



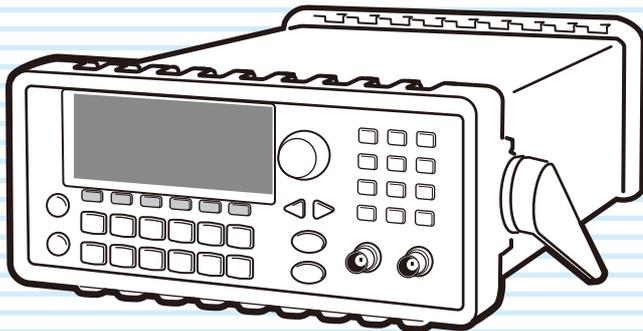
**KIKUSUI**

Part No. IB022477  
Apr. 2017

# User's Manual

Waveform/Function Generator

## FGA5050



General Information

1

Preparation

2

Common Settings

3

Waveform Output  
Settings

4

System Settings

5

Specifications

6

## About the Manuals

There are two manuals for the FGA5050: the User's Manual (this manual) and the Remote Interface Manual.

The manuals are intended for users of the FGA5050 and their instructors. The manuals assume that the reader has knowledge about the electrical aspects of signal generators.

- User's manual (this manual)  
This manual is intended for first-time users of the FGA5050. It gives an overview of the FGA5050, connecting procedures, safety precautions, etc. Please read through and understand this manual before operating the product.
- Remote interface manual  
This manual explains how to control the FGA5050 remotely using SCPI remote interface commands. The interface manual is written for readers with sufficient basic knowledge of how to control measuring instruments using a PC.

Every effort has been made to ensure the accuracy of this manual. However, if you have any questions or find any errors or omissions, please contact your Kikusui agent or distributor.

If you find any misplaced or missing pages in this manual, it will be replaced. If the manual gets lost or soiled, a new copy can be provided for a fee. In either case, please contact your Kikusui agent or distributor, and provide the "Part No." given on the cover.

After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

You can download the most recent version of the manuals from the Kikusui Electronics Corporation website (<http://www.kikusui.co.jp/en/download/>).

## The product that this manual covers

This user's manual is for the FGA5050 Waveform/Function Generator.

When contacting us about the product, please provide us with:  
The model (written on the front panel)  
The serial number (written on the rear panel)

## How to read this manual

This manual is designed to be read from beginning to end. We recommend that you read it thoroughly before using this product for the first time.

## Copyrights

The contents of this manual may not be reproduced, in whole or in part, without the prior consent of the copyright holder.

The specifications of this product and the contents of this manual are subject to change without prior notice.

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## Notations used in this manual

- In this manual, the FGA5050 Waveform/Function Generator may be referred to as "the FGA5050."
- The following markings are used in the explanations in the text.

### WARNING

Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.

### CAUTION

Indicates a potentially hazardous situation which, if ignored, may result in damage to the product or other property.

### NOTE

Indicates information that you should know.

### DESCRIPTION

Explanation of terminology or operation principle.

### See

Indicates a reference to detailed information.



## Safety Symbols

### DANGER

Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.

### WARNING

Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.

### CAUTION

Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.



Indicates a general danger, warning, or caution. When this symbol is marked on the product, see the relevant sections in the operation manual.



Indicates that a high voltage is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.



Indicates a location whose surface can become hot.



Shows that the act indicated is prohibited.



Direct current (DC)



Alternating current (AC)



Direct current (DC) and alternating current (AC)



Protective conductor terminal



Earth (ground) terminal



Chassis (frame) terminal



On (supply)



Off (supply)



On (supply) / standby  
This product is not completely disconnected from MAINS when it is in standby mode.



In position of a bi-stable push control



Out position of a bi-stable push control

### CAT II\*

IEC Measurement Category II

Applies to test and measuring circuits connected directly to utilization points of the low-voltage installation. This category applies to circuits connected to circuits of equipment on the primary side of a transformer. Such pieces of equipment have a power cord connected to a power outlet. Examples are household appliances and portable tools.

### CAT III\*

IEC Measurement Category III

Applies to test and measuring circuits connected to the distribution part of the building's low-voltage installation. For example, this category applies to circuits connected to distribution boards, circuit breakers, and wiring systems in the fixed distribution installation, and to stationary motors with a permanent connection to the fixed distribution installation.

### CAT IV\*

IEC Measurement Category IV

Applies to test and measuring circuits connected at the source of the building's low-voltage installation. For example, this category applies to circuits connected to a building's service lines, electricity meters, primary overcurrent protection equipment (switchboards and distribution boards), and their electric circuits.



Indicates that this product conforms to the requirements of the applicable EU directive.



Indicates that this product conforms to the requirements of the Waste Electrical and Electronic Equipment Directive.

In the EU, this product cannot be disposed of as domestic household waste.

When disposing of this product, follow the Waste Electrical and Electronic Equipment (WEEE) Directive.

In areas outside of the EU, dispose of it as per the instructions of the local authorities.

\* IEC 61010-2-030:2010 expresses other types of circuits that are not directly connected to MAINS (circuits that do not fall under CAT II to CAT IV) as "O" (Other).

## Safety Precautions

The following safety precautions must be observed to avoid fire hazards, electric shock, accidents, and other failures.

Using the product in a manner that is not specified in the operation manual may impair the protection functions provided by the product.



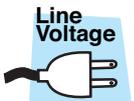
### Users

- This product must be used only by qualified personnel who understand the contents of this operation manual.
- If unqualified personnel is to use the product, be sure the product is handled under the supervision of qualified personnel (those who have electrical knowledge). This is to prevent the possibility of personal injury.



### Purpose

- Never use the product for purposes other than the product's intended use.
- This product is not designed or manufactured for general home or consumer use.



### Input power

- Use the product within the rated input power voltage range.
- For applying power, use the power cord provided. For details, see the respective page in the operation manual.
- This product is designed as an equipment of IEC Overvoltage Category II (energy-consuming equipment supplied from the fixed installation).



### Fuse

- With products with a fuse holder on the exterior surface, the fuse can be replaced with a new one. When replacing the fuse, use a fuse of shape, rating, and characteristics that conform to the product. For details, see the respective page in the operation manual.



### Cover

- Some parts inside the product may cause physical hazards. Do not remove the external cover.



### Grounding

- This product is IEC Safety Class I equipment (equipment with a protective conductor terminal). To prevent electric shock, be sure to connect the protective conductor terminal of the product to electrical ground (safety ground).



### Operation

- If a malfunction or abnormality is detected on the product, stop using it immediately, and remove the power plug from the outlet or turn off the circuit breaker of distribution. Make sure the product is not used until it is completely repaired.
- Use cables or wires with sufficiently large current capacity for output wires and load cables.
- Do not disassemble or modify the product. If you need to modify the product, contact your Kikusui distributor/agent.



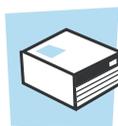
### Maintenance, Inspection and Calibration

- To maintain the performance and safe operation of the product, it is recommended that periodic maintenance, inspection, and cleaning be performed.
- To prevent the possibility of electric shock, remove the power plug from the outlet or turn off the circuit breaker of distribution before carrying out maintenance or inspection.
- Check periodically that there are no tears or breaks in the power cord.
- If the panel needs cleaning, gently wipe it using a soft cloth with water-diluted neutral detergent. Do not use volatile chemicals such as benzene or thinner.
- This product is calibrated before shipment. To maintain the product's performance, we recommend periodic calibration. To have your product calibrated, contact your Kikusui agent/distributor.



### Adjustments and Repairs

- Kikusui service engineers will perform internal service on the product. If the product needs adjustment or repairs, contact your Kikusui distributor/agent.

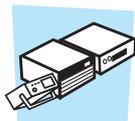


### Warning label

- Pay attention to the condition of the warning label attached to the outer surface of this product. If this label tears or falls off, replace with a new label. If you need a new label, contact your Kikusui agent or distributor.



## Precautions Concerning Installation Location



Note the following points when installing the product.

- Do not use the product in a flammable atmosphere.  
To prevent the possibility of explosion or fire, do not use the product near alcohol, thinner, or other combustible materials, or in an atmosphere containing such vapors.
- Avoid locations where the product is exposed to high temperature or direct sunlight.  
Do not install the product near a heater or in areas subject to drastic temperature changes. For the operating and storage temperature range of the product, see the specification table in the operation manual.
- Avoid high humidity.  
Do not install the product in high-humidity locations—near a boiler, humidifier, or water supply. For the operating and storage humidity range of the product, see the specification table in the operation manual.  
Condensation may occur even within the operating humidity range. In such cases, do not use the product until the condensation dries up completely.
- Be sure to use it indoors.  
This product is designed for safe indoor use.
- Do not install the product in a corrosive atmosphere.  
Do not install the product in a corrosive atmosphere or in environments containing sulfuric acid mist, etc. This may cause corrosion of various conductors and bad contacts of terminals inside the power supply leading to malfunction and failure, or in the worst case, a fire.
- Do not install the product in a dusty location.  
Accumulation of dust can lead to electric shock or fire.
- Do not use the product where ventilation is poor.  
On the rear panel of products that use fan-based forced air cooling, heat is expelled from vents. To prevent the heat from building up and causing a fire, keep the vents at least 20 cm away from walls. Also, do not place objects within 20 cm of the rear panel.  
For products that do not have fans and use unforced air cooling, air rises from the bottom panel to the top panel, so make sure that the bottom and top panels are not blocked.
- Do not place objects on the product.  
Placing objects on top of the product can cause failures (especially heavy objects).
- Do not install the product on an inclined surface or location subject to vibrations.  
The product may fall and break or cause personal injury.
- Do not use the product in a location where strong magnetic or electric fields are nearby or a location where large amount of distortion and noise is present on the input power supply waveform.  
The product may malfunction.
- Do not use the unit near highly sensitive measuring instruments or transceivers.  
The noise generated by the unit may affect them.
- Use the product in an industrial environment.  
This product may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.
- When installing products with casters, be sure to lock the casters.



## Precautions to Be Taken When Moving the Product



Note the following points when moving or transporting the product to the installation location.

- Turn off the power switch.  
Moving the product while the power is turned on can cause electric shock or damage to it.
- Remove all wiring.  
Moving the product with the wires connected can cause wires to break or injuries due to the product falling over.
- Use two or more persons when moving the product which weights more than 18 kg. The weight of the product is indicated on the rear panel of the product and in the specification table in this manual.
- Use extra precautions such as using more people when moving into or out of present locations including inclines or steps. Also handle carefully when relocating tall products as they can fall over easily.
- When transporting the product, be sure to use the original packing materials.  
Otherwise, damage may result from vibrations or from the product falling during transportation.
- Be sure to include the operation manual.

# Contents

Notations used in this manual .....	2
Safety Symbols .....	3
Safety Precautions .....	4
Precautions Concerning Installation Location .....	5
Precautions to Be Taken When Moving the Product .....	5

## 1 General Information

Product Overview .....	12
Features .....	12

## 2 Preparation

Checking the Package Contents .....	16
Using the Handle .....	17
Connecting the power cord .....	18
Factory Default Settings .....	20

## 3 Common Settings

Overview of the Common Settings .....	22
Display Mode .....	22
Numerical/Alphabetical Entry .....	23
Numerical entry .....	23
Alphabetical entry .....	23
Selecting an Output Function .....	24
Setting the Frequency or Period .....	25
Setting the Amplitude .....	26
Setting the DC Offset .....	28
Turning DC voltage output on and off ..	29
Setting the High and Low Level .....	30
Setting the Waveform Polarity .....	31
Setting the Output Impedance .....	32
Voltage Autoranging .....	33
Turning Output On and Off .....	34
Turning Sync Output On and Off .....	34
Restoring the Factory Default Settings .....	36

## 4 Waveform Output Settings

Waveform Output Overview .....	38
Sine Wave .....	39
Square Wave .....	40
Ramp Wave .....	42
Noise Wave .....	43
Pulse Wave .....	44

Arbitrary Waveform .....	46
Amplitude Modulation .....	48
Frequency Modulation .....	51
Phase Modulation .....	54
FSK Modulation .....	56
PWM Modulation .....	58
Frequency Sweep .....	60
Burst .....	64
Pattern Output .....	69

## 5 System Settings

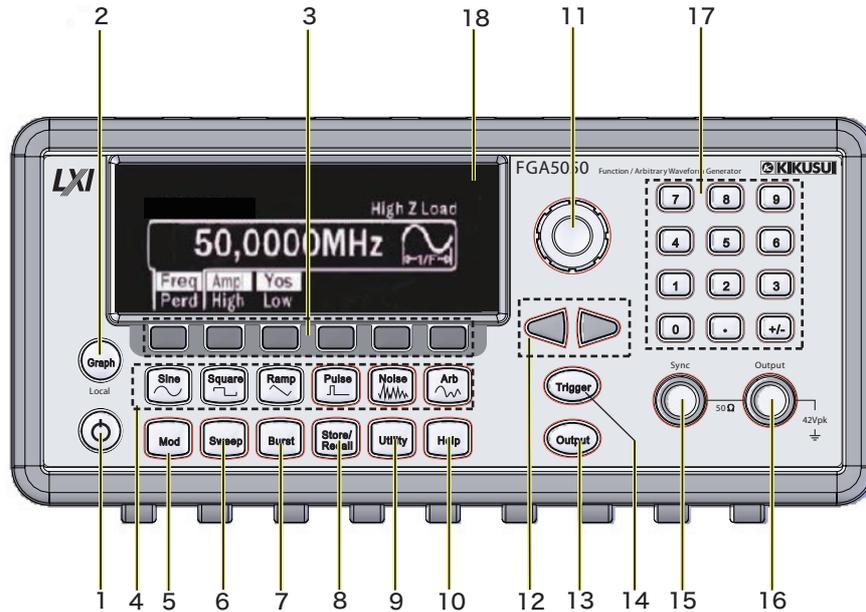
Overview of the System Settings .....	76
Trigger Settings .....	76
Selecting a trigger source .....	77
Software triggering .....	77
Trigger signal output .....	78
Storing and Recalling Setup Conditions ..	79
Storing .....	79
Recalling .....	80
Deleting the content of the memory ..	80
Recalling the contents of the memory when the power switch is turned on ..	81
Frequency Reference Output (10 MHz Out) Settings .....	82
Display Control .....	83
Beeper .....	84
Operation Confirmation Sound .....	84
Error Display .....	85

## 6 Specifications

Waveform characteristics .....	88
Common waveform characteristics .....	90
Modulation .....	91
Pattern output .....	93
General specifications .....	94

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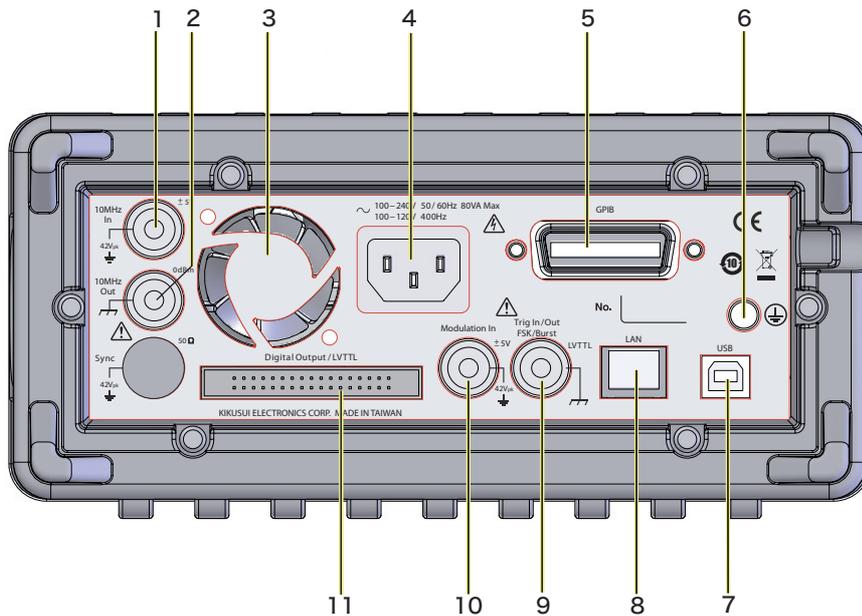
# Front panel



No.	Name	Description	See	
1	 Power switch	<p>Power switch/standby.</p> <ul style="list-style-type: none"> <li>This is a push-button switch. The power turns on when you press the switch. When you press the switch again, the power turns off (the FGA5050 goes into standby mode).</li> <li>In standby mode, the FGA5050 is not completely disconnected from the main power supply.</li> </ul>	p.19	
2	Graph/Local key	<p>Graph mode: Numbers and waveforms are used to display the waveform data.</p> <p>Local mode: Numbers are used to display the waveform data.</p>	p.22	
3	Menu operations	Softkeys	The softkey functions vary depending on the selected item.	
4	Waveform selection keys (lighted)	Sine key	Press to select a sine wave.	p.39
		Square key	Press to select a square wave.	p.40
		Ramp key	Press to select a ramp wave.	p.42
		Pulse key	Press to select a pulse wave.	p.44
		Noise key	Press to select a noise wave.	p.43
		Arb key	Press to select an arbitrary waveform.	p.46
5	Mod key (lighted)	Mod key	Press to select the modulation method.	p.48 p.51 p.54 p.56 p.58
6	Sweep key (lighted)	Sweep key	Press to enter sweep mode.	p.60

No.	Name		Description	
7	Burst key (lighted)	Burst key	Press to enter burst mode.	<i>p. 64</i>
8	Store/Recall key (lighted)	Store/Recall key	Press to store and recall setup conditions.	<i>p. 79</i>
9	Utility key (lighted)	Utility key	Opens the utility menu.	<i>p. 29</i> <i>p. 31</i> <i>p. 32</i> <i>p. 33</i> <i>p. 34</i> <i>p. 69</i> <i>p. 84</i> <i>p. 84</i>
10	Help key (lighted)	Help key	Press to display help topics and view error messages.	<i>p. 85</i>
11	Rotary knob		Use for numerical/alphabetical entry.	<i>p. 23</i>
12	Arrow keys	Right key	Moves the cursor to the next right digit.	-
		Left key	Moves the cursor to the next left digit.	-
13	Output key (lighted)	Output key	Turns waveform output on and off.	<i>p. 34</i>
14	Trigger key (lighted)	Trigger key	Use for manual triggering.	<i>p. 64</i> <i>p. 76</i>
15	Sync connector		Sync output connector.	<i>p. 34</i>
16	Output connector		Waveform output connector.	<i>p. 34</i>
17	Numeric keypad		Use to enter values.	<i>p. 23</i>
18	Display		Displays numeric values and graphs.	<i>p. 22</i>

# Rear panel



No.	Name	Description	<a href="#">See</a>
1	10 MHz In connector	For external frequency reference signal input	<i>p.91</i>
2	10 MHz Out connector	For frequency reference signal output	<i>p.91</i>
3	Vent	Cooling vent	-
4	AC inlet	Power inlet	<i>p.18</i>
5	GPIB (factory option)	GPIB port for controlling the FGA5050 remotely.	-
6	Protective conductor terminal	A grounding terminal for connecting to a power cord that does not have a three-prong plug.	-
7	USB	USB port for controlling the FGA5050 remotely	-
8	LAN	LAN port for controlling the FGA5050 remotely	-
9	Trig In/Out, FSK/Burst connector	Input connector for external triggering, external FSK modulation, and external gated burst mode	<i>p.56</i> <i>p.60</i> <i>p.64</i>
10	Modulation In connector	Input connector for external modulation signals (AM, FM, PM, and PWM)	<i>p.48</i> <i>p.51</i> <i>p.54</i> <i>p.58</i>
11	Digital Output/LVTTL connector	Connector for pattern output	<i>p.73</i>



# 1

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## General Information

This chapter contains general information about the FGA5050.

