Chinese Input Interface

1. Select Chinese input method

First check the input method type. If it shows "中/En", then go to Step 2; if it shows "En/中", click or tap the input method switchover key to switch to "中/En" (Chinese input method).

2. Clear the name input area

If there is no character in the "Name Input Area", please go to the next step. If there are characters in the "Name Input Area", click or tap the Backspace key to delete all the characters from the "Name Input Area" in order.

If there are characters in the "Pinyin Input Area", when you delete characters from the name input area, the characters in the Pinyin input area will be deleted first.

3. Input Chinese characters

Click or tap the characters in the virtual keypad to input Pinyin into the input area, then the characters to be selected will be displayed in the Chinese character selection area. Slide to view more Chinese characters for you to choose. Select the desired Chinese character, and then the selected character will be displayed in the input area.

4. Modify or delete the unwanted characters that have been input

During the name input process, you can modify or delete the unwanted character if necessary. To delete the characters that have been input, click or tap the Backspace key in the virtual keypad to delete the characters. To modify the characters that have been input, delete the unwanted characters first and then input the new characters.

5. Confirm the input

After completing the input operation, click or tap "OK".

Input a Value

When setting or modifying a parameter, input an appropriate value with the keypad.

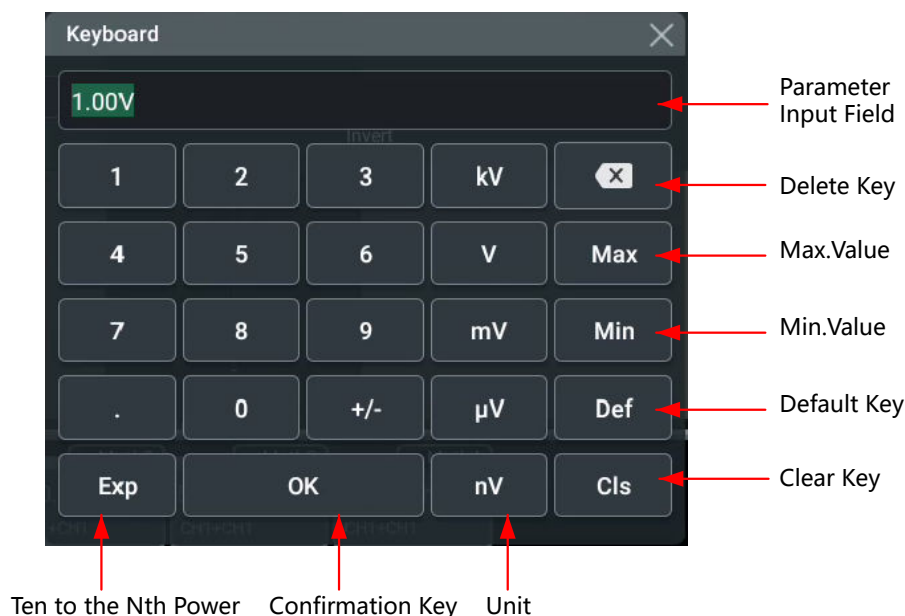



Figure 4.16 Numeric Keypad

Click or tap the value or unit in the numeric keypad to complete the input. After you input all the values and select the desired units, the numeric keypad is turned off automatically. This indicates that you have completed parameter setting. Besides, after you have input the values, you can also press "OK" directly to close the numeric

keypad. At this time, the unit of the parameter is the default unit. In the numeric keypad, you can perform the following operations:

- Delete the parameter value that has been input;
- Set the parameter value to a maximum or minimum value;
- Set the parameter to a default value;
- Clear the parameter input field.

4.7 To Use the Built-in Help System


The help system of this instrument provides instructions for all the function keys on the front panel and their corresponding menu keys. Click or tap  > **Help** to enter the "Help" system.

After entering the "Help" interface, you can get its help information by clicking or tapping the link for the desired item.

4.8 To View the Option Information and the Option Installation

DG70000 series provides multiple options to fulfill your measurement requirements. If you need any of these options, please order them according to the Order No. available in *Appendix A: Options and Accessories*, and then install the options by referring to this section. Besides, you can also view all options of the instrument or activate the newly purchased option.

View Options


Click or tap the navigation icon  at the lower-left of the screen and select **Utility** to access the utility function menu. Click or tap **Option** to view the option installation information.

Install Options

The option license is a string of fixed characters. The option file should be in specific format, with the file extension ".lic". After you purchase an option, you will obtain a key (used for obtaining desired the option license). Please install the option according to the following steps.

1. Obtain an option license

- a. Log in to the RIGOL official website (<http://www.rigol.com>). Click **SERVICE CENTRE** (or **PRODUCTS & SERVICES**) > **License Activation** to enter the software license registration interface.

- b. In the software license registration interface, input the correct key, serial number (click or tap  > **Utility** > **About** to obtain the serial number of the instrument), and verification code. Then click **Generate** to obtain the option license file download link. If you need to use the file, please download it to the USB storage device.

2. Install Options

- a. Ensure that the USB device is correctly connected to the instrument.
- b. You can install the option by sending SCPI commands. For details, refer to *DG70000 Programming Guide*. You can also click or tap **Install options from a USB stick** in the Option interface and then select the option license file to install in the pop-up storage menu.
- c. After installation, a prompt message "Option activated successfully" is displayed.



TIP

- A USB storage device can store multiple option license files of the same instrument and also the option license files of several different instruments. You are not allowed to modify the license filename.
- You can send the SCPI commands (:SYSTem:OPTion:INSTall <license>) to install options.
- In the Option interface, you can enter the correct key in the input field to install options.

5 Project Management

This instrument allows you to store its states in any number of project files (.awg file) for backup. You can also store the instrument states in an external USB storage device and load them in another instrument to ensure the same operating state. The stored state contains parameters of clock, channel, trigger, output, offset as well as the waveform, sequence, and modulated signal that were selected in the corresponding operation interface.

Click or tap **Project** at the left side of the screen to enter the project interface, as shown in the figure below. You can manage and preview your projects. You can also click or tap the preview area to open the specified project and enter the corresponding operation interface. The name of the current project file is displayed at the upper-left corner of the interface.

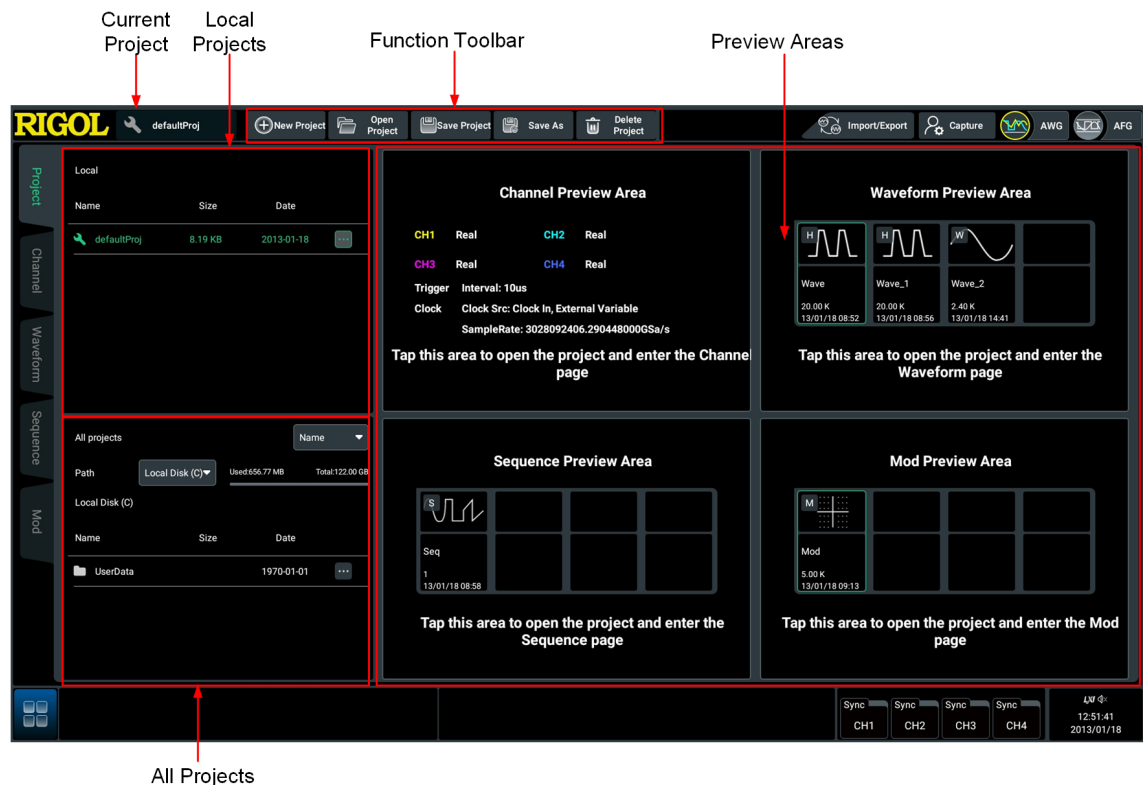




Figure 5.1 Project Interface



After entering the project interface, you can first select a file (highlighted in green) and then use the tools buttons at the top of the interface to perform operations including create new project, open project, save project, delete project and save as project file. You can also open, delete, save as, or rename the specified file through clicking or tapping  at the right side of the file.

Store Instrument State

1. Click or tap **New Project** in the toolbar to create a new project file with the default name "Project_n". The project stores the current state of the instrument.
2. Optional: click or tap  > **Rename** at the right side of the file to modify filename with the pop-up keypad.
3. To change the instrument state stored in the project, please open the project to modify parameters. Then click or tap **Save Project** to save the project.

Save As

You can save the specified project file to internal memory or external USB storage device in either "Local" or "All projects" area.



1. You can select a local project displayed in "Local" area and then click or tap **Save As** in the toolbar for a pop-up storage menu. You can also directly click or tap  > **Save As** at the right side of the specified file for the pop-up storage menu.
You can preview project files stored in internal memory/external storage device in "All projects" area. Find the target project and then click or tap  > **Save As** for a pop-up storage menu.
2. Select and enter the target path in the menu and then click or tap **Paste**. The project file will be saved to the current path.

TIP

Before using the external storage device, please make sure that the USB storage device (FAT32/NTFS format) is properly connected.

Recall Instrument State

You can open a project to recall the instrument state stored in the project.

- Select a local project displayed in "Local" area and then click or tap **Open Project** in the toolbar. You can also directly click or tap  > **Open** at the right side of the specified file.
- Select a project file stored in internal memory/external storage device in "All projects" area and then click or tap  > **Open**.
- Select a project file (highlighted in green) in "Local" area. Click or tap the Channel/Waveform/Sequence/Mod Preview Area and a prompt message is displayed. Click or tap **OK** to open the selected project and enter the corresponding interface.

**TIP**

- The recalled project files must be state files of the same instrument model.
- When recalling a file from the external storage device, the instrument automatically copies the file to the local disk and then opens the file.

Preview Project

In the Channel Preview Area, you can preview the channel settings of the project currently selected, including the channel output modes, trigger and clock parameters.

You can also preview waveforms, sequences, or modulated signals in the Waveform/Sequence/Mod Preview Area. Take the waveform preview as an example. Open the project named "Project" and then go to the waveform interface to select the waveform named "SINE_SP". Then go back to the project interface and save the project. Then you can see that in the "Waveform Preview Area" the previously selected waveform "SINE_SP" has its box highlighted in green, as shown in the figure below.

You can also click or tap a preview area to open the selected project and enter the corresponding operation interface (Channel, Waveform, Sequence, or Modulation).

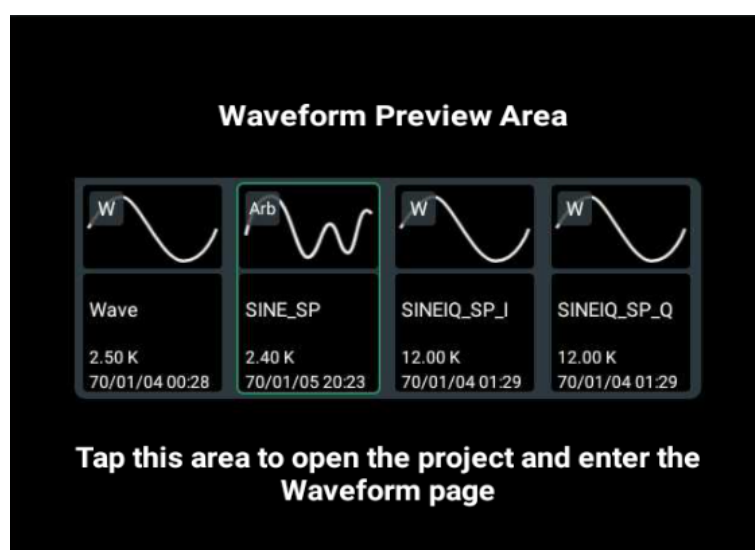


Figure 5.2 Waveform Preview Area

Delete Project

You can select a local project displayed in "Local" area and then click or tap **Delete**

Project in the toolbar to delete the file. You can also directly click or tap > **Delete** at the right side of the specified file.

You can also preview project files stored in internal memory/external storage device

in "All projects" area. Find the target project file and then click or tap > **Delete** at

the right side of the file. A prompt message "Are you sure to delete the file?" will be displayed. Click or tap **OK** to delete the file.

6 Waveform Editing and Management

DG70000 allows you to create and edit various types of waveforms for use, and also manage all waveforms created. It provides four waveform editors including Basic Wave editor, Table Editor, Advanced editor (optional), and High Speed Serial editor (optional).

Click or tap the **Waveform** tab at the left side of the screen to simply enter the waveform editing and management interface, as shown in the figure below. The upper area is the waveform list where you can manage the waveforms using the function keys on the right; the lower area is the waveform editing area.

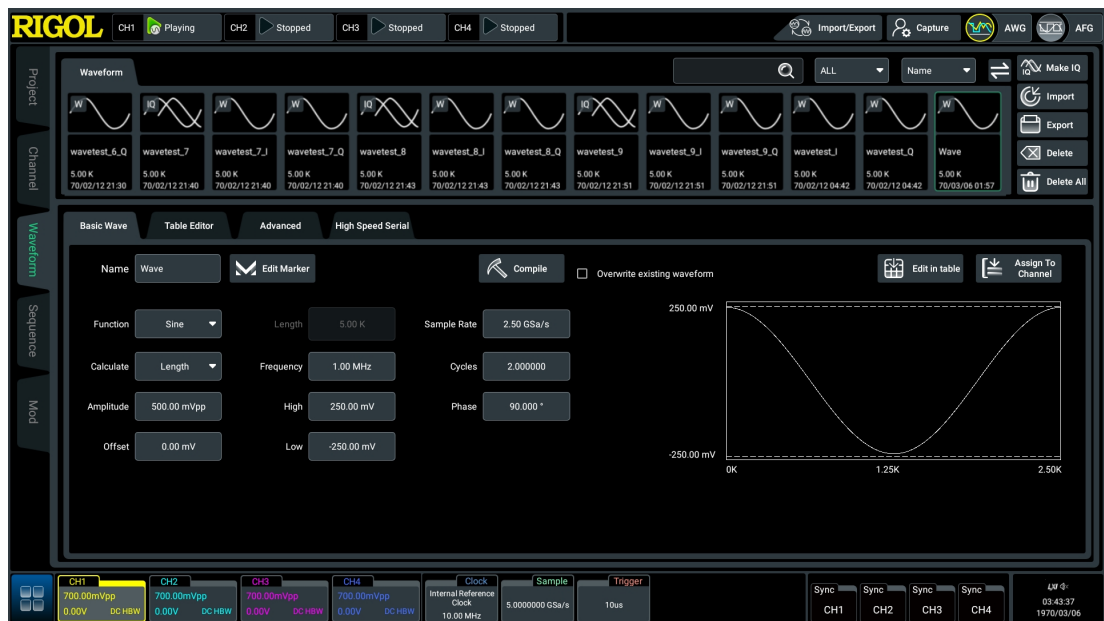


Figure 6.1 Waveform Editing and Management Interface

After editing a waveform, click or tap **Assign to Channel** and a pop-up "Assign to channel" menu will be displayed. Select the playout channel intended for the compiled waveform and then click or tap **OK** to assign the waveform. If "Assign to channel and play" is ticked, the instrument automatically loads the waveform and starts the waveform playout.

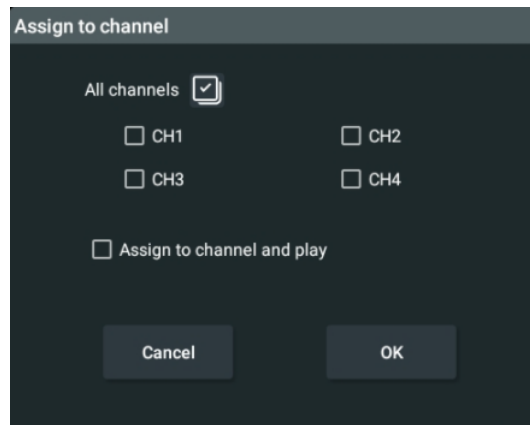


Figure 6.2 "Assign to channel" Menu

6.1 Basic Waveform Editor

The Basic Waveform editor of DG70000 provides a method to quickly and easily create waveforms including Sine, DC, Square, Triangle, Noise, Sinc, Sine (IQ). The default is Sine. The created waveform is graphically displayed at the right side of the interface.

Name

Click or tap the "Name" input field and use the pop-up keypad to set the name of the waveform to be created. The length of the name is no more than 26 bytes.

To Edit Sine

Click or tap the "Function" drop-down menu to select Sine.

- **High Value/Low Value/Amplitude/Offset**
 - Click or tap the input fields of "High" and "Low" and then set the high and low values of the Sine wave with the pop-up keypad. The high value ranges from -1 V to 1 V, and the default is 250 mV. The low value ranges from -1 V to 1 V, and the default is -250 mV. The "High" and "Low" values are inter-dependent. If the input value is invalid, a prompt message will pop up, and the value will be modified automatically to ensure that the "High" value is always greater than the "Low" value, and that $\text{High value} - \text{Low value} \geq 20 \text{ mV}$.
 - The "High" and "Low" values affect the "Amplitude". Setting the "High" and "Low" values causes the instrument to calculate the "Amplitude" automatically. Changing the "Amplitude" causes the instrument to recalculate the "High" and "Low" values without changing the offset. The amplitude ranges from 20.00 mV_{pp} to 2.00 V_{pp}, and the default is 500.00 mV_{pp}.

- The offset is determined by both "High" value and "Low" value. Setting the "High" and "Low" values causes the instrument to calculate the "Offset" automatically. Changing the "Offset" causes the instrument to recalculate the "High" and "Low" values without changing the amplitude. The offset ranges from -990 mV to 990 mV, and the default is 0 V.
- **Length/Sample Rate/Frequency/Cycles**
Click or tap the input field of "Length", "Sample Rate", "Frequency", or "Cycles" and set the the corresponding value with the pop-up keypad. The formula below describes the relationship among length, sample rate, frequency, and cycles: $\text{Length} = (\text{Sample Rate} \times \text{Cycles}) / \text{Frequency}$. Their values are mutually constrained. If the input value is invalid, a prompt message will pop up and the value will be modified automatically based on the current configuration.
 - Length is the number of all sample points of the waveform to be created. It ranges from 2.4 kpts to 1.5 Gpts, and the default is 12.00 kpts.
 - Sample rate ranges from 100 Sa/s to 5.00 GSa/s (default). It should be greater than or equal to 2.5 times the frequency.
 - Frequency ranges from 1 μHz to 2.00 GHz, and the default is 1.00 GHz.
 - Cycles is a multiple of the current waveform period. It ranges from 0.007813 to 644245094.4, and the default is 2.400000k.
- **Phase**
Click or tap the input field of "Phase" to set the phase with the pop-up keypad. The phase ranges from 0° to 360° , and the default is 0.000° .
- **Calculate**
In the "Calculate" drop-up menu, you can choose one of the properties (Length, Sample Rate, Frequency, or Cycles) to calculate. After a property is chosen, it will be grayed out and cannot be edited manually. The chosen property can only be calculated automatically based on the other three properties.
 - $\text{Length} = (\text{Sample Rate} \times \text{Cycles}) / \text{Frequency}$
 - $\text{Frequency} = (\text{Sample Rate} \times \text{Cycles}) / \text{Length}$
 - $\text{Sample Rate} = (\text{Length} \times \text{Frequency}) / \text{Cycles}$
 - $\text{Cycles} = (\text{Length} \times \text{Frequency}) / \text{Sample Rate}$

To Edit DC

Click or tap the "Function" drop-down menu to select "DC".

- **Length/Sample Rate/Duration**

The formula below describes the relationship among length, sample rate, and duration: $\text{Length} = \text{Sample Rate} \times \text{Duration}$. Their values are mutually constrained.

If the input value is invalid, a prompt message will pop up and the value will be modified automatically based on the current configuration.

- Length ranges from 2.4 kpts to 1.5 Gpts, and the default is 12.00 kpts.
- Sample rate ranges from 100 Sa/s to 5.00 GSa/s (default).
- Duration ranges from 480 ns to 16,106,127.36 s, and the default is 2.40 μ s.
- **Offset**
The offset ranges from -1 V to 1 V, and the default is 0.00 mV.
- **Calculate**
In the "Calculate" drop-up menu, you can choose one of the properties (Length, Sample Rate, or Duration) to calculate. After a property is chosen, it will be grayed out and cannot be edited manually. The chosen property can only be calculated automatically based on the other properties.
 - $\text{Length} = \text{Sample Rate} \times \text{Duration}$
 - $\text{Sample Rate} = \text{Length} / \text{Duration}$
 - $\text{Duration} = \text{Length} / \text{Sample Rate}$

To Edit Square

Click or tap the "Function" drop-down menu to select "Square". To set its length, sample rate, frequency, cycles, high value, low value, amplitude, offset, phase, and calculate mode, please refer to [To Edit Sine](#).

The duty cycle ranges from 0.001% to 99.999%, and the default is 50.000%. Click or tap the input field of "Duty" to set the duty cycle of the created square with the pop-up keypad.

To Edit Triangle

Click or tap the "Function" drop-down menu to select "Triangle". To set its length, sample rate, frequency, cycles, high value, low value, amplitude, offset, phase, and calculate mode, please refer to [To Edit Sine](#).

The symmetry ranges from 0% to 100%, and the default is 50.0%. Click or tap the input field of "Symm" to set the symmetry with the pop-up keypad.

To Edit Noise

Click or tap the "Function" drop-down menu to select "Noise".

- To set its high value, low value, amplitude, and offset, please refer to [To Edit Sine](#).
- To set its length, sample rate, duration, and calculate mode, please refer to [To Edit DC](#).

To Edit Sinc

Click or tap the "Function" drop-down menu to select "Sinc".

- To set its high value, low value, amplitude, and offset, please refer to [To Edit Sine](#).
- Length ranges from 2.4 kpts to 1.5 Gpts, and the default is 12.00 kpts.
- Sample rate ranges from 100 Sa/s to 5.00 GSa/s (default).
- Peak position specifies the position of the crest point on a wave. It ranges from 0.001% to 99.999%, and the default is 50.000%.
- Loop width specifies the percentage of the loop in the entire length. It ranges from 0.001% to 99.999%, and the default is 50.000%.

To Edit Sine (IQ)

To edit Sine (IQ), please refer to [To Edit Sine](#).

After the editing Sine (IQ), three waveforms will be added to the waveform list. Among them, two signals-I signal and Q signal-are 90° out of phase. Combined together, they display as the IQ signal.

Compile

After the editing operation, click or tap **Compile** to generate the waveform. The new waveform will be added in the waveform list at the top of the screen.

When you tick "Overwrite existing waveform", the created waveform will overwrite any existing waveform of the same name. Otherwise, the filename of the new waveform will be automatically added the suffix "_n" (n is a positive integer), for example, "Wave_1".

6.2 Table Editor

The Table Editor of DG70000 can display all sample points of a waveform in table format. Using the table, you can directly modify any sample point of the waveform, including the Marker data.

In the waveform editing and management interface, click or tap **Table Editor** to access the "Table Editor" menu, as shown in the figure below.

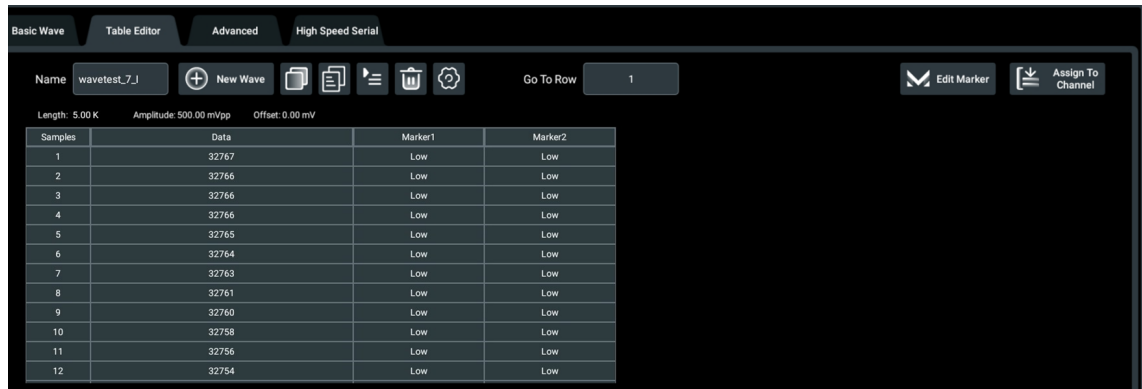


Figure 6.3 "Table Editor" Menu

6.2.1 New Waveform

Click or tap **New Wave** and the "Generate New Waveform" menu will be displayed.

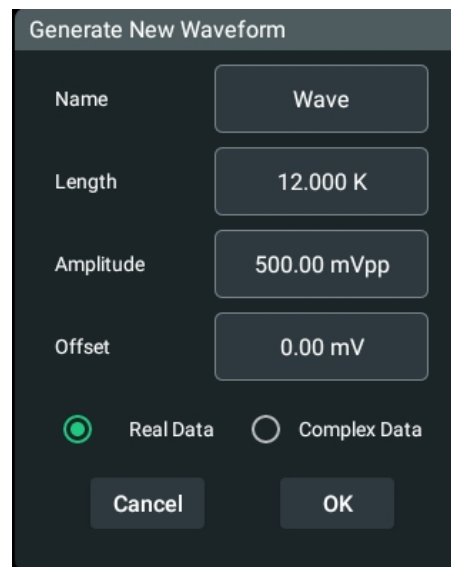


Figure 6.4 "Generate New Waveform" Menu

New Waveform

- To set the name, length, amplitude, and offset of the new waveform, please refer to *Basic Waveform Editor*.
- You can create either "Real Data" or "Complex Data" (IQ data).

6.2.2 Table Management

In the "Table Editor" menu, you can modify any sample data of a waveform in the table.



| Samples | I Data | Q Data | Marker1 | Marker2 |
|---------|--------|--------|---------|---------|
| 1 | 0 | 0 | Low | Low |
| 2 | 31163 | 31163 | Low | Low |
| 3 | 19259 | 19259 | Low | Low |
| 4 | -19259 | -19259 | Low | Low |
| 5 | -31163 | -31163 | Low | Low |
| 6 | 0 | 0 | Low | Low |
| 7 | 31163 | 31163 | Low | Low |
| 8 | 19259 | 19259 | Low | Low |
| 9 | -19259 | -19259 | Low | Low |
| 10 | -31163 | -31163 | Low | Low |
| 11 | 31163 | 31163 | Low | Low |
| 12 | 0 | 0 | Low | Low |

Figure 6.5 "Table Editor" Menu

To Modify Sample Data

If the current waveform is a real waveform, the sample data is displayed in Data column. The Data column splits into two data columns (I Data and Q Data) when an IQ waveform is viewed.



You can select any cell of the sample data to modify its value with the pop-up keypad. The value ranges from -32768 to 32767.



To Modify Marker

Click or tap the cell in Marker1 column or Marker2 column to toggle between "High" and "Low" level.


To Copy and Paste Sample Data

- To copy and paste a value in a cell, please perform the following operations.

Select any value in "Data" column and then click or tap  to copy the value. Select the target Data cell and paste the copied value through clicking or tapping .


- To copy and paste an entire row, please perform the following operations. Click or tap any number in "Samples" column to select the entire row. Click or tap  to copy the row to the clipboard. Then select the desired row and paste the data from the copy clipboard to the table through clicking or tapping .

To Delete Sample Data


You can select any value in "Data" column or any number in "Samples" column and then click or tap  to remove the entire row from the table.

The minimum waveform length is 2.4k. You cannot delete any data when the length reaches the minimum. Otherwise, a prompt message "Length reaches the minimum!" will be displayed.

To Insert a Row

Click or tap any cell in "Samples" or "Data" column to select a row. Then click or tap  to insert a new row below the selected row.

Setting

Click or tap  and the setting menu will pop up.

- The Amplitude ranges from 20.0 mV_{pp} to 2.0000 V_{pp}, and the default is 500.0 mV_{pp}.
- The offset ranges from -1.0000 V to 1.0000 V, and the default is 0.0 V.

Go To Row

The number of rows in the table is identical to the length of the waveform created. You can drag the table up and down to view all the data. If the waveform is too long, you can click or tap the input field of "Go To Row" and set the desired row number with the pop-up numeric keypad. After clicking or tapping "OK", you can jump directly to the desired row for further operation.

6.3 Advanced Editor (Optional)

In the waveform editing and management interface, click or tap **Advanced** to enter the Advanced editor menu in which you can generate multitone waveforms.

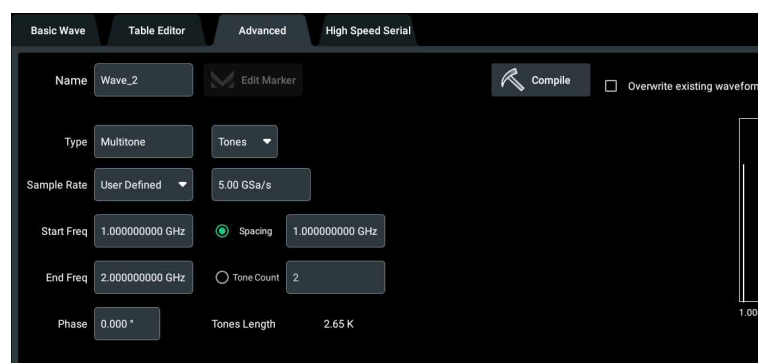


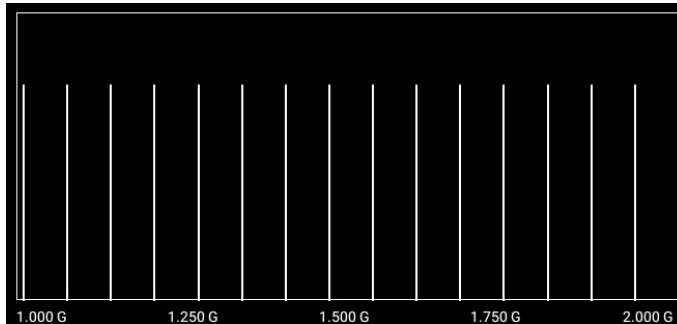
Figure 6.6 Advanced Editor Menu

Name

Click or tap the "Name" input field and use the pop-up keypad to set the name of the waveform to be created. The length of the name is no more than 26 bytes.

Tones Mode

Selecting the Tones mode can generate multitone waveforms composed of equally spaced tones at different frequencies, as shown in the figure below. Click or tap the drop-down button at the right side of "Multitone" and select "Tones" to enable the Tones mode.



- **Sample Rate**

Click or tap the "Sample Rate" drop-down button to select "Auto" or "User Defined" mode.

- When "Auto" is selected, the sample rate is fixed to 5.00 GSa/s.
- When "User Defined" is selected, you can click or tap the "Sample Rate" input field to set the sample rate, which can range from 5 kSa/s to 5 GSa/s.

- **Start/End Frequency**

- Start Frequency: ranges from 1 kHz to 1.999999 GHz, and the default is 1.000000000 GHz.
- End Frequency: ranges from 2 kHz to 2 GHz, and the default is 2.000000000 GHz.

TIP

- End Frequency \geq Start Frequency + 1 kHz. If the input value is out of range, it will be automatically modified by the system.
- In actual use, the end frequency and sample rate are mutually constrained. The sample rate is always greater than or equal to 2.5 times the end frequency.

- **Spacing/Tone Count**

You can set either the number of tones (Tone Count) or spacing between tones (Spacing) within the frequency range (from the start frequency to the end frequency).

When choosing to set the spacing between tones, you can click or tap the "Spacing" input field to set the value. The available range is from 1 kHz to 1.999999 GHz, and the default is 1.000000000 GHz. Setting a spacing value automatically creates the number of tones (Tone Count) within the set frequency range.

When choosing to set the number of tones, you can click or tap the "Tone Count" input field to set the value. The available range is from 2 (default) to 16. Setting a tone count automatically creates the spacing between tones.

TIP

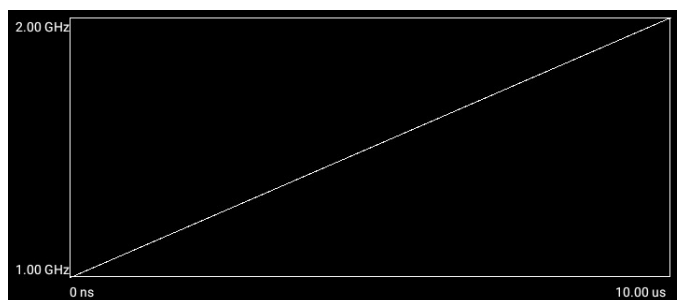
In actual use, the Spacing and Tone Count are mutually constrained. $\text{Spacing} = (\text{End Frequency} - \text{Start Frequency}) / (\text{Tone Count} - 1)$. Their values cannot exceed the range.

- **Phase**

You can click or tap the "Phase" input field to self-define a phase shift in degrees. The available range is from 0° to 360°, and the default is 0.000°.

Chirp Mode

Selecting the Chirp mode can generate linear chirp waveforms, as shown in the figure below. Click or tap the "Multitone" drop-down button and select "Chirp" to enable the Chirp mode.



- **Sample Rate**

Please refer to *Tones Mode*.

- **High/Low Frequency**

- Low Frequency: ranges from 1 Hz to 1.999999999 GHz, and the default is 1.000000000 GHz.
- High Frequency: ranges from 2 Hz to 2 GHz, and the default is 1.100000000 GHz.

TIP

- High Frequency \geq Low Frequency + 1 Hz. If the input value is out of the range, it will be automatically modified by the system.
- In actual use, the high frequency and sample rate are mutually constrained. The sample rate is always greater than or equal to 2.5 times the high frequency.

- **Sweep Time/Sweep Rate**

You can set the amount of time to complete a full cycle of sweeps from start frequency to stop frequency (Sweep Time) and changes in frequency per unit time (Sweep Rate).

Sweep time is the length of time for the signal to rise from the low frequency to high frequency or to drop from the high frequency to low frequency. When choosing to set the sweep time, you can click or tap the "Sweep Time" input field to set the value. The available range is from 500 ns to 320 ks, and the default is 10.000 μ s. Setting a sweep time automatically creates the sweep rate.

