RIGOL

DG70000 Series

Arbitrary Waveform Generator

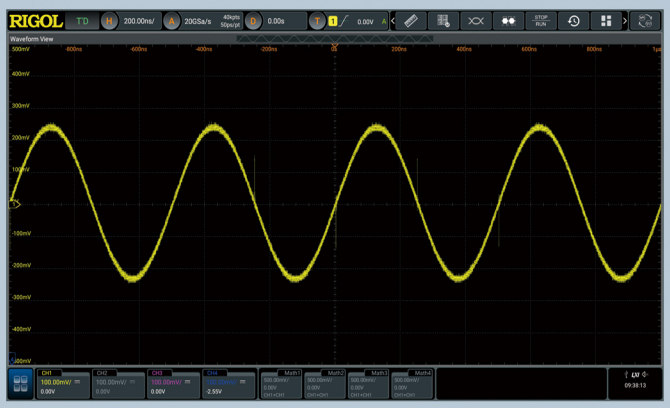
DataSheet

DG70000 Series Arbitrary Waveform Generator

High Sample Rate and High Resolution, Restore Signals with High Quality

The DG70000 series AWG provides sample rate up to 12 GSa/s, adjustable setting range from 1 uSa/s to 12 GSa/s. The 16-bit high resolution ensures its high fidelity.
To restore the signal with high quality is the basis for reliable and repeatable testing. The DG70000 series features excellent sample rate and resolution, capable of restoring the signal vividly, presenting users with more real test results.

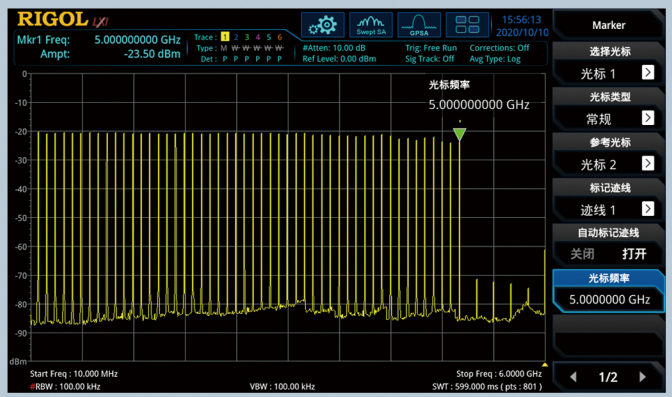
- **12GSa/s Sample Rate**
  (5 GSa/s data rate, interpolated: 10 GSa/s for real-number waveform output; 12 GSa/s for complex IQ waveform output)
- **16-bit Vertical Resolution**

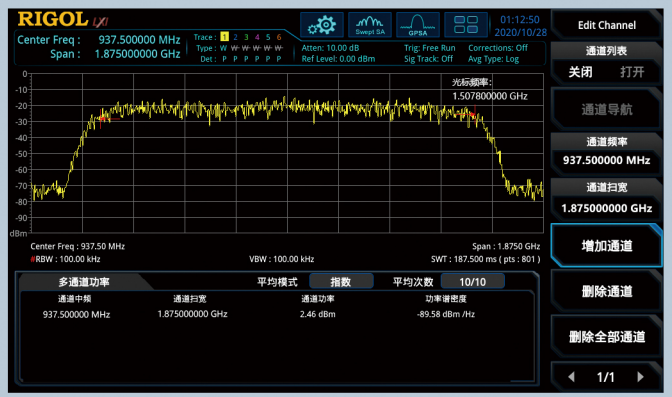


Wider Output Frequency Range and Modulation Bandwidth Ensures Wireless Signal Simulation Test

With the renewal and iteration of wireless standards, the carrier frequency and modulation bandwidth of wireless signals are constantly improving, imposing severe test challenges on users.
The DG70000 series supports the output frequency range from DC to 5 GHz, the modulation bandwidth up to 1.5 GHz. It can output IQ baseband signal or use the Digital Up Converter (DUC) option to generate the RF modulated signal directly, meeting the demands of users for testing the simulation of the various types of wireless standard signals.