# Product Overview

The FGA5050 is a robust, highly versatile 50 MHz arbitrary waveform and function generator. It has built-in function waveforms and arbitrary waveforms. It is standard-equipped with USB and LAN interfaces.

## Features

- **Oscillation frequency: 50 MHz for sine waves and 25 MHz for square waves**
- **Waveforms: Sine, square, ramp, noise, pulse, and DC**
- **Arbitrary waveforms: Exponential rising, exponential falling, negative ramp (reverse ramp), sinc, and cardiac (cardiac electrogram)**
- **Equipped with 16-bit pattern output**
- **Equipped with frequency reference output and external frequency reference input**
- **Capable of displaying numeric values and graphs**
- **Standard-equipped with USB and LAN interfaces (the GPIB interface is a factory option)**
- **Fundamental Features**

Feature	
Display mode	In menu mode, numbers are used to display the waveform data. In graph mode, numbers and waveforms are used to display the waveform data.
Numerical/alphabetical entry	You can use the numeric keypad and the rotary knob to enter numeric values. You can use the (left and right) cursor keys and the rotary knob to enter alphabetic characters.
Output waveform	You can choose to generate standard, arbitrary, modulated, frequency sweep, or burst waveforms.
Frequency and period	You can set the frequency or the period.
Amplitude	You can set the amplitude and the amplitude unit.
DC offset	You can set a DC offset.
High and low level settings	You can set the amplitude and the DC offset by specifying a high level and a low level.
Waveform polarity	You can select Normal or Inverted mode.
Load resistance	You can specify a value between 1 $\Omega$ and 10 k $\Omega$ or specify Hi-Z (high impedance).
Voltage autoranging	You can enable or disable voltage autoranging.
Output on/off	You can turn output on and off. Output is automatically disabled when an excessive external voltage is applied.
Sync output	You can turn sync output on and off.
Factory default settings	You can restore the FGA5050 factory default settings.

## ● Waveform output settings

Feature	
Sine waves	You can set the frequency or period, amplitude, and DC offset of sine waves.
Square waves	You can set the frequency or period, amplitude, and DC offset of square waves.
Ramp waves	You can set the frequency or period, amplitude, and DC offset of ramp waves.
Noise waves	You can set the amplitude and DC offset of noise waves.
Pulse waves	You can set the frequency or period, amplitude, and DC offset of pulse waves.
Arbitrary waveforms	You can select an exponential rising wave, exponential falling wave, negative ramp wave (reverse ramp wave), sinc wave, or cardiac wave (cardiac electrogram wave).
Amplitude modulation	You can configure amplitude modulation (AM). You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.
Frequency modulation	You can configure frequency modulation (FM). You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.
Phase modulation	You can configure phase modulation (PM). You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.
FSK modulation	You can configure FSK (frequency-shift keying) modulation. You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.
PWM modulation	You can configure phase width modulation (PWM). The carrier wave must be a pulse wave.
Frequency sweep	You can sweep from a start frequency to a stop frequency. You can choose to use a logarithmic or linear sweep.
Burst	You can generate the selected waveform for the specified number of cycles. You can select a sine wave, ramp wave, pulse, square waveform, arbitrary waveform, or noise wave.
Pattern output	You can generate a pattern that has a 16-bit resolution and up to 256 K points.

## ● System settings

Feature	
Trigger settings	You can select internal triggering, external triggering, or manual triggering.
You can store and recall setup conditions	You can store setup conditions to four non-volatile memory locations.
Display control	You can turn off the display.
Beeper	You can turn the beeper off.
Operation confirmation sound	You can turn the operation confirmation sound off.
Error display	Errors are displayed in first in, first out (FIFO) order.

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# 2

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## Preparation

This chapter describes how to unpack and prepare this product before you use it.

# Checking the Package Contents

When you receive the product, check that all accessories are included and that the accessories have not been damaged during transportation. If any of the accessories are damaged or missing, contact your Kikusui agent or distributor.

We recommend that all packing materials be saved, in case the product needs to be transported at a later date.

## Accessories

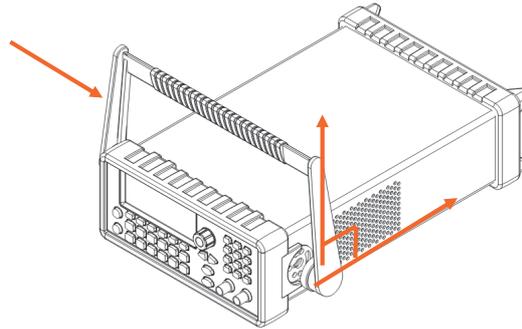
Item	Quantity
Power cord	1 pc.
Pattern generator cable	1 pc.
USB cable	1 pc.
CD-ROM (includes a PDF of the operation manual and the application software)	1 pc.
Packing list, safety precautions	1 English, 1 Japanese

# Using the Handle

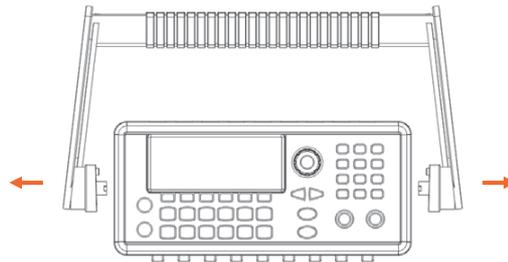
## You can remove the handle

Move the handle to the vertical position above the FGA5050 before removing it.

- 1 Hold the handle's attachment parts (on the left and right), and pull them outwards.
- 2 Move the handle to the vertical position above the FGA5050.



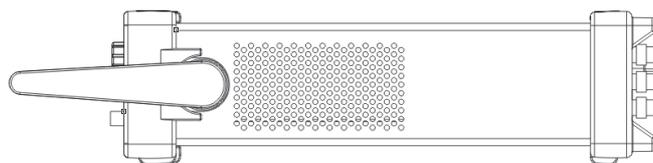
- 3 Pull the handle's attachment parts (on the left and right) outwards to detach them.



## You can adjust the handle angle.

- 1 Hold the handle's attachment parts (on the left and right), and pull them outwards.
- 2 Move the handle to the desired position.  
If you are going to carry the FGA5050 by the handle, move the handle to the position shown below.

When you move the FGA5050 using its handle



# Connecting the power cord

## **WARNING**

To avoid electric shock:

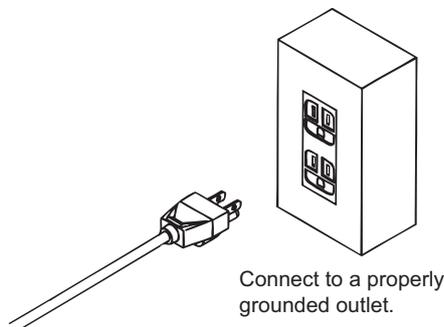
- This product is a piece of equipment that conforms to IEC Safety Class I (equipment that has a protective conductor terminal). Be sure to ground (earth) the unit.
- The product is grounded through the power cord ground wire. Connect the protective conductor terminal to earth ground.

## **NOTE**

- Use the supplied power cord to connect to the AC line.  
If the supplied power cord cannot be used due to the rated voltage or the plug shape, have a qualified engineer replace it with an appropriate power cord of length 3 m or less. If obtaining a power cord is difficult, contact your Kikusui agent or distributor.
- The power cord with a plug can be used to disconnect the FGA5050 from the AC line in an emergency. Connect the plug to an easily accessible power outlet so that the plug can be removed from the outlet at any time. Be sure to provide adequate clearance around the power outlet.
- Do not use the supplied power cord on other instruments.

This product is a piece of equipment that conforms to IEC Overvoltage Category II (energy-consuming equipment that is supplied from a fixed installation).

- 1 Turn off the power switch.**
- 2 Check that the AC power supply meets the nominal input rating of the product.**  
The product can receive a nominal line voltage in the range of 100 Vac to 240 Vac at 50 Hz or 60 Hz.  
At 400 Hz, the product can receive a nominal line voltage in the range of 100 Vac to 120 Vac.
- 3 Connect the power cord to the AC inlet (the voltage setting selector area) on the rear panel.**
- 4 Connect the power plug to an outlet with a ground terminal.**



### ■ Turning the power switch on

#### 5 Press the power switch .

The FGA5050 will start up with the factory default settings. If you notice strange sounds, unusual odors, fire, or smoke around or from inside the FGA5050, turn the power switch off.

### ■ Turning the power switch off

#### 6 Press the power switch .

The FGA5050 enters standby mode. In standby mode, the FGA5050 is not completely disconnected from the main power supply.

# Factory Default Settings

See p.36

The FGA5050 starts up with the factory default settings when you turn on the power switch. The factory default settings are indicated below.

Item		Factory default setting
Output settings	Waveform	Sine wave
	Frequency	1 kHz
	Amplitude	100 mVpp
	DC offset	0.000 Vdc
	Output unit	Vpp
	Output impedance	50 Ω
	Autoranging	On
Modulation	Carrier wave (AM, FM, PM, or FSK)	1 kHz sine wave
	Carrier wave (PWM)	1 kHz pulse
	Modulation signal (AM)	100 Hz sine wave
	Modulation signal (PM, FM, or PWM)	10 Hz sine wave
	Amplitude modulation depth	100 %
	Frequency modulation, frequency deviation	100 Hz
	Phase modulation, phase deviation	180 °
	FSK hop frequency	100 Hz
	FSK rate	10 Hz
	PWM modulation, pulse width deviation	10 μs
	Modulation operation	Off
Sweep	Start/stop frequency	100 Hz/1 kHz
	Sweep time	1 s
	Sweep mode	Linear
	Sweep operation	Off
Burst	Burst count	1
	Burst period	10 ms
	Starting burst phase	0 °
	Burst operation	Off
System settings	Power-Down Recall	Disabled
	Display mode	ON
	Error queue	0 errors
	Output on/off	Off
Trigger	Trigger source	Internal triggering (Immediate)
Remote interface	GPIO address	10
	DHCP	On
	IP address	169.254.02.020
	Subnet mask	255.255.0.0
	Default gateway	0.0.0.0
	DNS server	0.0.0.0
	Host name	None
Domain name	None	



# 3

---

## Common Settings

This chapter explains the basic operating procedures of the FGA5050.

# Overview of the Common Settings

The common settings of the FGA5050 are shown in the following table.

Settings		
Display mode	In menu mode, numbers are used to display the waveform data. In graph mode, numbers and waveforms are used to display the waveform data.	p.22
Numerical/alphabetical entry	You can use the numeric keypad and the rotary knob to enter numeric values. You can use the (left and right) cursor keys and the rotary knob to enter alphabetic characters.	p.23
Output waveform	You can choose to generate standard, arbitrary, modulated, frequency sweep, or burst waveforms.	p.24
Frequency and period	You can set the frequency or the period.	p.25
Amplitude	You can set the amplitude and the amplitude unit.	p.26
DC offset voltage	You can set the DC offset.	p.28
High and low levels	You can set the amplitude and the DC offset by specifying a high level and a low level.	p.30
Waveform polarity	You can select Normal or Inverted mode.	p.31
Load resistance	You can specify a value between 1 $\Omega$ and 10 k $\Omega$ or specify Hi-Z (high impedance).	p.32
Voltage autoranging	You can enable or disable voltage autoranging.	p.33
Output on/off	You can turn output on and off. Output is automatically disabled when an excessive external voltage is applied.	p.34
Sync output	You can turn the Sync output signal on and off.	p.34
Factory default	You can set the FGA5050 to its factory default settings.	p.36

## Display Mode

There are two display modes: the menu mode and the graph mode.

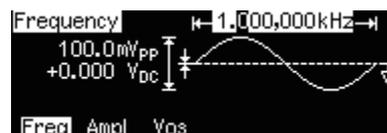
In menu mode, numbers are used to display the waveform data. In graph mode, numbers and waveforms are used to display the waveform data.

You can view the waveform visually in graph mode and change the waveform parameters by using the rotary knob and the (left and right) cursor keys. You can only use the rotary knob to adjust parameter values up to a certain resolution. To finely adjust the parameters, use the numeric keypad to input the desired values, or set them in menu mode.

Menu mode



Graph mode



- 1 Press Graph.**  
Graph mode is enabled.
- 2 Press Graph again.**  
Menu mode is enabled again.

# Numerical/Alphabetical Entry

You can use the numeric keypad and the rotary knob to enter numeric values. You can use the (left and right) cursor keys and the rotary knob to enter alphabetic characters.

## Numerical entry

You can use the numeric keypad and the rotary knob to enter numeric values. Use the (left and right ) cursor keys to move the cursor on the display and the rotary knob to increase or decrease the digit.

When you use the numeric keypad, all the available units appear on the display. Press a unit's softkey to select it.

### Entering a value using the rotary knob

- 1 Use the (left and right ) cursor keys to move the cursor on the display.**
- 2 Turn the rotary knob to set the value and the unit.**  
The settings are applied.

### Entering a value using the numeric keypad

- 1 Enter a value.**  
All the valid units are assigned to softkeys.
- 2 Press a unit's softkey to select it.**  
The settings are applied. If you entered the wrong value, press the Cancel softkey, and reenter the value.

## Alphabetical entry

To enter alphabetical characters, turn the rotary knob until the desired letter appears on the display. Use the cursor keys to move the cursor and enter the next letter or to modify a previously entered letter. You can also use the +/- key on the keypad to delete the previously entered letter.

### Entering alphabetical characters using the rotary knob

- 1 Use the (left and right ) cursor keys to move the cursor on the display.**
- 2 Turn the rotary knob to select a character.**  
The settings are applied. You cannot select letters in the numerical entry portion.

# Selecting an Output Function

The following output functions are available:

## ■ Standard waveforms

There are five standard waveform outputs: sine, square, ramp, pulse and noise. The factory default waveform output is a sine wave.

See p.39, p.42,  
p.44, p.43

## ■ Arbitrary waveforms

You can create five arbitrary waveform types. You can customize the waveforms using the software, Wavepatt, that came with the unit.

See p.46

## ■ Modulation

You can modulate sine, square, ramp, and arbitrary waveforms using AM, FM, PM, or FSK. You can also use PWM to modulate pulse waveforms.

See p.48, p.51  
p.54, p.56, p.58

## ■ Frequency sweeping

Linear and logarithmic frequency sweeping modes are available for sine, square, ramp, and arbitrary waveforms.

See p.60

## ■ Burst operation

You can generate a burst waveform from any single standard or arbitrary waveform (except for DC).

See p.64

## Setting limits

Frequency limit	<ul style="list-style-type: none"><li>When the maximum frequency of a newly selected waveform is less than that of the previously selected waveform, the maximum frequency is automatically set to the maximum frequency of the newly selected waveform.</li></ul>
Amplitude limit	<ul style="list-style-type: none"><li>When the maximum amplitude of a newly selected waveform is less than that of the previously selected waveform, the maximum amplitude is automatically set to the maximum amplitude of the newly selected waveform. This type of situation occurs when the output unit becomes Vrms or dBm because of the differences between the crest factors of the different output waveforms.</li></ul>

## Remote interface operation

```
FUNction {SINusoid|SQUare|RAMP|PULSe|NOISe|DC|USER|PATTern}
```

You can use a single APPLY command to set the waveform, frequency, amplitude, and DC offset all at once.

# Setting the Frequency or Period

To set the frequency or period, press the Freq/Perd softkey to switch between the frequency and the period. The frequency range that you can select varies depending on the waveform.

## Setting conditions

Frequency range	Sine	1 $\mu$ Hz to 50 MHz
	Square	1 $\mu$ Hz to 25 MHz
	Ramp	1 $\mu$ Hz to 200 kHz
	Pulse	500 $\mu$ Hz to 10 MHz
	Arbitrary	1 $\mu$ Hz to 10 MHz
Factory default frequency setting	Sine	1 kHz
Frequency limit	• If the current frequency setting exceeds the maximum frequency of a newly selected waveform, the maximum frequency is automatically set to the smaller of the two maximum frequencies.	

## Procedure

### 1 Press one of the waveform keys to select a waveform.

The selected key lights.

### 2 Press the Freq/Perd softkey.

To set the frequency, use the key to highlight Freq. To set the period, use the key to highlight Perd.

Frequency Setting



Period Setting



### 3 Use the numeric keypad or the cursor keys and the rotary knob to set the frequency or the period.

The settings are applied.

## Remote interface operation

FREQuency {<frequency> | MINimum | MAXimum}

# Setting the Amplitude

To set the amplitude, press the Ampl/High softkey. You can also set the amplitude by specifying a high and low level. You can set the amplitude unit to Vpp, Vrms, or dBm.

## Setting conditions

Factory default amplitude setting	<ul style="list-style-type: none"><li>• 100 mVpp (for a 50 Ω load)</li></ul>
Amplitude units	<ul style="list-style-type: none"><li>• You can select Vpp, Vrms, or dBm. When the load resistance is set to high impedance, you cannot select dBm. The unit is automatically set to Vpp.</li><li>• The unit setting is stored in volatile memory. The factory default setting is restored after the power is turned off and after the FGA5050 is reset from the remote interface.</li><li>• The factory default setting is Vpp.</li></ul>
DC offset limit	<ul style="list-style-type: none"><li>• The output amplitude is determined by the following equation: <math display="block">V_{pp} \leq 2 \times (V_{max} -  V_{offset} )</math></li><li>• where Vmax is the maximum peak voltage for the selected load resistance. (5 V for a 50 Ω load or 10 V for a high-impedance load).</li></ul>
Amplitude limits caused by unit selections	<ul style="list-style-type: none"><li>• The limit of the output amplitude may be affected by the unit settings. This type of situation occurs when the unit becomes Vrms or dBm because of the differences between the crest factors of the different output waveforms. For example, if you output a 5 Vrms square wave (into 50 Ω) and then change it to a sine wave, the FGA5050 automatically sets the output amplitude to 3.536 Vrms, which is the maximum for sine waves in Vrms.</li></ul>
Relationship between the load resistance and the amplitude	<ul style="list-style-type: none"><li>• The output amplitude is automatically set when you change the load resistance. For example, when you change the output termination from 50 Ω to high impedance, the amplitude and DC offset are doubled. When you change the output termination from high impedance to 50 Ω, the amplitude and DC offset are halved.</li></ul>
Amplitude limit for arbitrary waveforms	<ul style="list-style-type: none"><li>• If the waveform data points do not span the full range of the output DAC (digital-to-analog converter), the maximum amplitude is limited. For example, if the built-in sinc wave does not span the maximum range ±1, its maximum amplitude is limited to 6.087 Vpp (into 50 Ω).</li></ul>

## Procedure

### 1 Press one of the waveform keys to select a waveform.

The selected key lights.

### 2 Press the Ampl/ High softkey.

Use the key to highlight Ampl.



### 3 Use the numeric keypad or the cursor keys and the rotary knob to set the amplitude.

The settings are applied.

See p.30

### ■ Setting the High and Low Levels

High Level Setting



Low Level Setting



Setting the amplitude by specifying a high level and a low level is the same as setting the amplitude and the DC offset.

For example, if you set the high level to +2 V and the low level to -3 V, the DC offset is -0.5 V, and the amplitude is 5 Vpp.



### ■ Setting the amplitude unit to dBm

See p.32

When you set the unit of amplitude to dBm, to achieve the correct amplitude, you need to set the output impedance to 50  $\Omega$ .

