Synthesized Function Generator
SFG-2000/SFG-2100 Series

USER MANUAL
GW INSTEK PART NO. 82FG-21200MD

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Good Will Instrument Co., Ltd.
No. 7-1, Jhongsing Rd., Tucheng City, Taipei County 236, Taiwan.
# Table of Contents

**SAFETY INSTRUCTIONS** ................................................... 5
- Safety Symbols.................................................................. 5
- Safety Guidelines ................................................................ 6

**GETTING STARTED** .......................................................... 9
- Technical background ..................................................... 10
- Lineup/Features ................................................................ 12
- Front Panel ....................................................................... 13
- Rear Panel ........................................................................ 19
- Set Up ............................................................................. 20
- Operation Shortcuts ...................................................... 22
- Default Setting Contents .............................................. 24

**SINE/SQUARE/TRIANGLE WAVE** ...................................... 25
- Select the waveform.......................................................... 26
- Set the Frequency............................................................ 26
- Set the Duty Cycle (Square Waveform) .......................... 28
- Set Amplitude ................................................................. 29
- Set Offset ........................................................................ 30

**TTL CMOS OUTPUT** .......................................................... 31
- Select the waveform.......................................................... 32
- Set the Frequency............................................................ 32
- Set the Duty Cycle............................................................ 33
- Set Amplitude ................................................................. 34

**SWEEP** ............................................................................ 35

**AMPLITUDE MODULATION** ............................................ 37

**FREQUENCY MODULATION** .......................................... 38

**COUNTER INPUT** ............................................................. 40

**STORE/RECALL SETTING** ............................................... 42

**APPLICATION EXAMPLES** ............................................. 44
- Reference Signal for PLL System ..................................... 44
- Trouble-Shooting Signal Source ..................................... 44
- Transistor DC Bias Characteristics Test .......................... 45
- Amplifier Over-Load Characteristic Test ....................... 46
- Amplifier Transient Characteristics Test ....................... 46
- Logic Circuit Test............................................................ 48
- Impedance Matching Network Test ............................... 48
- Speaker Driver Test....................................................... 49
- Sweep for Speaker Test ............................................... 50

**FAQ** .................................................................................. 51

**APPENDIX** ....................................................................... 52
- Error Messages .............................................................. 52
- Specification ................................................................. 53
- Declaration of Conformity .............................................. 55

**INDEX** ............................................................................. 56
SAFETY INSTRUCTIONS

This chapter contains important safety instructions that you must follow when operating SFG-2000 series and when keeping it in storage. Read the following before any operation to insure your safety and to keep the best condition for SFG-2000 series.

Safety Symbols

These safety symbols may appear in this manual or on SFG-2000 series.

⚠️ WARNING

Warning: Identifies conditions or practices that could result in injury or loss of life.

⚠️ CAUTION

Caution: Identifies conditions or practices that could result in damage to SFG-2000 series or to other properties.

⚠️

Attention Refer to the Manual

Earth (ground) Terminal

Safety Guidelines

General Guideline

- Do not place any heavy object on SFG-2000 series.
- Avoid severe impacts or rough handling that leads to damaging SFG-2000 series.
- Do not discharge static electricity to SFG-2000 series.
- Use only mating connectors, not bare wires, for the terminals.
- Do not block or obstruct cooling vent opening.
- Do not perform measurements at power source and building installation site (Note below).
- Do not disassemble SFG-2000 series unless you are qualified as service personnel.

(Note) EN 61010-1:2001 specifies the measurement categories and their requirements as follows. SFG-2000 series falls under category II.

- Measurement category IV is for measurement performed at the source of low-voltage installation.
- Measurement category III is for measurement performed in the building installation.
- Measurement category II is for measurement performed on the circuits directly connected to the low voltage installation.

Power Supply

⚠️ WARNING

Input voltage: 115/230V AC, ±10%, 50/60Hz

- The power supply voltage should not fluctuate more than 10%.
- Connect the protective grounding conductor of the power cord to earth ground, to avoid electrical shock.

Fuse

⚠️ WARNING

- Fuse type: T0.125A/ 250V
- Only service personnel are allowed to access internal fuse holders.
- Replace the fuse with the specified type and rating only, for continued fire protection.
- Disconnect the power cord before fuse replacement.
- Make sure the cause of the fuse blowout is fixed before fuse replacement.
SAFETY INSTRUCTIONS

Cleaning
SFG-2000 series

• Disconnect the power cord before cleaning.
• Use a soft cloth dampened in a solution of mild detergent and water. Do not spray any liquid into SFG-2000 series.
• Do not use chemicals or cleaners containing harsh materials such as benzene, toluene, xylene, and acetone.

Operation Environment

• Location: Indoor, no direct sunlight, dust free, almost non-conductive pollution (Note below)
• Relative Humidity: < 80%
• Altitude: < 2000m
• Temperature: 0°C to 40°C

(Note) EN 61010-1:2001 specifies the pollution degrees and their requirements as follows. SFG-2000 series falls under degree 2. Pollution refers to "addition of foreign matter, solid, liquid, or gaseous (ionized gases), that may produce a reduction of dielectric strength or surface resistivity".

• Pollution degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
• Pollution degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.
• Pollution degree 3: Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation which is expected. In such conditions, equipment is normally protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity is controlled.

Storage Environment

• Location: Indoor
• Relative Humidity: < 80%
• Temperature: −10°C to 70°C

Power cord for the United Kingdom

When using SFG-2000 series in the United Kingdom, make sure the power cord meets the following safety instructions.

NOTE: This lead / appliance must only be wired by competent persons

WARNING: THIS APPLIANCE MUST BE EARTHED

IMPORTANT: The wires in this lead are coloured in accordance with the following code:

Green / Yellow: Earth
Blue: Neutral
Brown: Live (Phase)

As the colours of the wires in main leads may not correspond with the colours marking identified in your plug/appliance, proceed as follows:

The wire which is coloured Green & Yellow must be connected to the Earth terminal marked with the letter E or by the earth symbol ⬤ or coloured Green or Green & Yellow.

The wire which is coloured Blue must be connected to the terminal which is marked with the letter N or coloured Blue or Black.

The wire which is coloured Brown must be connected to the terminal marked with the letter L or P or coloured Brown or Red.

If in doubt, consult the instructions provided with the equipment or contact the supplier.

