WAVE FACTORY

MULTIFUNCTION GENERATOR

WF1947/WF1948

Instruction Manual (Operations)

NF Corporation

DA00037851-002

MULTIFUNCTION GENERATOR

WF1947/WF1948

Instruction Manual (Operations)

——— Preface ———

Thank you very much for purchasing our "Multifunction Generator WF1947/WF1948".

To ensure safe and proper use of this electric equipment, please read first "Safety Precautions" on the following pages.

●Caution symbols used in this manual

The following caution symbols are used in this manual. Be sure to observe these caution symbols and their contents to ensure the safety of the user and avoid damage to the equipment.

⚠WARNING

This symbol indicates information for the avoidance of a hazard that may endanger human life or cause injury during handling of the equipment.

⚠ CAUTION

This symbol indicates information for the avoidance of personal injury or equipment damage during handling of the equipment.

●This manual has the following chapter organization.

The instructions for the external control (GPIB, USB) are provided in a separate manual included in the attached CD-ROM.

If using this equipment for the first time, start with "1. Outline."

Operations

1. Outline

   This chapter describes the overview and brief operating principles of this product.

2. Preparations before Use

   This chapter describes important preparations before installation and operation.

3. Panels and I/O Terminals

   This chapter describes the functions and operations of the switches and I/O terminals on the panels.

4. Basic Operation

   This chapter describes basic operations.

5. Saving and Recalling Settings

   This chapter describes how to save and recall the settings.

6. Creating Arbitrary Waveforms

   This chapter describes how to input and edit arbitrary waveforms from the panel control.

7. Convenient Use of 2-channel Equipment (WF1948 Only)

   This chapter describes how to coordinate the settings of two channels.

8. Synchronizing Multiple Units

This chapter describes how to configure a multi-phase oscillator by connecting multiple units of this product.

9. Using External Frequency Reference

This chapter describes how to use external frequency reference.

10. Using User-defined Units

This chapter describes the units which users can define by themselves.

11. Other Utility Settings

This chapter describes how to set display and operational details.

12. Troubleshooting

This chapter describes the error messages and handlings when problems occur.

13. Maintenance

This chapter describes how to perform the operation inspection and performance test.

14. List of Initial Settings

This chapter describes the initial settings.

15. Specifications

This chapter describes the product's specifications (functions and performance).

——— Safety Precautions ———

To ensure safe use, be sure to observe the following warnings and cautions.

NF Corporation shall not be held liable for damages that arise from a failure to observe these warnings and cautions.

This product is a Class I equipment (with protective conductor terminal) that conforms to the JIS and IEC insulation standards.

- Be sure to observe the contents of instruction manual.

  This instruction manual contains instructions for safe operation and use of this product.

  Be sure to read this manual first before using this product.

  All the warnings in this instruction manual are intended to prevent hazards that may lead to serious accidents. Be sure to observe them.

- Be sure to ground the product.

  This product uses a line filter, which may cause electric shock if the product is not grounded.

  This product is grounded automatically by connecting a three-pin power supply plug to a power supply outlet with a protective earth contact.

- Check the power supply voltage.

  This product operates on the power supply voltage indicated in "2.3 Grounding and Power Connections" in this instruction manual.

  Prior to connecting the power supply, check that the outlet voltage matches the rated power voltage of the product.

- In case of suspected anomaly

  If this product emits smoke, an abnormal smell, or abnormal noise, immediately power it off and stop using it.

  If such an abnormal occurs, prevent anyone from using this product until it has been repaired, and immediately report the problem to NF Corporation or one of our representatives.

- Do not use this product when gas is present.

  An explosion or other such hazard may result.

- Never remove the cover.

  This product has high-voltage portions inside. Absolutely never remove its cover.

  Even when the inside of this product needs to be inspected, do not touch the inside. All such inspections are to be performed by service technicians designated by NF Corporation.

- Do not modify the product.