### ■ Output attenuator switching

When you change the amplitude, you may notice a disruption in the output waveform at certain voltages. This disruption is caused by the switching of the output attenuators. However, the amplitude is controlled, so the output voltage will never exceed the current setting. To prevent this type of output disruption, disable voltage autoranging.

## Remote interface operation

---

```
VOLTage {<amplitude>|MINimum|MAXimum}
```

```
VOLTage:UNIT {VPP|VRMS|DBM}
```

The command for setting the unit

---

# Setting the DC Offset

To set the DC offset, press the Vos/Low softkey. You can also set the DC offset from the Utility menu. The range within which the DC offset can be set is limited by the amplitude and the load resistance.

## Setting conditions

Relationship between the amplitude and the output impedance	<ul style="list-style-type: none"><li>The DC offset, Voffset, is determined by the following equation: <math> V_{\text{offset}}  \leq V_{\text{max}} - V_{\text{pp}}/2</math></li><li>where Vmax is the maximum peak voltage for the selected output impedance. (5 V for a 50 Ω load or 10 V for a high-impedance load). If the specified DC offset is invalid, the DC offset is automatically set to the maximum allowable value for the specified amplitude.</li><li>The factory default DC offset setting is 0 V.</li></ul>
Amplitude limit for arbitrary waveforms	<ul style="list-style-type: none"><li>If the waveform data points do not span the full range of the output DAC (digital-to-analog converter), the maximum DC offset and maximum amplitude are limited.</li></ul>

## Procedure

### 1 Press one of the waveform keys to select a waveform.

The selected key lights.

### 2 Press the Vos/Low softkey.

Use the key to highlight Vos.



### 3 Use the numeric keypad or the cursor keys and the rotary knob to set the DC offset.

The settings are applied.

#### ■ Setting a high and low level

Setting the amplitude by specifying a high level and a low level is the same as setting the amplitude and the DC offset.

For example, if you set the high level to +2 V and the low level to -3 V, the DC offset is -0.5 V, and the amplitude is 5 Vpp.

## Remote interface operation

```
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
```

See p.30

## Turning DC voltage output on and off

You can generate DC voltage. The voltage that you can set is determined by the output impedance. The maximum voltage that you can set is  $\pm 5$  V for a  $50 \Omega$  load or  $\pm 10$  V for a high-impedance load.

### Procedure

- 1 Press Utility.**  
The Utility key lights. The Utility menu appears.
- 2 Press the DC/ OFF softkey.**  
ON is highlighted. All the waveform key lights turn off.
- 3 Use the numeric keypad or the cursor keys and the rotary knob to set the DC voltage.**  
The settings are applied.

# Setting the High and Low Level

You can set the amplitude and the DC offset by specifying a high level and a low level.

## Procedure

**1 Press one of the waveform keys to select a waveform.**  
The selected key lights.

**2 Press the Ampl/ High softkey.**  
Use the key to highlight High.

High Level Setting



Low Level Setting



**3 Use the numeric keypad or the cursor keys and the rotary knob to set the high level.**

The high level setting is applied.

**4 Press the Vos/Low softkey.**  
Use the key to highlight Low.

**5 Use the numeric keypad or the cursor keys and the rotary knob to set the low level.**

The low level setting is applied.

## Remote interface operation

---

```
VOLTage:HIGH {<voltage>|MINimum|MAXimum}  
VOLTage:LOW {<voltage>|MINimum|MAXimum}
```

---

# Setting the Waveform Polarity

You can set the waveform polarity mode to Normal or Inverted. In Normal mode, the first part of the waveform cycle is positive. In Inverted mode, the first part of the waveform cycle is negative.

## Setting conditions

Factory default	• Normal mode: The first part of the waveform cycle is positive.
When a DC offset has been set	• If a DC offset other than 0 V has been set, the waveform polarity is determined on the basis of the DC offset, in other words, the part of the waveform above the DC offset is considered positive while the part below the DC offset is considered negative. The DC offset is not affected by the polarity.
Sync output	• When the waveform is inverted, the Sync output associated with the waveform is not inverted.

## Procedure

- 1 Press Utility.**  
The Utility key lights.
- 2 Press the Output Setup softkey.**
- 3 Press the Norm/ Invt softkey to switch between Normal and Inverted mode.**  
The name of the selected mode is highlighted.
- 4 Press the DONE softkey to finish configuring the settings.**  
The settings are applied.

## Remote interface operation

```
OUTPut:POLarity {NORMal|INVerted}
```

# Setting the Output Impedance

The output impedance of the FGA5050 Output connector is 50  $\Omega$ . When the load resistance is not 50  $\Omega$ , the values specified for the output amplitude and the DC offset will be different from the actual values. To compensate for this difference, if you enter the actual load resistance, you can set the correct output amplitude and DC offset.

## Setting conditions

Factory default output impedance setting	• 50 $\Omega$
Output impedance range	• You can specify a value between 1 $\Omega$ and 10 k $\Omega$ or specify Hi-Z (high impedance).
Amplitude unit	• When the unit is set to dBm and you set the output impedance to high, the unit is automatically set to Vpp.

## Procedure

- 1 Press Utility.**  
The Utility key lights.
- 2 Press the Output Setup softkey.**  
Use the key to highlight Load. If Load isn't highlighted, press the softkey so that Load is highlighted.



- 3 Use the numeric keypad or the cursor keys and the rotary knob to set the impedance.**  
The settings are applied.
- 4 You can select high impedance by pressing the Load/Hi-Z softkey.**  
Use the key to highlight High Z.
- 5 Press the DONE softkey to finish configuring the setting.**  
The setting is applied.

## Remote interface operation

```
OUTPut:LOAD {<ohms> | INFinity | MINimum | MAXimum}
```

# Voltage Autoranging

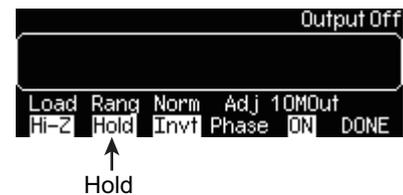
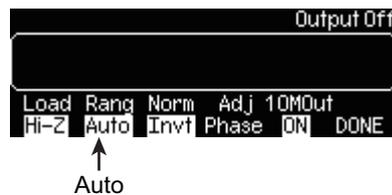
You can configure the output attenuators to obtain the optimal output. The output attenuators can be switched through autoranging or according to a fixed range. In autoranging, the FGA5050 sets the optimal conditions for the output amplifier and attenuators.

## Setting conditions

Factory default • Autoranging

## Procedure

- 1 Press Utility.**  
The Utility key lights.
- 2 Press the Output Setup softkey.**
- 3 Press the Rang softkey to switch between Auto (autoranging) and Hold (fixed range).**



- 4 Press the DONE softkey to finish the selection.**  
The setting is applied.

### ■ Output attenuator switching

When you change the amplitude, you may notice a disruption in the output waveform at certain voltages. This disruption is caused by the switching of the output attenuators. However, the amplitude is controlled, so the output voltage will never exceed the current setting. To prevent this type of output disruption, disable voltage autoranging.

### ■ Effects of turning autoranging off

When autoranging is off and the amplitude falls to a level lower than the expected range, the accuracy and resolution of the amplitude and DC offset are affected. When autoranging is on, it may not be possible to set the smallest amplitude that can be output.

## Remote interface operation

VOLTage:RANGe:AUTO {OFF|ON|ONCE}

# Turning Output On and Off

You can use the Output key to turn output on and off.

## Setting conditions

Factory default	• Output off
-----------------	--------------

## Procedure

### 1 Press Output to turn output on or off.

When output is on, the Output key lights.

## Remote interface operation

OUTPut {OFF ON}
-----------------

### NOTE

- When an excessive external voltage is applied to the Output connector, output is automatically stopped, and an error message appears. To recover from the error, turn on the output after first removing the excessive voltage being applied to the Output connector.

# Turning Sync Output On and Off

Sync output is generated for all the standard output functions, except DC and noise.

## Setting conditions

Signal level when sync output is off	• When sync output is off, a TTL low signal is generated.
Storing the sync output on/off setting	• The sync output on/off setting is stored in non-volatile memory. The stored setting remains in the memory even after the power is turned off.
For sine, ramp, and pulse waves	• The Sync signal is a square waveform with a 50 % duty cycle.
When a DC offset has been set	• The sync signal is a TTL high when the waveform polarity is positive with respect to the DC offset and a TTL low when the waveform polarity is negative with respect to the DC offset.
For square waveforms	• The Sync signal is a square waveform with the same duty cycle.
For arbitrary waveforms	• The sync signal is a square waveform with a 50 % duty cycle. • When the first waveform point is output, the sync signal is a TTL high.
For internal modulation (AM, FM, PM, and PWM)	• The sync signal is aligned with the modulation signal and is a square wave with a 50 % duty cycle. • The sync signal is a TTL high during the first half period of the modulation signal.
For external modulation (AM, FM, PM, and PWM)	• The sync signal is aligned with the carrier waveform and is a square wave with a 50 % duty cycle.

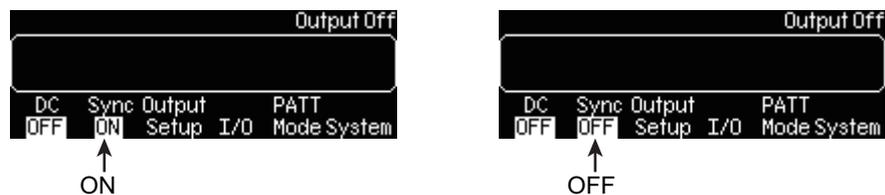
For FSK modulation	<ul style="list-style-type: none"> <li>The Sync signal is aligned with shifts in frequency. The sync signal is a TTL high during the output of the hop frequency and a TTL low during the output of the carrier frequency.</li> </ul>
For frequency sweeping	<ul style="list-style-type: none"> <li>When the marker frequency is on, the sync signal is a TTL high when sweeping starts and changes to a TTL low at the marker frequency.</li> <li>When the marker frequency is off, the sync signal is a square wave with a 50 % duty cycle. The sync signal is a TTL high when sweeping starts and changes to a TTL low at the central point of the sweep.</li> </ul>
For triggered bursts	<ul style="list-style-type: none"> <li>When the burst is triggered, the sync signal is a TTL high.</li> <li>The sync signal changes to a TTL low at the end of the specified number of cycles (this may not be at a zero-crossing point if the waveform has a non-zero phase).</li> <li>If the burst count is set to infinite, the sync signal is generated in the same way that it is for continuous waveforms.</li> </ul>
For externally gated signals with short pulse widths	<ul style="list-style-type: none"> <li>The sync signal becomes a TTL high at the start of the externally gated signal.</li> <li>The sync signal will not change to a TTL low until the end of the last cycle (this may not be at a zero-crossing point if the waveform has a non-zero phase).</li> </ul>
Relationship to the output waveform polarity	<ul style="list-style-type: none"> <li>Even if the polarity of a waveform is inverted, the corresponding sync signal is not affected.</li> </ul>

## Procedure

### 1 Press Utility.

The Utility key lights.

### 2 Press the Sync softkey to switch between the ON and OFF settings.



### 3 Press Utility again.

The Utility key light turns off. The configuration of the sync output on/off setting is complete.

## Remote interface operation

---

OUTPut:SYNC {OFF|ON}

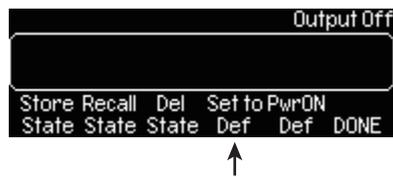
---

# Restoring the Factory Default Settings

Restore the factory default settings of the FGA5050.

**1 Press Store/Recall.**  
The Store/Recall key lights.

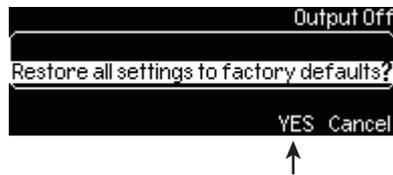
**2 Press the Set to Def softkey.**



Output Off  
Store Recall Del Set to PwrON  
State State State Def Def DONE

↑

**3 Press the Yes softkey.**



Output Off  
Restore all settings to factory defaults?  
YES Cancel

↑

See p.20

The factory default settings of the FGA5050 are restored.

To cancel the restoration of the factory default settings, press the Cancel softkey and then the DONE softkey.



# 4

---

## Waveform Output Settings

This chapter explains the waveform output settings that can be set from the front panel.

# Waveform Output Overview

The following waveform output settings are available.

Settings		
Sine wave	Sine wave settings.	p. 39
Square wave	Square wave settings.	p. 40
Ramp wave	Ramp wave settings.	p. 42
Noise wave	Noise wave settings.	p. 43
Pulse wave	Pulse wave settings.	p. 44
Arbitrary waveform	Arbitrary waveform settings. The available arbitrary waveforms include an exponential rising wave, exponential falling wave, negative ramp wave (reverse ramp wave), sinc wave, and cardiac wave (cardiac electrogram wave).	p. 46
Amplitude modulation	Amplitude modulation (AM) settings. You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.	p. 48
Frequency modulation	Frequency modulation (FM) settings. You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.	p. 51
Phase modulation	Phase modulation (PM) settings. You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.	p. 54
FSK modulation	FSK (frequency-shift keying) settings. You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.	p. 56
PWM modulation	Pulse width modulation (PWM) settings. The carrier wave must be a pulse wave.	p. 58
Frequency sweep	You can sweep from a start frequency to a stop frequency. You can choose to use a logarithmic or linear sweep. You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.	p. 60
Burst	You can generate the selected waveform for the specified number of cycles. You can set the waveform to a sine wave, ramp wave, pulse, square waveform, arbitrary waveform, or noise wave.	p. 64
Pattern output	You can generate a pattern that has a 16-bit resolution and up to 256 K points.	p. 69

## Modulation methods and carrier waves

Modulation Method	Carrier Wave						
	Sine wave	Square wave	Ramp wave	Noise wave	Pulse wave	Arbitrary waveform	DC output
Amplitude modulation	Selectable	Selectable	Selectable	-	-	Selectable	-
Frequency modulation	Selectable	Selectable	Selectable	-	-	Selectable	-
Phase modulation	Selectable	Selectable	Selectable	-	-	Selectable	-
FSK modulation	Selectable	Selectable	Selectable	-	-	Selectable	-
PWM modulation	-	-	-	-	Selectable	-	-

# Sine Wave

The method for configuring a sine wave is explained below.

## Setting conditions

Frequency range	<ul style="list-style-type: none"><li>• 1 <math>\mu</math>Hz to 50 MHz</li><li>• The factory default setting is 1 kHz.</li></ul>
-----------------	--

## Procedure

- 1 Press Sine.**  
The Sine key lights.
- 2 Set the frequency or period, amplitude, DC offset, etc.**

 p. 25, p. 26,  
p. 28



- 3 To check the waveform parameters, press Graph.**  
Graph mode is enabled.

## Remote interface operation

```
APPLY:SINusoid [<frequency>[,<amplitude>[,<offset>]]]
```

or

```
FUNCTION {SINusoid}  
FREQUENCY {<frequency>|MINimum|MAXimum}  
VOLTage {<amplitude>|MINimum|MAXimum}  
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
```

# Square Wave

The method for configuring a square wave is explained below. The duty cycle of a square wave represents the amount of time in each cycle during which the wave is at the high level.

- **Duty cycle = (High level time interval) / period x 100 %**

## Setting conditions

Frequency range	<ul style="list-style-type: none"><li>• 1 <math>\mu</math>Hz to 25 MHz</li><li>• The factory default setting is 1 kHz.</li></ul>
Factory default duty cycle setting	<ul style="list-style-type: none"><li>• The factory default setting is 50 %. The setting is stored while the FGA5050 is being used, but the factory default setting is restored after the power is turned off or the FGA5050 is reset from the remote interface.</li></ul>
Duty cycle memory	<ul style="list-style-type: none"><li>• When you change the output waveform from a square waveform to another waveform, the duty cycle is retained. The same duty cycle is used when you select a square waveform again.</li></ul>
Duty cycle range	<ul style="list-style-type: none"><li>• For frequencies greater than 10 MHz: The duty cycle range is 40 % to 60 %. For other frequencies: The duty cycle range is 20 % to 80 %. If you specify a duty cycle that is outside of the range, the maximum duty cycle within the range is automatically selected.</li></ul>
Automatic duty cycle setting	<ul style="list-style-type: none"><li>• If you change to a new frequency at which the previous duty cycle can no longer be used, the duty cycle is automatically set to the closest value to the new frequency.</li></ul>
Duty cycles of modulation signals	<ul style="list-style-type: none"><li>• If you set the modulation signal to a square wave, the duty cycle is fixed at 50 %.</li><li>• The duty cycle setting also applies to AM, FM, PM, and PWM square carrier waves.</li></ul>

## Procedure

### 1 Press Square.

The Square key lights.

### 2 Set the frequency or period, amplitude, DC offset, etc.



### 3 Press the DutyCycle softkey.

The duty cycle can now be set.

### 4 Use the numeric keypad or the cursor keys and the rotary knob to set the duty cycle.

Set the unit to %. To change the value, press the Cancel softkey and reenter it.

### 5 To check the waveform parameters, press Graph.

Graph mode is enabled.

See p. 25, p. 26,  
p. 26

## Remote interface operation

---

```
APPLY:SQUare [<frequency>[,<amplitude>[,<offset> or
```

```
FUNCTION {SQUare}
```

```
FREQUENCY {<frequency>|MINimum|MAXimum}
```

```
VOLTage {<amplitude>|MINimum|MAXimum}
```

```
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
```

```
FUNCTION:SQUare:DCYCLE {<percent>|MINimum|MAXimum}
```

---

# Ramp Wave

A ramp wave is a triangle wave with adjustable symmetry. A ramp wave's symmetry is the percentage of time during which the ramp wave is rising.

## Setting conditions

Frequency range	<ul style="list-style-type: none"><li>• 1 <math>\mu</math>Hz to 200 kHz</li><li>• The factory default setting is 1 kHz.</li></ul>
Factory default symmetry setting	<ul style="list-style-type: none"><li>• The factory default setting is 100 %. The setting is stored while the FGA5050 is being used, but the factory default setting is restored after the power is turned off or the FGA5050 is reset from the remote interface.</li></ul>
Symmetry memory	<ul style="list-style-type: none"><li>• When you change the output waveform from a ramp waveform to another waveform, the symmetry is retained. The same symmetry is used when you select a ramp wave again.</li></ul>
When a ramp wave is used as the modulation signal	<ul style="list-style-type: none"><li>• The symmetry setting does not apply when a ramp wave is used as the modulation signal for AM, FM, PM, or PWM.</li></ul>

## Procedure

### 1 Press Ramp.

The ramp key lights.

### 2 Set the frequency or period, amplitude, DC offset, etc.



### 3 Press the Symmetry softkey.

The symmetry can now be set.

### 4 Use the numeric keypad or the cursor keys and the rotary knob to set the symmetry.

Set the unit to %. To change the value, press the Cancel softkey and reenter it.

### 5 To check the waveform parameters, press Graph.

Graph mode is enabled.

## Remote interface operation

```
APPLY:RAMP [<frequency>[, <amplitude>[, <offset>]]]
```

Creates a ramp wave with 100 % symmetry

or

```
FUNCTION {RAMP}  
FREQUENCY {<frequency>|MINimum|MAXimum}  
VOLTage {<amplitude>|MINimum|MAXimum}  
VOLTage:OFFSet {<offset>|MINimum|MAXimum}  
FUNCTION:RAMP:SYMMetry {<percent>|MINimum|MAXimum}
```

See p. 25, p. 26,  
p. 28

# Noise Wave

You can set the amplitude and DC offset of a noise waveform.