This cable/appliance should be protected by a suitably rated and approved HBC mains fuse: refer to the rating information on the equipment and/or user instructions for details. As a guide, cable of 0.75mm² should be protected by a 3A or 5A fuse. Larger conductors would normally require 13A types, depending on the connection method used.

Any moulded mains connector that requires removal /replacement must be destroyed by removal of any fuse & fuse carrier and disposed of immediately, as a plug with bare wires is hazardous if engaged in live socket. Any re-wiring must be carried out in accordance with the information detailed on this label.
GETTING STARTED

This chapter describes SFG-2000 series in a nutshell, including main features and front/rear/display introduction. Follow the Set Up section to properly install and power up SFG-2000 series.

Technical background

Traditional function generators

SFG-2000 series uses the latest Direct Digital Synthesis (DDS) technology to generate stable, high resolution output frequency. The DDS technology solves several problems encountered in traditional function generators, as follows.

Constant current circuit methodology

This analog function generating method uses a constant current source circuit built with discrete components such as capacitors and resistors. Temperature change inside the generator greatly affects the components characteristics which lead to output frequency change. The results are poor accuracy and stability.

DDS methodology

In DDS, the waveform data is contained in and generated from a memory. A clock controls the counter which points to the data address. The memory output is converted into analog signal by a digital to analog converter (DAC) followed by a low pass filter. The resolution is expressed as \( \frac{f_s}{2^k} \) where \( f_s \) is the frequency and \( k \) is the control word, which contains more than 28 bits. Because the frequency generation is referred to clock signal, this achieves much higher frequency stability and resolution than the traditional function generators.
DDS synthesizer consists of Phase accumulator (counter), lookup table data (ROM), Digital-to-analog converter (DAC), and Low-pass filter (LPF).

The phase accumulator adds the frequency control word K at every clock cycle fs. The accumulator output points to a location in the Table ROM/RAM. The DAC converts the digital data into an analog waveform. The LPF filters out the clock frequency to provide a pure waveform.

### Lineup/Features

#### Series lineup

<table>
<thead>
<tr>
<th>Lineup</th>
<th>Duty cycle</th>
<th>Offset</th>
<th>TTL/CMOS</th>
<th>Sweep</th>
<th>AM-FM</th>
<th>Counter</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFG-2004 (4MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>SFG-2007 (7MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>SFG-2010 (10MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>SFG-2020 (20MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>SFG-2104 (4MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>SFG-2107 (7MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>SFG-2110 (10MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>SFG-2120 (20MHz)</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>

### Main features

#### Performance
- High resolution using DDS and FPGA technology
- High frequency accuracy: 20ppm
- Low distortion: −55dBc
- High resolution 100mHz maintained at full range

#### Features
- Wide output frequency range: 4, 7, 10, 20MHz
- Various output waveforms: Sine, Square, and Triangle
- TTL/CMOS output
- Variable DC offset control
- Output overload protection
- Store/recall: 10 settings
- Counter up to 150MHz high frequency (SFG-2100 series)
- AM/FM with internal and external (SFG-2100 series)
- Sweep mode with LINE and LOG (SFG-2100 series)

#### Input/Output
- Frequency output
- TTL/CMOS output
- Counter input (SFG-2100 series)
- External modulation input (SFG-2100 series)
Front Panel

SFG-2100 series front panel

- Main Display
- Waveform selection Key
- Entry Keys
- Editing Knob
- Cursor Keys
- Power Switch
- Sweep Time Speed Control
- Log/Log Selector
- DC Offset Control
- Counter Input
- Waveform Output

SFG-2000 series front panel

- Main Display
- Waveform selection Key
- Entry Keys
- Editing Knob
- Cursor Keys
- Power Switch
- CMOS Amplitude Control
- DC Offset Control
- Amplitude/Attenuation Control
- TTL/CMOS Output
- Waveform Output

Main display

8. (7 segment)

Shows the waveform frequency, counter frequency, and duty cycle.

OVER

For SFG-2100 series only. In the counter mode, indicates that the leftmost digit (100MHz) is hidden but contains a real number. For counter details, see page40.

GATE

For SFG-2100 series only. In counter mode, indicates gate selection. For counter details, see page40.

TTL

Indicates that the TTL or CMOS output is enabled. For TTL/CMOS details, see page31.

DUTY

For square waveform only. Indicates that the duty cycle is being edited. For square waveform details, see page25.

-20dB

Indicates that the waveform output is attenuated by −20dB. For attenuation details, see page29.

SWEEP

For SFG-2100 series only. Indicates that the sweep mode is activated. For sweep details, see page35.

FM	AM

For SFG-2100 series only. Indicates that FM or AM mode is enabled. For modulation details, see page37 (AM) or page38 (FM).

COUNT

For SFG-2100 series only. Indicates that the counter mode is enabled. For counter details, see page40.

EXT

For SFG-2100 series only. Indicates that the external modulation input is used. For details, see page37 (AM) or page39 (FM).
Indicates the waveform shape: Sine, Square, and Triangle. For details, see page 26.

Indicates that the Shift key is pressed.

Indicates the output frequency: MHz, kHz, or Hz.

Indicates the duty cycle unit. For duty cycle details, see page 28.

Selects the waveform shape: sine, square, and triangle. For details, see page 26.

Enters frequency, duty cycle, and various parameters.

1.2MHz

37kHz

45% (in duty cycle mode)

45Hz (in frequency mode)

Enter duty cycle (page 28).

Attenuate the waveform output by ~20dB (page 29).

Enables TTL/CMOS output (page 31).

Deletes previous entry (backspace).

Selects Amplitude Modulation (page 37).

Selects Frequency Modulation (page 38).

Selects sweep mode (page 35).

Stores the parameter setting (page 42).

Recalls the parameter setting (page 42).

Recalls the default parameter setting (page 43).

Switches to counter mode (page 40).

Accepts external modulation signal (page 37-AM) or (page 38-FM).

Increases (right turn) or decreases (left turn) the frequency or duty cycle.

Moves the editing point left or right in case of manual editing.

Outputs sine, square, and triangle waveform. BNC terminal, 50Ω output impedance.

Outputs TTL or CMOS output waveform, BNC terminal. For TTL/CMOS mode details, see page 31.