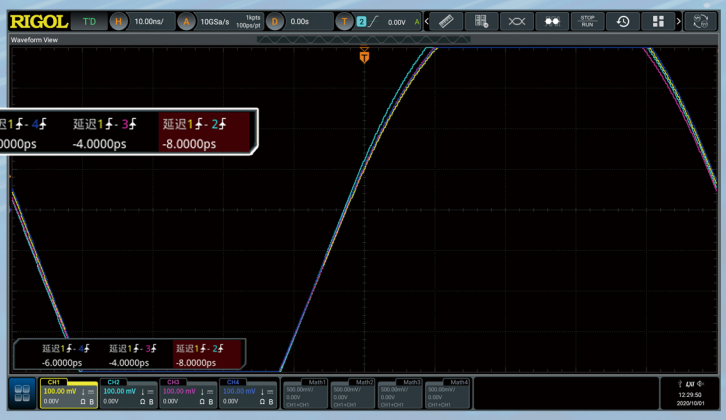
- **DC~5 GHz Output Frequency Range**
- **Max 1.5 GHz Modulation Bandwidth**





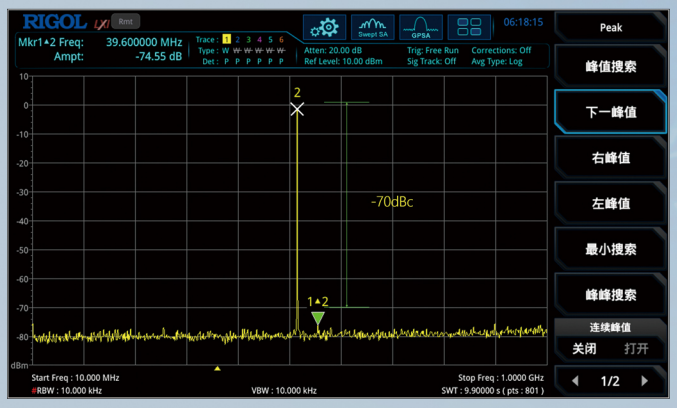
Lower Channel-to-Channel Delay and Multi-Channel Extension Reproduce Complex Test Scenarios

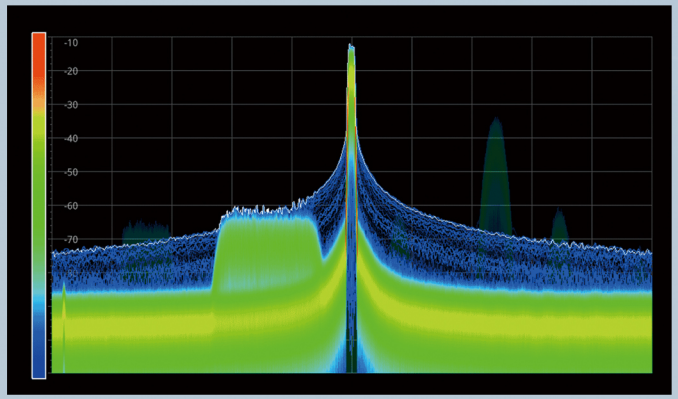
In the cutting-edge fields such as quantum technology, it is necessary to build a multi-channel high-speed signal system. Such complex test scenarios require that the arbitrary waveform generator should have multi-channel signal output and low delay between channels.
The DG70000 series supports the multi-channel synchronous output through the expansion of synchronization machine, and the delay between channels of a single device is as low as 10 ps. Such functions enable users to rebuild multi-channel and low-latency complex test scenarios.



- **Min. 10 ps Channel-to-Channel Delay**
- **Max. 224Ch Multi-device Synchronization Expansion Channel**