## Procedure

- 1 Press Noise.**  
The Noise key lights.
- 2 Set the amplitude, DC offset, etc.**

 p. 26, p. 28



- 3 To check the waveform parameters, press Graph.**  
Graph mode is enabled.

## Remote interface operation

---

```
APPLy:NOISe [<frequency|DEF>[,<amplitude>[,<offset>]]]
```

In the APPL:NOIS command, the frequency parameter has no effect, but you still need to specify a frequency or "DEFault" (the factory default setting) for it.

or

```
FUNCTion {NOISe}  
VOLTage {<amplitude>|MINimum|MAXimum}  
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
```

---

# Pulse Wave

You can set the period, pulse width, and edge time (rising or falling) of a pulse wave.

## Setting conditions

Frequency range	<ul style="list-style-type: none"> <li>• 500 <math>\mu</math>Hz to 10 MHz</li> <li>• The factory default setting is 1 kHz.</li> </ul>															
Pulse period (frequency)	<ul style="list-style-type: none"> <li>• The range is from 100 ns to 2000 s (frequency: 10 MHz to 0.5 mHz). The pulse period is determined by the following inequality:  Pulse period <math>\geq</math> Pulse width + 1.6 x edge time</li> <li>• The factory default setting is 1 ms (frequency: 1 kHz).</li> </ul>															
Pulse width	<ul style="list-style-type: none"> <li>• The range is from 20 ns to 2000 s. The actual range is determined by the following inequality:  1.6 x edge time <math>\leq</math> Pulse width <math>\leq</math> Pulse period - 1.6 x edge time Wmin <math>\leq</math> Pulse width <math>\leq</math> Pulse period - Wmin</li> <li>• Wmin is a minimum allowable value that is determined by the pulse period in the manner indicated below. When the value that the pulse width is set to exceeds the allowable range, the value is automatically adjusted so that it matches the given pulse period.</li> <li>• The pulse width refers to the time from the 50 % point of a rising edge to the 50 % point of the next falling edge.</li> <li>• The factory default setting is 100 <math>\mu</math>s.</li> </ul> <table border="1"> <thead> <tr> <th>Wmin conditions</th> <th>Condition</th> <th>Wmin</th> </tr> </thead> <tbody> <tr> <td></td> <td>Pulse period <math>\leq</math> 10 s</td> <td>20 ns</td> </tr> <tr> <td></td> <td>10 s &lt; pulse period <math>\leq</math> 100 s</td> <td>200 ns</td> </tr> <tr> <td></td> <td>100 s &lt; pulse period <math>\leq</math> 1000 s</td> <td>2 <math>\mu</math>s</td> </tr> <tr> <td></td> <td>1000 s &lt; pulse period</td> <td>20 <math>\mu</math>s</td> </tr> </tbody> </table>	Wmin conditions	Condition	Wmin		Pulse period $\leq$ 10 s	20 ns		10 s < pulse period $\leq$ 100 s	200 ns		100 s < pulse period $\leq$ 1000 s	2 $\mu$ s		1000 s < pulse period	20 $\mu$ s
Wmin conditions	Condition	Wmin														
	Pulse period $\leq$ 10 s	20 ns														
	10 s < pulse period $\leq$ 100 s	200 ns														
	100 s < pulse period $\leq$ 1000 s	2 $\mu$ s														
	1000 s < pulse period	20 $\mu$ s														
Edge time	<ul style="list-style-type: none"> <li>• The range is from 5 ns to 100 ns. The edge time is determined by the following condition. When the right side of the following inequality is 100 ns or less, the pulse width setting is prioritized.  Edge time <math>\leq</math> 0.625 x pulse width</li> <li>• The edge time refers to the time from the 10 % point of a rising or falling edge to the 90 % point of the edge.</li> <li>• The factory default setting is 5 ns.</li> </ul>															
Pulse duty cycle	<ul style="list-style-type: none"> <li>• You can define pulse waves by setting the pulse duty cycle. The pulse duty cycle is defined as follows: Duty cycle = Pulse width / pulse period x 100 %</li> <li>• If the specified pulse cycle doesn't match the specified pulse width or vice versa, the most recently specified of the two values is prioritized.</li> <li>• The range is from 0 % to 100 %, with the following constraints: Duty cycle <math>\geq</math> Wmin / pulse period x 100 % Duty cycle <math>\leq</math> (1.0 - Wmin / pulse period) x 100 %</li> <li>• Wmin has been defined above and is the minimum allowable pulse width value. It is set automatically according to the pulse period.</li> <li>• The factory default setting is 10 %.</li> </ul>															

## Procedure

See p. 25, p. 26,  
p. 28

- 1 **Press Pulse.**  
The Pulse key lights.
- 2 **Set the frequency or period, amplitude, DC offset, etc.**  

- 3 **Press the Width/Duty softkey.**  
To set the pulse width of the pulse wave, use the softkey to highlight Width. To set the duty cycle of the pulse wave, use the softkey to highlight Duty.
- 4 **Use the numeric keypad or the cursor keys and the rotary knob to set the value.**  
If you are setting the pulse width, select a unit of time ( $\mu\text{s}$ , ms, s, etc.). If you are setting the duty cycle, select %. To change the value, press the Cancel softkey and reenter it.
- 5 **Press the Edge Time softkey.**  
The edge time can now be set.
- 6 **Use the numeric keypad or the cursor keys and the rotary knob to set the edge time.**  
The unit is ns. The settings are applied.
- 7 **To check the waveform parameters, press Graph.**  
Graph mode is enabled.

4

Waveform Output Settings

## Remote interface operation

---

```
APPLY:PULSe [<frequency>[,<amplitude>[,<offset>]]]
```

or

```
FUNCTION {PULSe}
FREQUENCY {<frequency>|MINimum|MAXimum}
VOLTage {<amplitude>|MINimum|MAXimum}
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
PULSe:PERiod {<seconds>|MINimum|MAXimum}
FUNCTION:PULSe:WIDTh {<seconds>|MINimum|MAXimum}
FUNCTION:PULSe:DCYCLe {<percent>|MINimum|MAXimum}
FUNCTION:PULSe:TRANSition {<percent>|MINimum|MAXimum}
```

---

# Arbitrary Waveform

The FGA5050 has 5 built-in arbitrary waveforms. You can specify up to four additional arbitrary waveforms and store them in non-volatile memory. The built-in arbitrary waveforms are an exponential rising wave, exponential falling wave, negative ramp wave (reverse ramp wave), sinc wave, and cardiac wave (cardiac electrogram wave).

## Setting conditions

Frequency range	<ul style="list-style-type: none"> <li>• 1 <math>\mu</math>Hz to 10 MHz</li> <li>• The factory default setting is 1 kHz.</li> </ul>
Factory default built-in arbitrary waveform setting	<ul style="list-style-type: none"> <li>• Exponential rising wave</li> </ul>
User-defined waveforms	<ul style="list-style-type: none"> <li>• You can create up to 262 144 (256 K) points from the remote interface.</li> <li>• If you select an arbitrary waveform as the modulation signal for an AM, FM, PM, or PWM signal, the waveform is limited to 4 K points through automatic decimation.</li> </ul>
Wavepatt waveform editor	<ul style="list-style-type: none"> <li>• You can use Wavepatt to create waveforms or import previously captured waveforms from an oscilloscope. For detailed information about user-defined waveforms, see the Wavepatt online help.</li> </ul>

## Procedure (for built-in arbitrary waveforms)

**1 Press Arb.**  
The Arb key lights.

**2 Press the Select Wform softkey.**  
The setting options are assigned to softkeys.



**3 Press the Built In softkey.**  
The built-in arbitrary waveforms are assigned to softkeys.



**4 Press the softkey of the arbitrary waveform that you want to select.**  
The parameters of the selected arbitrary waveform are assigned to softkeys.



**5 Set the frequency or period, amplitude, DC offset, etc.**

**6 To check the waveform parameters, press Graph.**  
Graph mode is enabled.

See p. 25, p. 26,  
p. 28

## Remote interface operation

---

```
FUNCTION USER {EXP_RISE|EXP_FALL|NEG_RAMP|SINC|CARDIAC}
```

```
DATA:DAC VOLATILE, {<binary block>|<value>, <value>, ...}
```

```
DATA VOLATILE, <value>, <value>, ...
```

```
FORMAt:BORe {NORMal|SWAPped}
```

```
DATA:COpy <destination arb name> [,VOLATILE]
```

```
DATA:CATalog?
```

```
DATA:NVOLatile:CATalog?
```

```
DATA:NVOLatile:FREE?
```

```
DATA:ATTRibute:AVERage? [<arb name>]
```

```
DATA:ATTRibute:CFACTOR? [<arb name>]
```

```
DATA:ATTRibute:POINTs? [<arb name>]
```

```
DATA:ATTRibute:PTPeak? [<arb name>]
```

---

# Amplitude Modulation

In amplitude modulation, a modulation signal changes the amplitude of a carrier wave.

## Setting conditions

Carrier wave	<ul style="list-style-type: none"> <li>You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform. You cannot select a pulse, noise, or DC wave.</li> <li>The factory default setting is a sine wave.</li> </ul>												
Carrier wave frequency	<ul style="list-style-type: none"> <li>Each type of carrier wave has its own frequency range. <a href="#">See</a> p. 25</li> <li>The factory default carrier wave frequency setting for all waveforms is 1 kHz.</li> </ul>												
Modulation signal	<ul style="list-style-type: none"> <li>You can use an internal or external modulation signal. You cannot use both at the same time.</li> <li>The factory default setting is for an internal signal to be used.</li> </ul>												
Internal modulation signal	<table border="1"> <thead> <tr> <th>Waveform</th> <th>Factory default setting</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>This is the factory default waveform.</td> </tr> <tr> <td>Square wave</td> <td>50 % duty cycle</td> </tr> <tr> <td>Ramp wave</td> <td>Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry</td> </tr> <tr> <td>Triangle wave</td> <td>50 % symmetry, ramp wave</td> </tr> <tr> <td>Noise and arbitrary waveforms</td> <td>If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.</td> </tr> </tbody> </table>	Waveform	Factory default setting	Sine wave	This is the factory default waveform.	Square wave	50 % duty cycle	Ramp wave	Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry	Triangle wave	50 % symmetry, ramp wave	Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.
	Waveform	Factory default setting											
	Sine wave	This is the factory default waveform.											
	Square wave	50 % duty cycle											
	Ramp wave	Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry											
	Triangle wave	50 % symmetry, ramp wave											
Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.												
	<ul style="list-style-type: none"> <li>The frequency range is from 2 mHz to 20 kHz.</li> <li>The factory default frequency setting is 100 Hz.</li> </ul>												
External modulation signal	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the carrier wave is modulated by the signal applied to the Modulation In connector on the rear panel.</li> </ul>												
Modulation depth	<ul style="list-style-type: none"> <li>You can set the modulation depth to a value between 0 % and 120 %. The modulation depth is defined by the following equation:</li> </ul> $\text{Modulation depth} = (\text{Maximum amplitude} - \text{minimum amplitude}) / \text{amplitude} \times 100 \%$ <ul style="list-style-type: none"> <li>The amplitude refers to the amplitude of the carrier wave. The maximum amplitude and minimum amplitude are the maximum and minimum amplitudes of the modulation wave.</li> <li>When the modulation depth is set to 0 %, the FGA5050 is designed to maintain a relationship wherein the amplitude of the modulation wave is half that of the carrier wave. As a result, the minimum amplitude may be negative when the modulation depth exceeds 100 %.</li> <li>The factory default setting is 100 %.</li> </ul>												
Modulation depth (external modulation signal)	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the modulation is determined by the set modulation depth and the signal level of the <math>\pm 5</math> V external modulation signal.</li> <li>When the external modulation signal is +5 V, the output amplitude is at its maximum, and when the external modulation signal is -5 V, the output amplitude is at its minimum.</li> <li>Even when the modulation depth exceeds 100 %, the modulated output cannot exceed <math>\pm 5</math> V (into 50 <math>\Omega</math>).</li> </ul>												
One type of modulation at a time	<ul style="list-style-type: none"> <li>Only one type of modulation can be selected at a time.</li> </ul>												
Sweep or burst mode	<ul style="list-style-type: none"> <li>You cannot select amplitude modulation and sweep or burst mode at the same time. The sweep and burst modes become invalid when you select amplitude modulation.</li> </ul>												

## Procedure

- 1 Press one of the waveform selection keys—Sine, Square, Ramp, or Arb—to select the carrier wave.**

The selected key lights.

- 2 Specify all the necessary waveform parameters for the carrier wave.**

- 3 Press Mod.**

The Mod key lights. The modulation options are assigned to softkeys.



- 4 Press the Type softkey.**

The modulation methods are assigned to softkeys.

- 5 Press the AM softkey to select amplitude modulation.**

Amplitude modulated output is generated.

### ■ Selecting the modulation signal

- 6 Press the Src softkey.**

The Int (internal signal) and Ext (external signal) modulation signal options are assigned to softkeys.

- 7 Select Int (internal signal) or Ext (external signal).**

### ■ If you select the Int (internal signal) modulation signal option

- 8 Press the Shape softkey.**

The waveforms are assigned to softkeys.

- 9 Select the waveform you want to use as the modulation signal.**

The modulation signal waveforms that you can select are Sine, Squ, Trngl, U Ramp (ramp wave), D Ramp (reverse ramp wave), Noise, and Arb.

If you select Arb (arbitrary waveform) as the modulation signal, the selected arbitrary waveform is specified. When you press Mod, the settings of the arbitrary waveform are temporarily displayed.

- 10 Press the AM Freq softkey.**

- 11 Use the numeric keypad or the cursor keys and the rotary knob to set the modulation frequency.**

- 12 Press the AM Depth softkey.**

- 13 Use the numeric keypad or the cursor keys and the rotary knob to set the modulation depth.**

- 14 To check the waveform parameters, press Graph.**

Graph mode is enabled.

See p. 39, p. 40,  
p. 42, p. 46

■ If you select the Ext (external signal) modulation signal option

- 8 Press the AM Depth softkey.
- 9 Use the numeric keypad or the cursor keys and the rotary knob to set the modulation depth.
- 10 To check the waveform parameters, press Graph.  
Graph mode is enabled.

### Remote interface operation

---

```
FUNction {SINusoid|SQUare|RAMP|USER}
FREQuency {<frequency>|MINimum|MAXimum}
VOLTage {<amplitude>|MINimum|MAXimum}
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
AM:INTernal:FUNCTion
{SINusoid|SQUare|RAMP|NRAMP|TRIangle|NOISE|USER}
AM:INTernal:FREQuency {<frequency>|MINimum|MAXimum}
AM:DEPTTh {<depth in percent>|MINimum|MAXimum}
AM:SOURce {INTernal|EXTernal}
AM:STATe ON
```

---

# Frequency Modulation

In frequency modulation, a modulation signal changes the frequency of a carrier wave.

## Setting conditions

Carrier wave	<ul style="list-style-type: none"> <li>You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform. You cannot select a pulse, noise, or DC wave.</li> <li>The factory default setting is a sine wave.</li> </ul>												
Carrier wave frequency	<ul style="list-style-type: none"> <li>Each type of carrier wave has its own frequency range. <a href="#">See</a> p. 25</li> <li>The factory default carrier wave frequency setting for all waveforms is 1 kHz.</li> </ul>												
Modulation signal	<ul style="list-style-type: none"> <li>You can use an internal or external modulation signal. You cannot use both at the same time.</li> <li>The factory default setting is for an internal signal to be used.</li> </ul>												
Internal modulation signal	<table border="1"> <thead> <tr> <th>Waveform</th> <th>Factory default setting</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>This is the factory default waveform.</td> </tr> <tr> <td>Square wave</td> <td>50 % duty cycle</td> </tr> <tr> <td>Ramp wave</td> <td>Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry</td> </tr> <tr> <td>Triangle wave</td> <td>50 % symmetry, ramp wave</td> </tr> <tr> <td>Noise and arbitrary waveforms</td> <td>If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.</td> </tr> </tbody> </table>	Waveform	Factory default setting	Sine wave	This is the factory default waveform.	Square wave	50 % duty cycle	Ramp wave	Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry	Triangle wave	50 % symmetry, ramp wave	Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.
	Waveform	Factory default setting											
	Sine wave	This is the factory default waveform.											
	Square wave	50 % duty cycle											
	Ramp wave	Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry											
	Triangle wave	50 % symmetry, ramp wave											
	Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.											
	<ul style="list-style-type: none"> <li>The frequency range is from 2 MHz to 20 kHz.</li> <li>The factory default frequency setting is 10 Hz.</li> </ul>												
External modulation signal	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the carrier wave is modulated by the signal applied to the Modulation In connector on the rear panel.</li> </ul>												
Frequency deviation	<ul style="list-style-type: none"> <li>The frequency deviation is the peak deviation of the modulated frequency output. The ranges for different carrier waves are indicated below.</li> <li>The factory default setting is 100 Hz.</li> </ul>												
	<table border="1"> <thead> <tr> <th>Waveform</th> <th>Frequency deviation</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>1 <math>\mu</math>Hz to 25.05 MHz (when the carrier wave frequency is 25.05 MHz)</td> </tr> <tr> <td>Square wave</td> <td>1 <math>\mu</math>Hz to 12.55 MHz (when the carrier wave frequency is 12.55 MHz)</td> </tr> <tr> <td>Ramp wave</td> <td>1 <math>\mu</math>Hz to 150 kHz (when the carrier wave frequency is 150 kHz)</td> </tr> <tr> <td>Arbitrary waveform</td> <td>1 <math>\mu</math>Hz to 5.05 MHz (when the carrier wave frequency is 5.05 MHz)</td> </tr> </tbody> </table>	Waveform	Frequency deviation	Sine wave	1 $\mu$ Hz to 25.05 MHz (when the carrier wave frequency is 25.05 MHz)	Square wave	1 $\mu$ Hz to 12.55 MHz (when the carrier wave frequency is 12.55 MHz)	Ramp wave	1 $\mu$ Hz to 150 kHz (when the carrier wave frequency is 150 kHz)	Arbitrary waveform	1 $\mu$ Hz to 5.05 MHz (when the carrier wave frequency is 5.05 MHz)		
	Waveform	Frequency deviation											
	Sine wave	1 $\mu$ Hz to 25.05 MHz (when the carrier wave frequency is 25.05 MHz)											
	Square wave	1 $\mu$ Hz to 12.55 MHz (when the carrier wave frequency is 12.55 MHz)											
	Ramp wave	1 $\mu$ Hz to 150 kHz (when the carrier wave frequency is 150 kHz)											
	Arbitrary waveform	1 $\mu$ Hz to 5.05 MHz (when the carrier wave frequency is 5.05 MHz)											
	<ul style="list-style-type: none"> <li>You cannot set a frequency deviation that is greater than the frequency of the carrier wave.</li> <li>The sum of the frequency deviation and the carrier wave frequency must be less than the sum of the maximum frequency of the selected carrier wave and 100 kHz. (See below.)</li> </ul>												
	<table border="1"> <thead> <tr> <th>Waveform</th> <th>Maximum frequency deviation</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>50.1 MHz</td> </tr> <tr> <td>Square wave</td> <td>25.1 MHz</td> </tr> <tr> <td>Ramp wave</td> <td>300 kHz</td> </tr> <tr> <td>Arbitrary waveform</td> <td>10.1 MHz</td> </tr> </tbody> </table>	Waveform	Maximum frequency deviation	Sine wave	50.1 MHz	Square wave	25.1 MHz	Ramp wave	300 kHz	Arbitrary waveform	10.1 MHz		
Waveform	Maximum frequency deviation												
Sine wave	50.1 MHz												
Square wave	25.1 MHz												
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Arbitrary waveform	10.1 MHz												
	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the modulation is determined by the set frequency deviation and the signal level of the <math>\pm 5</math> V external modulation signal.</li> <li>When the external modulation signal is +5 V, the output frequency deviation is at its maximum. For example, when the frequency deviation is set to 100 kHz, the frequency increases to the carrier frequency plus 100 kHz.</li> <li>When the external modulation signal is -5 V, the output frequency is lower than the carrier frequency.</li> </ul>												
Frequency deviation (external modulation signal)													
One type of modulation at a time	<ul style="list-style-type: none"> <li>Only one type of modulation can be selected at a time.</li> </ul>												
Sweep or burst mode	<ul style="list-style-type: none"> <li>You cannot select frequency modulation and sweep or burst mode at the same time. The sweep and burst modes become invalid when you select frequency modulation.</li> </ul>												

## Procedure

- 1 Press one of the waveform selection keys—Sine, Square, Ramp, or Arb—to select the carrier wave.**

The selected key lights.