Accepts signals for frequency counting. BNC, AC 30Vrms maximum. For counting mode details, see page 40.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amplitude/Attenuation control</strong></td>
<td>Sets the sine/square/triangle waveform amplitude. Turn left (decrease) or right (increase). When pulled out, attenuates the sine/square/triangle waveform amplitude by −20dB. The −20dB display turns On. For details, see page 29.</td>
</tr>
<tr>
<td><strong>DC offset control</strong></td>
<td>When pulled out, sets the DC offset level for sine/square/triangle waveform. Turn left (decrease) or right (increase). The range is −5V ~ +5V, in 50Ω load. For details, see page 30.</td>
</tr>
<tr>
<td><strong>CMOS amplitude control</strong></td>
<td>This knob becomes effective when the TTL/CMOS output is enabled (page 31). Selects TTL as output. When pulled out, selects CMOS as output. Sets the CMOS output level. Turn left (decrease) or right (increase).</td>
</tr>
<tr>
<td><strong>Sweep speed control</strong></td>
<td>This knob is available in SFG-2100 series only. It becomes effective in sweep time mode. Sets the sweep speed. Turn left (slow) or right (fast). The range is 1 ~ 30 seconds. For sweep details, see page 35.</td>
</tr>
<tr>
<td><strong>Log/Linear sweep selector</strong></td>
<td>Selects linear sweep. When pulled out, selects logarithmic sweep.</td>
</tr>
</tbody>
</table>

**Sweep span control**
- This knob is available in SFG-2100 series only. It becomes effective in sweep mode and AM/FM mode.
  - In Sweep mode: Sets the sweep span. Turn left (narrow) or right (wide). The range is 1 ~ 100. For sweep details, see page 36.
  - In AM/FM mode:
    - Sets the FM deviation (page 38). Turn left (decrease) or right (increase). The range is over −50kHz ~ +50kHz, centered at 1MHz.
    - When pulled out, sets the AM depth (page 37). Turn left (shallow) or right (deep). The range is 0 ~ 100%. |
| **Power switch** | Turns the main power On/Off. For power up sequence, see page 20. |
### Rear Panel

- **External Modulator Input**: Accepts the modulation signal from an external device. BNC male connector, 10Vp-p maximum. SFG automatically switches the modulation signal from internal to external. For modulation details, see page 37 (AM) or page 38 (FM).

- **AC Power Input**: Accepts the AC power cord. 115 or 230V, 50/60Hz.

- **AC Voltage Selector**: Selects 115V or 230V for power source.
  - AC 100/110/120V → select 115V.
  - AC 220/230/240V → select 230V.

  **Warning**: Improper selection might lead to internal fuse blowout.

---

### Set Up

**Tilt stand**

1. Pull out the handle sideways and rotate it.
2. Place SFG horizontally.
3. Or tilt stand.
4. Place the handle vertically for hand carry.
GETTING STARTED

Power up

1. Select the AC voltage on the rear panel accordingly.
   AC 100/110/120V → select 115V.
   AC 220/230/240V → select 230V.

2. Connect the power cord.

3. Push and turn On the main power switch on the front panel.

4. The display shows model name and the last setup.
   Example: SFG-2110, 500Hz triangle wave in sweep mode and −20dB attenuation enabled

   SFG-2110
   ~
   500.0
   Hz

Recall the default setting

Press 2 to recall the default setup. SFG shows the message “done”, and outputs 10kHz sine wave.

   done
   10.000

Functionality check

Connect SFG output to measurement device such as oscilloscope and check the waveform characteristics.

Operation Shortcuts

Here are the collections of operation example shortcuts.

Sine wave 250Hz, −20dB amplitude

1. Press Wave key and select Sine
2. Press 2 + 5 + 0 + Hz/% key
3. Press Shift + 8 key (−20dB)
   ...Or pull Amplitude knob or AMPL ADJ

Triangle wave 8kHz, +2V Offset

1. Press Wave key and select Triangle
2. Press 8 + kHz key
3. Pull Offset knob (ADJ) and Rotate

Square Wave 1MHz, 45% duty

1. Press Wave key and select Square
2. Press 1 + MHz key
3. Press Shift + 7 key (Duty)
4. Press 4 + 5 + Hz/% key
   ...Or Rotate the Scroll knob

TTL Output 10kHz TTL/CMOS

1. Press Shift + 9 key (TTL)
2. Press 1 + 0 + kHz key
3. Press TTL/CMOS knob (TTL)

CMOS Out 10kHz, 10Vpp TTL/CMOS

1. Press Shift + 9 key (TTL)
2. Press 1 + 0 + kHz key
3. Pull TTL/CMOS knob (CMOS) and rotate
1. Press Wave key and select Sine

2. Press 2 + 5 + 0 + Hz/% key

3. Press Shift + 5 key (Sweep)

4. Press SWEEP TIME knob (LIN) and rotate

5. Press SWEEP SPAN knob and rotate

---

1. Press Wave key and select Triangle

2. Press 8 + kHz key

3. Press Shift + 5 key (Sweep)

4. Pull SWEEP TIME knob (LOG) and rotate

5. Press SWEEP SPAN knob and rotate

---

1. Press Wave key and select Sine

2. Press 1 + 0 + kHz key

3. Press Shift + .(dot) key (AM)

4. Pull SWEEP SPAN knob (AM %) and rotate

---

1. Press Wave key and select Sine

2. Press 1 + MHz key

3. Input external modulation signal (EXT sign appears)

4. Press Shift + 4 key (FM)

5. Push SWEEP SPAN knob (FM Dev) and rotate

---

1. Press Shift + 1 (Counter)

2. The Gate sign flashes when counted

3. Enter the memory number (1 ～ 10)

4. The “done” sign appears

---

1. Press Shift + 6 (Store)

2. The “Store” sign appears

3. Enter the memory number (1 ～ 10)

4. The “done” sign appears

---

1. Press Shift + 3 (Recall)

2. The “Recall” sign appears

3. Enter the memory number (1 ～ 10)

4. The “done” sign appears

---

Default Setting Contents

Recall default settings

Press the shift key, then 2 to recall the default setting. The “done” message appears, followed by display update.

<table>
<thead>
<tr>
<th>Wave type</th>
<th>Sine wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>10.0000kHz</td>
</tr>
<tr>
<td>TTL/CMOS</td>
<td>Disabled</td>
</tr>
<tr>
<td>−20dB</td>
<td>Disabled</td>
</tr>
<tr>
<td>Modulation</td>
<td>Disabled</td>
</tr>
<tr>
<td>Sweep mode</td>
<td>Disabled</td>
</tr>
</tbody>
</table>
**SINE/SQUARE/TRIANGLE WAVE**

**Select waveform**
Select the waveform............................................... 26

**Set frequency**
Enter frequency...................................................... 26
Edit frequency......................................................... 27

**Set duty cycle** (for square wave)
Enter duty cycle....................................................... 28
Edit duty cycle......................................................... 28

**Set amplitude**
Normal output.......................................................... 29
Attenuate by −20dB .................................................... 29

**Set offset**
Activate offset....................................................... 30
Adjust offset............................................................ 30
Limitation ............................................................. 30

---

**Select the waveform**

Press **WAVE** key repeatedly. The corresponding icon appears on the display.

