NF

WAVE FACTORY

MULTIFUNCTION SYNTHESIZER

WF1944B

INSTRUCTION MANUAL

NF Corporation

WF1944B
MULTIFUNCTION
SYNTHESIZER
Instruction Manual

WAVE FACTORY

Foreword

Thank you very much for procuring the WF1944B MULTIFUNCTION SYNTHESIZER. At the outset, please take a few minutes to read the Safety Precautions indicated in this manual in order to use this equipment safely and correctly.

● **Warning and Caution notices**

The following Warning and Caution notices appear in this manual. These must be observed in order to protect both the user from physical harm and the equipment from damage.

> ⚠ **WARNING**
>
> Risk of serious and possibly fatal physical injury from electric shock or other cause.

> ⚠ **CAUTION**
>
> Risk of damage to the equipment.

● **Manual composition**

Please read Section 1 before using the equipment for the first time. Refer to a separate volume for a description of remote control (GPIB or USB).

Section 1   Overview

　　　　Provides a general description of the equipment and a simple outline of the operating principles.

Section 2   Preparation

　　　　Required preparatory work before installing and operating the equipment. Be sure to read this section.

Section 3   Basic operation

　　　　Panel functions, operating principles and basic operations are described. Read while operating the equipment.

Section 4   Applications

　　　　Expanded operations are described.

Section 5   Other operations

　　　　Operations not covered in Sections 3 and 4 are described.

Section 6   Troubleshooting

　　　　Corrective measures when error messages or abnormalities occur.

Section 7   Maintenance

　　　　Inspection and performance tests are described.

Section 8   Specifications

　　　　Equipment specifications (functions and performance) are described.

Safety Precautions

Observe the following warnings and cautions in order to use this equipment safely. No responsibility or warranty is assumed for damages arising from use in a manner contrary to these warnings and cautions.

This product is an insulation standard class I device (with a protective conductor terminal) as defined by the JIS and IEC standards.

● Observe text instructions

This manual has been compiled in order to enable safe operation and use of this equipment. Be sure to read this manual before using the equipment.

Items designated by Warning advise of serious physical hazards. Be sure to observe these carefully.

● Be sure to connect ground

Since the unit includes a built-in line filter, there is risk of shock if used without grounding.

To prevent electric shock, be sure to properly connect the device to the electric ground which ground resistance is less than 100 Ω.

● Confirm power source voltage

Before connecting this equipment, check that the proper voltage is being supplied to the power outlet.

Refer to the Grounding and Power Supply section of this manual.

● Use only the properly rated fuse

Improperly rated fuses present a fire hazard and other risks. Refer to the Grounding and Power Supply section of this manual and confirm the fuse rating.

Be sure to disconnect the equipment from the power source before replacing the fuse.

● Smoke, odor, noise

In event smoke, peculiar odor or noise is emitted, immediately disconnect the power source and avoid further operation. Contact service.

● Flammable gas

Do not use this equipment in the presence of flammable gas. There is danger of fire and explosion.

● Do not remove covers

This equipment contains dangerously high voltages. Do not remove external covers.

Refer all internal inspection and service to a qualified service technician who fully understands the hazards.

● **Do not modify**

Do not use parts other than specified by the manufacturer and by no means attempt to modify the equipment. There is risk of personnel hazard and damage to the equipment. The manufacturer reserves the option of refusing service in such cases.

● **Safety related symbols and indications**

Following are general definitions of the symbols and indications used in the text and on the product.

⚠   Advises of possible hazard to the user, as well as the need to consult this manual when using an operation or function.

⚠ **WARNING**

     Appears in the text and on the product to advise risk of fatal or otherwise serious physical injury.

⚠ **CAUTION**

     Appears in the text and on the product to advise risk of damage to the product.

Ground indication:
Indicates connector housing and signal ground is connected to a chassis ground.

Indicates power switch on state.

Indicates power switch off state.

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Section 1   Overview

1.1 Features

The WF1944B Wave Factory is a multifunctional synthesizer based on the direct digital synthesizer (DDS) system.

Although the WF1944B is 2-channel, the series also includes the single-channel WF1943B, the single-channel WF1945B with multiple functions, and the 2-channel WF1946B with additional multiple functions.

- Frequency setting range   : 0.01 μHz to 15 MHz
- Maximum output voltage   : 20 Vp-p/open, ±10 V/open
- Waveform resolution: 14 bits
- Key navigation lights the next keys to be operated, thus improving operational ease.
- User units function allows setting formula and character string to convert settings and display to the desired units.
- LOAD function aligns the setting and actual output voltages when an arbitrary load impedance in connected.
- Convenient use as a pulse generator with pulse period, width, high level and low level setting and display.   A trigger delay function is also included.
- Five standard waveforms: sinewave, triangular wave, squarewave, rising sawtooth and descending sawtooth, plus arbitrary waveform.
- Frequency change and frequency sweep are coupled with phase, avoiding waveform cutoff.
- Unpredicted voltage is not produced during amplitude change.   Since the output range is fixed, the amplitude can be changed from 0 to maximum without waveform cutoff.
- Versatile channel mode utilizing 2 channels
    - ・2 channel independent mode
    - ・2 phase mode oscillating at the same frequency
    - ・2 tone mode oscillating at a fixed frequency difference
    - ・Ratio mode oscillating continuously at a fixed frequency ratio
    - ・Differential mode for simultaneous output of waveforms with top and bottom symmetrical
- Versatile oscillation modes
    - ・Continuous
    - ・Intermittent: Burst, trigger, gate, in addition to triggered gate for repeated oscillation start/stop
    - ・Sweep: Frequency,   phase
    - ・Modulation: FM (FSK), phase (PSK)
    - ・White noise generator
    - ・DC voltage generator
- Floating inputs and outputs to prevent ground loop effects. Isolation is also used between channels.

1.2 Operating principles

■ Block diagram
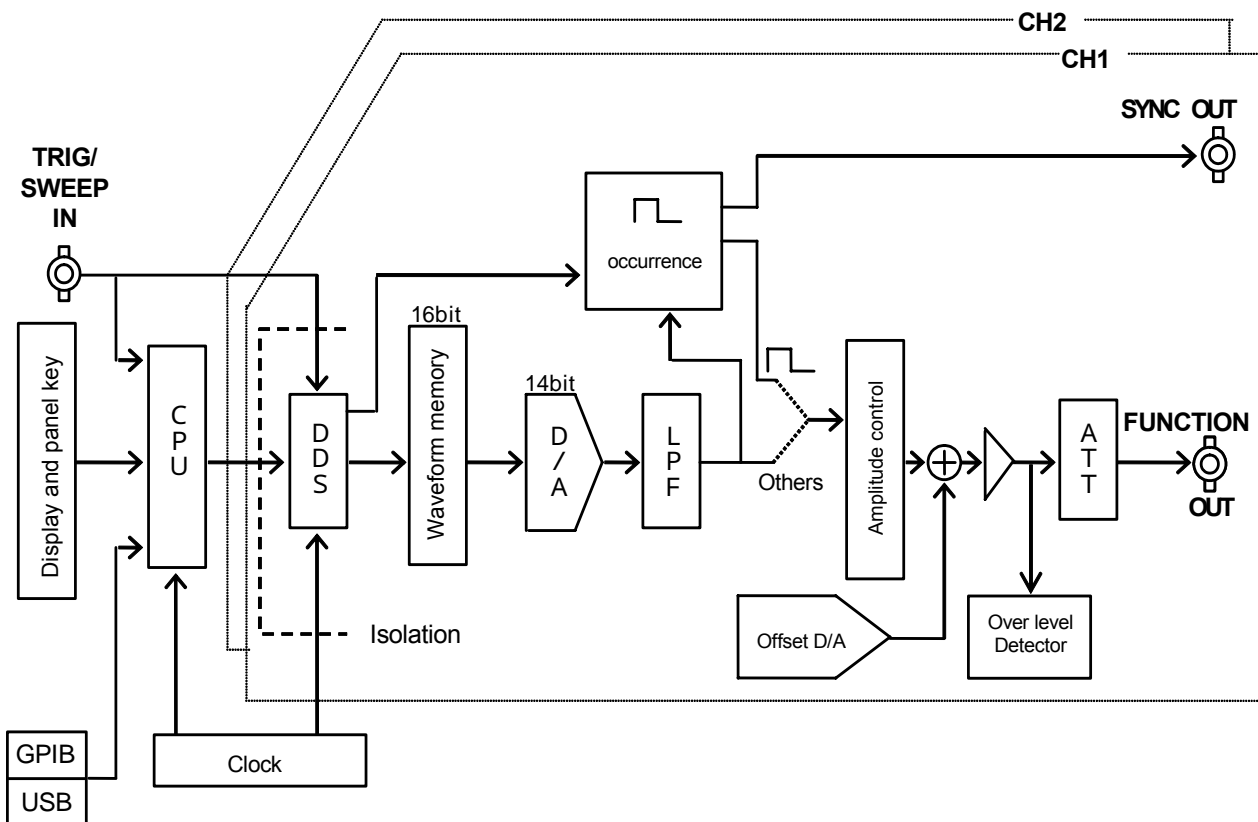
- The CPU conducts analog control for display, panel keys, remote control (GPIB, USB), DDS, amplitude and DC offset.　Sweep/internal modulation are also conducted.
- The clock generator produces DDS reference and CPU clock signals.
- Two sets of circuits for DDS and analog compose two channels.
- An isolation circuit between the CPU and DDS provides floating functions.
- The DDS (Direct Digital Synthesizer) uses an original LSI device and generates digital data of the setting frequency.
- The waveform memory converts digital data from the DDS into standard or arbitrary waveform data.　Waveform data are set from the CPU.
- The digital to analog (D/A) converter produces an analog signal from the resulting waveform data.
- The lowpass filter (LPF) smoothes the stepped D/A output signal.
- Amplitude control is set by the gain control.　DC offset is produced by the offset D/A converter and the output amplifier adds and amplifies the output signal.
- The attenuator (ATT) selects the output range by 1/10 attenuation on/off.

1.3 Function outline

■ Main functions

● Channel mode selection

Channel 1 and Channel 2 operation can be set for 2 channel independent, 2 phase, fixed frequency difference, fixed frequency ratio or differential output.

● Oscillation mode selection

The oscillation type can be set for continuous, intermittent, sweep, modulated, noise or DC.

● Waveform selection

The waveform type can be set for sinewave ($\curvearrowright$), triangle waveform ($\wedge$), squarewave ($\sqcap$, 50 % fixed duty), squarewave ($\sqcap$, variable duty), rising sawtooth ($\diagup$), descending sawtooth ($\diagdown$), or arbitrary (ARB).

● Frequency setting

The frequency can be set by the keypad or modify dial.

The period, i.e., inverse of frequency, can also be set.

The duty and pulse width can also be set for the variable duty squarewave.

● Amplitude setting

The amplitude can be set by the keypad or modify dial.

● DC offset setting

The DC offset can be set by the keypad or modify dial.

● Phase setting

Phase between channels and oscillation starting phase during burst oscillation can be set.

● Output on/off

The waveform and sync signal output connectors are on/off switchable for each channel.

The setting prior to power off is returned at power on.   Be sure to set to either on or off as required.

● User units setting

Coefficients and compensation can be applied to frequency, period, amplitude, DC offset, phase and duty for setting and displaying these in desired units.   The units can be expressed by up to 4 desired characters.

● Setting store and recall

The settings for frequency, amplitude, etc., can be stored and recalled.

The WF1944B is capable of 10 combinations store/recall.

● Computer control

Remote control (GPIB or USB) enables external control from a personal computer.

Section 2   Preparation

2.1 Check before using

■ Safety check

Before using the WF1944B, refer to the **Safety precautions** of this manual and confirm safety.

Also, before connecting the power, refer to **Section 2.2   Power source and grounding** and thoroughly check the safety.

■ Unpacking and repacking

First, inspect the equipment for possible damage in shipping.

Check for the presence of the following items.

Mainframe ·· 1	
Operation Manual ··· 1	
Remote Control Operation Manual ································· 1	
0105 Arbitrary Waveform Editor (CD-ROM)································ 1	
Supplied accessories	
Power cable: (3-conductors)··· 1	
Fuse : (100/115 V: 2 A or 230 V: 1 A) ···························· 1	
(Time lag, 250 V, $\phi 5.2 \times 20$ mm)	

For information on how to use 0105 Arbitrary Waveform Editor, refer to the CD-ROM of the 0105.

When repacking the equipment for transportation, use a packing carton having ample strength to protect the equipment and bear the weight of stacking.

⚠ WARNING

Do not remove covers.

This equipment contains dangerously high voltages.   Do not remove external covers.

Refer all internal inspection and service to a qualified service technician who fully understands the hazards.

2.2 Power source and grounding

■ Grounding

> **⚠ WARNING**
>
> **This equipment must be grounded in order to prevent electric shock accidents.**
>
> **Confirm the protective ground terminal is connected to ground before connecting the equipment for measurements.   The WF1944B protective ground is connected to ground by the 3-prong power supply plug.**
> **Use the supplied power supply cable to connect to a 3-terminal power outlet that has a protective ground contact.**

■ Line filter

The WF1944B uses a line filter that incorporates the circuit below.

Because the maximum leakage current is 0.5 mArms at 250 V/62 Hz, touching a metallic part of the WF1944B could cause an electric shock.

For your safety, be sure to ground the device.
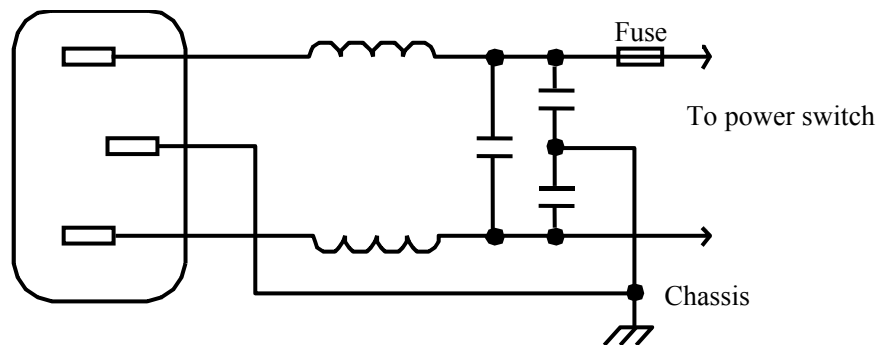
■ Power source

> **⚠ CAUTION**
>
> **Be sure to observe the following in order to prevent damage to the equipment.**
> **Confirm the power source voltage is within the range specified for the WF1944B.**

Check the power source voltage indication on the rear panel above the power source inlet.   The WF1944B operates from the following commercial power source.

Power supply voltage range: AC100V/115V/230V±10%

Power supply frequency range: 50/60 Hz ±2 Hz

Power consumption: Max. 100 VA

Overvoltage category: II

Connect to the power source according to the following procedure:

1.   Set the WF1944B power switch to off.
2.   Adjust the source voltage change-over switch at the back of the unit to the source voltage to be used.
3.   Insert the power cable into the power inlet on the back of the unit.
4.   Insert the power cable plug into a 3-terminal wall socket.

With a screwdriver, move the slide control of the source voltage change-over switch to the line indicating the source voltage to be used.   Do not set the slide control between lines.
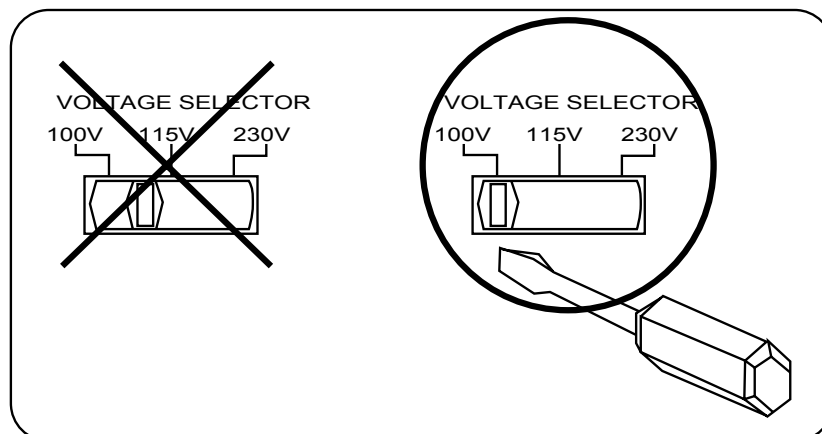
Before using the WF1944B with a source voltage that differs from the factory setting, be sure to contact the sales representative of NF Corporation.

Make sure that the power switch is off before connecting the power cable.   Also, after switching power off, wait at least five seconds before switching the power on again.

Confirm the power switch is off before connecting the power cable.
Also, after switching power off, wait at least 5 seconds before again switching power on.

■ Power supply fuse

> ⚠ **WARNING**
>
> **Use only a fuse with the specified rating.**
>
> **There is risk of fire from an improperly rated fuse.   Be sure to disconnect the power cable before replacing the fuse.**

Fuse: Time lag 2 A (100/115 V) or time lag 1 A (230 V)

250 V, $\phi 5.2 \times 20$ mm

The specified rating of a fuse changes depending on the power source voltage.

2.3 Installation

■ Cautions

<div style="border:1px solid">

⚠ **CAUTION**

Observe the following cautions to avoid damaging the WF1944B.

- **The unit is cooled by a fan. In event the fan does not function, switch off the power and contact service. Continued use without the fan operating can lead to extensive damage and service complexity.**
- **Ventilation openings are located on the side and rear panels. Avoid obstructing the openings and provide at least 10 cm clear space at the sides and back of the unit when installing.**
- **Do not use the unit vertically (with the rear panel downward).**

</div>

■ Installation conditions

Observe the following ambient when installing and storing the equipment. Moisture condensation must also be absent.

Temperature and humidity ranges

Guaranteed performance: +5 to +35 °C, 5 to 85 %RH

(no condensation at an absolute humidity of 1 to 25 g/m^3)

Ambient storage conditions: -10 to +50 °C, 5 to 95 %RH

(no condensation at an absolute humidity of 1 to 29 g/m^3)

Pollution degree : 2

Avoid installing the equipment in the following types of locations.

- In direct sunlight or near heat sources
- Where subjected to dust, salt or metallic dust
- Corrosive gas, steam or oily smoke
- Flammable gas or vapors
- Strong vibration
- Strong magnetic or electromagnetic fields
- Near pulse type noise sources

Also, when using, provide separation between the power cords and signal cables of the WF1944B and those of other equipment. Operating error can occur if the power cords and signal cables are too close. Cable routing requires particular attention when installing in a rack or other facility.

■ Panel and case cleaning

Use a soft cloth to wipe dust from the panel and case. If soiling is severe, moisten the cloth slightly with a neutral detergent.

Do not use sprays, petroleum distillates or commercial cleaning cloths, which can deform or peel the finish.

2.4 Conformable standards

The WF1944B conforms to the following standards.

Safety: EN 61010-1: 2001

EMC: EN 61326: 1997/A1: 1998/A2: 2001

However, the performance criteria for the following standards are as follows:

EN61000-4-2(1995):C

EN61000-4-4(1995), EN61000-4-5(1995), EN61000-4-11(1994):B

The phase synchronization (ϕSYNC) operation may be required because the phase difference between channels is caused by the electrostatic discharge.

The following cables are used for the test of EN 61326: 1997/A1: 1998/A2: 2001

- Power cable   : Accessory
- Signal cables   : Coaxial cable with BNC connectors, 1 m (3D-2W or RG-143B/U or RG-223/U)
- GPIB cable   : Shielded cable, 1 m (DDK: 408JE-101)

2.5 Calibration

Section 7.3 the **Performance tests** are recommended at least once a year.

These should also be conducted before important tests and measurements.

Section 3   Basic operation

・Following is an example of the display when using this section.

Fully lighted (bold)   Flashing

```
PRESET
SYSTEM: RANGE  PRESET  USER-UNIT  ▶
```

Fully lighted (bold)   Dimly lighted

3.1 Panel description

This section describes the indications and functions of the front and rear panels of the WF1944B.

■ Front panel

Output waveform on/off.
Key lamp lights when on, extinguishes when off.

Key button, top or bottom lamps light only for operable keys.

When Modify lamp lights, turn dial to set values or parameters.

Press to enter, e.g., a numerical input.

Return to the previous step.

Undo key (page 5-19)

Memory save, recall, etc. (pages 5-13)

Waveform output connector (page 3-5)

Lamp lights to indicate output range.
When the range is set for automatic switching, the Auto lamp lights (page 5-16).
The OVER lamp flashes when the output voltage exceeds the upper limit (page 3-5).

Sync signal output connector (page 3-6)

Displays frequency, amplitude, offset and load impedance settings, in addition to information to assist when setting.

Lamps light to indicate present oscillation mode and waveform selection.

Oscillation mode selection (page 3-18)

Frequency and amplitude setting (page 3-22)

Selects channel mode.
Lamp above key indicates present selection. (page 3-13)

Waveform select (page 3-19)

Selects channel for display and setting.
Lamp above key indicates present selection.

Trigger/sweep input connector (page 3-9)

Power on/off. Depress for power on, press and release to raised position for power off.

Setting initialize (page 3-10), output range setting (page 5-16), user unit setting (page 5-9)

■ Rear panel

3.2 Input and output connectors

■ Waveform output (FUNCTION OUT)
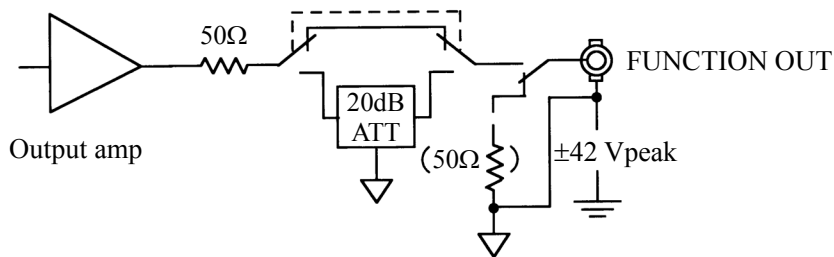
Maximum output voltage :   20 Vp-p/open, 10 Vp-p/50 Ω load

Output impedance :   50 Ω, unbalanced

Load impedance: More than 45 Ω

Output off status :   Open when output off (can be modified for 50 Ω at output off.   Consult company.)

Ground :   Connected to signal ground (floating from chassis)

⚠ **CAUTION**

Avoid shorting the output or applying an external signal.   The unit can be damaged.

・**Output limiting**

If the following voltages are exceeded by the amplitude, DC offset, the OVER lamp flashes and the output is clipped.

10 V range: Approx. 11 Vp/open
1 V range: Approx. 1.1 Vp/open

・**Output connection note**

The Function Out impedance is 50 Ω.   By using coaxial cable   with 50 Ω characteristic impedance for connection to other equipment, amplitude accuracy at high frequency can be improved and waveform disturbance reduced.   In addition, performance deterioration up to maximum frequency can be prevented by connecting to a terminal having 50 Ω input impedance or terminating the input at 50 Ω.

・**Setting and output voltages**

The setting voltage display and actual output voltage (load terminal voltage) differ according to the load resistance.   ☞ 5.4 Other settings (■LOAD function (equalize setting and output values))

■ Sync signal output (SYNC OUT)
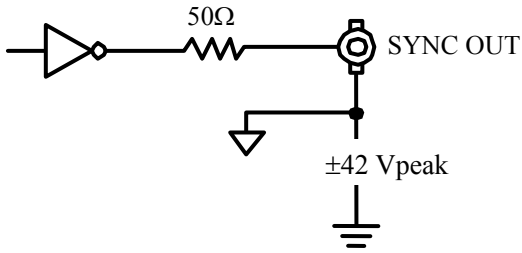
Output waveform :   ⊓_

Output voltage :   0 V/+5 V (open)

Output impedance: 50 Ω, unbalanced

Load impedance: More than 45 Ω

Status at output off :   High impedance

Ground :   Connected to signal ground (floating from chassis)

⚠ **CAUTION**

Avoid shorting the output or applying an external signal.   The unit can be damaged.

・**Output connection note**

The Sync Out impedance is 50 Ω.   By using coaxial cable with 50 Ω characteristic impedance for connection to other equipment, waveform disturbance can be reduced.   Although 50 Ω termination is possible, the high level voltage is reduced by about half.

・**Waveform and sync signal output relationship (Waveform phase definition)**

(1) Continuous oscillation mode (NORMAL)

① Sinewave
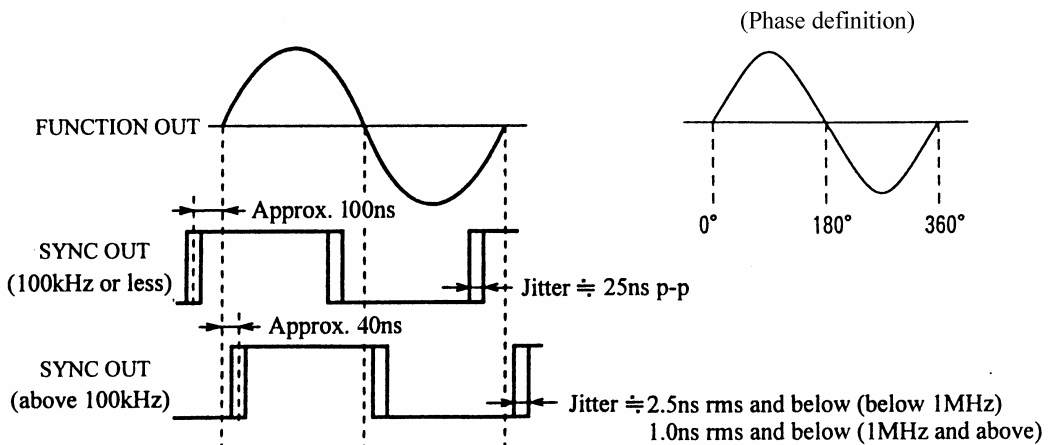
② Triangular, rising sawtooth, descending sawtooth, arbitrary

(Phase definition)

FUNCTION OUT
triangular

FUNCTION OUT
rising sawtooth

FUNCTION OUT
descending sawtooth

FUNCTION OUT
arbitrary

About
100 ns

Jitter ≒ 25 ns p-p

SYNC OUT

0° 180° 360°

Arbitrary waveform:
Address = 0

Arbitrary waveform:
Address = data size - 1
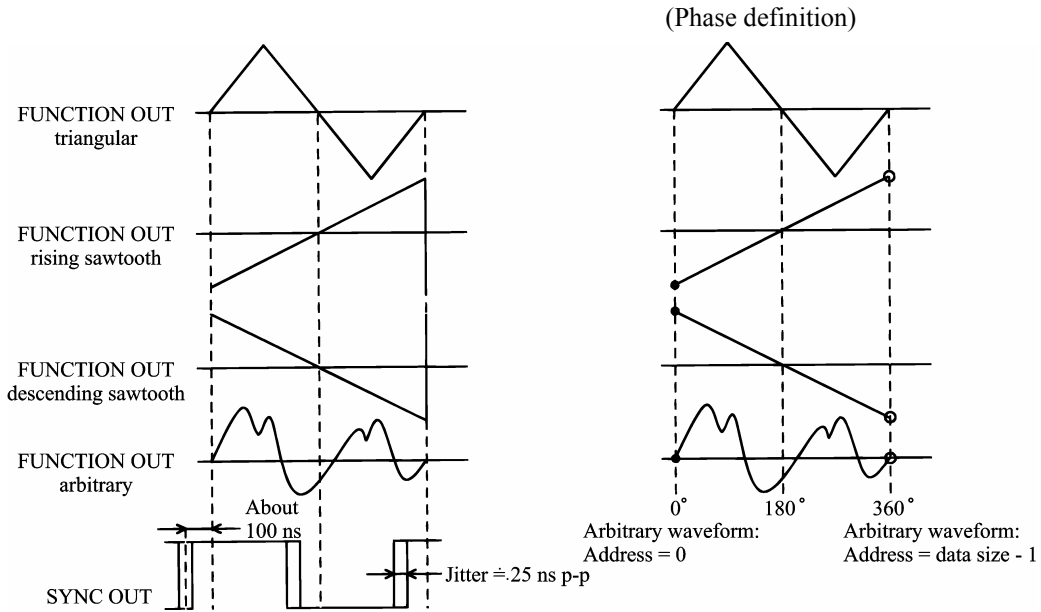
③ Squarewave (fixed 50 % duty)

(Phase definition)

Above 100 kHz with stop
level off.
At other times, see
example ④ below.

Approx. 2°

0° 180° 360°

FUNCTION OUT

Approx. 15ns

SYNC OUT

Rising and falling edge hysteresis zones vary with phase
history.

Jitter ≒
25 ns p-p (Stop level on or 100 kHz and below)
2.5 ns rms and below (Stop level off and between above 100 kHz
and below 1 MHz)
1.0 ns rms and below (Stop level off and 1 MHz and above)

Approximately 25 ns p-p jitter is also produced in
the FUNCTION OUT waveform when stop level is
On or 100 kHz and below.

④ Squarewave (variable duty)

(Phase definition)

FUNCTION OUT

Appendix. 14ns

Jitter ≒ 25ns p-p

SYNC OUT

0° 360°

Approximately 25 ns p-p jitter is also produced in the FUNCTION OUT waveform.

(2) Burst mode (BURST)
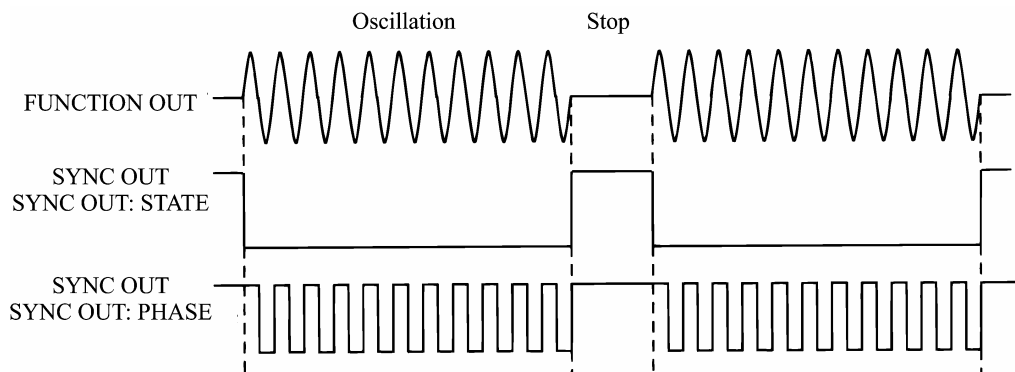
(3) Sweep mode (SWEEP)

Low level during sweep from start to stop points.   High level at other times.