More Sample Points Provide More Pure Signals



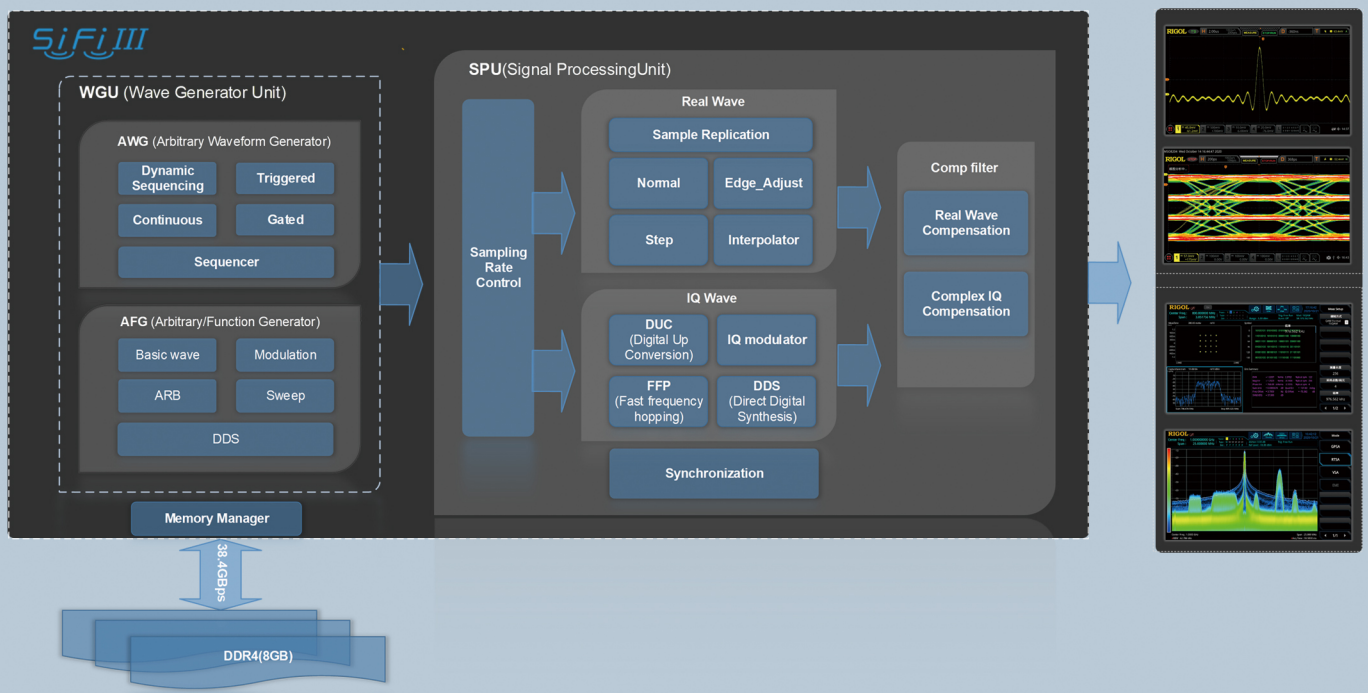


Building real target scenes to carry out the simulation testing can effectively reduce the cost of system testing. Improving signal purity and building complex signals that exist in a long period of time are key requirements for constructing real target scenes for simulation.
The DG70000 series can provide -70 dBc spurious-free dynamic range (SFDR) and up to 4G sample points per channel, ensuring signal purity and creating long-term complex waveforms without undermining signal bandwidth. At the same time, it has a powerful function of creating advanced sequences, which can divide the waveform memory to store several waveform segments, efficiently making use of the waveform storage space. It also enables users to flexibly construct waveforms through internal and external trigger events as needed.

- **1.5G Sample Points Waveform Memory**
- **-70 dBc SFDR**

Brand New SiFi III Technical Platform

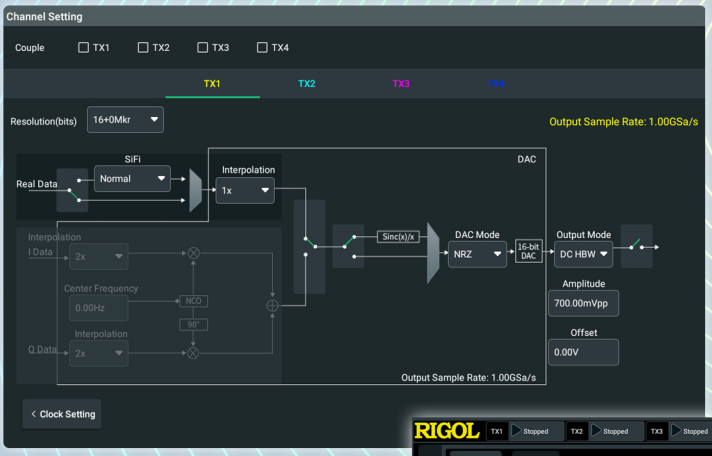
With RIGOL's brand new SiFi III technical platform, the DG70000 series supports multiple signal output modes such as sequence output, precise trigger output, continuous output and dynamic jump output. Its built-in waveform memory has the industry-leading waveform storage space, achieving a maximum data throughput of 38.4 Gbps. The advanced sequence function supports a flexible configuration of waveform storage space and dynamic jump output. In the signal processing, the DG70000 series can realize variable sample rate control, IQ modulation, DUP, fast frequency hopping, and direct digital synthesis (DDS).



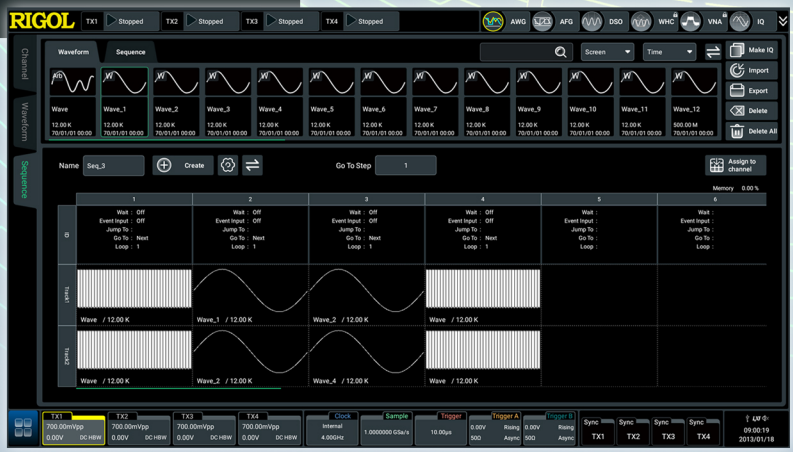
High-Definition Large Touch Screen

The DG70000 series is equipped with a 15.6-inch multi-touch capacitive screen. Users can complete all operations without connecting any external control and display device. When editing local waveforms and sequences, it offers better operating experience than PC software.