- **Sine waveform.**
- **Square waveform.**
- **Triangle waveform.**

The waveform comes out from the main terminal.

- 10Vp-p maximum (50Ω load)
- 20Vp-p maximum (no load)

---

**Set the Frequency**

Enter frequency using the numerical keys.

- 1.2MHz
- 37kHz
- 45Hz
- Delete a number (backspace)

Triangle waveform frequency is limited to maximum 1MHz. When the input exceeds it, the following message (Freq-Err2) appears and forces the frequency to 1MHz.

For full error message list, see page 52.
Set the Duty Cycle (Square Waveform)

The duty cycle setting is not available in sine/triangle waveform.

Enter duty cycle

Press the Shift key, then 7 to enter duty cycle editing mode. The duty sign appears on the display.

The default value is 50%.

The settable range is 20% ~ 80%, 2Hz ~ 1MHz.

Use numerical keys to enter value.

Example: 45%

Delete a number (backspace)

Edit duty cycle

The editing knob changes the value, and the cursor keys moves the active digit (same as entering frequency).

When inactive for 5 seconds, the display automatically goes back to previous mode (frequency view).

Setting duty cycle (press \text{\textbf{SHIFT}} \text{\texttt{7}}) is not available when sine or triangle waveform is activated. The following message appears.

\textbf{dut y \textit{- eff l}}

For full error message list, see page 52.
Set Amplitude

Normal output

Turn the Amplitude knob right (increase) or left (decrease).

The range is 10Vpp for 50Ω load.

Attenuate by −20dB

Sine/square/triangle waveform can be attenuated by −20dB, in two ways: −40dB altogether.

**Method1**

Pull out the Amplitude knob. The output amplitude is attenuated by −20dB (no display sign).

**Method2**

Press the shift key, then 8. The output amplitude is attenuated by −20dB. The −20dB sign appears on the display.

Set Offset

SFG can add or delete offset to the sine/square/triangle waveform, thus changing the waveform vertical position.

Use the OFFSET knob.

**Activate offset**

Pushed: Offset Off

Pulled: Offset On

**Adjust offset**

Turn the knob right (higher position) or left (lower position).

The range is −5V ~ +5V for 50Ω load.

**Limitation**

Note that the output amplitude, including the offset, is still limited to:

−5 ~ +5V (50Ω load)

−10 ~ +10V (no load)

Therefore excessive offset leads to peak clip as below.
Select waveform

- **TTL/CMOS**
  - Press Shift key, then 9. The TTL sign appears on the display.
  - The TTL/CMOS output is always On when the square wave is activated.
  - Push/pull the TTL/CMOS knob to select the waveform.
  - Pushed: TTL is selected as output.
  - Pulled: CMOS is selected as output.
  - The waveform comes out from the TTL/CMOS terminal.
  - TTL: ≥3Vp-p (fixed)
  - CMOS: 4V±1Vp-p ~ 15±1Vp-p

Set frequency
- Enter frequency
- Edit frequency

Set duty cycle
- Enter duty cycle
- Edit duty cycle

Set amplitude
- Set Amplitude

---

Set the Frequency

Enter frequency

- 1MHz
- 1.2MHz
- 37kHz
- 45Hz

Delete a number (backspace)
**Edit frequency**

Left cursor key moves the active cursor left.

Right cursor key moves the active cursor right.

Turn the editing knob left to decrease the frequency.

Turn the editing knob right to increase the frequency.

---

**Set the Duty Cycle**

Press the Shift key, then 7 to enter duty cycle editing mode. The duty sign appears on the display.

The default value is 50%.

The settable range is 20% ~ 80%, 2Hz ~ 1MHz.

Use the numerical keys to enter value. Example: 45%

Delete a number (backspace)

---

**Set Amplitude**

Use the TTL/CMOS knob.

Pushed: selects TTL output with fixed amplitude, min. 3Vp-p.

Pulled: selects CMOS output, amplitude range 4V±1Vp-p ~ 15±0.5Vp-p.

Turn the knob right (increase amplitude) or left (decrease amplitude).
Sweep

SFG can add sweep to the waveform output, a convenient tool for measuring the frequency response of the DUT.

- Sweep function applies only to SFG-2100 series.
- Sweep and Modulation (page 37) cannot be used together.

Activate sweep

1. Output the waveform. Sine/Triangle/Square (page 25) or TTL/CMOS (page 31).
2. Press the Shift key, then 5 (Sweep).
3. Sweep is activated and the sign appears on the display.

When the sweep is activated, the duty cycle of Square/TTL/CMOS wave is fixed to 50%.

Select Log/Lin Sweep

Logarithmic Sweep:
Pull the SWEEP TIME knob.

Linear Sweep:
Push the SWEEP TIME knob.

Set Sweep Time

Sweep time sets the time it takes for a single sweep from the start frequency to the end frequency.

Rotate the SWEEP TIME knob, right (fast) or left (slow).

Range 1 ~ 30 seconds

Note: If the sweep time becomes too long, the stop frequency might reach the rating (4, 7, 10, or 20MHz). In this case, the frequency stays at the rating to the end.

Set Sweep Span

Sweep span sets the frequency width of the sweep.

The current output frequency becomes the start frequency.

Rotate the SWEEP SPAN knob, right (wide) or left (narrow).

Range 1 ~ 100 frequency ratio

Note: In order to get the maximum span (frequency ratio), set the sweep time to a sufficient length (not too short).
AMPLITUDE MODULATION

- AM applies only to SFG-2100 series.
- Modulation and Sweep (page 35) cannot be used together.

Activate AM
1. Output the waveform, Sine/Triangle/Square (page 25).
2. Press the Shift key, then Dot (AM). AM is activated and the sign appears on the display.

Set AM depth
1. Pull the SWEEP SPAN knob (AM %).
2. Turn the knob left (shallow) or right (deep).