☞ 4.2 Sweep (■Sweep value and SYNC OUT)

(4) Modulation mode (MODU)

High level when modulation waveform phase is above 0 and less than 180 degrees.   Low level above 180 and below 360 degrees.
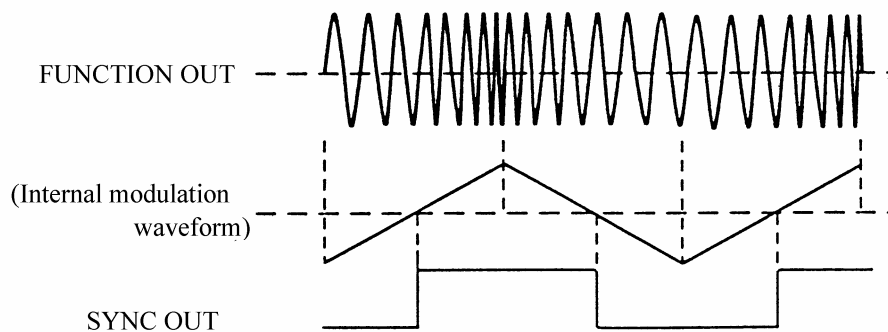
(5) Noise mode (NOISE)

Digital (binary) noise source output.

(6) DC mode (DC)

Always high level.

■ Trigger/sweep input (TRIG/SWEEP IN)
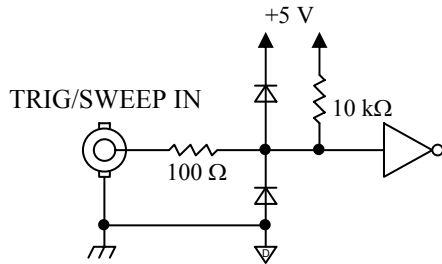
Signal characteristics: The following types are produced during the burst oscillation mode.

        Trigger: Select oscillation start for either ⌐ or ⌐.

        Gate: Select oscillation at either high or low level.

        Triggered gate: Oscillation start/stop at ⌐ or ⌐.   Select either.

        Minimum pulse width is 50 ns.

    In sweep oscillation mode, the sweep starts at ⌐ or ⌐.   Select either.

        Minimum pulse width is 200 ns.

Input voltage :   High level $\geq$ +3.9 V

        Low level $\leq$ +1.6 V

Input voltage range : -0.5 to +5.5 V

Input impedance :   Pull up to +5 V at approx. 10 kΩ

Ground :   Connected to chassis ground

⚠ **CAUTION**

Do not apply a signal exceeding the above input voltage range.   The unit can be damaged.

• Drive circuit examples
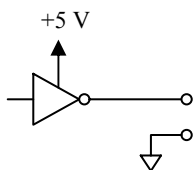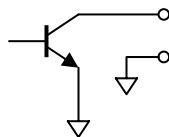
    (a) TTL logic output   (b) Open collector output   (c) High voltage logic output
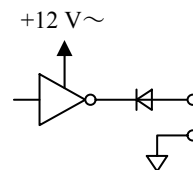
Connect the trigger and sweep input drive signals to TTL or C-MOS logic IC outputs.

Since the input circuit is provided with a built-in pullup resistor, an open collector output drive can also be used.   However, contact chatter from a mechanical switch or relay can prevent normal operation.   Also, chattering will prevent normal operation when the oscillation mode is triggered gate.

Avoid using a logic IC circuit having a power supply voltage higher than +5 V such as example (c) for the WF1944B input

3.3 Basic operation

Basic operation is described using an example of a triangular waveform with frequency 1 kHz, amplitude 2 Vp-p and DC offset +1 V from the waveform output connector.

Amplitude: 2V p-p

0

Waveform center
DC offset: +1V

Period (frequency): 1ms(1kHz)
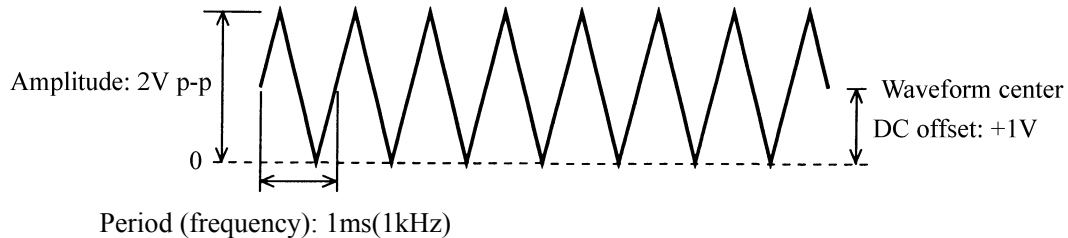
■ Setting initialize(PRESET)

The operation of initializing all settings is described.　This operation manual presumes operation directly after initializing.

Operation:

① Press the $\overset{\text{SYSTEM}}{\bigcirc}$ key, then use the ◁ and ▷ keys to produce the following display. (lower PRESET flashes).

```
P R E S E T
S Y S T E M : R A N G E   PRESET   U S E R − U N I T   ▶
```

② Press the $\overset{\text{ENTER}}{\bigcirc}$ key (upper PRESET flashes).

③ Again press the $\overset{\text{ENTER}}{\bigcirc}$ key to initialize.　To return without initializing, before pressing $\overset{\text{ENTER}}{\bigcirc}$, press the $\overset{\text{EXIT}}{\bigcirc}$ key twice.

Initialized settings ：

Initialized settings are indicated in the table.

Settings related to output on/off, output on/off at power on, arbitrary waveform, setting memory, user units , remote control, GPIB address, GPIB delimiter, and USB ID are not initialized.

Initialization table

Key operation	Menu	Initial settings	Remarks
CH 1/CH 2		CH 1(BOTH is off)	
CHANNEL MODE		INDEP	
MODE		NORMAL	
MODE→BURST	TYPE	BURST	
	SOURCE	EXT ↴ (1 ms, at INT)	When TYPE=TRIG, GATE,T-GATE
	SOURCE(CH2)	EXT CH2 ↴ (1 ms, at INT)	When TYPE=TRIG, GATE,T-GATE
	DELAY	0.3 μs	When TYPE=TRIG
	MARK	1.0	When TYPE=BURST, TRIG
	SPACE	1.0	When TYPE=BURST
	STOP-LEVEL	OFF (0%, at ON).	
	OPER-COMMON	OFF	Both channels MODE=BURST, TYPE=TRIG, GATE or T-GATE, same TYPE.
MODE→SWEEP	TYPE	FREQ	
	SOURCE	EXT ↴ (1 ms at INT)	When MODE=SINGLE, GATED
	SOURCE(CH2)	EXT CH2 ↴ (1 ms, at INT)	When MODE=SINGLE, GATED
	MODE	SINGLE	
	FUNCTION	LIN ⟋	
	TIME	1 s	
	STOP-LEVEL	OFF (0%, at ON).	When MODE=GATED
	OPER-COMMON	OFF	When both channels SWEEP MODE
MODE → SWEEP, TYPE=FREQ	START	1000 Hz	
	STOP	10000 Hz	
	CENTER	5500 Hz	
	SPAN	9000 Hz	
MODE → SWEEP, TYPE=PHASE	START	−90 deg	
	STOP	90 deg	
	CENTER	0 deg	
	SPAN	180 deg	

Continued from previous page

Key operation	Menu	Initial settings	Remarks
MODE→MODU	TYPE	FM	
	FREQUENCY	100 Hz	
	FUNCTION	⌒⌄	
	OPER-COMMON	OFF	When both channels MODU MODE
MODE → MODU, TYPE=FM	DEVIATION	1000 Hz	
MODE → MODU, TYPE=PM	DEVIATION	90 deg	
ENTRY→FREQ		1000 Hz	
ENTRY→AMPTD		0.1 Vp-p	
ENTRY→OFFSET		0 V	
ENTRY→PHASE		0 deg	
ENTRY→WIDTH		0.0005 s	In case of FUNCTION=⎍
ENTRY→DUTY		50 %	In case of FUNCTION=⎍
ENTRY→PERIOD		0.001 s	
ENTRY→HIGH		0.05 V	
ENTRY→LOW		−0.05 V	
ENTRY→ΔFREQ		0 Hz	When CHANNEL MODE=2 TONE
ENTRY→RATIO		0000001:0000001	When CHANNEL MODE=RATIO
FUNCTION		⌒⌄	
SYSTEM	RANGE	AUTO	
	LOAD	OPEN (50 ohms at SET)	
	DUTY-VALID	IMMED	
	SYNC OUT	STATE	

■ **Channel mode selection (** CHANNEL MODE **)**

Selecting the operating modes for channels 1 and 2 are described.

Definitions:

INDEP (independent 2 channel) : CH1 and CH2 operate independently.

2 PHASE : CH1 and CH2 operate at the same frequency.

Example:

CH1	1 kHz	10 kHz
CH2	1 kHz	10 kHz

Frequency sweep and frequency modulation settings and operation are also the same for CH1 and CH2.

2 TONE (fixed frequency difference) : CH1 and CH2 operate continuously at a fixed frequency difference.

Example:

CH1	1 kHz	10 kHz
CH2	2 kHz	11 kHz

Frequency sweep and frequency modulation settings are at the fixed frequency difference.

RATIO (fixed frequency ratio) : CH1 and CH2 operate continuously at a fixed frequency ratio.

Example:

CH1	1 kHz	10 kHz
CH2	2 kHz	20 kHz

Frequency sweep and frequency modulation settings are at the fixed frequency ratio.

DIFF (differential output) : CH1 and CH2 operate at the same frequency, amplitude and DC offset, but at opposite waveforms (reverse phase).
In this mode, amplitude, DC offset, output range, output on/off, phase, frequency sweep and frequency modulation settings are copied from CH1 to CH2.

Operation:

As an example, 2 phase operation is described.

① Press the ⌐CHANNEL MODE⌐ key, then select the mode with the ◁ and ▷ keys (2 PHASE flashes

in this example).

```
INDEP  2PHASE  2TONE  ▶
SELECT  CHANNEL  MODE
```
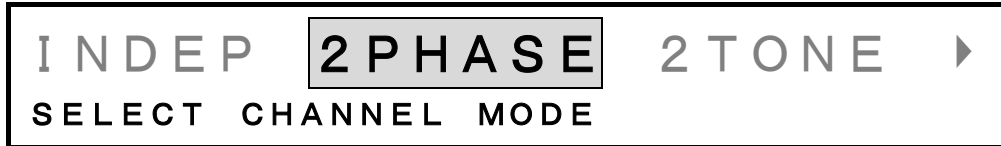
② Press the ⌐ENTER⌐ key to change the mode.

The 2PHASE lamp above the ⌐CHANNEL MODE⌐ key lights.

This completes channel mode change.

Other:

・ When the channel mode is changed, the CH2 setting is determined on the basis of the CH1 setting.

・ The channel mode and setting relationships

☞ 3.3 Basic operation (■Channel modes and settings)

■ **Channel modes and settings**

The channel modes and setting limits are indicated in the following table.

○ : Independent setting

△ : Both channel settings are the same.

▲ : Frequency difference (Δ FREQ) and frequency ratio (RATIO) relationships are maintained.

× : Not settable

*2: Gated sweep mode not selectable

*3: LOG sweep function not selectable

*4: Only CH1 usable for TRIG/SWEEP IN and SWEEP PAUSE IN

*5: When the oscillation mode is sweep or modulation, FREQ indicated the type is frequency and OTHER indicates other than this.

*6: Control operation is common between channels.

Key operation	Channel mode→ Menu name	[INDEP]	[2PHASE] FREQ *5	[2PHASE] other *5	[2TONE] FREQ *5	[2TONE] other *5	[RATIO] FREQ *5	[RATIO] other *5	[DIFF]	Note
MODE→NORMAL		○	△	○	△	○	△	○	△	
MODE→BURST		○	×	×	×	×	×	×	×	
	TYPE	○	×	×	×	×	×	×	×	
	SOURCE	○	×	×	×	×	×	×	×	SOURCE other than TYPE=BURST
	INT/EXT	○	×	×	×	×	×	×	×	
	INT RATE	△	×	×	×	×	×	×	×	RATE is internal trigger period
	INT ↑↓	○	×	×	×	×	×	×	×	
	EXT ↑↓	○	×	×	×	×	×	×	×	
	EXT CH	○	×	×	×	×	×	×	×	
	DELAY	○	×	×	×	×	×	×	×	When TYPE=TRIG
	MARK	○	×	×	×	×	×	×	×	When TYPE=BURST and TRIG
	SPACE	○	×	×	×	×	×	×	×	When TYPE=BURST
	STOP-LEVEL	○	×	×	×	×	×	×	×	
	OPER-COMMON	△	×	×	×	×	×	×	×	Both channels BURST and same TYPE
MODE→SWEEP		○	△	○	△	○	△	○	△	
	TYPE	○	△	○	△	○	△	○	△	
	SOURCE	○	△	○	△	○	△	○	△	SOURCE other than MODE=CONT
	INT/EXT	○	△	○	△	○	△	○	△	
	INT RATE	△	△	△	△	△	△	△	△	RATE is internal trigger period
	INT ↑↓	○	△	○	△	○	△	○	△	
	EXT ↑↓	○	△	○	△	○	△	○	△	
	EXT CH	○	CH1*4	○	CH1*4	○	CH1*4	○	CH1*4	
	MODE	○	△*2	○*2	△*2	○*2	△*2	○*2	△*2	
	FUNCTION	○	△	○	△*3	○*3	△	○	△	
	START	○	△	○	▲	○	▲	○	△	
	STOP	○	△	○	▲	○	▲	○	△	
	TIME	○	△	○	△	○	△	○	△	
	STOP-LEVEL	○	×	×	○	○	×	×	×	When MODE=GATE
	CENTER	○	△	○	▲	○	▲	○	△	
	SPAN	○	△	○	△	○	▲	○	△	

Continued next page

Continued from previous page

Key operation	Menu name	[INDEP]	[2PHASE] FREQ *5	[2PHASE] other *5	[2TONE] FREQ *5	[2TONE] other *5	[RATIO] FREQ *5	[RATIO] other *5	[DIFF]	Note
MODE→SWEEP	START-STATE	○	△	○	▲	○	▲	○	△	
	STOP-STATE	○	△	○	▲	○	▲	○	△	
	OPER-COMMON	△	ON*6	△	ON*6	△	ON*6	△	ON*6	When both channels SWEEP mode
MODE→MODU		○	△	○	△	○	△	○	△	
	TYPE	○	△	○	△	○	△	○	△	
	DEVIATION	○	△	○	△	○	▲	○	△	
	FREQ	○	△	○	△	○	△	○	△	
	FUNCTION	○	△	○	△	○	△	○	△	
	OPER-COMMON	△	ON*6	△	ON*6	△	ON*6	△	ON*6	When both channels are MODU
MODE→NOISE		○	×	×	×	×	×	×	×	
MODE→DC		○	×	×	×	×	×	×	×	
ENTRY→FREQ		○	△	△	▲	▲	▲	▲	△	
ENTRY→AMPTD		○	○	○	○	○	○	○	△	
ENTRY→OFFSET		○	○	○	○	○	○	○	△	
ENTRY→PHASE		○	○	○	○	○	○	○	△	
ENTRY→WIDTH		○	○	○	○	○	○	○	△	
ENTRY→DUTY		○	○	○	○	○	○	○	△	
ENTRY→PERIOD		○	△	△	▲	▲	▲	▲	△	
ENTRY→HIGH		○	○	○	○	○	○	○	△	
ENTRY→LOW		○	○	○	○	○	○	○	△	
FUNCTION→?		○	○	○	○	○	○	○	△	? is waveform select
ARB EDIT	SELECT	○	○	○	○	○	○	○	△	
	NAME	○	○	○	○	○	○	○	△	
	EDIT	○	○	○	○	○	○	○	△	
	COPY	○	○	○	○	○	○	○	△	
	MARK→CLEAR	○	○	○	○	○	○	○	△	
	CLEAR	○	○	○	○	○	○	○	△	
	SIZE	△	△	△	△	△	△	△	△	
SYSTEM	RANGE	○	○	○	○	○	○	○	△	
	PRESET	△	△	△	△	△	△	△	△	
	USER-UNIT	○	○	○	○	○	○	○	△	
	LOAD	○	○	○	○	○	○	○	△	
	ΦSYNC	△	△	△	△	△	△	△	△	
	POWER-ON	○	○	○	○	○	○	○	△	
	REMOTE	△	△	△	△	△	△	△	△	
	DUTY-VALID	○	○	○	○	○	○	○	△	
	SYNC OUT	○	○	○	○	○	○	○	△	
CH 1/CH 2		○	○	○	○	○	○	○	×	
CH 1, CH 2 OUT		○	○	○	○	○	○	○	△	

■ Channel selection ($\boxed{\text{CH 1 / CH 2}}$)

Channel selection for setting and display is described.

Procedure:

Each time that the $\boxed{\text{CH 1 / CH 2}}$ key is pressed, the lamp that lights or flashes changes as shown below:

```
        ↓
      CH1      (Set to CH1 only)
        ↓
      CH2      (Set to CH2 only)
        ↓
BOTH and CH1   (Set to both CH1 and CH2 simultaneously.  The displayed unit and
               auxiliary unit are the same as those of the preceding CH1)

BOTH and CH2   (Set to both CH1 and CH2 simultaneously.  The displayed unit and
               auxiliary unit are the same as those of the preceding CH2)
```
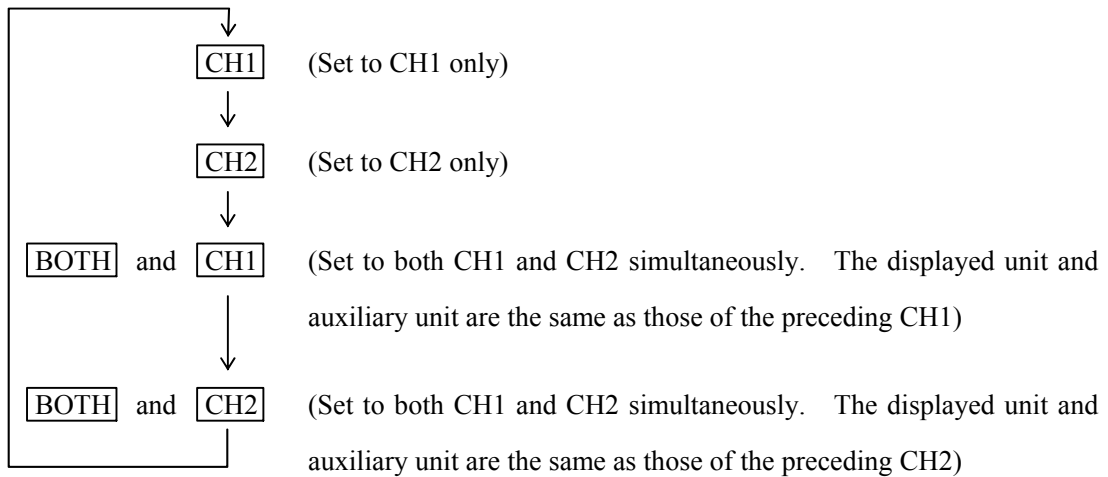
While CH1 is flashing, however, the value of CH2 is different from the displayed value. Also, while CH2 is flashing, the value of CH1 is different from the displayed value. If set again, CH1 and CH2 will operate with the same setting.

Operation:

In this example, CH1 is selected.

① Press the $\boxed{\text{CH 1 / CH 2}}$ key to where the CH1 lamp above the key lights.

This selects the setting and display for CH1.

Each time the key is pressed, the setting and display change as follows: CH1 → CH2 → CH1 BOTH → CH2 BOTH → CH1…

Other:

The channel cannot be selected when the channel mode is DIFF.

■ Oscillation mode selection ($\overset{\text{MODE}}{\fbox{}}$)

Oscillation mode (continuous, burst, sweep, etc.) selection is described.

Terms:

NORMAL (continuous): Continuous oscillation; normally use this mode.

BURST : Intermittent oscillation (BURST, TRIG, GATE, T-GATE)
☞ 4.1 Burst oscillation

SWEEP : Item such as frequency is automatically varied.
☞ 4.2 Sweep

MODU (modulation) : Modulated waveform output (FM, PM)
☞ 4.3 Modulation

NOISE : White noise output

DC : DC output

Operation:

The selected oscillation mode is indicated in the STATUS area, which is located to the left of $\overset{\text{MODE}}{\fbox{}}$ key. When the $\overset{\text{MODE}}{\fbox{}}$ key is pressed, the $\overset{\text{MODE}}{\fbox{}}$ key lamp lights, and at the same time, the lamp of every key located to the right of the $\overset{\text{MODE}}{\fbox{}}$ key lights.

To use another oscillation mode (one whose key lamp is already lit), press the key of the mode.

Operation example:

In this example, first set to DC, then to continuous (NORMAL).

① Press the $\overset{\text{MODE}}{\fbox{}}$ key, then the $\overset{\text{DC}}{\fbox{}}$ key to set the DC mode.
The $\boxed{\text{DC}}$ STATUS lamp lights.

② Press the $\overset{\text{MODE}}{\fbox{}}$ key, then the $\overset{\text{NORMAL}}{\fbox{}}$ key to set the NORMAL mode.
The $\boxed{\text{NORMAL}}$ STATUS lamp lights.

■ Waveform selection ($\boxed{\text{FUNCTION}}$)

Waveform selection is described.

Symbols:

⌒⌣ : Sinewave

⌒⌄ : Triangular wave

⊓⌐ : Squarewave (50 % fixed duty)

⌐⌐ : Squarewave (variable duty)

⟋ : Rising sawtooth

⟍ : Descending sawtooth

ARB: Arbitrary waveform

☞ 4.4 Arbitrary Waveform (ARB)

Operation:

The selected waveform is indicated in the STATUS area, which is located to the left of $\boxed{\text{FUNCTION}}$ key. When the $\boxed{\text{FUNCTION}}$ key is pressed, the $\boxed{\text{FUNCTION}}$ key lamp lights, and at the same time, the lamp of every key located to the right of the $\boxed{\text{FUNCTION}}$ key lights. The lamp of the selected waveform blinks. To select another waveform (one whose key lamp is already lit), press the key of the waveform.

Operation example:

In this example, a triangular waveform is selected.

① Press the $\boxed{\text{FUNCTION}}$ key, then the $\boxed{⌒⌄}$ key.

The $\boxed{⌒⌄}$ STATUS lamp lights

② After selecting, press the $\boxed{\text{EXIT}}$ key once to exit the setting mode.

Other:

In ⌐⌐ squarewaves (variable duty), pulses may disappear depending on the relations between the cycle and duty when the pulse width falls below 25 ns. For such settings, an error message is displayed.

When the pulse width is 100 ns or less, jitter becomes relatively larger compared with the pulse width, and a warning message is displayed.

If the pulse width falls below 25 ns, pulses may disappear.

If the pulse width falls below 100 ns, jitter becomes relatively larger compared with the pulse width.
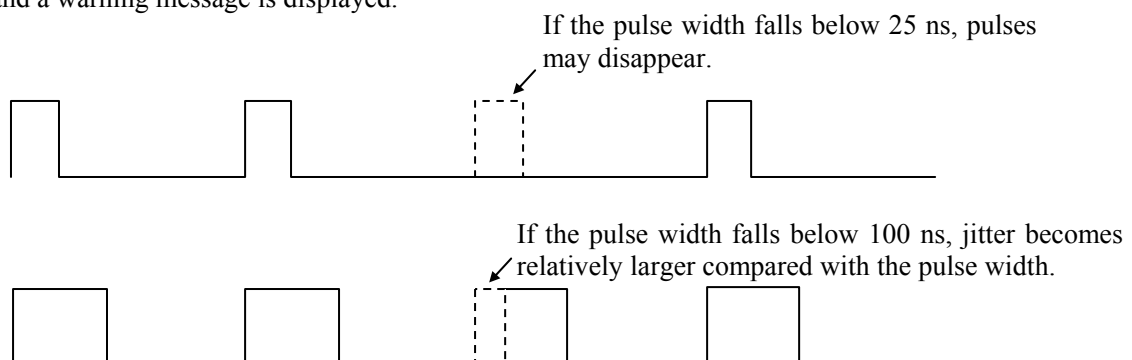
If the phase of the ⊓̲ squarewaves (fixed duty) or ⊓̲ squarewaves (variable duty) is changed, multiple pulses may be output in one cycle, as shown below.
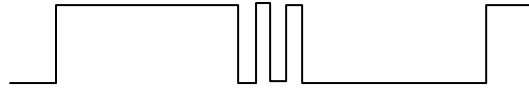
If the duty of the ⊓̲ squarewaves (variable duty) is changed, multiple pulses may be output in one cycle, as shown below.
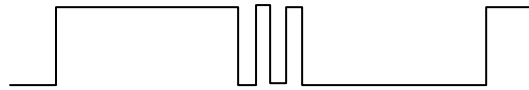
If the pulse width is larger than 75 ns after the duty is changed, it is possible to suppress the output of multiple pulses in one cycle.   Therefore, set DUTY-VALID to CYCLE.
Note, however, that this setting cannot be made if the oscillation mode is SWEEP or MODU.

```
┌─────────────────────────────────────────────────┐
│ I MMED   C Y C L E   E X P A N D                  │
│ S Y S T E M : ◄  Φ S Y N C  D U T Y ─ V A L I D  ► │
└─────────────────────────────────────────────────┘
```

If DUTY-VALID is set to CYCLE, the set duty will be reflected in the subsequent cycles.
Even though DUTY-VALID is set to CYCLE, extra pulses may be output if the frequency or phase is changed.

Operation when DUTY-VALID: IMMED

The setting will be reflected at the same time that the duty changes

Operation when DUTY-VALID: CYCLE

Duty change   The setting will be reflected in the subsequent cycles
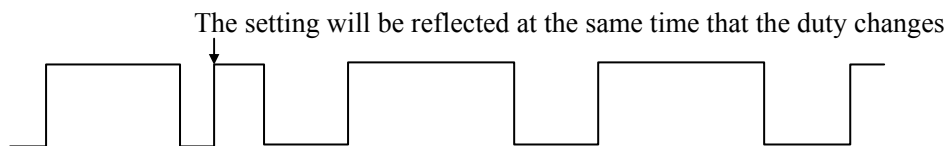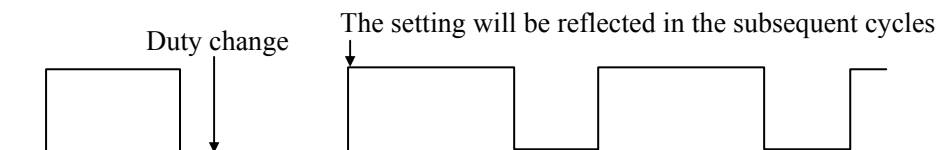
・ In ⌐_ squarewaves (variable duty), the duty range can be switched to 0.0000% to 100.0000% or 0.0100% to 99.9900%.   To set a duty in the range from 0.0000% to 100.0000%, set DUTY-VALID to EXPAND.

```
IMMED  CYCLE  EXPAND
SYSTEM:◄  ΦSYNC  DUTY−VALID  ►
```

It is not possible to set CYCLE and EXPAND simultaneously.

If DUTY-VALID is set to IMMED or CYCLE, the range in which the duty can be set is 0.0100% to 99.9900%.   When the frequency is about 4 kHz or less, pulse losses can be prevented by restricting the duty range to 0.0100% to 99.9900%.

The waveform cannot be selected in the following cases.

・ Oscillation mode is NOISE or DC.

■ **Frequency setting ($\overset{\text{ENTRY}}{\square} \rightarrow \overset{\text{FREQ}}{\square}$)**

Frequency (FREQ) setting is described.

Operation:

Two methods can be used for setting the frequency.

(1) Keypad

This method is convenient when the frequency has been determined beforehand.

For example, set 1 kHz as follows.

① Press the $\overset{\text{ENTRY}}{\square}$ key, then the $\overset{\text{FREQ}}{\square}$ key.

Frequency

```
  1 0 0 0 . 0 0 0 0 0 0 0 0   H z
A 0 . 1 0 0 0 V p－p   O＋0 . 0 0 0 0 V   ／O P E N
```

Amplitude   DC offset
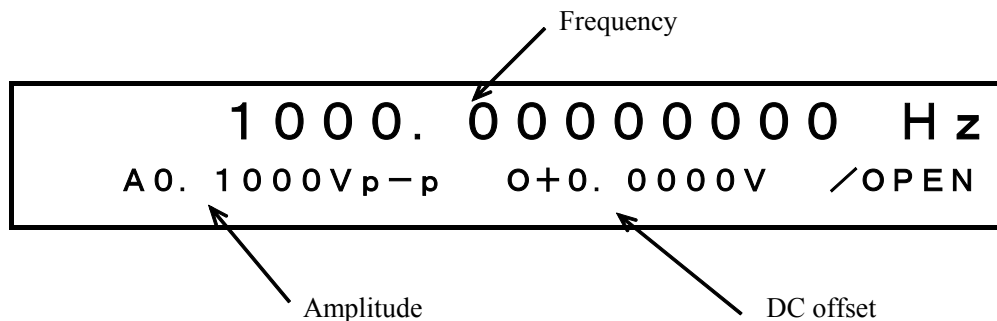
② Press the $\boxed{1}$ key, then the $\boxed{k}$ key.

If the number was entered incorrectly, press the $\overset{}{\underset{\text{BS}}{\square}}$ key before pressing the $\boxed{k}$ key.

③ After setting, press the $\overset{\text{EXIT}}{\square}$ key to exit the setting mode.

(2) Modify dial

This is convenient for continuously setting the frequency.

① Press the $\overset{\text{ENTRY}}{\square}$ key, then the $\overset{\text{FREQ}}{\square}$ key.

② Select the digit to be changed with the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys. The selected digit flashes.

③ Turn the $\overset{\text{MODIFY}}{\bigcirc}$ dial to set the digit.

④ After setting, press the $\overset{\text{EXIT}}{\square}$ key.