  Absolutely never modify this product, as this may cause new hazards and may disqualify this product from repair in case of failure.

- Safety-related symbols

  The general definitions of the safety-related symbols used on this product are provided below.

   Instructions Manual Reference Symbol

  This symbol is displayed to alert the user to potential danger and refer him/her to the instruction manual.

   Electric Shock Danger Symbol

  This symbol indicates locations that present a risk of electric shock under specific conditions.

The general definitions of the safety-related symbols used in the instruction manual are provided below.

⚠ WARNING Warning Symbol

This symbol indicates information for the avoidance of a hazard such as electric shock that may endanger human life or cause injury during handling of the equipment.

⚠ CAUTION Caution Symbol

This symbol indicates information for the avoidance of damage to the equipment during handling.

- Other symbols

   This mark indicates that the outer conductor of the connector is connected to the enclosure.

  This mark indicates that the outer conductor of the connector is insulated from the enclosure.

  It indicates, however, that the potential difference from the grounding potential is restricted to 42Vpk or lower for safety (Since this product is grounded when being used, the potential of the enclosure equals the grounding potential).

- Request about disposal

  To protect the environment, ensure that this device is disposed of by an appropriate industrial waste processor. A battery is not used for this product.

Table of Contents

Attached Figures and Tables

1. Outline

1.1 Features

NF's WAVE FACTORY, "Multifunction Generator WF1947" and "Multifunction Generator WF1948" are multifunctional oscillators based on DDS (Direct Digital Synthesizer).
WF1947 is a 1-channel device, while WF1948 is a 2-channel device.

- Highest frequency: 30MHz (sine wave), 20MHz (square wave, pulse)
- Frequency accuracy: ±(3ppm + 2pHz), high resolution of 0.01μHz. 10MHz external frequency reference can be used
- Maximum output voltage: 20Vp-p/open, 10Vp-p/50Ω
- Large number of standard waveforms: Sine wave, square wave (variable duty), pulse (variable pulse width/duty, Leading time, Trailing time), ramp wave (variable symmetry), and so on
- Large-capacity arbitrary waveform memory: Maximum 512 K words, saving capacity: 128 waveforms/4 M words
- Phase and waveform remain continuous even when frequency is changed or during frequency sweep.
- Square wave and pulse with variable duty and high resolution of 0.0001%
- Pulse with variable Leading/Trailing time
- Various oscillation modes
  - Continuous oscillation
  - Modulation: FM, FSK, PM, PSK, AM, DC offset modulation, PWM
  - Sweep: Frequency, phase, amplitude, DC offset, and duty
  - Burst oscillation: Auto burst, trigger burst, gate oscillation, triggered gate oscillation
- Intuitive user interface through use of high-resolution QVGA TFT color LCD
- Two-channel coordination function with 2 phases, constant frequency difference, constant frequency ratio, and differential output (WF1948 only)
- Floated from enclosure for each channel to reduce the effect of ground loop
- Multiple-phase oscillator can be configured by synchronizing multiple units
- USB and GPIB interfaces provided