Sweep rate is the rate at which the frequency range is traversed per second. When choosing to set the sweep rate, you can click or tap the "Sweep Rate" input field to set the value. The available range is from 0 Hz/ μ s to 4 GHz/ μ s, and the default is 10.000000 MHz/ μ s. Setting a sweep rate automatically creates the sweep time. When the sample rate is less than or equal to 5 MSa/s, the sweep rate cannot be configured.

TIP

- In actual use, the Sweep Time and Sweep Rate are mutually constrained. Sweep Time=(High Frequency-Low Frequency)/Sweep Rate. Their values cannot exceed the range.
- Sweep Time is affected by Sample Rate: $2500 \leq \text{Sweep Time} \times \text{Sample Rate} \leq 1.610612736\text{G}$.

- **Frequency Sweep**

- High to Low: sweeps from the high frequency to low frequency within the sweep time.
- Low to High: sweeps from the low frequency to high frequency within the sweep time.

Compile

After the editing operation, click or tap **Compile** to generate the waveform. The new waveform will be added in the waveform list at the top of the screen.

When you tick "Overwrite existing waveform", the created waveform will overwrite any existing waveform of the same name. Otherwise, the filename of the new waveform will be automatically added the suffix "_n" (n is a positive integer), for example, "Wave_1".

6.4 High Speed Serial Editor (Optional)

This function allows you to create high speed serial signals. In the waveform editing and management interface, click or tap **High Speed Serial** to enter the High Speed Serial editor menu, as is shown in the figure below. You can perform the operations including pattern setting, transmitter setting, channel setting, and Pre/De-emphasis

setting. The system can generate the eye diagram of high speed serial signals for your reference according to your settings.



Figure 6.7 High Speed Serial Editor Menu

6.4.1 Pattern Setting

In the High Speed Serial interface, click or tap **Pattern** to enter the "Pattern" menu. You can set the Basic Settings, Encoding/Modulation, Step Response, Scrambling, and Duty Cycle Distortion (DCD).

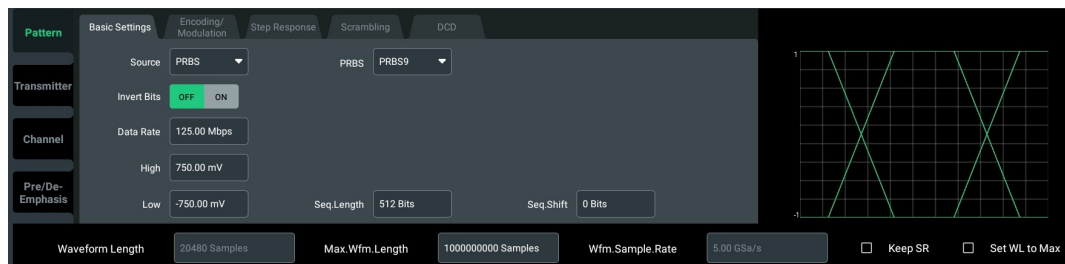


Figure 6.8 Pattern Setting Menu

Basic Settings

- **Source**

DG70000 supports data sources including Clock, All Zero, All One, PRBS, Pattern, and File. The default setting is "PRBS". Click or tap the "Source" drop-down button to select the data source.

- Clock: set the data source to clock signal.

- All Zero: set the signal to a sequence in which all bits are 0.
 - All One: set the signal to a sequence in which all bits are 1.
 - PRBS: set the data source to PRBS (Pseudo Random Binary Sequence). When the source is set to "PRBS", you can click or tap the "PRBS" drop-down button to select the sequence type. You can also select "User Define" to self-define the PRBS polynomial expression and the shift register initial value.
 - Pattern: set the data source to self-defined symbol. When the data source is set to "Pattern", you can set the pattern type to binary, hex, or KD symbol. Click or tap the input field at the right side and use the pop-up numeric keypad (depending on the selected pattern type) to define the data. The maximum data length is 8000 Bits for binary data and 2000 Bits for hexadecimal data and KD symbol.
 - File: import user-defined codes (within 250M) via the internal memory/ external USB storage device. When the data source is set to "File", you can click or tap the import path input field or **Import File** at the right side and select the desired file in the pop-up storage menu. For general operations of the storage menu, please refer to *Storage Management*.
- **Sequence Shift**

When the data source is set to "PRBS", you can set a shift for the generated PRBS sequence. Click or tap the "Seq.Shift" input field to set the shift with the pop-up virtual keypad. The available range is from -1,500,000,000 Bits to 1,500,000,000 Bits, and the default is 0 Bit.
 - **Invert Bits**

Click or tap the "Invert Bits" on/off switch to turn on/off inverting the bits.
 - **Data Rate**

Click or tap the "Data Rate" input field to set the rate with the pop-up virtual keypad. The available range is from 500 kbps to 2.5 Gbps, and the default is 125 Mbps.
 - **High/Low Level**

Click or tap the "High"/"Low" input field and set the high/low level with the pop-up virtual keypad. The high level ranges from -980 mV to 1 V and the default is 750.00 mV. The low level ranges from -1 V to 980 mV and the default is -750.00 mV.
 - **Sequence Length**

Click or tap the "Seq.Length" input field to set the sequence length with the pop-up numeric keypad. Maximum sequence length = maximum waveform length*current bit rate/current sample rate. The default is 511 Bits.

Encoding/Modulation

Click or tap **Encoding/Modulation** to enter the menu as shown in the figure below.

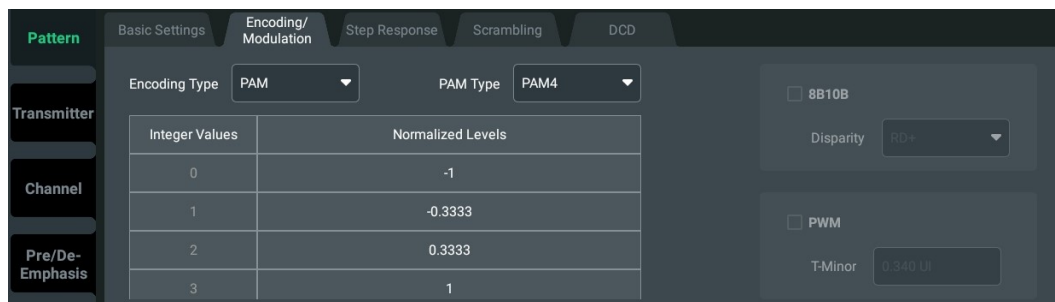


Figure 6.9 Encoding/Modulation Menu

- **Encoding Type**

Click or tap the "Encoding Type" drop-down button to set the encoding type to NRZ, NRZ-I, RZ, RZ-P, or PAM.

- NRZ: Non-Return-to-Zero
- NRZ-I: Non-Return-to-Zero Inverted
- RZ: Unipolar Return-to-Zero
- RZ-P: Bipolar Return-to-Zero
- PAM: Pulse Amplitude Modulation. When the encoding type is set to "PAM", you can click or tap the "PAM Type" drop-down button to select PAM4, PAM5, PAM8, PAM10, PAM12, or PAM16. PAM-n has n levels.

The correspondence of the normalized level to the value will be displayed in the table as shown in *Figure 6.9*. You can click or tap any voltage value in the "Normalized Levels" column and then use the pop-up numeric keypad to define the level of the corresponding bit data.

- **8B10B**

8B10B is used to encode 8-bit data to 10-bit data. This function is available only when the data source is set to **Pattern** > **KD Symbol** or **File** > **KD Symbol** in *Basic Settings*. Otherwise, it is grayed out.

After the 8B10B encoding function is enabled, you can set the disparity. Disparity represents the difference between the number of 1 bits and 0 bits after encoding. Available options include RD+ (more 0 bits than 1 bits or equal number of 1 bits and 0 bits) and RD- (more 1 bits than 0 bits).

NOTE

- The 8B10B function is available only when the encoding type is set to "NRZ" or "NRZ-I".



- When it is enabled, if the selected encoding type is neither "NRZ" or "NRZ-I", a prompt message "Opening function failed" will appear. You need to disable the 8B10B function to select other encoding types.

- **PWM**

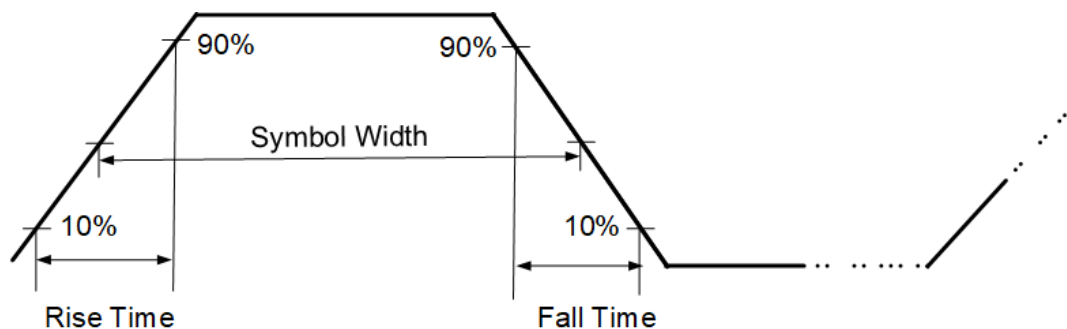
It is used to generate a Pulse Width Modulated signal for "NRZ" or "NRZ-I". It is not available when other encoding type is selected. In the PWM modulation, each original bit is represented in terms of 0s and 1s. After the PWM function is enabled, you also can set the T-Minor parameter to specify the duration of the encoded bit 0 or 1 with respect to the original unit interval (UI). If the original bit was 0, then T_Minor specifies the width of the encoded bit 1. If the original bit was 1, then T_Minor specifies the width of the encoded bit 0. T-Minor ranges from 0.01 UI to 0.5 UI, and the default is 0.2 UI.


NOTE

- You cannot enable the PWM and DCD at the same time.
- When it is enabled, if the selected encoding type is neither "NRZ" or "NRZ-I", a prompt message "Opening function failed" will appear. You need to disable the PWM function to select other encoding types.

Step Response

Click or tap **Step Response** to enter the "Step Response" setting menu. You can set the edge shape and the rise time measured at 20%~80% or 10%~90% of the signal amplitude. The following figure shows the rise time measured between 10% and 90% of the signal amplitude.



- **Edge Shape**

Click or tap the "Edge Shape" drop-down button to select "Gaussian", "Trapezoidal", "First Order", "Bessel-Thomson", "Raised Cosine", or "Root Raised Cosine".

- **Thresholds**

Click or tap the "Thresholds" drop-down button to select 20%/80% (20%~80%) or 10%/90% (10%~90%).

- **Rise Time**

Based on the selected "Thresholds" setting, the rise time can be defined as the time required for the amplitude of a symbol to rise from 10% to 90% or from 20% to 80%. Click or tap the "Rise Time" input field to set the rise time with the pop-up numeric keypad. The available range is from 0 UI to 1 UI, and the default is 0.4 UI. This setting is available for all edge shapes except "Raised Cosine" and "Root Raised Cosine".

- **Alpha**

The "Alpha" setting appears when the edge shape is set to "Raised Cosine" or "Root Raised Cosine". Click or tap the "Alpha" input field to set the roll-off factor. The available range is from 0 to 1, and the default is 1.



TIP

The unit interval (UI) is the time interval taken to transmit one bit, or the time taken in a data stream by each symbol. When the rise time is set to 0.5 UI, the rise time is half of the symbol width.

Scrambling

Click or tap **Scrambling** to enter the "Scrambling" setting menu. You can click or tap the "Scrambling" on/off switch to enable or disable the scrambling function. After the scrambling function is enabled, you can set the following parameters.

- **Scrambling Type**

Click or tap the "Scrambling Type" drop-down button to select "Additive" or "Multiplicative".

- **Polynomial Expression**

Click or tap the "Polynomial" input field and use the pop-up symbol keypad to set the polynomial expression, for example, $X^9 + X^4 + 1$.

- **Register Initial Value**

Click or tap the "Initial Value" input field and use the Binary/Hex keypad to set the register initial value. You can set the format of the initial value to "Binary" or "Hex". The length of the register initial value is equal to the highest degree of the polynomial expression.

Duty Cycle Distortion (DCD)

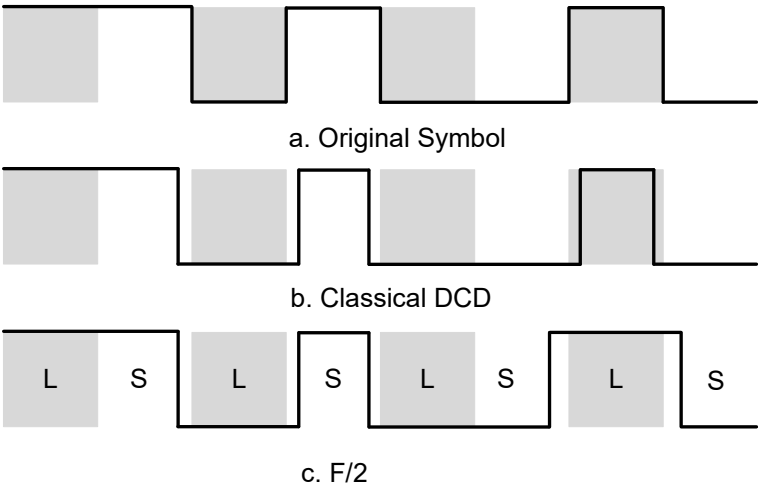
Click or tap **DCD** to enter the "DCD" setting menu. You can click or tap the "DCD" on/off switch to enable or disable the DCD function. After the DCD function is enabled, you can set the following parameters.

- **Mode**

Click or tap the "Mode" drop-down button to select "Classical" or "F/2".

- Classical: The durations of high level symbols are compressed or expanded relative to the durations of low level symbols, as shown in the figure below.

- F/2: The durations of all symbols are compressed (S) or expanded (L). The duration of a symbol flips between two values from one symbol to the next, as shown in the figure below.



- **Magnitude**

Click or tap the "Magnitude" input field and use the pop-up numeric keypad to set the DCD magnitude. The available range is from -1 UI to 1 UI.



NOTE

- When the encoding type is set to "RZ" or "RZ-P", or when the PWM function is enabled, the DCD function is not available.
- When the DCD function is enabled, if the selected encoding type is not "NRZ", "NRZ-I", or "PAM", a prompt message "Opening function failed" will appear. You need to disable the DCD function to select other encoding types.

6.4.2 Transmitter

In the high-speed serial editor menu, click or tap **Transmitter** to enter the "Transmitter" setting menu, as is shown in the figure below. You can set the jitter, noise, and spread spectrum clock (SSC).

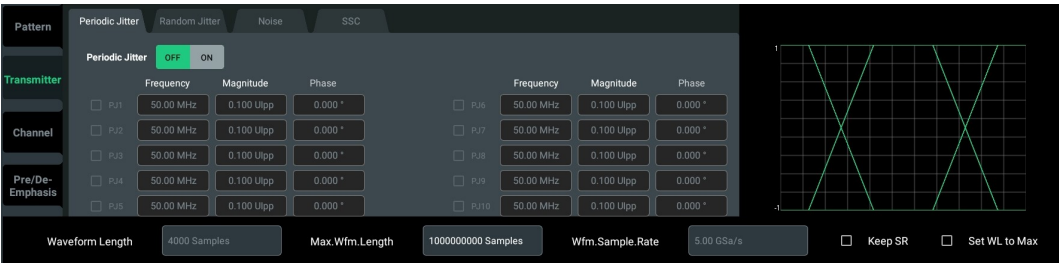
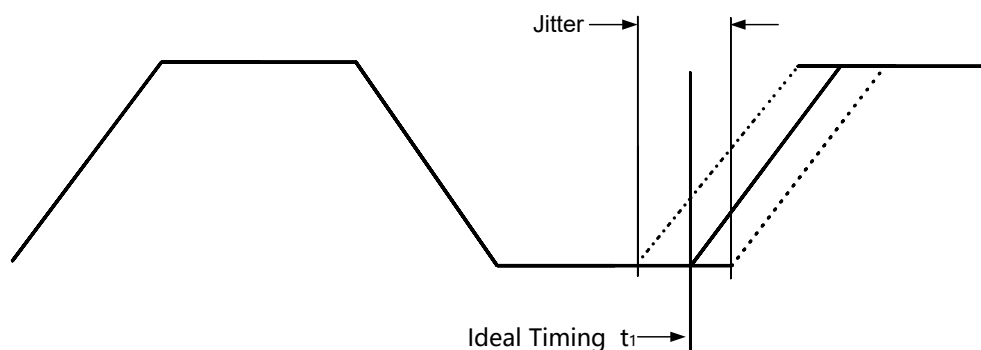


Figure 6.10 "Transmitter" Menu

Periodic Jitter

Jitter is the deviation in the edge timing of the high speed serial signal with respect to the ideal edge timing. Periodic jitter, also known as Sinusoidal jitter, is the portion of the deterministic jitter that is periodic, but is not correlated with the waveform data. Click or tap the "Periodic Jitter" on/off switch to enable or disable the periodic jitter function. After the periodic jitter is enabled, you can tick the corresponding check box of the periodic jitter (PJ1-PJ10) to add the periodic jitter and set the jitter parameters.



- **Frequency**

Click or tap the "Frequency" input field to set the frequency of the sine wave (jitter) with the pop-up numeric keypad. The available range is from 1 Hz to 1 GHz, and the default is 50 MHz.

- **Magnitude**

Click or tap the "Magnitude" input field to set the magnitude of the sine wave (jitter) with the pop-up numeric keypad. The available range is from 0 UIpp to 10 UIpp, and the default is 0.1 UIpp.

- **Phase**

Click or tap the "Phase" input field to set the phase of the sine wave (jitter). The available range from -360° to 360° , and the default is 0° .

Random Jitter

In the Transmitter setting menu, click or tap **Random Jitter** to enter the "Random Jitter" setting menu. It follows the Gaussian probability distribution. Click or tap the "Random Jitter" on/off switch to enable or disable the random jitter function. After the random jitter is enabled, you can tick the corresponding check box of the random jitter (RJ1-RJ3) to add the random jitter and set the jitter parameters.

- **Crest Factor**

Crest factor is the ratio between the maximum peak of the jitter and the the rms value, expressed in dB. For example, if the crest factor of RJ1 is set to 6 dB, the peak-to-peak jitter is twice the rms value. Click or tap the "Crest Factor" input field to set the crest factor of random jitter. The available range is from 0 dB to 12 dB, and the default is 6 dB.

- **Magnitude**

Click or tap the "Magnitude" input field to set the rms magnitude (not the max. magnitude) of the random jitter with the pop-up numeric keypad. The available range is from 0 Ulrms to 100 Ulrms, and the default is 0.1 Ulrms.

- **Bandwidth**

Click or tap the "Bandwidth" input field to set the bandwidth of the random jitter. The available range is from 1 Hz to 1 GHz, and the default is 50 MHz.

Noise

In the Transmitter setting menu, click or tap **Noise** to enter the "Noise" setting menu.

- **Gaussian Noise**

Click or tap the "Gaussian Noise" on/off switch to enable or disable the Gaussian noise function. After the Gaussian noise is enabled, you can generate the Gaussian noise with the specified bandwidth and magnitude to add to the signal.

- Noise bandwidth: ranges from 1 Hz to 1.25 GHz (no more than the current sample rate/2), and the default is 500 MHz.
- Noise magnitude: The magnitude of Gaussian noise is defined as the percentage of the deviation from "low" level to "high" level. Wherein, the "high"/"low" level is the final stable state of the signal after a long period of operation. It is not affected by the low pass filter or Pre/De-Emphasis. The Gaussian noise magnitude ranges from 0% to 100%, and the default is 5%.
- Crest factor: ranges from -60 dB to 20 dB.

- **Single Tone Noise**

Click or tap the "Single Tone Noise" on/off switch to enable or disable the single tone noise function. After this function is enabled, you can generate the sine wave with the specified frequency as noise to add to the signal.

- Frequency: ranges from 10 Hz to 1.25 GHz (no more than current sample rate/2), and the default is 500 MHz.
- Magnitude (S-Noise): ranges from 0% to 100%, and the default is 5%.

SSC

Spread Spectrum Clock (SSC) can modulate the bit rate of the high speed serial signal. In the Transmitter setting menu, click or tap **SSC** to enter the "SSC" setting menu. Click or tap the "SSC" on/off switch to enable or disable the SSC function. After the SSC function is enabled, you can set the SSC parameters.

- **Shape**

Click or tap the "Shape" drop-down button to select "Sine", "Square", or "Triangle".

- **Deviation (Peak-to-Peak)**

The peak-to-peak clock deviation is expressed in ppm (parts per million) of the bit rate value (refer to *Basic Settings* in *Pattern Setting*). Click or tap the "Dev(pk-pk)" input field to set the peak-to-peak deviation with the pop-up numeric keypad. The available range is from 0 ppm to 200 kppm, and the default is 0 ppm.

- **Repetition Rate**

Click or tap the "Rep.Rate" input field to set the repetition rate with the pop-up numeric keypad. The available range is from 10 kHz to 500 kHz, and the default is 500 kHz.

- **Symmetry**

This setting is available only when the SSC shape is set to "Triangle". Click or tap the "Symmetry" input field to set the symmetry with the pop-up numeric keypad. The available range is from 0% to 100%, and the default is 50%.

6.4.3 Channel Setting

In the high-speed serial editor menu, click or tap **Channel** to enter the "Channel" setting menu, as shown in the figure below. You can set the low pass filter and intersymbol interference (ISI).

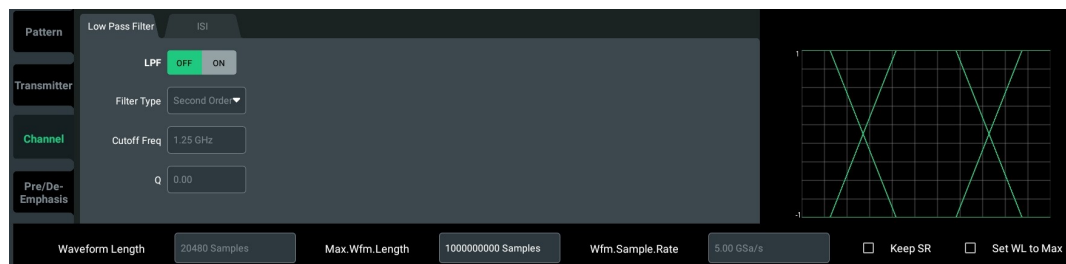


Figure 6.11 Channel Setting Menu



NOTE

As the low pass filter and ISI are mutually exclusive, you can only enable one of the two functions.

Low Pass Filter

Click or tap the "LPP" on/off switch to enable or disable the low pass filter function. After the low pass filter is enabled, you can set the filter type and cutoff frequency.

- **Filter Type**

Click or tap the "Filter Type" drop-down button to select "Brickwall", "First Order", or "Second Order".

- **Cutoff Frequency**

Click or tap the "Cutoff Freq" input field and use the virtual numeric keypad to set the cutoff frequency (the 3 dB-attenuation frequency). The minimum value is 1/1000 of the current sample rate and the maximum value is 1.25 GHz (no more than half of the current sample rate). The default cutoff frequency is 500 MHz.

- **Q Factor**

The Quality Factor (or Q Factor) is only available for second-order filter. When the filter type is set to "Second Order", you can click or tap the "Q" input field to set the Q factor for the second-order filter with the pop-up numeric keypad. The available range is from 0.01 to 1000, and the default is 1.

ISI

The ISI can simulate some characteristics of hardware filters, introducing the effects of intersymbol interference into the signal. In the Channel setting menu, click or tap **ISI** to enter the ISI setting menu. Click or tap the "ISI" on/off switch to enable or disable the ISI function.

After the ISI function is enabled, you can click or tap the "Slope" input field to define the ISI filter. The attenuation slope ranges from 0 dB/100 MHz to 100 dB/100 MHz, and the default is 0 dB/100 MHz.

6.4.4 Pre/De-Emphasis

The Pre-emphasis and De-emphasis function can filter the symbol one by one to compensate for signal high frequencies or to attenuate low frequencies. In the high-speed serial editor menu, click or tap **Pre/De-Emphasis** to enter the "Pre/De-Emphasis" setting menu, as shown in the figure below.

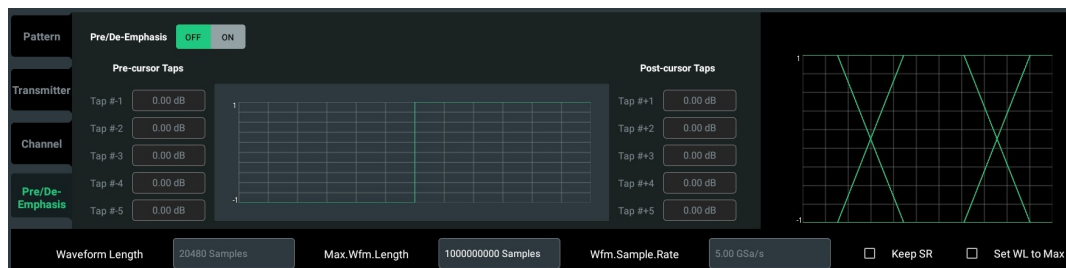


Figure 6.12 Pre/De-Emphasis Menu

Click or tap the "Pre/De-Emphasis" on/off switch to enable or disable the Pre/De-Emphasis function. After this function is enabled, you can set the pre-cursor taps (Tap#-1 to Tap#-5) and post-cursor taps (Tap#+1 to Tap#+5). The available range is from -20 dB to 20 dB. The system will plot the corresponding step response according to the set tap.

6.4.5 Other Waveform Parameters

- **Waveform Length**

The waveform length cannot be edited. It is related to the selected symbol, bit rate, and sequence length. You can limit this value through the "Max.Wfm.Length" setting.

- **Maximum Waveform Length**

Click or tap the "Max.Wfm.Length" input field to set the maximum waveform length. The length of the generated waveform should be less than the set maximum length.

- **Sample Rate**

When "Keep SR" is ticked, the sample rate is fixed to 5 GSa/s; when it is not ticked, the system automatically calculates the sample rate and recommends a proper one.

- **Keep Sample Rate**

When "Keep SR" is ticked, the sample rate is fixed to 5 GSa/s.

- **Set WL to Max**

After "Set WL to Max" is ticked, the system calculates the signal length according to the waveform length closest to the upper limit (the maximum waveform length).

6.5 Marker

The instrument supports 2 marker outputs for each analog output channel. The marker waveform can mark the specified position of a waveform, outputting in high or low levels. The output interfaces are the CH1:1~CH4:2 interfaces (CH1:1~CH2:2 for two-channel models) on the rear panel.

The precondition of this function is to use 1 bit or 2 bits for marker output through setting the *Resolution* in *Channel Setup* menu.

In the waveform editing and management interface, click or tap **Edit Marker** to enter the marker editing menu.

Range

You can set the range of samples to edit for the output Marker in the following two ways:

- **All Samples:** Selects all sample points in the waveform.
- **Between Cursors:** Extracts a specified segment of the waveform with cursors. After selecting this range, you can position the Cursor ① and Cursor ② on the waveform to extract a specified segment. You can also click or tap the input fields of X1 and X2 and use the pop-up numeric keypad to input the positions of Cursor ① and Cursor ② in order to extract the specified segment.

Tick "Marker1"/"Marker2" and then click or tap **Compile** to apply the settings for Marker1 or Marker2.

To Edit Type

- **High/Low:** All sample points within the specified "Range" (all samples or between cursors) are set to their "High"/"Low" values.
- **Pulse:** The sample points within the specified "Range" (all samples or between cursors) alternate between their high and low values. You can set the following parameters of Pulse.
 - **Start Level:** Sets whether the cycle of pulses starts from their high or low voltage level.
 - **High Steps/ Low Steps:** Click or tap the input field and use the numeric keypad to set how many sample points are set to high or low values. The available range is related to the waveform length, and the default is 1 Sa.

To Apply Modifications

After modifying the "Range" and "Edit Type", click or tap **Compile** to apply the modifications.

6.6 Waveform Management

Above the waveform editing area is the management area where you can view all created waveforms in the waveform list or manage the waveforms using the function keys on the right. The waveform management area is as shown in the figure below.

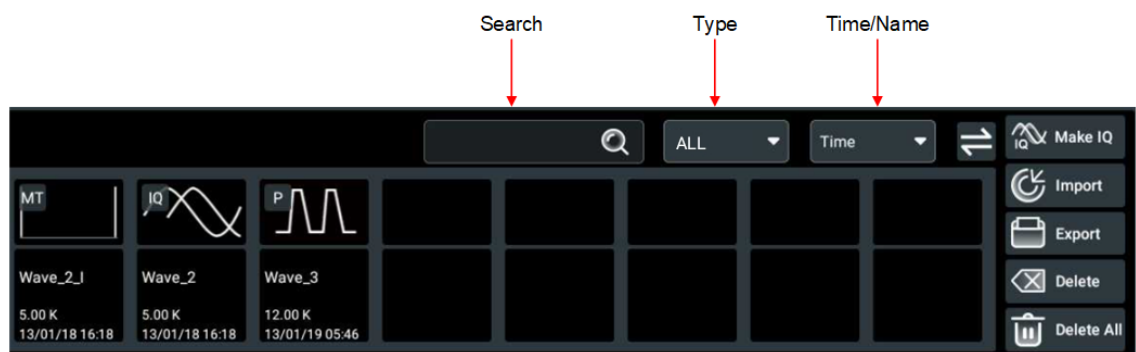



Figure 6.13 Waveform List

To Adjust the Menu Structure

Click or tap  at the upper-right of the screen to toggle between top-down structure and left-right structure.

To View Created Waveforms

- In the waveform list, you can view the thumbnail, name, length, and time of the created waveforms.
- You can click or tap the specified waveform to view its editing interface below.
- If there are too many waveforms for the current list to display, you can slide the list left and right to view other waveforms.

To Group by Type

Click or tap the "Type" drop-down menu to select waveform type. Then the waveform list will only display waveforms of the selected type. Available waveform types include Basic, Arbitrary, IQ, Multitone, and High Speed Serial. The default setting is to display all types of waveforms.

To Sort by Time/Name

You can sort the listed waveforms either by created "Time" or "Name" with the drop-down button.

To Search Waveform

Click or tap the search box and use the pop-up keypad to input specified character strings. Then all waveforms whose name contains the strings will be displayed in the waveform list. The input string cannot be longer than 26 bytes.

After the string is deleted from the search box, all waveforms will be displayed in the list again.

To Delete Waveform

- To delete one single waveform, perform the following operations. Click or tap the waveform that you want to delete from the list. Then click or tap **Delete** on the right side and a pop-up message box is displayed. Click or tap **OK** to delete the selected waveform.
- To delete all waveforms, perform the following operations. Click or tap **Delete All** and a pop-up message box is displayed. Click or tap **OK** to delete all waveforms.

To Export Waveform

To export the waveform in the system to the internal memory/external storage device, perform the following operations.

1. Click or tap **Export** to pop up the "Storage(Export Wave)" menu.
2. Enter the system memory. Select the file that you want to export and then click or tap **Export**.

3. Enter the target folder in the internal memory/external storage device. Click or tap **Paste** to complete the export operation. Then you can see the specified waveform that you exported under the target folder.

You can also refer to *Import/Export* to export waveform. For general operations of the "Storage" menu, please refer to *Storage Management*.

To Import Waveform

To import a waveform stored in the internal memory/external storage device into the instrument system, perform the following operations.

1. Click or tap **Import** to pop up the "Storage(Import Wave)" menu.
2. Enter the internal memory/external storage device. Select the file that you want to import and then click or tap **Import** to complete the import operation. Then you can see the imported waveform in the waveform list.

You can also refer to *Import/Export* to import waveform. For general operations of the "Storage" menu, please refer to *Storage Management*.

Make IQ

Click or tap **Make IQ** to pop up the "Resource List" menu, as is shown in the figure below.

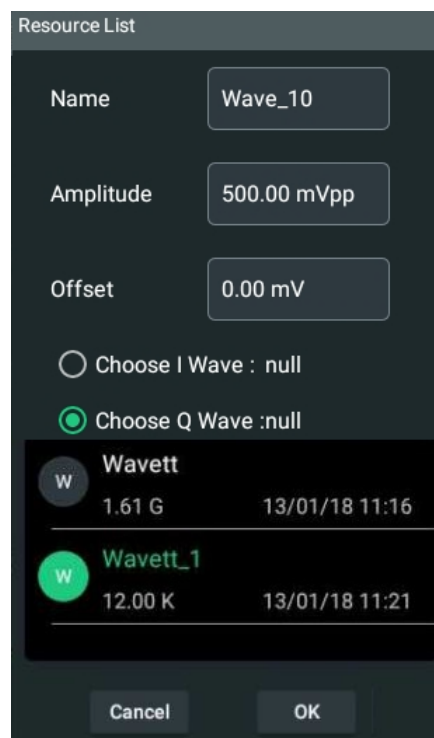


Figure 6.14 Resource List Menu

1. Click or tap the input fields and use the pop-up keypad to set the name, amplitude, and offset of the IQ signal respectively.
2. Select "Choose I Wave" and select one waveform from the waveform list below. Then the character string "null" after "Choose I Wave" will be changed to the filename of the waveform that you selected. Likewise, follow the above operations to select Q Wave.

**TIP**

The selected I wave and Q wave should be of equal length.

3. Click or tap **OK** to finish making IQ. After that, you can see the created IQ waveform in the waveform list.

If you select an IQ wave in the list, the I wave and Q wave will be selected together, and all sample data will be displayed in *Table Editor* interface.

7 Sequence Editing and Management (Optional)

Based on waveform segments, steps, sequences, and subsequences, the sequence editor allows you to create various complex waveform files which are controlled by a sequence definition that uses rules including Loop, Go To, Wait, Event Jump To.

You can click or tap the **Sequence** tab to enter the sequence editing and management interface, as shown in the figure below. The upper area is the sequence list which displays all created sequences. You can manage those sequences with the function keys on the right. The lower area is the sequence editing area in which you can create a new sequence or edit existing sequences.

After editing a sequence, click or tap **Assign to Channel**. Select the desired Track and channel in the pop-up "Assign to channel" menu. Then click or tap **OK** to load the sequence. If "Assign to channel and play" is ticked, the instrument automatically loads the sequence and starts the playback.