The DG70000 series not only can display the complete signal processing link on the 15.6-inch large display screen, but also allows users to quickly set the sample rate, output mode, output amplitude and other key information on the displayed link graph. The operation is very easy and convenient.



Channel Setting Interface



Advanced Sequence Interface

High-Definition Smart and Quick-responsive Keyboard

The auxiliary 3.5-inch minor touch screen can be served as a customized high-definition smart and quick-responsive keyboard, enabling users to customize the shortcut menu according to their own habits and open the desired menu quickly.

Wear-free Long Service Life Photoelectric Encoder

The wear-free and endurable photoelectric encoder operating knob of the DG70000 series improves the knob pressing and rotation operation by 3 times and 30 times respectively. This design ensures the knob service life and reliability of the knob operation for its frequent use.

Product Features

Product Features

- Up to 5 GSa/s sample rate (interpolated: 12 GSa/s)
- 4 channels for a single instrument, supporting multi-channel synchronization
- -70 dBc SFDR
- 16-bit vertical resolution
- Up to 1.5 G sample points in single-channel mode
- Generate carrier waveforms directly up to a 5 Ghz signal
- Generate the arbitrary waveforms point by point; recover the signal without distortion
- Total jitter low as 10 ps, random jitter low as 350 fs
- Sample rate adjustable, ranging from 100 Sa/s to 12 GSa/s
- High-precision synchronization, the skew repeatability between any two channels is 10 ps
- Support creating advanced sequence to define outputs of various types of complex waveforms
- Multiple external interfaces: LAN, USB3.0, HDMI
- Support import of waveform files from the external
- Angle-adjustable 15.6" touch screen

The DG70000 series arbitrary waveform generator (AWG) has a unique SiFi III technical platform and Android operating system. It features the following advantages: sample rate accurate and adjustable; generate the arbitrary waveforms point by point; recover the signal without distortion; etc. The DG70000 series offers users a variety of functions suitable for practical applications. For example, the creation of advanced sequences enables users to self-define complex waveforms. The multi-channel high-precision synchronization, high-bandwidth and low-jitter waveform output can meet their demands for applications in a variety of industrial and communications fields. It also brings brand new UI and user experience. It is equipped with a high-definition angle-adjustable 15.6-inch capacitive touch screen, and supports displaying in multiple windows. It has multiple standard configuration interfaces, enabling users to realize remote control over the instruments, offering users more solutions.

Specifications

Specifications are valid under the following conditions:

the instrument is within the calibration period; stored for at least two hours at 0℃ to 50℃ temperature; 40-minute warm-up.

Unless otherwise noted, the specifications in the manual include the measurement uncertainty.

- **Typical (typ.)**: typical performance, which 80 percent of the measurement results will meet at room temperature (approximately 25℃). The data are not warranted and do not include the measurement uncertainty.
- **Nominal (nom.):** the expected mean or average performance or a designed attribute (such as the 50Ω connector). The data are not warranted and are measured at room temperature (approximately 25℃).
- **Measured (meas.):** an attribute measured during the design phase which can be compared to the expected performance, i.e. the amplitude drift varies with time. The data are not warranted and are measured at room temperature (approximately 25℃).

Note:

All charts in this manual are the measurement results of multiple instruments at room temperature unless otherwise noted.

Overview of the DG70000 Series Technical Specifications

Overview of the DG70000 Series Technical Specifications		
Sample Rate	100 Sa/s~12 GSa/s[1]	
No. of Channels	4 (for each set)	
Vertical Resolution	16 bits (0 Marker/CH) 15 bits (1 Marker/CH) 14 bits (2 Marker/CH)	
Memory Depth	1.5 Gpts/CH	
Output Mode	NRZ, RZ , and MIX	
Sin(x)/x(-3dB)	2.22 GHz @ 5 Gs/s, 4.44 GHz interpolated @ 10 GS/s	
Multi-channel Synchronization	Skew Repeatability	<10 ps
	Delay Correction Resolution	3 ps