Range 0 ~ 100%

Use external modulating signal
SFG-2000 series uses an internal 400Hz sine wave as the default modulating signal.
1. Connect the modulating signal to the rear panel terminal.
2. Press the Shift key, then 0 (EXT MOD). External modulation is activated.

FREQUENCY MODULATION

- FM applies only to SFG-2100 series.
- Modulation and Sweep (page 35) cannot be used together.

Activate FM
1. Output the waveform, Sine/Triangle/Square (page 25) or TTL/CMOS (page 31).
2. Press the Shift key, then 4 (FM). FM is activated and the sign appears on the display.

Set FM deviation
1. Push the SWEEP SPAN knob (FM Dev).
2. Turn the knob left (shallow) or right (deep).

The output frequency becomes the Center Frequency.

Deviation Range 0 ~ ±50kHz, centered at 1MHz
When the deviation is added to the center frequency, the result must be smaller than the rating frequency.

**Center Frequency + Deviation ≤ Rating(4.7,10,20MHz)**

When this rule is violated, the “Freq-Err3” error message appears and the FM setting will be cancelled.

**F R E Q - E R R 3**

For more error message details, see page 52.

Center frequency (=Output frequency) must be set within this range.

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFG-2104</td>
<td>300kHz ~ 3.7MHz</td>
</tr>
<tr>
<td>SFG-2107</td>
<td>300kHz ~ 6.7MHz</td>
</tr>
<tr>
<td>SFG-2110</td>
<td>300kHz ~ 9.7MHz</td>
</tr>
<tr>
<td>SFG-2120</td>
<td>300kHz ~ 19.7MHz</td>
</tr>
</tbody>
</table>

Use external modulating signal

SFG-2000 series uses an internal 400Hz sine wave as the default modulating signal.

1. Connect the modulating signal to the rear panel terminal.
2. Press the Shift key, then 0 (EXT MOD). External modulation is activated.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>1kHz (fixed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td></td>
</tr>
</tbody>
</table>

COUNTER INPUT

Counter input applies only to SFG-2100 series.

1. Connect the signal input to the Counter input terminal. Press Shift key, then 1 (Counter).
2. EXT and COUNT sign appear on the display.
3. The display shows the input signal frequency.
4. The GATE sign flashes when the gate condition is met.

<table>
<thead>
<tr>
<th>Gate</th>
<th>Range</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 ~ 150MHz</td>
<td>100nHz for 1Hz input, 0.1Hz for 100MHz input</td>
</tr>
</tbody>
</table>

Set the gate time

Gate time sets the display update rate and counter resolution. These two parameters are in trade-off. Short gate time = faster update, coarse resolution Long gate time = slower update, fine resolution

To change the gate time, turn the editing knob right (increase) or left (decrease).
### COUNTER INPUT

The following table shows the relationship between counter frequency, gate time, resolution, and display.

<table>
<thead>
<tr>
<th>Input</th>
<th>Gate time</th>
<th>Resolution</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1Hz</td>
<td>0.01s</td>
<td>10µHz</td>
<td>1.00000Hz</td>
</tr>
<tr>
<td></td>
<td>0.1s</td>
<td>1µHz</td>
<td>1.000000Hz</td>
</tr>
<tr>
<td></td>
<td>1s</td>
<td>100mHz</td>
<td>1.0000000Hz</td>
</tr>
<tr>
<td></td>
<td>10s</td>
<td>1000mHz</td>
<td>1.00000000Hz</td>
</tr>
<tr>
<td>10Hz</td>
<td>0.01s</td>
<td>100µHz</td>
<td>10.00000Hz</td>
</tr>
<tr>
<td></td>
<td>0.1s</td>
<td>10µHz</td>
<td>10.000000Hz</td>
</tr>
<tr>
<td></td>
<td>1s</td>
<td>1µHz</td>
<td>10.0000000Hz</td>
</tr>
<tr>
<td></td>
<td>10s</td>
<td>100mHz</td>
<td>10.00000000Hz</td>
</tr>
<tr>
<td>100Hz</td>
<td>0.01s</td>
<td>1mHz</td>
<td>100.000Hz</td>
</tr>
<tr>
<td></td>
<td>0.1s</td>
<td>10µHz</td>
<td>100.0000Hz</td>
</tr>
<tr>
<td></td>
<td>1s</td>
<td>1µHz</td>
<td>100.00000Hz</td>
</tr>
<tr>
<td></td>
<td>10s</td>
<td>100mHz</td>
<td>100.000000Hz</td>
</tr>
<tr>
<td>1kHz</td>
<td>0.01s</td>
<td>10mHz</td>
<td>100000Hz</td>
</tr>
<tr>
<td></td>
<td>0.1s</td>
<td>1µHz</td>
<td>1000000Hz</td>
</tr>
<tr>
<td></td>
<td>1s</td>
<td>100µHz</td>
<td>10000000Hz</td>
</tr>
<tr>
<td></td>
<td>10s</td>
<td>10µHz</td>
<td>100000000Hz</td>
</tr>
<tr>
<td>1MHz</td>
<td>0.01s</td>
<td>10Hz</td>
<td>1000000Hz</td>
</tr>
<tr>
<td></td>
<td>0.1s</td>
<td>1µHz</td>
<td>10000000Hz</td>
</tr>
<tr>
<td></td>
<td>1s</td>
<td>100mHz</td>
<td>100000000Hz</td>
</tr>
<tr>
<td></td>
<td>10s</td>
<td>10mHz</td>
<td>1000000000Hz</td>
</tr>
<tr>
<td>10MHz</td>
<td>0.01s</td>
<td>100Hz</td>
<td>10000000Hz</td>
</tr>
<tr>
<td></td>
<td>0.1s</td>
<td>10µHz</td>
<td>100000000Hz</td>
</tr>
<tr>
<td></td>
<td>1s</td>
<td>1µHz</td>
<td>1000000000Hz</td>
</tr>
<tr>
<td></td>
<td>10s</td>
<td>100mHz</td>
<td>10000000000Hz</td>
</tr>
<tr>
<td>100MHz</td>
<td>0.01s</td>
<td>1000Hz</td>
<td>1000000000Hz</td>
</tr>
<tr>
<td></td>
<td>0.1s</td>
<td>10µHz</td>
<td>10000000000Hz</td>
</tr>
<tr>
<td></td>
<td>1s</td>
<td>1µHz</td>
<td>100000000000Hz</td>
</tr>
<tr>
<td></td>
<td>10s</td>
<td>100mHz</td>
<td>1000000000000Hz</td>
</tr>
</tbody>
</table>

**Over sign**

* The OVER sign shows that the 100MHz digit contains a real number but hidden from the display. It turns On under the following condition.
  - Input frequency: ≥100MHz
  - Gate Time: 10s
To view the 100MHz digit, switch to smaller gate time such as 1s or 0.1s.