- 2 Specify all the necessary waveform parameters for the carrier wave.**

- 3 Press Mod.**

The Mod key lights. The modulation options are assigned to softkeys.



- 4 Press the Type softkey.**

The modulation methods are assigned to softkeys.

- 5 Press the FM softkey to select frequency modulation.**

Frequency modulated output is generated.

### ■ Selecting the modulation signal

- 6 Press the Src softkey.**

The Int (internal signal) and Ext (external signal) modulation signal options are assigned to softkeys.

- 7 Select Int (internal signal) or Ext (external signal).**

### ■ If you select the Int (internal signal) modulation signal option

- 8 Press the Shape softkey.**

The waveforms are assigned to softkeys.

- 9 Select the waveform you want to use as the modulation signal.**

The modulation signal waveforms that you can select are Sine, Squ, Trngl, U Ramp (ramp wave), D Ramp (reverse ramp wave), Noise, and Arb.

If you select Arb (arbitrary waveform) as the modulation signal, the selected arbitrary waveform is specified. When you press Mod, the settings of the arbitrary waveform are temporarily displayed.

- 10 Press the FM Freq softkey.**

- 11 Use the numeric keypad or the cursor keys and the rotary knob to set the modulation frequency.**

- 12 Press the Freq Dev softkey.**

- 13 Use the numeric keypad or the cursor keys and the rotary knob to set the frequency deviation.**

- 14 To check the waveform parameters, press Graph.**

Graph mode is enabled.

See p. 39, p. 40,  
p. 42, p. 46

- If you select the Ext (external signal) modulation signal option

**8** Press the FreqDev softkey.

**9** Use the numeric keypad or the cursor keys and the rotary knob to set the frequency deviation.

**10** To check the waveform parameters, press Graph.  
Graph mode is enabled.

## Remote interface operation

---

```

FUNCTION {SINusoid|SQUare|RAMP|USER}
FREQuency {<frequency>|MINimum|MAXimum}
VOLTagE {<amplitude>|MINimum|MAXimum}
VOLTagE:OFFSet {<offset>|MINimum|MAXimum}
FM:INTernal:FUNCTion
{SINusoid|SQUare|RAMP|NRAMP|TRIangle|NOISe|USER}
FM:INTernal:FREQuency {<frequency>MINimum|MAXimum}
FM:DEVIation {<peak deviation in Hz>|MINimum|MAXimum}
FM:SOURce {INTernal|EXTernal}
FM:STATe ON

```

---

# Phase Modulation

In phase modulation, a modulation signal changes the phase of a carrier wave.

## Setting conditions

Carrier wave	<ul style="list-style-type: none"> <li>You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform. You cannot select a pulse, noise, or DC wave.</li> <li>The factory default setting is a sine wave.</li> </ul>												
Carrier wave frequency	<ul style="list-style-type: none"> <li>Each type of carrier wave has its own frequency range. <a href="#">See</a> p. 25</li> <li>The factory default carrier wave frequency setting for all waveforms is 1 kHz.</li> </ul>												
Modulation signal	<ul style="list-style-type: none"> <li>You can use an internal or external modulation signal. You cannot use both at the same time.</li> <li>The factory default setting is for an internal signal to be used.</li> </ul>												
Internal modulation signal	<table border="1"> <thead> <tr> <th>Waveform</th> <th>Factory default setting</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>This is the factory default waveform.</td> </tr> <tr> <td>Square wave</td> <td>50 % duty cycle</td> </tr> <tr> <td>Ramp wave</td> <td>Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry</td> </tr> <tr> <td>Triangle wave</td> <td>50 % symmetry, ramp wave</td> </tr> <tr> <td>Noise and arbitrary waveforms</td> <td>If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.</td> </tr> </tbody> </table>	Waveform	Factory default setting	Sine wave	This is the factory default waveform.	Square wave	50 % duty cycle	Ramp wave	Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry	Triangle wave	50 % symmetry, ramp wave	Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.
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	Triangle wave	50 % symmetry, ramp wave											
Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.												
	<ul style="list-style-type: none"> <li>The frequency range is from 2 mHz to 20 kHz.</li> <li>The factory default frequency setting is 10 Hz.</li> </ul>												
External modulation signal	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the carrier wave is modulated by the signal applied to the Modulation In connector on the rear panel.</li> </ul>												
Phase deviation	<ul style="list-style-type: none"> <li>The phase deviation is the peak deviation of the modulated phase output. You can set the phase deviation to a value between 0 ° and 360 °.</li> <li>The factory default setting is 180 °.</li> </ul>												
Phase deviation (external modulation signal)	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the modulation is determined by the set phase deviation and the signal level of the ±5 V external modulation signal.</li> <li>When the external modulation signal is +5 V, the output phase deviation is at its maximum. When the external modulation signal is -5 V, the output phase deviation is at its minimum.</li> </ul>												

## Procedure

- 1 Press one of the waveform selection keys—Sine, Square, Ramp, or Arb—to select the carrier wave.**

The selected key lights.

- 2 Specify all the necessary waveform parameters for the carrier wave.**

- 3 Press Mod.**

The Mod key lights. The modulation options are assigned to softkeys.



- 4 Press the Type softkey.**

The modulation methods are assigned to softkeys.

- 5 Press the PM softkey to select phase modulation.**

Phase modulated output is generated.

[See](#) p. 39, p. 40, p. 42, p. 46

### ■ Selecting the modulation signal

#### 6 Press the Src softkey.

The Int (internal signal) and Ext (external signal) modulation signal options are assigned to softkeys.

#### 7 Select Int (internal signal) or Ext (external signal).

### ■ If you select the Int (internal signal) modulation signal option

#### 8 Press the Shape softkey.

The waveforms are assigned to softkeys.

#### 9 Select the waveform you want to use as the modulation signal.

The modulation signal waveforms that you can select are Sine, Sqr, Trngl, U Ramp (ramp wave), D Ramp (reverse ramp wave), Noise, and Arb.

If you select Arb (arbitrary waveform) as the modulation signal, the selected arbitrary waveform is specified. When you press Mod, the settings of the arbitrary waveform are temporarily displayed.

#### 10 Press the PM Freq softkey.

#### 11 Use the numeric keypad or the cursor keys and the rotary knob to set the modulation frequency.

#### 12 Press the Phase Dev softkey.

#### 13 Use the numeric keypad or the cursor keys and the rotary knob to set the phase deviation.

#### 14 To check the waveform parameters, press Graph.

Graph mode is enabled.

### ■ If you select the Ext (external signal) modulation signal option

#### 8 Press the Phase Dev softkey.

#### 9 Use the numeric keypad or the cursor keys and the rotary knob to set the phase deviation.

#### 10 To check the waveform parameters, press Graph.

Graph mode is enabled.

### Remote interface operation

---

```

FUNCTION {SINusoid|SQUare|RAMP|USER}
FREQUENCY {<frequency>|MINimum|MAXimum}
VOLTage {<amplitude>|MINimum|MAXimum}
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
PM:INTernal:FUNCTion
{SINusoid|SQUare|RAMP|NRAMP|TRIangle|NOISe|USER}
PM:INTernal:FREQUENCY {<frequency>|MINimum|MAXimum}
PM:DEVIation {<deviation in degrees>|MINimum|MAXimum}
PM:SOURce {INTernal|EXTernal}
PM:STATe ON

```

---

# FSK Modulation

In FSK (Frequency-Shift Keying) modulation, the frequency of the generated signal switches between two frequencies (the frequency of the carrier wave and the hop frequency) in accordance with the modulation signal. The speed at which switching occurs is determined by the internal or external modulation signal.

## Setting conditions

Carrier wave	<ul style="list-style-type: none"> <li>You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform. You cannot select a pulse, noise, or DC wave.</li> <li>The factory default setting is a sine wave.</li> </ul>										
Carrier wave frequency	<ul style="list-style-type: none"> <li>Each type of carrier wave has its own frequency range. <a href="#">See</a> p. 25</li> <li>The factory default carrier wave frequency setting for all waveforms is 1 kHz.</li> </ul>										
Modulation signal	<ul style="list-style-type: none"> <li>You can use an internal or external modulation signal. You cannot use both at the same time.</li> <li>The factory default setting is an internal square wave signal with a 50 % duty cycle.</li> </ul>										
Hop frequency	<ul style="list-style-type: none"> <li>The hop frequency is the peak modulated frequency output. The ranges for different carrier waves are indicated below.</li> <li>The factory default setting is 100 Hz.</li> </ul> <table border="1"> <thead> <tr> <th>Waveform</th> <th>Hop frequency</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>1 <math>\mu</math>Hz to 50 MHz (when the carrier wave frequency is 1 <math>\mu</math>Hz)</td> </tr> <tr> <td>Square wave</td> <td>1 <math>\mu</math>Hz to 25 MHz (when the carrier wave frequency is 1 <math>\mu</math>Hz)</td> </tr> <tr> <td>Ramp wave</td> <td>1 <math>\mu</math>Hz to 200 kHz (when the carrier wave frequency is 1 <math>\mu</math>Hz)</td> </tr> <tr> <td>Arbitrary waveform</td> <td>1 <math>\mu</math>Hz to 10 MHz (when the carrier wave frequency is 1 <math>\mu</math>Hz)</td> </tr> </tbody> </table>	Waveform	Hop frequency	Sine wave	1 $\mu$ Hz to 50 MHz (when the carrier wave frequency is 1 $\mu$ Hz)	Square wave	1 $\mu$ Hz to 25 MHz (when the carrier wave frequency is 1 $\mu$ Hz)	Ramp wave	1 $\mu$ Hz to 200 kHz (when the carrier wave frequency is 1 $\mu$ Hz)	Arbitrary waveform	1 $\mu$ Hz to 10 MHz (when the carrier wave frequency is 1 $\mu$ Hz)
Waveform	Hop frequency										
Sine wave	1 $\mu$ Hz to 50 MHz (when the carrier wave frequency is 1 $\mu$ Hz)										
Square wave	1 $\mu$ Hz to 25 MHz (when the carrier wave frequency is 1 $\mu$ Hz)										
Ramp wave	1 $\mu$ Hz to 200 kHz (when the carrier wave frequency is 1 $\mu$ Hz)										
Arbitrary waveform	1 $\mu$ Hz to 10 MHz (when the carrier wave frequency is 1 $\mu$ Hz)										
FSK rate	<ul style="list-style-type: none"> <li>When an internal signal has been selected as the modulation signal, the FSK rate determines the speed at which the oscillation frequency shifts between the carrier frequency and the hop frequency. The range is from 2 mHz to 100 kHz.</li> <li>The factory default setting is 10 Hz.</li> </ul>										
External modulation signal	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the carrier wave is modulated by the signal applied to the Trig In/Out, FSK/Burst connector on the rear panel.</li> <li>The carrier wave frequency is output when the external modulation signal is a TTL low and the hop frequency is output when the external modulation signal is a TTL high.</li> </ul>										

## Procedure

- 1 Press one of the waveform selection keys—Sine, Square, Ramp, or Arb—to select the carrier wave.**

The selected key lights.

- 2 Specify all the necessary waveform parameters for the carrier wave.**

- 3 Press Mod.**

The Mod key lights. The modulation options are assigned to softkeys.



- 4 Press the Type softkey.**

The modulation methods are assigned to softkeys.

- 5 Press the FSK softkey to select FSK modulation.**

FSK modulated output is generated.

[See](#) p. 39, p. 40,  
p. 42, p. 46

### ■ Selecting the modulation signal

#### 6 Press the Src softkey.

The Int (internal signal) and Ext (external signal) modulation signal options are assigned to softkeys.

#### 7 Select Int (internal signal) or Ext (external signal).

### ■ If you select the Int (internal signal) modulation signal option

#### 8 Press the FSK Rate softkey.

#### 9 Use the numeric keypad or the cursor keys and the rotary knob to set the switching speed.

#### 10 Press the Hop Freq softkey.

#### 11 Use the numeric keypad or the cursor keys and the rotary knob to set the hop frequency.

#### 12 To check the waveform parameters, press Graph.

Graph mode is enabled.

### ■ If you select the Ext (external signal) modulation signal option

#### 8 Press the Hop Freq softkey.

#### 9 Use the numeric keypad or the cursor keys and the rotary knob to set the hop frequency.

#### 10 To check the waveform parameters, press Graph.

Graph mode is enabled.

## Remote interface operation

---

```

FUNCTION {SINusoid|SQUare|RAMP|USER}
FREQUENCY {<frequency>|MINimum|MAXimum}
VOLTage {<amplitude>|MINimum|MAXimum}
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
FSKey: FREQUENCY {<frequency>|MINimum|MAXimum}
FSKey:INTernal:RATE{<rate in Hz>|MINimum|MAXimum}
FSKey:SOURce {INTernal|EXTernal}
FSKey:STATe ON

```

---

# PWM Modulation

In pulse width modulation (PWM), the pulse width of a pulse carrier wave is changed. The pulse width of the pulse carrier wave changes according to the modulation signal. The pulse width is indicated in units of time or as a duty cycle percentage.

## Setting conditions

Carrier wave	<ul style="list-style-type: none"> <li>You can only select a pulse wave as the carrier wave. The default range for the period of a carrier wave pulse is from 100 ns to 2000 s.</li> <li>The factory default carrier wave pulse period setting is 1 ms.</li> </ul>												
Modulation signal	<ul style="list-style-type: none"> <li>You can select an internal or external modulation signal, but you cannot use both at the same time.</li> <li>The factory default setting is for an internal signal to be used.</li> </ul>												
Internal modulation signal	<table border="1"> <thead> <tr> <th>Waveform</th> <th>Factory default setting</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>This is the factory default waveform.</td> </tr> <tr> <td>Square wave</td> <td>50 % duty cycle</td> </tr> <tr> <td>Ramp wave</td> <td>Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry</td> </tr> <tr> <td>Triangle wave</td> <td>50 % symmetry, ramp wave</td> </tr> <tr> <td>Noise and arbitrary waveforms</td> <td>If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.</td> </tr> </tbody> </table>	Waveform	Factory default setting	Sine wave	This is the factory default waveform.	Square wave	50 % duty cycle	Ramp wave	Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry	Triangle wave	50 % symmetry, ramp wave	Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.
	Waveform	Factory default setting											
	Sine wave	This is the factory default waveform.											
	Square wave	50 % duty cycle											
	Ramp wave	Ramp wave: 100 % symmetry Reverse ramp wave: 0 % symmetry											
	Triangle wave	50 % symmetry, ramp wave											
Noise and arbitrary waveforms	If you select an arbitrary waveform, the waveform is limited to 4 K points through automatic decimation.												
	<ul style="list-style-type: none"> <li>The frequency range is from 2 mHz to 20 kHz.</li> <li>The factory default frequency setting is 10 Hz.</li> </ul>												
External modulation signal	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the carrier wave is modulated by the signal applied to the Modulation In connector on the rear panel.</li> </ul>												
Pulse width deviation	<ul style="list-style-type: none"> <li>The pulse width deviation is the peak deviation of the pulse width of the modulated output. The deviation range is from 0 s to 1000 s. The deviation never exceeds the pulse width of the carrier wave and is determined by the following inequalities. Width deviation <math>\leq</math> Pulse width - Wmin Pulse deviation <math>\leq</math> Period - (Pulse width + Wmin)</li> <li>Wmin is the minimum pulse width. <a href="#">See</a> p. 44</li> <li>The factory default setting is 10 <math>\mu</math>s.</li> </ul>												
Pulse width deviation (external modulation signal)	<ul style="list-style-type: none"> <li>If you select an external modulation signal, the modulation is determined by the set pulse width deviation and the signal level of the <math>\pm 5</math> V external modulation signal.</li> <li>When the external modulation signal is +5 V, the output pulse width is at its maximum. When the external modulation signal is -5 V, the output pulse width is at its minimum.</li> </ul>												

## Procedure

- 1 Press the Pulse waveform key to select the carrier wave.**  
The Pulse key lights.
- 2 Specify all the necessary waveform parameters for the carrier wave.**
- 3 Press Mod.**  
The Mod key lights. The PWM modulation options are assigned to softkeys.



[See](#) p. 44

### ■ Selecting the modulation signal

#### 4 Press the Src softkey.

The Int (internal signal) and Ext (external signal) modulation signal options are assigned to softkeys.

#### 5 Select Int (internal signal) or Ext (external signal).

### ■ If you select the Int (internal signal) modulation signal option

#### 6 Press the Shape softkey.

The waveforms are assigned to softkeys.

#### 7 Select the waveform you want to use as the modulation signal.

The modulation signal waveforms that you can select are Sine, Sqr, Trngl, U Ramp (ramp wave), D Ramp (reverse ramp wave), Noise, and Arb.

If you select Arb (arbitrary waveform) as the modulation signal, the selected arbitrary waveform is specified. When you press Mod, the settings of the arbitrary waveform are temporarily displayed.

#### 8 Press the PWM Freq softkey.

#### 9 Use the numeric keypad or the cursor keys and the rotary knob to set the modulation frequency.

#### 10 Press the Width Dev softkey.

#### 11 Use the numeric keypad or the cursor keys and the rotary knob to set the pulse width deviation.

#### 12 To check the waveform parameters, press Graph.

Graph mode is enabled.

### ■ If you select the Ext (external signal) modulation signal option

#### 6 Press the Width Dev softkey.

#### 7 Use the numeric keypad or the cursor keys and the rotary knob to set the pulse width deviation.

#### 8 To check the waveform parameters, press Graph.

Graph mode is enabled.

## Remote interface operation

```

FUNC PULSe
VOLTage {<amplitude>|MINimum|MAXimum}
VOLTage:OFFSet {<offset>|MINimum|MAXimum}
PULSe:PERiod {<seconds>|MINimum|MAXimum}
FUNction:PULSe:WIDTh {<seconds>|MINimum|MAXimum}
FUNction:PULSe:TRANSition {<seconds>|MINimum|MAXimum}
FUNction:PULSe:DCYClE {<percent>|MINimum|MAXimum}
PWM:INTernal:FUNCTion
{SINusoid|SQUare|RAMP|NRAMP|TRIangle|NOISE|USER}
PWM:INTernal:FREQUency {<frequency>|MINimum|MAXimum}
PWM:DEVIation {<deviation in seconds>|Minimum|Maximum}
PWM:DEVIation:DCYClE {<deviation in seconds>|Minimum|Maximum}
PWM:SOURce {INTernal|EXTernal}
PWM:STATe ON

```

# Frequency Sweep

In frequency sweeping, the FGA5050 sweeps from the start frequency to the stop frequency at a specified speed. You can set the carrier wave to a sine wave, square wave, ramp wave, or arbitrary waveform.