Analog Output

Analog Output		
DC High Bandwidth Output	Amplitude Range	350 mVpp-700 mVpp (single-ended, into 50 Ω)[2] 700 mVpp-1400 mVpp (differential, into 100 Ω)
	Amplitude Accuracy	±2% of the setting value
	Analog Bandwidth	2 GHz (-3 dB), 4 GHz(-6 dB)
	Offset	±20 mV (50 Ω to GND), ±40 mV to VDC terminator[3]
	Offset Resolution	50 uV
	Offset Accuracy	±2 mV

Analog Output		
DC Amplifier Output	Amplitude Range	25 mVpp-1000 mVpp (single-ended, into 50 Ω) 50 mVpp-2000 mVpp (differential, into 100 Ω)
	Amplitude Accuracy	±2% of the setting value ≥ 100 mVp-p ±5% of the setting value < 100 mVp-p
	Offset	±2 V (50 Ω to GND)
	Offset Accuracy	Common-mode: ±(2% of the offset + 10 mV); ((OutP +OutN)/2)[3] Differential mode: ±20 mV; (OutP - OutN)[3]
	Analog Bandwidth	1.3 GHz (-3 dB), 2.6 GHz (-6 dB)
AC Output	Amplitude Range	-20 dBm to +10 dBm
	Amplitude Accuracy	±0.5 dB
	Offset	±2 V@100mA
	Offset Accuracy[3]	±(2% of the offset + 20 mV); into an open circuit (zero-load current)
	Analog Bandwidth	10 Mhz～2 GHz (-3 dB), 10 MHz～4 GHz (-6 dB), 10 Mhz～5 GHz (-16 dB)
No. of Channels	4	SMA interface (front panel)

Time Domain

Time Domain		
Rise/Fall Time Measured at 20%-80% Levels	<110 ps @ 700 mVp-p single-ended <180 ps @ 1.0 Vp-p single-ended	
Bit Rate (Sample Rate/4 points per cycle)	Max. 1.25 Gb/s	
Jitter	Random Jitter	350 fs_{RMS}
	Total Jitter	10 ps $_{(p-p)}$

Frequency Domain

Frequency Domain		
VSWR Out	DC HBW	DC-4 GHz < 1.8:1
	DC AMP	DC-2.6 GHz < 1.8:1
	AC Output	DC-5 GHz < 2.0:1
TOI	100 MHz ± 1 MHz	-70 dBc
	1 GHz±1 MHz	-60 dBc

SFDR

SFDR Characteristics: SFDR is determined as a function of the directly generated carrier frequency. Harmonics not included. Measured with a balun and with output amplitude set to 500 mV.

SFDR DC HBW Output

		In-Band Performance		Adjacent-Band Performance	
	DC HBW Output	Actual Range	Specifications	Actual Range	Specifications
2.5 GSa/s	100 MHz	DC-500 MHz	-80 dBc	DC-1.25 GHz	-72 dBc
	DC-625 MHz	DC-625 MHz	-70 dBc	DC-1.25 GHz	-62 dBc
	DC-1 MHz	DC-1 MHz	-60 dBc	DC-1.25 GHz	-58 dBc
5 GSa/s	100 MHz	DC-1 MHz	-80 dBc	DC-2.5 GHz	-72 dB
	DC-1.25 GHz	DC-1.25 GHz	-70 dBc	DC-2.5 GHz	-62 dBc
	DC-2 GHz	DC-2 GHz	-60 dBc	DC-2.5 GHz	-58 dBc
10 GSa/s	100 MHz	DC-1 GHz	-80 dBc	DC-5 GHz	-70 dBc
	DC-1.25 GHz	DC-1.25 GHz	-70 dBc	DC-5 GHz	-60 dBc
	DC-2 GHz	DC-2 GHz	-60 dBc	DC-5 GHz	-56 dBc
	2 GHz-3.5 GHz	2 GHz-3.5 GHz	-55 dBc	DC-5 GHz	-50 dBc
	3.5 GHz-4 GHz	3.5 GHz-4 GHz	-55 dBc	DC-5 GHz	-50 dBc