Other:

・ The frequency cannot be set in the **NOISE** or **DC** oscillation modes.

・ When keys such as $\boxed{k}$ are not being used for industrial units (e.g., 50 Hz), press the $\overset{\text{ENTER}}{\square}$ key directly after entering the frequency. ☞ 5.2 Units

・ The frequency generating period can also be set.

☞ 5.1 Convenient Settings (■Frequency [Hz] setting by period [s])

■ **Amplitude setting (** ⌐ENTRY⌐ → ⌐AMPTD⌐ **)**

Amplitude (AMPTD) setting is described.

Operation:

The amplitude can be set by two methods.

(1) Keypad

Convenient when the amplitude has been determined beforehand.

For example, set 2 Vp-p as follows.

① Press the ⌐ENTRY⌐ key, then the ⌐AMPTD⌐ key.
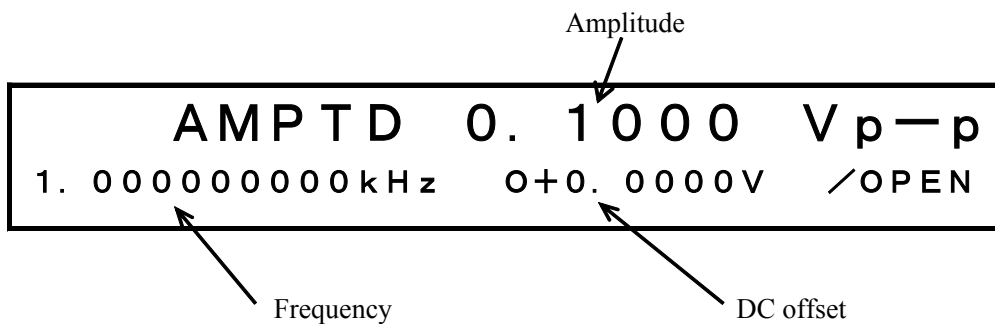
The following display is produced.

Amplitude

```
┌─────────────────────────────────────────────┐
│   AMPTD   0. 1000   Vp−p                      │
│ 1. 000000000kHz    O+0. 0000V   ╱OPEN         │
└─────────────────────────────────────────────┘
```

Frequency   DC offset

② Press the ⌐2⌐ key, then the ⌐ENTER⌐ key.

To correct an entry, press the ⌐BS⌐ key before pressing ⌐ENTER⌐ key.

③ This completes setting, afterwards, press the ⌐EXIT⌐ key.

(2) Modify dial

The amplitude can be changed continuously.

① Press the ⌐ENTRY⌐ key, then the ⌐AMPTD⌐ key.

② Select the digit to be changed with the ⌐◁⌐ and ⌐▷⌐ keys.

③ Turn the ⌐MODIFY⌐ dial to set the flashing digit.

④ After setting, press the ⌐EXIT⌐ key to release the setting mode.

Other:

・ When the oscillation mode is DC, the amplitude cannot be set.

・ Units other than Vp-p can also be set. ☞ 5.2 Units

・ Can also be set by waveform high level and low level.

☞ 5.1 Convenient Settings (■Amplitude and DC offset setting by high and low level)

■ DC offset setting ($\overset{\text{ENTRY}}{\Box}$ → $\overset{\text{OFFSET}}{\Box}$)

DC offset determines the offset component added to the waveform or the output voltage when the oscillation mode is DC.

Setting the DC offset (OFFSET)is described.

Operation:

Two methods can be used for setting the DC offset.

(1) Keypad

Convenient when the DC offset has been determined beforehand.

For example, set +1 V as follows.

① Press the $\overset{\text{ENTRY}}{\Box}$ key, then the $\overset{\text{OFFSET}}{\Box}$ key.
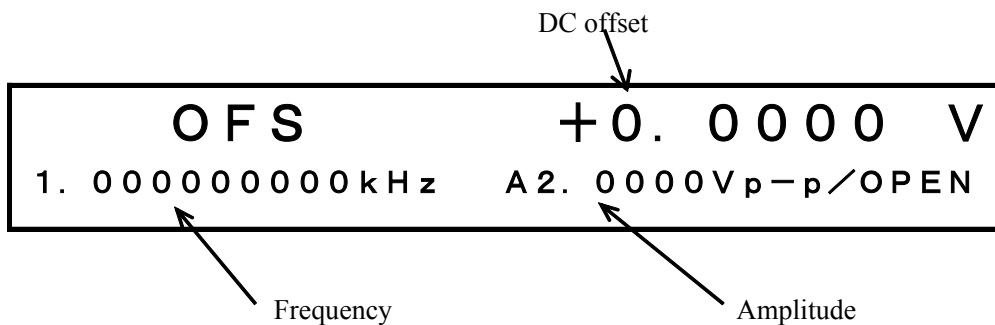
The following display is produced.

DC offset

```
  OFS          +0. 0000  V
1. 000000000kHz  A2. 0000Vp-p／OPEN
```

Frequency   Amplitude

② Press the $\boxed{1}$ key, then the $\overset{\text{ENTER}}{\Box}$ key.

To correct an entry, press the $\overset{}{\underset{\text{BS}}{\Box}}$ key before pressing $\overset{\text{ENTER}}{\Box}$.

③ This completes setting, afterwards, press the $\overset{\text{EXIT}}{\Box}$ key.

(2) Modify dial

The offset can be changed continuously.

① Press the $\overset{\text{ENTRY}}{\Box}$ key, then the $\overset{\text{OFFSET}}{\Box}$ key.

② Select the digit to be changed with the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys.

③ Turn the $\overset{\text{MODIFY}}{\circledcirc}$ dial to set the flashing digit.

④ After setting, press the $\overset{\text{EXIT}}{\Box}$ key to release the setting mode.

Other:

・ Can also be set by waveform high level and low level.

☞ 5.1 Convenient Settings (■Amplitude and DC offset setting by high and low level)

■ **Phase setting (** $\overset{\text{ENTRY}}{\Box}$ → $\overset{\text{PHASE}}{\Box}$ **)**

The oscillation starting phase setting for burst and (gated) sweep is described.

Set CH1 and CH2 independently to also allow setting the phase difference between these channels.

☞ 5.4 Other settings (■Phase sync)

Operation:

Two methods can be used for setting the phase.

(1) Keypad

Convenient when the phase has been determined beforehand.

For example, set 90 degrees as follows.

① Press the $\overset{\text{ENTRY}}{\Box}$ key, then the $\overset{\text{PHASE}}{\Box}$ key.

The following display is produced.
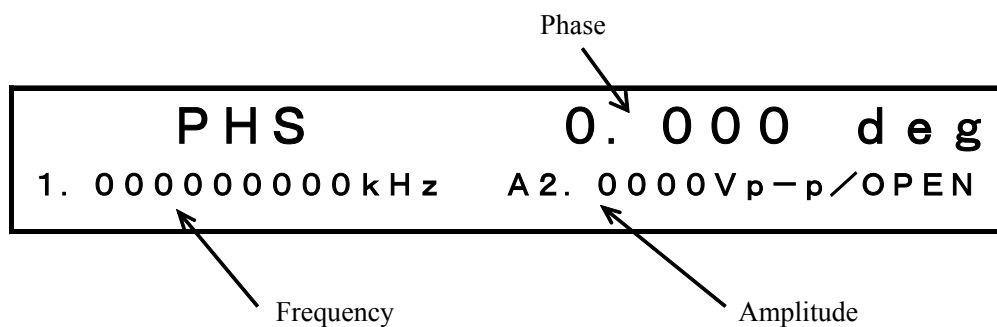
Phase

```
PHS            0. 000  deg
1. 000000000kHz  A2. 0000Vp-p／OPEN
```

Frequency   Amplitude

② Press keys ⟨ 9 ⟩ and ⟨ 0 ⟩ , then the $\overset{\text{ENTER}}{\Box}$ key.

To correct an entry, press the $\underset{\text{BS}}{\Box}$ key before pressing $\overset{\text{ENTER}}{\Box}$.

③ This completes setting, afterwards, press the $\overset{\text{EXIT}}{\Box}$ key.

(2) Modify dial

The phase can be changed continuously.

① Press the $\overset{\text{ENTRY}}{\Box}$ key, then the $\overset{\text{PHASE}}{\Box}$ key.

② Select the digit to be changed with the ⟨◁⟩ and ⟨▷⟩ keys.

③ Turn the $\overset{\text{MODIFY}}{\circledcirc}$ dial to set the flashing digit.

④ After setting, press the $\overset{\text{EXIT}}{\Box}$ key to release the setting mode.

■ Output on/off

Output on/off setting is described.

Operation:

① Press the $\overset{\text{CH 1 OUT}}{\underset{\text{ON/OFF}}{\boxed{}}}$, $\overset{\text{CH 2 OUT}}{\underset{\text{ON/OFF}}{\boxed{}}}$ key.   The setting alternates between on and off each time the key is pressed.

The lamp lights when on, extinguishes when off.

Other:

When the channel mode is DIFF and the selected channel is not BOTH CH1 and BOTH CH2, each channel operates independently.

When the channel mode is DIFF and the selected channel is BOTH CH1 or BOTH CH2, the channel outputs are coupled (i.e., by operation of either CH1 OUT or CH2 OUT, both channel outputs are set on/off).

■ **Operation tree**

CH 1 OUT   CH 2 OUT
⬚ , ⬚ —— Output on/off
ON/OFF   ON/OFF

⬚ —— Channel mode [INDEP/2PHASE/2TONE/RATIO/DIFF]
CHANNEL MODE

⬚ —— Channel selection [CH 1/CH 2/BOTH CH1/BOTH CH2]
CH 1/CH 2

MODE
⬚ —— Oscillation mode
         NORMAL   BURST   SWEEP   MODU   NOISE   DC
          ⬚ / ⬚ / ⬚ / ⬚ / ⬚ / ⬚

BURST
⬚   Menu
    — TYPE (Burst type) [BURST/TRIG/GATE/T-GATE]
    — SOURCE (Trigger/gate source selection)
    — DELAY (Trigger delay)   * For TYPE: TRIG
    — MARK (Number of cycles signal present)   * For TYPE: BURST/TRIG
    — SPACE (Number of cycles signal not present)   * For TYPE: BURST
    — STOP-LEVEL (Stop level)
    — OPER-COMMON (Simultaneous operation of both channels)
        * When the same TYPE is set for both channels

BURST
⬚   Operation
        ⬚
       MAN TRIG

SWEEP
⬜ Menu

— TYPE (Sweep target) [FREQ/PHASE]

— SOURCE (Trigger source selection)   * For MODE: SINGLE/GATED

— MODE (Sweep mode) [SINGLE/CONT/GATED]

— FUNCTION (Sweep waveform) [LIN/LOG, ∧/⋀/⌐/SIN]

— START (Sweep start value)

— STOP (Sweep end value)

— TIME (Sweep time)

— STOP-LEVEL (Stop level)   * For MODE: GATED

— CENTER (Sweep center value)

— SPAN (Sweep width)

— START-STATE (Start state)

— STOP-STATE (Stop state)

— OPER-COMMON (Simultaneous operation of both channels)

　* When sweeping both channels

SWEEP
⬜ Operation
　└ ⬜ / ⬜ / ⬜
　　START / STOP / PAUSE

MODU
⬜ Menu (Internal modulation)

— TYPE (Modulation type) [FM/PM]

— DEVIATION (Deviation)

— FREQ (Modulation frequency)

— FUNCTION (Modulated waveform) [SIN/∧/⊓/⋀/⟍]

— OPER-COMMON (Simultaneous operation of both channels)

　* When modulating both channels

MODU
⬜ Operation
　└ ⬜ / ⬜
　　START / STOP

ENTRY
⬜ —— Main operation
　└ ⬜ / ⬜ / ⬜ / ⬜ / ⬜ / ⬜ / ⬜ / ⬜ / ⬜ /
　　FREQ / AMPTD / OFFSET / PHASE / DUTY / WIDTH / PERIOD / HIGH / LOW /

　　⬜ / ⬜
　　△FREQ / RATIO

　　　　　　　* DUTY/WIDTH for FUNCTION: ⌐
　　　　　　　△FREQ is for CHANNEL MODE: 2TONE
　　　　　　　RATIO is for CHANNEL MODE: RATIO

3.3 Basic operation

FUNCTION ⬜ —— Waveform selection

⌒ / ⌒⌒ / ⬓ / ◿ / ◺ / ARB / ⬒

ARB EDIT ⬜ Arbitrary waveform menu   * For FUNCTION: ARB

—— SELECT (Select arbitrary waveform)

—— NAME (Arbitrary waveform name)

—— EDIT (Edit arbitrary waveform)

—— COPY (Copy arbitrary waveform)

—— MARK-CLEAR (Clear mark)

—— CLEAR (Clear arbitrary waveform)

—— SIZE (Select arbitrary waveform data size)

SYSTEM ⬜ —— Other operation menus

—— RANGE (Select output range) [AUTO/10V/1V]

—— PRESET (Initialization)

—— USER-UNIT (User-unit menu)

　　　—— TYPE (Setting target) [FREQ/PERIOD/AMPTD/OFFSET/PHASE/DUTY]

　　　—— NAME (Unit name)

　　　—— FORMULA (Formula)

　　　—— SCALE (Multiplier)

　　　—— OFFSET (Offset)

—— LOAD (LOAD function)

—— COPY 1 → 2 (Copy a setting)

—— COPY 2 → 1 (Copy a setting)

—— φ SYNC (Phase synchronization)

—— DUTY-VALID (Duty)

—— POWER-ON (Output state selection at power-on)

—— REMOTE (Remote control menu)

　　　—— INTERFACE (Interface)

　　　—— ADDRESS/ID (GPIB address/USB ID)

　　　—— DELIMITER (GPIB delimiter)

MEMORY
☐ Setup memory menu
├── STORE (Save setup memory)
├── RECALL (Call setup memory)
└── CLEAR (Clear setup memory)

☐
LOCAL   (Release remote state)

UNDO
☐   (Cancel setting)

EXIT
☐   (Move to menu immediately above)

ENTER
☐   (Accept input value)

Numeric input (keypad)

[+/-] / [·] / [0] / [1] / [2] / [3] / [4] / [5] / [6] / [7] /

[8] / [9] / [M] / [μ] / [k] / [m] / ☐
                                              BS

Numeric modification (Modify)

MODIFY
[◁] / [▷] / ◎

Section 4   Applications

・Following is an example of the display when using this section.

Fully lighted (bold)   Dimly lighted

```
BURST   TRIG  GATE  ▶
BURST: TYPE  MARK SPACE STOP—LEVEL
```

Fully lighted   Flashing   Dimly lighted
(bold)

4.1 Burst oscillation

■ **Burst oscillation (Type: Burst) (** $\overset{\text{MODE}}{\Box} \rightarrow \overset{\text{BURST}}{\Box} \rightarrow$ **TYPE : BURST)**

Burst oscillation (Type: Burst) produces an intermittent oscillation at the designated oscillation cycle and stop cycle.

Operation is described with reference to an example of producing a waveform output such as indicated in the figure.

In this example, the waveform is triangular, the DC offset is set to 0 V, the oscillation start phase is set to 0 degrees, and the frequency and amplitude are set to arbitrarily defined values.
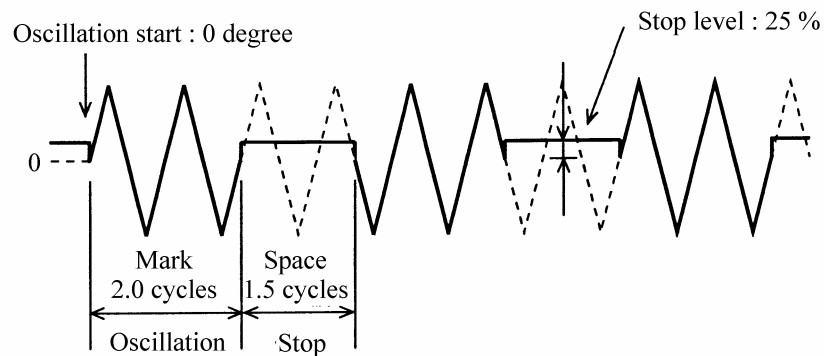
Operation:

(1) Set the burst oscillation TYPE to BURST.

① Press the $\overset{\text{MODE}}{\Box}$ key, then the $\overset{\text{BURST}}{\Box}$ key.

② Use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to select the type (TYPE flashes).

```
┌─────────────────────────────────────────┐
│ B U R S T   T R I G   G A T E   ▶        │
│ B U R S T : TYPE  MARK  SPACE  STOP—LEVEL │
└─────────────────────────────────────────┘
```

③ Press the $\overset{\text{ENTER}}{\Box}$ key, then produce the following display with the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys (BURST flashes).

```
┌─────────────────────────────────────────┐
│ BURST   T R I G   G A T E   ▶            │
│ B U R S T : T Y P E  MARK  SPACE  STOP—LEVEL │
└─────────────────────────────────────────┘
```

④ This sets the burst oscillation type to burst. Press the $\overset{\text{EXIT}}{\Box}$ key once to exit type setting.

(2) Set MARK cycle

① Use the ◁ and ▷ keys to produce the following display (MARK flashes).

```
                                    1 . 0   c y c l e
B U R S T : T Y P E  MARK  S P A C E  S T O P — L E V E L
```

② Press the ENTER key.

③ Set the mark cycles with the keypad or ⊚ MODIFY dial (0.5 cycles).

   In this example, the setting is 2.0 cycles.

④ After setting, press the EXIT key once to exit mark cycle setting.

(3) Set SPACE cycle

① Use the ◁ and ▷ keys to produce the following display (SPACE flashes)

```
                                    1 . 0   c y c l e
B U R S T : T Y P E  M A R K  SPACE  S T O P — L E V E L
```

② Press the ENTER key.

③ Set the space cycles with the keypad or ⊚ MODIFY dial (0.5 cycles). In this example, the setting

   is 1.5 cycles.

④ After setting, press EXIT once to release space cycle setting.

(4) Set STOP-LEVEL

① Use the ◁ and ▷ keys to produce the following display (STOP-LEVEL flashes).

```
O F F
B U R S T : T Y P E  M A R K  S P A C E  STOP—LEVEL
```

② Press the $\boxed{\text{ENTER}}$ key.

Turn the $\underset{\text{MODIFY}}{\bigcirc}$ dial to produce the following display (ON flashes).

```
┌─────────────────────────────────────────────────┐
│ ┌──┐                                             │
│ │ON│                              0. 00   %      │
│ └──┘                                             │
│ BURST : TYPE  MARK  SPACE  STOP─LEVEL            │
└─────────────────────────────────────────────────┘
```

③ Press the $\boxed{\triangleright}$ key, then set the stop level with the keypad or $\underset{\text{MODIFY}}{\bigcirc}$ dial.

   In this example, the setting is 25 %.

The stop level is the percentage with respect to the maximum positive (+100 %) and negative (-100 %) amplitude.

④ After setting, press the $\boxed{\text{EXIT}}$ key to release the setting mode.

This completes burst oscillation (type: burst) setting.

Other:

• If the frequency exceeds 5 MHz, mark cycles and space cycles may be unpredictable.
  If the cycles are undefined, the start phase may be shifted by half a cycle even though the frequency is set to less than 5 MHz. If such a shift occurs, set the continuous oscillation and then the burst oscillation.

• Stop level off: Oscillation stops at the phase (set by $\boxed{\text{ENTRY}}$ → $\boxed{\text{PHASE}}$) setting (mark cycles more than 1.0 and mark + space cycles are integers).

Waveform example of oscillation start phase:-90°, mark waves:2, space waves:1

Oscillate 2 waves   Stop 1 wave
Oscillation start
Start phase: -90°
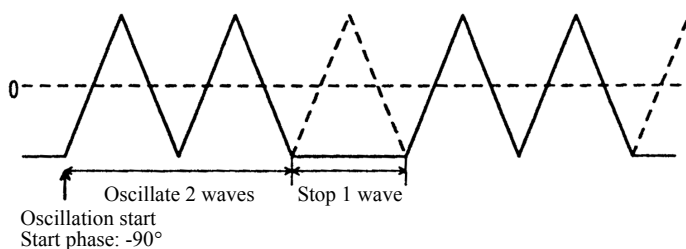
*Also, by setting an amplitude (Vp-p) 1/2 DC offset or the low level to 0 V, a unipolar waveform can be obtained.

☞ 5.1 Convenient Settings (■Amplitude and DC offset setting by high and low level)

• Burst oscillation setting items (BURST menu)
  TYPE: BURST
  MARK (oscillation cycle) [cycle]
  SPACE (cycle when oscillation stops) [cycle]
  STOP-LEVEL [OFF, ON[%]]
  PHASE (phase when oscillation starts) [deg] * ENTRY menu

■ **Burst oscillation (Type: Trigger) (** <u>MODE</u>◯ → <u>BURST</u>◯ → **TYPE : TRIG)**

Burst oscillation (Type: Trigger) produces an intermittent oscillation output at a designated cycle at each trigger signal.

Operation is described with reference to an example of producing a waveform output such as indicated in the figure in response to an external trigger (⌐).

The example is a triangular waveform, DC offset 0 V, frequency and amplitude arbitrary.
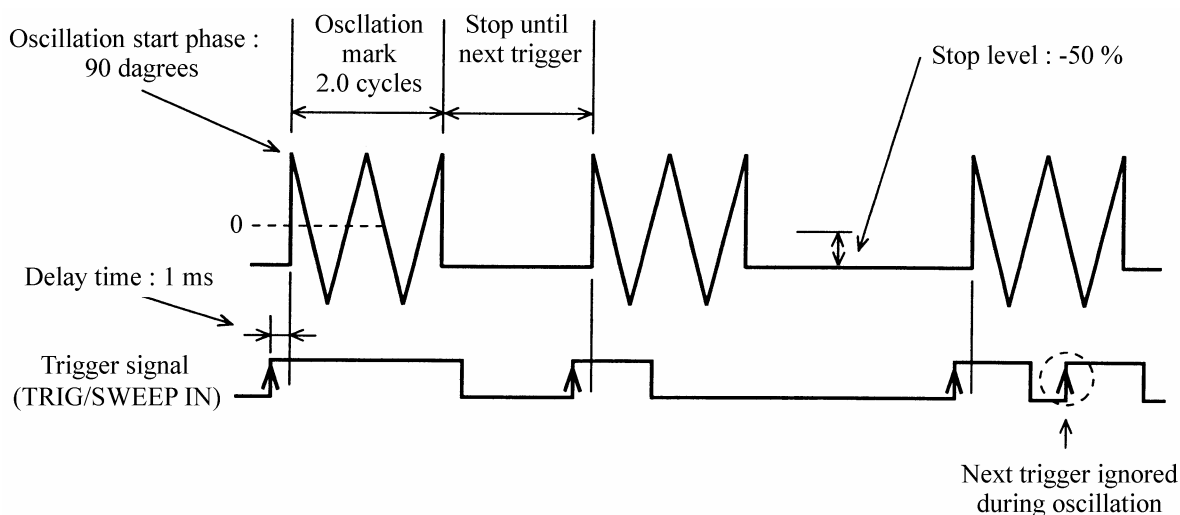
Operation:

(1) Set the burst oscillation TYPE to TRIG.

① Press the <u>MODE</u>◯ key, then the <u>BURST</u>◯ key.

② Use the ◁ and ▷ keys to select the type (TYPE flashes).

③ Press the ENTER◯ key, then produce the following display with the ◁ and ▷ keys (TRIG flashes).

④ This sets the burst oscillation type to trigger. Press the EXIT◯ key to exit type setting.

(2) Select trigger SOURCE

① Use the ◁ and ▷ keys to produce the following display (SOURCE flashes).

```
┌─────────────────────────────────────────────────┐
│                                                   │
│   E X T                      ─────┐               │
│                                   ↓___            │
│                                                   │
│   T R I G : T Y P E  │SOURCE│  D E L A Y  M A R K  ▸  │
│                                                   │
└─────────────────────────────────────────────────┘
```

② Press the ⎢ENTER⎥ key.
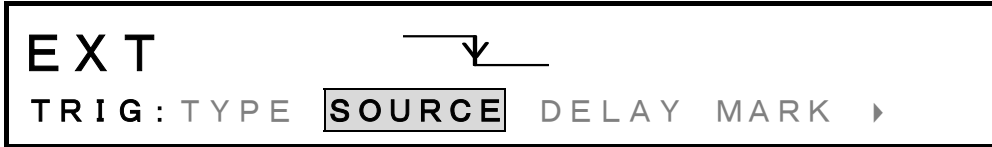
③ Press the ▷ key, then turn the ◎ MODIFY dial to select rising trigger (_⌐).

(¬_ indicates falling trigger).

④ After setting, press ⌐EXIT once to release trigger source setting.

(3) Set DELAY time

① Use the ◁ and ▷ keys to produce the following display (DELAY flashes).

```
┌─────────────────────────────────────────────────┐
│                                                   │
│                                  0 . 3 μ s        │
│                                                   │
│   T R I G : T Y P E  S O U R C E  │DELAY│  M A R K  ▸  │
│                                                   │
└─────────────────────────────────────────────────┘
```

② Press the ⎢ENTER⎥ key.

③ Set the delay time with the keypad or ◎ MODIFY dial.

For example, set to 1 ms.

④ After setting, press ⌐EXIT once to release delay time setting.

(4) Set MARK cycle

① Use the ◁ and ▷ keys to produce the following display (MARK flashes).

```
                              1 . 0   c y c l e
T R I G : T Y P E   S O U R C E   D E L A Y   MARK   ▸
```

② Press the ENTER key.

Set the mark cycles with the keypad or ◎ MODIFY dial (0.5 cycles).

In this example, the setting is 2.0 cycles.

③ After setting, press EXIT once to release mark cycle setting.

(5) Set STOP-LEVEL

① Use the ◁ and ▷ keys to produce the following display (STOP-LEVEL flashes).

```
O F F
T R I G : ◂   STOP—LEVEL
```

② Press the ENTER key.

Turn the ◎ MODIFY dial to produce the following display (ON flashes).

```
O N                           0 . 0 0   %
T R I G : ◂   S T O P — L E V E L
```

③ Press the ▷ key, then set the stop level with the keypad or ◎ MODIFY dial.

In this example, the setting is -50 %.

The stop level is the percentage with respect to the maximum positive (+100 %) and negative (-100 %) amplitude.

④ After setting, press the EXIT key to release the setting mode.

(6) Phase setting

① Press the ⌷ (ENTRY) key, then the ⌷ (PHASE) key

② Set the phase with the keypad or ◎ (MODIFY) dial.

For example, set the phase to 90 degrees.

③ After setting, press the ⌷ (EXIT) key to release the setting mode.

The above sets burst oscillation (type: trigger).   Oscillation is produced when a signal (⌐) is applied to the TRIG/SWEEP IN connector.

Additional information:

• **Internal trigger** : The trigger signal is produced at the rate indicated below for oscillation start/stop. The trigger rate is common for CH1 and CH2.

```
I N T              ⌐    1 . 0 0 0 m s
TRIG: TYPE  SOURCE   DELAY  MARK  ▸
```
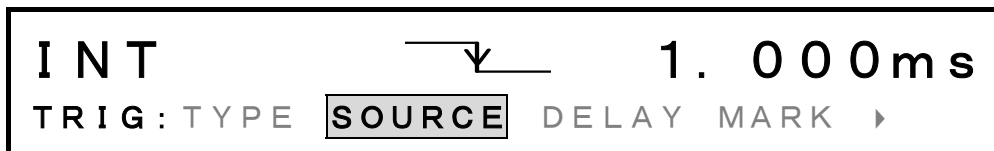
• **Stop level off**   : Oscillation stops at the phase (set by ⌷ (ENTRY) → ⌷ (PHASE)) setting (mark cycle is integer).

• **Manual trigger**   : Press the ⌷ (MAN TRIG) key, then set the trigger source to EXT ⌐.   Operation is based on the logical OR of the external signal, key, and type of remote control (GPIB or USB).

• **To generate the trigger signal via remote control (GPIB or USB),** set the GET command or TRG command from the remote control interface.
Also, set the trigger source to EXT ⌐.

For details of the remote control command, ☞ Remote Control Instruction Manual.

• **To simultaneously generate a trigger signal for both channels manually or via remote control (GPIB or USB)**, set Type for both channels to Trigger and set OPER-COMMON to on.

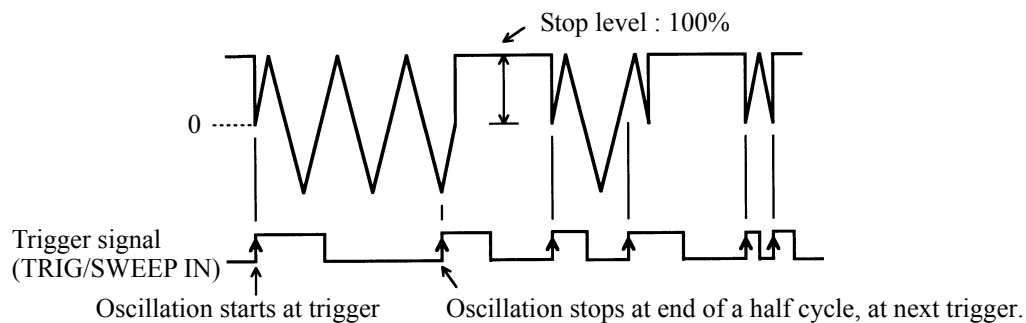If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
OFF   ON

TRIG: ◄  STOP—LEVEL  OPER−COMMON
```

• Burst oscillation (type: trigger) setting items (BURST menu)

    TYPE: TRIG

    SOURCE (trigger source) CH1: [EXT ⌐↓, EXT ↑⌐, INT ⌐↓ [s], INT ↑⌐ [s]]

                                   CH2: [EXT CH2 ⌐↓, EXT CH2 ↑⌐, EXT CH1 ⌐↓,

                                              EXT CH1 ↑⌐, INT ⌐↓ [s], INT ↑⌐ [s]]

    DELAY (trigger delay) [s]

    MARK (oscillation cycle) [cycle]

    STOP-LEVEL [OFF, ON[%]]

    OPER-COMMON (trigger in both channels) [OFF, ON]

    PHASE (phase when oscillation starts) [deg] * ENTRY menu

■ Burst oscillation (Type: Gate) (MODE → BURST → TYPE : GATE)

Burst oscillation (Type: Gate) is intermittent with start and stop according to the trigger signal level.

Operation is described with reference to an example of producing a waveform output such as indicated in the figure in response to an external gate signal.

The example is a triangular waveform, DC offset 0 V, oscillation start phase 0 degrees, frequency and amplitude arbitrary.

Gate signal (TRIG/SWEEP IN)

Oscillation starts at gate signal high level.

Oscillation stops at end of a half cycle, when gate signal is low level
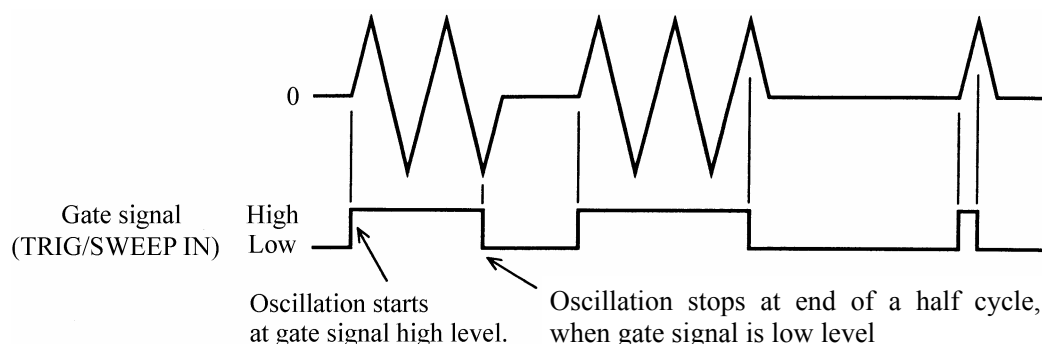
Operation:

(1) Set burst oscillation TYPE to GATE.

① Press the ⬚ (MODE) key, then the ⬚ (BURST) key.

② Use the ◁ and ▷ keys to produce the following display (TYPE flashes).