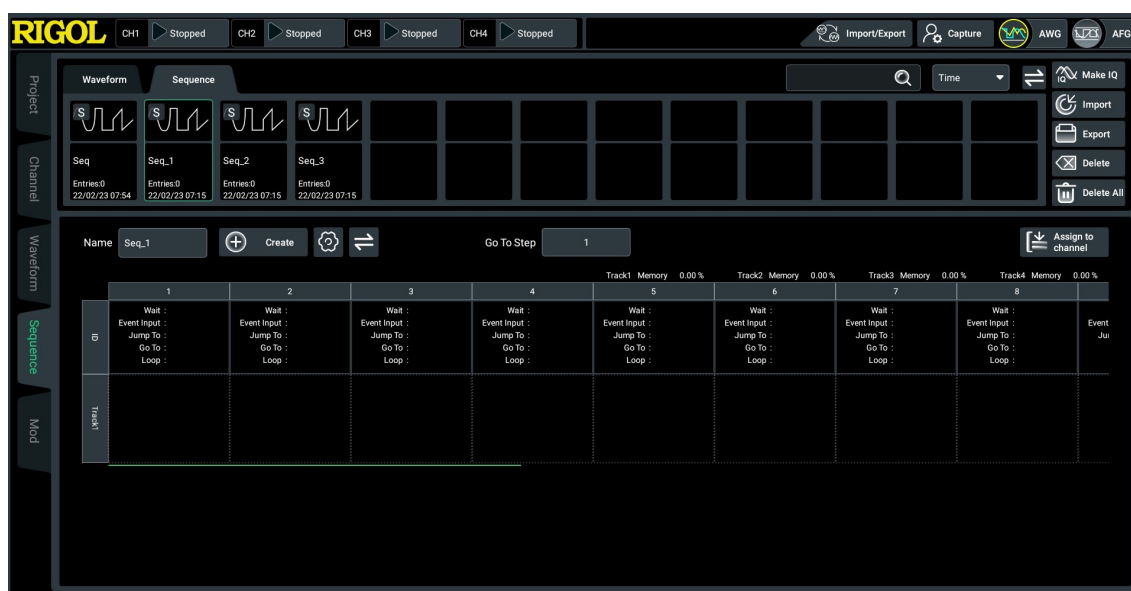


Figure 7.1 Sequence Editing and Management Interface

7.1 New Sequence

A sequence is a combination of multiple individual waveforms and subsequences. A subsequence is simply an existing sequence that is assigned to a step in a sequence. This section introduces how to create a new sequence.

To Create an Empty Sequence

Click or tap **Create** to create an empty sequence with the default name. The new sequence will be displayed in the sequence list at the top of the screen. You can click

or tap the "Name" input field to modify the sequence name which can only contain English letters, numbers, and underscores. The name cannot be the same as that of an existing sequence. In the sequence list, you can view the sequence name, number of steps contained, and the last modification time.



Figure 7.2 Creating an Empty Sequence

To Create a Track

By default, after a new sequence is created, it contains an empty Track, Track1.

Click or tap **Track1** and a tool bar will pop up, as is shown in the figure below. Click or tap **New** to create a new Track for the current sequence. The maximum number of tracks supported by a sequence is the same as the number of channels available. For example, for four-channel models, a maximum of four tracks (Track1 to Track4) are available for a sequence.

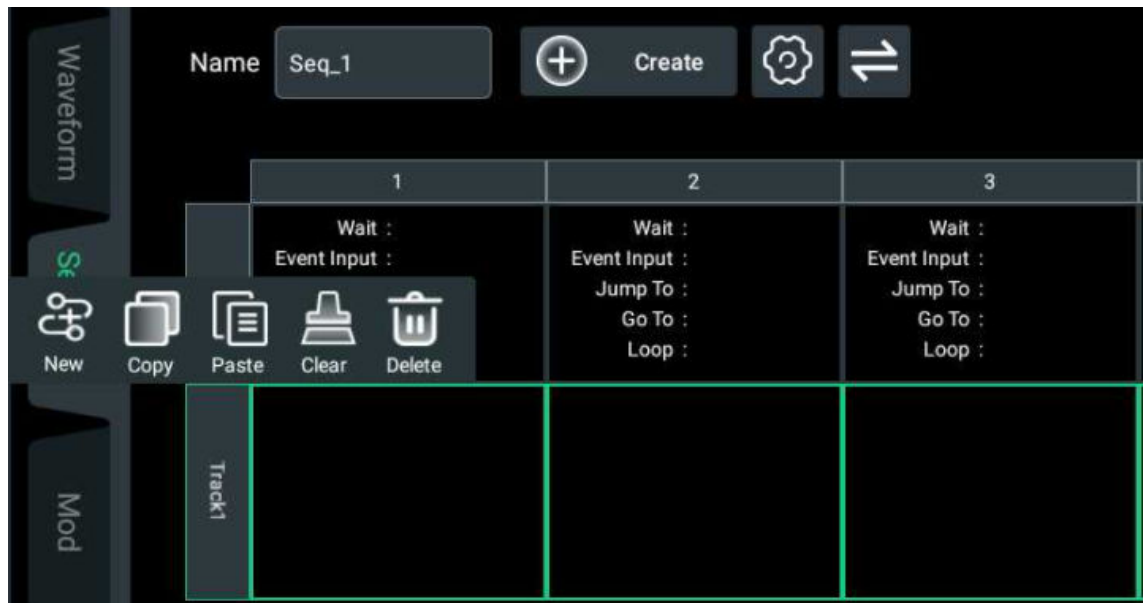


Figure 7.3 Creating a Track

To Add Resources to Track

Drag the desired sequence/waveform from the sequence/waveform list onto the specified location of the Track in the sequence editor, as shown in the figure below.

Each Track can store up to 1610612736 (1.5×2^{30}) sample points (including waveforms and waveforms contained in subsequences). Adding a waveform or subsequence to several steps of a Track will not occupy the storage capacity repeatedly. The amount of storage currently used by each Track is displayed above the sequence editor.

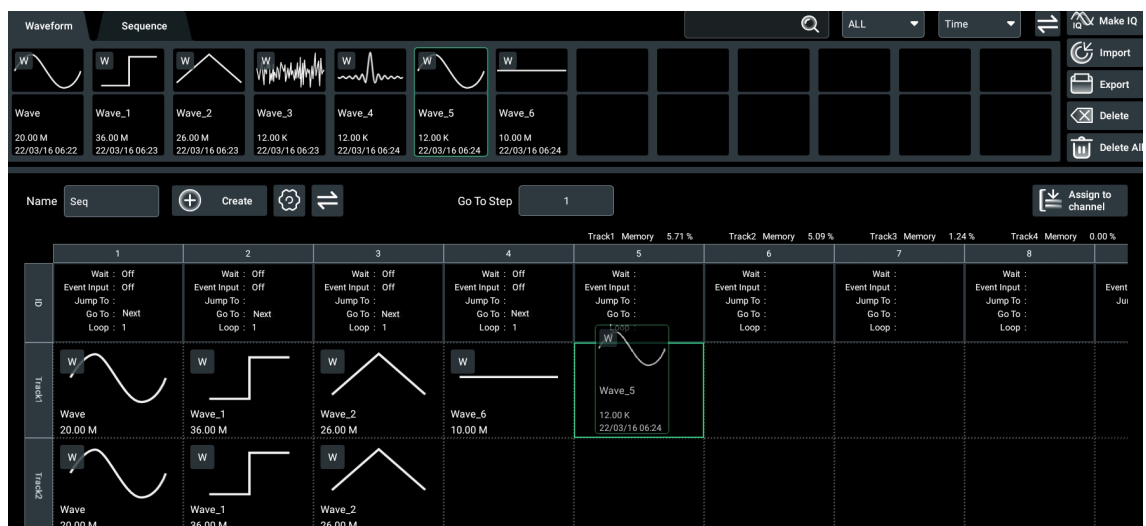


Figure 7.4 Adding Resources to Track



TIP

- A subsequence cannot contain another subsequence.
- When a subsequence is added to a Track step, it is automatically added to the steps of other three Tracks.
- A Track mixing IQ waveforms and real waveforms cannot be assigned to a channel for playout.
- Each step in the same ID column of different Tracks must use waveforms of equal length.

7.2 Output Rules

After adding one or more specified waveforms/subsequences to a sequence, you can view the output rules of each step from the ID row of the sequence editor, as shown in the figure below. By default, the waveform starts to play by ID number without a trigger signal and does not repeat. DG70000 series allows you to define the output rules of any step in a sequence as required.

| | 1 | 2 | 3 |
|----|--|--|--|
| ID | Wait : Off Event Input : Off Jump To : Go To : Next Loop : 1 | Wait : Off Event Input : Off Jump To : Go To : Next Loop : 1 | Wait : Off Event Input : Off Jump To : Go To : Next Loop : 1 |

In the sequence editor, click or tap the cell in ID row of the specified step to pop up its "Rule Setting" menu, in which you can edit the output rules of the step in a sequence. The rules include Wait, Go To, Event Jump To, and Loop. Jump execution order: Event Jump takes precedence over the Go To jump.

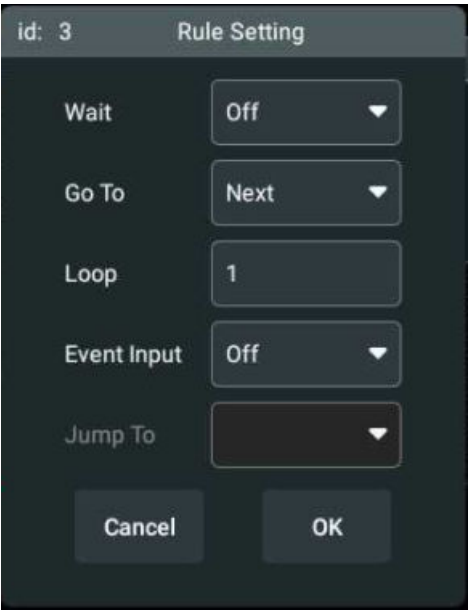


Figure 7.5 "Rule Setting" Menu

After editing the rules, click or tap **OK** to complete the modification. Otherwise, click or tap **Cancel** to abandon the modification.

7.2.1 Wait

The Wait condition is available for each step in a sequence. It defines the condition required for the step to start playing the assigned waveform, including whether to wait for a trigger signal and the type of trigger signal. In the menu as shown in *Figure 7.5*, click or tap the "Wait" drop-down button to set the Wait condition.

- **Off:** No waiting. The waveform plays immediately without waiting for trigger. The default is Off.
- **Trig A:** The step does not start playing the waveform until a trigger signal Trig A is received. To configure Trig A, please refer to *Trigger Setup*.
- **Trig B:** The step does not start playing the waveform until a trigger signal Trig B is received. To configure Trig B, please refer to *Trigger Setup*.
- **Internal:** The step does not start playing the waveform until an internal trigger signal is received. To configure internal trigger signal, please refer to *Trigger Setup*.



TIP

The Wait conditions are ignored if a sequence is used as a subsequence.

7.2.2 Go To

Go To jump is available for each step and subsequence in a sequence. It defines which step in the sequence to jump to and play when the current step has finished playing its waveform. In the menu as shown in *Figure 7.5*, click or tap the "Go To" drop-down button to set the step to go to.

- **Next:** The sequence goes to the next step in the sequence. This is the default setting. If "Next" is chosen for the last step in the sequence, the sequence goes to the first step and play after the last step finishes its layout. If "Next" is chosen for the last step in a subsequence, it goes to the sequence and continues to play after the last step finishes its layout.
- **First:** The sequence jumps to the first step in the sequence.
- **Last:** The sequence jumps to the last step in the sequence.
- **End:** The sequence ends when finished with this step. However, if it is a subsequence, the sequence continues to play.
- **Enter step:** You can also directly jump to a specific step through entering the step ID with the numeric keypad.

7.2.3 Loop

The loop defines how many times the waveform or subsequence plays for the step in the sequence. In the menu as shown in [Figure 7.5](#), click or tap the "Loop" input field and set the number of times with the pop-up numeric keypad.

- You can enter the number of times to repeat the waveform. The loop ranges from 1 to 4294967295 ($2^{32}-1$).
- Entering "0" or " ∞ " sets the loop to infinity and the sequence will continuously play the waveform until a jump condition occurs.



7.2.4 Event Jump To

Event Input

It is available for each step in a sequence. It defines the event that will cause a jump to occur in the sequence step, deciding whether an event jump is active and the type of trigger signal for the jump to occur. If a trigger signal is received, the sequence uses the Event Jump To definition to jump to a specified step. Please refer to [Trigger Source](#) for trigger sources available.

- **Off:** A jump is not active for the step. The sequence executes by ID number or uses the Go To definition after finishing this step. The default setting is Off.
- **Trig A:** A jump occurs when a trigger signal Trig A is received.
- **Trig B:** A jump occurs when a trigger signal Trig B is received.
- **Internal:** A jump occurs when an internal trigger signal is received.

Jump Timing

You can access the jump timing settings by clicking or tapping  to pop up the "Sequence Setting" menu, as shown in the figure below. Two options are available: "Jump Immediately" and "Jump At End". You can choose one option through ticking the box of the option. Once selected, the box will turn into .

- **Jump Immediately:** A jump occurs immediately at the time a trigger signal is received, stopping the playback of the waveform currently playing.
- **Jump At End:** When a trigger signal is received, a jump occurs only after the currently playing waveform completes its playback.

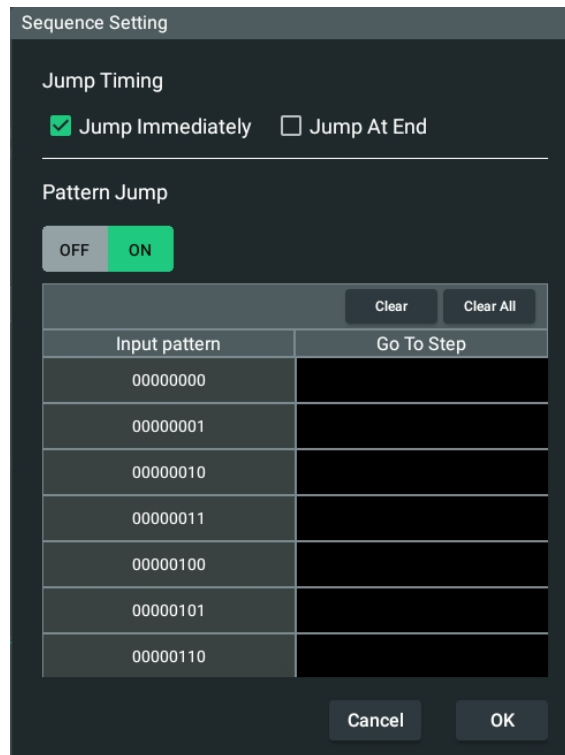


Figure 7.6 "Sequence Setting" Menu

**TIP**

This setting also applies to pattern jump. For details, please refer to [Pattern Jump](#).

Event Jump To

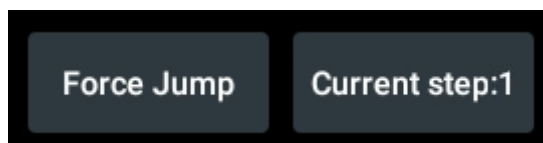
It defines which step to jump to when a trigger signal is received. In the menu as shown in [Figure 7.5](#), click or tap the "Jump To" drop-down button to select the "Next", "First", or "Last" to jump to and play. You can also directly jump to a specified step through entering the step ID with the numeric keypad.

**TIP**

The Event Jumps are ignored if a sequence is used as a subsequence.


7.2.5 Force Jump

After assigning a sequence to a channel, you can click or tap **Force Jump** in the corresponding channel operation area to pop up the Force Jump menu. You can click or tap the "Jump To" drop-down button to select "First", "Last", "Current", or "End". You can also select the "Step number" and then enter the desired step number to jump to. After applying the force jump settings, you can click or tap **Current Step** to check the currently played step.



7.3 Pattern Jump

DG70000 series allows you to send 8 bit command via the **[Pattern Jump In]** connector. When the instrument receives the command, it performs 8 bit addressing and jump to the specified step based on predefined jump destinations. Up to 256 predefined input patterns are available for DG70000. The digital pattern is applied to the **[Pattern Jump In]** connector on the rear panel.

Click or tap  to pop up the "Sequence Setting" menu, as shown in the figure below.

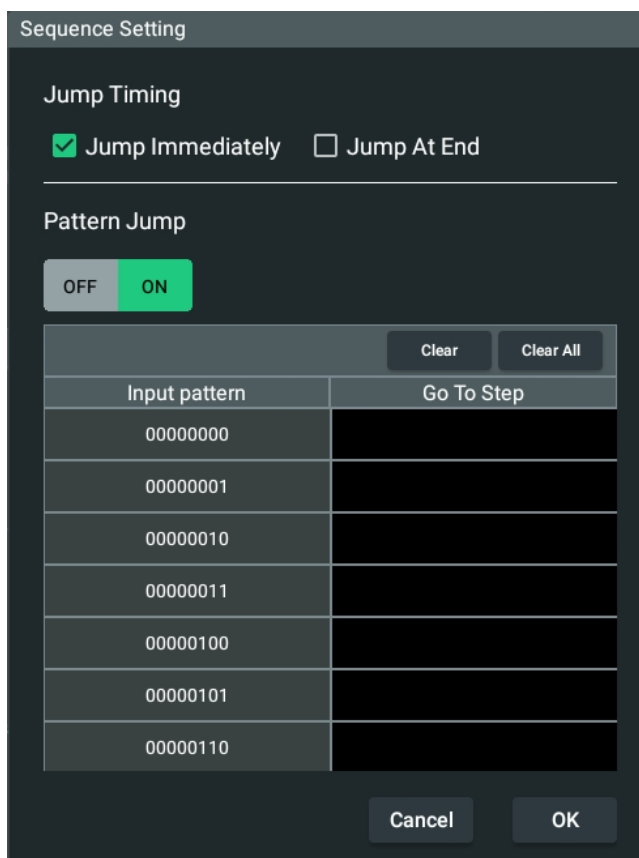



Figure 7.7 "Sequence Setting" Menu

Pattern Jump On/ Off

In the "Sequence Setting" menu, click or tap **ON** to enable pattern jump and the jump will occur when the input signal meets the trigger condition. Otherwise, click or tap

OFF to disable pattern jump. The sequence output is not affected by the trigger signal.

Jump Timing

Two jump timing options are available: "Jump Immediately" and "Jump At End". You can choose one option through ticking the box of the option. Once selected, the box will turn into .

- **Jump Immediately:** A jump occurs immediately at the time a trigger signal is received, stopping the playout of the waveform currently playing.
- **Jump At End:** When a trigger signal is received, a jump occurs only after the currently playing waveform completes its playout.

TIP

This setting also affects event jump. For details, please refer to *Jump Timing*.

To Set Pattern Jump

The "Input Pattern" column represents the input digital signal from the **[Pattern Jump In]** connector on the rear panel. The pattern is a 8-bit binary number, representing data from the 8 pins of the connector. For the pin assignments for the connector, please refer to *DG70000 Data Sheet*.

To jump to a specified step, you can simply go to a corresponding input pattern and enter the step number in "Go to Step" column with the pop-up numeric keypad. The step entered in the column must be a valid step number.

To clear the value in a cell, you can select the cell and then click or tap **Clear**. To delete all values in the table, click or tap **Clear All**.

After the above operations, click or tap **OK** to complete setting the pattern jump of the current sequence. Otherwise, click or tap **Cancel** to abandon the current setting.

You can also set which slope to use (rising or falling edge) of the pattern jump strobe input signal for a trigger event to occur in the "Strobe Edge" drop-down button of the "Trigger Setting" menu (*Figure 13.1*).

TIP

- Jump priority: Force Jump > Pattern Jump > Event Jump > Go To jump.
- The Pattern Jump is ignored if the sequence is used as a subsequence.

7.4 Viewing Sequence Editor

To Switch Sequence Display Style

The sequence editor has two display styles. By default, the waveform ID is the column number and the TrackID is the row number. The first row displays the output rules of a step in the corresponding column.

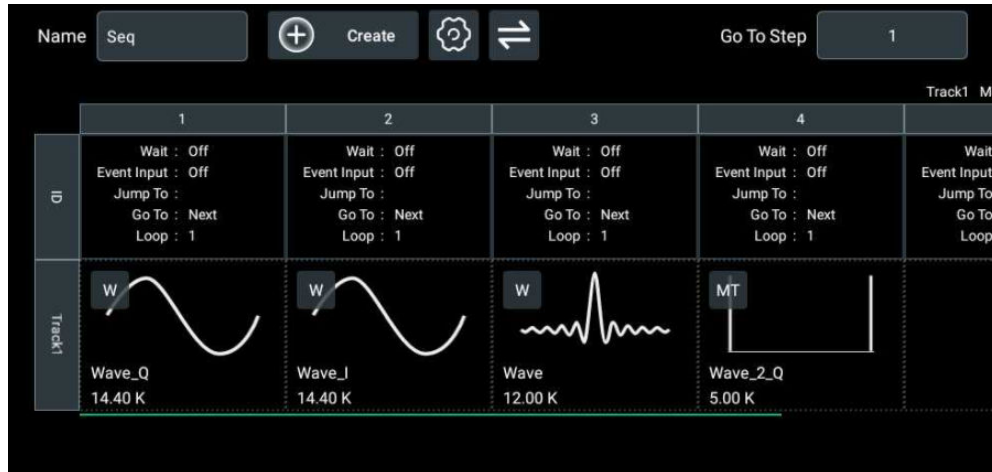



Figure 7.8 Sequence Editor Default Style

You can click or tap  to switch the display style. Then the waveform ID is the row number while the column identifies the output rules of the step in the corresponding row. The display mode is shown in the figure below.

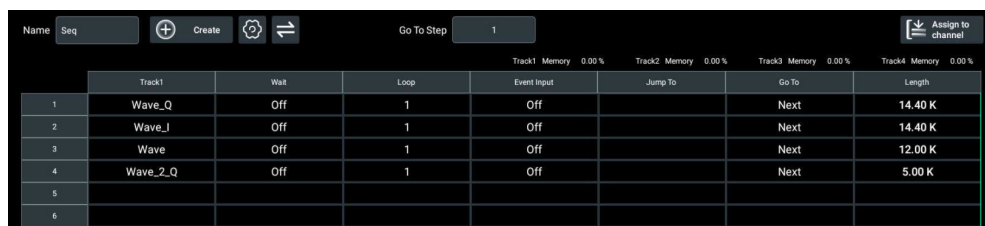



Figure 7.9 Switching Display Style

You can click or tap  again to restore to the default style.

To View All Steps or a Specified Step

When a large number of steps are added to a sequence, the current screen cannot display all steps in the sequence. You can view those steps through sliding the editor left and right (the default style) or up and down (the switched style).

To check a specified step, you can click or tap the input field of "Go To Step" and use the pop-up numeric keypad to enter the step ID. Then it will automatically jump to the specified position in the editor.

7.5 Sequence Editing Tools

The DG70000 series allows you to modify the created sequence. Common operations are as follows.

To Modify Sequence Name

Click or tap the specified sequence in the sequence list and the input field of "Name" will display the name of the currently selected sequence. You can click or tap the input field and use the pop-up virtual keypad to modify the name. The sequence name is a character string which can contain numbers, English letters, and underscores. Its length ranges from 1 to 26 bytes.

To Edit Track

Click or tap **Track(n)** (n=1~4) to pop up the Track editing tool bar.

- **To Delete Track**

Click or tap **Delete** to remove the selected Track from sequence.

- **To Copy Track**

Select the specified Track in the current sequence and copy the Track through clicking or tapping **Copy** in the pop-up tool bar. Then select the target Track in the sequence. Click or tap **Paste** to paste all waveforms/subsequences copied from the specified Track into the target Track.

- **To Clear Track**

Click or tap **Clear** to clear the selected Track.

To Edit Step

- **To Clear Step**

Select the specified step in the current sequence and then click or tap **Clear** in the pop-up tool bar to remove the waveform/subsequence from the step.

- **To Copy Step**

Select the specified step in the current sequence and copy the step through clicking or tapping **Copy** in the pop-up tool bar. Then select the target step in the sequence. Click or tap **Paste** to paste the step into the specified position.


7.6 Sequence Management

In the upper management area, you can view all created sequences in the list and manage those sequences with the function keys on the right.



Figure 7.10 Sequence List

To Adjust the Menu Structure

Click or tap  at the upper-right of the screen to toggle between top-down structure and left-right structure.

To View Sequence

- In the sequence list, you can view the thumbnail, name, entries (number of all waveforms/subsequences in a sequence), and the created time.
- You can select a sequence in the list and view more details about the sequence in the sequence editing area below.
- If there are too many sequences for the screen to display, you can slide the list left and right to view other sequences.

To Sort by Time/Name

You can sort the listed sequences either by last modified "Time" or "Name" with the drop-down button.

Also, when a new sequence is created, it will be added to the sequence list in order of "Time" or "Name".

To Search Sequence

Click or tap the search box and use the pop-up keypad to enter specified character strings. Then all sequences whose name contains the strings will be displayed in the sequence list. The input string cannot be longer than 26 bytes.

After the input string is deleted from the search box, all sequences will be displayed in the list again.

To Delete Sequence

- To delete a single sequence, perform the following operations. Click or tap the sequence that you want to delete from the list. Then click or tap **Delete** on the right side and a pop-up message box is displayed. Click or tap **OK** to delete the selected sequence.

- To delete all sequences, perform the following operations. Click or tap **Delete All** and a pop-up message box is displayed. Click or tap **OK** to delete all sequences.

To Export Sequence

To export the sequence in the system to the internal memory/external storage device, perform the following operations.

1. Click or tap **Export** to pop up the "Storage(Export Sequence)" menu.
2. Enter the system memory. Select the file that you want to export and then click or tap **Export**.
3. Enter the target folder in the internal memory/external storage device. Click or tap **Paste** to complete the export operation. Then you can see the specified sequence that you exported under the target folder.

You can also refer to *Import/Export* to export sequence. For general operations of the "Storage" menu, please refer to *Storage Management*.

To Import Sequence

To import a sequence stored in the internal memory/external storage device into the instrument system, perform the following operations.

1. Click or tap **Import** to pop up the "Storage(Import Sequence)" menu.
2. Enter the internal memory/external storage device. Select the file that you want to import and then click or tap **Import** to complete the import operation. Then you can see the imported sequence in the list.

You can also refer to *Import/Export* to import sequence. For general operations of the "Storage" menu, please refer to *Storage Management*.

8 Modulation

The "Modulation" function allows you to set code type and create modulated signals. Click or tap the **Mod** tab at the left side of the screen to enter the modulation interface, as shown in the figure below. The interface is divided into two areas. The lower area of the interface is the modulation editing area while the upper area is the list where modulated waveforms will be displayed.

After editing a waveform, click or tap **Assign to Channel**. Select the channel to assign the waveform in the pop-up "Assign to channel" menu. Then click or tap **OK** to load the waveform. If "Assign to channel and play" is ticked, the instrument automatically loads the waveform and starts the waveform payout. After the waveform is assigned, it can be viewed in the channel's plot area in *Channel Management* interface.

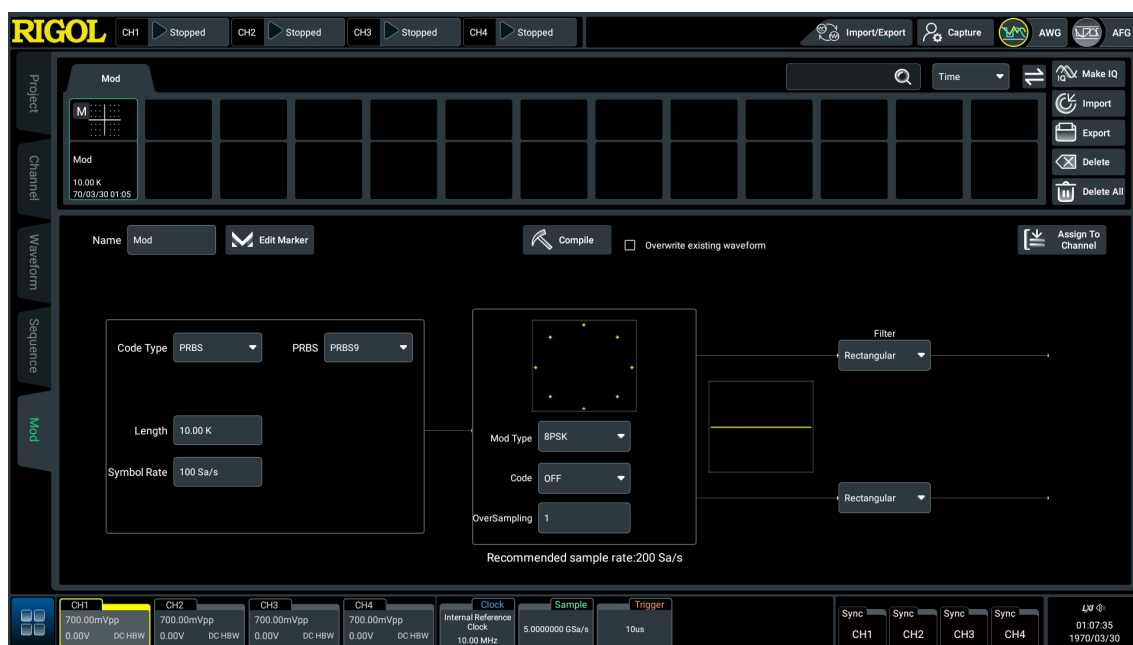


Figure 8.1 Modulation Interface

8.1 Modulating Waveform

Name

Click or tap the "Name" input field and use the pop-up keypad to set the name of the waveform to be created. The length of the name is no more than 26 bytes.

Marker

Please refer to *Marker*.

Code Type

Click or tap the "Code Type" drop-down menu to select the code type.

- **All One:** Create a sequence in which all bits are 1.
- **All Zero:** Create a sequence in which all bits are 0.
- **PRBS:** When setting the type to "PRBS", you can click or tap the "PRBS" drop-down menu at the right side to set the type to PRBS9, PRBS11, PRBS15, PRBS16, PRBS20, PRBS21, and PRBS23.

Length

Click or tap the "Length" input field to set the length with the pop-up numeric keypad. The available range is from 10 to 20M, and the default is 10k.

Symbol Rate

Symbol rate refers to the number of symbols transmitted per second. Click or tap the "Symbol Rate" input field to set the rate with the pop-up numeric keypad. The available range is from 100 Sa/s to 100 MSa/s, and the default is 1 MSa/s.

Modulation Type

Click or tap the "Mod Type" drop-down menu to select the modulation scheme. The DG70000 series supports 8 schemes including BPSK, QPSK, 8PSK, 16QAM, 32QAM, 64QAM, 128QAM, and 256QAM.

Based on your selection, the constellation diagram of the corresponding modulation scheme is displayed above the "Mod Type". For example, the constellation diagram of 8PSK is shown in the figure below.

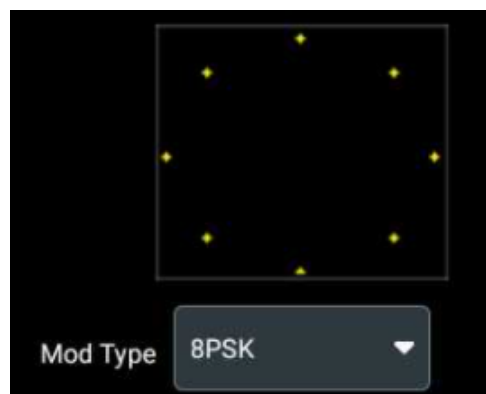


Figure 8.2 Constellation diagram of 8PSK

Code

Click or tap the "Code" drop-down menu to select OFF, Differential, Differential+Gray, or Gray.

Oversampling

Oversampling refers to the interpolation and filtering of the IQ baseband modulation signal to output the signal at a higher sampling rate. If the original IQ baseband signal symbol rate R_s is raised to a signal with a sample rate of $f_s = R \times R_s$ after

oversampling, R is the factor by which the signal is oversampled. The value ranges from 1 to 16, and the default is 4.

Filter

Click or tap the "Filter" drop-down menu to select filter.

- **Rectangular:** It passes all signals with frequency lower than a given cutoff frequency, and removes all frequency components above the cutoff frequency. Its frequency response is a rectangular function.
- **Cosine:** When selecting the cosine filter, you need to set the roll-off factor "Alpha/BT". The available range is from 0.05 to 1, and the default is 0.25.
- **Root cosine:** When selecting the root cosine filter, you need to set the roll-off factor "Alpha/BT". The available range is from 0.05 to 1, and the default is 0.25.

Compile

After the editing operation, click or tap **Compile** to generate the modulated signals. The new waveform will be added in the upper modulation list.

When you tick "Overwrite existing waveform", the created waveform will overwrite any existing waveform of the same name. Otherwise, the filename of the new waveform will be automatically added the suffix "_n" (n is a positive integer), for example, "Wave_1".


8.2 Modulated Waveform Management

As is shown in the figure below, above the modulation editing area is the management area where you can view the modulated signals in the modulation list or manage the modulated signals through using the function keys at the right side.



Figure 8.3 Modulation List

To Adjust the Menu Structure

Click or tap  at the upper-right of the screen to toggle between top-down structure and left-right structure.

To View Modulated Waveforms

- In the modulation list, you can view the thumbnail, name, length, and time of the created waveforms.

- You can select a waveform in the list and view more details about the waveform in its editing area below.
- If there are too many modulated waveforms for the current list to display, you can slide the list left and right to view other waveforms.

To Sort by Time/Name

You can sort the modulated waveforms in the list either by "Time" or "Name".

To Search Waveform

Click or tap the search box and use the pop-up keypad to input specified character strings. Then all modulated signals whose name contains the character strings will be displayed in the modulation list. The input string cannot be longer than 26 bytes.

After the input string is deleted from the search box, all modulated waveforms will be displayed in the list again.

To Delete Waveform

- To delete one single waveform, perform the following operations. Click or tap the waveform that you want to delete from the list. Then click or tap **Delete** on the right side and a pop-up message box is displayed. Click or tap **OK** to delete the selected waveform.
- To delete all modulated waveforms, perform the following operations. Click or tap **Delete All** and a pop-up message box is displayed. Click or tap **OK** to delete all waveforms.



TIP

When a modulated signal is deleted from the list, it will also be removed from the channel it was assigned to.

Export

To export the created modulated signal in the system to the internal memory/external storage device, please perform the following operations.

1. Click or tap **Export** to pop up the "Storage(Export Modulation)" menu.
2. Enter the system memory. Select the file that you want to export and then click or tap **Export**.
3. Enter the target folder under the internal memory/external storage device. Click or tap **Paste** to complete the export operation. Then you can see the specified file that you exported under the target folder.

You can also refer to *Import/Export* to export modulated waveforms. For general operations of the "Storage" menu, please refer to *Storage Management*.

Import

To import the modulated signal stored in the internal memory/external storage device into the instrument system, please perform the following operations.

1. Click or tap **Import** to pop up the "Storage(Import Modulation)" menu.
2. Enter the internal memory/external storage device. Select the file that you want to import and then click or tap **Import** to complete the import operation. Then you can see the imported signal in the modulation list.

You can also refer to *Import/Export* to import modulated waveforms. For general operations of the "Storage" menu, please refer to *Storage Management*.

9 Channel Management

Click or tap the **Channel** tab at the left side of the screen to enter the channel output management interface. The following figure shows the operation interface of CH1.