SFDR DC AMP Output

		In-Band Performance		Adjacent-Band Performance	
	DC AMP Output	Actual Range	Specifications	Actual Range	Specifications
2.5 GSa/s	100 MHz	DC-500 MHz	-80 dBc	DC-1.25 GHz	-72 dBc
	DC-625 MHz	DC-625 MHz	-70 dBc	DC-1.25 GHz	-62 dBc
	DC-1 GHz	DC-1 GHz	-60 dBc	DC-1.25 GHz	-58 dBc
5 GSa/s	100 MHz	DC-1 GHz	-80 dBc	DC-2.5 GHz	-72 dB
	DC-1.25 GHz	DC-1.25 GHz	-70 dBc	DC-2.5 GHz	-62 dBc
	DC-2 GHz	DC-2 GHz	-60 dBc	DC-2.5 GHz	-58 dBc
10 GSa/s	100 MHz	DC-1 GHz	-80 dBc	DC-5 GHz	-72 dBc
	DC-1.25 GHz	DC-1.25 GHz	-70 dBc	DC-5 GHz	-62 dBc
	DC-2 GHz	DC-2 GHz	-60 dBc	DC-5 GHz	-58 dBc
	2 GHz-2.6 GHz	2 GHz-2.6 GHz	-60 dBc	DC-5 GHz	-50 dBc

SFDR AC Output

		In-Band Performance		Adjacent-Band Performance	
	AC Output	Actual Range	Specifications	Actual Range	Specifications
2.5 GSa/s	100 MHz	DC-500 MHz	-80 dBc	DC-1.25 GHz	-72 dBc
	DC-625 MHz	DC-625 MHz	-70 dBc	DC-1.25 GHz	-62 dBc
	DC-1 GHz	DC-1 GHz	-60 dBc	DC-1.25 GHz	-58 dBc
5 GSa/s	100 MHz	DC-1 GHz	-80 dBc	DC-2.5 GHz	-72 dB
	DC-1.25 GHz	DC-1.25 GHz	-70 dBc	DC-2.5 GHz	-62 dBc
	DC-2 GHz	DC-2 GHz	-60 dBc	DC-2.5 GHz	-58 dBc

SFDR AC Output					
10 GSa/s	100 MHz	DC-1 GHz	-80 dBc	DC-5 GHz	-72 dBc
	DC-1.25 GHz	DC-1.25 GHz	-70 dBc	DC-5 GHz	-62 dBc
	DC-2 GHz	DC-2 GHz	-60 dBc	DC-5 GHz	-58 dBc
	2 GHz-3.5 GHz	2 GHz-3.5 GHz	-50 dBc	DC-5 GHz	-44 dBc
	3.5 GHz-4 GHz	3.5 GHz~4 GHz	-46 dBc	DC-5 GHz	-40 dBc

Harmonics and Phase Noise

Harmonics		
Harmonic Distortion (THD, @ 500 mVpp)		
Second Harmonic (Differential or with a balun)	10 MHz to 500 MHz	<-62 dBc
	500 MHz to 1 GHz	<-50 dBc
	1 GHz to 4 GHz	<-30 dBc
Second Harmonic (Single-ended)	10 MHz to 500 MHz	<-42 dBc
	500 MHz to 1 GHz	<-40 dBc
	1 GHz to 4 GHz	<-25 dBc
THG	10 MHz to 750 MHz	<-55 dBc
	750 MHz to 1 GHz	<-50 dBc
	1 GHz to 2 GHz	<-35 dBc
Harmonic Distortion (THD, @ 1000 mVpp)		
Second Harmonic (Differential or with a balun)	10 MHz to 500 MHz	<-55 dBc
	500 MHz to 1 GHz	<-45 dBc
	1 GHz to 2.6 GHz	<-35 dBc
Second Harmonic (Single-ended)	10 MHz to 500 MHz	<-38 dBc
	500 MHz to 1 GHz	<-30 dBc
	1 GHz to 2.6 GHz	<-25 dBc
THG	10 MHz to 500 MHz	<-33 dBc
	500 MHz to 1 GHz	<-30 dBc
	1 GHz to 2.6 GHz	<-25 dBc

Phase Noise	
Output Phase Noise Typical[4]	-126 dBc/Hz offset 10 kHz @ 100 MHz
	-112 dBc/Hz offset 10 kHz @ 1 GHz
	-106 dBc/Hz offset 10 kHz @ 2 GHz
	-100 dBc/Hz offset 10 kHz @ 4 GHz

Input

Input		
Trig Input	Qty.	2
	Polarity	Positive or negative
	Impedance	1 MΩ
	Range	1 MΩ: ±8 Vrms
	Threshold Level	Range: -5.0 V to 5.0 V Resolution: 0.1 V
	Pulse width	20 ns
	Trigger Bandwidth	50 MHz
	Trigger Sensitivity	500 mVpp
Modulating Signal Input	Qty.	4
	Interface Definition	Analog Modulation Input or Baseband IQ Input
	Frequency Range	DC-100 MHz
	Input Level	1 Vpp (full-range)
	Impedance	50 kΩ (nominal)
	Connector Type	SMA female
Dynamic Jump Input	Input Impedance	1 kΩ to GND
	Input Level	3.3 V LVCMOS
	Qty. of Jumps	256
	Gated Polarity	Negative
	Gated Setup Time	5 ns
	Gated Hold Time	5 ns
	Min. Pulse Width	64 ns