```
BURST  TRIG  GATE  ▶
BURST:|TYPE| MARK  SPACE  STOP—LEVEL
```

③ Press the ENTER key, then produce the following display with the ◁ and ▷ keys (GATE flashes).

```
BURST  TRIG  GATE  ▶
GATE:TYPE  SOURCE  STOP—LEVEL
```

④ This sets the burst oscillation type for gate.
Press the EXIT key once to release the type setting mode.

**(2) Select gate SOURCE**

① Use the ◁ and ▷ keys to produce the following display (SOURCE flashes).

```
EXT        L—ON
GATE:TYPE  |SOURCE|  STOP—LEVEL
```

② Press the ENTER key.

③ Press the ▷ key, then select positive logic (H-ON) with the ◎ (MODIFY) dial.

④ After setting, press the EXIT key to release the setting mode.

(3) Set STOP-LEVEL

① Use the ◁ and ▷ keys to produce the following display (STOP-LEVEL flashes).

```
┌────────────────────────────────────────────┐
│ O F F                                        │
│ G A T E :  T Y P E   S O U R C E   STOP−LEVEL│
└────────────────────────────────────────────┘
```

② Press the ENTER key.

Turn the MODIFY dial to produce the following display (ON flashes).

```
┌────────────────────────────────────────────┐
│ O N                          0 .  0 0   %   │
│ G A T E :  T Y P E   S O U R C E   STOP−LEVEL│
└────────────────────────────────────────────┘
```

③ Press the ▷ key, then set the stop level with the keypad or MODIFY dial.

In this example, the setting is 0 %.

The stop level is the percentage with respect to the maximum positive (+100 %) and negative (-100 %) amplitude.

④ After setting, press the EXIT key to release the setting mode.

The above selects sets burst oscillation (type: gate). Oscillation occurs when a high level signal is applied to the TRIG/SWEEP IN connector. If the connection is open, oscillation continues due to internal pullup.

Other settings:
• At the above settings, when the waveform is squarewave, a three-state squarewave is obtained such as shown in the following figure.
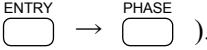
(When stop level is off, the oscillation stops at either high or low level.)

• **Internal gate source**   : A 50 % duty gate signal is generated at the following period for oscillation start/stop.
The gate rate is common for CH1 and CH2.

```
┌────────────────────────────────────────────┐
│ I N T        H − O N   1 .  0 0 0 m s       │
│ G A T E :  T Y P E   SOURCE   S T O P − L E V E L │
└────────────────────────────────────────────┘
```

• **Stop level off** : Oscillation stops at the half-cycle after gate signal off (i.e., at the phase set by
ENTRY → PHASE).

• **Manual gate signal** : Press the MAN TRIG key. The gate signal is on (i.e., oscillation) while the key is
pressed. In this case, set the trigger source for EXT L-ON.

• **To generate the trigger signal via remote control (GPIB or USB),** set the GET command or TRG
command from the remote control interface.
Also, set the trigger source to EXT L-ON.
For details of the remote control command, ☞ Remote Control Operation Manual.

• **To simultaneously generate a gate signal for both channels manually or via remote control
(GPIB or USB),** set Type for both channels to Gate and set OPER-COMMON to on.
If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
O F F    O N
G A T E :  ◀   O P E R — C O M M O N
```

• Burst oscillation (type: gate) setting items (BURST menu)
TYPE: GATE
SOURCE (trigger source)
CH1: [EXT L-ON, EXT H-ON, INT L-ON [s], INT H-ON [s]]
CH2: [EXT CH2 L-ON, EXT CH2 H-ON, EXT CH1 L-ON, EXT CH1 H-ON, INT L-ON [s],
INT H-ON [s]]
STOP-LEVEL (stop level) [OFF, ON [%]]
OPER-COMMON (simultaneous gate generation for both channels) [OFF, ON]
PHASE (phase when oscillation starts) [deg] * ENTRY menu

■ **Burst oscillation (Type: Triggered Gate) (** $\overset{\text{MODE}}{\bigcirc}$ → $\overset{\text{BURST}}{\bigcirc}$ → **TYPE : T-GATE)**

Burst oscillation (Type: Triggered Gate) is intermittent with repeated start and stop at each trigger signal.

Operation is described with reference to an example of producing a waveform output such as indicated in the figure in response to an external trigger ($\underline{\quad\rfloor\overline{\quad}}$).

The example is a triangular waveform, DC offset 0 V, oscillation start phase 0 degrees, frequency and amplitude arbitrary.

Stop level : 100%

0 ......

Trigger signal
(TRIG/SWEEP IN)

Oscillation starts at trigger   Oscillation stops at end of a half cycle, at next trigger.

Operation:

(1) Set burst oscillation TYPE to trig'd gate (T-GATE)

① Press the $\overset{\text{MODE}}{\bigcirc}$ key, then the $\overset{\text{BURST}}{\bigcirc}$ key.

② Use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (TYPE flashes)

```
BURST   TRIG  GATE  ▶
BURST: TYPE  MARK  SPACE  STOP—LEVEL
```

③ Press $\overset{\text{ENTER}}{\boxed{}}$ key, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (T-GATE flashes).

```
◀    T—GATE
T—GATE: TYPE  SOURCE  STOP—LEVEL
```

④ This sets the burst oscillation type for triggered gate.   Press the $\overset{\text{EXIT}}{\bigcirc}$ key once to release the type setting mode.

(2) Select trigger source (SOURCE)

① Use the ◁ and ▷ keys to produce the following display (SOURCE flashes).

```
EXT              ⌐⌐⌐↓⌐⌐
TRIG: TYPE  SOURCE  STOP—LEVEL
```
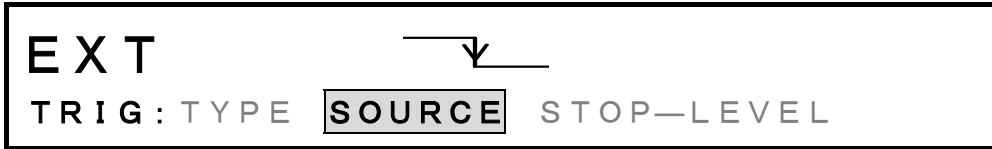
② Press the ENTER key.

③ Select rising (◿) using the MODIFY ◎ dial. (◿ indicates falling of the trigger signal)

④ After making a selection, press the EXIT key once to exit the trigger source selection.

(3) Set STOP-LEVEL

① Use the ◁ and ▷ keys to produce the following display (STOP-LEVEL flashes).

```
OFF
T—GATE: TYPE  SOURCE  STOP—LEVEL
```

② Press the ENTER key.

③ Turn the MODIFY ◎ dial to produce the following display (ON flashes).

```
ON                       0. 00  %
T—GATE: TYPE  SOURCE  STOP—LEVEL
```

④ Press the ▷ key, then set the stop level with the keypad or MODIFY ◎ dial.   For example, set to 100 %.

The stop level is the percentage with respect to the maximum positive (+100 %) and negative (−100 %) amplitude.

⑤ After setting, press the EXIT key to release the setting mode.

The above sets the burst oscillation (type: triggered gate).   Oscillation alternates between start and stop each time a signal (◿) is applied to the TRIG/SWEEP IN connector.

Other settings:

- **Stop level off** : Oscillation stops after the trigger signal is applied, at the end of a half cycle (i.e., at the phase set by $\overset{\text{ENTRY}}{\boxed{}}$ → $\overset{\text{PHASE}}{\boxed{}}$) or plus 180 degrees from that phase.

- **Manual trigger** : When a manual trigger signal is desired, press the $\underset{\text{MAN TRIG}}{\boxed{}}$ key. Oscillation starts and stops each time the key is pressed.

  However, produce the manual trigger signal after the oscillation has stopped.   If oscillation is from an external signal, oscillation will not stop even if the $\underset{\text{MAN TRIG}}{\boxed{}}$ key is pressed.
  Oscillation stops during power-on.

- **To generate the trigger signal via remote control (GPIB or USB),** set the GET command or TRG command from the remote control interface.
  Also, set the trigger source to EXT $\underline{\int}$.

  For details of the remote control command, ☞ Remote Control Instruction Manual.

- **To simultaneously generate a signal for both channels manually or via GPIB,** set Type for both channels to Trigger and set OPER-COMMON to on.
  If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
OFF  ▐ON▌

T−GATE: ◄   OPER−COMMON
```

- Burst oscillation (type: triggered gate) setting items (BURST menu)
  TYPE: T-GATE
  SOURCE (trigger source) CH1: [EXT $\overline{\backslash}\!\!\downarrow$, EXT $\underline{\int}$]

  　　　　　　　　　　　　CH2: [EXT CH2 $\overline{\backslash}\!\!\downarrow$, EXT CH2 $\underline{\int}$, EXT CH1 $\overline{\backslash}\!\!\downarrow$,

  　　　　　　　　　　　　　　　EXT CH1 $\underline{\int}$]

  STOP-LEVEL (stop level) [OFF, ON[%]]
  OPER-COMMON (trigger in both channels) [OFF, ON]
  PHASE (phase when oscillation starts)　* ENTRY menu

4.2 Sweep

■ **Sweep (Mode: Single) (** $\overset{\text{MODE}}{\square}$ → $\overset{\text{SWEEP}}{\square}$ → **MODE : SINGLE)**

In a Sweep (Mode: Single), oscillation occurs by varying parameters such as the frequency and amplitude one time between the start and stop settings.   Oscillation continues after the sweep is completed.

Operation to produce a waveform output with frequency that varies linearly and continuously is described. The setting example is a sinewave with arbitrary amplitude and DC offset.

Start frequency : 100Hz

Stop frequency : 1000Hz

Sweep time : 3 seconds
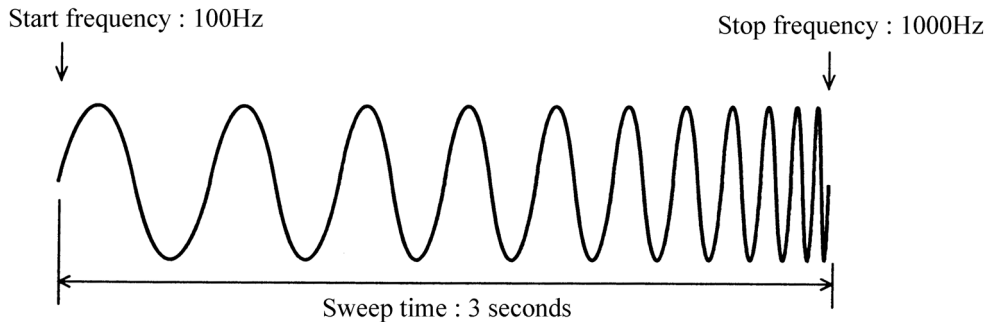
Operation:

(1) Set sweep MODE to SINGLE

① Press the $\overset{\text{MODE}}{\square}$ key, then the $\overset{\text{SWEEP}}{\square}$ key.

② Use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (MODE flashes).

```
SINGLE  CONT  GATED
F-SWP:TYPE SOURCE  MODE  ▸
```

③ Press $\overset{\text{ENTER}}{\square}$, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (SINGLE flashes).

```
SINGLE  CONT  GATED
F-SWP:TYPE SOURCE  MODE  ▸
```

④ This sets the sweep mode for single.   Press the $\overset{\text{EXIT}}{\square}$ key once to release mode select.

(2) Set the sweep TYPE to FREQ

① Use the ◁ and ▷ keys to produce the following display (TYPE flashes).

```
FREQ  PHASE
F−SWP:TYPE  SOURCE  MODE  ▶
```

② Press ENTER key, then use the ◁ and ▷ keys to produce the following display (FREQ flashes).

```
FREQ  PHASE
F−SWP:TYPE  SOURCE  MODE  ▶
```

③ This sets the sweep type for frequency.   Press the EXIT key once to release the type setting mode.

(3) Select sweep FUNCTION

① Use the ◁ and ▷ keys to produce the following display (FUNCTION flashes).

```
LIN    ╱⎯
F−SWP:◀  FUNCTION  START  STOP  ▶
```

② Press the ENTER key.

③ Press the ▷ key, then select ╱╲ with the MODIFY dial.

④ After selecting, press the EXIT key once to release the function select mode.

(4) Set START frequency
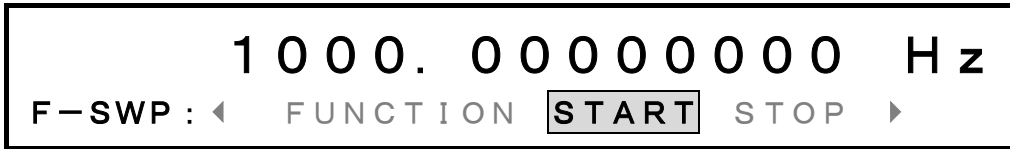
① Use the ◁ and ▷ keys to produce the following display (START flashes).

```
1 0 0 0 .  0 0 0 0 0 0 0 0   H z
F－SWP: ◀   FUNCTION  START   STOP   ▶
```

② Press [ENTER] key.

③ Set the start frequency with the keypad or (MODIFY) dial.

For example, set to 100 Hz.

④ After setting, press the [EXIT] key once to release the start frequency setting mode.

(5) Set STOP frequency

① Use the ◁ and ▷ keys to produce the following display (STOP flashes).

```
1 0 0 0 0 .  0 0 0 0 0 0 0 0   H z
F－SWP: ◀   FUNCTION  START   STOP   ▶
```

② Press [ENTER] key.

③ Set the stop frequency with the keypad or (MODIFY) dial.

For example, set to 1000 Hz.

④ After setting, press the [EXIT] key once to release the stop frequency setting mode.

(6) Set sweep TIME

① Use the ◁ and ▷ keys to produce the following display (TIME flashes).

```
                              1 . 0 0 0   s

F−SWP : ◀   TIME  CENTER  SPAN  ▶
```

② Press [ENTER] key.

③ Set the sweep time with the keypad or [MODIFY] dial.

For example, set to 3 seconds.

④ After setting, press the [EXIT] key once to release the sweep time setting mode.

(7) Sweep operation

① Sweep starts when the [START] key is pressed.

When sweep is started, an existing output frequency is quickly changed to the start frequency.   If desiring to set the start frequency output beforehand, press the [STOP] key.

The output quickly changes to the start frequency, then sweeps to the stop frequency in 3 seconds (in this example).   Oscillation then continues at the stop frequency.

When the [START] key is again pressed, sweep begins at the stop frequency and ends at the start frequency.

Other operations:

• **Sweep stop** : Press the [STOP] key.   When sweep is stopped at the stop value at single sweep

end or during sweep, press the [STOP] key to set the start value.

• **Sweep pause** : Press the [PAUSE] key.   Again press the [PAUSE] key to resume sweep.

• **Single sweep operation examples**
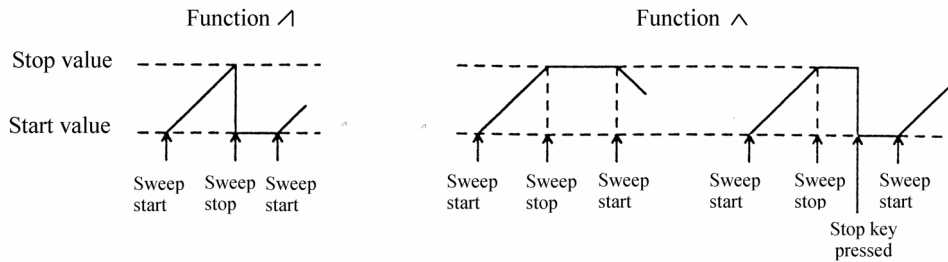
• **Dead time and trigger delay**

: Triggers input within 100 ms of completion of the last sweep are ignored.

The trigger delay for the first sweep after power-on or a parameter change is 40 ms.

Otherwise, it is 2 ms.
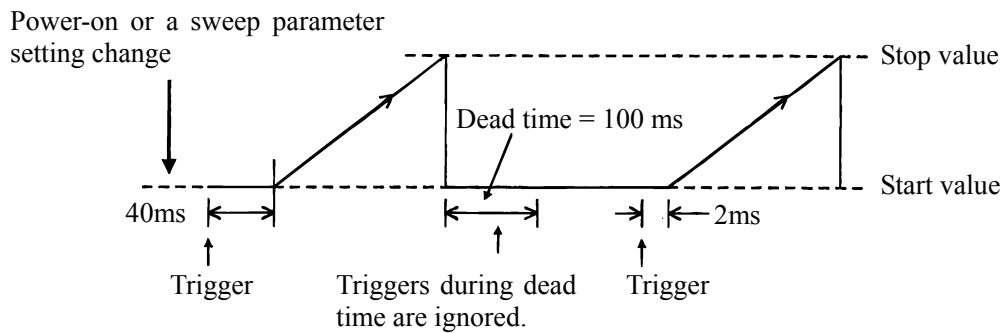
• **External sweep start**

: Set the sweep trigger source to EXT and select rising or falling.   Supply an

external signal to the front panel TRIG/SWEEP IN connector.   However, note that

retrigger cannot be applied for 100 ms after sweep start.

During a sweep, the sweep restarts if a trigger is input.

• **FUNCTION** determines the sweep type.

: For example, ⌐ provides step-type change of output (e.g., frequency) at the sweep time halfway

point.   LIN/LOG provides linear or logarithmic variation of the output with respect to the time axis.

- ╱| ⟵ LIN
  ╲ LOG

- ╱╲ ⟵ LIN
  ╲ LOG

- ⌐

- SIN (∿) ⟵ LIN
  ╲ LOG

• **Internal sweep trigger source**

: The trigger signal is generated at the following rate, then sweep is conducted. However, the trigger interval is 100 ms even if set to less.

The trigger rate is common for CH1 and CH2.

Trigger rate

```
┌─────────────────────────────────────────┐
│ I N T              ↴         1 0 0 . 0 m s │
│ F - S W P : T Y P E   SOURCE   M O D E   ▶ │
└─────────────────────────────────────────┘
```
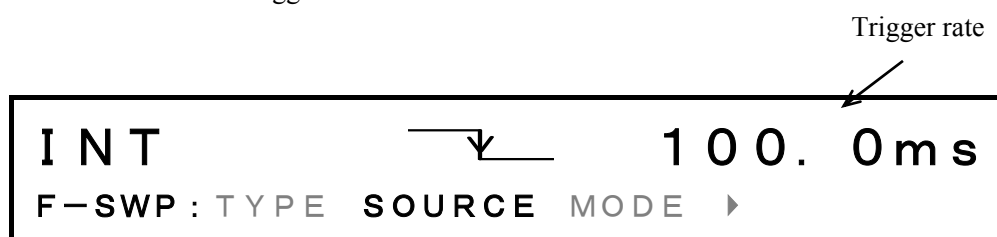
• **START-STATE and STOP-STATE** : Respectively set the output to start and stop values.

Since the sweep synchronization output becomes the respective start and stop states, the state of external equipment can be checked.   The Start-State is the same as pressing the

STOP key (during single sweep).

Relationship between sweep values and sweep synchronization output,

☞ 4.2 Sweep (■Sweep value and SYNC OUT).

• During sweep, if the oscillation mode of the other channel is changed, sweep stops.

• **To generate the trigger signal via remote control (GPIB or USB),** set the GET command or TRG command from the remote control interface.

For details of the remote control command, ☞ Remote Control Instruction Manual.

• **To simultaneously operate sweep (start, stop, pause, restart) for both channels manually or via remote control (GPIB or USB),** set both channels to sweep mode and set OPER-COMMON to on.

If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
┌─────────────────────────────────────────┐
│ O F F    ON                               │
│ F - S W P :  ◀   O P E R - C O M M O N    │
└─────────────────────────────────────────┘
```

■ Sweep (Mode: Continuous) ($\overset{\text{MODE}}{\bigcirc}$ → $\overset{\text{SWEEP}}{\bigcirc}$ → MODE : CONT)

In a Sweep (Mode: Continuous), oscillation occurs by varying parameters such as the frequency and amplitude continuously between the start and stop settings.

Operation is described for producing a waveform output with linear and continuously frequency.

The waveform is a sinewave with arbitrary Amplitude and DC offset.

Start frequency : 100Hz   Stop frequency : 1000Hz

Sweep time : 2 seconds
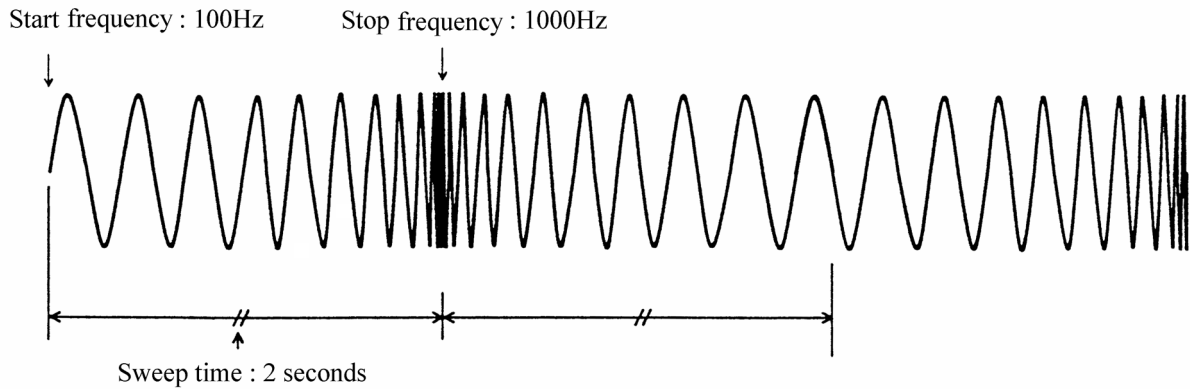
Operation:

(1) Set sweep MODE to continuous (CONT)

① Press the $\overset{\text{MODE}}{\bigcirc}$ key, then the $\overset{\text{SWEEP}}{\bigcirc}$ key.

② Use the ◁ and ▷ keys to produce the following display (MODE flashes).

```
S I N G L E    C O N T    G A T E D
F－SWP : T Y P E   S O U R C E   [MODE]   ▶
```

③ Press the $\boxed{\text{ENTER}}$ key, then use the ◁ and ▷ keys to produce the following display (CONT flashes).

```
S I N G L E   [C O N T]   G A T E D
F－SWP : T Y P E   MODE   F U N C T I O N   S T A R T   ▶
```

④ This completes setting the sweep mode to continuous. Press the $\overset{\text{EXIT}}{\bigcirc}$ key once to release the setting mode.

(2) Set sweep TYPE to frequency (FREQ)

① Use the ◁ and ▷ keys to produce the following display (TYPE flashes).

```
FREQ  PHASE
F-SWP: TYPE  MODE  FUNCTION  START  ▸
```

② Press the [ENTER] key, then use the ◁ and ▷ keys to produce the following display (FREQ flashes).

```
FREQ  PHASE
F-SWP: TYPE  MODE  FUNCTION  START  ▸
```

③ This completes setting the sweep type to frequency.　Press the [EXIT] key once to release the setting mode.

(3) Select the sweep FUNCTION

① Use the ◁ and ▷ keys to produce the following display (FUNCTION flashes).

```
LIN  ╱
F-SWP: TYPE  MODE  FUNCTION  START  ▸
```

② Press the [ENTER] key.

③ Press the ▷ key, then turn the ◎ MODIFY dial to select ∧ .

④ After selecting, press the [EXIT] key once to release the function select mode.

(4) Set the START frequency (START)

① Use the ◁ and ▷ keys to produce the following display (START flashes).

```
      1 0 0 0 . 0 0 0 0 0 0 0 0   H z
F－SWP : T Y P E   M O D E   F U N C T I O N   START   ▶
```

② Press the ENTER key.

③ Set the start frequency with the key pad or MODIFY dial.

For example, set to 100 Hz.

④ After setting, press the EXIT key once to release the start setting mode.

(5) Set the STOP frequency (STOP)

① Use the ◁ and ▷ keys to produce the following display (STOP flashes).

```
      1 0 0 0 0 . 0 0 0 0 0 0 0 0   H z
F－SWP : ◀   STOP   T I M E   C E N T E R   S P A N   ▶
```

② Press the ENTER key.

③ Set the stop frequency with the key pad or MODIFY dial.

For example, set to 1000 Hz.

④ After setting, press the EXIT key once to release the stop setting mode.

(6) Set the sweep TIME

① Use the ◁ and ▷ keys to produce the following display (TIME flashes).

```
                              1 . 0 0 0   s
F－SWP： ◀  STOP  TIME  CENTER  SPAN  ▶
```

② Press the [ENTER] key.

③ Set the sweep time with the key pad or ⊙ (MODIFY) dial.

For example, set to 2 seconds.

④ After setting, press the [EXIT] key once to release the sweep time setting mode.

(7) Sweep operation

① Press the [START] key, then sweep starts.

The output quickly changes to the sweep start frequency.

If desiring to set the start frequency output beforehand, press the [STOP] key.

Other operations:

• **Sweep stop** : Press the [STOP] key. This becomes the sweep start value.

• **Sweep pause** : Press the [PAUSE] key. To resume sweep, again press the [PAUSE] key.

• **FUNCTION** : The function determines the sweep type. For example, ⊓ provides step-type change of output (e.g., frequency) at the sweep time halfway point. LIN/LOG provides linear or logarithmic variation of the output with respect to the time axis.

• ╱ ⟨ LIN / LOG

• ⋀ ⟨ LIN / LOG

• ⊓

• SIN (∿) ⟨ LIN / LOG

• **START-STATE and STOP-STATE** : Set output to start and stop values, respectively. Since sweep synchronization output becomes the respective start and stop states, full-scale adjustments of the recorder and the status of external equipment can be checked. START-STATE is the same as pressing the ☐ STOP key (during a continuous sweep).

Relationship between sweep values and sweep synchronization output,

☞ 4.2 Sweep (■Sweep value and SYNC OUT).

• During sweep, if the oscillation mode of the other channel is changed, sweep stops.

• **To start, stop, pause, or restart a sweep operation on both channels simultaneously by manual operation or via remote control (GPIB or USB),** set both channels to sweep mode and set OPER-COMMON to on.

If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
OFF   ON
F-SWP: ◀   OPER-COMMON
```

■ **Sweep (Mode: Gated) (** MODE ⬭ → SWEEP ⬭ → **MODE : GATED)**

In a Sweep (Mode: Gated), oscillation occurs by varying parameters such as the frequency and amplitude one time between the start and stop settings.   Oscillation stops before the sweep starts and when the sweep is completed.

Operation to produce a waveform output with frequency that varies in step form and oscillation stops is described.

The setting example is a sinewave with arbitrary amplitude and DC offset 0.
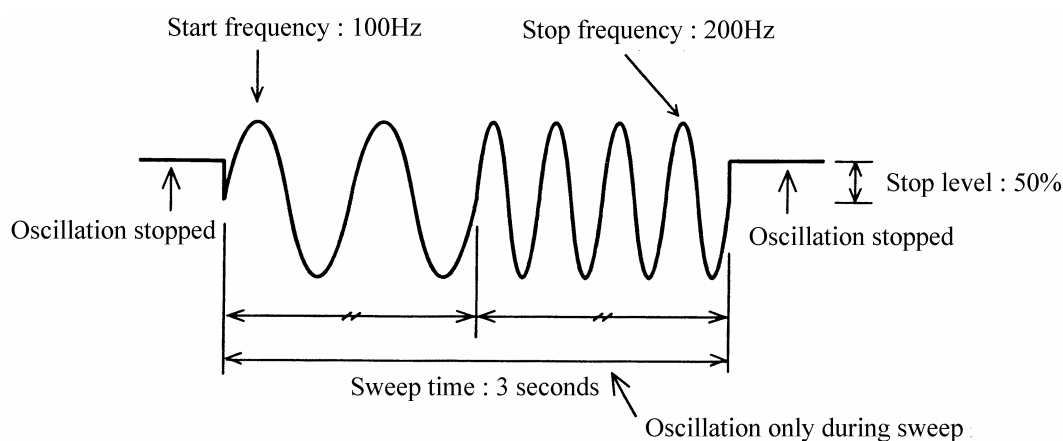
Operation:

(1) Set sweep MODE to GATED

① Press the MODE ⬭ key, then the SWEEP ⬭ key.

② Use the ◁ and ▷ keys to produce the following display (MODE flashes).

```
S I N G L E   C O N T   G A T E D
F－SWP : TYPE  SOURCE  [ MODE ]  ▶
```

③ Press the ENTER ⬭ key, then use the ◁ and ▷ keys to produce the following display (GATED flashes).