## ■ Sweep mode

In linear sweep mode, the frequency is shifted in linear intervals. In logarithmic sweep mode, the frequency is shifted in logarithmic intervals.

## ■ Start and stop frequencies

The FGA5050 sweeps from the start frequency to the stop frequency. When the stop frequency is higher than the start frequency, the FGA5050 sweeps from a low frequency to a high frequency. When the start frequency is higher than the stop frequency, the FGA5050 sweeps from a high frequency to a low frequency.

## ■ Center frequency and frequency span

You can set the frequency sweep range by specifying a center frequency and a frequency span. The range within which the frequency span can be set is determined by the center frequency and the type of waveform that is selected. Set a positive frequency span to make the frequency increase and a negative frequency span to make the frequency decrease.

## ■ Sweep time

The sweep time is the time (in seconds) required to sweep from the start frequency to the stop frequency. The number of frequency points is computed on the basis of the specified sweep time.

## Setting conditions

Waveform	<ul style="list-style-type: none"><li>You can set the waveform to a sine wave, square wave, ramp wave, or arbitrary waveform.</li><li>The factory default setting is a sine wave.</li></ul>										
Sweep mode	<ul style="list-style-type: none"><li>There are two sweep modes: linear and logarithmic.</li><li>The factory default setting is linear sweep mode.</li></ul>										
Start and stop frequencies	<ul style="list-style-type: none"><li>The factory default start frequency setting is 100 Hz. The factory default stop frequency setting is 1 kHz.</li></ul> <table><thead><tr><th>Waveform</th><th>Start and stop frequency range</th></tr></thead><tbody><tr><td>Sine wave</td><td>1 <math>\mu</math>Hz to 50 MHz</td></tr><tr><td>Square wave</td><td>1 <math>\mu</math>Hz to 25 MHz</td></tr><tr><td>Ramp wave</td><td>1 <math>\mu</math>Hz to 200 kHz</td></tr><tr><td>Arbitrary waveform</td><td>1 <math>\mu</math>Hz to 10 MHz</td></tr></tbody></table>	Waveform	Start and stop frequency range	Sine wave	1 $\mu$ Hz to 50 MHz	Square wave	1 $\mu$ Hz to 25 MHz	Ramp wave	1 $\mu$ Hz to 200 kHz	Arbitrary waveform	1 $\mu$ Hz to 10 MHz
Waveform	Start and stop frequency range										
Sine wave	1 $\mu$ Hz to 50 MHz										
Square wave	1 $\mu$ Hz to 25 MHz										
Ramp wave	1 $\mu$ Hz to 200 kHz										
Arbitrary waveform	1 $\mu$ Hz to 10 MHz										
Center frequency and frequency span	<ul style="list-style-type: none"><li>The factory default center frequency setting is 550 Hz. The factory default frequency span setting is 900 Hz.</li></ul> <table><thead><tr><th>Waveform</th><th>Center frequency range</th></tr></thead><tbody><tr><td>Sine wave</td><td>1 <math>\mu</math>Hz to 50 MHz</td></tr><tr><td>Square wave</td><td>1 <math>\mu</math>Hz to 25 MHz</td></tr><tr><td>Ramp wave</td><td>1 <math>\mu</math>Hz to 200 kHz</td></tr><tr><td>Arbitrary waveform</td><td>1 <math>\mu</math>Hz to 10 MHz</td></tr></tbody></table>	Waveform	Center frequency range	Sine wave	1 $\mu$ Hz to 50 MHz	Square wave	1 $\mu$ Hz to 25 MHz	Ramp wave	1 $\mu$ Hz to 200 kHz	Arbitrary waveform	1 $\mu$ Hz to 10 MHz
Waveform	Center frequency range										
Sine wave	1 $\mu$ Hz to 50 MHz										
Square wave	1 $\mu$ Hz to 25 MHz										
Ramp wave	1 $\mu$ Hz to 200 kHz										
Arbitrary waveform	1 $\mu$ Hz to 10 MHz										
Sweep time	<ul style="list-style-type: none"><li>The range is from 1 ms to 500 s.</li><li>The factory default setting is 1 s.</li></ul>										
Marker frequency	<ul style="list-style-type: none"><li>The range is determined by the stop frequency and the frequency span. The marker frequency must be below the maximum oscillation frequency.</li></ul>										

Sync output when the marker frequency is on.	<ul style="list-style-type: none"> <li>The marker frequency controls the output of the Sync connector on the front panel.</li> <li>When the marker frequency is on, the sync signal is a TTL high when sweeping starts and changes to a TTL low at the marker frequency.</li> <li>When the marker frequency is off, the sync signal is a square wave with a 50 % duty cycle. The sync signal is a TTL high when sweeping starts and changes to a TTL low at the central point of the sweep.</li> <li>The sync output frequency is inversely proportional to the sweep time.</li> <li>The factory default marker frequency setting is 500 Hz.</li> </ul>
Trigger source (internal triggering, external triggering, and manual triggering)	<ul style="list-style-type: none"> <li>You can set the trigger source to an internal trigger, external trigger, or manual trigger.</li> <li>When the trigger source is an internal trigger, the FGA5050 repeatedly performs sweeps of the duration specified by the sweep time.</li> <li>When the trigger source is an external trigger, the trigger signal is a TTL pulse of the specified edge polarity applied to the Trig In/Out,FSK/Burst connector on the rear panel.</li> <li>The trigger period must be greater than 1 ms plus the specified sweep time.</li> <li>When the trigger source is a manual trigger, the FGA5050 sweeps whenever the trigger key on the front panel is pressed.</li> <li>The factory default setting is for the FGA5050 to use an internal trigger.</li> </ul>
Trigger signal output	<ul style="list-style-type: none"> <li>The Trig In/Out,FSK/Burst connector on the rear panel produces the trigger signal output.</li> <li>When trigger signal output is on, a square wave that has TTL-compatible levels and that corresponds to the sweep output is generated.</li> <li>For an internal trigger, the square waveform has a 50 % duty cycle.</li> <li>For an external trigger, no output is produced by the Trig In/Out,FSK/Burst connector, because the connector is used to receive the external trigger signal.</li> <li>For a manual trigger, whenever a sweep starts, a pulse with a width greater than 1 <math>\mu</math>s is produced.</li> </ul>
Single sweep mode	<ul style="list-style-type: none"> <li>A single sweep is performed when the trigger signal is received. After the FGA5050 finishes a single sweep from the start frequency to the stop frequency, it waits for the next trigger while generating the start frequency.</li> </ul>

## Procedure

- 1 Press one of the waveform selection keys—Sine, Square, Ramp, or Arb—to select a sweep waveform.**

The selected key lights.

- 2 Specify all the necessary waveform parameters for the waveform.**

- 3 Press Sweep to start sweep mode.**

The Sweep key lights. The sweep settings are assigned to softkeys.

- 4 Press the Type softkey.**

The sweep mode options are assigned to softkeys.



- 5 Press the Linear/Log softkey to switch between linear and logarithmic sweeping.**

### ■ How to set the start and stop frequencies

- 6 Press the Start/Cntr softkey.**

Use the key to highlight Start.

See p. 39, p. 40,  
p. 42, p. 46

**7** Use the numeric keypad or the cursor keys and the rotary knob to set the start frequency.

**8** Follow the same procedure to use the Stop/Span softkey to set the stop frequency.  
Use the key to highlight Stop.

■ **How to set the center frequency and frequency span**

**9** Press the Start/Cntr softkey.  
Use the key to highlight Cntr.

**10** Use the numeric keypad or the cursor keys and the rotary knob to set the center frequency.

**11** Follow the same procedure to use the Stop/Span softkey to set the frequency span.  
Use the key to highlight Span.

■ **Sweep time**

**12** Press the Sweep Time softkey.

**13** Use the numeric keypad or the cursor keys and the rotary knob to set the sweep time.

■ **Marker frequency**

**14** Press the Mkr softkey to switch between Freq and OFF.  
Select Freq.

**15** Use the numeric keypad or the cursor keys and the rotary knob to set the marker frequency.

■ **Setting the trigger signal to Int (internal triggering), Ext (external triggering), or Man (manual triggering)**

**16** Press the Trig Setup softkey to enter the trigger setup menu.



**17** Press the Src softkey.  
The Int (internal triggering), Ext (external triggering), and Man (manual triggering) trigger signal options are assigned to softkeys.

**18** Select Int (internal triggering), Ext (external triggering), or Man (manual triggering).

■ **Method for Man (manual triggering)**

When you select Man (manual triggering), the Trigger key lights. Each time you press Trigger, the FGA5050 performs a single sweep.

- External trigger signal slope polarity (when Ext (external trigger) has been selected)

**19** Press the Slope softkey.

**20** Select  (rising) or  (falling).

**21** Press the DONE softkey to finish the trigger signal selection.

**22** To check the waveform parameters, press Graph.  
Graph mode is enabled.

- Trigger output (when Int (internal triggering) or Man (manual triggering) has been selected)

**19** Press the Trig Out softkey.

**20** Select OFF,  (rising), or  (falling).

**21** Press the DONE softkey to finish the trigger signal selection.

**22** To check the waveform parameters, press Graph.  
Graph mode is enabled.

## Remote interface operation

---

```

SWEep:SPACing {LINear|LOGarithmic|USER}
SWEep:TIME {<seconds>|MINimum|MAXimum}
FREQuency:START {<frequency>|MINimum|MAXimum}
FREQuency:STOP {<frequency>|MINimum|MAXimum}
FREQuency:CENTer {<frequency>|MINimum|MAXimum}
FREQuency:SPAN {<frequency>|MINimum|MAXimum}
MARKer:FREQuency {<frequency>|MINimum|MAXimum}
MARKer {OFF|ON}
SWEep:STATe ON

```

```

TRIGger:SOURce {IMMediate|EXTernal|BUS}

```

Specifies the trigger source.

```

TRIGger:SLOPe {POSitive|NEGative}

```

Specifies whether the sweep is triggered on the rising or falling edge.

```

OUTPut:TRIGger:SLOPe {POSitive|NEGative}

```

```

OUTPut:TRIGger {OFF|ON}

```

Sets the trigger output.

---

# Burst

In burst output, the selected waveform is generated for the specified number of cycles. There are two types of burst modes: triggered burst mode and external gated burst mode.

## ● Triggered burst mode

The factory default burst mode setting is triggered burst mode. When the FGA5050 receives a trigger, it generates a waveform for the number of cycles determined by the burst count. After the specified number of cycles have been generated, output stops, and the FGA5050 waits for the next trigger. You can trigger a burst by:

- Using an internal signal.
- Pressing the Trigger key on the front panel.
- Applying an external signal to the Trig In/Out,FSK/Burst connector on the rear panel.
- Receiving a software trigger from the remote interface.

## ● External gated burst mode

In external gated burst mode, the length of a burst is determined by the voltage level of the external signal applied to the Trig In/Out,FSK/Burst connector on the rear panel. While the external gate signal logic is true, the FGA5050 generates a continuous waveform. While the external gate signal logic is false, the FGA5050 generates the same voltage level as that of the starting burst phase of the selected waveform. For noise waves, the output stops immediately regardless of the phase.

## ● Available parameters for each burst mode

Burst Mode		Burst Count	Burst Period	Burst Phase	External Trigger Signal Polarity
Triggered burst mode	Internal triggering	Available	Available	Available	
	External triggering	Available		Available	
	Manual triggering	Available		Available	
External gated burst mode				Available	Available

## Setting conditions

Waveform	<ul style="list-style-type: none"><li>• In triggered burst mode, you can set the waveform to a sine wave, square wave, ramp wave, or arbitrary waveform.</li><li>• In external gated burst mode, you can set the waveform to a sine wave, square wave, ramp wave, pulse wave, noise wave, or arbitrary waveform.</li><li>• The factory default setting is a sine wave.</li></ul>
Burst count	<ul style="list-style-type: none"><li>• The burst count is the number of cycles that appear in each burst. The burst count is only valid in triggered burst mode.</li><li>• The range is from 1 to 50000 cycles. You can also set the burst count to infinite.</li><li>• The burst count is not valid in external gated burst mode. If you set a new burst count in external gated burst mode, the burst count is retained and used when triggered mode is selected.</li><li>• The factory default setting is 1 cycle.</li></ul>
Burst period	<ul style="list-style-type: none"><li>• When the trigger source is set to an internal trigger, bursts are output repeatedly at the specified burst period.</li><li>• The burst period is the interval between two consecutive bursts. The burst count must be less than the product of the burst period and the waveform frequency. <math display="block">\text{Burst count} &lt; \text{Burst period} \times \text{waveform frequency}</math></li><li>• The range is 1 <math>\mu</math>s to 500 s.</li><li>• When you set the burst count, the burst period is automatically set to the maximum allowable value. The waveform frequency is not affected by the burst count.</li></ul>

Burst period (continued)	<ul style="list-style-type: none"> <li>The burst period must be long enough for the FGA5050 to generate the burst count. When the burst period is too short in relation to the burst count, the burst period is automatically set to the shortest period that can be used with the specified burst count and waveform frequency. Burst period &gt; (Burst count / waveform frequency) + 200 ns</li> <li>The factory default setting is 10 ms.</li> </ul>												
Waveform frequency	<ul style="list-style-type: none"> <li>The waveform frequency is the frequency of the waveform that is generated when the trigger signal is at the high level.</li> <li>In triggered burst mode, the number of cycles specified by the waveform frequency are generated.</li> <li>In external gated burst mode, when the level of the external gate signal is high, the waveform frequency is generated.</li> <li>The setting ranges are listed below. The minimum frequency in internal triggered burst mode is 2.001 mHz. For sine and square waveforms, waveform frequencies greater than 10 MHz are only valid when the burst count is set to infinite.</li> <li>The factory default setting is 1 kHz.</li> </ul> <table border="1" data-bbox="722 696 1437 902"> <thead> <tr> <th>Waveform</th> <th>Waveform frequency range</th> </tr> </thead> <tbody> <tr> <td>Sine wave</td> <td>1 <math>\mu</math>Hz to 50 MHz</td> </tr> <tr> <td>Square wave</td> <td>1 <math>\mu</math>Hz to 25 MHz</td> </tr> <tr> <td>Ramp wave</td> <td>1 <math>\mu</math>Hz to 200 kHz</td> </tr> <tr> <td>Pulse wave</td> <td>1 <math>\mu</math>Hz to 10 MHz</td> </tr> <tr> <td>Arbitrary waveform</td> <td>1 <math>\mu</math>Hz to 10 MHz</td> </tr> </tbody> </table>	Waveform	Waveform frequency range	Sine wave	1 $\mu$ Hz to 50 MHz	Square wave	1 $\mu$ Hz to 25 MHz	Ramp wave	1 $\mu$ Hz to 200 kHz	Pulse wave	1 $\mu$ Hz to 10 MHz	Arbitrary waveform	1 $\mu$ Hz to 10 MHz
Waveform	Waveform frequency range												
Sine wave	1 $\mu$ Hz to 50 MHz												
Square wave	1 $\mu$ Hz to 25 MHz												
Ramp wave	1 $\mu$ Hz to 200 kHz												
Pulse wave	1 $\mu$ Hz to 10 MHz												
Arbitrary waveform	1 $\mu$ Hz to 10 MHz												
Burst phase	<ul style="list-style-type: none"> <li>The burst phase determines the starting burst phase.</li> <li>The range is from -360 ° to +360 °. From the front panel, you can only set the burst phase as a phase angle (in degrees). From the remote interface, you can set the burst phase as a phase angle (in degrees) or in radians.</li> <li>The factory default setting is a 0 °.</li> <li>For sine, square, and ramp waves, the 0 ° phase angle is at the point where the rising edge of the waveform crosses the zero volt line or the DC offset value. For arbitrary waveforms, the 0 ° phase angle is at the first point on the waveform. The burst phase does not affect pulse or noise waves.</li> <li>In external gated burst mode, when the level of the external gate signal is too low, the generation operation stops. When this happens, the FGA5050 generates the same voltage level as that of the starting burst phase.</li> </ul>												
Trigger source (internal triggering, external triggering, and manual triggering)	<ul style="list-style-type: none"> <li>You can set the trigger source to an internal trigger, external trigger, or manual trigger.</li> <li>The factory default setting is for the FGA5050 to use an internal trigger.</li> <li>In triggered burst mode, whenever a trigger is received, the FGA5050 generates a burst for the specified number of cycles and then waits for the next trigger event.</li> <li>When the trigger source is an internal trigger, bursts are generated according to the burst period.</li> <li>When the trigger source is a manual trigger, a burst is only generated when Trigger is pressed.</li> <li>When the trigger source is an external trigger, a burst is generated whenever a TTL pulse of the specified edge polarity is applied to the Trig In/Out,FSK/Burst connector on the rear panel. Applied trigger signals are ignored while a burst is being generated.</li> <li>When the trigger source is an external trigger or manual trigger, the burst count and burst phase do not change, but the burst period is ignored.</li> </ul>												
Trigger signal output	<ul style="list-style-type: none"> <li>In internal triggered and manual triggered burst mode, you can produce a trigger signal from the Trig In/Out,FSK/Burst connector on the rear panel at the same time that a burst occurs.</li> <li>When trigger signal output is on, a TTL-compatible square wave that has a rising or falling slope and that corresponds to the burst output is generated.</li> <li>For an internal trigger, the square waveform has a 50 % duty cycle.</li> <li>For an external trigger, no output is produced by the Trig In/Out,FSK/Burst connector, because the connector is used to receive the external trigger signal.</li> <li>For a manual trigger, whenever a sweep starts, a pulse with a width greater than 1 <math>\mu</math>s is produced.</li> </ul>												

## Procedure (triggered burst mode)

- 1 Press one of the waveform selection keys—Sine, Square, Ramp, Pulse, or Arb—to select a burst waveform.

The selected key lights.

See p. 25

- 2 Set the frequency of the waveform you selected.

- 3 Press **Burst** to switch to burst mode.

The Burst key lights. The burst mode settings are assigned to softkeys.



### ■ Burst mode, burst count

- 4 Press the **N Cyc/Gated** softkey to select triggered burst mode.

Use the key to highlight N Cyc.

- 5 Press the **#Cyc/Inf** softkey to switch the burst count to **#Cyc (finite)** or **Inf (infinite)**.

To set a finite burst count, use the key to highlight #Cyc.

To set an infinite burst count, use the key to highlight Inf.

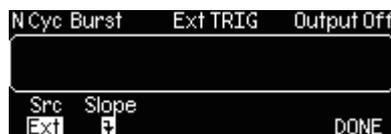
- 6 Use the numeric keypad or the cursor keys and the rotary knob to set the burst count.

- 7 Press the **Start Phase** softkey.

- 8 Use the numeric keypad or the cursor keys and the rotary knob to set the starting phase angle.

### ■ Setting the trigger signal to **Int (internal triggering)**, **Ext (external triggering)**, or **Man (manual triggering)**

- 9 Press the **Trig Setup** softkey to enter the trigger setup menu.



- 10 Press the **Src** softkey.

The Int (internal triggering), Ext (external triggering), and Man (manual triggering) trigger signal options are assigned to softkeys.

- 11 Select **Int (internal triggering)**, **Ext (external triggering)**, or **Man (manual triggering)**.

### ■ Burst period (when **Int (internal triggering)** or **Man (manual triggering)** has been selected)

- 12 Press the **Burst Perd** softkey.