Pin Assignments

Pin	Description	Pin	Description	Pin	Description
1	GND	6	GND	11	Data bit 5, input
2	Data bit 0, input	7	Gated, input	12	Data bit 6, input
3	Data bit 1, input	8	GND	13	Data bit 7, input
4	Data bit 2, input	9	GND	14	GND
5	Data bit 3, input	10	Data bit 4, input	15	GND

Waveform Function

Waveform Function	
Import of Waveform Files	*.txt waveform data file, data support voltage and normalized value *.wfm waveform data file, RIGOL AWG waveform table data file
Export of Waveform Files	*.txt waveform data file, data support normalized value *.wfm waveform data file, RIGOL AWG waveform table data file

Marker Output

Marker Output	
Qty.	0 (default), 1, or 2
Minimum Pulse Width	1.6 ns
Max. Data Rate	2.5 GSa/s
Mode	Single-ended
Impedance	50 Ω
Level to 50 Ω	Window: -0.5V~1.75 V Amplitude: 200 mV~1.75 V[L1] Resolution: 100 uV Rise Time (20%~80%): 750 ps
Delay Control	±2 ns

Sequence Generator

Sequence Generator	
Main Sequence	Count number supported by each main sequence: 1 to 16,384
Sub-sequence	Count number supported by each sub-sequence: 2 to 16,384
Waveform Segment	Waveform length: 256~1.5 G sample points Min. waveform acquisition: 16 sample points
Sequence	Executes the items of the main sequence and sub-sequence in specific order.
Loop	Executes 1 to 209,7151 times or infinite times in loop.
Jump	Wait: waits the events to be executed Sync Jump: supports the sync events jump for the waveform item and sub-sequence item. Async Jump: supports the async events jump for the waveform item and sub-sequence item. GoTo: goes to the next item. Dynamic Jump: supports dynamic jump for 256 main sequences.

Clock

Clock		
10 MHz Out Reference Clock	Output Amplitude	+4 dBm to ±2 dBm
	Output Frequency	10 MHz ± (1 ppm + aging)
	Temperature Stability	＜ 0.5 ppm (0℃ to 50℃, with the reference 25℃)
	Aging Rate	＜ 1 ppm/year
	Output Impedance	50 Ω
Sample Clock Output	Output Amplitude	+2 dBm to +8 dBm
	Output Frequency	2.5 GHz to 6 GHz
	Output Impedance	50 Ω

Clock		
Sync Clock Output	Output Amplitude	1.0 V ±150 mVp-p to 50 Ω
	Output Frequency	Sample clock frequency/32
	Output Impedance	50 Ω
Reference Clock 10 MHz In	Input Amplitude	-5 dBm to +5 dBm
	Fixed Frequency	10 MHz, ±40 Hz
	Adjustable Frequency Range	35 MHz to 150 MHz
	Input Impedance	50 Ω
External Sample Clock Input	Input Amplitude	0 dBm to +10 dBm
	Input Frequency	2.5 GHz to 6.0 GHz
	Input Impedance	50 Ω
Interface Type	SMA interface on the rear panel	

Note:

- [1] 5 Gsa/s data rate, interpolated: 10 GSa/s for real-number waveform output; 12 Gsa/s for complex IQ waveform output
- [2] The output terminal that is not in use must use a 50 Ω load to connect to GND.
- [3] Within the internal self-calibration temperature ±5℃
- [4] 5 GHz sample clock

General Specifications

Characteristics

Characteristics	
Operating System	Android
Touch Screen	15.6" main screen, 3.5" auxiliary screen

I/O

I/O	
LAN Interface	1 on the rear panel, RJ-45 Ethernet connector, 10/100/1000BASE-T port, supporting LXI-C
Web Remote Control	Support Web Control interface (input the IP address of the AWG into the Web browser to display the operation interface of the AWG)
HDMI Interface	1 on the rear panel, HDMI 1.4b, A plug; used to connect to an external monitor or projector
USB Host 3.0 High-Speed Interface	4 (2 on the front panel and 2 on the rear panel)
USB Device 3.0 High-Speed Interface	1 on the rear panel
SYNC Control IN/OUT	1 on the rear panel, SCSI interface, used as a control interface for multi-device synchronization

Power

Power	
Input Voltage Range, AC	90 V to 264 V (nominal)
AC Frequency	47 Hz to 63 Hz
Power Consumption	300W (typical)) 650W (maximum)