---

### STORE/RECALL SETTING

**Store the panel setting**

Press the Shift key, then 6 to store the current panel setting to internal memories.

- Memory range: 0 ~ 9 (10 set)

Enter the memory number, 0 ~ 9. (for example, 1)

**Done**

The “done” sign appears.

**Recall the panel setting**

Press the Shift key, then 3 to recall a panel setting stored in internal memories.

- Memory range: 0 ~ 9 (10 set)

Enter the memory number, 0 ~ 9. (for example, 1)

**Recall**

The “done” sign appears and the panel setting changes accordingly.

**Done**
Recall the default panel setting

Press the shift key, then 2 to recall the default panel setting.

The “done” message appears.

done

The panel is updated with the default setting.

10.0000

<table>
<thead>
<tr>
<th>Wave type</th>
<th>Sine wave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>10.0000kHz</td>
</tr>
<tr>
<td>TTL/CMOS</td>
<td>Disabled</td>
</tr>
<tr>
<td>−20dB</td>
<td>Disabled</td>
</tr>
<tr>
<td>Modulation</td>
<td>Disabled</td>
</tr>
<tr>
<td>Sweep mode</td>
<td>Disabled</td>
</tr>
</tbody>
</table>

### Application Examples

**Reference Signal for PLL System**

**Description**
The SFG output can be used as a cost-effective reference signal for Phase-Locked-Loop system. Directly connect SFG output to PLL input.

**Block diagram**

```
SFG series
PLL
Reference In
Output
```

### Trouble-Shooting Signal Source

**Description**
The SFG output can be used as the signal source to test the failed part in a circuit system. Isolate the problematic part from the rest, feed the SFG output as a stimulus, and observe the outcome using an oscilloscope.

**Block diagram**

```
SFG series
Oscilloscope
Circuit System
```
Transistor DC Bias Characteristics Test

**Description**
Use SFG-2000 series as the signal source for a transistor. Compare the transistor input/output waveform using the oscilloscope. Adjust the DC voltage source to find out the maximum output without distorting the waveform.

**Block diagram**

![Block diagram of Transistor DC Bias Characteristics Test](image)

Amplifier Over-Load Characteristic Test

**Description**
Use the triangle wave output from SFG-2000 series to check the amplifier output distortion caused by overload. The common sine wave is not the ideal source in this case. Observe the linearity of the triangle waveform using an oscilloscope.

**Block diagram**

![Block diagram of Amplifier Over-Load Characteristic Test](image)

Amplifier Transient Characteristics Test

**Description**
Use the square wave output from SFG-2000 series to check the transient frequency response of an amplifier. The common sine wave is not the ideal source in this case. Observe the waveform using an oscilloscope.

**Block diagram**

![Block diagram of Amplifier Transient Characteristics Test](image)
APPLICATION EXAMPLES

Test step

1. Apply a triangle waveform to the amplifier first. Adjust the waveform amplitude to make sure there is no clipping.
2. Switch to square waveform and adjust its frequency to the middle of the amplifier pass band, such as 20Hz, 1kHz, and 10kHz.
3. Observe the shape of the amplifier output. The following table shows the possible output distortions and their explanations.

<table>
<thead>
<tr>
<th>Transient characteristic list</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude reduction at low frequency</td>
<td>No phase shift</td>
</tr>
<tr>
<td>Low frequency boosted (accentuated fundamental)</td>
<td></td>
</tr>
<tr>
<td>High frequency loss</td>
<td>No phase shift</td>
</tr>
<tr>
<td>Low frequency phase shift</td>
<td>Trace thickened by hum-voltage</td>
</tr>
<tr>
<td>High frequency loss</td>
<td>Phase shift</td>
</tr>
<tr>
<td>Low frequency loss</td>
<td>Phase shift</td>
</tr>
<tr>
<td>Low frequency loss</td>
<td>Low frequency phase shift</td>
</tr>
<tr>
<td>High frequency loss</td>
<td>Low frequency phase shift</td>
</tr>
<tr>
<td>Damped oscillation</td>
<td></td>
</tr>
</tbody>
</table>

Note: For narrow band amplifier testing, square wave may not be suitable.

Logic Circuit Test

Description
Use the TTL/CMOS output from SFG-2000 series to test digital circuits. Observe the timing relation of input/output waveform using an oscilloscope.

Block diagram

Impedance Matching Network Test

Description
Use SFG-2000 series for impedance matching network: testing its frequency characteristic and matching the impedance.

Block diagram

Test step
Adjust the potentiometer until $V_2$ becomes the half of $V_1$ ($V_2 = 0.5V_1$). Then the impedance $Z$ of the network becomes identical to the potentiometer.
**Speaker Driver Test**

**Description**  
Use SFG-2000 series for testing the frequency characteristics of audio speakers. Record the volt reading versus the input signal frequency.

**Block diagram**

- Oscilloscope (or Voltmeter)
- SFG series
- Speaker

**Graph**  
The peak voltage occurs on the resonant frequency of the speaker.

**Sweep for Speaker Test**

**Description**  
Use the sweep feature in SFG-2000 series for testing the frequency response of an audio speaker.

**Test description**

1. Set SFG output to sine wave, 20Hz.
2. Activate sweep and set LIN/LOG, sweep time, and sweep span.
3. Change the frequency if other bands need to be tested.

**Block diagram**

- SFG series
- Amplifier
- Speaker
FAQ

- I pressed the Power key on the front panel but nothing happens.
- How can I get out of Counter/Sweep/Modulation/TTL/-20dB mode?
- The device accuracy does not match the specification.
- What are these error messages?

I pressed the Power key on the front panel but nothing happens.

Make sure the AC source voltage setting on the rear panel is correct (page 21). Otherwise the internal fuse might be blown out. Contact the service personnel.

How can I get out of Counter/Sweep/Modulation/TTL/-20dB mode?

Press the Shift key, then the relevant numerical key. (Do the same action as you entered those modes)

For example: To get out of Counter mode, press Shift then 1.

The device accuracy does not match the specification.