**13** Use the numeric keypad or the cursor keys and the rotary knob to set the burst period.

**14** Press the DONE softkey to finish the trigger signal selection.

**15** To check the waveform parameters, press Graph.  
Graph mode is enabled.

■ **Method for Man (manual triggering)**

When you select Man (manual triggering), the Trigger key lights. Each time you press Trigger, the FGA5050 performs a single burst.

■ **External trigger signal slope polarity (when Ext (external trigger) has been selected)**

**12** Press the Slope softkey.

**13** Select  (rising) or  (falling).

**14** Press the DONE softkey to finish the trigger signal selection.

**15** To check the waveform parameters, press Graph.  
Graph mode is enabled.

■ **Trigger output (when Int (internal triggering) or Man (manual triggering) has been selected)**

**12** Press the Trig Out softkey.

**13** Select OFF,  (rising), or  (falling).

**14** Press the DONE softkey to finish the trigger signal selection.

**15** To check the waveform parameters, press Graph.  
Graph mode is enabled.

**Procedure (external gated burst mode)**

**1** Press one of the waveform selection keys—Sine, Square, Ramp, Pulse, Noise, or Arb—to select a burst waveform.

The selected key lights.

**2** Set the frequency of the waveform you selected.

**3** Press Burst to switch to burst mode.

The Burst key lights. The burst mode settings are assigned to softkeys.



**4** Press the N Cyc/Gated softkey to select external gated burst mode.

Use the key to highlight Gated.

See p. 25

**5 Press the Polar softkey to switch between Neg and Pos.**

Select the external gate signal level at which the logic value is true. The selected level is highlighted.

**6 Press the Start Phase softkey.****7 Use the numeric keypad or the cursor keys and the rotary knob to set the starting phase angle.****8 To check the waveform parameters, press Graph.**

Graph mode is enabled.

**Remote interface operation**


---

```

FUNCTION {SINusoid|SQUare|RAMP|PULSe|USER}
FREQUENCY {<frequency>|MINimum|MAXimum}
BURSt:MODE {TRIGgered|GATed}
BURSt:GATE:POLarity {NORMal|INVerted}
BURSt:NCYCles {<#cycles>|INFinity|MINimum|MAXimum}
BURSt:INTernal:PERiod {<seconds>|MINimum|MAXimum}
BURSt:PHASe {<angle>|MINimum|MAXimum}
UNIT:ANGLE {DEGree|RADian}
TRIGger:SOURce {IMMediate|EXTernal|BUS}
TRIGger:SLOPe {POSitive|NEGative}
OUTPut:TRIGger:SLOPe{POSitive|NEGative}
OUTPut:TRIGger {OFF|ON}
BURSt:STATe ON

```

---

# Pattern Output

In addition to arbitrary waveforms, the FGA5050 can generate a pattern that has a 16-bit resolution and up to 256 K points. Just as with arbitrary waveforms, you can choose from 5 built-in patterns or generate one of up to four user-defined patterns stored in non-volatile memory. The built-in patterns are an exponential rising wave, exponential falling wave, negative ramp wave (reverse ramp wave), sinc wave, and cardiac wave (cardiac electrogram wave). The factory default setting is for the FGA5050 to produce an exponential rising wave pattern.

- **User-defined patterns**

You can use the attached Wavepatt application software to generate patterns. You can also use Wavepatt to load waveforms that you have acquired with an oscilloscope. For detailed information about user-defined patterns, see the Wavepatt online help.

## Procedure (using the built-in patterns)

**1 Press Utility.**

The Utility key lights. The Utility menu appears.



**2 Press the PATT Mode softkey to enter the PATTERN OUT menu.**



**3 Press the Select Wform softkey to enter the selection menu.**



**4 Press the Built In softkey.**

**5 Press the softkey of the built-in waveform whose pattern you want to select.**

You can select Exp Rise, Exp Fall, Neg Ramp, Sinc, or Card.

**6 Press the Fclk/Perd softkey to switch between Fclk (frequency) and Perd (period).**

Set Fclk (frequency) or Perd (period).

The pattern clock range is from 1  $\mu$ Hz to 50 MHz.



**7 Press the Start Addr (or End Addr) softkey to select the output pattern start (or end) point.**

See p. 25

- 8 Use the cursor keys and the rotary knob to set the value.
- 9 If you use the numeric keypad, after you enter a value, press the Enter softkey.

To cancel the value you entered, press the Cancel softkey.



- 10 Press the Output Setup softkey to enter the output setup menu.

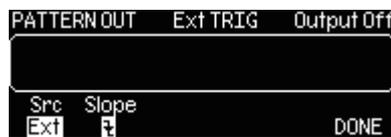


- 11 Press the RPT. softkey to set pattern repetition to ON (the pattern is repeated) or OFF (the pattern is not repeated).
- 12 Press the CLK softkey, to set the pattern output trigger slope to  (rising) or  (falling).

- 13 Press the DONE softkey to finish configuring the settings.

- **Setting the trigger signal to Ext (external triggering) or Man (manual triggering)**

- 14 Press the Trig Setup softkey to enter the trigger setup menu.



- 15 Press the Src softkey.  
The Ext (external triggering) and Man (manual triggering) trigger signal options are assigned to softkeys.

- 16 Set the trigger signal to Ext (external triggering) or Man (manual triggering).

- **Method for Man (manual triggering)**

When you select Man (manual triggering), the Trigger key lights. Each time you press Trigger, the FGA5050 generates a single pattern.

- **External trigger signal slope polarity (when Ext (external triggering) has been selected)**

- 17 Press the Slope softkey.
- 18 Select  (rising) or  (falling).
- 19 Press the DONE softkey to finish the trigger signal selection.

**20** To check the waveform parameters, press Graph.

Graph mode is enabled.

■ **Trigger output (when Man (manual triggering) has been selected)**

**17** Press the Trig Out softkey.

**18** Select OFF,  (rising), or  (falling).

**19** Press the DONE softkey to finish the trigger signal selection.

**20** To check the waveform parameters, press Graph.

Graph mode is enabled.

**Procedure (using the user-defined patterns)**

**1** Press Utility.

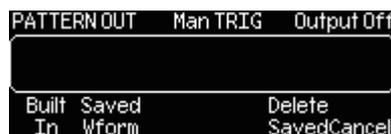
The Utility key lights. The Utility menu appears.



**2** Press the PATT Mode softkey to enter the PATTERN OUT menu.



**3** Press the Select Wform softkey to enter the selection menu.



**4** Press the Saved Wform softkey.

**5** Press the softkey of the user-defined pattern that you want to select.

**6** Afterward, the procedure is the same as steps 6 to 20 for using a built-in pattern.

■ **Deleting a user-defined pattern**

**1** Press the Delete Saved softkey.

**2** Press the softkey of the user-defined pattern that you want to delete.

**3** Press the DONE softkey to finish the operation.

## PATTERN OUT commands: (Add Pattern Out commands)

---

**FUNCTION:PATTERN** {data name}

Select the file name of a pattern, such as EXP\_RISE, EXP\_FALL, NEG\_RAMP, SINC, or CARDIAC.

**FUNCTION:PATTERN?**

Queries the file name of the pattern.

**DIGITAL:PATTERN:FREQUENCY** {<frequency>, MINimum, MAXimum}

Sets the pattern frequency to a value from 1  $\mu$ Hz to 50 MHz.

**DIGITAL:PATTERN:FREQUENCY?** [MINimum, MAXimum]

Queries the minimum and maximum pattern frequencies.

**DIGITAL:PATTERN:START** {<address>, MINimum, MAXimum}

Sets the pattern start address (min. 1).

**DIGITAL:PATTERN:START?** [MINimum, MAXimum]

Queries the pattern start address.

**DIGITAL:PATTERN:STOP** {<address>, MINimum, MAXimum}

Sets the pattern end address.

**DIGITAL:PATTERN:STOP?** [MINimum, MAXimum]

Queries the pattern end address.

**DIGITAL:PATTERN:REPEAT** {ON, OFF}

Enables (ON) or disables (OFF) pattern repetition.

**DIGITAL:PATTERN:REPEAT?**

Queries whether pattern output is repeated (ON or OFF).

**DIGITAL:PATTERN:CLOCK** {POS, NEG}

Sets the latching data clock of the pattern to a positive (rising) or negative (falling) edge.

**DIGITAL:PATTERN:CLOCK?**

Queries whether the latching data clock is set to a positive (rising) or negative (falling) edge.

**DIGITAL:PATTERN:TRIGGER:SOURCE** {EXT, BUS}

Sets the pattern trigger source to EXT or BUS.(There is no IMM internal trigger.)

**DIGITAL:PATTERN:TRIGGER:SOURCE?**

Queries the trigger source of the pattern.

**DIGITAL:PATTERN:TRIGGER:SLOPE** {POS, NEG}

Sets the trigger slope of the pattern to a positive (rising) or negative (falling) edge.

**DIGITAL:PATTERN:TRIGGER:SLOPE?**

Queries the trigger slope of the pattern.

DIGital:PATtern:OUTPut:TRIGger {OFF, ON}

Sets the pattern output trigger to ON or OFF.

DIGital:PATtern:OUTPut:TRIGger?

Queries the pattern output trigger.

DIGital:PATtern:OUTPut:TRIGger:SLOPe {POS, NEG}

Sets the trigger slope of the pattern output to a positive (rising) or negative (falling) edge.

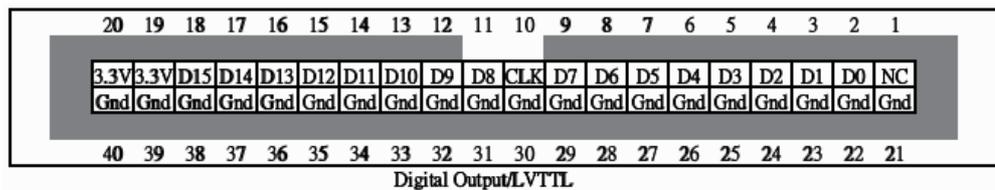
DIGital:PATtern:OUTPut:TRIGger:SLOPe?

Queries whether the trigger slope of the pattern output is set to a positive (rising) or negative (falling) edge.

DATA:PATTERN VOLATILE, <binary block>

Downloads binary data into volatile memory. You can download from 1 to 262 144 (256 K) points per waveform in IEEE-488.2 binary block format.

### Digital Output/LVTTL connector pinout



The FGA5050 has a 40-pin, flat pattern generator cable. You can use this cable to output patterns.

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# 5

---

## System Settings

This chapter explains the system settings.

# Overview of the System Settings

The following system settings items are explained.

Item		
Trigger settings	Internal triggering, external triggering, or manual triggering	p. 76
Storing and recalling setup conditions	Storing setup conditions to four non-volatile memory locations	p. 79
Frequency reference output (10 MHz Out) settings	Synchronizing multiple FGA5050s	p. 82
Display control	Turning the display off	p. 83
Beeper	Turning the beeper off	p. 84
Operation confirmation sound	Turning the operation confirmation sound off	p. 84
Error display	Errors are displayed in first in, first out (FIFO) order.	p. 85

## Trigger Settings

There are three trigger options: internal triggering, external triggering, and manual triggering. Triggering is valid for bursts, frequency sweeping, and FSK modulation (internal and external triggering only). The factory default setting is for the FGA5050 to use internal triggering.

### Internal triggering

The FGA5050 generates a burst or sweep when a trigger signal is generated on the basis of the internal signal.

### External triggering

The Trig In/Out,FSK/Burst connector on the rear panel receives an external trigger signal. The FGA5050 generates a burst or sweep whenever a TTL pulse is applied to the Trig In/Out,FSK/Burst connector. You can set the FGA5050 to trigger on the rising or falling slope of the external trigger signal.

- **Externally-modulated FSK mode**

The carrier wave frequency is output when the input to the Trig In/Out,FSK/Burst connector is a TTL low, and the hop frequency is output when the input to the Trig In/Out,FSK/Burst connector is a TTL high. The maximum shift speed is 100 kHz.

- **Triggered sweep mode**

The FGA5050 generates a sweep at the specified slope whenever a TTL pulse is applied to the Trig In/Out,FSK/Burst connector.

- **Triggered burst mode**

The FGA5050 generates a burst whenever a TTL pulse of the specified edge polarity (rising or falling) is applied to the Trig In/Out,FSK/Burst connector.

- **External gated burst mode**

While the external gate signal logic is true (high level), the FGA5050 generates a continuous waveform. While the external gate signal logic is false (low level), after the FGA5050 finishes the current cycle, it produces voltage at the same level as that of the starting burst phase. For

noise waveforms, output stops immediately when the external gate signal logic becomes false (low level).

## Manual triggering

In manual triggering, the FGA5050 produces a burst or sweep whenever the Trigger key on the front panel is pressed. The Trigger key lights while the FGA5050 waits for the next trigger event. When a function other than burst or sweep is selected, triggering is invalid.

## Selecting a trigger source

Select internal triggering, external triggering, or manual triggering.

 p. 60 , p. 64

- 1 Enable burst mode or frequency sweeping.**
- 2 Press the Trig Setup softkey to enter the trigger setup menu.**
- 3 Press the Src softkey.**  
The Int (internal triggering), Ext (external triggering), and Man (manual triggering) trigger signal options are assigned to softkeys.
- 4 Select Int (internal triggering), Ext (external triggering), or Man (manual triggering).**
- 5 Press the DONE softkey to finish configuring the trigger.**  
The trigger source settings are saved to volatile memory. After you turn the power off and then on again, the factory default settings are restored.

### Remote interface operation

---

```
TRIGger:SOURce {IMMediate|EXTernal|BUS}
TRIGger:SLOPe {POSitive|NEGative}
```

---

## Software triggering

In software triggering, the FGA5050 is triggered through the remote interface. The FGA5050 generates a burst or sweep after receiving a bus command from the remote interface. This operation is similar to the pressing of the Trigger key in manual trigger mode.

### Remote interface operation

---

```
TRIGger:SOURCe BUS
*TRG
TRIGger
```

To trigger the FGA5050 from the remote interface, set the trigger source to BUS. Then send one of the following commands.

```
*TRG
TRIGger
```

---

## Trigger signal output

When an external trigger signal is applied to the Trig In/Out,FSK/Burst connector on the rear panel, at the beginning of a sweep or burst, the FGA5050 can produce a TTL-compatible square wave with either a rising or a falling edge.

- When you select internal triggering, the trigger signal output is a square wave with a 50 % duty cycle. The trigger signal output period is the same as the sweep time or burst period.
- When you select external triggering, the trigger signal output cannot be generated because the trigger signal output uses the same connector as the trigger input.
- When you select manual or bus triggering and a frequency sweep starts, the Trig In/Out,FSK/Burst connector produces a pulse whose width is greater than 1  $\mu$ s.

- 1 Start sweep or burst mode.**
- 2 Press the Trig Setup softkey to enter the trigger setup menu.**
- 3 Press the Trig Out softkey.**
- 4 Select OFF,  (rising), or  (falling).**
- 5 Press the DONE softkey to finish the trigger signal selection.**

### Remote interface operation

---

```
OutPut:TRIGger {OFF|ON}  
OutPut:TRIGger:SLOPe {POSitive|NEGative}
```

---

# Storing and Recalling Setup Conditions

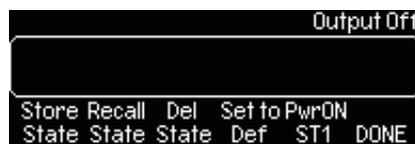
You can store setup conditions to four non-volatile memory locations. You can store all the parameters, including the waveform, frequency, DC offset, amplitude, duty cycle, symmetry, and type of modulation.

## Storing

**1 Configure the setup conditions that you want to store.**

**2 Press Store/Recall to enter the instrument state menu.**

The Store/Recall key lights.



**3 Press the Store State softkey to enter the store state submenu.**

The names of the memory locations that you can store to appear. The locations are State1 to State4.

**4 Press the softkey of the location you want to store to.**

**5 You can name the memory locations. Use the numeric keypad or the cursor keys and the rotary knob to enter a name.**

You can use up to 12 characters in the name. The first character must be a letter of the alphabet. The remaining characters may be numbers, letters of the alphabet, or underscores.



**6 Press the Store State softkey.**

The setup conditions are stored to the specified memory location.

To cancel a store operation, press the Cancel softkey and then the DONE softkey.

## Remote interface operation

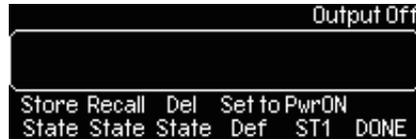
```
*SAV {0|1|2|3|4}
Memory:STATe:NAME {0|1|2|3|4} [, <name>]
```

The factory default settings are stored in memory location 0. Memory location 0 can only be accessed from the remote interface. You can assign a name to memory location 0 from the remote interface. You cannot assign a name to memory location 0 using the front panel.

## Recalling

**1 Press Store/Recall to enter the instrument state menu.**

The Store/Recall key lights.



**2 Press the Recall State softkey to enter the Recall state submenu.**

The memory locations that have been stored to and their names appear. If all the memory locations have been stored to, State1 to State4 appear.



**3 Press the softkey of the memory location whose settings you want to recall.**

**4 Press the Recall State softkey.**

The setup conditions of the specified memory location are recalled.

To cancel a recall operation, press the Cancel softkey and then the DONE softkey.

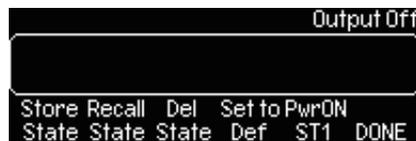
### Remote interface operation

\*RCL {0|1|2|3|4}

## Deleting the content of the memory

**1 Press Store/Recall to enter the instrument state menu.**

The Store/Recall key lights.



**2 Press the Del State softkey to enter the Delete state submenu.**

The memory locations that have been stored to and their names appear. If all the memory locations have been stored to, State1 to State4 appear.

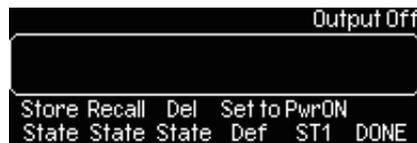


- 3 Press the softkey of the memory location whose settings you want to delete.**
- 4 Press the Delete State softkey.**  
The setup conditions of the specified memory location are deleted.  
To cancel a delete operation, press the Cancel softkey and then the DONE softkey.

## Recalling the contents of the memory when the power switch is turned on

You can use this feature to recall the setup conditions that you want to use when the power switch is turned on. You can recall the setup conditions from a memory location from State1 to State4 or from State Def (the factory default conditions).

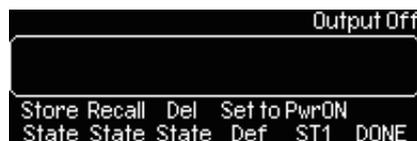
- 1 Press Store/Recall to enter the instrument state menu.**  
The Store/Recall key lights.



- 2 Press the PwrON/ST1 softkey to enter the Power on state submenu.**  
The memory locations that have been stored to and their names appear. If all the memory locations have been stored to, State1 to State4 appear. The factory default settings are indicated by State Def. In the above figure, PwrON/ST1 is displayed because ST1 (State1) has been selected.



- 3 Press the softkey of the memory location you want to select or press the State Def softkey (to select the factory default settings).**
- 4 Press the DONE softkey.**  
The item that you select appears below PwrOn in the instrument state menu. The following figure shows what the menu looks like when State1 has been selected and ST1 appears.



- 5 Press the DONE softkey to finish configuring the settings.**

# Frequency Reference Output (10 MHz Out) Settings

You can produce an internal frequency reference from the 10 MHz Out connector on the rear panel. You can synchronize multiple FGA5050s by connecting their 10 MHz Out connectors and 10 MHz In connectors.