1.2 Operating Principles

■ WF1947 block diagram

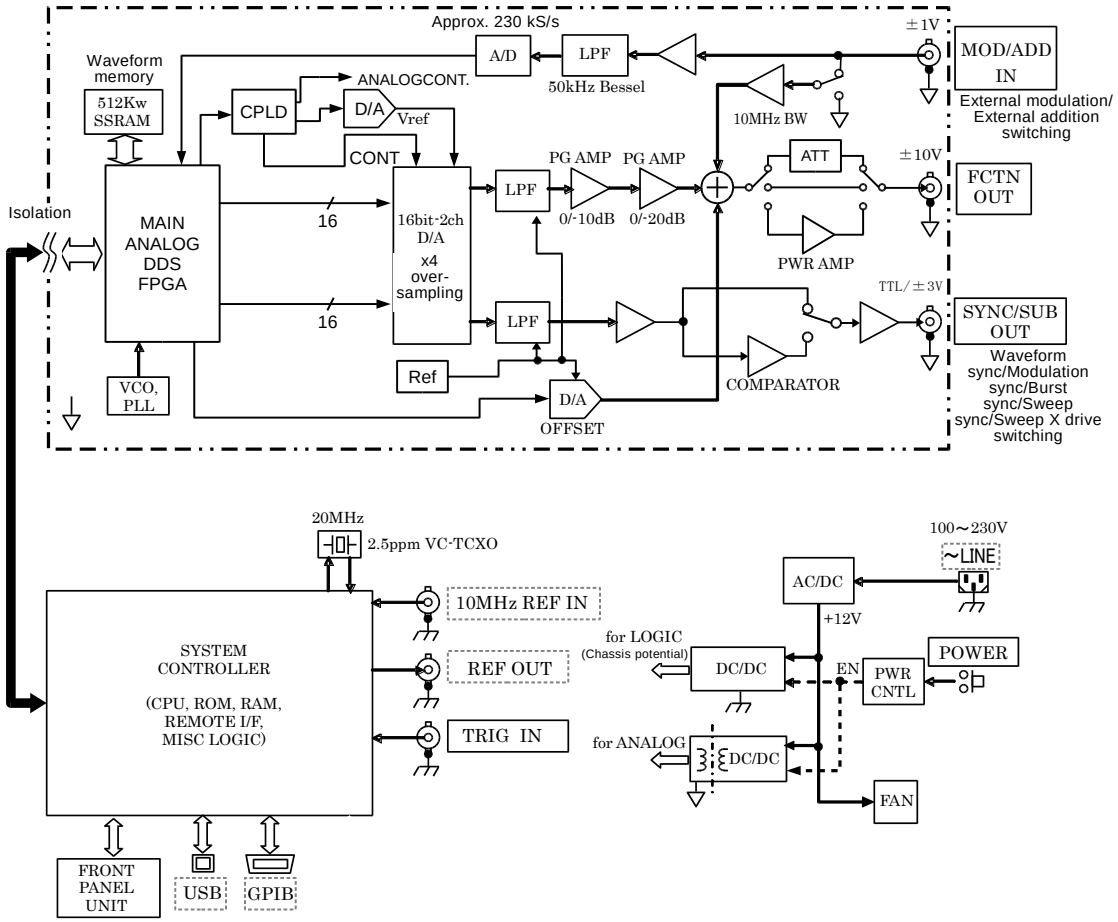


Figure 1-1 WF1947 Block Diagram

■ Analog block

- The DDS (direct digital synthesizer) operates at 120 MHz clock and generates various types of oscillation and waveform. The modulation, sweep, and burst are also processed within the DDS FPGA.
- The digital waveform generated by the DDS are controlled by the specified polarity (normal, inversed) and the amplitude range (-FS/0, ±FS, 0/+FS). After digital amplitude adjustment, its signal is input into the D/A converter.
- Also, in the D/A converter, analog amplitude control is performed, and the waveform converted into analog signal is smoothed by the LPF (lowpass filter).
- The amplitude is controlled in 10 dB steps by the PG AMP (programmable gain amplifier).
- The external addition signal and DC offset are added to the PG AMP output. If the required output voltage is ±400mV/open or less, output is done via x1/5 ATT. If the required output voltage exceeds ±2V/open, then output is done via x5 amplifier.
- The maximum output voltage of the product is either 20 Vp-p, 4 Vp-p, or 800 mVp-p, depending on whether the x1/5 ATT or x5 amplifier is used. In conjunction with this, the external addition gain is either x10, x2, or x0.4.
- The external modulation signal is passed through the LPF, converted by the A/D converter, and then input into the DDS.