Make sure the device is powered On for at least 30 minutes, within +20°C~+30°C. This is necessary to stabilize the unit to match the specification.

What are these error messages?

Several messages appear when trying to set the frequency or duty cycle in forbidden way. Page 52 summarizes all the error message content.

If there is still a problem, please contact your local dealer or GWInstek at www.gwinstek.com.tw / marketing@goodwill.com.tw.

APPENDIX

Error Messages

Frequency error

FrEq-Err1 Sine and square wave frequency over range. This message appears when entering sine or square waveform frequency larger than the rating. See page 26 for sine/square rating.

FrEq-Err2 Triangle wave Frequency over range. This message appears when entering triangle waveform frequency larger than 1MHz. See page 26 for triangle wave rating.

FrEq-Err3 FM Center Frequency over range. This message appears when trying to enter FM center frequency larger than specified. See page 38 for FM center frequency range.

Duty Cycle error

duty-Err1 Not square waveform. This message appears when trying to set duty cycle in non-square (=sine or triangle) waveform. For duty cycle setting, see page 28 (square wave) or page 33 (TTL/CMOS output).

duty-Err2 Square wave frequency over range. This message appears when trying to set duty cycle when the square wave frequency is over 1MHz. For square wave frequency setting, see page 26.

duty-Err3 Duty over range. This message appears when the duty cycle setting goes outside 20~80% range. For duty cycle range, see page 28 (square wave) or page 33 (TTL/CMOS output).
## Specification

### Main

<table>
<thead>
<tr>
<th>Output Function</th>
<th>Sine, Square, Triangle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude Range</td>
<td>10Vp-p (into 50Ω load)</td>
</tr>
<tr>
<td>Impedance</td>
<td>50Ω ± 10%</td>
</tr>
<tr>
<td>Attenuator</td>
<td>-20dB ± 1dB x2</td>
</tr>
<tr>
<td>DC Offset</td>
<td>&lt; -5V – &gt;+5V (50Ω load)</td>
</tr>
<tr>
<td>Duty Range</td>
<td>20% – 80%, 2Hz–1MHz (Square Wave)</td>
</tr>
<tr>
<td>Duty Resolution</td>
<td>1% (Square Wave Only)</td>
</tr>
<tr>
<td>Display</td>
<td>9 digits LED display</td>
</tr>
</tbody>
</table>

### Sine/Square Waveform Range

<table>
<thead>
<tr>
<th>Sine/Square Waveform Range</th>
<th>SFG-2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1Hz – 1MHz</td>
<td>0.1Hz – 4MHz</td>
</tr>
<tr>
<td>(1Hz – 1MHz for SFG-2000/2120)</td>
<td></td>
</tr>
</tbody>
</table>

### Frequency

<table>
<thead>
<tr>
<th>Triangle Waveform Range</th>
<th>0.1Hz – 1MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>0.1Hz (1Hz for SFG-2000)</td>
</tr>
<tr>
<td>Stability</td>
<td>±20ppm</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±20ppm</td>
</tr>
<tr>
<td>Aging</td>
<td>±5ppm/year</td>
</tr>
</tbody>
</table>

### Harmonic Distortion

| Sine Wave | ≥−55dBc, 0.1Hz – 200kHz |
|           | ≥−40dBc, 0.2MHz – 4MHz |
|           | ≥−30dBc, 4MHz – 20MHz |
|           | (Amplitude at maximum position without attenuating 1/10 of any combination setting, TTL/CMOS off) |

| Triangle Wave | 98% |
|              | 95% |

### Square Wave

<table>
<thead>
<tr>
<th>Symmetry</th>
<th>±1% of period + 4ns, 0.1Hz – 100kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rise/Fall Time</td>
<td>≤ 25ns at maximum output (50Ω load)</td>
</tr>
</tbody>
</table>

### CMOS Output

<table>
<thead>
<tr>
<th>Level</th>
<th>4 ± 1Vpp – 15 ± 1Vpp, adjustable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rise/Fall Time</td>
<td>≤ 120ns</td>
</tr>
</tbody>
</table>

### TTL Output

<table>
<thead>
<tr>
<th>Level</th>
<th>≥ 3Vpp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Out</td>
<td>20 TTL Load</td>
</tr>
</tbody>
</table>
Declaration of Conformity

We
GOOD WILL INSTRUMENT CO., LTD.
(1) No.7-1, Jhongsing Rd., Tucheng City, Taipei County, Taiwan
(2) No. 69, Lu San Road, Suzhou City (Xin Qu), Jiangsu Sheng, China
declare, that the below mentioned product
Type of Product: Synthesized Function Generator
Model Number: SFG-2004, SFG-2007, SFG-2010, SFG-2020,
SFG-2104, SFG-2107, SFG-2110, SFG-2120
are herewith confirmed to comply with the requirements set out in the
relating to Electromagnetic Compatibility (89/336/EEC, 92/31/EEC,
For the evaluation regarding the Electromagnetic Compatibility and Low
Voltage Directive, the following standards were applied:

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Fluctuations</td>
<td>Electrical Fast Transients EN 61000-4-4: 2004</td>
</tr>
<tr>
<td>Voltage Dip/ Interruption</td>
<td>Electrostatic Discharge EN 61000-4-11: 2004</td>
</tr>
</tbody>
</table>

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Safety Requirements
IEC/EN 61010-1: 2001

INDEX

| S | 20dB attenuation ................................ 29 |
|   | example setting ................................ 22 |
| A | AM example setting ................................ 23 |
|   | setup .............................................. 37 |
|   | amplifier application example .................... 46 |
|   | application examples ............................. 44 |
| C | cleaning .............................................. 7 |
|   | CMOS activation .................................. 32 |
|   | example setting ................................ 22 |
|   | constant current circuit ......................... 10 |
|   | control knob overview ........................... 17 |
|   | counter gate time ................................ 40 |
|   | counter input .................................... 40 |
|   | example setting ................................ 24 |
| D | DDS block diagram ................................ 11 |
|   | default panel setting contents .................. 43 |
|   | recall .............................................. 43 |
|   | default setting contents ......................... 24 |
|   | default setting recall ........................... 21 |
|   | direct digital synthesis .......................... 10 |
|   | display contents overview ....................... 14 |
|   | duty cycle example setting ....................... 22 |