```
S I N G L E   C O N T   [ G A T E D ]
F－SWP : TYPE  SOURCE  MODE  ▶
```

④ This completes setting the sweep mode to gated.   Press the EXIT ⬭ key once to release the setting mode.

(2) Set sweep TYPE to FREQ

① Use the ◁ and ▷ keys to produce the following display (TYPE flashes).

```
FREQ   PHASE
F−SWP: TYPE   SOURCE  MODE   ▶
```

② Press the ‾ENTER‾ key, then use the ◁ and ▷ keys to produce the following display (FREQ flashes).

```
FREQ   PHASE
F−SWP: TYPE   SOURCE  MODE   ▶
```

③ This completes setting the sweep type to frequency.   Press the ‾EXIT‾ key once to release the setting mode.

(3) Select the sweep FUNCTION

① Use the ◁ and ▷ keys to produce the following display (FUNCTION flashes).

```
LIN   ⟋
F−SWP: ◀   FUNCTION   START  STOP   ▶
```

② Press the ‾ENTER‾ key.

③ Press the ▷ key, then select ⌐ with the MODIFY ◎ dial

④ After selecting, press the ‾EXIT‾ key once to release the function select mode.

(4) Set the START frequency

① Use the ◁ and ▷ keys to produce the following display (START flashes).

```
        1 0 0 0 . 0 0 0 0 0 0 0 0   H z
F − S W P : ◀   F U N C T I O N   START   S T O P   ▶
```

② Press the ENTER key.

③ Set the frequency with the keypad or MODIFY dial.

For example, set to 100 Hz.

④ After setting, press the EXIT key once to release the start frequency setting mode.

(5) Set the STOP frequency

① Use the ◁ and ▷ keys to produce the following display (STOP flashes).

```
        1 0 0 0 0 . 0 0 0 0 0 0 0 0   H z
F − S W P : ◀   F U N C T I O N   S T A R T   STOP   ▶
```

② Press the ENTER key.

③ Set the frequency with the keypad or MODIFY dial.

For example, set to 200 Hz.

④ After setting, press the EXIT key once to release the stop frequency setting mode.

(6) Set the sweep TIME

① Use the ◁ and ▷ keys to produce the following display (TIME flashes).

```
                              1 . 0 0 0   s
F − S W P :  ◀   TIME  S T O P − L E V E L   C E N T E R   ▶
```

② Press the ENTER key.

③ Set the sweep time with the keypad or ⊙ MODIFY dial.

For example, set to 3 seconds.

④ After setting, press the EXIT key once to release the sweep time setting mode.

(7) Set the STOP-LEVEL

① Use the ◁ and ▷ keys to produce the following display (STOP-LEVEL flashes).

```
O F F
F − S W P :  ◀   T I M E  STOP−LEVEL  C E N T E R   ▶
```

② Press the ENTER key.

③ Turn the ⊙ MODIFY dial to produce the following display (ON flashes).

```
O N                           0 . 0 0   %
F − S W P :  ◀   T I M E  S T O P − L E V E L   C E N T E R   ▶
```

④ Press the ▷ key, then set the stop level with the keypad or ⊙ MODIFY dial. For example, set to 50 %.

The stop level is a percentage with respect to the maximum positive and negative amplitudes taken respectively as +100 % and -100 %.

⑤ After setting, press the EXIT key to exit stop level setting.

(8) Start sweep

① Press the ⬚ (START) key.

In this example, sweep ends after 3 seconds and oscillation stops. Again press the ⬚ (START) key to sweep from the stop to the start frequency.

Other operations:

• **Sweep stop**   : Press the ⬚(STOP) key.   Oscillation stops.   When sweep is stopped at gated sweep
end or during sweep, press the ⬚(STOP) key to set the start value. (Oscillation stops)

• **Sweep pause**   : Press the ⬚(PAUSE) key.   To resume sweep, again press the ⬚(PAUSE) key.

• **Gated sweep operation examples**
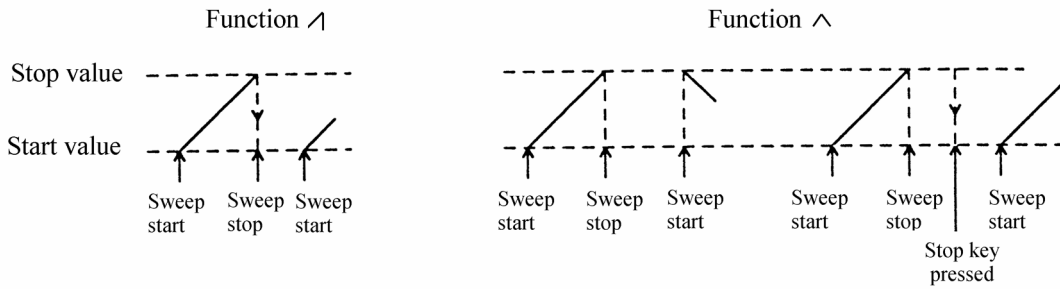
• **External start**   :Change the sweep trigger source to EXT and select rising or falling.   Supply an
external signal to the front panel TRIG/SWEEP IN connector.   Observe that
retrigger is not accepted for 100 ms after sweep start.
If a trigger is input during the sweep, the sweep restarts.

• **FUNCTION**   : The function determines the sweep type.   For example, ⌐ provides step-type
change of output (e.g., frequency) at the sweep time halfway point.   LIN/LOG
provides linear or logarithmic variation of the output with respect to the time axis.

• **Internal trigger source**

: The internal trigger signal is produced at the rate indicated below.   Even is set to less than 100 ms, the trigger is applied only at 100 ms intervals.

The trigger rate is common for CH1 and CH2.

Trigger rate

```
┌─────────────────────────────────────────────┐
│                                               │
│  I N T              ⌐⌐       1 0 0 . 0 m s    │
│  F − S W P : T Y P E  SOURCE  M O D E   ▶     │
│                                               │
└─────────────────────────────────────────────┘
```
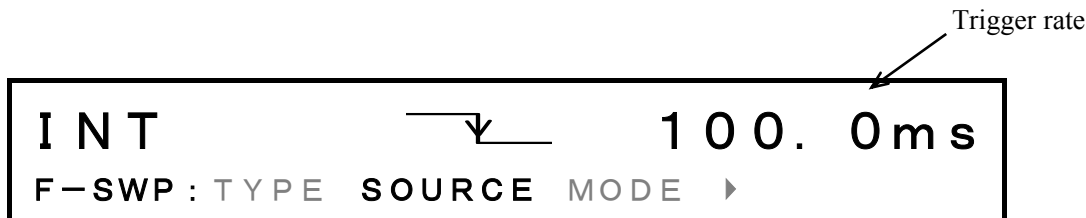
• **START-STATE and STOP-STATE :** Set output to start and stop values, respectively.

Both START-STATE and STOP-STATE oscillation can be conducted together with a gated sweep.   Since sweep synchronization output becomes the respective start and stop states, full-scale adjustments of the recorder and the status of external equipment can be checked.

Relationship between sweep values and sweep synchronization output,

☞ 4.2 Sweep (■Sweep value and SYNC OUT).

• If the frequency is low and the sweep rest period short, in some cases, oscillation may not stop immediately at the end of sweep.

• During sweep, if the oscillation mode of the other channel is changed, sweep stops.

• **TO start, stop, pause, or restart a sweep operation on both channels simultaneously by manual operation or via remote control (GPIB or USB),** set both channels to sweep mode and set OPER-COMMON to on.

If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
┌─────────────────────────────────────────────┐
│                                               │
│  O F F    O N                                 │
│  F − S W P : ◀   O P E R − C O M M O N        │
│                                               │
└─────────────────────────────────────────────┘
```

■ CENTER, SPAN

• **Center** is the sweep center value, while **span** is the range setting.   The relationship among center, span, start and stop is as follows.

Values cannot be entered for CENTER and SPAN, however, if the sweep type is set from a user unit that has the log function.

• When start is changed:
  Stop does not change.
  CENTER = (START+STOP) ÷ 2
  SPAN = |START−STOP|

• When stop is changed:
  Start does not change.
  CENTER = (START + STOP) ÷ 2
  SPAN = |START − STOP|

• When center is changed:
  Span does not change.
  START = CENTER −/+ (SPAN ÷ 2)
  STOP = CENTER +/− (SPAN ÷ 2)

• When span is changed:
  Center does not change.
  START = CENTER − /+ (SPAN ÷ 2)
  STOP = CENTER +/− (SPAN ÷ 2)

■ Summary of the sweep setting items

• The following summarizes the items that need to be set during a sweep operation (in the SWEEP menu).

TYPE (sweep target) [FREQ, PHASE]

SOURCE (trigger source)   CH1: [EXT ‾↓_, EXT _↗‾, INT ‾↓_ [s], INT _↗‾ [s]]

CH2: [EXT CH2 ‾↓_, EXT CH2 _↗‾, EXT CH1, INT ‾↓_ [s],

INT _↗‾ [s]]

* Set when the sweep mode is SINGLE or GATED

MODE (sweep mode) [SINGLE, CONT, GATED]

FUNCTION (sweep waveform) [LIN ⟋, LOG ⟋, ⌐, LIN SIN, LOG SIN, LIN ⋀, LOG ⋀]

START (sweep start value)/STOP (sweep stop value) ⎤

or   ⎬ Sweep range setting

CENTER (sweep center value)/SPAN (sweep width) ⎦

TIME (sweep time) [s]

STOP-LEVEL (stop level)

⎤
⎬ Set when the sweep mode is GATED

PHASE (phase when oscillation starts) * ENTRY menu ⎦

OPER-COMMON (simultaneous sweep operation of both channels) [OFF, ON]

• Sweep operations

• Main operation

START (sweep start)

STOP (sweep end/sweep start state)

*For subsequent operation when the sweep has been completed, the state is reset to the sweep start state.

PAUSE (sweep pause/restart)

• In the SWEEP menu

START-STATE (sweep start state)

STOP-STATE (sweep stop state)

■ Sweep (Modulation) steps and step width

Sweep and modulation outputs are changed by software.　Methods for estimating sweep, modulation step number (number of output changes between start and stop values) and step width (variation width per change) are indicated below.

Sweep is described here.　For modulation, replace sweep function with modulation waveform, sweep type with modulation type, and sweep time with modulation period, respectively.

The modulation period is determined as follows.

When the waveform is SIN, ∿ , ⊓⌴ , : Modulation period = 1 ÷ (Modulation frequency × 2)

When the waveform is ⟋ , ∿ : Modulation period = 1 ÷ Modulation frequency

• **Step number derivation (**when oscillation mode of only one channel is sweep or modulation.　Other times, see next page.**)**

(1) Sweep function is step (⌐):

Step number = Sweep time [s] × 10000 (raise up, even number *1)

(2) Sweep function is other than step and sweep type is frequency:

① Sweep time is 25 ms and below:

Step number = Sweep time [s] × 10000

② Sweep time is more than 25 to 31.25 ms and below:

Step number = 250 (fixed)

③ Sweep time is more than 31.25 ms:

Step number = Sweep time [s] × 8000

(3) Sweep function is other than step and sweep type is other than frequency:

① Sweep time is 50 ms and below:

Step number = Sweep time [s] × 10000

② Sweep time is more than 50 to 62.5 ms and below:

Step number = 250 (fixed)

③ Sweep time is more than 62.5 ms:

Step number = Sweep time [s] × 8000

*1:　If raising up results in odd number, -1.

• Step number derivation (when oscillation mode of both channels is sweep or modulation.   Other times, see previous page.)

First, determine the reference and secondary channels.   The reference channel is that with the shorter sweep time or modulation period and is defined by the following method.   The reverse is used for the secondary channel.   The modulation period is determined by the following formulae.

When the modulation waveform is SIN, $\wedge\!\!\!\vee$ or $\sqcap\!\!\!\llcorner$,

the modulation period = 1 ÷ (modulation frequency × 2)

When the modulation waveform is $\diagup\!\!\!|$ or $|\!\!\!\diagdown$,

the modulation period = 1 ÷ (modulation frequency)

a. Reference channel step number

(1) Sweep type is frequency

① Sweep time: 25 ms and less

Step no. = sweep time (s) × 5000 (rounded down, even number if more than 1.6 ms *2)

② Sweep time: more than 25 ms, but 31.25 ms and less

Step no. = 124 (fixed)

③ Sweep time: more than 31.25 ms

Step no. = sweep time (s) × 4000

(2) Sweep type other than frequency

① Sweep time: 50 ms and less

Step no. = sweep time (s) × 5000 (rounded down, even number if more than 1.6 ms *2)

② Sweep time: more than 50 ms, but 62.5 ms and less

Step no. = 250 (fixed)

③ Sweep time: more than 62.5 ms

Step no. = sweep time (s) × 4000

(3) Modulation type is frequency

① Modulation period: 25 ms and less

Step no. = sweep time (s) × 2500

(rounded down, if modulation waveform is $\diagup\!\!\!|$ or $|\!\!\!\diagdown$, even number *2, also integer multiple of 4 if more than 3.2 ms. If other modulation waveform, even number if more than 1.6 *2.)

② Modulation period: more than 25 ms, but 31.25 ms and less

Step no. = 124 (fixed)

③ Modulation period: more than 31.25 ms

Step no. = sweep time (s) × 4000

(rounded up, if modulation waveform is step, even number)

*2:   If rounded up/down results are odd, -1.

(4) Modulation type other than frequency

   ① Modulation period: 50 ms and less

      Step no. = sweep time (s) $\times$ 5000

      (rounded down, if   modulation waveform is ⟋ or ⟍ , even number *2, also integer multiple of 4 if more than 3.2 ms.   If other modulation waveform, even number if more than 1.6 ms)

   ② Modulation period: more than 50 ms, but 62.5 ms and less

      Step no. = 250 (fixed)

      (248 if the modulated waveform is ⟋ or ⟍)

   ③ Modulation period: more than 62.5 ms

      Step no. = modulation period (s) $\times$ 4000

      (rounded up, if modulation waveform is step, even number)

(5) Exceptions

   ① If the sweep type is changed after setting the sweep time, the step number remains the same. For example, if the sweep type is changed from frequency to phase, the step number remains as in item (1).

   ② If the modulation type is changed after the modulation frequency is set, the step number remains the same.   For example, if the modulation type is changed from frequency to phase, the step number remains the same as in (3).

b. Secondary channel step number

   Step no. = reference channel step no. $\times$ secondary channel sweep time (modulation period) $\div$ reference channel sweep time (modulation period)

   (If function is step, round up to even number *2, if other function, round down.)

*2:   If rounded up/down results are odd, -1.

• Deriving step width

During linear sweep, step width = $\dfrac{\text{Span}}{\text{Step number -1}}$

During logarithmic sweep, step width = $\log_{10}^{-1} \left[\log_{10} \dfrac{\text{stop}}{\text{start}} \div (\text{step no. -1}) \right]$

Step width during log sweep changes with step progression.

■ Sweep value and SYNC OUT

Sweep function			Single, gated sweep (↓ is sweep start timing, ※ is sweep in progress, ☆ is sweep end state, ⟋ gated is fine line.)		Continuous sweep	
			Start value < stop value	Start value > stop value	Start value < stop value	Start value > stop value
⟋	Sweep value	High / Low				
	Sync output	High / Low	Sweep time	Sweep time	Sweep time	Sweep time
⌐	Sweep value	High / Low				
	Sync output	High / Low	Sweep time	Sweep time	Sweep time	Sweep time
SIN	Sweep value	High / Low				
	Sync output	High / Low	Sweep time	Sweep time	Sweep time	Sweep time
∧	Sweep value	High / Low				
	Sync output	High / Low	Sweep time	Sweep time	Sweep time	Sweep time

◆ Approximately 200 to 250 μs when the oscillation mode of both CH1 and CH2 is sweep or modulation, approx. 100 to 125 μs at other times.

4.3 Modulation

■ Frequency modulation (FM) ($\overset{\text{MODE}}{\Box}$ → $\overset{\text{MODU}}{\Box}$ → TYPE : FM)

Operation to produce a frequency modulated waveform output is described.

The example is a sinewave, 1 kHz, amplitude and DC offset arbitrary.
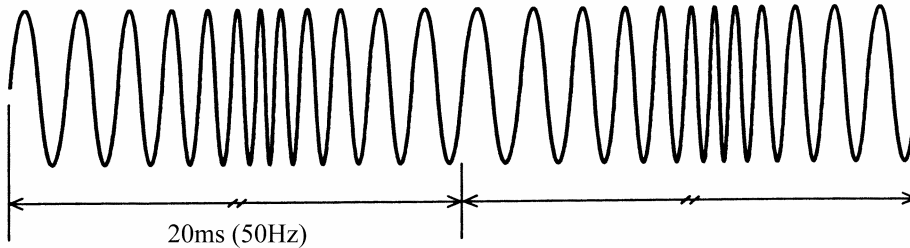
20ms (50Hz)

Frequency is 1 kHz varying ± 250 Hz
Deviation period is 20 ms (50 Hz)

Operation:

(1) Set modulation TYPE to frequency (FM)

① Press the $\overset{\text{MODE}}{\Box}$ key, then the $\overset{\text{MODU}}{\Box}$ key.

② Use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (TYPE flashes).

```
FM  PM
FM:[TYPE] DEVIATION FREQ FUNCTION
```

③ Press the $\overset{\text{ENTER}}{\Box}$ key, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (FM flashes).

```
[FM]  PM
FM:TYPE DEVIATION FREQ FUNCTION
```

④ This sets the modulation type for frequency.   Press the $\overset{\text{EXIT}}{\Box}$ key once to release the type setting mode.

(2) Set the frequency DEVIATION

① Use the ◁ and ▷ keys to produce the following display (DEVIATION flashes).

```
           1000. 00000000  Hz
FM: TYPE  DEVIATION  FREQ  FUNCTION
```

② Press the ENTER key.
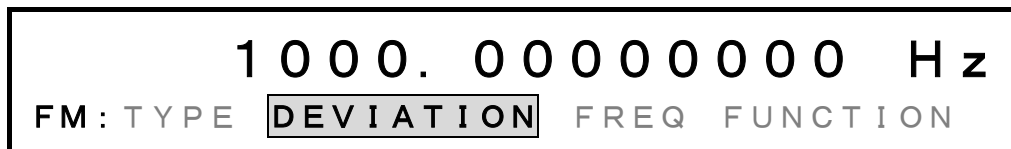
③ Set the deviation with the keypad or ⊙ MODIFY dial.

   For example, set to 500 Hz.

④ After setting, press the EXIT key once to exit frequency deviation setting.

(3) Set the modulation FREQ

① Use the ◁ and ▷ keys to produce the following display (FREQ flashes).

```
                       100. 00  Hz
FM: TYPE  DEVIATION  FREQ  FUNCTION
```

② Press the ENTER key.

③ Set the frequency with the keypad or ⊙ MODIFY dial.

   For example, set to 50 Hz (20 ms).

④ After setting, press the EXIT key once to release the modulation setting mode.

(4) Select the modulation waveform (FUNCTION)

① Use the ◁ and ▷ keys to produce the following display (FUNCTION flashes).

```
SIN   ⌒   ⊓   ⟋   ⟍
FM: TYPE  DEVIATION  FREQ  FUNCTION
```

② Press the $\boxed{\text{ENTER}}$ key, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (SIN flashes).

```
┌─────────────────────────────────────────────┐
│  S I N    ∿     ⊓     ⟋     ⟍               │
│  FM : TYPE  DEVIATION  FREQ  FUNCTION         │
└─────────────────────────────────────────────┘
```

③ After making a selection, press the $\boxed{\text{EXIT}}$ key to exit function setting.

The above completes frequency modulation setting.

Other operations:

• When the oscillation mode is changed to modulation (MODU), modulation occurs at the setting at that time point.
  To stop modulation: Press the $\boxed{\text{STOP}}$ key.   Resume modulation by pressing the $\boxed{\text{START}}$ key.

• During modulation, if the oscillation mode of the other channel is changed, modulation stops.

• **To start or stop modulation of both channels simultaneously on a manual operation or via remote control (GPIB or USB),** set both channels to modulation mode and set OPER-COMMON to on.
  If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
┌─────────────────────────────────────────────┐
│  O F F    O N                                 │
│  FM : ◀   FUNCTION   OPER−COMMON              │
└─────────────────────────────────────────────┘
```

• Setting items at frequency modulation (MODU menu)
  TYPE: FM
  DEVIATION (frequency deviation) [Hz]
  FREQ (modulation frequency) [Hz]
  FUNCTION (modulation waveform) [SIN, ∿ , ⊓ , ⟋ , ⟍]
  OPER-COMMON (operation in both channels) [OFF, ON]

■ Phase modulation (PM) ($\overset{\text{MODE}}{\bigcirc}$ → $\overset{\text{MODU}}{\bigcirc}$ → TYPE : PM)

Operation to produce a phase modulated waveform output is described below. In this example, the waveform is triangular, the 1 kHz, DC offset is set to 0 V, the oscillation start phase is set to 0 degrees, and the frequency and amplitude are set to arbitrarily defined values.
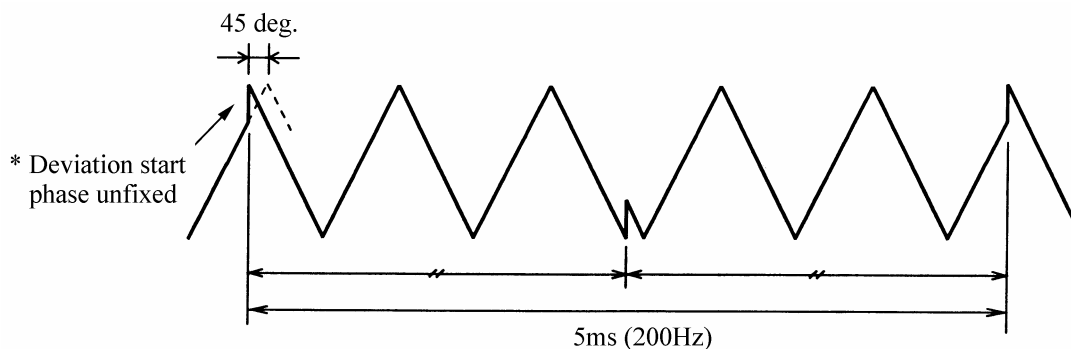
Operation:

(1) Set modulation TYPE to phase (PM)

① Press the $\overset{\text{MODE}}{\bigcirc}$ key, then the $\overset{\text{MODU}}{\bigcirc}$ key.

② Use the ◁ and ▷ keys to produce the following display (TYPE flashes).

```
F M    P M
FM: TYPE   DEVIATION  FREQ  FUNCTION
```

③ Press the $\overset{\text{ENTER}}{\bigcirc}$ key, then use the ◁ and ▷ keys to produce the following display (PM flashes).

```
F M    PM
PM: TYPE   DEVIATION  FREQ  FUNCTION
```

④ This sets the modulation type for phase. Press the $\overset{\text{EXIT}}{\bigcirc}$ key once to release the type setting mode.

(2) Set the phase DEVIATION

① Use the ◁ and ▷ keys to produce the following display (DEVIATION flashes).

```
                              90. 000  deg
PM: TYPE  DEVIATION  FREQ  FUNCTION
```

② Press the ENTER key.

③ Set the deviation with the keypad or ◎ (MODIFY) dial.

   For example, set to 45 degrees.

④ After setting, press the EXIT key once to exit frequency deviation setting.

(3) Set the modulation FREQ (frequency with varying phase)

① Use the ◁ and ▷ keys to produce the following display (FREQ flashes).

```
                              100. 00  Hz
PM: TYPE  DEVIATION  FREQ  FUNCTION
```

② Press the ENTER key.

③ Set the frequency with the keypad or ◎ (MODIFY) dial.

   For example, set to 200 Hz (5 ms).

④ After setting, press the EXIT key once to release the modulation frequency setting mode.

(4) Select the modulation waveform (FUNCTION)

① Use the ◁ and ▷ keys to produce the following display (FUNCTION flashes).

```
SIN  ⌄  ⊓  ⟋  ⟍
PM: TYPE  DEVIATION  FREQ  FUNCTION
```

② Press the ENTER key, then use the ◁ and ▷ keys to produce the following display (⌐L flashes).

```
SIN  ∿  ⌐L  ⟋  ⟍

PM: TYPE DEVIATION FREQ FUNCTION
```
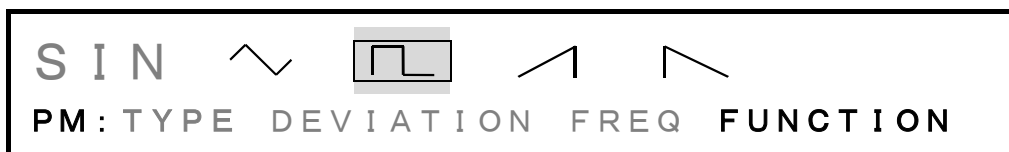
③ After selecting, press the EXIT key to release the function setting mode.

The above completes phase modulation setting.

Other operations:

• When the oscillation mode is changed to modulation (MODU), modulation occurs at the setting at that time point.

To stop modulation : Press the STOP key.   Resume modulation by pressing the START key.

• During modulation, if the oscillation mode of the other channel is changed, modulation stops.

• **To start or stop modulation of both channels simultaneously on a manual operation or via remote control (GPIB or USB),** set both channels to sweep mode and set OPER-COMMON to on.
If the BOTH lamp is on, behavior is the same even though OPER-COMMON is off.

```
OFF  ON

PM: ◀  FUNCTION  OPER−COMMON
```

• Setting items at phase modulation (MODU menu)

TYPE: PM

DEVIATION (phase deviation) [deg]

FREQ (modulation frequency) [Hz]

FUNCTION (modulation waveform) [SIN, ∿ , ⌐L , ⟋ , ⟍]

OPER-COMMON (operation in both channels) [OFF, ON]

4.4 Arbitrary Waveform

■ **Arbitrary waveform (ARB) (** $\overset{\text{FUNCTION}}{\boxed{}}$ → $\overset{\text{ARB}}{\boxed{}}$ **)**

Operation using arbitrary waveform (ARB) to produce a sinewave with clipped peak output is described.

Waveform data : + 23170

Waveform data : 0

Waveform data : - 23170

Waveform address → 0   1024   3072   5120   7168   8191
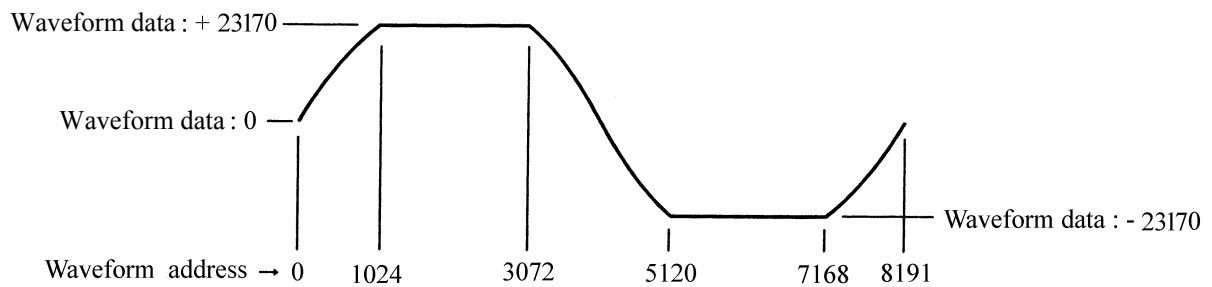
Operation:

(1) Set waveform to arbitrary (ARB)

① Press the $\overset{\text{FUNCTION}}{\boxed{}}$ key, then the $\overset{\text{ARB}}{\boxed{}}$ key.

(2) Select an arbitrary waveform to be edited/output (SELECT).

① Press the $\overset{\text{ARB EDIT}}{\boxed{}}$ key, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (SELECT flashes).

```
0 : ARB_00   1 : ARB_01   ▶
ARB : SELECT  NAME  EDIT  COPY  ▶
```

② Press the $\overset{\text{ENTRY}}{\boxed{}}$ key, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (1:ARB_01 flashes).

```
0 : ARB_00   1 : ARB_01   ▶
ARB : SELECT  NAME  EDIT  COPY  ▶
```

③ This completes the selection of an arbitrary waveform (No. 1 is selected here).   Press the $\overset{\text{EXIT}}{\boxed{}}$ key one time to release the arbitrary waveform selection mode.

(3) Copy the waveform, for example, sinewave

① Press the ^{ARB EDIT}⬜ key, then use the ◁ and ▷ keys to produce the following display (COPY flashes).

```
S I N      ∿      ⊓_      ╱      ╲

ARB : SELECT  NAME  EDIT  [COPY]  ▸
```

② Press ⬜ENTER key, then use the ◁ and ▷ keys to produce the following display (SIN flashes).

```
[S I N]      ∿      ⊓_      ╱      ╲

ARB : SELECT  NAME  EDIT  COPY  ▸
```

③ Press ⬜ENTER key to copy the sinewave.

(4) Edit the waveform, for example, peak clip

① Use the ◁ and ▷ keys to produce the following display (EDIT flashes).

Waveform address   Waveform data

```
 A D : 0 0 0 0    D T : + 0 0 0 0 0
ARB : SELECT  NAME  EDIT  COPY  ▸
```
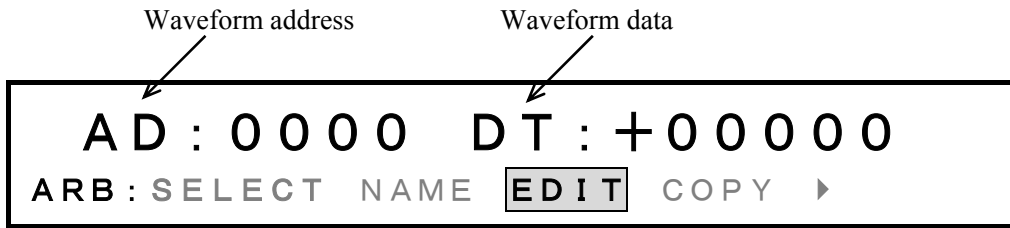
② Press ENTER key, then the ◁ key (AD digit flashes).

```
 A D : 0 0 0 0    D T : + 0 0 0 0 0
ARB : SELECT  NAME  EDIT  COPY  ▸
```

③ Set the waveform address (AD) with the keypad or ◎ MODIFY dial.

    For example, set to 1024.

④ Press the m key to produce the following display (the asterisk (*) is displayed).