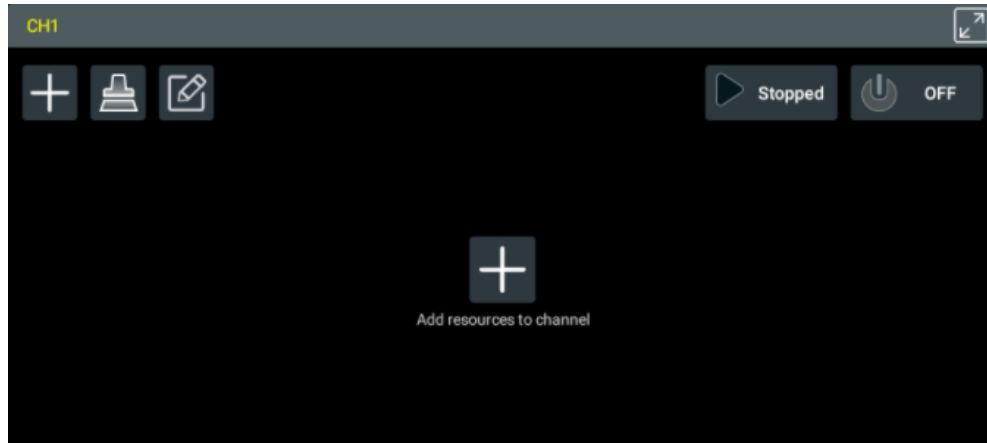



Figure 9.1 CH1 Operation Interface

9.1 Adding Resources to Channel

Click or tap **Add resources to channel** or  at the upper-left of the interface and a "Resource List" menu is displayed, as shown in the figure below.

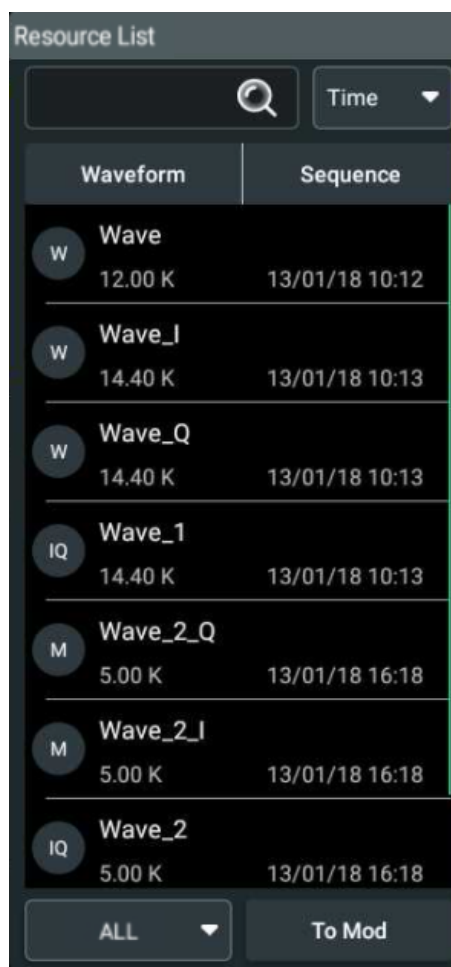


Figure 9.2 "Resource List" Menu

Click or tap **Waveform** to check all waveform files in internal memory or **Sequence** to check all sequence files in internal memory. You can also click or tap **To Mod** at the lower-right corner to display all modulated signal files. Click or tap the desired file to simply add the file to the specified channel.

If there are too many files, you can quickly navigate to the specified file through sorting the files by time or name, grouping the resources by type, or using the search function.


- **To Group by Type**

Click or tap the "All" drop-down button to select a waveform type. Then the list will only display the specified type of waveforms. Available waveform types include Basic, Arbitrary, IQ, Multitone, and High Speed Serial. The default setting is to display all types of waveforms.

- **To Sort by Time/Name**

With the drop-down menu, you can sort the files in the list by date modified or filename.

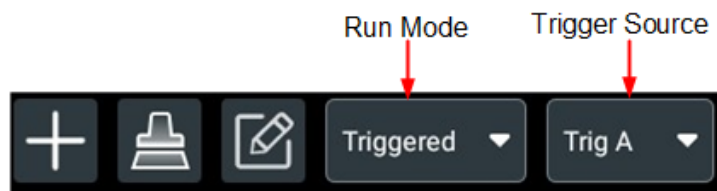
- **To Search for Resources**

Click or tap the search box and use the pop-up keypad to enter specified character strings. After that, click or tap  and all the files whose name contains the strings will be displayed in the list. The input string cannot be longer than 26 bytes.

After the string is deleted from the search box, all resources will be displayed in the list again.

9.2 Run Mode and Trigger Source

After assigning a waveform or modulated waveform to a channel, you can set the trigger mode which controls when a waveform starts to output, after the run state is set to Playing. You can set the run mode and trigger source for each channel in the corresponding operation area.



Run Mode

You can select the run mode in the drop-down menu. Four selections are available in the AWG mode.

- **Continuous:** Waveform starts to play and continues to repeat, without the need for a trigger event.
- **Triggered:** Waveform starts to play and stops after one complete waveform cycle when a trigger event occurs. Waveform playout cannot be retriggered until the current waveform playout completes an entire cycle. After setting the run mode to Triggered, you can select the trigger source from Trig A, Trig B, and Internal.
- **Trig'd Cont:** Waveform starts to play continuously until stopped by the user once a trigger event occurs. Retriggering is not required in waveform playout. After setting the run mode to Trig'd Cont, you can select the source from Trig A, Trig B, and Internal.
- **Gated:** Waveform starts to play when it is within the high level threshold of the trigger signal. After setting the run mode to Gated, you can select the trigger source from Trig A and Trig B.

Trigger Source

The trigger source selection only appears when the run mode is set to a triggered mode (Triggered, Trig'd Cont, or Gated). The trigger sources available include:

- **Trig A:** The rear-panel **[TRIG A]** interface (for external trigger signal A) is used as the source for a trigger event. The **Force Trig A** button is also active.
- **Trig B:** The rear-panel **[TRIG B]** interface (for external trigger signal B) is used as the source for a trigger event. The **Force Trig B** button is also active.
- **Internal:** An internally generated trigger signal is used as the trigger source. It is not available when the run mode is set to Gated.

To define the trigger parameters of Trig A, Trig B, or Internal, please refer to *Trigger Setup*.




TIP


- Each channel can use an independent run mode and trigger source, but synced channels must use the same run mode and trigger source.
- The run mode selection and trigger source selection are not available for a sequence assigned to a channel. For sequence trigger settings, please refer to *Output Rules*.

9.3 Common Operations


To Remove Resources

Click or tap  to remove the resource added to the channel.

To Edit Loaded Resources

If you need to modify the resource file already assigned to the channel, you can click or tap  to directly access the *Waveform Editing and Management*, *Sequence Editing and Management (Optional)*, or *Modulation* interface of the file for modification. After modification, reassign the edited resource to the channel.

To Expand/Collapse the Window



You can expand the selected channel window to a full screen by using the  button at the upper-right side, making it easier to view the channel resource clearly. You can click or tap the channel label to switch to the corresponding channel's operation interface.






Clicking or tapping  again can restore the window to the default setting.

9.4 Channel Output Control

Channel On/Off

Turning the channel ON can enable the channel output. Turning the channel OFF can disable the channel output (outputs are electrically disconnected).

The  button at the upper-right corner of the screen is the global on/off switch used to control the on/off status of all channels. You can also turn on/off each individual channel using the  button at the upper-right corner of each channel window.

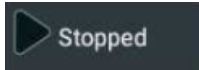
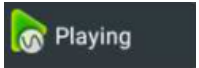
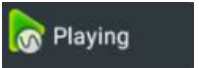
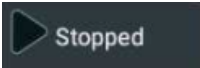
The default setting is **OFF**. Click or tap  and the button will be illuminated as , turning the channel state into **ON**. Click or tap the button again to restore to . Turning on the global switch will turn on all channels with their buttons illuminated as . Turning off any one of them will automatically turn off the global switch as .

When a channel is enabled, its output connector LED indicator and the photoelectric encoders of the operating knobs on the front panel are illuminated.

Playing/Stopped

The Playing/Stopped button is used to control the run state of resources assigned to each channel. You can view the current run state of all channels at the upper-left side of the screen, as shown in the figure below.



The default run state is **Stopped**. You can click or tap  to switch to  and the resource starts to play. Click or tap  again to restore to .

The Playing/Stopped function and Channel On/Off switch are independent of each other. If the run state is set to Playing but the channel is OFF, then there is no signal output in the channel. Turn the channel ON and the signal will start to play from the current position.


TIP

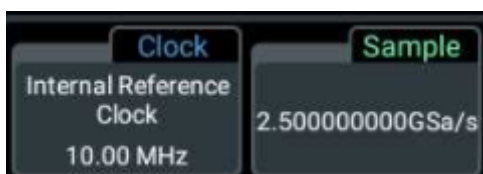
- Adding an invalid resources file to the current channel will disable the channel from playing resources.
- As DG70002 is a two-channel model, it only provides the Playing/Stopped button for CH1 and CH2.



10 Clock Setup

In the "Clock Setting" menu, you can determine the source used to drive the sample clock signal and the waveform output sample rate. You can also make the instrument's internal clock source available to other equipment. You can access the "Clock Setting" menu in the following ways.

- Click or tap the navigation icon  at the lower-left of the screen and then select **Clock**.
- Click or tap the "Clock" label or "Sample" label at the bottom of the screen.



The "Clock" label displays the current clock source and the clock frequency while the "Sample" label displays the current sample rate.

- In *Channel Setup* menu, click or tap **Clock Setting** at the lower-left of the menu to enter the "Clock Setting" menu.
- Tap the **Clock** function key on the secondary touch screen.

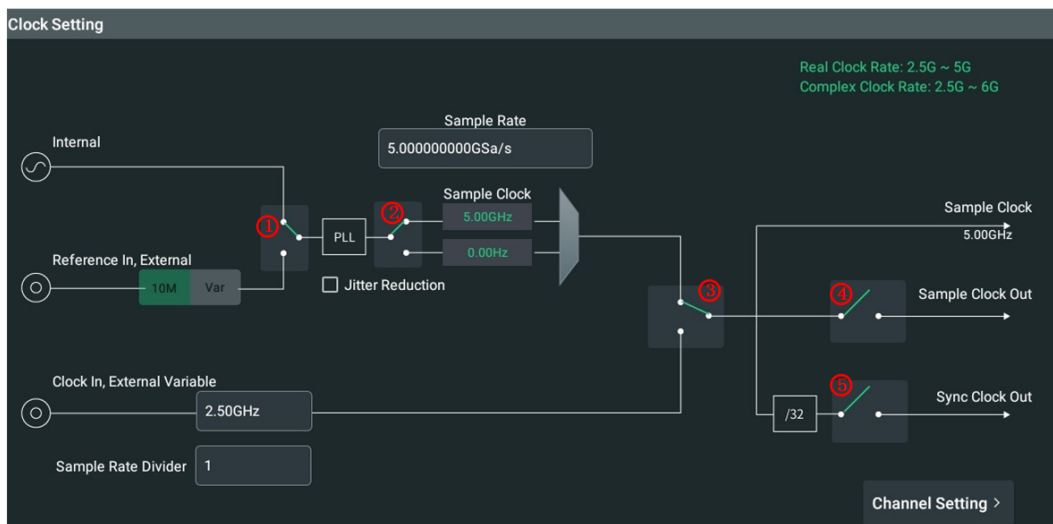


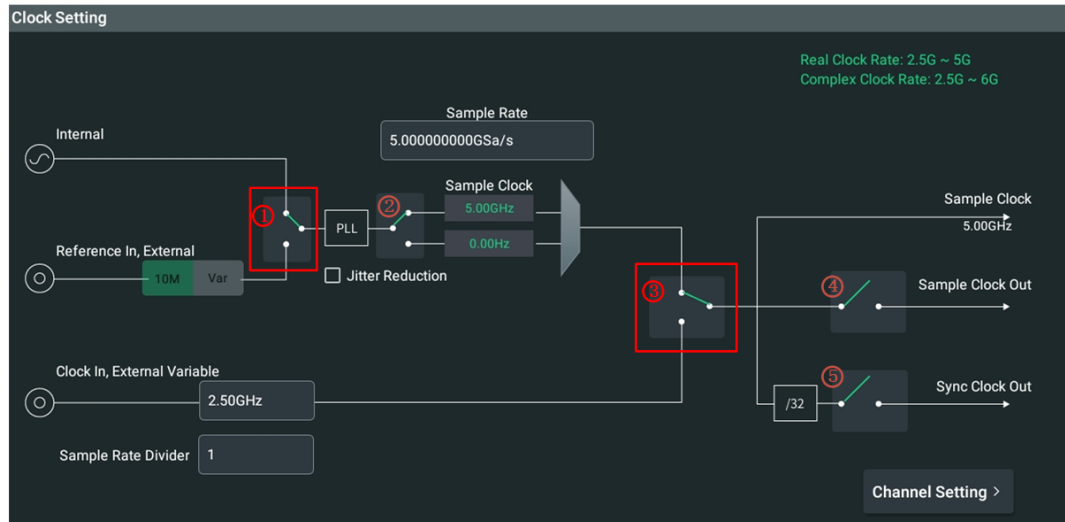
Figure 10.1 "Clock Setting" Menu

10.1 Clock and Reference Sources

DG70000 can generate internal sample clock based on internal/external reference signal, and also accept external clock signal as sample clock.

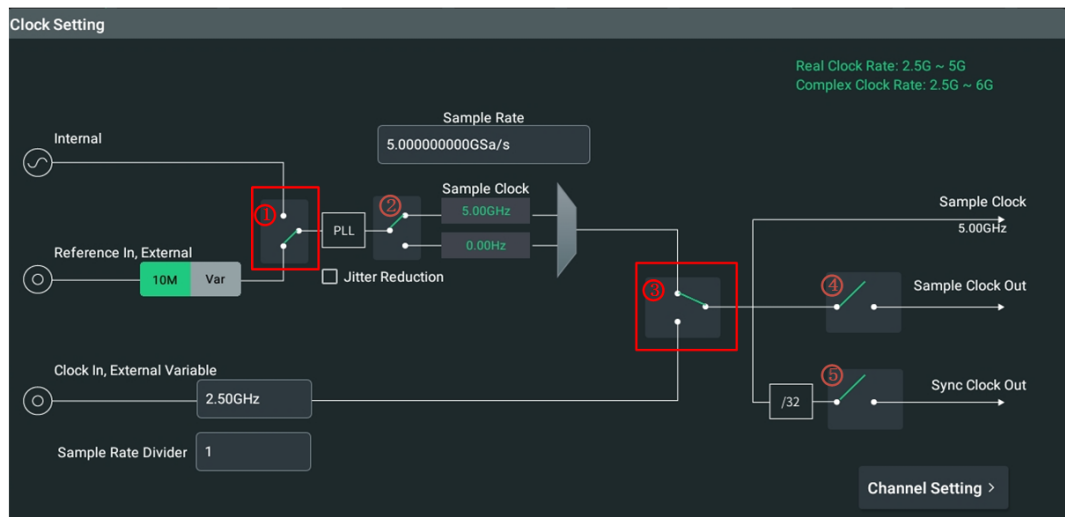
Internal Reference Clock

When both switch ① and ③ are up, the clock is derived from the instrument's internal oscillator as the reference signal. You can set your desired sample rate and the sample clock frequency is automatically generated based on the internal reference clock.



External Reference Clock

When switch ① is down and ③ up, the external clock is the reference signal of the system clock source. The instrument accepts external clock source input from the [EXT REF IN] connector on the rear panel. You can set your desired sample rate and the sample frequency is automatically generated based on the external reference clock.



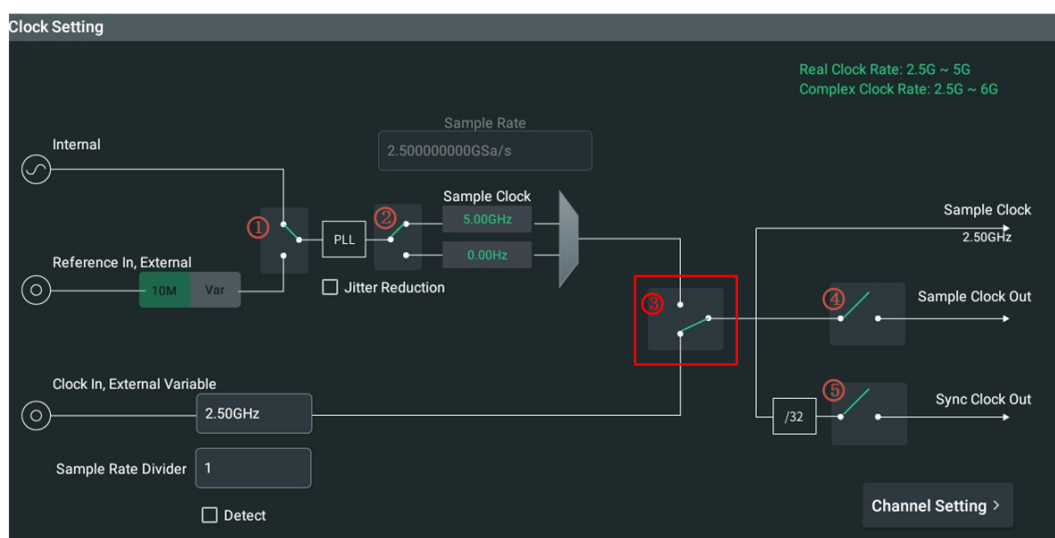
- By default, the 10 MHz signal applied to the [EXT REF IN] connector is used as a reference 10M Var.
- You can also click or tap **Var** to set the reference frequency manually 10M Var. The clock is then derived from the signal applied to the [EXT REF IN] connector.

Available reference frequency is from 35 MHz to 150 MHz. You can click or tap the input field below **Var** and set the frequency of the external reference with the pop-up numeric keypad.

Moreover, DG70000 can measure the actual frequency of the external reference signal. If the frequency of the external clock source input does not match the current set frequency, a prompt message "Ext Variable Clk Input error!" will pop up. Tick "Detect" and the actual frequency of the applied signal will be displayed.

External Sample Clock

As shown in the figure below, when the switch ③ is down, the instrument directly accepts the signal applied to the **[SCLK IN]** connector on the rear panel as the sample clock.



You need to set the frequency of the external sample clock. The available frequency ranges from 2.5 GHz to 6 GHz, and the default is 5 GHz. If the input value does not match the actual frequency of the external sample clock and exceeds the adjustable range, then the clock link is invalid and a prompt message is displayed.

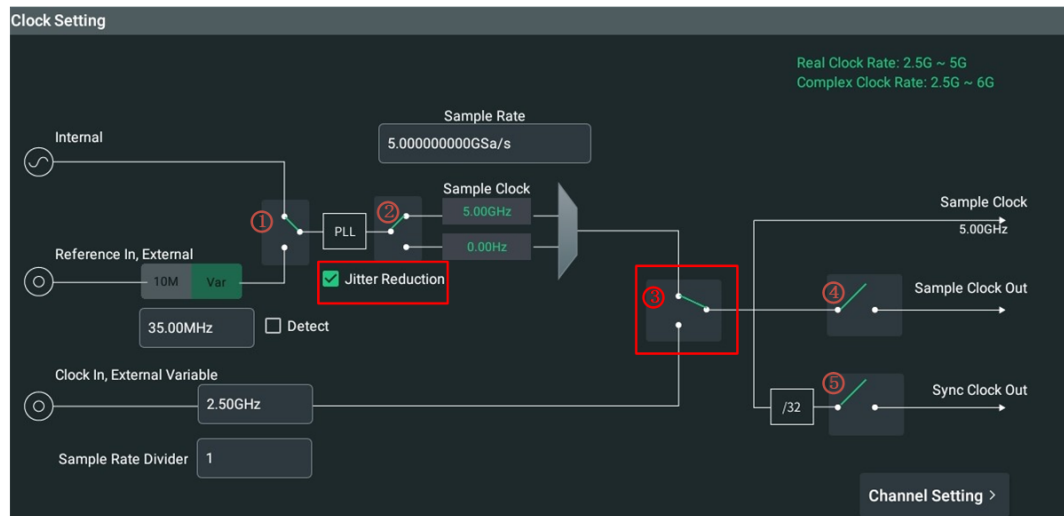
Under this circumstance, if the "Detect" function is enabled, the actual frequency will be displayed after "Detect".

Through configuring the "Sample Rate Divider" item, you can also divide the input signal to acquire different sample clocks. Click or tap the "Sample Rate Divider" input field and use the pop-up keypad to set the value (2^n) to divide the signal. The range is related to the frequency of the current external sample clock.

10.2 Jitter Reduction

As shown in the figure below, selecting to use the internal clock or an external reference (the switch ③ is up), you can tick "Jitter Reduction" to reduce the jitter through a phase-locked loop (PLL). At this point, if the internal clock or the 10 MHz

external reference is used, it is recommended to configure the sample clock to an integer multiple of 100 MHz for better results.



10.3 Sample Rate and Sample Clock

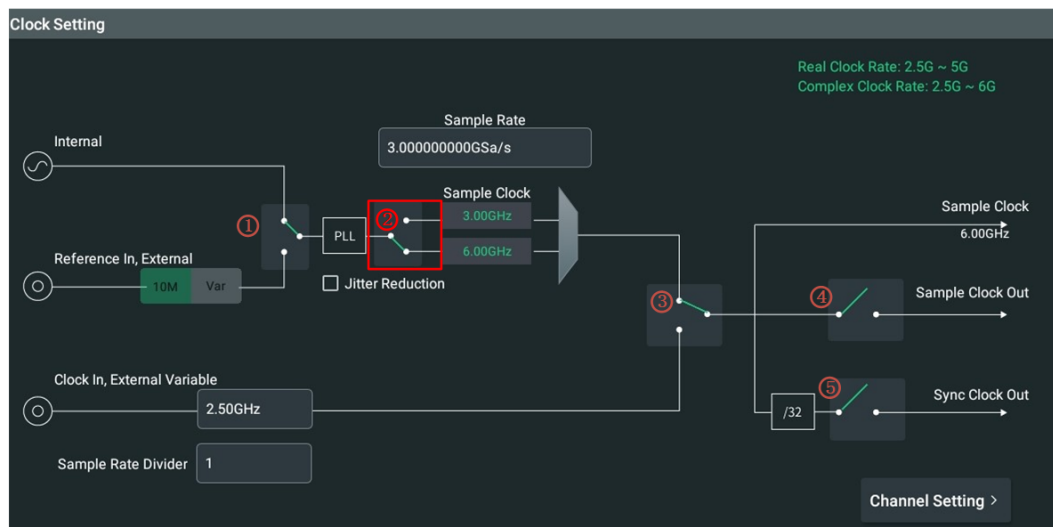
When selecting to use Internal or Reference In, External, you can set your desired sample rate. The instrument will configure the sample rate based on the reference signal. Click or tap the "Sample Rate" input field and set the rate with the pop-up numeric keypad. The value ranges between 100 Sa/s and 5 GSa/s, and the default is 5 GSa/s.

You can also use the switch ② to change the sample clock frequency. If you want the sample clock frequency to range from 5 GHz to 6 GHz, you can divide 5 GHz-6 GHz by 2^n to get the sample rate and then put switch ② down. For example, you can set the "Sample Rate" to 3 GSa/s and put switch ② down. As a result, the sample clock frequency is 6 GHz (twice the sample rate), as shown in the figure below. Through modifying the interpolation, you can make the best of the instrument's output sample rate capacity with the desired sample clock frequency.



TIP

When the sample clock frequency ranges from 5 GHz to 6 GHz, all channels will output IQ waveforms only.



10.4 Clock Output

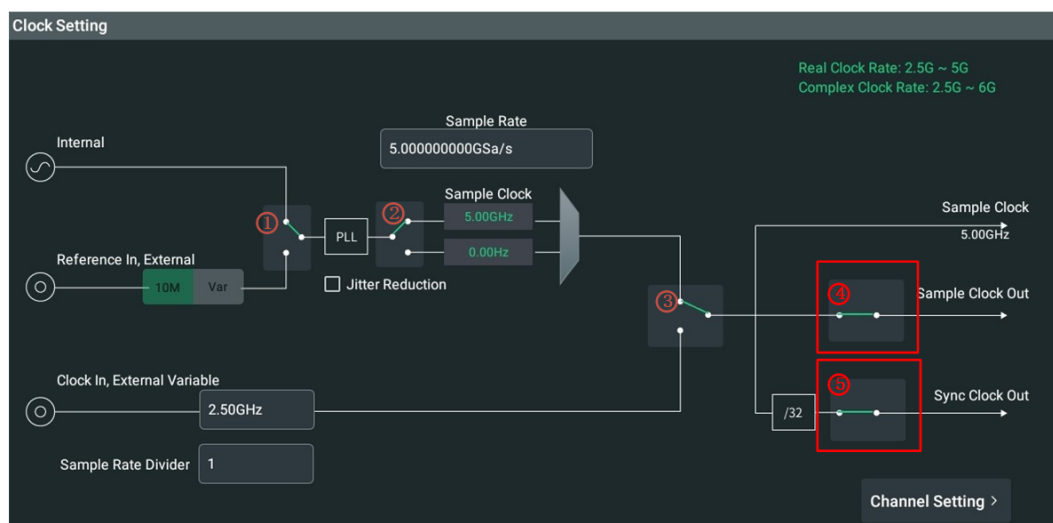
The DG70000 series enables you to make the instrument's clock frequency source available to other equipment using the following clock signals.

- **Sample Clock Output**

As shown in the figure below, when the switch ④ is closed, the instrument will directly output the system sample clock signal via the **[SCLK OUT]** connector on the rear panel. Below the "Sample Clock" item is the current Sample Clock frequency.


- **Sync Clock Output**

As shown in the figure below, when the switch ⑤ is closed, the instrument will output sync clock signal via the **[SYNC OUT]** connector on the rear panel. The Sync Clock Out frequency is 1/32th of the Sample Clock frequency.



11 Channel Setup

The DG70000 series allows you to set parameters for each analog output channel in the "Channel Setting" menu. You can access the "Channel Setting" menu in the following ways.

- Click or tap the navigation icon  at the lower-left of the screen and select **Channel**.
- Tap the **Channel** function key on the secondary touch screen.
- Click or tap any channel label at the bottom of the screen as shown in *Figure 11.1* to access the menu of the corresponding channel.

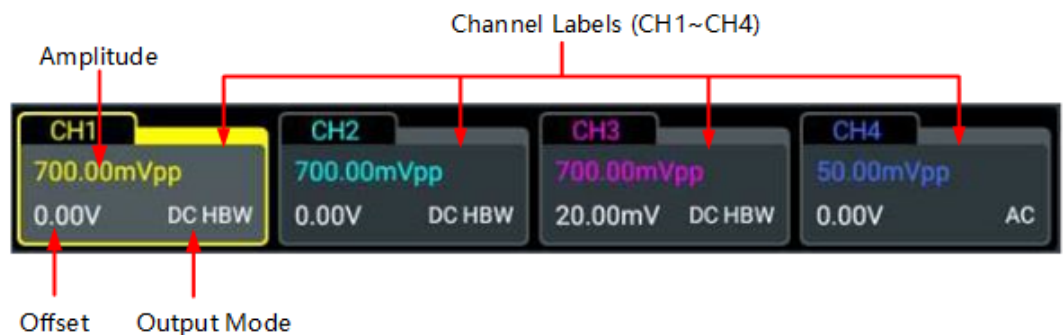


Figure 11.1 Channel Labels

The channel label displays the current output voltage amplitude, output voltage offset, and output mode.

- In *Clock Setup* menu, click or tap **Channel Setting** at the lower-right corner.

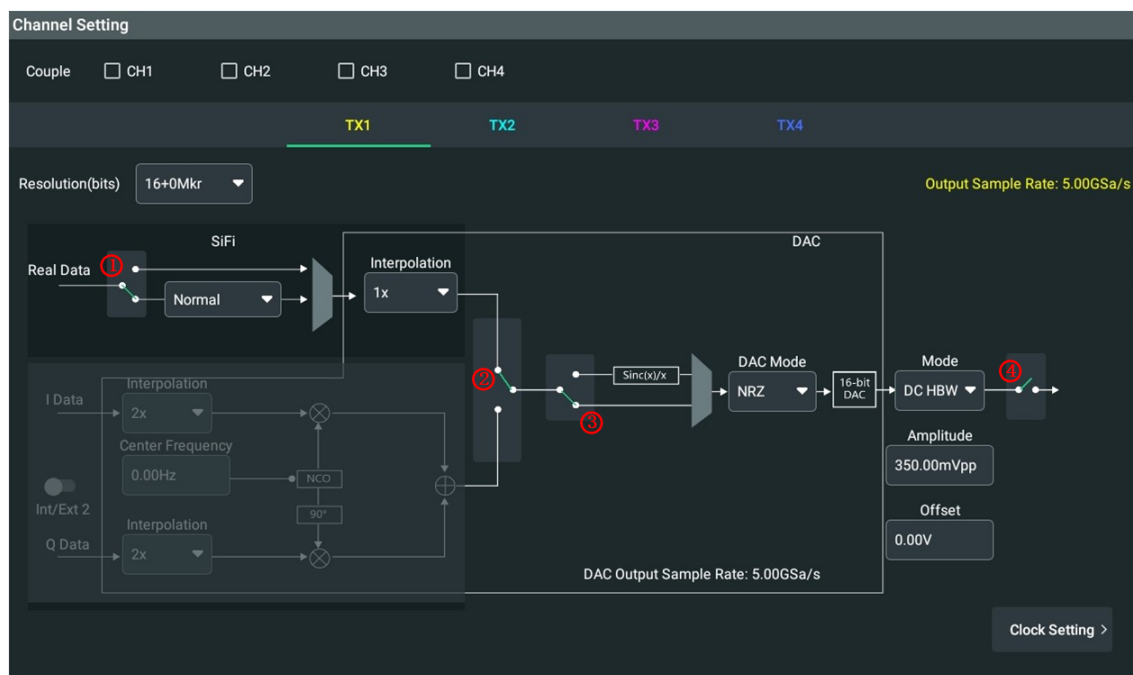


Figure 11.2 "Channel Setting" Menu

As shown in the figure above, you can switch to different channel setting menus in the following ways.

- Click or tap **TX1**, **TX2**, **TX3**, or **TX4** to switch to the setting menu of CH1, CH2, CH3, and CH4 respectively.
- Slide the configuration window left and right to switch to the configuration window of CH1, CH2, CH3, or CH4.

NOTE

As DG70002 is a two-channel model, it only supports configuration on CH1 and CH2.

Also, DG70000 provides the channel coupling function, allowing you to change settings to multiple channels simultaneously.

Channel Coupling

If you want to set the same parameters for multiple channels, you can use the channel coupling function.

For 4-channel models, you can select multiple channels to couple their settings in the "Couple" item. Once coupled, you can use one channel to make changes, which will affect other coupled channels.

For 2-channel models, you can select CH1→CH2 (CH1 settings overwritten by CH2 settings) or CH2→CH1 (CH2 settings overwritten by CH1 settings) in the "Couple" item. If the two channels have different parameter settings, the coupled channel will automatically use the settings of the reference channel after the coupling function is

enabled. Once coupled, you can use either channel to make changes, which will affect the other channel.

The coupling function makes it easier to configure the same parameters for multiple channels.

11.1 Resolution

In "Channel Setting" menu, you can set the resolution of the output waveform in the channel by setting the bits used for the waveform and the Marker.

In the drop-down menu of "Resolution", you can choose from the following:

- **16+0Mkr:** Use 16 bits for the output waveform with no bit for marker.
- **15+1Mkr:** Use 15 bits for the output waveform and one bit for a single marker-Marker 1.
- **14+2Mkr:** Use 14 bits for the output waveform and two bits for markers-Marker 1 and Marker 2.

After setting the marker bits, the channel can output analog signals via the corresponding ports on the front panel and digital signals via ports on the rear panel. The correspondence between the Marker and the ports on the rear panel is shown in the following table.

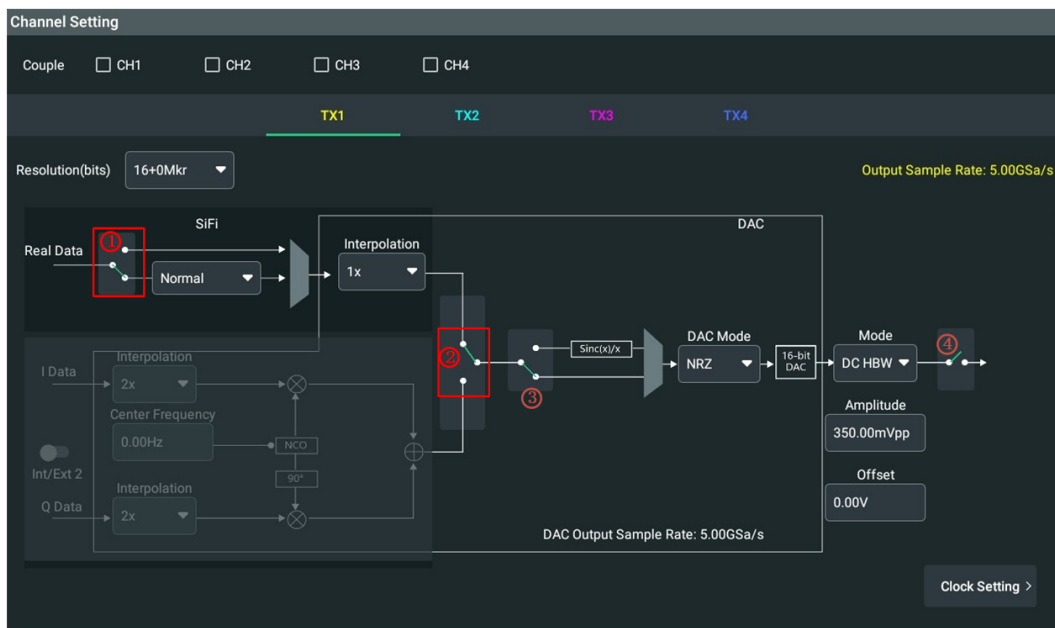
Table 11.1 Correspondence of Marker to Output Port

| | Channel 1 | Channel 2 | Channel 3 (4-channel models only) | Channel 4 (4-channel models only) |
|----------|-----------|-----------|-----------------------------------|-----------------------------------|
| Marker 1 | CH1:1 | CH2:1 | CH3:1 | CH4:1 |
| Marker 2 | CH1:2 | CH2:2 | CH3:2 | CH4:2 |

For how to configure the output digital signal of the Marker, please refer to *Marker*.

11.2 Real Waveform

As shown in the figure below, in "Channel Setting" menu, if the switch ② is up, the channel is set to output real waveforms. After setting the channel to output real waveform, you can set the SiFi mode and interpolation.



SiFi

In the "Channel Setting" menu, if the switch ① is up, the SiFi function is disabled (default); if the switch ① is down, the SiFi function is enabled, as shown in the figure above. This function allows you to output waveforms of arbitrary sample rates with high fidelity. You can select the mode in its drop-down menu. The following SiFi modes are available:

- **Normal:** It has wide and flat frequency response as well as short edge time, but the step response produces a large overshoot.
- **Step:** It has more ideal step response, narrow bandwidth, longer rise/fall time, and longer edge time.
- **Interpolation:** It guarantees the output of signals with no distortion at all.
- **Edge Adjust:** It allows you to define the edge time to create pulses with arbitrary edge time.

The Normal, Step, and Interpolation mode support different filtering bandwidth (-3dB bandwidth).