© Safety


Safety Requirements
IEC/EN 61010-1: 2001

INDEX

| S | 20dB attenuation ................................ 29 |
|   | example setting ................................ 22 |
| A | AM example setting ................................ 23 |
|   | setup .............................................. 37 |
|   | amplifier application example .................... 46 |
|   | application examples ............................. 44 |
| C | cleaning .............................................. 7 |
|   | CMOS activation .................................. 32 |
|   | example setting ................................ 22 |
|   | constant current circuit ......................... 10 |
|   | control knob overview ........................... 17 |
|   | counter gate time ................................ 40 |
|   | counter input .................................... 40 |
|   | example setting ................................ 24 |
| D | DDS block diagram ................................ 11 |
|   | default panel setting contents .................. 43 |
|   | recall .............................................. 43 |
|   | default setting contents ......................... 24 |
|   | default setting recall ........................... 21 |
|   | direct digital synthesis .......................... 10 |
|   | display contents overview ....................... 14 |
|   | duty cycle example setting ....................... 22 |

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Safety Requirements
IEC/EN 61010-1: 2001

INDEX

| S | 20dB attenuation ................................ 29 |
|   | example setting ................................ 22 |
| A | AM example setting ................................ 23 |
|   | setup .............................................. 37 |
|   | amplifier application example .................... 46 |
|   | application examples ............................. 44 |
| C | cleaning .............................................. 7 |
|   | CMOS activation .................................. 32 |
|   | example setting ................................ 22 |
|   | constant current circuit ......................... 10 |
|   | control knob overview ........................... 17 |
|   | counter gate time ................................ 40 |
|   | counter input .................................... 40 |
|   | example setting ................................ 24 |
| D | DDS block diagram ................................ 11 |
|   | default panel setting contents .................. 43 |
|   | recall .............................................. 43 |
|   | default setting contents ......................... 24 |
|   | default setting recall ........................... 21 |
|   | direct digital synthesis .......................... 10 |
|   | display contents overview ....................... 14 |
|   | duty cycle example setting ....................... 22 |

© Safety


Safety Requirements
IEC/EN 61010-1: 2001

INDEX

| S | 20dB attenuation ................................ 29 |
|   | example setting ................................ 22 |
| A | AM example setting ................................ 23 |
|   | setup .............................................. 37 |
|   | amplifier application example .................... 46 |
|   | application examples ............................. 44 |
| C | cleaning .............................................. 7 |
|   | CMOS activation .................................. 32 |
|   | example setting ................................ 22 |
|   | constant current circuit ......................... 10 |
|   | control knob overview ........................... 17 |
|   | counter gate time ................................ 40 |
|   | counter input .................................... 40 |
|   | example setting ................................ 24 |
| D | DDS block diagram ................................ 11 |
|   | default panel setting contents .................. 43 |
|   | recall .............................................. 43 |
|   | default setting contents ......................... 24 |
|   | default setting recall ........................... 21 |
|   | direct digital synthesis .......................... 10 |
|   | display contents overview ....................... 14 |
|   | duty cycle example setting ....................... 22 |

© Safety


Safety Requirements
IEC/EN 61010-1: 2001

INDEX

| S | 20dB attenuation ................................ 29 |
|   | example setting ................................ 22 |
| A | AM example setting ................................ 23 |
|   | setup .............................................. 37 |
|   | amplifier application example .................... 46 |
|   | application examples ............................. 44 |
| C | cleaning .............................................. 7 |
|   | CMOS activation .................................. 32 |
|   | example setting ................................ 22 |
|   | constant current circuit ......................... 10 |
|   | control knob overview ........................... 17 |
|   | counter gate time ................................ 40 |
|   | counter input .................................... 40 |
|   | example setting ................................ 24 |
| D | DDS block diagram ................................ 11 |
|   | default panel setting contents .................. 43 |
|   | recall .............................................. 43 |
|   | default setting contents ......................... 24 |
|   | default setting recall ........................... 21 |
|   | direct digital synthesis .......................... 10 |
|   | display contents overview ....................... 14 |
|   | duty cycle example setting ....................... 22 |

© Safety


Safety Requirements
IEC/EN 61010-1: 2001

INDEX

| S | 20dB attenuation ................................ 29 |
|   | example setting ................................ 22 |
| A | AM example setting ................................ 23 |
|   | setup .............................................. 37 |
|   | amplifier application example .................... 46 |
|   | application examples ............................. 44 |
| C | cleaning .............................................. 7 |
|   | CMOS activation .................................. 32 |
|   | example setting ................................ 22 |
|   | constant current circuit ......................... 10 |
|   | control knob overview ........................... 17 |
|   | counter gate time ................................ 40 |
|   | counter input .................................... 40 |
|   | example setting ................................ 24 |
| D | DDS block diagram ................................ 11 |
|   | default panel setting contents .................. 43 |
|   | recall .............................................. 43 |
|   | default setting contents ......................... 24 |
|   | default setting recall ........................... 21 |
|   | direct digital synthesis .......................... 10 |
|   | display contents overview ....................... 14 |
|   | duty cycle example setting ....................... 22 |

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Safety Requirements
IEC/EN 61010-1: 2001

INDEX
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
</tr>
<tr>
<td>main feature list</td>
</tr>
<tr>
<td>memory recall</td>
</tr>
<tr>
<td>memory store</td>
</tr>
<tr>
<td>model lineup</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>numerical keys overview</td>
</tr>
<tr>
<td>O</td>
</tr>
<tr>
<td>offset</td>
</tr>
<tr>
<td>operation environment</td>
</tr>
<tr>
<td>operation shortcuts</td>
</tr>
<tr>
<td>P</td>
</tr>
<tr>
<td>phase locked loop</td>
</tr>
<tr>
<td>power supply</td>
</tr>
<tr>
<td>power up sequence</td>
</tr>
<tr>
<td>FAQ</td>
</tr>
<tr>
<td>R</td>
</tr>
<tr>
<td>rear panel</td>
</tr>
<tr>
<td>recall setting</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>safety</td>
</tr>
<tr>
<td>guidelines</td>
</tr>
</tbody>
</table>

symbol: 5
UK power cord: 8
setup step: 20
sine wave: 22
selection: 26
speaker application example: 49, 50
specification: 53
FAQ: 51
square wave: 28
duty cycle: 22
exponential setting: 22
selection: 26
storage environment: 7
store setting: 42
sweep: 23
setup: 35

T

table of contents: 3
technical background: 10
tilt stand: 20
transistor application example: 45
triangle wave: 22
selection: 26
troubleshooting application example: 44
TTL activation: 32
example setting: 22