## Connection Method

Use a coaxial cable to connect the 10 MHz Out connector of the master to the 10 MHz In connector of the slave. If there are multiple slaves, connect the slaves to each other in the same way that you connected the master to the slave.

## Procedure

- 1 Press Utility.**  
The Utility key lights.
- 2 Press the Output Setup softkey.**
- 3 Press the 10MOut softkey to switch between the ON and OFF settings.**  
To produce a signal, select ON.



- 4 Press the DONE softkey to finish the selection.**

# Display Control

You can turn off the display. Use this feature for security or to increase the speed at which commands from the remote interface are executed. This feature can only be used from the remote interface.

## Setting conditions

---

Exceptions	<ul style="list-style-type: none"><li>• After you turn the display off, if a *RST (reset) command is executed when the power switch is turned on or the FGA5050 returns to local (front panel) operation, the display is automatically turned on.</li><li>• Error messages are always displayed.</li></ul>
Storing the display setting	<ul style="list-style-type: none"><li>• You can store the display setting by using the *SAV command. If you redo the settings by executing the *RCL command, the display setting returns to the previously stored condition.</li></ul>

---

## Remote interface operation

---

DISP OFF

Turns the display off.

DISP:TEXT 'message to display'

Displays a message and turns the display on again.

DISP:TEXT CLEAR

Deletes the current display message.

---

# Beeper

The FGA5050 produces a sound when an error is detected. You can turn this sound off as necessary. The beeper setting is stored in non-volatile memory. The setting is retained even after the power is turned off or the FGA5050 is reset from the remote interface.

- 1 Press Utility.**  
The Utility key lights.
- 2 Press the System softkey to enter the system related submenu.**
- 3 Press the Beep softkey to switch between the ON and OFF settings.**

## Remote interface operation

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```
SYSTem: BEEPer  
SYSTem: BEEPer: STATe {OFF | ON}
```

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# Operation Confirmation Sound

The FGA5050 produces an operation confirmation sound when you use its operation keys or rotary knob. You can turn the operation confirmation sound off as necessary. The operation confirmation sound setting is stored in non-volatile memory. The setting is retained even after the power is turned off or the FGA5050 is reset from the remote interface.

- 1 Press Utility.**  
The Utility key lights.
- 2 Press the System softkey to enter the system related submenu.**
- 3 Press the Sound softkey to switch between the ON and OFF settings.**

## Remote interface operation

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```
SYSTem: SOUND  
SYSTem: SOUND: STATe {OFF | ON}
```

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# Error Display

The FGA5050 can store up to 20 syntax or hardware errors in its error queue. Each error can be up to 255 characters in length. Each time an error is detected, the beeper sounds (unless the beeper has been turned off). Errors are displayed in first in, first out (FIFO) order, and viewed errors are deleted.

To clear the error queue from the remote interface, use the \*CLS command. You cannot clear the error queue by using the \*RST command, but errors are deleted when you turn off the power.

## Reading error messages

- 1 Press Help to enter the help topic selection.**  
The Help key lights.
- 2 Use the up and down softkeys to scroll through the topics until View remote command error queue is highlighted.**
- 3 Press the Select softkey.**  
The error messages appear.
- 4 Press the DONE softkey.**  
The help topic selection closes.

## Remote interface operation

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SYSTem: ERRor?

View one error from the error queue.

\*CLS

Delete all errors in the error queue.

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# 6

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## Specifications

This chapter contains the specifications of the FGA5050.

## Waveform characteristics

### Waveforms

Item	Specification
Standard waveforms	Sine, square, ramp, triangle, pulse, noise, and DC
Arbitrary waveforms	Exponential rising wave, exponential falling wave, reverse ramp wave, sinc wave, and cardiac wave (cardiac electrogram wave)

### Sine waves

Item	Specification		
Frequency	1 $\mu$ Hz to 50 MHz		
Amplitude flatness <sup>1,2</sup> (relative to 1 kHz)	Less than 100 kHz		0.1 dB
	Less than 5 MHz		0.15 dB
	Less than 20 MHz		0.3 dB
	Less than 50 MHz		0.5 dB
Harmonic distortion <sup>2,3</sup>	DC to 20 kHz	Less than 1 Vpp	-70 dBc
		1 Vpp or more	-70 dBc
	20 kHz to 100 kHz	Less than 1 Vpp	-65 dBc
		1 Vpp or more	-60 dBc
	100 kHz to 1 MHz	Less than 1 Vpp	-50 dBc
		1 Vpp or more	-45 dBc
	1 MHz to 20 MHz	Less than 1 Vpp	-40 dBc
		1 Vpp or more	-35 dBc
	20 MHz to 50 MHz	Less than 1 Vpp	-35 dBc
		1 Vpp or more	-30 dBc
Total harmonic distortion	DC to 20 kHz	0.5 Vpp or more	0.06 % or less
Spurious <sup>2,4</sup> (non-harmonic)	DC to 1 MHz		-70 dBc
	1 MHz to 50 MHz		-70 dBc + 6 dB/octave
Phase noise (10 kHz offset)	0.1 Vpp or more 1 MHz or more	Typically -115 dBc/Hz	

- 1 Add 1/10th to the output amplitude and DC offset specifications per 1 °C for operations outside the range of 18 °C to 28 °C.
- 2 When autoranging is enabled
- 3 DC offset set to 0 V
- 4 Spurious output at low amplitudes is typically -75 dBm.

### Square waves

Item	Specification		
Frequency	1 $\mu$ Hz to 25 MHz		
Rising, falling time	Less than 10 ns		
Overshoot	Less than 2 %		
Variable duty cycle	Less than 10 MHz	20 % to 80 %	
	Less than 25 MHz	40 % to 60 %	
Asymmetry	50 % duty cycle	1 % of period + 5 ns	
Jitter (RMS)	0.1 Vpp or more 1 MHz or more	200 ps	

## Ramp and triangle waves

Item	Specification
Frequency	1 $\mu$ Hz to 200 kHz
Linearity	Less than 0.1 % of the peak output
Symmetry	0.0 % to 100.0 %

## Pulse wave

Item	Specification	
Frequency	500 $\mu$ Hz to 10 MHz	
Pulse width	20 ns minimum	
	Resolution (period $\leq$ 10 s)	10 ns
Variable edge time	Less than 10 ns to 100 ns	
Overshoot	Less than 2 %	
Jitter (RMS)	0.1 Vpp or more 50 kHz or more	200 ps

## Noise waves

Item	Specification
Bandwidth	Typically 20 MHz

## Arbitrary waveforms

Item	Specification	
Frequency	1 $\mu$ Hz to 10 MHz	
Wavelength	2 to 256 K points	
Resolution	14 bits (including the sign)	
Sampling rate	125 megasamples per second	
Minimum rising or falling time	Typically 30 ns	
Linearity	Less than 0.1 % of the peak output	
Settling time	Up to 0.5 % of the final value	Less than 250 ns
Jitter (RMS)	6 ns + 30 ppm	
Non-volatile memory	4 waveforms, 256 K points per waveform	

## Common waveform characteristics

### Frequency

Item	Specification
Resolution	1 $\mu$ Hz

### Amplitude

Item	Specification	
Range	50 $\Omega$ termination	10 mVpp to 10 Vpp
	No termination	20 mVpp to 20 Vpp
Accuracy <sup>1,2</sup>	At 1 kHz	$\pm 1$ % of setting $\pm 1$ mVpp
Units	Vpp, Vrms, and dBm	
Resolution	4 digits	

- 1 Add 1 ppm/1  $^{\circ}$ C (average) for operations outside the range of 18  $^{\circ}$ C to 28  $^{\circ}$ C.
- 2 When autoranging is enabled

### DC offset

Item	Specification	
Range (peak AC + DC)	50 $\Omega$ termination	$\pm 5$ V
	No termination	$\pm 10$ V
Accuracy <sup>1,2</sup>	$\pm 2$ % of offset setting $\pm 0.5$ % of amplitude setting $\pm 2$ mV	
Resolution	4 digits	

- 1 Add 1 ppm/1  $^{\circ}$ C (average) for operations outside the range of 18  $^{\circ}$ C to 28  $^{\circ}$ C.
- 2 When autoranging is enabled

### Main output

Item	Specification	
Impedance	Typically 50 $\Omega$	
Isolation	From earth	Up to 42 Vpk
Protection	Short-circuit protection, overload automatically stops output	

### Internal frequency reference

Item	Specification	
Accuracy <sup>1</sup>	90 days	$\pm 10$ ppm
	1 year	$\pm 20$ ppm

- 1 Add 1 ppm/1  $^{\circ}$ C (average) for operations outside the range of 18  $^{\circ}$ C to 28  $^{\circ}$ C.

## External frequency reference input

Item	Specification	
Lock range	10 MHz $\pm$ 500 Hz	
Level	100 mVpp to 5 Vpp	
Impedance	AC coupled	Typically 1 k $\Omega$
Lock time	Less than 2 s	

## frequency reference output

Item	Specification	
Lock range	10 MHz	
Level	Typically 632 mVpp (0 dBm)	
Impedance	AC coupled	Typically 50 $\Omega$

## Phase offset

Item	Specification	
Range	-360 $^{\circ}$ to +360 $^{\circ}$	
Resolution	0.001 $^{\circ}$	
Accuracy	8 ns	

## Modulation

### Types of modulation

Item	Specification	
Modulation	AM, FM, PM, FSK, PWM, sweep, and burst	

### AM (amplitude modulation)

Item	Specification	
Carrier wave	Sine, square, ramp, or arbitrary	
Modulation signal	Internal or external	
Internal modulation signal	Sine, square, ramp, triangle, noise, or arbitrary	
Internal modulation signal frequency range	2 mHz to 20 kHz	
Modulation depth	0.0 % to 120.0 %	

### FM (frequency modulation)

Item	Specification	
Carrier wave	Sine, square, ramp, or arbitrary	
Modulation signal	Internal or external	
Internal modulation signal	Sine, square, ramp, triangle, noise, or arbitrary	
Internal modulation signal frequency range	2 mHz to 20 kHz	
Deviation	DC to 25 MHz	

### PM (phase modulation)

Item	Specification
Carrier wave	Sine, square, ramp, or arbitrary
Modulation signal	Internal or external
Internal modulation signal	Sine, square, ramp, triangle, noise, or arbitrary
Internal modulation signal frequency range	2 mHz to 20 kHz
Deviation	0.0 ° to 360 °

### PWM (pulse width modulation)

Item	Specification
Carrier wave	Pulse wave
Modulation signal	Internal or external
Internal modulation signal	Sine, square, ramp, triangle, noise, or arbitrary
Internal modulation signal frequency range	2 mHz to 20 kHz
Deviation	0 % to 100 % of the pulse width

### FSK modulation

Item	Specification
Carrier wave	Sine, square, ramp, or arbitrary
Modulation signal	Internal or external
Internal modulation signal	Square wave signal with a 50 % duty cycle
Internal modulation signal frequency range	2 mHz to 100 kHz

### External Modulation Input

Item <sup>1</sup>	Specification
Input voltage range	±5 V full scale
Input resistance	Typically 8.7 kΩ
Bandwidth	DC to 20 kHz

1 FSK modulation uses the Trig In/Out, FSK/Burst connector (the maximum frequency is 1 MHz).

### Sweep

Item	Specification
Waveforms	Sine, square, ramp, or arbitrary
Method	Linear and logarithmic
Direction	Up, down
Sweep time	1 ms to 500 s
Trigger	Internal, external, or manual
Marker	The falling edge of the sync output signal

## Burst

Item	Specification
Waveforms <sup>1</sup>	Sine, square, ramp, triangle, noise, or arbitrary
Method	Internal or external
Starting and ending phases	-360 ° to +360 °
Internal period	1 μs to 500 s
Gate signal	External
Trigger signal	Internal, external, or manual

1 Sine and square waveforms above 10 MHz are can only be used with an infinite burst count.

## Trigger input

Item	Specification
Input level	TTL compatible
Slope	Select rising or falling
Pulse width	Greater than 100 ns
Impedance	Greater than 10 kΩ (DC coupling)
Latency	Less than 500 ns

## Trigger output

Item	Specification
Output Level	TTL equivalent (load of 1 kΩ or more)
Pulse width	Greater than 400 ns
Impedance	Typically 50 Ω
Maximum speed	1 MHz
Fan-out	Up to 4 FGA5050s

## Pattern output

### Output

Item	Specification
Maximum clock speed	50 MHz
Output Level	TTL equivalent (load of 2 kΩ or more)
Output impedance	Typically 110 Ω
Pattern Length	2 to 256 K points

## General specifications

Item	Specification	
Input voltage range	Single-phase 100 Vac to 240 Vac, 50 Hz to 60 Hz Single-phase 100 Vac to 120 Vac, 400 Hz	
Input frequency range	50 Hz/60 Hz, 400 Hz	
Power consumption	80 VA max	
Warm-up time	1 hour	
Operating temperature range	0 °C to 55 °C (80 %rh or less, no condensation)	
Storage temperature range	-30 °C to 70 °C (80 %rh or less, no condensation)	
Operating altitude	Up to 2000 m	
Dimensions (mm)	253 W × 107 H × 381 D mm (9.96 W × 4.21 H × 15.0 D inch)	
Weight	Approx. 4 kg (8.8 lb)	
Interface	LAN, USB, GPIB (factory option)	
Safety <sup>1</sup>	Complies with the requirements of the following directive and standard. Low Voltage Directive 2014/35/EU <sup>2</sup> EN 61010-1 (Class I <sup>3</sup> , Pollution degree 2 <sup>4</sup> )	
Electromagnetic compatibility (EMC) <sup>1 2</sup>	Complies with the requirements of the following directive and standard. EMC Directive 2014/30/EU EN 61326-1 (Class A <sup>5</sup> ) EN 55011 (Class A <sup>5</sup> , Group 1 <sup>6</sup> ) EN 61000-3-2 EN 61000-3-3	
Accessories	Power cord	1 pc. (with three-pronged plug)
	Pattern generator cable	1 pc.
	USB cable	1 pc.
	CD-ROM <sup>7</sup>	1 pc.
	Packing list, safety precautions	1 English, 1 Japanese
	China RoHS disclosure report <sup>8</sup>	1 pc.

- 1 Does not apply to specially made or modified FGA5050.
- 2 Limited to products that have the CE mark on their panels.
- 3 This is a Class I equipment. Be sure to ground this product's protective conductor terminal. The safety of this product is only guaranteed when the product is properly grounded.
- 4 Pollution is addition of foreign matter (solid, liquid or gaseous) that may produce a reduction of dielectric strength or surfaceresistivity. Pollution Degree 2 assumes that only non-conductive pollution will occur except for an occasional temporary conductivity caused by condensation.
- 5 This is a Class A equipment. This product is intended for use in an industrial environment. This product may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.
- 6 This is a Group 1 equipment. This product does not generate and/or use intentionally radio-frequency energy, in the form of electromagnetic radiation, inductive and/or capacitive coupling, for the treatment of material or inspection/analysis purpose.
- 7 Contains the User's Manual and the Remote Interface Manual.
- 8 Only 220 V model

# INDEX

#Cyc/Inf softkey .....	66	Frequency reference output .....	91
<b>Numerics</b>		frequency span .....	60
10 MHz In connector .....	10	frequency sweeping .....	24
10 MHz Out connector .....	10	FSK rate .....	56
10MOut softkey .....	82	FSK softkey .....	56
<b>A</b>		<b>G</b>	
Accessories .....	16, 94	GPIB .....	10
Adjusting the handle angle .....	17	Graph mode .....	22
AM Depth softkey .....	49, 50	Graph/Local key .....	8
AM Freq softkey .....	49	<b>H</b>	
AM softkey .....	49	handle, removal .....	17
Ampl/ High softkey .....	26, 30	Help key .....	9
Arb key .....	8	Hop Freq softkey .....	57
arbitrary waveforms .....	24	hop frequency .....	56
Arrow keys .....	9	<b>I</b>	
Autoranging .....	33	Internal frequency reference .....	90
<b>B</b>		internal triggering .....	76
Built In softkey .....	46, 69	<b>L</b>	
burst count .....	64	LAN .....	10
Burst key .....	9	Linear/Log softkey .....	61
burst operation .....	24	Load/Hi-Z softkey .....	32
Burst Perd softkey .....	66	<b>M</b>	
burst period .....	64	manual triggering .....	77
burst phase .....	65	marker frequency .....	60
<b>C</b>		Menu mode .....	22
center frequency .....	60	Mkr softkey .....	62
CLK softkey .....	70	Mod key .....	8
<b>D</b>		modulation .....	24
DC/ OFF softkey .....	29	Modulation depth .....	48
Del State softkey .....	80	Modulation In connector .....	10
Delete Saved softkey .....	71	<b>N</b>	
Digital Output/LVTTL connector .....	10	N Cyc/Gated softkey .....	66, 67
Duty cycle .....	40	Noise key .....	8
DutyCycle softkey .....	40	Norm/Invt softkey .....	31
<b>E</b>		Numeric keypad .....	9, 23
edge time .....	44	<b>O</b>	
Edge Time softkey .....	45	operating temperature range .....	94
external frequency reference input .....	91	Output attenuators .....	33
external gated burst mode .....	76	output attenuators .....	27
external triggering .....	76	Output connector .....	9
<b>F</b>		Output key .....	9
Factory default .....	36	Output Setup .....	82
Factory default settings .....	20	Output Setup softkey .....	31, 32, 33, 70
Fclk/Perd softkey .....	69	<b>P</b>	
FM Freq softkey .....	52	PATT Mode softkey .....	69
FM softkey .....	52	Phase Dev softkey .....	55
Freq Dev softkey .....	52	phase deviation .....	54
FreqDev softkey .....	53	PM Freq softkey .....	55
Frequency deviation .....	51		

PM softkey .....	54
Polar softkey .....	68
power consumption .....	94
Power switch .....	8
power switch, turning on .....	19
Pulse key .....	8
pulse width deviation .....	58
PWM Freq softkey .....	59
PwrON/ST1 softkey .....	81

## R

Ramp key .....	8
Rang softkey .....	33
Recall State softkey .....	80
Rotary knob .....	9, 23

## S

Saved Wform softkey .....	71
Select softkey .....	85
Select Wform softkey .....	46, 69
Selecting dBm .....	27
Set to Def softkey .....	36
Shape softkey .....	49, 52, 55, 59
Sine key .....	8
single sweep mode .....	61
Slope softkey .....	63, 67, 70
Square key .....	8
Src softkey .....	49, 52, 55, 57, 59, 62, 66, 70, 77
standard waveforms .....	24
Start Phase softkey .....	66
Start/Cntr softkey .....	61
Stop/Span softkey .....	62
storage temperature range .....	94
Store State softkey .....	79
Store/Recall key .....	9
Sweep key .....	8
sweep mode .....	60
sweep time .....	60
Sweep Time softkey .....	62
Symmetry .....	42
Symmetry softkey .....	42
Sync connector .....	9
Sync softkey .....	35
System softkey .....	84

## T

Trig In/Out,FSK/Burst connector .....	10
Trig Out softkey .....	63, 67, 71, 78
Trig Setup softkey .....	62, 66, 70, 77, 78
Trigger key .....	9
triggered burst mode .....	76
triggered sweep mode .....	76
Type softkey .....	49, 52, 54, 56, 61

## U

USB .....	10
User-defined patterns .....	69
Utility key .....	9

## V

Vos/Low softkey .....	28, 30
-----------------------	--------

## W

weight .....	94
Width Dev softkey .....	59
Width/Duty softkey .....	45



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