```
 A D : 1 0 2 4    D T : + 2 3 1 7 0    *
ARB : SELECT  NAME  EDIT  COPY  ▸
```

∗ is interpolation type mark and indicates the linear interpolation type address.   The mark appears and extinguishes each time the m key is pressed.

⑤ Next, use above steps ③ and ④ to set the interpolation mark (*) to waveform address 3072.

⑥ Press the ⌈k⌉ key for linear interpolation. In this example, the first half of the sinewave is clipped (⁀). The waveform data (DT) change as a result of linear interpolation between the starred addresses.

⑦ Press the ⌢EXIT key, then use the ◁ and ▷ keys to produce the following display (MARK-CLEAR flashes).

```
1 : A R B _ 0 1
A R B : ◄   MARK−CLEAR   C L E A R   S I Z E
```

Press the ⌢ENTER key twice to clear the interpolation marks from addresses 1024 and 3072.

⑧ In the same manner as above steps ① to ⑥, clip the first half of a sinewave (set interpolation marks at 5120 and 7168).

The above completes arbitrary waveform setting.

Other operations:

• **Arbitrary waveform data input:** ARB EDIT ⬜ → EDIT select → ENTER ⬜ → ▷ flashes the waveform data (DT) digits.   Use the keypad or MODIFY ◎ dial to set the data.

Data upper and lower limits are +32767 and −32768, which correspond to the amplitude peak-to-peak settings.   For this reason, when the waveform vertical limits are changed by the above type of method, the amplitude setting (Vp-p) and the actual output waveform Vp-p do not coincide.   The data set addresses are automatically the linear interpolation addresses (the * mark is displayed).

• **Clear (to 0) waveform data:** ARB EDIT ⬜ → CLEAR select → ENTER ⬜ , then again press ENTER ⬜ .   The interpolation marks (*) are also cleared.

• **Apply a name to an arbitrary waveform:** ARB EDIT ⬜ → NAME select → ENTER ⬜ , then use the MODIFY ◎ dial to select the characters.   Shift position with ◁ and ▷ , and input.

Up to 8 characters can be input.   Following are the usable characters.

a b c d e f g h i j k l m n o p q r s t u v w x y z ▾ (s p a c e)
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9
! ” # $ % & ’ ( ) * + , − . / : ; < = > ? @ [¥] ^ _ ` { | } → ←

• Change the waveform data size: ARB EDIT ⬜ → SIZE select → ENTER ⬜ → Use ◁ and ▷ to select the data size

Relation between the waveform data size and number of waveforms

Data size	Waveform number												Number of waveforms
8K(8192)	0	1	2	3	4	5	6	7	8	9	10	11	12
16K(16384)	0		1		2		3		4		5		6
32K(32768)	0				1				2				3
64K(65536)	0												1

The output waveform changes as described below when the waveform data size is changed.

If, for example, the waveform data size is changed from 16 KB to 8 KB when there is a waveform like ⌒⌄ for waveform number 0, ⌒ is assigned to waveform number 0 and ⌄ to waveform number 1.

• Arbitrary waveform data are common for CH1 and CH2.

4.5 Selecting waveforms of synchronous signals (SYNC OUT)

This section describes the switching of SYNC OUT waveforms.

■ Procedure

① Press the SYSTEM key, then use the ◁ and ▷ keys to produce the following display (The lower SYNC OUT flashes).

```
S T A T E    : P H A S E
S Y S T E M :  ◀  S Y N C O U T   P O W E R − O N   R E M O T E
```

② Press the ENTER key, then use the ◁ and ▷ keys to set the SYNC OUT waveform.

③ After setting, press the EXIT key to release the SYNC OUT waveform setting mode.

■ When the oscillation mode is BURST

- STATE: Low level during oscillation.   High level while stopped.
- PHASE: For ⌐ squarewaves (variable duty), the same waveform as that for FUNCTION OUT.
  For other cases, high level while between 0 and 180 degrees of the waveform in the oscillation period, and low level while between 180 and 360 degrees.
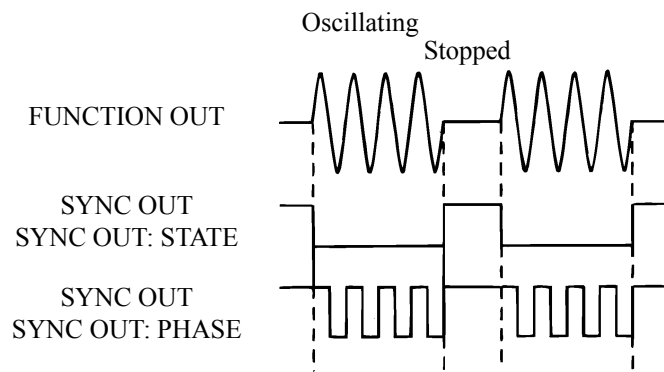
■ When the oscillation mode is SWEEP

• STATE: Low level while sweeping from the start value to the stop value or stopped.   Otherwise, high level.

• PHASE: For ⌐‾squarewaves (variable duty), the same waveform as that for FUNCTION OUT. Otherwise, high level while between 0 and 180 degrees of the waveform, and low level while between 180 and 360 degrees.

Sweeping

FUNCTION OUT

SYNC OUT
SYNC OUT: STATE

SYNC OUT
SYNC OUT: PHASE
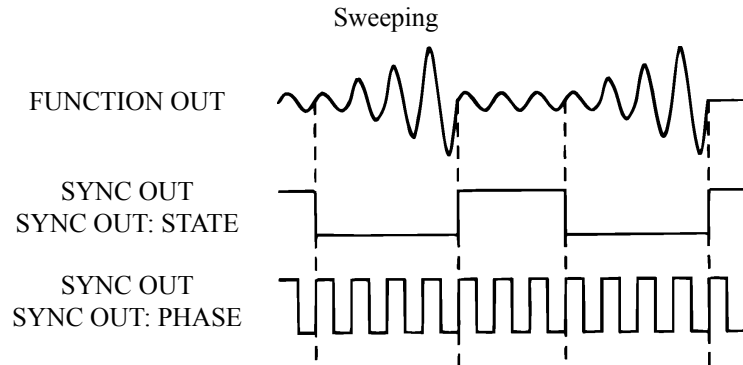
■ When the oscillation mode is MODU

• STATE: STATE: Low level while executing modulation and between 180 and 360 degrees of the modulated waves.   Otherwise, high level.

• PHASE: For ⌐‾squarewaves (variable duty), the same waveform as that for FUNCTION OUT. Otherwise, high level while between 0 and 180 degrees of the modulated waves, and low level while between 180 and 360 degrees.

Modulation execution

FUNCTION OUT

SYNC OUT
SYNC OUT: STATE

SYNC OUT
SYNC OUT: PHASE
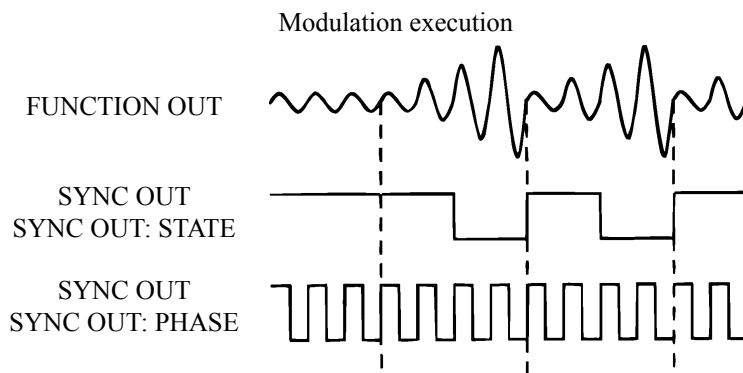
■ **Additional information**

• For ⌒⌣ and ⊓⌐ (fixed duty) at frequencies over 100 kHz, if SYNC OUT is set to PHASE, output becomes the waveform which applied the analog signal of a sinewave to the comparator. For this reason, the output level (high or low) may be undefined at 0, 180, and 360 degrees (±2 degrees, approximately).

In particular, note that when the oscillation mode is switched during a burst or gated sweep while oscillation is stopped, the output level may vary or the waveform may become glitch-shaped.

If a precise output level is required while oscillation is stopped, shift the phase setting.   For example, setting the phase at + 90 degrees shifts the output level to the high level while oscillation is stopped.
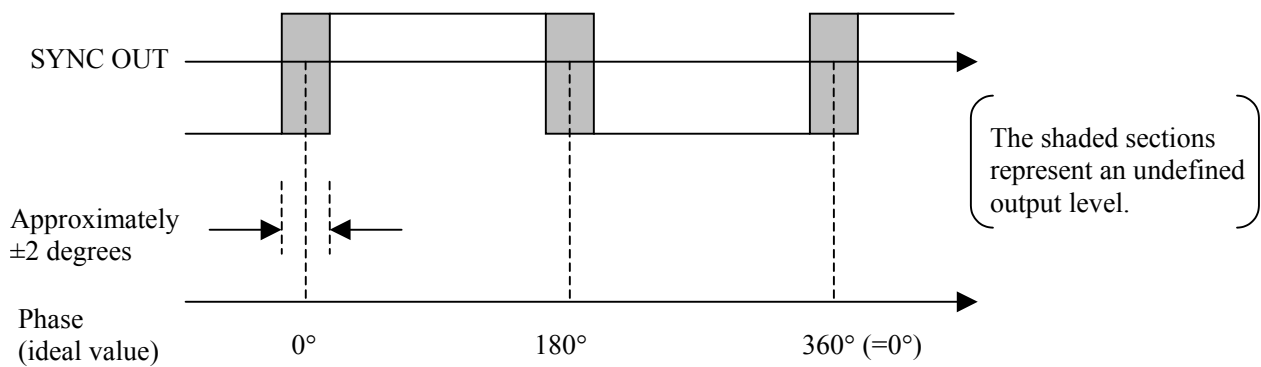
4.6 Output waveforms for sweeping and modulation

The setup values for sweeping and modulation are updated every 100 to 252 μs.   Thus, if the sweep time is short or the modulation frequency is high, the amount of change for updating increases, leading to marked discontinuities.

If the sweep function (modulated waves) is ⌐L , ⟋ , or ⟍ , discontinuities become conspicuous in some of the stepwise variations.

Since the setup values vary enormously in some of the stepwise variations, discontinuities are generated.   If such discontinuities are removed, the remaining variations have the appearance shown below.

If, as an extreme example, the oscillation frequency is 1 kHz, the sweep time is 4 ms, the start phase is 180 degrees, the stop phase is -180 degrees, and the sweep function is ⟋ in the phase sweep, the phase shifts about 26 degrees every 100 μs, producing the following output waveforms.   Discontinuities are generated not only by ⟍⟋ , but also by ⟍⟍ , ⟋ , and ⟍ .

Since the phase changes at intervals of 100 to 252 μs, discontinuities are generated

The phase is swept

Waveform when swept

Update interval 100 to 252 μs

Waveform when not swept
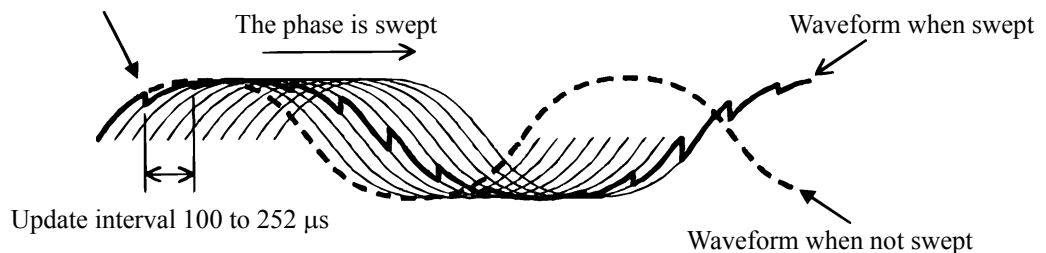
Since the ⌐_ squarewaves (fixed duty) and ⌐_ squarewaves (variable duty) are generated differently from other waveforms, extra pulses are produced.

Similarly, extra pulses are also produced by phase modulation, duty sweep, and PWM.

Update interval 100 to 252 μs

If the sweep function (FUNCTION) is triangular and the change rate of phase is large

Output waveform

Extra pulses are produced
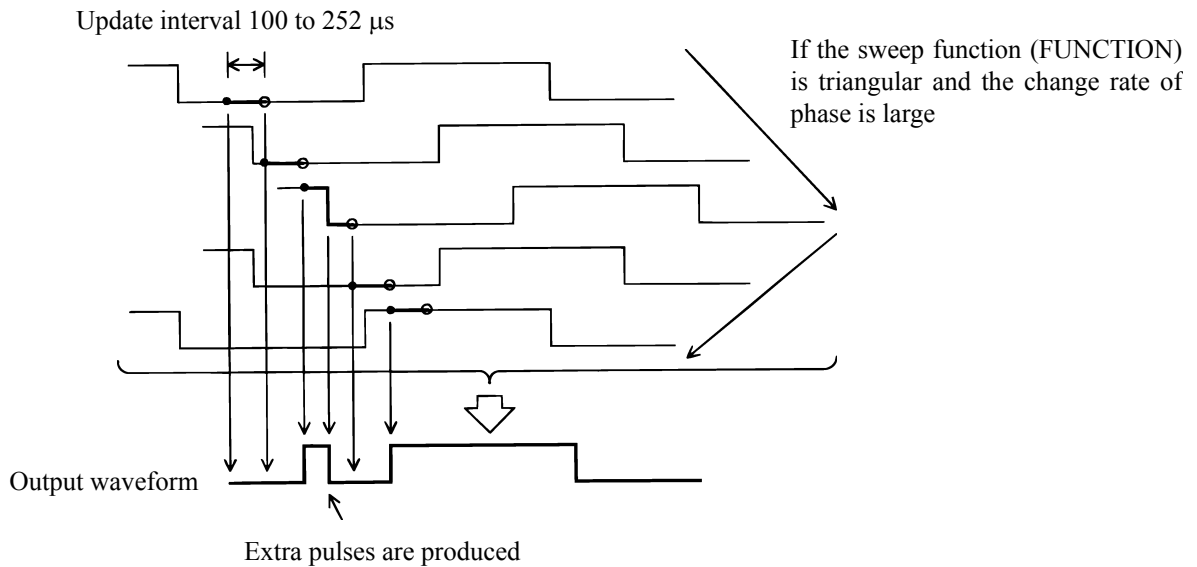
The occurrence frequency when the sweep function is ⌄, ⌄, or ↘ is roughly given by the following formula:

$$\text{Occurrence frequency [\%]} = \frac{\text{phase span [deg]}}{360 \times \text{oscillation frequency [Hz]} \times \text{sweep time [s]}} \times 100$$

If, for example, the frequency is 1 kHz, the phase span is 90 degrees, and the sweep time is 100 ms, an extra pulse is generated every 400 cycles on average.

4.7 Equivalent noise bandwidth

The density of noise generated by the WF1944B is as shown in the following figure (a) "Frequency characteristics of noise generated by the WF1944B."

The effective values (rms) of (a) are equal to those of white noise in the figure (b) "Frequency characteristics of white noise," that follows.   This equivalent bandwidth (500 kHz) is called the equivalent noise bandwidth.

(a) Frequency characteristics of noise
generated by the WF1944B

Noise density
[V/$\sqrt{\text{Hz}}$]

About 320 kHz
-3dB

A [V/$\sqrt{\text{Hz}}$]

Frequency

Effective values are equal

(b) Frequency characteristics of white
noise

Noise density
[V/$\sqrt{\text{Hz}}$]

A [V/$\sqrt{\text{Hz}}$]

Frequency

500kHz

Section 5　Other Operations

・Following is a typical example of the display panel indications used in this Section.

Fully lighted(bold)　　　　　Dimly lighted

```
FREQ    PERIOD   AMPTD   ▶
USER UNIT:TYPE  NAME  FORMURA   ▶
```

Fully lighted(bold)　　　Flashing　　Dimly lighted
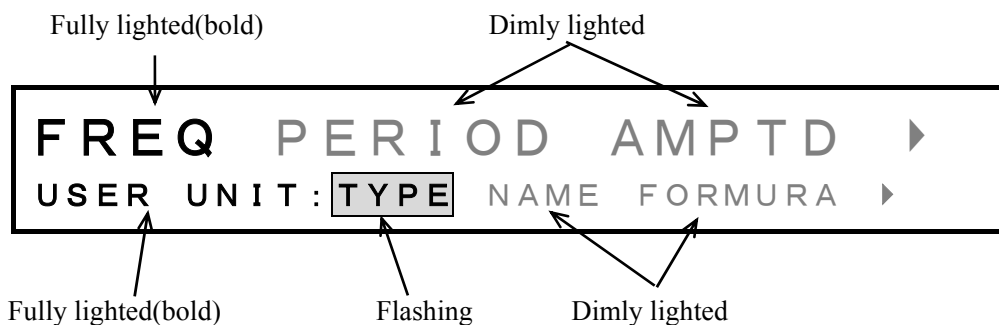
5.1 Convenient Settings

■ **Frequency [Hz] setting by period [s] (** $\overset{\text{ENTRY}}{\fbox{ }}$ → $\overset{}{\underset{\text{PERIOD}}{\fbox{ }}}$ **)**

Operation is described for setting the waveform repetition rate not in frequency (Hz) but as period (s).

Operation:

① Press the $\overset{\text{ENTRY}}{\fbox{ }}$ key, then the $\underset{\text{PERIOD}}{\fbox{ }}$ key to produce the following display.

```
P       0. 001000000000   s
  A0. 1000Vp-p    O+0. 0000V   /OPEN
```

② Set the period with the keypad or $\overset{\text{MODIFY}}{\odot}$ dial.

Other:

The period setting is frequency with the reciprocal less than 0.01 μHz, the number should be rounded off. Thus, the setting tolerance is large when the frequency setting digits are fewer (period longer).

In this situation, even if setting is changed by the keypad or $\overset{\text{MODIFY}}{\odot}$ dial, the actual oscillation period does not change in some cases.

■ **Squarewave duty setting (** $\overset{\text{ENTRY}}{\boxed{}}$ → $\overset{\text{DUTY}}{\boxed{}}$ **)**

Operation to set the squarewave duty is described.   The setting changes the width (%) of the pulse with respect to the overall waveform (⊓⌐ portion indicated by arrows).

Select squarewave (⎍ variable duty).

Operation:

① Press the $\overset{\text{ENTRY}}{\boxed{}}$ key, then the $\overset{\text{DUTY}}{\boxed{}}$ key to produce the following display.

```
┌─────────────────────────────────────────────┐
│   D U T Y           5 0 .  0 0 0 0   %        │
│ 1 0 0 0 . 0 0 0 0 0 0 0 H z   A 0 . 1 0 0 0 V p－p／O P E N │
└─────────────────────────────────────────────┘
```

② Set the duty with the keypad or $\overset{\text{MODIFY}}{\bigcirc}$ dial.

Other:

• The table indicates the effects on other parameters when the frequency, period, width or duty is changed.

Change ↓	Frequency (FREQ)	Period (PERIOD)	Pulse width (WIDTH)	Duty (DUTY)
Frequency (FREQ)		Changed	Changed	Unchanged
Period (PERIOD)	Changed		Unchanged	Changed
Pulse width (WIDTH)	Unchanged	Unchanged		Changed
Duty (DUTY)	Unchanged	Unchanged	Changed	

• Due to the oscillation period and duty relationship, the pulse can be lost when the actual pulse width is less than 25 ns.   An error message is displayed at this type of setting.
  Also, jitter increases when the pulse width is less than 100 ns.   A warning message is displayed at this type of setting.

• The actual waveform duty resolution is approx. (oscillation frequency ÷ 40 MHz (0.00001 % at minimum)).   When the stop level is on, the minimum actual waveform duty resolution is approximately 0.003 %.

• For other notes, see "■Waveform selection " in Section 3.3, "Basic operation."

■ **Squarewave pulse width setting (** $\overset{\text{ENTRY}}{\square}$ → $\overset{}{\underset{\text{WIDTH}}{\square}}$ **)**

Operation to set the squarewave pulse width is described.   The setting changes the width of the pulse (portion indicated by arrows ⊢⌐⌐).

Select squarewave (⌐⌐ variable duty).

Operation:

① Press the $\overset{\text{ENTRY}}{\square}$ key, then the $\underset{\text{WIDTH}}{\square}$ key to produce the following display.

```
┌─────────────────────────────────────────────────┐
│ W             0. 000500000  s                     │
│    A0. 1000Vp−p     O+0. 0000V  ／OPEN            │
└─────────────────────────────────────────────────┘
```
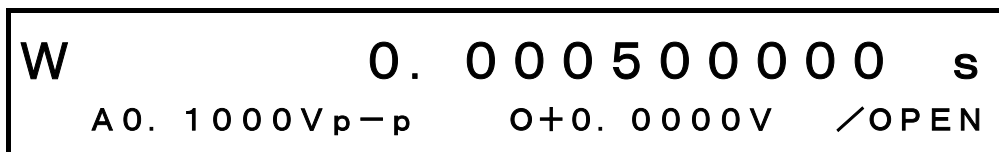
② Set the width with the keypad or $\overset{\text{MODIFY}}{\circledcirc}$ dial.

Other:
• The table indicates the effects on other parameters when the frequency, period, width or duty is changed.

Change ↓	Frequency (FREQ)	Period (PERIOD)	Pulse width (WIDTH)	Duty (DUTY)
Frequency (FREQ)		Changed	Changed	Unchanged
Period (PERIOD)	Changed		Unchanged	Changed
Pulse width (WIDTH)	Unchanged	Unchanged		Changed
Duty (DUTY)	Unchanged	Unchanged	Changed	

• Due to the oscillation period and duty relationship, the pulse can be lost when the actual pulse width is less than 25 ns.   An error message is displayed at this type of setting.

Also, jitter increases when the pulse width is less than 100 ns.   A warning message is displayed at this type of setting.

■ **Amplitude and DC offset setting by high and low level ($\overset{\text{ENTRY}}{\square}$ → $\underset{\text{HIGH}}{\square}$ / $\underset{\text{LOW}}{\square}$)**

Operation to set the waveform vertical size as high and low level, in place of amplitude and DC offset, is described.
Select the waveform type for squarewave.

Amplitude: 5Vp-p

High level: +5V

DC offset: +2.5V

Low level: +0V

0
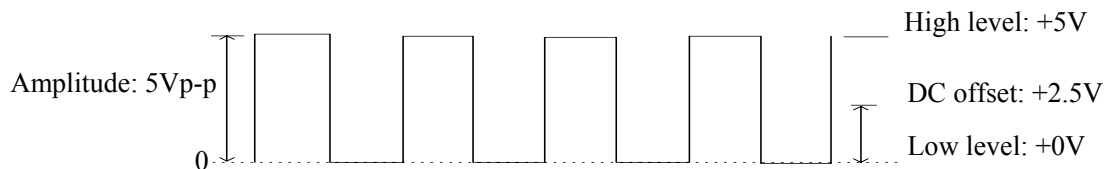
Operation:

① Press the $\overset{\text{ENTRY}}{\square}$ key, then the $\underset{\text{HIGH}}{\square}$ key to produce the following display.

```
HIGH        +0. 0500  V
1000. 0000000Hz   L−0. 0500V   ／OPEN
```

② Set the High level with the keypad or $\overset{\text{MODIFY}}{\circledcirc}$ dial.

For example, set to +5 V.

③ Press the $\overset{\text{EXIT}}{\square}$ key, then the $\underset{\text{LOW}}{\square}$ key to produce the following display.

```
LOW         −0. 0500  V
1000. 0000000Hz   H+5. 0000V   ／OPEN
```

④ Set the Low level with the keypad or $\overset{\text{MODIFY}}{\circledcirc}$ dial.

For example, set to +0 V.

Other:

The table indicates the effects on other parameters when the amplitude, DC offset, high level or low level is changed

Change ↓	Amplitude (AMPTD)	DC offset (OFFSET)	High level (HIGH)	Low level (LOW)
Amplitude (AMPTD)		Unchanged	Changed	Changed
DC offset (OFFSET)	Unchanged		Changed	Changed
High level (HIGH)	Changed	Changed		Unchanged
Low level (LOW)	Changed	Changed	Unchanged	

• Due to the relationships between high and low level settings, and between amplitude and DC offset settings, when the output voltage exceeds the following values, the Over lamp flashes and the output is clipped in some cases.

    10 V range: Approx. 11 V peak/open time

     1 V range: Approx. 1.1 V peak/open time

5.2 Units

■ Engineering unit (μ, m, k, M) display

Operation is described for displaying engineering units (e.g., the k of 1 kHz). As an example, the frequency units are changed.

Operation:

① Press the $\overset{\text{ENTRY}}{\boxed{}}$ key, then the $\overset{\text{FREQ}}{\boxed{}}$ key.

```
┌─────────────────────────────────────────┐
│      1 0 0 0 .  0 0 0 0 0 0 0 0    H z    │
│   A 0 .  1 0 0 0 V p - p    O + 0 .  0 0 0 0 V   ╱ O P E N │
└─────────────────────────────────────────┘
```

② Press the $\boxed{\text{k}}$ key to change the display as follows.

```
┌─────────────────────────────────────────┐
│      1 .  0 0 0 0 0 0 0 0 0 0 0 k H z     │
│   A 0 .  1 0 0 0 V p - p    O + 0 .  0 0 0 0 V   ╱ O P E N │
└─────────────────────────────────────────┘
```

Other:

• **Unit change enable:** Only when the $\boxed{\text{μ}}$, $\boxed{\text{m}}$, $\boxed{\text{k}}$ or $\boxed{\text{M}}$ key is lighted.

• **Initializing units (e.g., from kHz to Hz):** At above step②, press the $\overset{\text{ENTER}}{\boxed{}}$ key.

■ Amplitude units change

Operation to change the amplitude units is described.   For example, set to Vrms.

Operation:

① Press the [ENTRY] key, then the [AMPTD] key.

② Press the [▷] key to produce the following display (Vp-p lights).

```
┌──────────────────────────────────────────────┐
│  AMPTD  0. 1000  │Vp−p│       │
│  1000. 0000000Hz    O+0. 0000V   ╱OPEN         │
└──────────────────────────────────────────────┘
```

③ Turn the [MODIFY] dial to produce the following display.

```
┌──────────────────────────────────────────────┐
│  AMPTD  0. 0354  │Vrms│       │
│  1000. 0000000Hz    O+0. 0000V   ╱OPEN         │
└──────────────────────────────────────────────┘
```
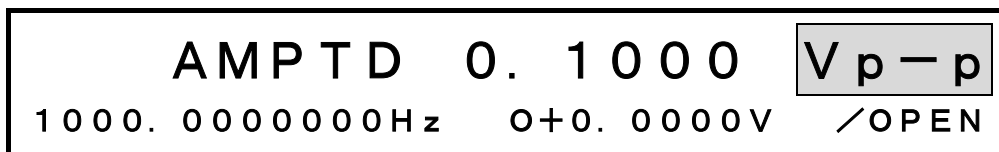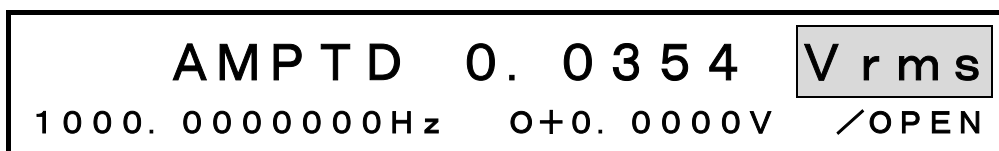
Other:

• The following units can be used.

   • Vp-p, Vrms, dBV, dBm (*1), USER (*2)

   *1:   Selectable when LOAD function is SET.

   *2:   Set User units name is displayed.

   Notes: Only Vp-p and USER can be selected when the oscillation mode is NOISE.

            Only Vp-p and USER can be selected when the selected waveform is ARB.

• Even if the amplitude units are changed, the actual output voltage does not change.

■ **User-unit setting (** $\overset{\text{SYSTEM}}{\Box}$ → **USER-UNIT)**

Operation for changing the units by using the user unit function is described.

For example, set for expressing frequency as rpm (revolutions per minute, e.g., engine rotation).

Operation:

(1) Select setting type, for example, frequency

① Press the $\overset{\text{SYSTEM}}{\Box}$ key, then use the ◁ and ▷ keys to produce the following display (USER-UNIT flashes).

```
USER  UNIT  MENU
SYSTEM:RANGE  PRESET  USER−UNIT  ▸
```

② Press the $\overset{\text{ENTER}}{\Box}$ key, then use the ◁ and ▷ keys to produce the following display (TYPE flashes).

```
FREQ  PERIOD  AMPTD  ▸
USER  UNIT:TYPE  NAME  FORMULA  ▸
```

③ Again press the $\overset{\text{ENTER}}{\Box}$ key, then use the ◁ and ▷ keys to produce the following display (FREQ flashes).

```
FREQ  PERIOD  AMPTD  ▸
USER  UNIT:TYPE  NAME  FORMULA  ▸
```

④ This selects the setting type to frequency. Press the $\overset{\text{EXIT}}{\Box}$ key once to release the type select mode.

(2) Set the unit NAME (e.g., rpm)

① Use the ◁ and ▷ keys to produce the following display (NAME flashes).

```
┌─────────────────────────────────────────────────┐
│  U S E R                                          │
│  USER  UNIT : TYPE  [NAME]  FORMULA   ▸           │
└─────────────────────────────────────────────────┘
```

② Press the [ENTER] key, then use the [MODIFY] ◎ dial and ◁ and ▷ keys to input the unit name (e.g., rpm).   Up to 4 of the following characters can be used for the unit name.

a b c d e f g h i j k l m n o p q r s t u v w x y z ▾ (s p a c e)

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9

! " # $ % & ' ( ) * + , − . / : ; < = > ? @ [¥] ^ _ ` { | } → ←

③ After inputting, press the [EXIT] key once to release unit name setting.

(3) Select the FORMULA, for example, (h+n)∗m.   The setting type (e.g., frequency) is h, n is offset, and m is the coefficient.

① Use the ◁ and ▷ keys to produce the following display (FORMULA flashes).