- Normal: $0.27 \times \text{Sample Rate}$
- Step: $0.13 \times \text{Sample Rate}$
- Interpolation: $0.4 \times \text{Sample Rate}$

Interpolation

The DG70000 series supports higher resolution through interpolation algorithm. You can select the interpolation factor in the drop-down menu of "Interpolation".

- **1x:** No interpolation.

- **2x**: Interpolation by a factor of 2.

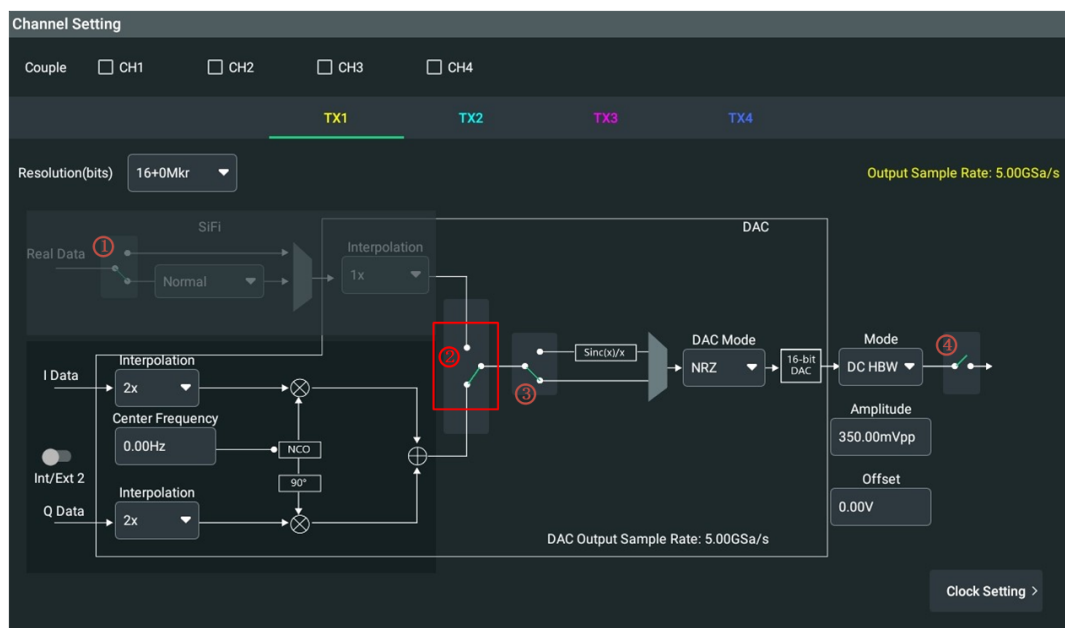
11.3 IQ Waveform (Optional)

DG70000 series supports the output of both complex waveform (IQ waveform) and real waveform. As shown in the figure below, in "Channel Setting" menu, if the switch ② is down, the channel is set to output IQ waveforms.

IQ modulation refers to the process of transmitting data by modulating two carrier signals which are orthogonal.

- **I** represents in-phase.
- **Q** represents quadrature.

An IQ waveform comprises the I-component and Q-component, two signals that have the same frequency and are 90° out of phase. As is shown in the configuration window, via a numerically controlled oscillator (NCO), the I signal integrates with a Q signal that is shifted by 90°. The two signals are orthogonal to each other and do not interfere with each other.



After setting the channel to output complex waveform, you can adjust the IQ signal before DAC.

Internal/External Modulation

Click or tap the **Int/Ext** on-off switch to toggle between internal modulation and external modulation. The two modulation modes have different data inputs. When "internal IQ modulation" is selected, the I/Q signals are generated inside the instrument; when "external IQ modulation" is selected, the I/Q signals are input

signals from **[MOD IN2]** interfaces (**[MOD IN1]** not available for now) on the rear panel.

Interpolation

In the "Interpolation" drop-down menu, you can select the interpolations of I data and Q data, which change synchronously. The interpolation of one data will change accordingly when that of the other is modified. Available interpolation includes 2×, 4×, and 8×.

The interpolation will affect the output sample rate, which can be observed through the value in "Output Sample Rate" at the upper-right corner of the menu.

TIP

When the clock frequency ranges from 2.5 GHz to 5 GHz, 2× and 4× are available; when the clock frequency exceeds 5 GHz (only for IQ mode), only 8× is available. For clock settings, please refer to [Clock Setup](#).

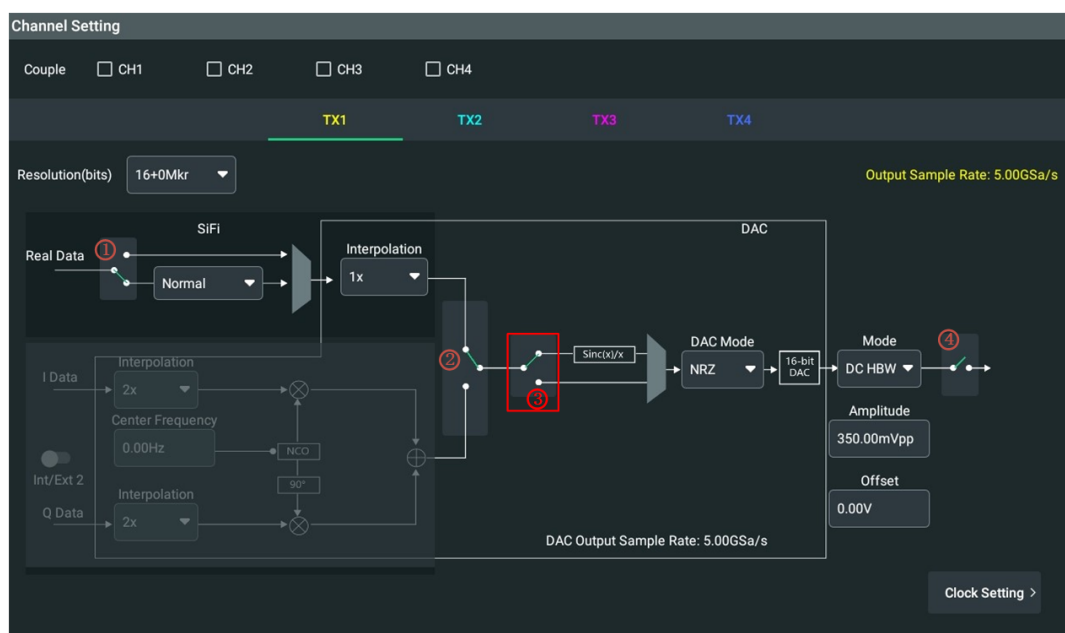
Center Frequency

Click or tap the "Center Frequency" input field to set the center frequency of NCO with the pop-up numeric keypad. The center frequency of the I/Q waveform ranges from DC to 5 GHz, and the default is 0.00 Hz.

11.4 DAC Mode

Filtering

As shown in the figure below, if the switch ③ is up, the waveform will be corrected by the $\sin(x)/x$ filter before going through the DAC. Rather, if the switch ③ is down, no filtering will be performed.



DAC Mode

In the "Channel Setting" menu, you can select the DAC mode in its drop-down menu. Available DAC modes include NRZ, RZ, and Mixed.

- **NRZ (Non-return to Zero):** non-return-to-zero line code, in which low voltage level represents logic state 0 and high voltage level represents logic state 1.
- **RZ (Return to Zero):** return-to-zero line code. During a cycle, bits of data are transmitted in binary states and the signal returns to zero after the data bit pulse. The falling edge represents 0 and the rising edge represents 1.
- **Mixed:** mixed mode. The falling edge sample is just a supplement to the rising edge sample.



TIP

- In real waveform output mode, only the NRZ mode is available when the interpolation is set to "2×".
- In IQ waveform output mode, only NRZ mode is available when the interpolation is set to "4×" or "8×".

11.5 Output Settings

Channel On/Off

As shown in *Figure 11.2*, in "Channel Setting" menu, if the switch ④ is up, the channel is disabled with no signal output. Click or tap the switch ④ to go down. Then the channel is enabled for signal output. At this time, its output connector LED indicator and the photoelectric encoders of the operating knobs on the front panel are illuminated.

Apart from the above operations, DG70000 also supports other operation methods to control the on/off state of the channel. For details, please refer to *Channel Output Control*.

Output Mode

You can select the channel output path in the "Output Mode" drop-down button.

- **DC HBW:** DC high-bandwidth output mode. For outputs via the front-panel Analog DC+ and DC- output connectors.
- **DC AMP (optional):** DC amplifier output mode. For outputs via the front-panel Analog DC+ and DC- differential output connectors. Compared with DC HBW, it provides greater amplitude range.
- **AC:** AC output mode. For outputs via the single-ended AC connector on the front panel.

Amplitude and Offset

The output mode determines the range of available amplitude and offset. The unit of output amplitude is V or dB.


- When selecting DC HBW, you can set the following parameters.
 - **Amplitude:** ranges from 350.0 mV_{pp} (default) to 700.0 mV_{pp} or from -5.14 dBm to +0.88 dBm.
 - **Offset:** ranges from -20.00 mV to 20.00 mV, and the default is 0.00 V.
- When selecting DC AMP (optional), you can set the following parameters.
 - **Amplitude:** ranges from 25.00 mV_{pp} (default) to 1.00 V_{pp} or from -28.6 dBm to +3.98 dBm.
 - **Offset:** ranges from -1.0000 V to 1.0000 V, and the default is 0.00 V.
- When selecting AC, you can set the following parameters.
 - **Amplitude:** ranges from 50.0 mV_{pp} (default) to 2.00 V_{pp} or from -22.04 dBm to +10 dBm.
 - **Offset:** ranges from -2.5000 V to 2.5000 V, and the default is 0.00 V.

To View Output Settings

You can also view the current output settings of the specified channel directly from the channel label at the bottom of the screen, as is shown in *Figure 11.1*.

12 Output Setup

In the "Output Option" menu, you can define the state of analog outputs and Marker outputs when a channel is in waiting state or when the channel is turned on but a waveform is not being played out. For more details about channel state and waveform playout status, please refer to [Channel Output Control](#). You can enter the "Output Option" menu in the following two ways.

- Click or tap  > **Output** at the lower-left of the screen.
- Tap **Output** function key on the secondary touch screen.

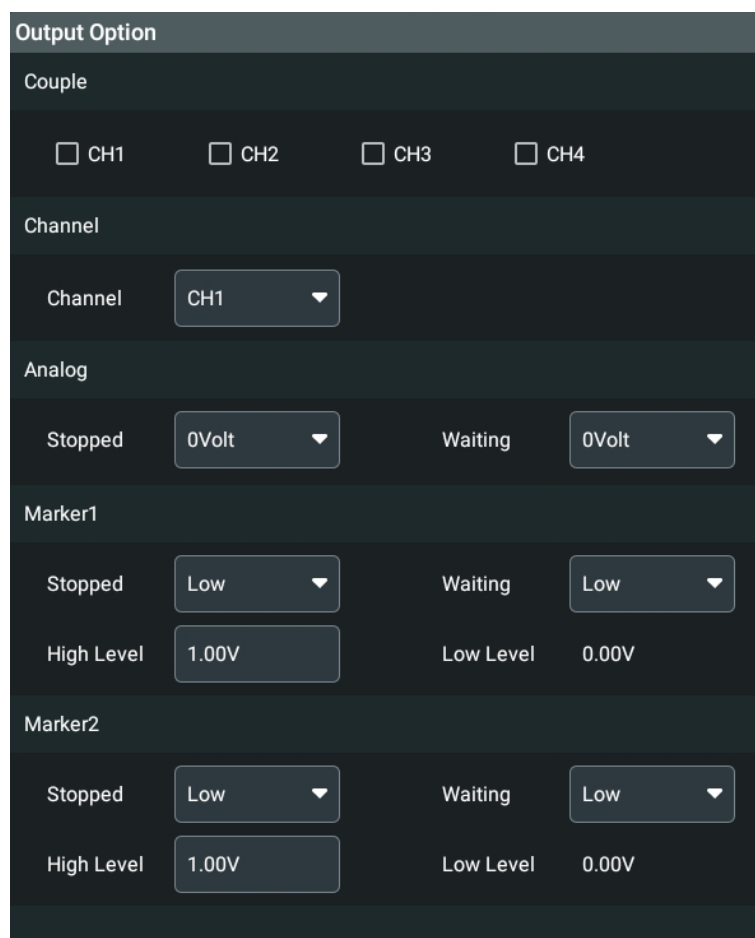


Figure 12.1 "Output Option" Menu

Channel Coupling

If you want to set the same parameters for multiple channels, you can use the channel coupling function.

For 4-channel models, you can select multiple channels to couple their settings in the "Couple" item. Once coupled, you can use one channel to make changes, which will affect other coupled channels.

For 2-channel models, you can select CH1→CH2 (CH1 settings overwritten by CH2 settings) or CH2→CH1 (CH2 settings overwritten by CH1 settings) in the "Couple" item. If the two channels have different parameter settings, the coupled channel will automatically use the settings of the reference channel after the coupling function is enabled. Once coupled, you can use either channel to make changes, which will affect the other channel.

The coupling function makes it easier to configure the same parameters for multiple channels.

Channel

Use the "Channel" pull-down menu to select which channel to control. CH1, CH2, CH3, and CH4 are available, and the default is CH1. For two-channel models, only CH1 and CH2 are available.

Once a channel is selected, the settings in the menu are only applicable to the selected channel, unless the "Couple" function is used.

Analog Output Settings

In the "Analog" output settings, you can define the state of the analog outputs when the channel is "ON", and the output is in "Stopped" or "Waiting" state.

- **Stopped State**

Set the output values in "Stopped" state when the channel is "ON".

- **0Volt:** Output is set to 0 volts.
- **OFF:** Output is disconnected. There is no electrical connection between the channel and the instrument.

- **Waiting State**

Set the output values in "Waiting" state when the channel is "ON".

- **0Volt:** Output is set to 0 volts.
- **First Point:** Output is set to the value of the first point of the waveform.

Marker1/Marker2 Output Settings

In the "Marker1"/"Marker2" output settings, you can define the state of Marker outputs when the channel is "ON", and the output is in "Stopped" or "Waiting" state. For more details, please refer to [Resolution](#).

- **Stopped State**


Set the Marker1/Marker2 output values when the channel is "ON" and the output is in "Stopped" state.

- **Low level:** Output is set to a logic low (0.00 V).

- **OFF:** Output is disconnected. There is no electrical connection between the channel and the instrument.
- **Waiting State**
Set the Marker1/Marker2 output values when the channel is "ON" and the output is in "Waiting" state.
 - **Low level:** Output is set to a logic low (0.00 V).
 - **High Level:** Output is set to a logic high. You can click or tap the input field of "High Level" and use the pop-up numeric keypad to set the value. It ranges from 200.00 mV to 1.7500 V, and the default is 1.00 V.
 - **First Point:** Output is set to the value of the first point of the marker.

13 Trigger Setup

In the "Trigger Setting" menu, you can set the parameters of a trigger source, internal or external. You can enter the "Trigger Setting" menu in the following three ways.

- Click or tap  > **Trigger**.
- Tap **Trigger** function key on the secondary touch screen.
- Click or tap the **Trigger** label at the bottom of the screen.



The label displays the interval of the current internal trigger signal.

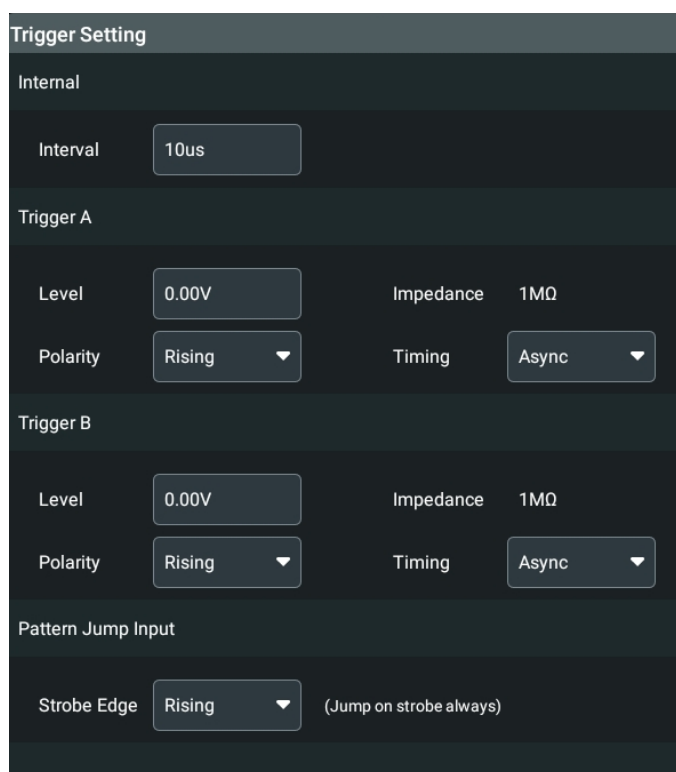


Figure 13.1 Trigger Setting Menu

Internal Trigger

When the trigger is set to "Internal", the trigger event is generated from the instrument's internal clock. Click or tap the input field and set the interval with the pop-up numeric keypad. The available range is from 10 μ s to 10 s.

Trigger A/B

- **Level:** The external trigger input signal from [TRIG A]/[TRIG B] interface must cross the set trigger level for a trigger event to occur. Click or tap the input field and use the pop-up numeric keypad to set the trigger level. The level ranges from -5.00 V to 5.00 V.
- **Impedance:** The trigger impedance is fixed to 1 MΩ.
- **Polarity:** You can set the external trigger input signal from [TRIG A]/[TRIG B] interface to cross the "Rising" or "Falling" edge of the trigger level for a trigger event to occur.
- **Timing:** Trigger Timing is the trigger timing speed in relation to the speed of the sampling clock frequency. Trigger timing is selectable between Sync (Slow) and Async (Fast) when using an external input.
 - Sync: Synchronous triggering slows the trigger clock rate to provide a longer setup time, making it easier to align timing events between instruments.
 - Async: Asynchronous triggering provides the smallest delay between the trigger event and starting the waveform payout.

Pattern Jump Input

Use the "Strobe Edge" drop-down menu to set which slope to use (rising or falling edge) of the pattern jump strobe input signal for a trigger event to occur. For more details about pattern jump, please refer to [Pattern Jump](#).

14 Synchronization Setup

DG70000 supports the synchronization of multiple analog channels. Click or tap the Sync label at the bottom of the screen to directly enter the "Sync" setting menu.

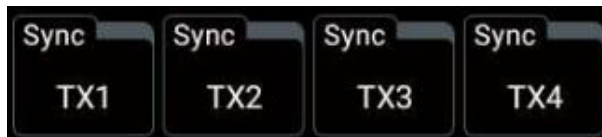


Figure 14.1 Sync Labels

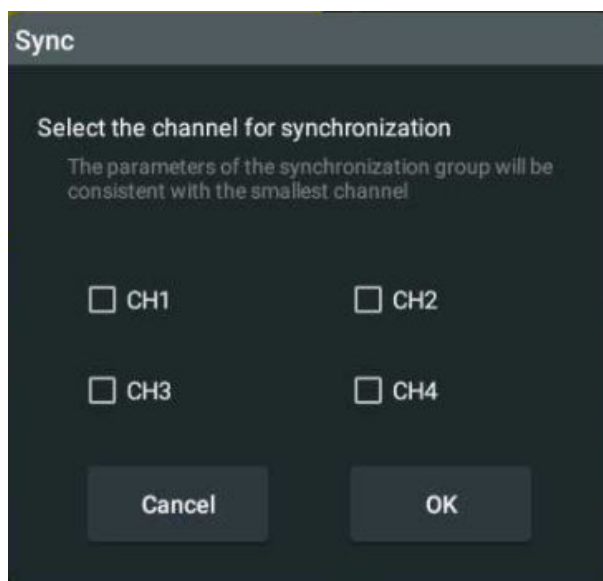


Figure 14.2 Sync Setting Menu

As shown in the figure above, you can check two or more CH boxes. For example, you can select all the channels (CH1, CH2, CH3, and CH4) and then click or tap **OK** to synchronize their outputs. After that, the Sync labels will be displayed as shown in the figure below.



Figure 14.3 All Channels Synchronized




NOTE

For two-channel models, you can simply click or tap the sync label to enable or disable the synchronization between CH1 and CH2.

For synchronized channels, their channel parameters, run mode, and trigger source change simultaneously. Click or tap **Stopped/Playing** button of any one of those channels and all channels will start playing or stop playing simultaneously. For details about channel state management, please refer to *Channel Output Control*. For channel parameter configuration, please refer to *Channel Setup*.

15 Skew Setup

In the "Skew Setting" menu, you can set the relative timing (skew) of the Marker outputs and the skew between the analog channels under situation of *Synchronization Setup*.

- Click or tap the navigation icon  at the lower-left of the screen and select **Skew**.
- Tap the **Skew** function key on the secondary touch screen.

Analog Channel Skew Settings

For multi-channel instruments, the channel outputs might not always be perfectly aligned due to many factors. In the "Skew Setting" menu, click or tap **Analog** to switch to the relative timing setting menu of the analog output and set the skew of output waveforms, as shown in the figure below.

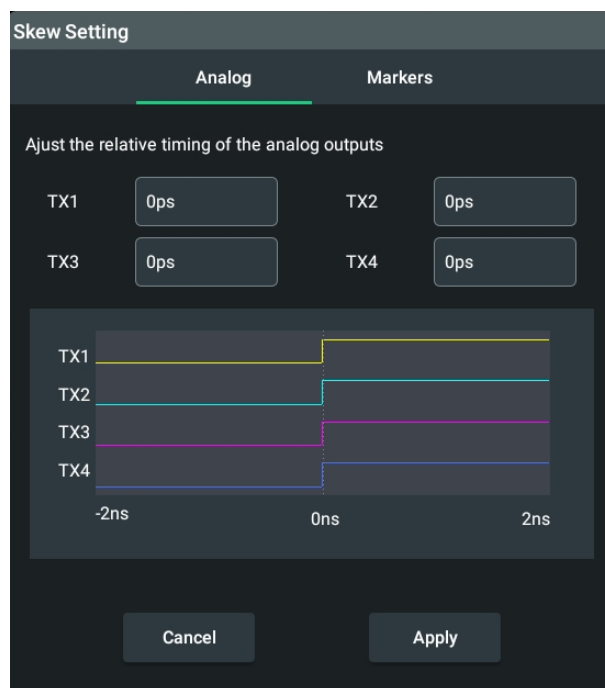


Figure 15.1 Skew Setting Menu of Analog Outputs

Click or tap the input field of a channel (TX1, TX2, TX3 or TX4) and use the pop-up numeric keypad to set the skew of analog outputs (CH1, CH2, CH3 or CH4). The skew ranges from -2.000 ns to 2.000 ns, and the default is 0 ps.

Then click or tap **Apply** to apply your settings. The skew figure of CH1, CH2, CH3, and CH4 is displayed in the lower part of the window.

**TIP**

- As DG70002 is a two-channel model, it only supports skew settings for CH1 and CH2.
- You can observe the waveform changes while adjusting the skew.

Marker Skew Settings

In the "Skew Setting" menu, click or tap **Markers** to switch to the relative timing setting menu of the Marker output. For more details about the Marker, please refer to *Resolution*.

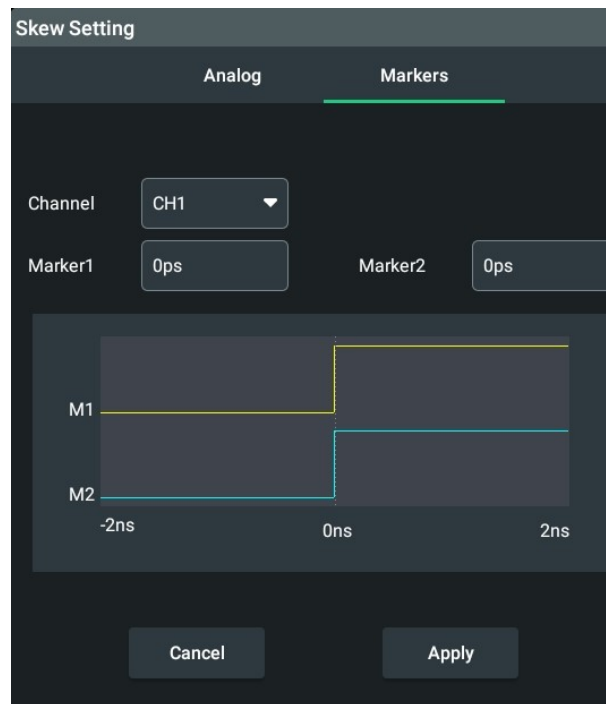


Figure 15.2 Skew Setting Menu of Marker Outputs

Use the "Channel" drop-down button to select a channel to configure.


Click or tap the input field of "Marker1" or "Marker2" and use the pop-up numeric keypad to set the skew for Marker1 or Marker2. The skew ranges from -2.000 ns to 2.000 ns, and the default is 0 ps.

Then click or tap **Apply** to apply your settings. The skew figure of Marker1 and Marker2 is displayed in the lower part of the window.

16 IQ Impairment

Ideally, the in-phase and orthogonal (I component and Q component) have equal amplitude gain and are 90° out of phase. In practical use, however, digital linear impairments such as I/Q imbalance would occur due to many factors. The impairment includes the following:

- **I/Q Offset:** A DC offset value is added to the I/Q offset with the center of signal amplitude away from 0 V.
- **I/Q Amplitude Gain Imbalance:** An I/Q gain is a multiplication of all I/Q amplitudes by a common factor. The effect is equivalent to two identical I and Q gain factors. An I gain multiplies the I amplitudes by a factor, leaving the Q amplitudes unchanged. A Q gain has the opposite effect. Different I and Q gain factors result in an I/Q imbalance.
- **Quadrature Offset:** Changes the phase angle between the I and the Q signals from the ideal 90 degrees, leaving the two signals not in quadrature.

The IQ Impairment function of DG70000 allows you to correct the IQ imbalance for input IQ signal. You can click or tap  > **IQ Impairment** to access the menu, as shown in the figure below.

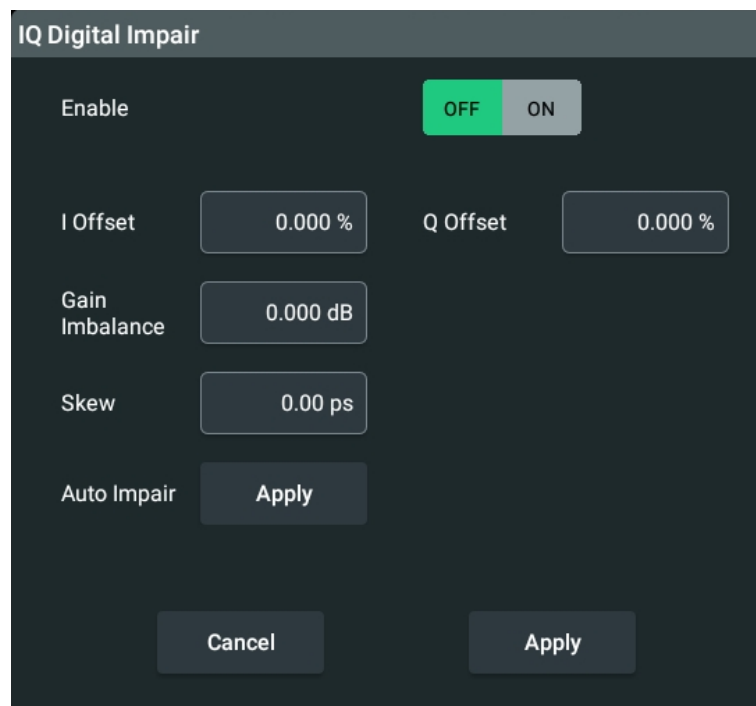


Figure 16.1 "IQ Impairment" Menu

Enable

Click or tap the "Enable" on/off button to select "ON" and the settings for this function will be applied.

I/Q Offset

You can click or tap the "I Offset"/"Q Offset" input field to set the carrier offset (in percent) of the amplitudes. The offset ranges from -10% to 10%, and the default is 0.000%.

Gain Imbalance

Click or tap the "Gain Imbalance" input field to set the imbalance of the I and Q signal. The value ranges from -2 dB to 2 dB, and the default is 0.000 dB.

TIP

1 dB offset is roughly 12% according to the following: $\text{Imbalance [dB]} = 20 \cdot \log(|\text{GainQ}|/|\text{GainI}|)$. Positive values mean that the Q vector is amplified more than the I vector by the corresponding percentage. Negative values have the opposite effect.

Skew

Click or tap the "Skew" input field to set the skew which ranges from -2 ns to 2 ns, and the default is 0 ps.

Auto Compensation

If you need to correct the IQ imbalance for your DUT, you can provide 10 MHz to 100 MHz IQ signal for the I/Q modulation input terminal (**[MOD IN2]**), and then click or tap the **Apply** of "Auto Impair". After that, the IQ imbalance is automatically adjusted and the compensation values are displayed in the menu.

Apply

You can click or tap **Apply** to apply the current settings, or **Cancel** to abandon your settings.

TIP

You can connect a spectrum analyzer to observe the signal quality during the process.


17 Storage Management

You can save the current instrument state or waveform data in internal memory/ external storage device and recall them when necessary.

DG70000 provides four USB HOST interfaces (two for front panel and two for rear panel) used to connect the USB storage device for external storage. Based on the time when USB devices detected by the USB HOST interfaces, "USB Disk (D)", "USB Disk (E)", "USB Disk (F)", and "USB Disk (G)" are displayed in the external directory. The local directory is "Local Disk (C)".

- **C Disk:** Built-in file management system with which you can perform regular file operations (similar to USB device). Its memory size is 128 GBytes.
- **D/E/F/G Disk:** When a USB device is detected, the file operations is similar to that of the C disk.

You can access the "Storage" menu in the following ways.

- Click or tap the navigation icon  at the lower-left of the screen and select **Storage**.
- Tap the **Storage** function key on the secondary touch screen.

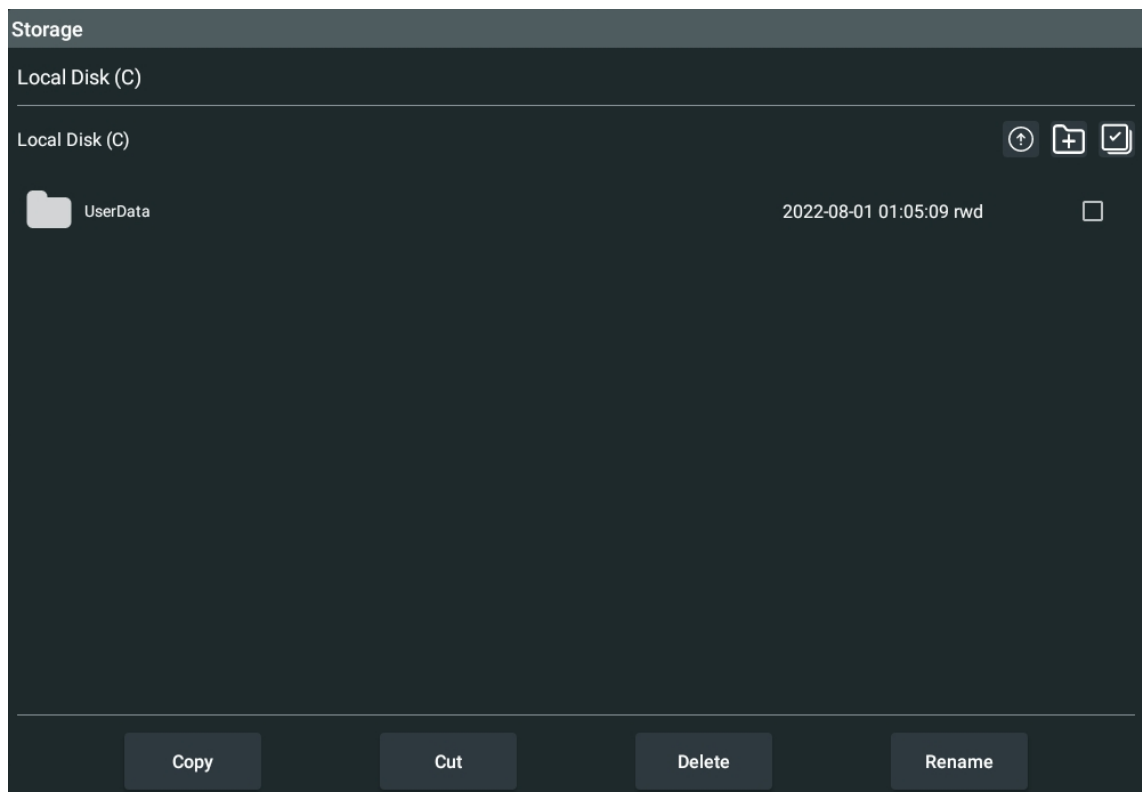


Figure 17.1 "Storage" Menu

To Select Disk

By default, the menu displays the content of "Local Disk(C)". You can switch to the external storage device in the drop-down menu of the hard disk at the upper-left side of the menu. For example, after "USB Disk(D)" is selected, the menu will display the content of the external storage device-D disk.


TIP

Before using the external storage device, please make sure that the USB storage device (FAT32/NTFS format) is properly connected.

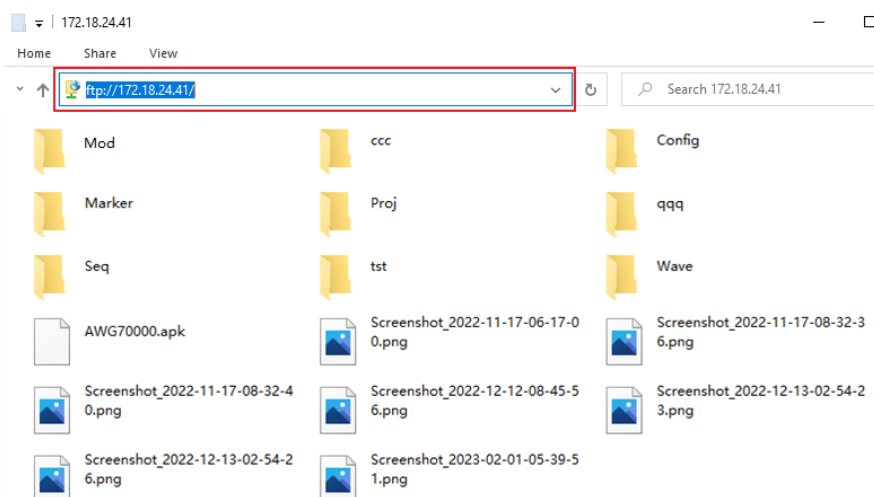
To Transfer Files with FTP

Apart from using the USB storage device, you can also use the File Transfer Protocol (FTP) to connect DG70000 to your PC, transferring files in either direction. The operation procedures are as follows:


1. Connect the instrument to your local area network (LAN).
2. Open the File Explorer on Windows and enter "ftp://nnn.nnn.nnn.nnn" in the address bar to set up the FTP connection between DG70000 and your PC.

The "nnn.nnn.nnn.nnn" is the IP address of DG70000. You can click or tap  > **Utility** > **IO** to access the address in **IP address**.


3. After the connection is established, the directory of DG70000 will appear in the pane of the File Explorer. You can upload the files in your PC to DG70000 or download the files in DG70000 into the PC.