Environment

Environment		
Temperature Range	Operating	-0℃~+50℃
	Non-operating	-30℃~+70℃
Humidity Range	Operating	below +30℃: ≤90% RH (without condensation)
		+30℃ to +40℃, ≤75% RH (without condensation)
		+40℃ to +50℃, ≤45% RH (without condensation)
	Non-operating	below 65℃: ≤90% RH (without condensation)

Environment		
Altitude	Operating	below 3,000
	Non-operating	below 15,000

Regulations

Regulations	
Safety	UL61010-1, CAN/CSA-22.2, No.61010-1-04, EN61010-1, IEC61010-1
Emissions	EN55011 (Class A), IEC61000-3-2, IEC61000-3-3
Immunity	IEC61326, IEC61000-4-2/3/4/5/6/8/11

Mechanical Characteristics

Mechanical Characteristics	
Size	439mm (W)×310 mm (H)×491 mm (D)

Warranty and Calibration Interval

Warranty and Calibration Interval	
Warranty	Three years for the mainframe, excluding the .
Recommended Calibration Interval	18 months

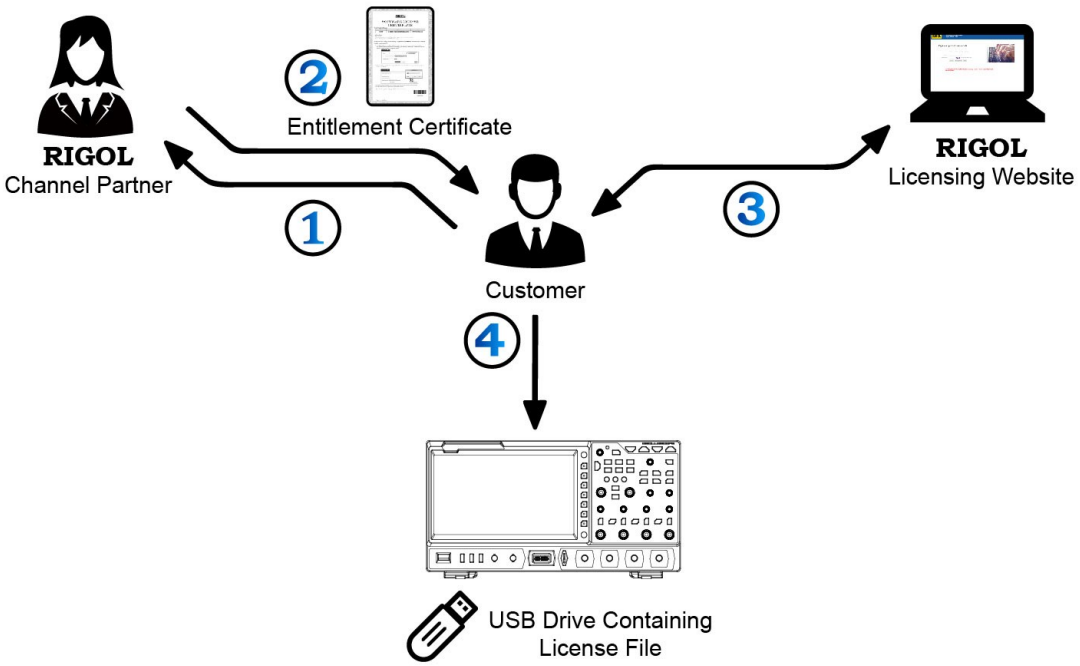
Order Information and Warranty Period

Order Information	Order No.
Model	
5 GHz, 5 GSa/s	DG70004
Standard Accessories	
Power Cord Conforming to the Standard of the Destination Country	— —
USB Cable	— —
Two 50 Ω, 18 GHz, SMA terminators per channel	— —
Performance Upgrade Option	
1.5 GSamples/channel upgrade option	DG70000-3RL
Function Upgrade Option	
Digital Up Converter (DUC) and IQ Modulation	DG70000-DIGUP
Complex Sequence function	DG70000-SEQ
DC Amplifier Output Option	DG70000-DC
USB-GPIB Interface Converter	USB-GPIB-L

Warranty Period

Three years for the mainframe, excluding the and accessories.

Option Ordering and Installation Process



1. According to the usage requirements, please purchase the corresponding functional options from your local **RIGOL Channel Partner,** and provide the serial number of the instrument that needs to install the option.
2. After receiving the option order, the RIGOL factory will mail the paper software product entitlement certificate to the address provided in the order.
3. Log in to **RIGOL** official website (www.rigol.com) for registration. Use the software key and oscilloscope serial number provided in the entitlement certificate to obtain the option license code and the option license file.
4. Download the option license file to the root directory of the USB storage device, and connect the USB storage device to the oscilloscope properly. After the USB storage device is successfully recognized, the **Option install** key is activated. Press this menu key to start installing the option.

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