```
┌─────────────────────────────────────────────────┐
│  ( h + n )  ∗ m    ( L o g  ( h )  + n )  ∗ m     │
│  USER  UNIT : TYPE  NAME  [FORMULA]   ▸           │
└─────────────────────────────────────────────────┘
```

② Press the [ENTER] key, then use the ◁ and ▷ keys to produce the following display [(h+n)*m flash].

```
┌─────────────────────────────────────────────────┐
│  [( h + n )  ∗ m]   ( L o g  ( h )  + n )  ∗ m    │
│  USER  UNIT : TYPE  NAME  FORMULA   ▸             │
└─────────────────────────────────────────────────┘
```

③ This sets the formula to (h+n)*m.   Press the [EXIT] key once to release the formula setting mode.

(4) Set the coefficient [SCALE (m)], e.g., to 60

① Use the ◁ and ▷ keys to produce the following display (SCALE (m) flashes).

```
＋1. 00000000000000E＋0
USER  UNIT: ◀  SCALE (m)   OFFSET (n)
```

② Press the ENTER key, then set the scale with the keypad or MODIFY ◎ dial.

③ Press the EXIT key to release the scale setting mode.

(5) Set the offset [OFFSET (n)], for example, to 0
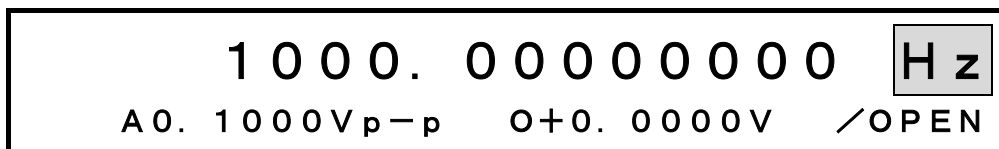
① Use the ◁ and ▷ keys to produce the following display [OFFSET (n) flashes].

```
＋0. 00000000000000E＋0
USER  UNIT: ◀  SCALE (m)   OFFSET (n)
```
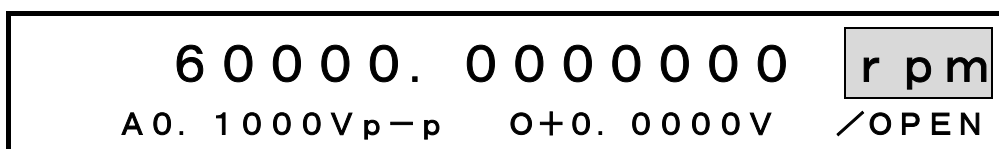
② Press the ENTER key, then set the offset with the keypad or MODIFY ◎ dial.

③ Press the EXIT key to release the offset setting mode.

(6) Display the above settings

① Press the ENTRY key, then the FREQ key.

② Press the ▷ key to produce the following display (Hz flashes).

```
      1000. 00000000  Hz
   A0. 1000Vp－p   O＋0. 0000V  ／OPEN
```

③ Turn the MODIFY ◎ dial to produce the following display.

```
      60000. 0000000  rpm
   A0. 1000Vp－p   O＋0. 0000V  ／OPEN
```

Other:

- User units can be used for frequency, period, amplitude, DC offset, phase and duty. Also, CH1 and CH2 can be set independently.

  However, at the channel mode difference (DIFF) setting, all CH1 user unit settings (formula, name, coefficient and offset) are copied to CH2.

  ☞ 3.3 Basic operation (■Channel modes and settings)

- Even when user units are set, the actual output does not change.

- According to the coefficient and offset settings, setting resolution may be less precise when user units are used.

- When using user units for the DC offset and phase in LOG selection, note the following.

  If a negative value is set before the conversion to user units is made, an attempt is made to calculate the logarithm of a negative value. Since the logarithm of a negative value cannot be a real number, "OVER" is displayed.

  Thereafter, user setup values can be arbitrarily changed. However, the DC offset and phase output to FUNCTION OUT cannot be converted to a negative value while user units are being used.

5.3 Setting memory (MEMORY)

■ **Setting store (MEMORY : STORE)**

Operation is described for saving frequency, amplitude and other settings in memory.

Operation:

① Press the MEMORY key, then use the ◁ and ▷ keys to produce the following display (STORE flashes).

```
STORE  MENU
MEMORY : STORE   RECALL  CLEAR
```

② Press the ENTER key, then use the ◁ and ▷ keys to produce the following display (0 flashes).

```
(NOT  STORED)
STORE : 0   1  2  3  4  5  6  7  8  9
```

③ Press the ENTER key, then apply a desired name to the memory (may also be omitted). Select characters with the MODIFY ◎ dial and shift position with the ◁ and ▷ keys.

Up to 20 characters can be selected from the following list.

a b c d e f g h i j k l m n o p q r s t u v w x y z ▾ (space)
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9
! " # $ % & ' ( ) * + , - . / : ; < = > ? @ [¥] ^ _ ` { | } → ←

④ Press the ENTER key to store the name (in this example, save to memory 0).

The above completes memory storage. Press the EXIT key to release the storage mode.

Other:

• By pressing the keypad at above step ②, name input is omitted and storage is at the memory of the depressed number.

■ **Setting recall (** $\overset{\text{MEMORY}}{\boxed{}}$ **: RECALL)**

Operation to recall settings from memory is described.

Operation:

① Press the $\overset{\text{MEMORY}}{\boxed{}}$ key, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (RECALL flashes).

```
R E C A L L   M E N U
M E M O R Y : S T O R E   [R E C A L L]   C L E A R
```

② Press the $\overset{\text{ENTER}}{\boxed{}}$ key, then use the $\boxed{\triangleleft}$ and $\boxed{\triangleright}$ keys to produce the following display (0 flashes).   In this example, TEST 1 is recalled from memory.

```
T E S T   1
S T O R E : [0]   1   2   3   4   5   6   7   8   9
```
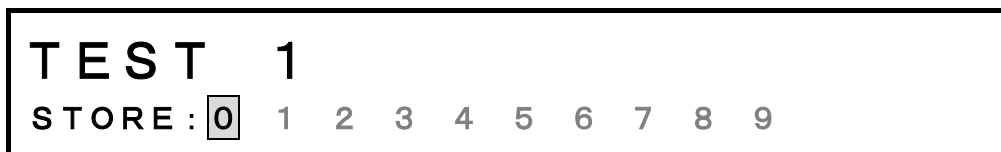
③ Press $\overset{\text{ENTER}}{\boxed{}}$ key for recall.

Other:

• If the keypad is pressed at above step ②, the pressed memory number is recalled.   Only the stored numbers of the keypad light.

• Items stored in the setting memory and user unit settings are noted in Section [3.3 Basic operation, Setting initialize]. The following items do not change before and after recall.

  • Channel selection
  • Output on/off
  • Output on/off state at power on
  • Arbitrary waveform relationship
  • Type of remote control
  • GPIB parameter
  • USB ID

■ Setting memory clear (_{MEMORY} : CLEAR)

Operation to clear the memory is described.   The operation also clears names entered in the memory.

Operation:

① Press the ^{MEMORY} key then use the ◁ and ▷ keys to produce the following display (CLEAR flashes).

```
CLEAR  MENU
MEMORY: STORE  RECALL  CLEAR
```

② Press the ENTER key, then use the ◁ and ▷ keys to produce the following display (0 flashes). In this example, TEST 1 is cleared from memory.

```
TEST   1
CLEAR: 0  1  2  3  4  5  6  7  8  9
```

③ Press ENTER key to clear the memory recall.

Other:

• At above step ②, pressing the keypad clears the corresponding memory number.   Only the stored numbers of the keypad light.

5.4 Other settings

■ Output range change (use with fixed range) (SYSTEM : RANGE)

Operation is described for fixing the voltage output range to 10 V.

Although AUTO is normally used, by fixing the range, output interruption from automatic switching can be avoided.

A disadvantage is during output voltage below 2 Vp-p (open), setting resolution is 1 digit less than the 1 V range.

Operation:

① Press the SYSTEM key, then use the ◁ and ▷ keys to produce the following display (RANGE flashes).
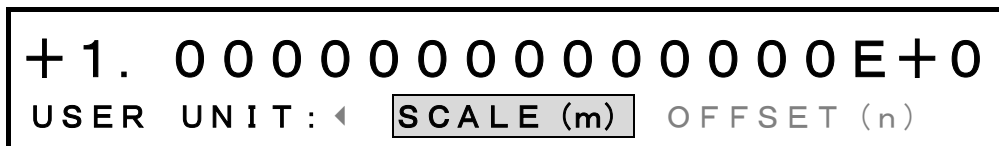
```
AUTO    10V    1V
SYSTEM:RANGE  PRESET  USER-UNIT  ▸
```

② Press the ENTER key, then use the ◁ and ▷ keys to produce the following display (10 V flashes).

```
AUTO    10V    1V
SYSTEM:RANGE  PRESET  USER-UNIT  ▸
```

Other:

• If the output range is set as 1 V when the amplitude setting is larger than 2 Vp-p (open), the amplitude is automatically changed to 1/10 since voltage exceeding 2 Vp-p (open) cannot be output in the 1 V range.

■ **Output on/off at power on (** ⌒SYSTEM **: POWER - ON)**

Selectable return to the state when the power supply was switched off or output on/off state. The example is setting the output for off at power on.

Operation:

① Press the ⌒SYSTEM key, then use the ◁ and ▷ keys to produce the following display (POWER-ON flashes).

```
L A S T − S T A T E   O F F   O N
SYSTEM: ◂  SYNCOUT  POWER−ON  REMOTE
```

② Press the ENTER key, then use the ◁ and ▷ keys to produce the following display (OFF flashes).

```
L A S T − S T A T E   OFF   O N
SYSTEM: ◂  SYNCOUT  POWER−ON  REMOTE
```

■ LOAD function (equalize setting and output values) ($\overset{\text{SYSTEM}}{\frown}$: LOAD)

Operation is described for equalizing the amplitude (AMPTD) and DC offset (OFFSET) setting values with the actual output values (FUNCTION OUT connector voltage).

The example is setting at the 100Ω load impedance.

Operation:

① Press the $\overset{\text{SYSTEM}}{\frown}$ key, then use the ◁ and ▷ keys to produce the following display (LOAD flashes).

```
O P E N
S Y S T E M :  ◂   LOAD   C O P Y 1 → 2   C O P Y 2 → 1   ▸
```

② Press the ENTER key, then turn the MODIFY dial to produce the following display(SET flashes).

```
S E T                          5 0    Ω
S Y S T E M :  ◂   L O A D   C O P Y 1 → 2   C O P Y 2 → 1   ▸
```

③ Press the ▷ key, then turn the MODIFY dial to set the load impedance to 100 Ω.

The above setting calculates the actual voltage of FUNCTION OUT connector from the WF1944B output impedance (50 Ω) and the load impedance for automatically changing the indicated value.

Other:

• The load impedance setting range is 45 to 999 Ω, resolution is 1 Ω.
• The WF1944B output impedance and voltage errors are not converted.

■ UNDO function

The UNDO function is described for returning a numerical or other setting to the previous state.

Operation:

① Press the ⌒UNDO⌒ to return a setting to the previous state (ineffective when UNDO is extinguished).

Other:

• Undo enabled:

1. Directly after changing frequency, amplitude, etc., with the keypad or MODIFY dial.
2. Directly after setting recall (⌒MEMORY⌒ → RECALL).   Press the ⌒UNDO⌒ key to return the state prior to recall.

■ Pulse generator function

Operation of the WF1944B as a pulse generator is described.

Operation:

(1) Set for continuous pulse output

Period: 2 ms

5V

0V
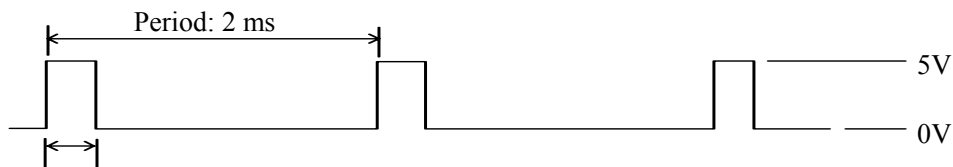
Pulse width: 0.2 ms

① Set the waveform to squarewave (variable duty), (FUNCTION → ⬜).

② Set the voltage High level to +5 V and the Low level to 0 V.
(ENTRY → HIGH → 5 → ENTER , ENTRY → LOW → 0 → ENTER)

③ Set the period to 2 ms (ENTRY → PERIOD → 2 → m).

④ Set the pulse width to 0.2 ms (ENTRY → WIDTH → . → 2 → m).

(2) Use external trigger for pulse output
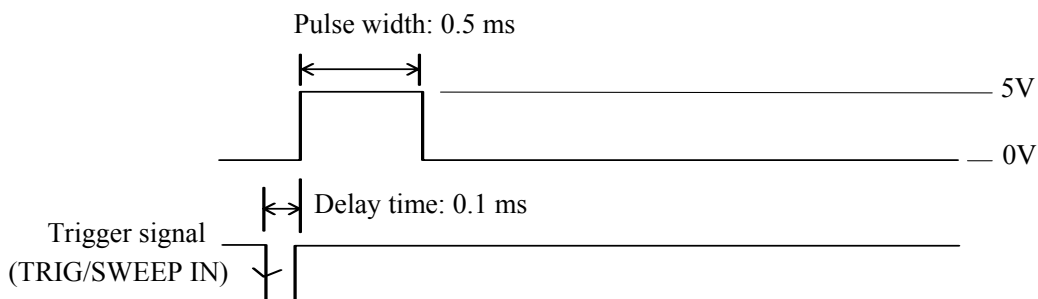
Pulse width: 0.5 ms

5V

0V

Delay time: 0.1 ms

Trigger signal
(TRIG/SWEEP IN)

① Set the waveform to squarewave (variable duty), (FUNCTION → ⬜).

② Set the voltage High level to +5 V and the Low level to 0 V.
(ENTRY → HIGH → 5 → ENTER , ENTRY → LOW → 0 → ENTER)

③ Set the pulse width to 0.5 ms ([ENTRY] → [WIDTH] → [.] → [5] → [m]).

④ Set oscillation mode.

([MODE] → [BURST] →TYPE = TRIG, SOURCE = EXT ⅄ , DELAY = 0.1 ms,

MARK = 1.0 cycle, STOP-LEVEL = ON −100%)

⑤ Apply the trigger signal to the TRIG/SWEEP IN connector.

Other:

• **Double pulse output:** At above step ④, set MARK = 2.0 cycles.

• **Manual trigger:** At above step ④, set SOURCE = EXT ⌐ and press the [MAN TRIG] key.

(Do not connect anything to the TRIG/SWEEP IN connector.)

■ Phase sync (SYSTEM ⌒ : φ SYNC)

Operation is described for restarting the CH1 and CH2 output waveforms from a set phase so as to clarify the phase relationship.

Use when the channel mode is INDEP.

When the channel mode is changed, phase sync is processed automatically.
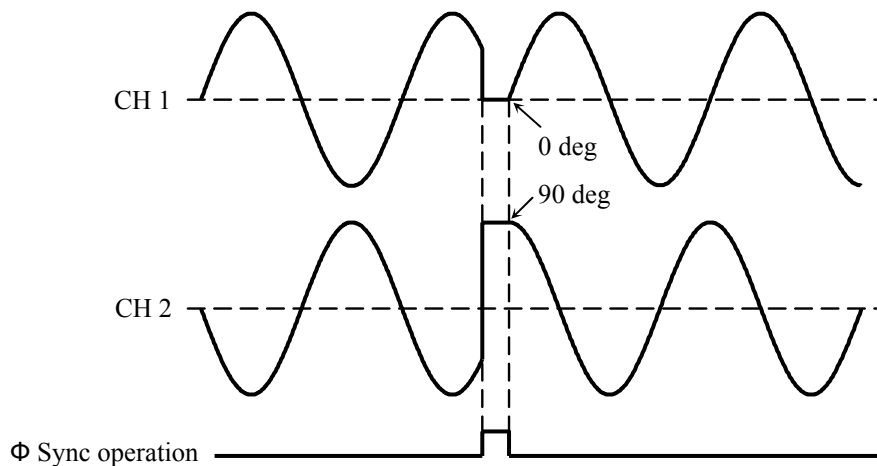
CH1 and CH2 waveform outputs in the INDEP channel mode when the phase is synchronized (CH1 is 0 deg. and CH2 is 90 deg.)

Operation:

① Press the SYSTEM ⌒ key, then use the ◁ and ▷ keys to produce the following display (φ SYNC flashes).

```
ΦSYNC
SYSTEM: ◀  ΦSYNC  DUTY−VALID  ▶
```

② Press the ENTER key to engage phase synchronization.

Other:

• φ sync is effective in Normal oscillation mode. In other modes, the phase may shift 180 degrees and the values of the mark cycle and space cycle settings may change.

■ **Copy settings between channels ($\overset{\text{SYSTEM}}{\frown}$: COPY1 → 2 / COPY2 → 1)**

Operation to copy settings from CH1 to CH2 (or vice versa) is described.

Operation:

① Press the $\overset{\text{SYSTEM}}{\frown}$ key, then the $\boxed{◁}$ and $\boxed{▷}$ keys to produce the following display (COPY 1 → 2 flashes).

```
COPY  CH1 → CH2
SYSTEM: ◀  LOAD  COPY1→2  COPY2→1  ▶
```
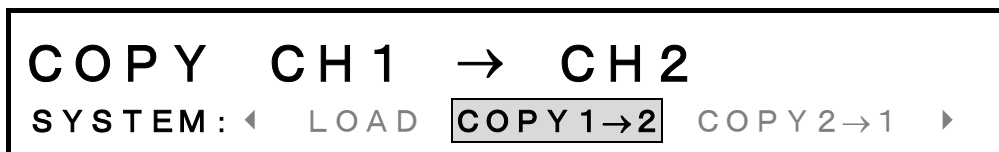
② Press the $\boxed{\text{ENTER}}$ key, COPY CH1 → CH2 flashes. Then again press the $\boxed{\text{ENTER}}$ key to copy between the channels.

This completes setting copy.

To copy from CH2 to CH1, at above step ①, flash COPY 2→1.

Other:

• The following items do not change before and after copying.
   • Channel select
   • Output on/off
   • Arbitrary waveform parameter
   • User units related : When the copy from settings are user units, the copy to settings are also user units. When user units are used for the respective channel settings (formula, name, coefficient, offset), the settings are determined so as to provide uniform final output values.
   • Type of remote control
   • GPIB related
   • USB ID

■ Fixed frequency difference (2TONE) (⬡ CHANNEL MODE : 2TONE)

Following is a description of the 2 tone channel mode whereby a fixed frequency difference is maintained between CH1 and CH2.

In this mode, if the frequency of either channel is changed, the frequency of the other channel is automatically changed to maintain the fixed difference.

Operation:

(1) Set the channel mode to 2 tone.

① Press the ⬡ CHANNEL MODE key, then the ◁ and ▷ keys to produce the following display (2 TONE flashes).

```
I N D E P   2 P H A S E   2 T O N E     ▸
S E L E C T   C H A N N E L   M O D E
```

② Press the ENTER key to select this channel mode.

(2) Set the frequency difference (ΔFREQ) between CH2 and CH1.

① Press the ENTRY key, then the △FREQ key.

② Set the frequency difference with the keypad or ◎ MODIFY dial.

③ Press the EXIT key once to release the setting mode.

Other:

• If the frequency difference (Δ FREQ) is changed, the frequency of CH2 changes.

• The frequency difference (Δ FREQ) cannot be a negative value.

• If the channel mode is set to the fixed frequency difference (2TONE), the frequency of CH2 changes according to the frequency difference (Δ FREQ).

■ Fixed frequency ratio (RATIO) (CHANNEL MODE : RATIO)

Following is a description of the ratio channel mode whereby a fixed frequency ratio is maintained between the frequencies of CH1 and CH2 (or vice versa).

In this mode, if the frequency of either channel is changed, the frequency of the other channel is automatically changed to maintain the fixed ratio.

Operation:

(1) Set the channel mode to ratio

① Press the CHANNEL MODE key, then the ◁ and ▷ keys to produce the following display (RATIO flashes).

```
┌────────────────────────────────────────┐
│  ◀   R A T I O   D I F F                 │
│  S E L E C T   C H A N N E L   M O D E   │
└────────────────────────────────────────┘
```

② Press the ENTER key to select this channel mode.

(2) Set the frequency ratio between CH2 and CH1.

① Press the ENTRY key, then the RATIO key.