To Create New Folder


You can create new folders in the menu. Click or tap  at the upper-right side of the menu and set the folder name with the pop-up virtual keypad. A new folder will be created under the current path with the file name.


To Check File

DG70000 supports *.jpg and *.png file formats. You can click or tap the file icon to directly open and check the file. To close the file, click or tap the  at the upper-right corner.

To Select File/Folder

You need to select the desired file/folder(s) before any further operation.

Tick the check box next to the file or folder and the box will be displayed as . You can click or tap the box again to cancel the selection.

DG70000 allows you to select multiple files or folders at once. You can click or tap  at the upper-right corner to select all files and folders under the directory; click or tap the icon again to cancel the operation.

After your selection, the number of items that you have selected will be indicated in the menu.

To Delete File/Folder

Under the current directory, select the file or folder that you want to delete. Click or tap **Delete** at the bottom of the menu. In the pop-up window, click or tap **OK** to complete the delete operation, or click or tap **Cancel** to cancel the operation.

To Cut, Copy, or Paste a File or Folder

- **To Cut a File to a Specified Directory**

Select a specified file or folder. Click or tap **Cut** and then access the target directory. Click or tap **Paste** to complete the operation.

- **To Copy a File to a Specified Directory**

Select a specified file or folder. Click or tap **Copy** and then access the target directory. Click or tap **Paste** to complete the operation.

To Rename a File or Folder

Select a specified file or folder. Click or tap **Rename** and set the name of the file or folder with the pop-up keypad.

TIP

DG70000 can only identify the file whose name contains Chinese characters or English letters (including numbers and underscores). The file or folder named by other characters cannot appear in the storage menu.



18 Import/Export

Click or tap **Import/Export** at the upper-right corner of the screen to pop up the "Import/Export" menu.

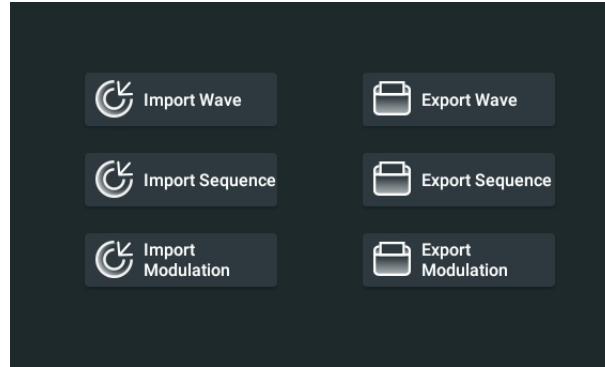


Figure 18.1 Import/Export Menu

In the "Import/Export" menu, you can import the edited waveform, modulation, or sequence files from the internal memory/external storage device to the DG70000 system, or export the files in the system to the internal memory/external storage device. Before any import/export operation with the external storage device, please make sure that the USB storage device (FAT32/NTFS format) is properly connected.

TIP

You can also click or tap **Import/Export** in the waveform/sequence/modulation interface to import or export the specified file. For details, please refer to [Waveform Management](#), [Sequence Management](#), and [Modulated Waveform Management](#).

To Import Waveform

Click or tap **Import Wave** to enter the "Import Wave" menu.



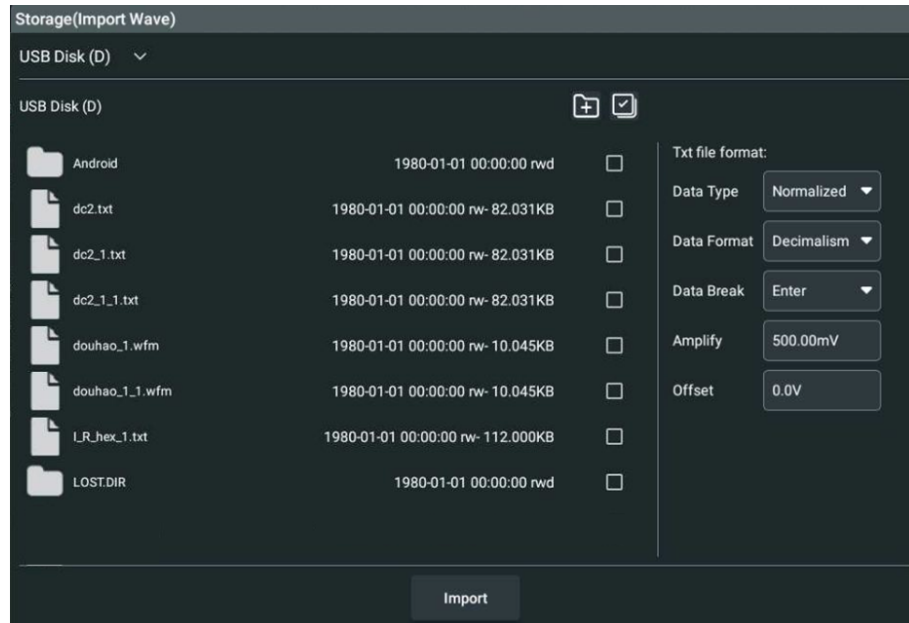


Figure 18.2 Import Wave Menu

If the imported waveform file is a TXT file, then you need to configure its data type. In the drop-down menu of "Data Type", select the data type from "Normalized" and "Volt".

- After setting the type to "Normalized", you need to perform the following operations.
 - **Data Format**
Select the data type of the imported file in the drop-down menu of "Data Format". DG70000 supports two data formats: "Decimalism" and "Hexadecimal". Please make sure that the selected data format is consistent with the format of the imported file.
 - **Data Break**
In the drop-down menu of "Data Break", select the data break of each cell data in the imported file from "Enter", ",", and ";".
 - **Amplitude**
Click or tap the input field of "Amplitude" and use the pop-up numeric keypad to set the amplitude of the imported waveform file. It ranges from 20 mV to 2.0000 V, and the default is 500.00 mV.
 - **Offset**
Click or tap the input field of "Offset" and use the pop-up numeric keypad to set the offset of the imported waveform file. It ranges from -1.0000 V to 1.0000 V, and the default is 0.0 V.

- After setting the type to "Volt", you need to configure the data break of each cell data in the imported file. In the drop-down menu of "Data Break", select the data break from "Enter", ",", and ";". Please make sure that the selected data break is consistent with that of the imported file.

Select the file that you want to import and then click or tap **Import** to complete the import operation. Then you can check the imported waveform in *Waveform Management*.

To Import Sequence/Modulation

Click or tap **Import Sequence/Import Modulation** to enter the function menu.

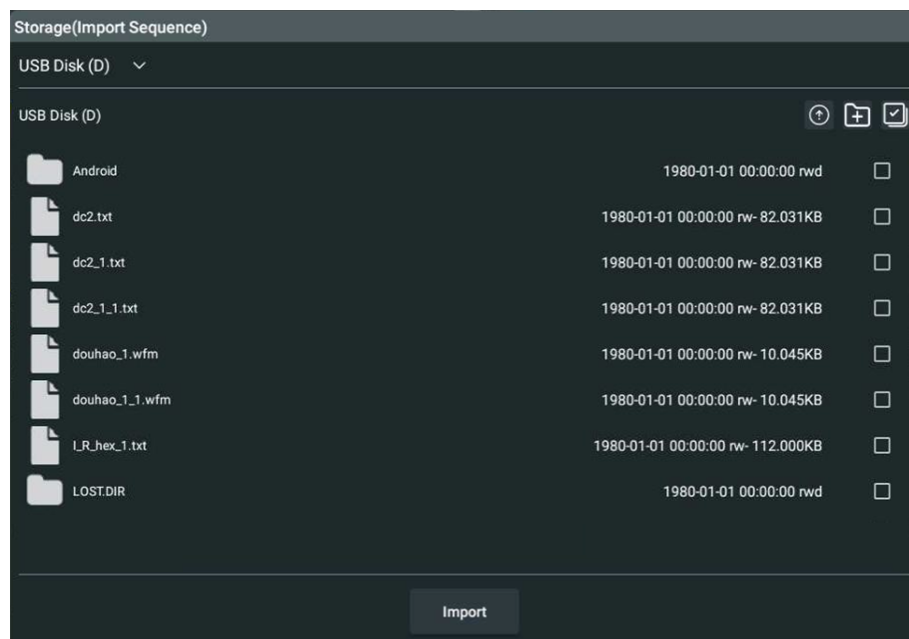


Figure 18.3 Import Sequence Menu

Select the folder and then click or tap **Import** to complete the import operation. Then you can check the imported sequence in *Sequence Management* and imported modulated waveform in *Modulated Waveform Management*.



TIP

The name of the imported sequence file (including waveform or subsequence files contained) cannot be the same as the name of any existing file in the instrument.

To Export Waveform

Click or tap **Export Wave** to enter the "Export Wave" menu.

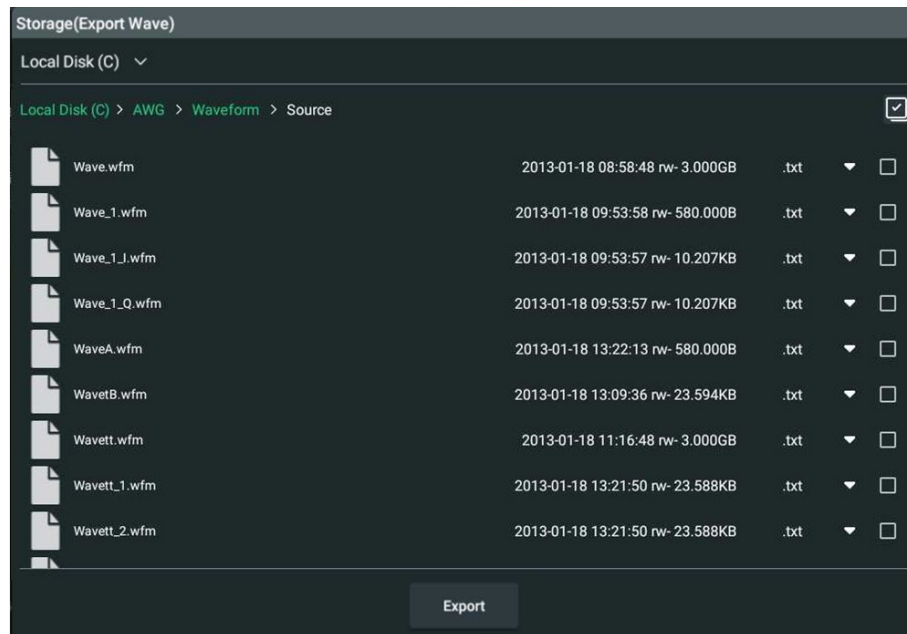


Figure 18.4 Export Waveform Menu

First of all, select the file format from ".txt" and ".wfm" in the drop-down menu. Then select the file that you want to export and then click or tap **Export**. Select the path and then click or tap **Paste** to complete the export operation. After that, you can check the exported waveform file in the directory of the internal memory/external storage device.

To Export Sequence/Modulation

Click or tap **Export Sequence/Export Modulation** to enter the function menu.

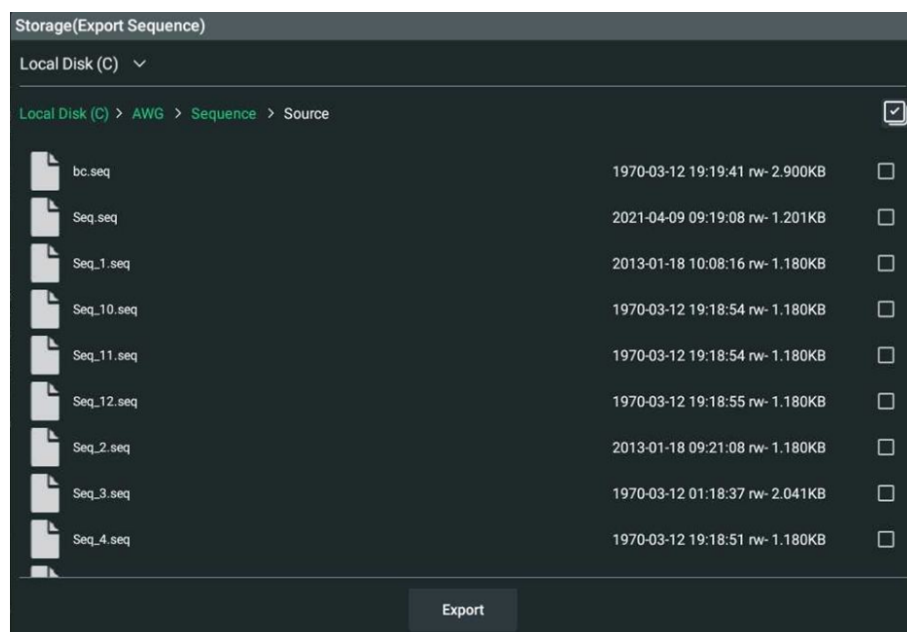



Figure 18.5 Export Sequence Menu

Then select the file that you want to export and then click or tap **Export**. Select the path and then click or tap **Paste** to complete the export operation. After that, you can check the exported file in the directory of the internal memory/external storage device.

19 System Utility Function Setting

In the **Utility** menu, you can set the I/O parameters and the system-related function parameters. To enter the "Utility" menu, perform the following operations.

- Click or tap the Notification Area at the lower-right corner of the screen. Then the **Utility** menu is displayed.
- Click or tap the function navigation icon  at the lower-left corner of the screen, then select **Utility** to enter the **Utility** menu.
- Tap the **Utility** icon on the small screen at the right side of the screen to enter the **Utility** menu.

19.1 I/O Setting

In **Utility** menu, click or tap **IO** to enter the I/O setting menu to configure the following parameters.

Network Status

Different prompts will be displayed according to the current network connection status.

- Network Config Succeeded!
- Acquiring IP...
- IP Conflict!
- DISCONNECTED!
- DHCP Config Failed
- Read Status Fail!
- CONNECTED
- Invalid IP
- IP lost
- Please wait...

MAC Address

For each instrument, the MAC address is unique. When assigning the IP address for the instrument, the system uses the MAC address to identify the instrument.

VISA Address

Displays the VISA address currently used by the instrument.

IP Configuration Type

The configuration type of the IP address can be DHCP, Auto IP, or Static IP. In different IP configuration types, the configurations for IP address and other network parameters are different.

- **DHCP**

If "DHCP" is selected, the DHCP server in the current network will assign the network parameters (e.g. IP address, Subnet, Gateway, and DNS) for the instrument.

- **Auto IP**

When "Auto IP" is selected, the instrument will acquire the IP address ranging from "169.254.0.1" to "169.254.255.254" and the subnet mask (255.255.0.0) automatically based on the current network configuration. The "Auto IP" works only when "DHCP" is not selected or connection is failed.

- **Static IP**

If "Static IP" is selected, the instrument is configured with static IP. In this case, you need to disable DHCP and Auto IP manually. Then you need to configure the parameters such as "IP address", "Subnet", "Gateway", and "DNS" manually. At this time, you can self-define the network parameters (e.g. IP address) of the instrument.

- **Set the IP address**

The format of the IP address is nnn.nnn.nnn.nnn. The range of the first segment (nnn) of the address is from 0 to 255 (except 127); wherein, the valid range is from 0 to 223. The range for the other three segments is from 0 to 255. You are recommended to ask your network administrator for an IP address available.

This setting will be saved to the non-volatile memory; if "Load Last" is set to "ON", then DHCP and Auto IP are disabled at the next power-on. The instrument will load the preset IP address automatically.

- **Set the subnet mask**

The format of the subnet mask is nnn.nnn.nnn.nnn. Wherein, the range of "nnn" is from 0 to 255. You are recommended to ask your network administrator for a subnet mask available.

This setting will be saved in the non-volatile memory; if "Load Last" is set to "ON", then DHCP and Auto IP are disabled at the next power-on. The instrument will load the preset subnet mask automatically.

- **Set the default gateway**

You can set this parameter in Static IP mode. The format of the gateway is nnn.nnn.nnn.nnn. The range of the first segment (nnn) is from 0 to 223 (except 127), and the range for the other three segments is from 0 to 255. You are recommended to ask your network administrator for a gate address available.

This setting will be saved in the non-volatile memory; if "Load Last" is set to "ON", then DHCP and Auto IP are disabled at the next power-on. The instrument will load the preset gateway automatically.

- **Set the DNS address**

You can set this parameter in Static IP mode. The format of the DNS address is "nnn.nnn.nnn.nnn". The range for the first segment (nnn) of the address is from 0 to 223 (except 127); and the range for the other three segments is from 0 to 255. You are recommended to ask your network administrator for an address available.

Generally, you do not need to set the DNS, therefore this parameter setting can be ignored.



TIP

- When the three IP configuration types are all turned on, the priority of the parameter configuration from high to low is "DHCP", "Auto IP", and "Static IP".
- The three IP configuration types cannot be all turned off at the same time.

mDNS

Click or tap the ON/OFF tab for mDNS to enable or disable the multicast Domain Name System (mDNS). This system is used to provide the function of DNS server for service discovery in a small network without a DNS server.

Host Name

If mDNS is enabled, you need to configure the mDNS host name, supporting inputting a maximum of 26-byte strings.

GPIB

When using the GPIB interface, use the USB-GPIB interface converter to extend the GPIB interface, and then use the GPIB cable to connect the instrument to the PC. Configure the GPIB address. Its settable range is from 1 to 30. By default, it is 1.

Apply the Network Parameter Setting

Click or tap **Apply** to validate the current network parameter setting.

19.2 Basic Settings

In the **Utility** menu, click or tap **Setup** to access the basic setting menu.

Language

This instrument supports two languages. Both Chinese and English are available for the display of the help information, prompt messages, and interface. Click or tap the drop-down button of **Language** to select the specified system language.

Load Last

You can set the system configuration to be recalled when the instrument is powered on again after power-off. You can use the **Load Last** switch to toggle between ON and OFF.

- ON: Loads the system setting at last power-off.
- OFF: Restores to the factory default settings.

Beeper

Click or tap the **Beeper** on/off switch to turn ON or OFF the beeper. After it is enabled, you can hear the beeper sound when the touch screen is used.

Touch Vibration



You can set whether to get the vibration feedback when you touch the secondary screen at the right side of the front panel.

Simply click or tap the **Touch Vibration** on/off switch to turn ON or OFF the vibration for touch.

Screen Lock

You can set whether to lock the touch screen. After the screen is locked, the touch screen function is disabled, for which you can no longer operate on the screen.

Click or tap the **Screen Lock** on/off switch to turn OFF the touch screen function.

Once the screen is locked, you can press the front-panel touch lock key  or local key  to unlock the screen.

ZBDBack

Click or tap the **ZBDBack** on/off switch to turn ON or OFF the backlight of the front-panel electronic label.

Date and Time

The date and time setting is displayed in the notification area at the lower-right corner of the screen. The date is displayed in "yyyy/mm/dd" format, and the time is displayed in "hh:mm:ss" format. When you save the waveform, the output file will contain the time information. You can self-define the system date and time.

- **Date:** Click or tap the "Date" area, then the date setting menu is displayed. Select a proper date, then click or tap **OK** to confirm the date modification. Otherwise, click or tap **CANCEL** to cancel date modification and exit the menu.
- **Time:** Click or tap the "Time" area, then the time setting menu is displayed.
 - Click or tap the "AM" or "PM" item at the left part of the menu to select an AM or PM time. The selected item is illuminated.
 - Click or tap the Hour/Minute number and then drag the hour/minute hand to modify the time.
 - After that, click or tap **OK** to confirm the setting. Otherwise, click or tap **CANCEL** to cancel modification and exit the menu.

19.3 About this Instrument

In **Utility** menu, click or tap **About**, and then you can view the model, version, and other information about this instrument in **About** menu.

- **Model**
Indicates the product model.
- **Serial number**
Indicates the serial number of the product, the unique identification for the product.
- **Firmware**
Indicates the firmware version number of the product.
- **Hardware**
Indicates the hardware version number of the product.
- **Build**
Indicates the creation time of the software version.
- **KUC/KUM/KUS**
Indicates the version number of each module.
- **Android.Build**
Indicates the creation time of the Android operating system.
- **Android.Version**
Indicates the version number of the Android operating system. For example, 7.1.0.
- **Launcher**
Indicates the desktop UI version number of the Android operating system.

- **WebControl**

Indicates the version number of browser remote control module.

19.4 Screen Saver

Click or tap **Screen Saver** in **Utility** to enter the Screen Saver menu. You can set the screen saver mode in this menu.

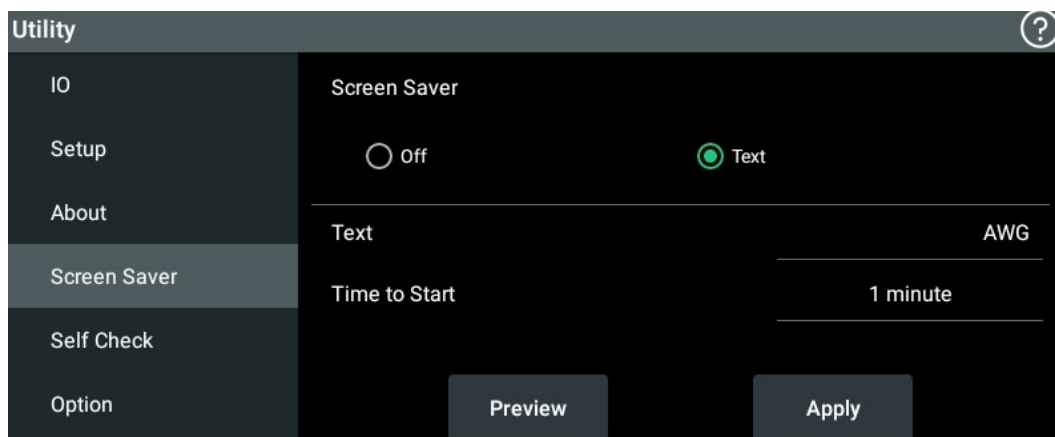


Figure 19.1 Screen Saver

- **Off:** Select "Off" to disable the screen saver function. The default is Off.
- **Text:** Select "Text" as the screen saver. Click or tap the input field of **Text** and use the pop up keypad to enter a character string. Then the screen will display the string when the instrument is idle.
- **Time to Start:** When the screen saver function is enabled, you can click or tap **Time to Start** input field and use the pop-up keypad to set the wait time, which ranges from 1 min to 999 min. The screen saver will activate if no operation is performed for more than the wait time that you set.
- **Preview:** Click or tap **Preview** to preview the screen saver setting.
- **Apply:** Click or tap **Apply** to save and apply the current settings.

19.5 Email

This instrument supports sending a file to the specified address by email. In the **Utility** menu, click or tap **Email** to configure the Email function.

1. To Set Mailbox Server

- **UserName:** Click or tap the input field of "UserName" and use the pop-up keypad to set the user name of the mailbox.

- **Password:** Click or tap the input field of "Password" and use the pop-up keypad to set the password of the mailbox.
- **SMTP:** Click or tap the input field of "SMTP" and use the pop-up keypad to set the SMTP server address. The default is smtp.qq.com.
- **Security Protocol:** Click or tap "ON" or "OFF" to enable or disable the security encryption function.
- **Default:** Click or tap **Default** to restore the Email menu to its default setting.

2. To Write Email


- **Receiver:** Click or tap the input field of "Receiver" and use the pop-up keypad to input the mailbox address of the receiver.
- **Subject:** Click or tap the input field of "Subject" and use the pop-up keypad to input the subject.
- **Content:** Click or tap the input field of "Content" and use the pop-up keypad to input the body content.
- **Attachment:** Click or tap **Browse** to upload the attachment.

3. To Send Email

Click or tap **Apply** to send the edited email to receiver.

19.6 Screen Capture

You can capture the current screen and save it in the UserData folder of internal memory by default.

- In the **Utility** menu, click or tap **Screen Capture** to enter the capture menu. Then click or tap **Screen Capture** to capture the screen.
- Click or tap **Capture** at the upper-right side of the screen to capture the screen.
- Click or tap the front-panel  to capture the screen.


19.7 Option

In the "Utility" menu, click or tap **Option** to view the option information and installation. To install options, please refer to *To View the Option Information and the Option Installation*.

20 Upgrade

DG70000 supports local upgrade and online upgrade.

Local Upgrade


1. Ensure that the USB device is correctly connected to the instrument.
2. Access the storage menu by referring to *Storage Management*.
3. Select the upgrade file and click or tap  in the menu. Then click or tap **OK** to complete the local upgrade.



TIP

When upgrading the Android operating system, use a USB storage device of FAT32 format.

Online Upgrade

1. First ensure that the rear-panel LAN interface is connected to the network (if you do not have access to the Internet, please ask the administrator to open the specified network authority).
2. Click or tap the function navigation icon  at the lower-left corner of the screen to enter the function navigation.
3. Then click or tap **Update** to perform the upgrade operation.

21 AFG Mode

The AFG mode allows you to generate continuous waves, bursts, sweeps, and modulated waveforms. With built-in standard waveforms and excellent stability, it has quick response to frequency changes.


Click or tap  at the upper-right of the interface to switch to AFG mode. The AFG mode interface is shown in the figure below.



Figure 21.1 AFG Mode Interface (4-channel Model)



Figure 21.2 AFG Mode Interface (2-channel Model)

1. Channel configuration area used to configure the output waveforms and channel parameters.
2. Screen capture key.
3. AWG mode key. Clicking or tapping the key can switch to AWG mode.
4. AFG mode key. It is lit when the instrument operates in AFG mode.
5. Channel All On/Off button. One global button to enable or disable all outputs.
6. Notification area, displaying the sound icon, USB icon, time, and LAN icon. Clicking or tapping this area can pop up the Utility menu (refer to *System Utility Function Setting*).
7. Sample rate label, displaying the current sample rate. In AFG mode, the sample rate is fixed to 10 GSa/s.
8. Clock label, displaying the clock information. You can click or tap the label to set the reference clock in AFG mode.
9. Channel labels, displaying the output mode and wave types for each channel. You can directly click or tap the specified channel label to enable/disable its output.
10. Function navigation icon. In AFG mode, you can click or tap the icon to open the function navigation in which you can access the Channel setup menu, Storage menu, Update menu, Clock setup menu, and Utility menu.

21.1 Continuous Mode

In the channel configuration area, click or tap the "Output Type" drop-down menu to select "Continuous". The Continuous Mode interface is shown in the figure below.

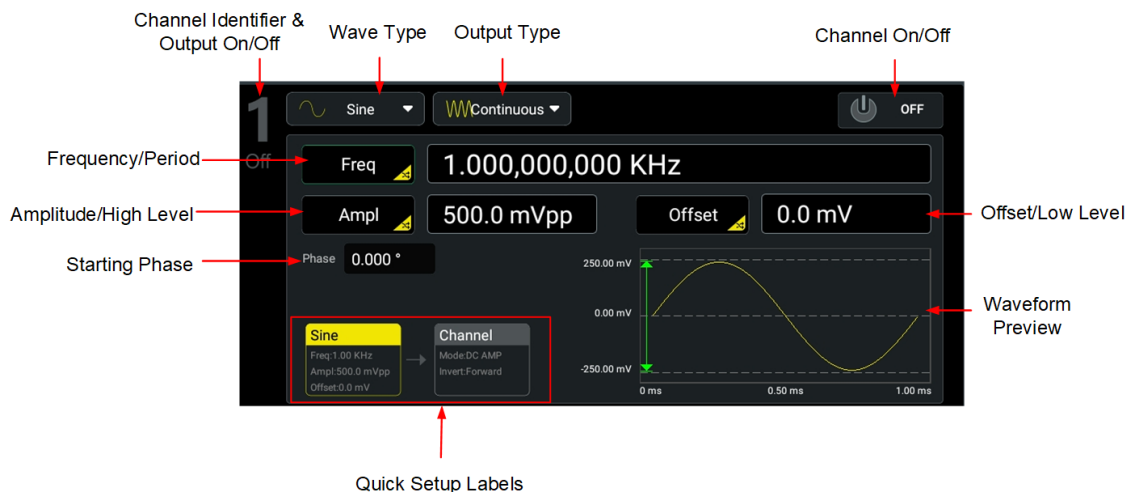


Figure 21.3 Continuous Mode Interface

After setting the output mode to "Continuous", you can configure the selected channel to output the following waveforms and then view the waveform in the waveform preview area.

- Sine Wave
- Square Wave
- Ramp Wave
- Pulse
- Noise

21.1.1 Sine Wave

In the interface as shown in *Figure 21.3*, click or tap the "Wave Type" drop-down button to select "Sine" to access the interface and create your desired sine wave.

Frequency/Period

Click or tap the **Freq/Period** button to set the parameter to "Freq". "Freq" is now active. Click or tap its input field and use the pop-up numeric keypad to set the frequency for sine wave. The available range is from 1 μ Hz to 2 GHz, and the default is 1 kHz. The resolution is 1 μ Hz.

You can click or tap the button again to toggle the parameter to "Period", which ranges from 500 ps to 1000 ks. The resolution is 1 ps.

Amplitude/High Level

Click or tap the **Ampl/HighL** button to set the parameter to "Ampl". "Ampl" is now active. Click or tap its input field and use the pop-up numeric keypad to set the amplitude for sine wave. The available range is from 25 mV to 1 V, and the default is 500 mVpp. The resolution is 0.1 mVpp.

You can click or tap the button again to toggle the parameter to "HighL". The high level ranges from -987.5 mV to 1.5 V, which is related to the low level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.

Offset/Low Level

Click or tap the **Offset/LowL** button to set the parameter to "Offset". "Offset" is now active. Click or tap its input field and use the pop-up numeric keypad to set the offset for sine wave. The available range is from -1 V to 1 V, and the default offset is 0 mV. The resolution is 0.1 mV.

You can click or tap the button again to toggle the parameter to "LowL". The low level ranges from -1.5 V to 987.5 mV, which is related to the high level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.


TIP

The "Ampl" and "Offset" buttons appear at the same time, so are the "HighL" and "LowL" buttons. For example, selecting "Offset" automatically toggles the "Ampl/HighL" parameter to "Ampl".

Starting Phase


Click or tap the "Phase" input field to set the starting phase, which ranges from 0° to 360°. The default phase is 0°, and the resolution is 0.001°.

Channel Setup

Click or tap the "Channel" quick setup label in the interface as shown in *Figure 21.3* to configure channel output. You can also click or tap  > **Channel**. For details, please refer to *Channel Setup*.

To Enable Channel Output

After setting the waveform parameters, you can turn on the specified channel to enable waveform output in the following ways.

- Click or tap the channel label at the bottom of the screen.
- Click or tap  > **Channel** > **Output** and select a channel to control. Click or tap the "Output" button to set the parameter to **ON**.
- Click or tap the All On/Off button at the upper-right corner of the AFG interface to enable all channel outputs; click or tap the On/Off button in the specified channel configuration area to enable individual channel output.

- Press the front-panel channel On/Off key to turn on the specified channel.

21.1.2 Square Wave

In the interface as shown in *Figure 21.3*, click or tap the "Wave Type" drop-down button to select "Square" to access the interface and create your desired square wave.

Frequency/Period

Click or tap the **Freq/Period** button to set the parameter to "Freq". "Freq" is now active. Click or tap its input field and use the pop-up numeric keypad to set the frequency for square waveform. The available range is from 1 μ Hz to 500 MHz, and the default is 1 kHz. The resolution is 1 μ Hz.

You can click or tap the button again to toggle the parameter to "Period", which ranges from 2 ns to 1000 ks. The resolution is 1 ps.

Amplitude/High Level

Click or tap the **Ampl/HighL** button to set the parameter to "Ampl". "Ampl" is now active. Click or tap its input field and use the pop-up numeric keypad to set the amplitude for square waveform. The available range is from 25 mV to 1 V, and the default is 500 mVpp. The resolution is 0.1 mVpp.

You can click or tap the button again to toggle the parameter to "HighL". The high level ranges from -987.5 mV to 1.5 V, which is related to the low level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.

Offset/Low Level

Click or tap the **Offset/LowL** button to set the parameter to "Offset". "Offset" is now active. Click or tap its input field and use the pop-up numeric keypad to set the offset for square waveform. The offset ranges from -1 V to 1 V, and the default offset is 0 mV. The resolution is 0.1 mV.

You can click or tap the button again to toggle the parameter to "LowL". The low level ranges from -1.5 V to 987.5 mV, which is related to the high level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.

TIP

The "Ampl" and "Offset" buttons appear at the same time, so are the "HighL" and "LowL" buttons. For example, selecting "Offset" automatically toggles the "Ampl/HighL" parameter to "Ampl".

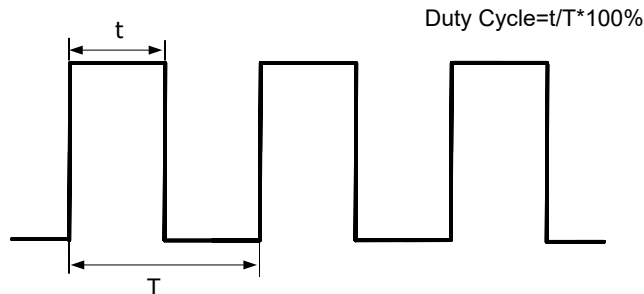
Starting Phase

Click or tap the "Phase" input field to set the starting phase, which ranges from 0° to 360°. The default phase is 0°, and the resolution is 0.001°.




Duty Cycle

Duty cycle represents the amount of time per period that the square wave is at a high level, as shown in the figure below. The "Duty" parameter setting only appears when "Square" or "Pulse" is selected.



Click or tap the "Duty" input field to set the duty cycle, which ranges from 0.001% to 99.999% (depending on the Period). The default value is 50%, and the resolution is 0.001%.

Channel Setup

Click or tap the "Channel" quick setup label in the interface as shown in [Figure 21.3](#) to configure channel output. You can also click or tap  > **Channel**. For details, please refer to [Channel Setup](#).

To Enable Channel Output

Please refer to [Channel On/Off](#).

21.1.3 Ramp Wave

In the interface as shown in [Figure 21.3](#), click or tap the "Wave Type" drop-down button to select "Ramp" to access the interface and create your desired ramp wave.

Frequency/Period

Click or tap the **Freq/Period** button to set the parameter to "Freq". "Freq" is now active. Click or tap its input field and use the pop-up numeric keypad to set the frequency for ramp waveform. The available range is from 1 μHz to 50 MHz, and the default is 1 kHz. The resolution is 1 μHz .

You can click or tap the button again to toggle the parameter to "Period", which ranges from 20 ns to 1000 ks. The resolution is 1 ps.

Amplitude/High Level

Click or tap the **Ampl/HighL** button to set the parameter to "Ampl". "Ampl" is now active. Click or tap its input field and use the pop-up numeric keypad to set the amplitude for ramp waveform. The default amplitude is 500 mVpp, and the resolution is 0.1 mVpp.

You can click or tap the button again to toggle the parameter to "HighL". The high level ranges from -987.5 mV to 1.5 V, which is related to the low level currently set: $25 \text{ mV} \leq (\text{High Level}-\text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level}+\text{Low Level}| \leq 2 \text{ V}$.

Offset/Low Level

Click or tap the **Offset/LowL** button to set the parameter to "Offset". "Offset" is now active. Click or tap its input field and use the pop-up numeric keypad to set the offset for ramp waveform. The available range is from -1 V to 1 V, and the default offset is 0 mV. The resolution is 0.1 mV.

You can click or tap the button again to toggle the parameter to "LowL". The low level ranges from -1.5 V to 987.5 mV, which is related to the high level currently set: $25 \text{ mV} \leq (\text{High Level}-\text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level}+\text{Low Level}| \leq 2 \text{ V}$.



TIP

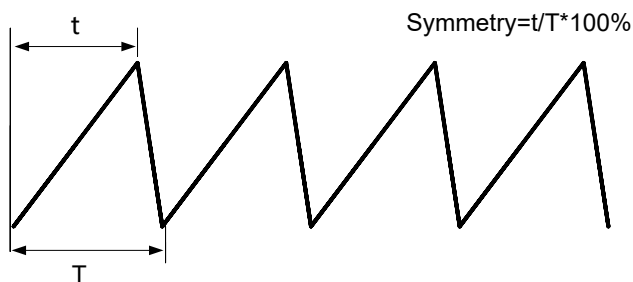
The "Ampl" and "Offset" buttons appear at the same time, so are "HighL" and "LowL" buttons. For example, selecting "Offset" automatically toggles the "Ampl/HighL" parameter to "Ampl".

Starting Phase

Click or tap the "Phase" input field to set the starting phase, which ranges from 0° to 360° . The default phase is 0° , and the resolution is 0.001° .


Symmetry

Symmetry is defined as the percentage of the amount of time Ramp wave is rising in the period, as shown in the figure below. It only appears when "Ramp" is selected.



Click or tap the "Symm" input field to set the symmetry, which ranges from 0% to 100%. The default value is 50%, and the resolution is 0.001%.

Channel Setup

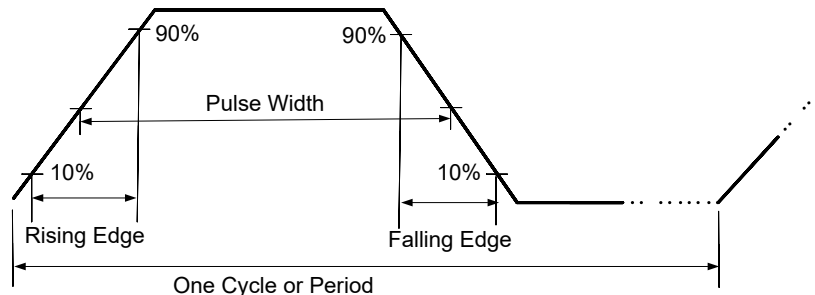
Click or tap the "Channel" quick setup label in the interface as shown in [Figure 21.3](#) to configure channel output. You can also click or tap  > **Channel**. For details, please refer to [Channel Setup](#).

To Enable Channel Output

Please refer to [Channel On/Off](#).

21.1.4 Pulse

In the interface as shown in [Figure 21.3](#), click or tap the "Wave Type" drop-down button to select "Pulse" to access the interface and set your desired pulse wave. In addition to basic parameters (e.g. Frequency, Amplitude, Offset, Starting Phase, High Level, Low Level) mentioned before, you also need to set the "Pulse Width/Duty Cycle", "Rising Edge", and "Falling Edge".



Frequency/Period

Click or tap the **Freq/Period** button to set the parameter to "Freq". "Freq" is now active. Click or tap its input field and use the pop-up numeric keypad to set the frequency for pulse waveform. The available range is from 1 μ Hz to 500 MHz, and the default is 1 kHz. The resolution is 1 μ Hz.

You can click or tap the button again to toggle the parameter to "Period", which ranges from 2 ns to 1000 ks. The resolution is 1 ps.

Amplitude/High Level

Click or tap the **Ampl/HighL** button to set the parameter to "Ampl". "Ampl" is now active. Click or tap its input field and use the pop-up numeric keypad to set the amplitude for pulse waveform. The available range is from 25 mV to 1 V, and the default is 500 mVpp. The resolution is 0.1 mVpp.

You can click or tap the button again to toggle the parameter to "HighL". The high level ranges from -987.5 mV to 1.5 V, which is related to the low level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.

Offset/Low Level

Click or tap the **Offset/LowL** button to set the parameter to "Offset". "Offset" is now active. Click or tap its input field and use the pop-up numeric keypad to set the offset for pulse waveform. The available range is from -1 V to 1 V, and the default offset is 0 mV. The resolution is 0.1 mV.

You can click or tap the button again to toggle the parameter to "LowL". The low level ranges from -1.5 V to 987.5 mV, which is related to the high level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.

**TIP**

The "Ampl" and "Offset" buttons appear at the same time, so are "HighL" and "LowL" buttons. For example, selecting "Offset" automatically toggles the "Ampl/HighL" parameter to "Ampl".

Starting Phase

Click or tap the "Phase" input field to set the starting phase, which ranges from 0° to 360°. The default phase is 0°, and the resolution is 0.001°.

Pulse Width/Duty Cycle

Pulse width is the time from the 50% threshold of a pulse's rising edge to the 50% threshold of the next falling edge, as shown in the figure above. The pulse duty cycle is defined as the percentage of the pulse width to the pulse period. Changing one of them automatically modifies the other.

Click or tap the **Width/Duty** button to set the parameter to "Width". "Width" is now active. Click or tap its input field and use the pop-up numeric keypad to set the pulse width. The available range is from 640 ps to 999.99 ks, and the default is 500 μs. The resolution is 1 ps.

**TIP**

The pulse width must conform to the following restrictions determined by the period and the minimum pulse width (W_{min} : 640 ps).

- Pulse Width \geq Minimum Pulse Width. When the period is greater than 1.64 μs, Pulse Width \geq Pulse Period/2560.
- Pulse Width \leq Period-Minimum Pulse Width

You can click or tap the button again to toggle the parameter to "Duty", which ranges from 0.001% to 99.999%. The default is 50% and the resolution is 0.001%.

**TIP**

The pulse duty cycle must conform to the following restrictions determined by the minimum pulse width and the period.

- Duty Cycle \geq (Minimum Pulse Width/Period)*100%
- Duty Cycle \leq (1-Minimum Pulse Width/Period)*100%

Rising/Falling Edge


The rising edge time is the transition time for the rising edge of a pulse from 10% and 90% threshold; falling edge time is the transition time for the falling edge of a pulse from 90% to 10% threshold.

Click or tap the corresponding input field and use the pop-up numeric keypad to set the rising/falling edge time. The rising (falling) edge time ranges from 300 ps to 1 s, and the default is 300 ps. The resolution is 1 ps.

**TIP**

The rising/falling edge time must fit within the current pulse width: Rising (Falling) Edge Time $\leq 0.625 \times$ Pulse Width.

Channel Setup

Click or tap the "Channel" quick setup label in the interface as shown in *Figure 21.3* to configure channel output. You can also click or tap  > **Channel**. For details, please refer to *Channel Setup*.

To Enable Channel Output

Please refer to *Channel On/Off*.

21.1.5 Noise

In the interface as shown in *Figure 21.3*, click or tap the "Wave Type" drop-down button to select "Noise" to access the interface and create your desired noise.

Amplitude/High Level

Click or tap the **Ampl/HighL** button to set the parameter to "Ampl". "Ampl" is now active. Click or tap its input field and use the pop-up numeric keypad to set the amplitude for noise. The available range is from 25 mV to 1 V, and the default is 500 mVpp. The resolution is 0.1 mVpp.

You can click or tap the button again to toggle the parameter to "HighL". The high level ranges from -987.5 mV to 1.5 V, which is related to the low level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.

Offset/Low Level

Click or tap the **Offset/LowL** button to set the parameter to "Offset". "Offset" is now active. Click or tap its input field and use the pop-up numeric keypad to set the offset for noise. The available range is from -1 V to 1 V, and the default offset is 0 mV. The resolution is 0.1 mV.

You can click or tap the button again to toggle the parameter to "LowL". The low level ranges from -1.5 V to 987.5 mV, which is related to the high level currently set: $25 \text{ mV} \leq (\text{High Level} - \text{Low Level}) \leq 1 \text{ V}$, and $|\text{High Level} + \text{Low Level}| \leq 2 \text{ V}$.

**TIP**

The "Ampl" and "Offset" buttons appear at the same time, so are the "HighL" and "LowL" buttons. For example, selecting "Offset" automatically toggles the "Ampl/HighL" parameter to "Ampl".

Channel Setup

For details, please refer to *Channel Setup*.

To Enable Channel Output

Please refer to *Channel On/Off*.

21.2 Burst Mode

DG70000 allows you to configure the instrument to output a waveform for a specified number of cycles, called a burst. The instrument can output a burst using standard waveforms such as sine, square, ramp, or pulse. When "Sine" wave is selected, the Sine frequency ranges from 1 μ Hz to 1 GHz.

In the channel configuration area, click or tap the "Output Type" drop-down menu to select "Burst" and access the interface as shown in the figure below. You can click or tap one of the Quick Setup labels to access the Continuous Mode, Burst Mode, or Channel Setup menu. For Continuous Mode and Channel Setup, please refer to *Continuous Mode* and *Channel Setup*. This section only describes the Burst Mode.

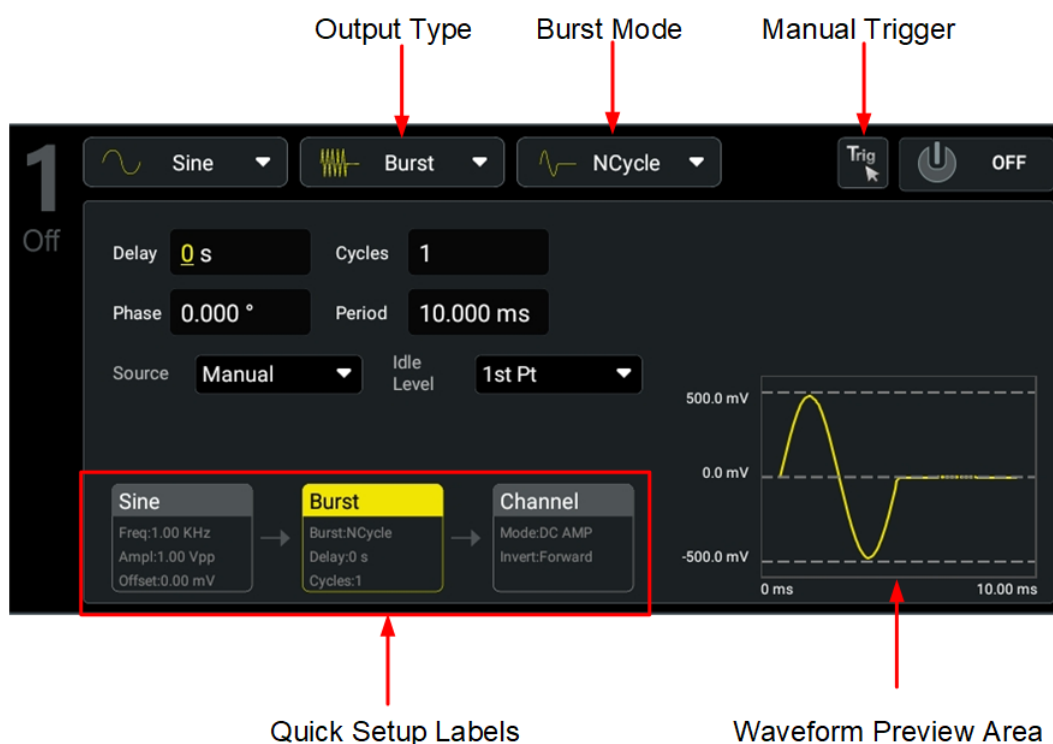


Figure 21.4 Burst Mode Interface

21.2.1 Burst Type

DG70000 allows you to use burst in one of two modes: N-Cycle Burst (default) or Infinite Burst.

N-Cycle Burst Waveform

The instrument outputs a waveform for specified number of cycles (burst count) each time trigger is received. After completing the specified number of cycles, the instrument stops the output and waits for the next trigger event. You can use sine, square, ramp, and pulse to create a N-Cycle burst waveform.

Infinite Burst Waveform

You can also set the cycles to "Infinite", which results in a continuous waveform once the instrument is triggered. You can use sine, square, ramp, and pulse to create an Infinite burst waveform.

The table below illustrates the trigger source and waveform parameters available for the two burst modes.

| Burst Type | Trigger Source | Waveform Parameters |
|-------------------------|-------------------------|--|
| N-Cycle Burst Waveform | Internal/Manual Trigger | Delay (for manual trigger only), Phase, Cycles, Period, Trigger Source, Idle Level |
| Infinite Burst Waveform | Manual Trigger | Delay, Phase, Trigger Source, Idle Level |

21.2.2 Burst Count

It sets the number of times to be output per burst (N-Cycle mode only). Click or tap the "Cycles" input field and use the pop-up numeric keypad to set the cycles.

- When the "Source" is set to "Internal", it ranges from 1 to 500k; when the "Source" is set to "Manual", it ranges from 1 to 1M. The default is 1.
- $\text{Burst Count} \leq (\text{Burst Period} - 1 \mu\text{s}) * \text{Waveform Frequency}$.
- If you change the burst count, the instrument automatically increases the burst period to accommodate the burst count (but the waveform frequency will not be changed).

21.2.3 Burst Delay

The burst delay setting is available for N-Cycle and Infinite mode only when the trigger source is set to "Manual". It is defined as the duration from the time when the instrument receives the trigger signal to the time when it starts to output the N-Cycle (or Infinite) burst.

Click or tap its input field and use the pop-up numeric keypad to set the delay. The available range is from 0 s to 500 s, and the default is 0 ps. The resolution is 1 ps.

21.2.4 Burst Phase

Burst phase is defined as the point at which the burst begins. Click or tap its input field and use the pop-up numeric keypad to set the phase. It ranges from 0° to 360°, and the default is 0°. The resolution is 0.001°.

21.2.5 Burst Period


It is defined as the time from the start of a burst to the time when the next burst starts.

You can click or tap its input field and use the pop-up numeric keypad to set the period. The available range is from 1 μs to 500 s, and the default is 10 ms. The resolution is 1 μs.

- The burst period must satisfy the following formula: $\text{Burst Period} \geq \text{Burst Count} / \text{Waveform Frequency} + 1 \mu\text{s}$.
- If the burst period is too short, the instrument will automatically increase it to output with the specified burst count.

21.2.6 Trigger Source

For bursts, the trigger source can be an internal trigger or manual trigger. Click or tap the "Source" drop-down button and select the trigger source. The default is "Internal".

- **Internal:** Internal trigger is available for N-Cycle burst waveform only. When internal trigger is selected, the instrument only outputs a burst of the specified cycles and the burst frequency is determined by *Burst Period*. After completing the specified number of cycles, the instrument stops and waits for the next trigger event.
- **Manual:** You can initiate a burst immediately by clicking or tapping the Manual Trig key  in the interface as shown in *Figure 21.4*.



TIP

Only "Manual" is available for Infinite burst. You can click or tap the Manual Trig key to initiate a burst or stop the output.

21.2.7 Burst Idle Level

After activating the Burst function, you can click or tap the "Idle Level" drop-down button to set the idle level.

- **1st Pt:** Selects the level at the first point of the waveform as the idle level.
- **Top:** Selects the level at the top point of the waveform as the idle level.

- **Center:** Selects the level at the center point of the waveform as the idle level.
- **Bottom:** Selects the level at the bottom point of the waveform as the idle level.
- **User:** Selects the level at the specified point of the waveform as the idle level.

Click or tap the input field and use the pop-up numeric keypad to enter the value. It ranges from 0 to 65,535, and the default is 0.

21.3 Modulation Mode

The AFG mode allows you to output modulated waveforms. Available modulation types include analog modulation (AM, FM, PM) and digital modulation (ASK, FSK, PSK). The instrument has multiple built-in modulation waveforms.

In the channel configuration area, click or tap the "Output Type" drop-down menu to select "Modulation" and access the interface as shown in the figure below. You can click or tap one of the Quick Setup labels to access the Continuous (Carrier) Mode, Modulation Mode, or Channel Setup menu. For Continuous (Carrier) Mode and Channel Setup, please refer to *Continuous Mode* and *Channel Setup*. This section only describes the Modulation Mode.

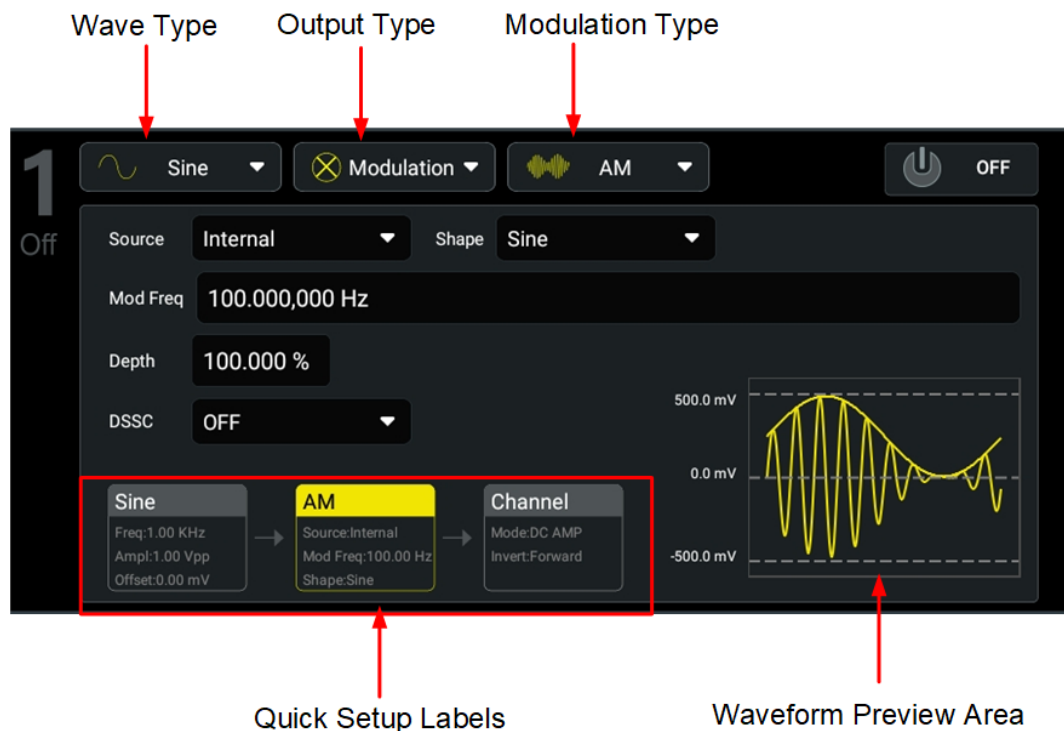


Figure 21.5 Modulation Mode Interface

21.3.1 Amplitude Modulation (AM)

In Amplitude Modulation (AM), a modulated waveform consists of a carrier waveform and a modulating waveform. The amplitude of the carrier waveform is varied by the instantaneous voltage of the modulating waveform. In the interface as shown in [Figure 21.5](#), click or tap the "Modulation Type" drop-down button to select "AM" and set its parameters.

Carrier Waveform

Available AM carrier waves include sine (default), square, and ramp wave. Pulse and noise cannot be carrier waveform for AM. Click or tap the "Wave Type" drop-down button to select the carrier waveform and access the setup interface. To configure different carrier waveforms, please refer to [Continuous Mode](#).



TIP

When "Sine" wave is selected, the Sine frequency ranges from 1 μ Hz to 1 GHz.

Modulating Waveform

The instrument uses the internal signal as an AM source. You can click or tap the "Shape" drop-down button to select the modulating waveform shape. Available modulating waveforms include:

- Sine wave
- Square with 50% duty cycle
- Triangle with 50% symmetry
- UpRamp with 100% symmetry
- DnRamp with 0% symmetry
- Noise-white gaussian noise



TIP

Noise can be used as modulating signal but not carrier signal.

Modulation Frequency

Click or tap the input field and use the pop-up numeric keypad to set the modulation frequency. The available range is from 2 mHz to 1 MHz, and the default is 100 Hz. The resolution is 1 μ Hz.

Modulation Depth

Modulation depth is a percentage that represents the amplitude variation. Click or tap the "Depth" input field to set the modulation depth. AM depth ranges from 0% to 120%. The default is 100%, and the resolution is 0.001%.

- At 0% depth, the amplitude is one-half of the carrier's amplitude setting.
- At 100% depth, the amplitude is identical to the carrier's amplitude setting.

DSSC

DG70000 supports two forms of amplitude modulation, "Normal" and Double Sideband Suppressed Carrier (DSSC). In "normal" AM, the modulated wave consists of the carrier wave and two sidebands. Such a modulation is inefficient because the carrier wave carries no information. If this carrier is suppressed and the saved power is distributed to the two sidebands, then such a process is called Double Sideband Suppressed Carrier (DSSC).

By default, the "DSSC" is off. To enable DSSC, you can click or tap the "DSSC" drop-down button to select "ON".

21.3.2 Frequency Modulation (FM)

In Frequency Modulation (FM), a modulated waveform consists of a carrier waveform and a modulating waveform. The frequency of the carrier waveform is varied by the instantaneous voltage of the modulating waveform. In the interface as shown in [Figure 21.5](#), click or tap the "Modulation Type" drop-down button to select "FM" and set its parameters.

Carrier Waveform

Available FM carrier waves include sine (default), square, and ramp wave. Pulse and noise cannot be carrier waveform for FM. Click or tap the "Wave Type" drop-down button to select the carrier waveform and access the setup interface. To configure different carrier waveforms, please refer to [Continuous Mode](#).

TIP

When "Sine" wave is selected, the Sine frequency ranges from 1 μ Hz to 1 GHz.

Modulating Waveform

The instrument uses the internal signal as an FM source. You can click or tap the "Shape" drop-down button to select the modulating waveform shape. Available modulating waveforms include:

- Sine wave
- Square with 50% duty cycle



- Triangle with 50% symmetry
- UpRamp with 100% symmetry
- DnRamp with 0% symmetry
- Noise-white gaussian noise

**TIP**

Noise can be used as modulating signal but not carrier signal.

Modulation Frequency

Click or tap the input field and use the pop-up numeric keypad to set the modulation frequency. The available range is from 2 mHz to 1 MHz, and the default is 100 Hz. The resolution is 1 μ Hz.

Frequency Deviation

It represents the peak variation in frequency of the modulated waveform from the carrier frequency. Click or tap the "Deviation" input field to set the frequency deviation. The minimum frequency deviation is 1 μ Hz.

- For FM, the frequency deviation must always be less than or equal to the carrier frequency. Attempting to set a deviation greater than the carrier frequency will cause the instrument to set the deviation equal to the carrier frequency.
- The carrier frequency plus the deviation cannot exceed the selected function's maximum frequency plus 1 kHz.

21.3.3 Phase Modulation (PM)

In Phase Modulation (PM), a modulated waveform consists of a carrier waveform and a modulating waveform. The phase of the carrier waveform is varied by the instantaneous voltage of the modulating waveform. In the interface as shown in [Figure 21.5](#), click or tap the "Modulation Type" drop-down button to select "PM" and set its parameters.

Carrier Waveform

Available PM carrier waves include sine (default), square, and ramp wave. Pulse and noise cannot be used as carrier waveform. Click or tap the "Wave Type" drop-down button to select the carrier waveform and access the setup interface. To configure different carrier waveforms, please refer to [Continuous Mode](#).

**TIP**

When "Sine" wave is selected, the Sine frequency ranges from 1 μ Hz to 1 GHz.

Modulating Waveform

The instrument uses the internal signal as a PM source. You can click or tap the "Shape" drop-down button to select the modulation shape. Available modulating waveforms include:

- Sine wave
- Square with 50% duty cycle
- Triangle with 50% symmetry
- UpRamp with 100% symmetry
- DnRamp with 0% symmetry
- Noise-white gaussian noise



TIP

Noise can be used as modulating signal but not carrier signal.

Modulation Frequency

Click or tap the input field and use the pop-up numeric keypad to set the modulation frequency. The available range is from 2 mHz to 1 MHz, and the default is 100 Hz. The resolution is 1 μ Hz.

Phase Deviation

The phase deviation represents the peak variation in phase of the modulated waveform from the carrier waveform. Click or tap the "Phase Dev" input field to set the phase deviation. It ranges from 0° to 360°, and the default is 90°. The resolution is 0.001°.

21.3.4 Amplitude Shift Keying (ASK)

With Amplitude Shift Keying (ASK), you can configure the instrument to "shift" its output amplitude between two preset values (called the "carrier amplitude" and the "modulation amplitude"). In the interface as shown in [Figure 21.5](#), click or tap the "Modulation Type" drop-down button to select "ASK" and set its parameters.

Carrier Waveform

Available ASK carrier waves include sine (default), square, and ramp wave. Pulse and noise cannot be carrier waveform for ASK. Click or tap the "Wave Type" drop-down button to select the carrier waveform and access the setup interface.

In the Carrier (Continuous) interface, click or tap the **Ampl/HighL** button to set the parameter to "Ampl". Click or tap its input field and use the pop-up numeric keypad to set the carrier amplitude. For details, please refer to [Continuous Mode](#).

**TIP**

When "Sine" wave is selected, the Sine frequency ranges from 1 μ Hz to 1 GHz.

Modulation Source

The instrument uses a square wave with 50% duty cycle as the ASK modulation source. The output amplitude "shifts" between "carrier amplitude" and "modulation amplitude". The shift rate is determined by "ASK Rate".

ASK Rate

ASK rate is the rate at which the output amplitude "shifts" between the carrier and modulation amplitude. Click or tap the "Mod Rate" input field and use the pop-up numeric keypad to set the rate. The available range is from 2 mHz to 1 MHz, and the default is 100 Hz. The resolution is 1 μ Hz.

Modulation Amplitude

Click or tap the "Mod Amp" input field and use the pop-up numeric keypad to set the modulation amplitude. The available range is from 25 mV to 1 V, and the default is 700 mVpp. The resolution is 10 μ Vpp.

21.3.5 Frequency Shift Keying (FSK)

With Frequency Shift Keying (FSK), you can configure the instrument to "shift" its output frequency between two preset values (called the "carrier frequency" and the "hop frequency"). In the interface as shown in *Figure 21.5*, click or tap the "Modulation Type" drop-down button to select "FSK" and set its parameters.

Carrier Waveform

Available FSK carrier waves include sine (default), square, and ramp wave. Pulse and noise cannot be carrier waveform for FSK. Click or tap the "Wave Type" drop-down button to select the carrier waveform and access the setup interface.

In the Carrier (Continuous) interface, click or tap the **Freq/Period** button to set the parameter to "Freq". Click or tap its input field and use the pop-up numeric keypad to set the carrier frequency. The frequency range depends on the selected carrier wave.

- Sine: 1 μ Hz to 1 GHz
- Square: 1 μ Hz to 500 MHz
- Ramp: 1 μ Hz to 50 MHz

Modulation Source

The instrument uses a square wave with 50% duty cycle as the FSK modulation source. The output frequency "shifts" between "carrier frequency" and "hop frequency". The shift rate is determined by "FSK Rate".

FSK Rate

FSK rate is the rate at which the output frequency "shifts" between the carrier frequency and the hop frequency using the internal FSK source. Click or tap the "Mod Rate" input field and use the pop-up numeric keypad to set the rate. The available range is from 2 mHz to 1 MHz, and the default is 100 Hz.

Hop Frequency

Click or tap the "Hop Freq" input field and use the pop-up numeric keypad to set the hop frequency. The available hop frequency depends on the selected carrier wave.

- Sine: 1 μ Hz to 1 GHz
- Square: 1 μ Hz to 500 MHz
- Ramp: 1 μ Hz to 50 MHz

21.3.6 Phase Shift Keying (PSK)

In Phase Shift Keying (PSK), the carrier waveform is phase "shifted" between two phase settings ("carrier phase" and "modulation phase"). In the interface as shown in *Figure 21.5*, click or tap the "Modulation Type" drop-down button to select "PSK" and set its parameters.

Carrier Waveform

Available PSK carrier waves include sine (default), square, and ramp wave. Pulse and noise cannot be carrier waveform for PSK. Click or tap the "Wave Type" drop-down button to select the carrier waveform and access the setup interface.

In the Carrier (Continuous) interface, click or tap the "Phase" input field and use the pop-up numeric keypad to set the starting phase. It ranges from 0° to 360°, and the default is 0°. The resolution is 0.001°.

Modulation Source

The instrument uses a square wave with 50% duty cycle as the PSK modulation source. The output phase "shifts" between "carrier phase" and "modulation phase". The shift rate is determined by "PSK Rate".

PSK Rate

PSK rate is the rate at which the output phase "shifts" between the carrier and modulation phase. Click or tap the "Mod Rate" input field and use the pop-up

numeric keypad to set the rate. The available range is from 2 mHz to 1 MHz, and the default is 100 Hz. The resolution is 1 μ Hz.

Phase

Click or tap its input field and use the pop-up numeric keypad to set the modulation phase. It ranges from 0° to 360°, and the default is 180°. The resolution is 0.001°.

21.4 Sweep Mode

In frequency sweep mode, the instrument moves from the start frequency to the stop frequency within a specified sweep time. You can sweep up or down in frequency, with linear, logarithmic, or step spacing. The instrument can sweep sine, square, and ramp.

In the channel configuration area, click or tap the "Output Type" drop-down menu to select "Sweep" and access the interface as shown in the figure below. You can click or tap one of the Quick Setup labels to access the Continuous Mode, Sweep Mode, or Channel Setup menu. For Continuous Mode and Channel Setup, please refer to *Continuous Mode* and *Channel Setup*. This section only describes the Sweep Mode.

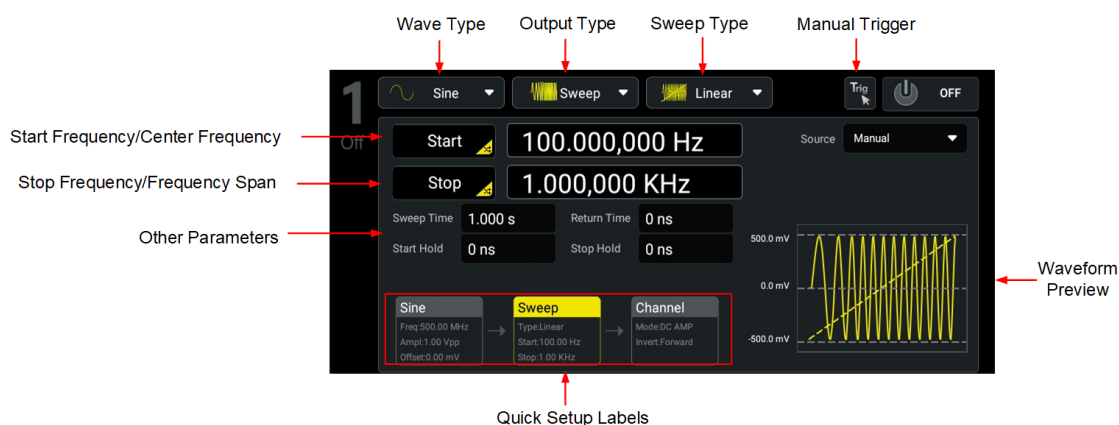


Figure 21.6 Sweep Mode Interface

21.4.1 Sweep Type

DG70000 supports linear (default), logarithmic, and step spacing. Click or tap the "Sweep Type" drop-down button to select "Linear", "Log", or "Step".

Linear Sweep

The instrument varies the output frequency linearly during the sweep, changing the output frequency by a constant number of Hz per second. It is characterized by "Start Frequency", "Stop Frequency", and "Sweep Time".

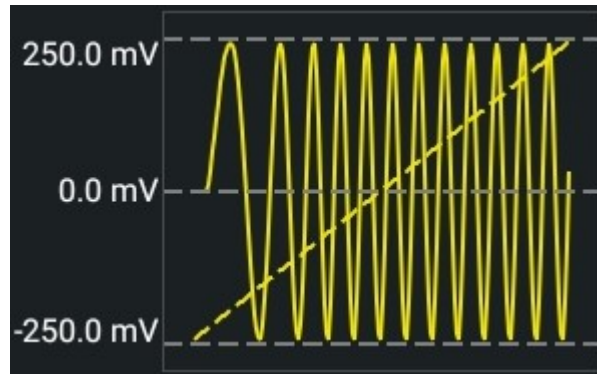


Figure 21.7 Linear Sweep

Logarithmic Sweep

The instrument varies the output frequency logarithmically, changing the frequency by a constant number of octaves or decades per second. It is characterized by "Start Frequency", "Stop Frequency", and "Sweep Time".

Define the start frequency, stop frequency, sweep time as F_{start} , F_{stop} , and T_{sweep} . The function of logarithmic sweep is $F=P^T$; wherein, P and T can be expressed in the following equations:

$$P = 10^{\lg(F_{stop}/F_{start})/T_{sweep}}$$

$$T = t + \lg(F_{start})/\lg(P)$$

In the equations above, "t" is the duration time after the sweep starts, ranging from 0 to T_{sweep} ; "F" is the current instantaneous frequency.

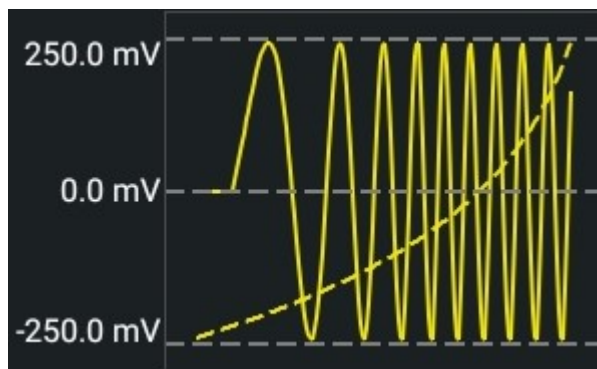


Figure 21.8 Logarithmic Sweep

Step Sweep

The instrument "steps" through a list of frequencies. The period that the output signal dwells on each frequency is determined by "Sweep Time" and "Step".

When the sweep type is set to "Step", click or tap the "Step" input field to set the number of steps. It ranges from 2 (default) to 1024.

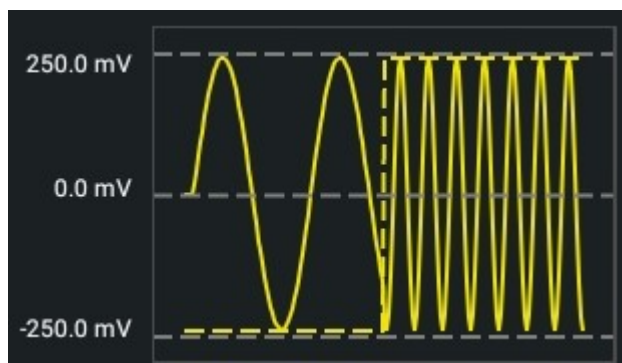


Figure 21.9 Step Sweep

21.4.2 Start Frequency and Stop Frequency

The start frequency and stop frequency set the sweep's upper and lower frequency bounds. The sweep begins at the start frequency, sweeps to the stop frequency, and then resets back to the start frequency.

- To sweep up in frequency, set the start frequency less than the stop frequency.
- To sweep down in frequency, set the opposite relationship.
- To sweep in a fixed frequency, set the same start frequency and stop frequency.