```
                    CH 1                         CH 2
┌────────────────────────────────────────────────────┐
│   R   0 0 0 0 0 0 1 : 0 0 0 0 0 0 1                  │
│  1 0 0 0 . 0 0 0 0 0 0 0 H z   A 0 . 1 0 0 0 V p−p ／O P E N │
└────────────────────────────────────────────────────┘
```
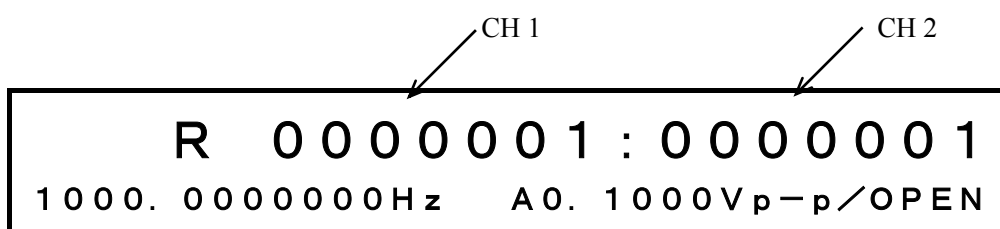
② Select the affected channel with the ◁ and ▷ keys, then set the frequency ratio with the keypad or MODIFY ⊙ dial.

③ Press the EXIT key once to release the setting mode.

Other:

• During ratio, the frequency resolution = 10 nHz × set ratio.

• If the channel mode is set to the fixed frequency ratio (RATIO), the frequency of CH2 changes according to the frequency ratio (RATIO).

Section 6   Troubleshooting

6.1 Error message

Self-check is conducted at power on and in case of an abnormality, an error message is displayed.   An error message is also displayed if an erroneous operation is conducted.

Error message contents, causes and corrective measures are indicated in the following tables.

■ Power on error

Error message	Cause	Corrective measures
BACKUP MEMORY LOST	Battery backup memory contents destroyed.	Backup battery probably depleted. Contact dealer. Press the ENTER key to start the system at the factory settings.
CALIBRATION MEMORY LOST	Calibration data destroyed.	Contact dealer. Although possible to start by pressing the ENTER key, accuracy cannot be guaranteed.
SYSTEM TEST FAILED 001	Internal ROM sum check error.	Contact dealer.
SYSTEM TEST FAILED 002	Internal RAM read/write error.	Contact dealer.

■ Operation error

Error message	Cause or corrective measures
DATA OUT OF RANGE	Input values outside of permissible setting range. Confirm permissible setting range and again input. Upper and lower limits can be easily checked by using the MODIFY dial to change the values.
INVALID NUMERIC DATA	Keypad input data invalid (e.g., decimal point only).
SETTINGS CONFLICT 001	Start or stop value set to 0 during LOG sweep and sweep cannot be executed.
SETTINGS CONFLICT 002	Combined center and span exceed the permissible sweep type (e.g., frequency) setting range.
SETTINGS CONFLICT 003	Combined modulation type (e.g., frequency) and Deviation exceed the permissible modulation type setting range and modulation cannot be executed.
SETTINGS CONFLICT 004	Combined modulation type (e.g., frequency) and Deviation exceed the permissible modulation type setting range.
SETTINGS CONFLICT 007	Combined period and pulse width exceed the permissible duty setting range.
SETTINGS CONFLICT 008	Combined frequency (FREQ) and frequency difference (ΔFREQ) or frequency ratio (RATIO) settings exceed the permissible frequency setting range.
SETTINGS CONFLICT 010	Since the mode is SWEEP or MODU for ⊓＿ (variable duty), DUTY-VALID cannot be set.

Error message	Cause or corrective measures
STORE/RECALL MEMORY LOST	Setting storage memory contents destroyed and settings cannot be recalled. Contact dealer.
WARNING 001	Combined frequency and duty set the pulse width to not more than 25 ns and the pulse may be lost.
WARNING 002	Combined frequency and duty set the pulse width to 25 and 100 ns and pulse width may be unstable (large jitter component).
WARNING 003	Since high frequency, burst oscillation mark and space may be unstable.
WARNING 004	Low level setting changed due to high level setting change, or conversely, high level setting changed due to low level setting change.
WARNING 005	Changed to simple standard units (Hz, s, Vp-p, V).
WARNING 006	Since combined period and pulse width exceed the permissible duty setting range, pulse width was changed in order to enter the permissible duty range.
WARNING 007	Changing the frequency relationship exceeded the permissible frequency setting range for the other channel. Therefore, the frequency relationship of both channels was changed to within this range.
WARNING 008	Because of channel mode change, the oscillation mode was changed to normal.

continued from previous page

Error message	Cause and treatment
WARNING 009	Due to channel mode change, the oscillation mode was changed to normal. The sweep/modulation type was changed to frequency. Therefore the other channel sweep/modulation was changed to frequency. Sweep/modulation type was changed to a type other than frequency, or the oscillation mode was changed to other than sweep/modulation. Therefore, the oscillation mode of the other channel was changed to normal.
WARNING 010	The sweep function was changed from LOG to LIN.
WARNING 011	The sweep mode was changed from gated to single.
WARNING 012	Since the oscillation mode of the other channel was changed during sweep or modulation, sweep or modulation was stopped.
WARNING 013	Sweep time or modulation frequency exceeded the settable range and was automatically changed to within the permissible setting range.
WARNING 015	Because of DUTY-VALID change, the duty was changed to 0.01% or 99.99%.
WARNING 017	Because of a mode change, DUTY-VALID was changed to IMMED.

6.2 Suspected failure

■ In case of abnormality

If an abnormality is suspected, check as indicated in the following table. If normal operation cannot be returned, contact the dealer.

Symptom	Possible causes	Correction
No power on	Power source not within specified range	Use the power source within the specified range.
	Power supply fuse open	Replace the power supply fuse. (Be sure to use the correctly rated fuse.)
	External noise	Install the equipment in a site with favorable conditions.
Panel inoperative	Remote mode enabled	Press the LOCAL key to set the local mode.
	Keys or Modify dial defective	Contact service.
Output abnormal	Ambient temperature and humidity outside specified range	Use the equipment under the specified environmental conditions.
	Inadequate warm up	Allow the equipment to warm up for at least 30 minutes after power on.
	DC offset applied	Set DC offset to 0 V.
	Set for user units	Select standard units
	LOAD function being used	Set for OPEN.
Cannot be set via remote control	Address or USB ID different from that in the program	Set the address and USB ID to match those in the program.
	Address or USB ID identical to that of another device	Set the address and USB ID so that they do not match those of other devices.
Does not operate according to instruction manual	Settings have been initialized (PRESET)	The instruction manual presumes the settings have been initialized.
	Operated channel reversed	Check if CH1 or CH2.

Section 7   Maintenance

7.1 Outline

■ Work contents

The following types of maintenance are required in order to use the equipment in optimum condition.

- Inspection   Check that the equipment is operating correctly.
- Performance tests   Check that the equipment meets specifications.
- Adjustment and calibration   When the equipment does not meet specifications, it is adjusted and calibrated in order to restore performance at the manufacturer.
- Service   Cause and location of failure are investigated and repair is conducted at the company.

This operation manual provides easily carried out procedures for inspection and performance checks. Consult the manufacturer or dealer regarding more thorough inspection, adjustment, calibration and repair.

> ### ⚠ WARNING
>
> **Do not remove external covers.**
>
> **Internal inspection of this equipment must be performed only by a trained service technician who is fully aware of the hazards involved.**

■ Required test instruments

The following equipment is required for inspection and performance tests.

- Oscilloscope   At least 100 MHz bandwidth
- Universal counter   Reference oscillator accuracy better than 5×10^{-7}
- DC voltmeter   Accuracy better than 0.1 %
- AC voltmeter 1   True rms, accuracy better than 0.3 %, bandwidth at least 100kHz, recommended: Keithley Model 2001
- AC voltmeter 2   True rms, accuracy better than 1 %, bandwidth at least 20MHz, recommended: Boonton Model 9200C+952016+952002
- Distortion meter   Full scale 0.1 %, frequency up to 100 kHz
- 50 Ω feed through terminator
- 50 Ω 20 dB attenuator

7.2 Operation checks

■ Preparatory checks

Check the following before inspection.

- Power source voltage is within specified range.
- Ambient temperature is within 5 to 35 °C.
- Ambient relative humidity is within 5 to 85 %RH (absolute humidity: 1 to 25 g/m^3)
- Condensation is absent.

■ Function checks

- Power on

  Confirm absence of error message at power on.

  If an error message appears, ☞ 6. Troubleshooting.

  If an abnormal indication appears at power on, switch power off and wait at least 5 seconds, then again switch power on.

- Main function checks

  To avoid setting error, initialize the settings (SYSTEM → PRESET).

  Connect FUNCTION OUT to an oscilloscope with 50 Ω coaxial cable to monitor the output.

  Operate to change the following settings several times and confirm normal functions.   Test both keypad and MODIFY dial for settings such as frequency.

  ・Frequency (ENTRY → FREQ)

  ・Amplitude (ENTRY → AMPTD)

  ・DC offset (ENTRY → OFFSET)

  ・Waveform (FUNCTION → ⌒ , ⌒ , ⊓ Duty fixed 50 %, ◺ , ◿)

  ・Duty (FUNCTION → ⊓ Variable duty, ENTRY → DUTY)

  ・Output on/off (CH 1 OUT ON/OFF , CH 2 OUT ON/OFF)

● Backup function

Switch off the power, wait at least 5 seconds, then switch the power on.

Confirm the settings for the following items prior to switching off the power have been correctly saved.

・Frequency

・Amplitude

・DC offset

・Waveform

・Duty

If stored at room temperature, the backup period is typically 3 years, but may vary among individual units and usage conditions.

To prevent any loss of setting information resulting from a depleted battery, regular battery replacement is recommended.

● GPIB/USB

Conduct some of the main function checks via GPIB/USB and confirm the same output variations.

Also note that the remote (REM) indicator lights.

Press the LOCAL key and confirm the remote indicator extinguishes and the local mode is returned (not local lock out).

7.3 Performance tests

■ Performance tests

Performance tests are an important part of preventive maintenance and serve to prevent serious deterioration of the equipment performance.

Conduct these tests at incoming inspection, routine inspection, following repair and whenever performance needs to be confirmed.

When specifications are not met in performance tests, service is required.   Contact the dealer.

■ Preparatory checks

Check the following before testing performance.

- Power source voltage is within specified range.
- Ambient temperature is 23 ± 5 °C.
- Ambient relative humidity is within 20 to 70 % RH.
- Condensation is absent.
- Allow at least 30 minutes warm up.

■ Test preparation

- Signal cables are 50 Ω coaxial, RG-58A/U or thicker, less than 1 meter length and fitted at both ends with BNC connectors.
- Where items call for 50 Ω termination, set the input impedance of the connected instrument to 50 Ω. Where this is impossible, use a 50 Ω feed through terminator at the test instrument input.
- Initialize the settings for each test item ([SYSTEM] → [PRESET]), set the output on (key internal LED lights according to [CH 1 OUT ON/OFF] or [CH 2 OUT ON/OFF]) and the item to be changed is indicated.

■ Frequency accuracy

Connection: Use coaxial cable to connect FUNCTION OUT to a universal counter (50 Ω termination).

Setting: Initialize, then set frequency to 1 MHz and amplitude to 20 Vp-p/open.

Measurement: Measure frequency with the universal counter (CH1).

Judgment: Normal if within ±5 ppm (999.995 to 1.000005 MHz) (when shipped)

However, since aging may occur with up to ±3 ppm/year, deterioration up to ±8 ppm (999.992 to 1.000008 MHz) may have occurred if one year has passed since shipment.

■ Amplitude accuracy

Connection: Use coaxial cable to connect FUNCTION OUT to AC voltmeter 1.

Setting: After setting initialize, set the amplitude, output range and waveform as indicated in the following table.

Measurement: Measure the true rms output voltage for each waveform. (CH1,CH2)

Judgment: The normal ranges are indicated in the table.

Waveform	Output range	Setting	Normal range
∿	10 V	20 Vp-p/open (7.071 Vrms/open)	7.004 to 7.138 Vrms
∿, ⟋, ⟍	10 V	20 Vp-p/open (5.774 Vrms/open)	5.719 to 5.828 Vrms
⊓_	10 V	20 Vp-p/open (10.00 Vrms/open)	9.905 to 10.095 Vrms
∿	10 V	10 Vp-p/open (3.536 Vrms/open)	3.493 to 3.578 Vrms
∿	10 V	5 Vp-p/open (1.768 Vrms/open)	1.738 to 1.798 Vrms
∿	10 V	2 Vp-p/open (0.707 Vrms/open)	0.684 to 0.730 Vrms
∿	1 V	2 Vp-p/open (0.7071 Vrms/open)	0.699 to 0.716 Vrms

■ DC offset accuracy

Connection: Connect FUNCTION OUT to a DC voltmeter.

Setting: After setting initialize, set the DC mode, output range and DC offset as indicated in the following table.

Measurement: Measure the output voltage. (CH1,CH2)

Judgment: The normal ranges are indicated in the table.

Output range	DC offset setting	Normal range
10 V	±10.000 V/open	±9.880 to ±10.12 V
10 V	±5.000 V/open	±4.905 to ±5.095 V
10 V	±2.000 V/open	±1.920 to ±2.080 V
10 V	±1.000 V/open	±0.925 to ±1.075 V
10 V	0.000 V/open	−0.070 to +0.070 V
1 V	±1.0000 V/open	±0.985 to ±1.015 V
1 V	0.0000 V/open	−0.010 to +0.010 V

■ **Amplitude vs. frequency characteristics**

Connection: Use coaxial cable to connect FUNCTION OUT to AC voltmeter 2 (50 Ω termination).

Setting: Initialize, then set the amplitude to 20 Vp-p/open and select the frequency and waveform as indicated in the table.

Measurement: Measure the true rms output voltage for each frequency and waveform. (CH1,CH2)

Judgment: The normal ranges are indicated in the table.

Waveform	1 kHz Setting	to 500 kHz	to 1 MHz	to 3 MHz	to 10 MHz	to 15 MHz
$\sim$	(Reference value)	+0.2/-0.3 dB	+0.2/-0.3 dB	+0.35/-0.7 dB	+0.5/–1.5 dB	+0.5/–2.0 dB
$\wedge$	(Reference value)	±0.3 dB	————	————	————	————
$\sqcap$	(Reference value)	±0.3 dB	±0.3 dB	————	————	————
$\diagup$	(Reference value)	±0.5 dB	————	————	————	————
$\diagdown$	(Reference value)	±0.5 dB	————	————	————	————

■ **Sinewave distortion**

Connection: Use coaxial cable to connect FUNCTION OUT to a distortion meter (50 Ω termination).

Setting: Initialize, then set the amplitude to 20 Vp-p/open and the frequency as indicated in the table.

Measurement: Measure the distortion (CH1,CH2)

Judgment: The normal range is indicated in the table.

Frequency	Normal range
10 Hz to 100 kHz	0.2 % or less

(Bandwidth 500 kHz)

■ Squarewave response

Connection: Use coaxial cable to connect FUNCTION OUT to an oscilloscope (50 Ω termination).

Setting: Initialize, then set ⌐L , frequency to 1 MHz and amplitude to 20 Vp-p/open.

Measurement: Observe the waveform and measure the rise and fall times, overshoot and undershoot.

Judgment: The normal range is indicated in the table.

Item	Normal range
Rise and fall times	20 ns or less
Overshoot and undershoot	5 % or less
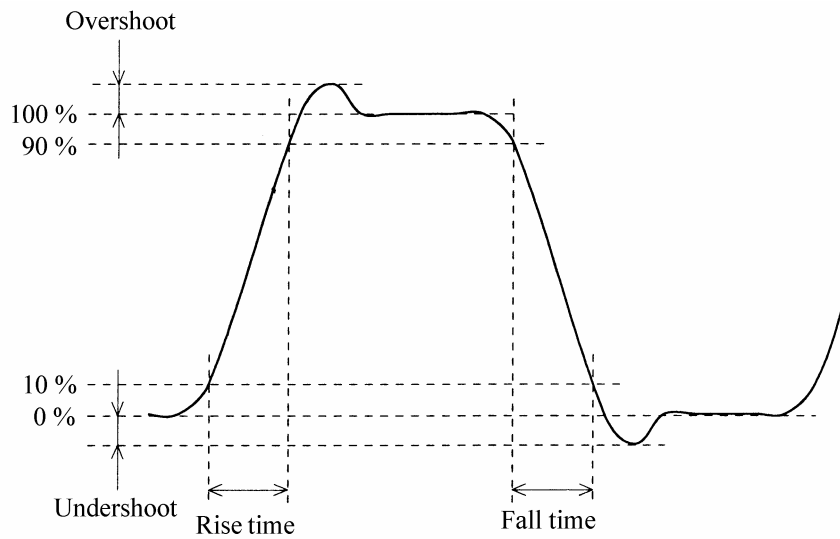
■ Duty factor

Connection: Use coaxial cable to connect Function Out to a universal counter (50 Ω terminated).

Settings: Initialize the settings, then set amplitude to 20 Vp-p, and waveform and frequency according to the following table.

Measurement: Set the counter rise and fall period to the interval timer mode and measure the duty (time).   Use the average value, since jitter will cause dispersion in the measurement values.

Determination: The ranges indicated in the following table are normal.

Waveform	Frequency	Rated range
⌐L (duty 50 % fixed)	1 MHz	490 to 510 ns
⌐L (duty 50 % fixed)	10 MHz	47.0 to 53.0 ns
⌐L (duty 50 % fixed)	15 MHz	30.0 to 36.7 ns
⌐L (duty variable)	100 kHz	4.90 to 5.10μ s

■ **Time difference between channels**

Connections:	CH1 Function Out to universal counter input 1 (50 Ω terminated)
	CH2 Function Out to universal counter input 2 (50 Ω terminated)
	Use the same length and same type coaxial cables.
Settings:	After setting initialize, set channel mode 2PHASE, amplitude 20 Vp-p/open (CH1 and CH2), CH2 phase 180 deg, and frequency and waveform according to the following table.
Measurement:	Set timer mode between counter inputs 1 and 2, and measure the time difference between CH1 and CH2. Set the counter trigger level to 0 V and the trigger polarity to rising for both inputs 1 and 2. Use the average value, since dispersion occurs in the measured values.
Determination:	The ranges indicated in the following table are normal.

Waveform	Frequency	Rating range
∿	10 MHz	40 to 60 ns
⊓_ (duty 50 % fixed)	10 MHz	40 to 60 ns
╲	500 kHz	990 to 1010 ns

Section 8   Specifications

Guaranteed values are shown with tolerance, values without tolerance are for reference.

8.1 Waveform and output characteristics

● **Waveforms (FUNCTION OUT)**

Output waveforms	$\sim$, $\wedge$, $\sqcap\!\!\!\llcorner$ (Duty 50 % fixed), $\!\!\sqcap\!\!\llcorner$ (Duty variable), $\diagup$, $\diagdown$, arbitrary waveform (ARB), and noise (NOISE), DC voltage (DC)
Waveform vertical resolution	14 bit ($\sim$, $\wedge$, $\diagup$, $\diagdown$, arbitrary waveform (ARB))

Output waveform and frequency

For continuous oscillation
$\sim$, $\sqcap\!\!\llcorner$ (duty 50% fixed) : 0.01 μHz to 15 MHz

$\wedge$, $\!\!\sqcap\!\!\llcorner$ (duty variable), $\diagup$, $\diagdown$: 0.01 μHz to 500 kHz

Arbitrary waveform : 0.01 μHz to 500 kHz   However, the frequency in which all the data of arbitrary waveforms can be outputted is the maximum of the following value.

(40MHz) ÷ [waveform data size (words)]

Analog band width 10MHz

For burst, trigger,
gate, triggered gate,
or gated sweep   0.01 μHz to 500 kHz

Frequency

Range	0.01 μHz to 15 MHz
Resolution	0.01 μHz
Accuracy when shipped	±5 ppm
Aging	±3 ppm/year

Setting by period   Frequency equivalent to inverse number of the setting period.
If the number is less than 0.01 μHz, the number should be rounded off.

Duty

Range	0.0100% to 99.9900%/0.0000% to 100.0000% switching
Resolution	0.0001 %

Arbitrary waveform data size   Can be switched among 8 K, 16 K, 32 K, and 64 K words.
1 K words equal 1024 words.

Number of arbitrary waveforms   Number of arbitrary waveforms that can be select, and
waveforms are backed up.
12 waveforms for 8 K words/6 waveforms for 16 K words/
3 waveforms for 32 K words/1 waveforms for 64 K words

Arbitrary waveform data   Point specification and linear interpolation by the panel operation
edit   or data writing by GPIB or USB

Arbitrary waveform data   16 bits (-32768 to 0 to +32767)
resolution   For output waveform, upper 14 bits are output.

Noise	Noise source: pseudo-M-series by 42-step shift register

Noise   Noise source: pseudo-M-series by 42-step shift register
                              Period 30.518 hours, Spectrum interval
                              9.1022 μHz
                              White noise bandwidth (equivalent noise bandwidth): about
                              500 kHz
                              Peak factor (crest factor): 6
                                  Amplitude can be set in Vp-p.
                                  rms value = (Vp-p set point) ÷ 2 ÷ (peak factor)
                              Binary output: Outputs from SYNC OUT during NOISE mode.

● Output characteristics (FUNCTION OUT)

Amplitude frequency   Continuous oscillation, 50 Ω load, DC offset 0 V, amplitude
characteristics   setting 10 Vp-p/50 Ω, normalized frequency 1 kHz, effective
                              rms value measurement
                              ∿   Up to 1 MHz: +0.2 dB, −0.3 dB
                                        1 MHz to 3 MHz: +0.35 dB, −0.7 dB
                                        3 MHz to 10 MHz: +0.5 dB, −1.5 dB
                                        10 MHz to 15 MHz: +0.5 dB, −2.0 dB
                              ⊓_   Up to 1 MHz: ±0.3 dB
                              ∧   Up to 500 kHz: ±0.3 dB
                              ⟋, ⟍   Up to 500 kHz: ±0.5 dB

∿ spectrum purity   Continuous oscillation, 50 Ω load, DC offset 0 V,
                              amplitude setting   10 Vp-p/50 Ω,

   Total harmonic distortion 10 Hz − 100 kHz: 0.2 % and below (bandwidth: 500 kHz)
   Harmonic spectrum   100 kHz to 1 MHz: −50 dBc and below
                              1 MHz to 15 MHz: −30 dBc and below
   Spurious output   Up to 15 MHz: −35 dBc and below

⊓_ waveform characteristics   Continuous oscillation, 50 Ω load, DC offset 0 V,
                              amplitude setting 10 Vp-p/50 Ω,
                              Rise and fall time: 20 ns and below
                              Overshoot: 5 % and below

Duty   Continuous oscillation, 50 Ω load, DC offset 0 V,
                              amplitude setting 10 Vp-p/50 Ω
                              ⊓_ (50 % fixed duty)
                                          Up to 1 MHz: ±1 % of the period
                                          1 MHz to 10 MHz: ±3 % of the period
                                          10 MHz to 15 MHz: ±5 % of the period
                              ⊓_ (duty variable)
                                          Up to 100 kHz: ±1 % of the period
                                              Jitter: 30 nsp-p and below

8.2 Output voltage

- ## Output voltage (FUNCTION OUT)

Output range	10 V range / 1V range fixed, or automatic switchable
Amplitude	
Range	10 V range : 0 mVp-p to 20.000 Vp-p/open
	1 V range : 0.0 mVp-p to 2.0000 Vp-p/open
Resolution	10 V range : 1 mVp-p/open
	1V range : 0.1 mVp-p/open
Accuracy	Continuous oscillation.$\sim$, 1 kHz, rms value measured
	10 V range : $\pm$ [0.7 % of amplitude setting (Vp-p) + 0.05 Vp-p]/open
	1 V range : $\pm$ [0.7% of amplitude setting (Vp-p) + 0.01 Vp-p]/open
DC offset	
Range	10 V range : $\pm$10.000 V/open
	1 V range : $\pm$1.0000 V/open
Resolution	10 V range : 1 mV/open
	1 V range : 0.1 mV/open
Accuracy	DC mode
	10 V range : $\pm$ (0.5% of DC offset setting [V] + 0.07 V)/open
	1 V range : $\pm$ (0.5% of DC offset setting [V] + 0.01 V)/open
Amplitude and DC offset limiting	If output voltage exceeds the following value, the OVER light blinks and the output may be clipped.
	10 V range : 11 V/open
	1 V range : 1.1 V/open
Output impedance	50 Ω, unbalanced
Load impedance	45 Ω and more
Output connector	Front panel, BNC receptacle (FUNCTION OUT)
Others	Output voltage can be set with high and low level buttons.

- ## SYNC OUT Output voltage (SYNC OUT)

Output voltage	0/+5V (open)
Output waveform	⊓⌐
Rise/fall time	2.5 ns
Output impedance	50 Ω, unbalanced
Load impedance	45 Ω and more
Output connector	Front panel BNC receptacle (SYNC OUT)

8.3 Other functions

● **Burst**

Oscillation modes	Burst, gate, trigger and trig'd gate
	(Trig'd gate: gate on/off at each trigger)
Mark wave number	0.5 to 500000.0, 0.5 cycles
	(The mark wave number is the oscillation wave number at the time of burst and trigger).
Space wave number	0.5 to 500000.0, 0.5 cycles
	(Space wave number is the stop wave number at the time of burst).
Phase	Phase from oscillation stop to oscillation start
Range	−1800.000° to +1800.000°
Resolution	0.001°
Trigger source	Selectable internal trigger oscillator or external trigger input.
	Trigger can be applied from the panel keys or via remote control (GPIB or USB).
	The external trigger of CH1 can also be selected as the CH2 trigger source.
External trigger	
Polarity	Trigger: Rising or falling edge selectable
	Gate: Positive or negative logic selectable.
	Trig'd gate: Rising or falling edge selectable
Input level	High level ≥ +3.9 V, low level ≤ +1.6 V
Minimum pulse width	50 ns
Input impedance	At 10 kΩ, pull up to +5 V.
Input connector	Front panel BNC receptacle (TRIG/SWEEP IN)
Internal trigger oscillator period	
Range	1µs to 100.0 s
Resolution	4 digits at 1 ms and more, 1 µs at less than 1 ms.
Trigger delay	
Range	0.3 µs to 100.00 s
Resolution	5 digits at 1 ms and more, 0.1 µs at less than 1 ms.
	Oscillation mode: Effective with trigger.
Trigger jitter	Less than 50 ns
Oscillation stop level	On and off settable
	Off: stops at set phase.
	On: stops at set stop level.
Range	−100.0 % (maximum negative output) to +100.0 % (maximum positive output),
Resolution	0.01 %

● **Sweep**

Sweep items	frequency and phase
Setting items	Sweep start/stop or sweep center/span
	Sweep start and stop conditions
Sweep functions	Continuous / single / gated sweep
	LIN/LOG (LOG is available frequency only)
	$\wedge$ / $\diagup$ / $\sqcap$ / $\sim$
Sweeping time	
Range	1 ms to 10000.000 s (during 2 channel independent, sweep or modulation of only one of the channels)
	2 ms to 10000.00 s (other times)
Resolution	1 ms
Sweep trigger	Indicates start of single / gated sweep.
Sweep trigger period	100 ms and more (If applying less than 100 ms, trigger is at 100 ms intervals).
Trigger source	Selectable internal trigger oscillator or external trigger input. Also, applicable from panel keys and via remote control (GPIB or USB)
	The CH1 external trigger can also be selected for the CH2 trigger source.
External trigger	
Polarity	Selectable rise/fall.
Input connector	Front panel, BNC receptacle (TRIG/SWEEP IN)
Minimum pulse width	200 ns
Trigger delay	2 ms
Internal trigger oscillator period	
Range	1 μs to 100.0 s
Resolution	4 digits at 1 ms and more, 1 μs at less than 1 ms.
Oscillation stop level	On/off setting effective during gated sweep.
	(However, ineffective and fixed at off if the sweep item is duty)
	Off: stop at set phase.
	On: stop at set stop level.
Range	−100.00 % (maximum negative output) to +100.00 % (maximum positive output)
Resolution	0.01 %

● **Sweep input/output**

Sweep trigger input

Input level	High level ≥ +3.9 V, low level ≤ +1.6 V
Signal characteristic	Single/gated sweep start at rising or falling edge (selectable)
Minimum pulse width	200 ns.
Input impedance	At 10 kΩ, pulling up to +5 V
Input connector	Front panel, BNC receptacle (TRIG/SWEEP IN)
	Combined use with trigger input for gate, trigger and trig'd gate

Synchronous sweep output

Output level	0/+5 V (open)
Signal characteristics	Low level: sweeping from start to stop
	High level: Other times
	(If ⟋ sweep, high level for about 0.2 ms to 0.5 ms directly before quick change from stop to start.)
Output impedance	50 Ω, unbalanced
Load impedance	45 Ω and more
Output connector	Front panel, BNC receptacle (SYNC OUT)
	Combined use with SYNC OUT

● **Internal modulation functions**

Modulation items	FM (FSK), PM (PSK)
Internal modulation frequency	
Range	0.1 mHz to 500.00 Hz (2 channel independent, sweep and modulation of only one channel)
	0.1 mHz to 250.00 Hz (other times)
Resolution	5 digits at 1 Hz and more, 0.1 mHz at less than 1 Hz.
Internal modulation waveform	∿, ⌄, ⊓, ⟋, ⟍

- **Channel operation**

Channel modes	2-channel independent/2 phase (same frequency)/fixed frequency ratio/fixed frequency difference/differential output (same frequency, amplitude, DC offset, reverse waveform)
Phase	Common with start phase during burst, gate, trigger, triggered gate and gated sweep.
Range	$-1800.000°$ to $+1800.000°$ (not effective for the differential output).
Resolution	$0.001°$
Time difference between channels	Less than ±10 ns during continuous oscillation, 50 Ω load, DC offset 0 V, amplitude setting 10 Vp-p/50 Ω, same waveform, 2-phase channel mode.
Frequency difference	Valid in fixed frequency difference mode. The frequency difference between CH2 and CH1 is set.
Range	0.00 μHz to 14.99999999999999 MHz
Resolution	0.01 μHz
Frequency ratio	Valid in fixed frequency ratio mode. The CH1 and CH2 frequency ratio is set in the form N:M.
Range	N and M are respectively 0000001 to 9999999.
Resolution	1 (Frequency resolutions are $N \times 0.01$ μHz and $M \times 0.01$ μHz respectively).
Phase synchronization	Manual or remote control (GPIB or USB) Automatic when changing channel mode. (Function restarts all channel output waveforms from the set phase. Used to clarify phase relationship. Effective for all connected channels during synchronous operation.)
Simultaneous setting	Function for making a setting for two channels simultaneously
Others	Copies the CH2 setting to CH1 Copies the CH1 setting to CH2

- **Setting initialization**

Functions	Initializes nearly all setting contents. Initialization setting, ☞ 3.3 Basic operation (Initialization table).

● **User-unit function**

Function	Converts to desired units for set up and display.
Setting items	Frequency, period, amplitude, DC offset, phase and duty.
Coefficient setting	Select either [(internal set up) + n] × m, or
	[$\log_{10}$ (internal set up) + n] × m; then, set the value of n and m.
	Frequency and period: 15 digits mantissa and 1 digit index (both m and n)
	Amplitude, DC offset, and duty.: 6 digits mantissa and 1 digit index (m and n)
	Phase : 7 digits mantissa and 1 digit index
Unit character string	Alphanumeric and 34 symbols
	Set up and display up to 4 characters.

● **Load function**

Function	Set up and display at actual voltage for an arbitrary load
	Conversion formula:
	(Output voltage at load) = (Output voltage at no-load) ×

$$\frac{\text{(Load impedance)}}{\text{(Output impedance} : 50\,\Omega) + \text{(Load impedance)}}$$

Load impedance	
Range	45 Ω to 999 Ω
Resolution	1 Ω

● **Output on/off**

Function	Output switched on/off
Output off state	FUNCTION OUT: open.
	SYNC OUT: TTL three states high impedance.
Power on state	Selectable return to the state when the power supply was switched off or output on/off state.

● **Setting memory, Backup**

Setting memory	Nearly all setting items can be stored and recalled.
	10 sets from 0 to 9
Backup	Battery back up for nearly all settings prior to power off.
Backup period	Three years and more under normal temperature.
Battery	Lithium cell
Operation when battery depleted	Error at power on and settings are initialized.
	Setting memory and arbitrary waveform memory are initialized.
	Battery needs replacement (fee charged)

8.4 Initialized settings

● **Initialized settings**

Initialization setting, ☞ 3.3 Basic operation (Initialization table).

● **Error from backup battery depletion**

In addition to setting initialization, following are set:

Output on/off	Off
Output on/off in turning on	LAST-STATE (condition just before power off)
Setting memory	ALL NOT STORED
Setting memory comment	" " (blank)
User unit name	USER
User unit computation formula	(h+n)*m
User unit coefficient	1
User unit offset	0
Arbitrary waveform selection	0: ARB_00
Arbitrary waveform name	ARB_00 ~ ARB_11
Arbitrary waveform data size	8 K
Arbitrary waveform data	All 0
Remote control interface	GPIB
GPIB address	2
GPIB delimiter	CR+LF
USB ID	2

8.5 Remote control

- ## GPIB interface

GPIB function	SH1	All source handshake functions
	AH1	All acceptor handshake functions
	T6	Basic talker, serial poll, talker release by MLA
	L4	Basic listener, listener release by MTA
	SR1	All service request functions
	RL1	All remote/local functions
	PP0	No parallel poll functions
	DC1	All device clear functions
	DT1	All device trigger functions
	C0	No controller functions
Use code		ISO 7 bit codes (ASCII code)
Address		0 to 30 (set from panel)
Output driver		DIO1-8, NDAC, NRFD and SRQ : Open collector
		DAV and EOI : three state
GPIB parameters		GPIB address (0 to 30), delimiter in transmission (CR/LF+EOI, CR+EOI, LF+EOI)
Remote release		Remote condition can be canceled by LOCAL key. (Except for Local Lockout)
Connector		Rear panel, IEEE 488 (24-pins) connector

- ## USB interface

USB1.1 full speed

8.6 General items

- **Input/output ground**

    The ground of FUNCTION OUT and SYNC OUT is floating from the chassis, within 1 channel these four signal input/output grounds are common.

    Signal ground withstand voltage:±42 Vpeak, 30 Vrms (DC to 20 kHz, continuous) Individually for CH1 and CH2.

    All other signal input/output grounds are connected to the chassis.

- **Power supply**

Power supply voltage range	AC100 V/115 V/230 V ± 10 %
Power supply frequency range	50/60 Hz ± 2 Hz
Power supply fuse	Time lag 2 A (100 V/115 V) or time lag 1 A (230 V)
	250 V, Φ5.2 × 20 mm
Consumption electric power	100 VA and less
Overvoltage category	II

- **Cooling**

    Forced-air cooling, rear exhaust

- **Setup condition**

    Horizontal (Within 10°)

- **Environmental conditions**

    Ambient temperature and humidity range

Performance guarantee	+5 to +35° C, 5 to 85 %RH
	(no condensation at an absolute humidity of 1 to 25 g/m^3)
Storage time	−10 to +50° C, 5 to 95 %RH
	(no condensation at an absolute humidity of 1 to 29 g/m^3)
Pollution degree	2

- **Insulation resistance**

    20 MΩ and more (DC 500 V, power input lines versus chassis).

- **Withstand voltage**

    AC 1500 V (power input lines versus chassis).

- **Dimensions**

    216(W) × 132.5(H) × 290(D) mm (Excluding protrusions).

- **Mass**

    Mainframe excluding attachments, options, etc.
    Approx. 4.5 kg,

- **Safety**

    EN 61010-1: 2001
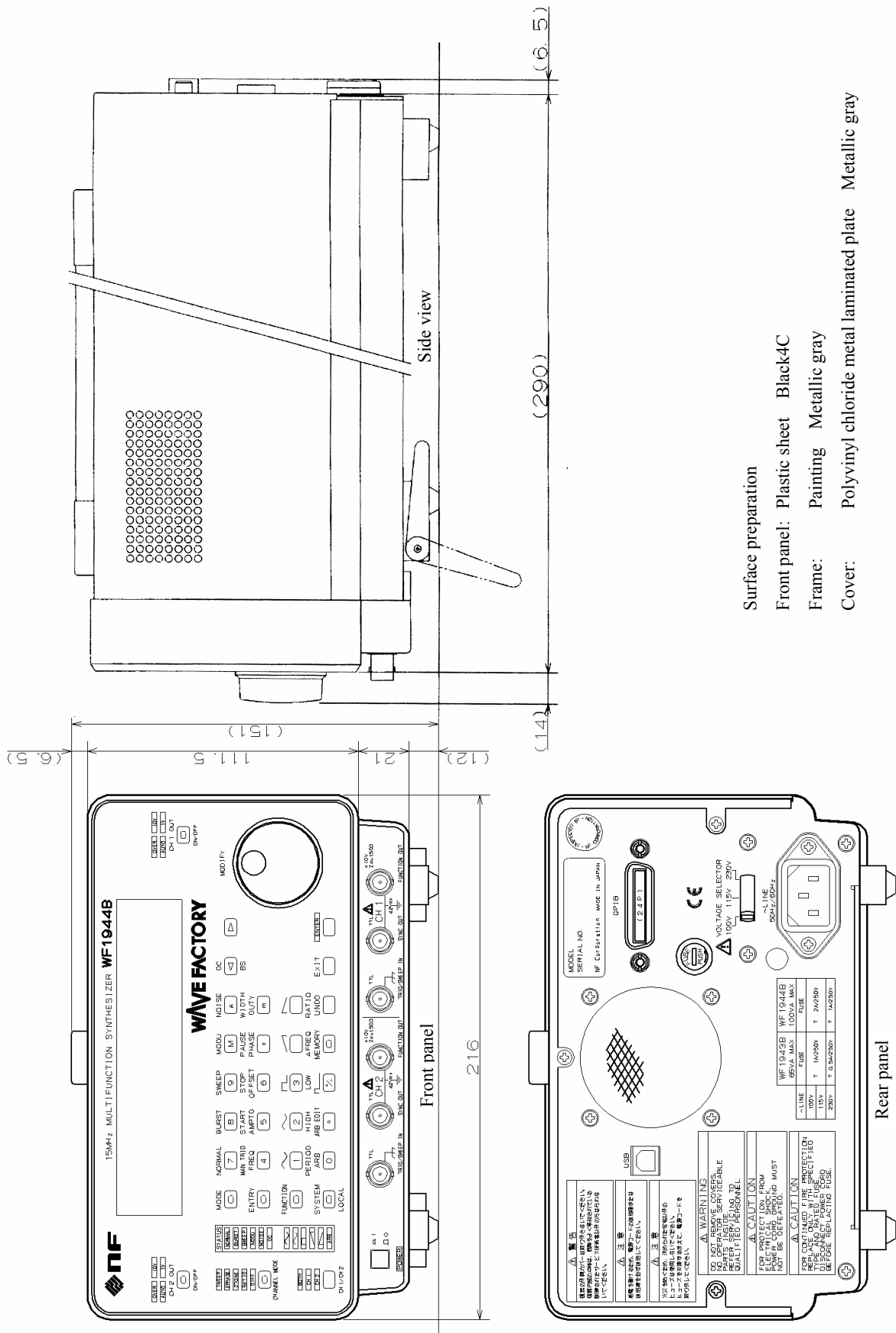
- **EMC**

    EN 61326: 1997/A1: 1998/A2: 2001
    However, the performance criteria for the following standards are as follows:
    EN61000-4-2(1995):C
    EN61000-4-4(1995), EN61000-4-5(1995), EN61000-4-11(1994):B

■ External drawing

Side view

Front panel

Rear panel

Surface preparation
Front panel: Plastic sheet Black4C
Frame: Painting Metallic gray
Cover: Polyvinyl chloride metal laminated plate Metallic gray

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Front and rear panel indications (alphabetical order).

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NF CORPORATION certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from our factory.

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WF1944B MULTIFUNCTION SYNTHESIZER Instruction Manual

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