Click or tap the **Start/Center** button to set the parameter to "Start". "Start" is now active. This operation also toggles the parameter of the **Stop/Span** button to "Stop". Click or tap the corresponding input field and use the pop-up numeric keypad to set the start frequency and stop frequency. By default, the start frequency is 100 Hz and the stop frequency is 1 kHz. The available start/stop frequency depends on the selected carrier wave.

- Sine: 1 μ Hz to 1 GHz
- Square: 1 μ Hz to 500 MHz
- Ramp: 1 μ Hz to 50 MHz

21.4.3 Center Frequency and Frequency Span

You can also set the sweep frequency boundaries of the sweep using a center frequency and frequency span.

- Center Frequency = (Start Frequency + Stop Frequency) / 2
- Frequency Span = Stop Frequency - Start Frequency

Click or tap the **Start/Center** button to set the parameter to "Center". "Center" is now active. This operation also toggles the parameter of the **Stop/Span** button to "Span". Click or tap the corresponding input field and use the pop-up numeric keypad to set the center frequency or frequency span. By default, the center frequency is 550 Hz

and the frequency span is 900 Hz. The center frequency and frequency span differ for different waves. Also, they are limited to each other.

The available range of center frequency for different waves is shown below:

- Sine: 1 μ Hz to 1 GHz
- Square: 1 μ Hz to 500 MHz
- Ramp: 1 μ Hz to 50 MHz

Define the maximum start/stop frequency as F_{\max} and the minimum start/stop frequency as F_{\min} . $F_m = (F_{\max} - F_{\min}) / 2$.

The frequency span is limited by the center frequency:

- When Center Frequency $< F_m$, the Frequency Span is $\pm 2 \times (\text{Center Frequency} - F_{\min})$.
- When Center Frequency $> F_m$, the Frequency Span is $\pm 2 \times (F_{\max} - \text{Center Frequency})$.

Take sine wave as an example. F_{\min} is 1 μ Hz, F_{\max} is 1 GHz, and F_m is 500 MHz. If the center frequency is 5 MHz, the frequency span range is $\pm 2 \times (5 \text{ MHz} - 1 \mu\text{Hz}) = \pm 10 \text{ MHz}$; if the center frequency is 800 MHz, the frequency span range is $\pm 2 \times (1 \text{ GHz} - 0.8 \text{ GHz}) = \pm 400 \text{ MHz}$.



TIP

To sweep up in frequency, set a positive frequency span; to sweep down, set a negative frequency span.

21.4.4 Sweep Time

Sweep time specifies the number of seconds required to sweep from the start frequency to the stop frequency. Click or tap its input field and use the pop-up numeric keypad to set the sweep time. It ranges from 1 ms to 500 s, and the default is 1.000 s. The resolution is 1 ns.

21.4.5 Start/Stop Hold Time

Start hold time specifies the number of seconds for the sweep to remain at the "Start Frequency". After the start hold time expires, the generator continues to sweep at varied frequencies according to the current sweep type.

Stop hold time specifies the number of seconds for the sweep to remain at the "Stop Frequency" after the generator sweeps from the "Start Frequency" to the "Stop Frequency".

You can click or tap the "Start Hold" or "Stop Hold" input field and use the pop-up numeric keypad to set the start/stop hold time. Its range is 0 s (default) or from 100 μ s to 500 s. The resolution is 1 ns.



TIP

A Start Hold/Stop Hold setting value less than 100 μ s will be automatically set to 0 s.

21.4.6 Return Time

Return time specifies the number of seconds to return from the "Stop Frequency" to the "Start Frequency".

Click or tap its input field and use the pop-up numeric keypad to set the return time. Its range is 0 s (default) or from 100 μ s to 500 s. The resolution is 1 ns.




TIP

A Return Time less than 100 μ s will be automatically set to 0 s.

After the return time is set, the instrument will sweep from the specified "Start Frequency" again.


21.4.7 Sweep Trigger Source

The sweep trigger source can be either "internal" or "manual". The instrument outputs a single sweep when a trigger signal is received and waits for the next trigger. Click or tap the "Source" drop-down button and select "Internal" or "Manual".

- **Internal:** The instrument outputs a continuous sweep. The trigger period is determined by the specified sweep time, return time, start hold time, and stop hold time.
- **Manual:** The instrument outputs one sweep each time you click or tap  in the channel configuration area.

21.5 Channel Setup

You can control channel outputs in the following two ways.

- Click or tap  > **Channel** to access the channel setting menu. As shown in the figure below, you can click or tap the corresponding channel label to set the output for each channel.

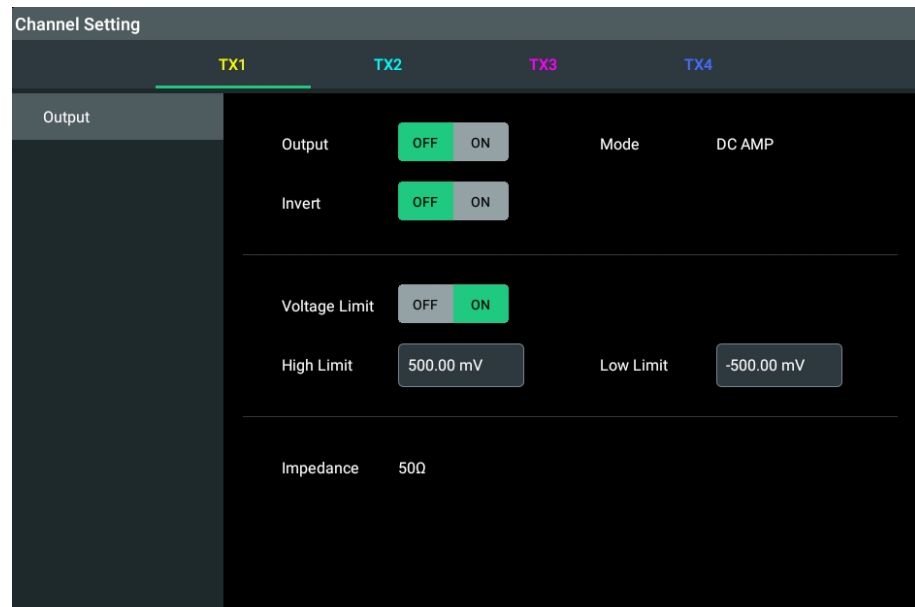


Figure 21.10 "Channel Setting" Menu

- Click or tap the "Channel" quick setup label in the channel configuration area to access the menu as shown in the figure below.



"Channel" Quick Setup Label

Figure 21.11 Channel Quick Setup Menu

Channel On/Off

As is shown *Figure 21.10*, click or tap the "Output" button to toggle between "ON" and "OFF". When "OFF" is selected, the channel is disabled without any signal output. When "ON" is selected, the channel is enabled.

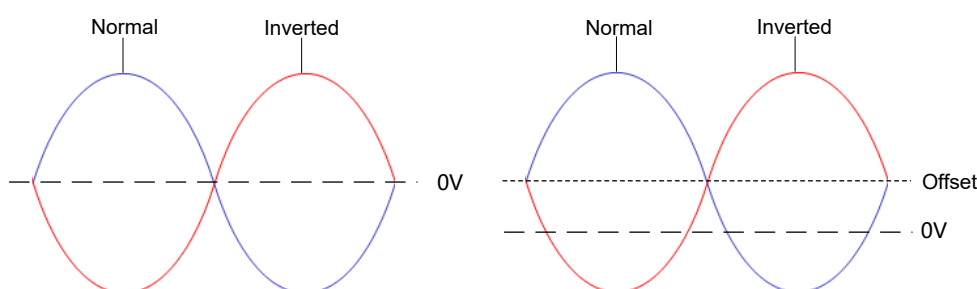
You can also control the channel on/off state in the following ways.

- Simply click or tap the channel label at the bottom of the screen to turn on the corresponding channel output.
- Click or tap the All On/Off button at the upper-right corner of the AFG interface to enable all channel outputs; click or tap the On/Off button in the specified channel configuration area to enable individual channel output.
- Press the front-panel channel On/Off key to turn on the specified channel.

Waveform Polarity

You can use either the normal mode or inverted mode to output signal. You can click or tap the "Invert" button to toggle between ON and OFF. The default is "OFF".

The waveform is inverted relative to the offset voltage. As shown in the figure below, relative to the offset voltage, the waveform is inverted.



TIP

The offset voltage remains unchanged when the waveform is inverted.

Output Voltage Limits

Click or tap the "Voltage Limit" button to toggle between "ON" and "OFF" (default). When it is "ON", the instrument protects the "HighL"/"LowL" values currently set from exceeding the values in "High Limit"/"Low Limit".

Click or tap the "High Limit"/"Low Limit" input field and use the pop-up keypad to set your desired limit values for high/low level.

TIP

Modifying the voltages limits will affect the high/low level and amplitude currently set.

Output Mode

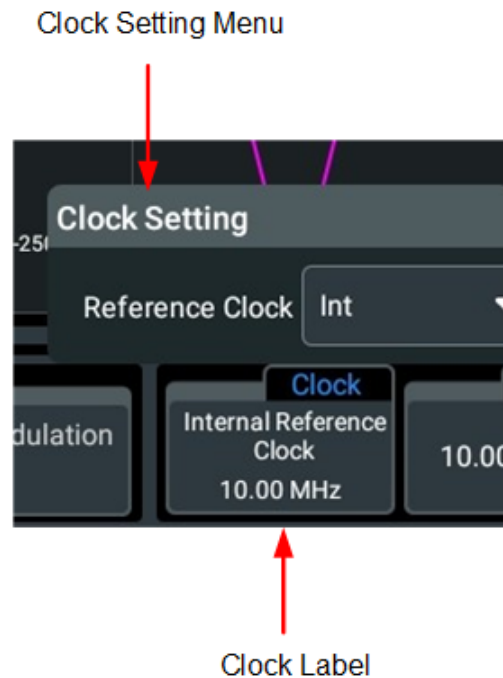
The AFG output mode is DC AMP. The signal is output through the differential output connectors of analog channel DC+ and DC- on the front panel of the instrument.

Impedance


DG70000 has a fixed series output impedance of 50 Ω to the front panel channel connectors. The impedance cannot be modified.

21.6 Clock Setup

Click or tap the "Clock" label to pop up the "Clock Setting" menu, as shown in the figure below. You can click or tap the "Reference Clock" drop-down button to select "Int" or "Ext". For more details, please refer to [Clock Setup](#).



21.7 AFG Storage Management

In AFG mode, you can click or tap  and then select **Storage** to access the storage menu and view files stored in internal memory/external storage device. The "Storage" menu is shown in the figure below. For general operations of the "Storage" menu, please refer to [Storage Management](#).

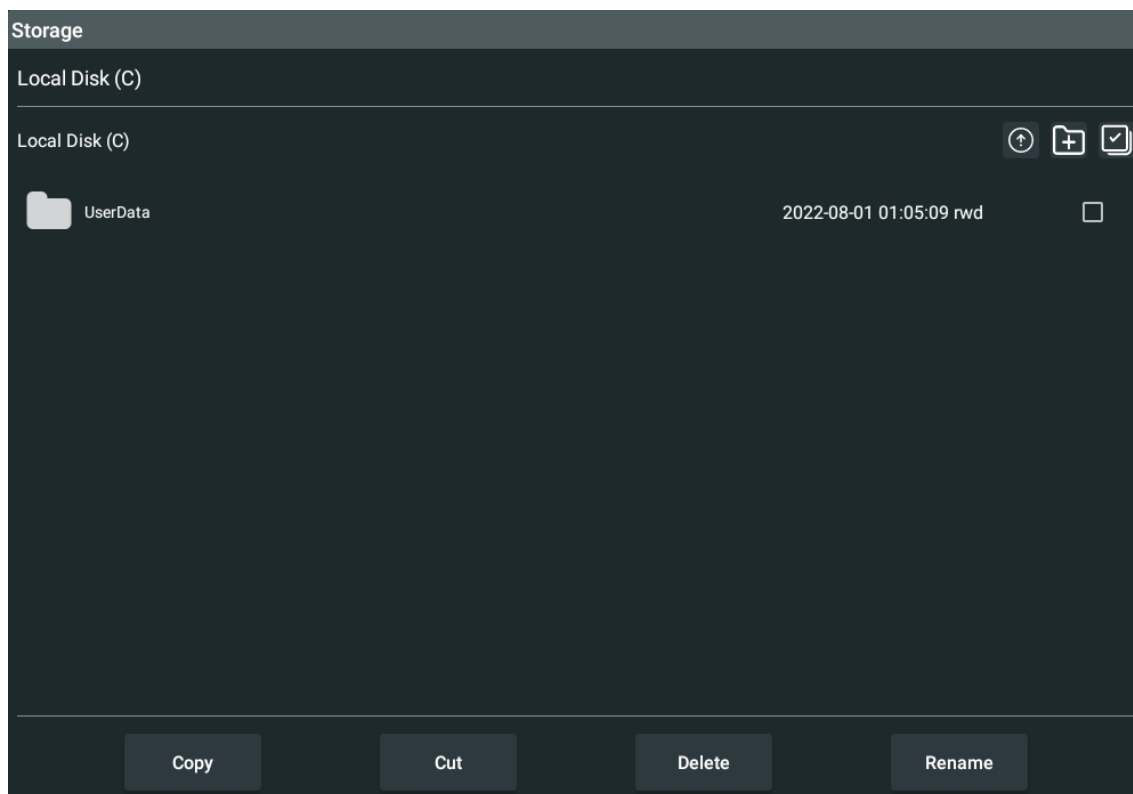




Figure 21.12 "Storage" Menu

21.8 AFG Upgrade

DG70000 supports online upgrade after it is connected to a network via the LAN

connector. Click or tap  > **Update** for AFG online upgrade. If no update firmware is available, a prompt message "No new version" will be displayed.

You can also choose local update. Properly connect the USB device where the upgrade file is stored to the instrument. Then enter the "Storage" menu (refer to [AFG Storage Management](#)) and select the upgrade file. Click or tap  and **OK** to complete the local update.



TIP

When upgrading the Android operating system, use a USB storage device of FAT32 format.

22 Remote Control

The following ways of remote control are supported:

- **User-defined Programming**

Users can program and control the instrument by using the SCPI (Standard Commands for Programmable Instruments) commands. For details about the SCPI commands and programming, refer to *Programming Guide* of this product series.

- **PC Software**

Users can use the PC software to send commands to control the instrument remotely. RIGOL Ultra Sigma is recommended. You can download the software from RIGOL official website (<http://www.rigol.com>).

Operation Procedures:

- Set up communication between the instrument and PC.
- Run Ultra Sigma and search for the instrument resource.
- Open the remote command control panel to send commands.

- **Web Control**

This instrument supports Web Control. Connect the instrument to the network, then input the IP address of the instrument into the address bar of the browser of your computer. The web control interface is displayed. Click Web Control to enter the web control page. Then you can view the display of the real-time interface of the instrument. Through the Web Control method, you can migrate the device control to the control terminals (e.g. PC, Mobile, iPad, and other smart terminals) to realize remote control of the instrument. .

This instrument can be connected to the PC via the USB, LAN, or GPIB interface to set up communication and realize remote control through the PC. The remote control can be realized by using SCPI (Standard Commands for Programmable Instruments) commands.

This chapter will illustrate how to use the RIGOL Ultra Sigma software to remotely control the instrument via various interfaces. Note: When communicating with the PC via GPIB, the instrument does not support large data transmission operation such as screen shot and waveform reading.



CAUTION

Before connecting the communication cable, please turn off the instrument to avoid causing damage to the communication interfaces.

22.1 Remote Control via USB

1. Connect the device

Use the USB cable to connect the rear-panel USB DEVICE interface of the instrument to the USB HOST interface of the PC.

2. Search for the device resource

Start up Ultra Sigma and the software will automatically search for the resource currently connected to the PC via the USB interface. You can also click **USB-TMC** to search for the resource.

3. View the device resource

The resources found will appear under the "RIGOL Online Resource" directory, and the model number and USB interface information of the instrument will also be displayed.

4. Control the instrument remotely

Right-click the device resource name and select "SCPI Panel Control" to open the remotely command control panel. Then you can send commands and read data through the panel. For details about the SCPI commands and programming, refer to the Programming Guide of this instrument.

22.2 Remote Control via LAN

1. Connect the device

Use the network cable to connect the instrument to your local area network (LAN).

2. Configure network parameters

Configure the network parameters of the instrument according to "*I/O Setting*".

3. Search for device resource

Start up Ultra Sigma and click **LAN** to open the panel as shown in the figure below. Click **Search** and the software searches for the instrument resources currently connected to the LAN and the resources found are displayed at the right section of the window as shown in the figure below. Click **OK** to add it.



Besides, you can input the IP address of the instrument manually into the text field under "Manual Input LAN Instrument IP", then click **TEST**. If the instrument passes the test, click **ADD** to add the instrument to the LAN instrument resource list in the right section; if the instrument fails the test, please check whether the IP address that you input is correct, or use the auto search method to add the instrument resource.

4. View the device resource

The resources found will appear under the "RIGOL Online Resource" directory.

5. Control the instrument remotely

Right-click the device resource name and select "SCPI Panel Control" to open the remotely command control panel. Then you can send commands and read data through the panel.

6. Load LXI webpage

As this instrument conforms to LXI CORE 2011 DEVICE standards, you can load LXI web page through Ultra Sigma (right-click the instrument resource name and select "LXI-Web"). Various important information about the instrument (including the model, manufacturer, serial number, description, MAC address, and IP address) will be displayed on the web page. You can also directly input the IP address of the instrument in the address bar of the PC browser to load the LXI web page.

22.3 Remote Control via GPIB

1. Connect the device

Use the USB-GPIB interface converter to extend the GPIB interface for the instrument, and then use the GPIB cable to connect the instrument to the PC to realize remote control.

2. Install the driver of GPIB card

Correctly install the driver of the GPIB card which has been connected to the PC.

3. Set the GPIB address

Click or tap the Notification Area at the lower-right corner of the screen, then the **Utility** menu is displayed. Click or tap **IO**, and then click or tap the input field of **GPIB** to input the GPIB address with the pop-up numeric keypad.

4. Search for the device resource

Start Ultra Sigma, and then click **GPIB**. A window is displayed as shown in *Figure 22.1*. Click **Search** and the software searches for the instrument resource currently connected to the PC via the GPIB interface. The resource found is displayed at the right side of the window, as shown in *Figure 22.2*. Click **OK** to add it.

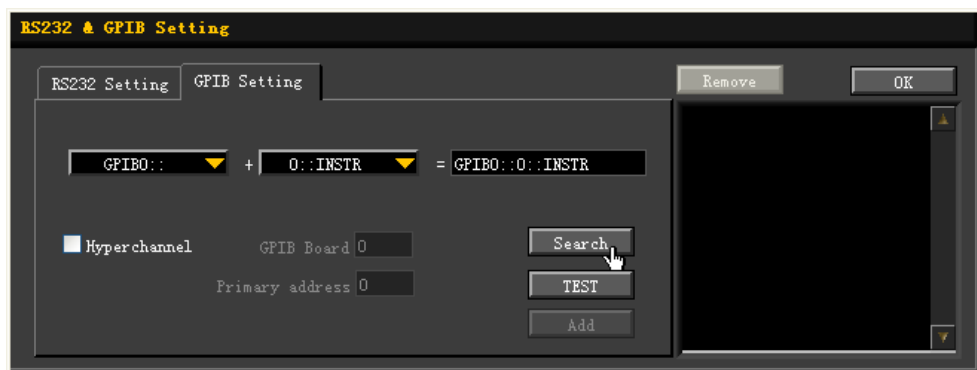


Figure 22.1 Search for the Available Device

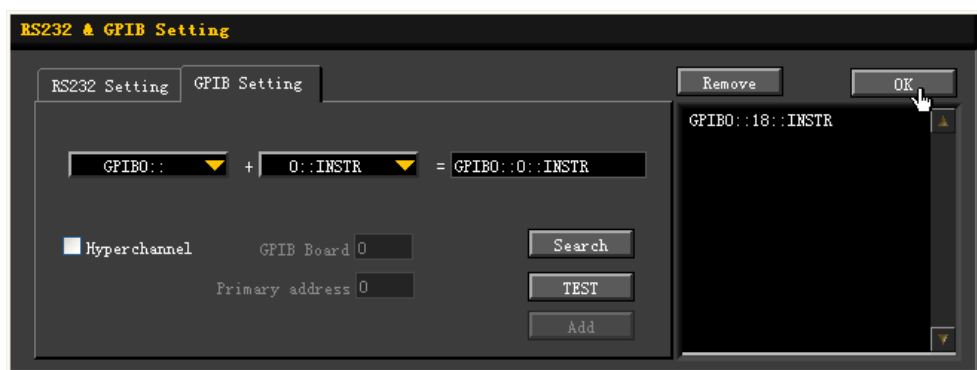


Figure 22.2 Confirm the Available Device

5. View the device resource

Click **OK** to go back to the main interface of Ultra Sigma. The searched instrument resource will be displayed under the directory of "RIGOL Online Resource".

6. Control the instrument remotely

Right-click the device resource name. In the displayed menu, select "SCPI Panel Control" to open the programming command control panel. Then you can input commands to send commands and read data.

23 Factory Defaults

Press the front-panel Default and a prompt message "Restore default settings?" is displayed. Click or tap **OK** to restore the instrument to its factory default settings, as shown in the table below.

Table 23.1 Factory Settings

| AWG Parameters | | Factory Settings |
|-------------------------------|--|--------------------------|
| Channel | | |
| Resolution | | 16+0Mkr |
| Output Waveform | | Real waveform |
| sin(x)/x Filter | | OFF |
| DAC Mode | | NRZ |
| Output Mode | | DC HBW |
| Amplitude | | 350 mVpp |
| Offset | | 0 mV |
| Channel Output | | OFF |
| Real Waveform | | |
| SiFi Mode | | OFF |
| Interpolation | | 1× |
| IQ Waveform (Optional) | | |
| I Data Interpolation | | 2× |
| Q Data Interpolation | | 2× |
| Int/Ext 2 | | Int |
| Center Frequency | | 0 Hz |
| Clock | | |
| Clock Source | | Internal Reference Clock |
| Sample Rate | | 5 GSa/s |
| Sample Clock | | 5 GHz |
| Jitter Reduction | | OFF |
| External Reference Clock | | 10M |
| External Sample Clock | | 5 GHz |
| Sample Rate Divider | | 1 |
| Sample Clock Out | | OFF |
| Sync Clock Out | | OFF |
| Basic Waveform | | |
| Name | | Wave |
| Function | | Sine |

| AWG Parameters | | Factory Settings | |
|-----------------------------|--|----------------------|--|
| Calculate | | Length | |
| Length | | 12k | |
| Sample Rate | | 5 GSa/s | |
| Frequency | | 1 GHz | |
| Cycles | | 2.4k | |
| Amplitude | | 500 mVpp | |
| High Level | | 250 mV | |
| Low Level | | -250 mV | |
| Offset | | 0 mV | |
| Phase | | 0° | |
| Table Editor | | | |
| Name | | Wave | |
| Length | | 12k | |
| Amplitude | | 500 mVpp | |
| Offset | | 0 mV | |
| Output Waveform | | Real Data | |
| Multitone (Advanced) | | | |
| Name | | Wave | |
| Type | | Tones | |
| Sample Rate | | User Defined 5 GSa/s | |
| Tones | | | |
| Start Frequency | | 1 GHz | |
| End Frequency | | 2 GHz | |
| Spacing | | 1 GHz | |
| Tone Count | | 2 | |
| Phase | | 0° | |
| Tones Length | | 2.65k | |
| Chirp | | | |
| Low Frequency | | 1 GHz | |
| High Frequency | | 1.1 GHz | |
| Sweep Time | | 10 μs | |
| Sweep Rate | | 10 MHz/μs | |
| Frequency Sweep | | Low to High | |
| Chirp Length | | 50k | |
| High Speed Serial | | | |
| Keep Sample Rate | | OFF | |
| Set WL to Max | | OFF | |
| Maximum Waveform Length | | 1000000000 Samples | |
| Waveform Generation | | | |

| AWG Parameters | Factory Settings |
|-----------------------------|------------------|
| Source | PRBS |
| PRBS | PRBS9 |
| Invert Bits | OFF |
| Data Rate | 125 Mbps |
| High Level | 750 mV |
| Low Level | -750 mV |
| Sequence Length | 511 Bits |
| Sequence Shift | 0 Bits |
| Encoding Type | NRZ |
| 8B10B | OFF |
| Disparity | RD+ |
| PWM | OFF |
| T-Minor | 0.2 UI |
| Edge Shape | Trapezoidal |
| Thresholds | 10%/90% |
| Rise Time | 0.4 UI |
| Scrambling | OFF |
| Scrambling Type | Additive |
| Polynomial Expression | X9+X4+1 |
| Register Initial Value | 11111111 |
| Register Initial Value Type | Binary |
| DCD | OFF |
| Mode | Classical |
| Magnitude | 0 UI |
| Transmitter | |
| Periodic Jitter | OFF |
| PJ1-PJ10 | OFF |
| Frequency (PJ1-PJ10) | 50 MHz |
| Magnitude (PJ1-PJ10) | 0.1 UIpp |
| Phase (PJ1-PJ10) | 0° |
| Random Jitter | OFF |
| RJ1-RJ3 | OFF |
| Crest Factor (RJ1-RJ3) | 6 dB |
| Magnitude (RJ1-RJ3) | 0.1 UIrms |
| Bandwidth (RJ1-RJ3) | 50 MHz |
| Gaussian Noise | OFF |
| Bandwidth | 500 MHz |
| Magnitude (Noise) | 5% |
| Crest Factor | 6 dB |
| Single Tone Noise | OFF |
| Frequency | 500 MHz |

| AWG Parameters | | Factory Settings | |
|-------------------------------------|--|------------------|--|
| Magnitude (S-Noise) | | 5% | |
| SSC | | OFF | |
| Shape | | Sine | |
| Deviation (Peak-to-Peak) | | 0 ppm | |
| Repetition Rate | | 500 kHz | |
| Channel Setting | | | |
| LPF | | OFF | |
| Filter Type | | Brickwall | |
| Cutoff Frequency | | 500 MHz | |
| Q Factor | | 1 | |
| ISI | | OFF | |
| Slope | | 0 dB/100 MHz | |
| Pre/De-Emphasis | | | |
| Pre/De-Emphasis | | OFF | |
| Pre-cursor Taps (Tap#-1 to Tap#-5) | | 0 dB | |
| Post-cursor Taps (Tap#+1 to Tap#+5) | | 0 dB | |
| Sequence | | | |
| Name | | Seq | |
| Jump Timing | | Jump Immediately | |
| Pattern Jump | | ON | |
| Go to Step | | 1 | |
| Modulation | | | |
| Name | | Mod | |
| Code Type | | All One | |
| Length | | 10k | |
| Symbol Rate | | 1 MSa/s | |
| Mod Type | | BPSK | |
| Code | | OFF | |
| Oversampling | | 4 | |
| Filter | | Rectangular | |
| Alpha/BT | | 0.25 | |
| Output | | | |
| Channel | | CH1 | |
| Analog | | | |
| Stopped State | | 0 Volt | |
| Waiting State | | 0 Volt | |

| AWG Parameters | | Factory Settings | |
|--------------------|--|------------------|--|
| Marker1 | | | |
| Stopped State | | Low Level | |
| Waiting State | | Low Level | |
| High Level | | 1 V | |
| Low Level | | 0 V | |
| Marker2 | | | |
| Stopped State | | Low Level | |
| Waiting State | | Low Level | |
| High Level | | 1 V | |
| Low Level | | 0 V | |
| | | | |
| Trigger | | | |
| Interval | | 10 μs | |
| Trigger A | | | |
| Level | | 0 V | |
| Impedance | | 1 MΩ | |
| Polarity | | Rising | |
| Timing | | Async | |
| Trigger B | | | |
| Level | | 0 V | |
| Impedance | | 1 MΩ | |
| Polarity | | Rising | |
| Timing | | Async | |
| Pattern Jump Input | | | |
| Strobe Edge | | Rising | |
| | | | |
| Skew | | | |
| Analog | | | |
| TX1 | | 0 ps | |
| TX2 | | 0 ps | |
| TX3 | | 0 ps | |
| TX4 | | 0 ps | |
| Markers | | | |
| Channel | | CH1 | |
| Marker1 | | 0 ps | |
| Marker2 | | 0 ps | |
| | | | |
| IQ Impairment | | | |
| Enable | | OFF | |
| I Offset | | 0% | |

| AWG Parameters | Factory Settings |
|---------------------------|------------------|
| Q Offset | 0% |
| Gain Imbalance | 0 dB |
| Skew | 0 ps |
| | |
| AFG Parameters | Factory Settings |
| Channel | |
| Output Type | Continuous |
| Wave Type | Sine |
| Output On/Off | OFF |
| | |
| Continuous | |
| Frequency | 1 kHz |
| Amplitude | 500 mV |
| Offset | 0 mV |
| Phase | 0° |
| High Level | 250 mV |
| Low Level | -250 mV |
| Duty Cycle (Square/Pulse) | 50% |
| Symmetry (Ramp) | 50% |
| Rising Edge | 300 ps |
| Falling Edge | 300 ps |
| | |
| Burst | |
| Burst Type | N-Cycle |
| Delay | 0 ps |
| Cycles | 1 |
| Phase | 0° |
| Period | 10 ms |
| Trigger Source | Internal |
| Idle Level | 1st Pt |
| | |
| AM | |
| Modulation Source | Internal |
| Shape | Sine |
| Modulation Frequency | 100 Hz |
| Modulation Depth | 100% |
| DSSC | OFF |
| | |

| AFG Parameters | | Factory Settings | |
|----------------------|--|------------------|--|
| FM | | | |
| Modulation Source | | Internal | |
| Shape | | Sine | |
| Modulation Frequency | | 100 Hz | |
| Deviation | | 1 kHz | |
| | | | |
| PM | | | |
| Modulation Source | | Internal | |
| Shape | | Sine | |
| Modulation Frequency | | 100 Hz | |
| Phase Deviation | | 90° | |
| | | | |
| ASK | | | |
| Modulation Source | | Internal | |
| Modulation Frequency | | 100 Hz | |
| Modulation Amplitude | | 700 mVpp | |
| | | | |
| FSK | | | |
| Modulation Source | | Internal | |
| Modulation Frequency | | 100 Hz | |
| Hop Frequency | | 10 kHz | |
| | | | |
| PSK | | | |
| Modulation Source | | Internal | |
| Modulation Frequency | | 100 Hz | |
| Phase | | 180° | |
| | | | |
| Sweep | | | |
| Sweep Type | | Linear Sweep | |
| Start Frequency | | 100 Hz | |
| Stop Frequency | | 1 kHz | |
| Center Frequency | | 550 Hz | |
| Frequency Span | | 900 Hz | |
| Trigger Source | | Internal | |
| Sweep Time | | 1 s | |
| Return Time | | 0 ns | |
| Start Hold Time | | 0 ns | |
| Stop Hold Time | | 0 ns | |

| AFG Parameters | Factory Settings |
|-------------------|------------------|
| Step (Step Sweep) | 2 |
| Channel | |
| Output | OFF |
| Invert | OFF |
| Voltage Limit | OFF |
| High Limit | 250 mV |
| Low Limit | -250 mV |
| Clock | |
| Reference Clock | Internal |

24 Troubleshooting

1. When I power on the instrument, the instrument stays black and does not display anything.

- a. Check whether the power supply has been connected correctly.
- b. Check whether the power key is really pressed.
- c. Check whether the fuse is blown. If you need to replace the fuse, use only the specified fuse that conforms to the product.
- d. Restart the instrument after finishing the above inspections.
- e. If the problem still persists, please contact RIGOL.

2. The settings are correct but no waveform is generated.

- a. Check whether the output cable is connected to the corresponding channel output terminal tightly.
- b. Check whether the output cable has internal damage.
- c. Check whether the output cable is connected to the test instrument tightly.
- d. If the problem still persists, please contact RIGOL.

3. The USB storage device cannot be recognized.

- a. Check whether the USB storage device can work normally when connected to other instruments or PC.
- b. Make sure that the USB storage device is FAT32/NTFS format and flash type. The instrument doesn't support hardware USB storage device.
- c. After restarting the instrument, insert the USB storage device again to check whether it can work normally.
- d. If the USB storage device still cannot work normally, please contact RIGOL.

4. Performance verification test is failed.

- a. Check whether the generator is within calibration period (1 year).
- b. Check whether the generator has been warmed up for at least 30 minutes before the test.
- c. Check whether the generator is under the specified temperature.
- d. Check whether the test is under strong-magnetism environment.
- e. Check whether the power supplies of the generator and test system have a strong interference.

- f. Check whether the performance of the test device used meets the requirement.
- g. Make sure that the test device used is within the calibration period.
- h. Check whether the test device used meets the required conditions of the manual.
- i. Check whether all the connections are tight.
- j. Check whether any cable has internal damage.
- k. Make sure that the operations conform to settings and processes which are required by the performance verification manual.
- l. Check whether the error calculation has faults.
- m. Correctly understand the definition of "typical value" for this product: the performance specification of this product under specified conditions.

5. The touch-enabled operation does not work.

- a. Check whether you have locked the touch screen. If yes, unlock the touch screen.
- b. Check whether the screen or your finger is stained with oil or sweat. If yes, please clean the screen or dry your hands.
- c. Check whether there is a strong magnetic field around the instrument. If the instrument is close to the strong magnetic field (e.g. a magnet), please move the instrument away from the magnet field.
- d. If the problem still persists, please contact RIGOL.

25 Appendix

25.1 Appendix A: Options and Accessories

| Order Information | Order No. |
|---|-----------------|
| Model | |
| 4-channel, 2 GHz bandwidth, 5 GSa/s data rate, 1.5G sample points | DG70004 |
| 2-channel, 2 GHz bandwidth, 5 GSa/s data rate, 1.5G sample points | DG70002 |
| Standard Shipped Accessory | |
| Power cord (based on destination country) | — — |
| USB cable | — — |
| Three 50 Ω , 18 GHz SMA terminators per channel | — — |
| Performance Upgrade Option | |
| Digital Up Converter (DUC) and IQ Modulation | DG70000-DIGUP |
| Complex Sequence Function | DG70000-SEQ |
| High-speed Serial Function | DG70000-PJ |
| DC Amplifier Output | DG70000-DC |
| Multitone & Chirp Mode | DG70000-MTONENL |

25.2 Appendix B: Warranty

RIGOL TECHNOLOGIES CO., LTD. (hereinafter referred to as RIGOL) warrants that the product mainframe and product accessories will be free from defects in materials and workmanship within the warranty period. If a product proves defective within the warranty period, RIGOL guarantees free replacement or repair for the defective product.

To get repair service, please contact your nearest RIGOL sales or service office.

There is no other warranty, expressed or implied, except such as is expressly set forth herein or other applicable warranty card. There is no implied warranty of merchantability or fitness for a particular purpose. Under no circumstances shall RIGOL be liable for any consequential, indirect, ensuing, or special damages for any breach of warranty in any case.

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