■ WF1948 block diagram

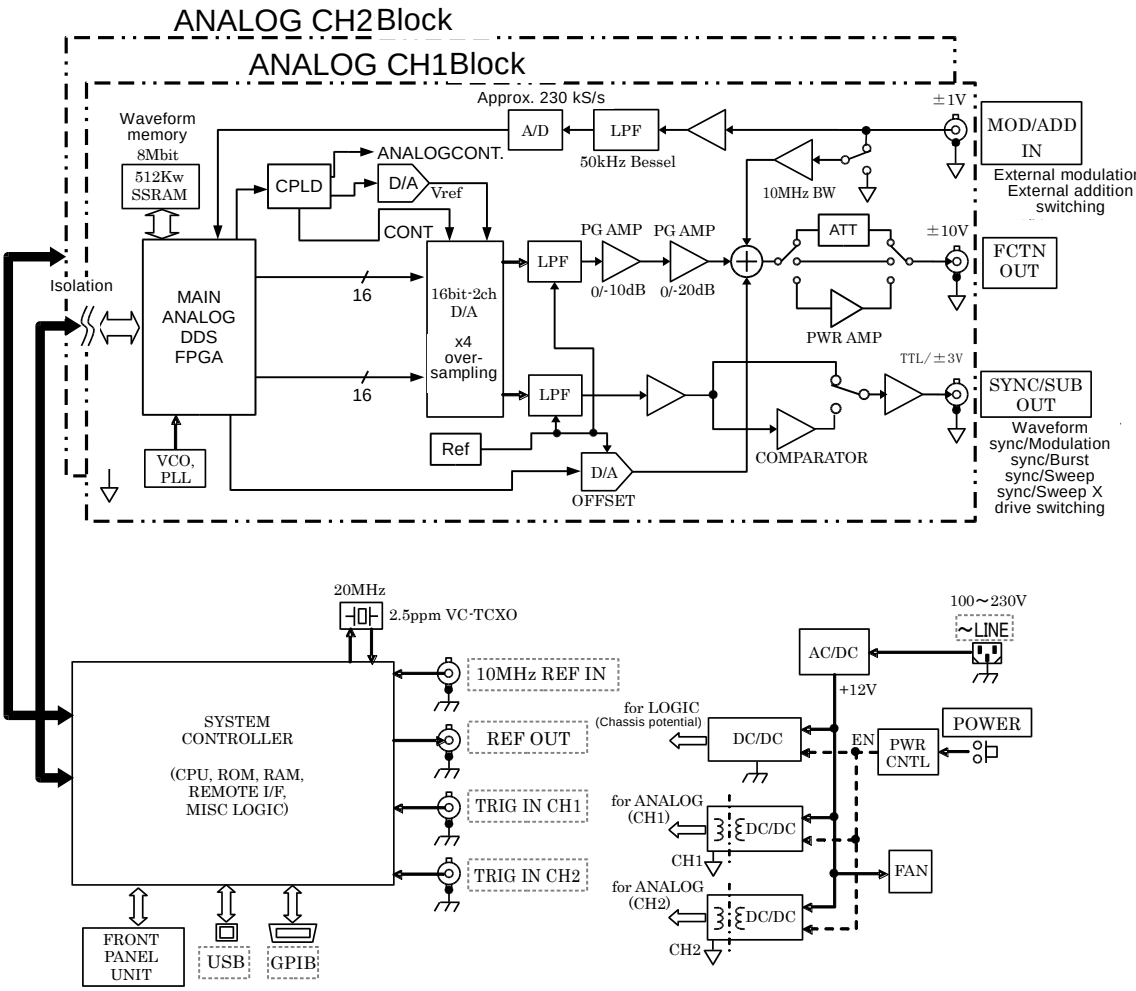


Figure 1-2 WF1948 Block Diagram

- The analog block is insulated from the system controller block located in the enclosure potential.
- In WF1948, the analog block includes 2 channels, each of which is individually isolated from the enclosure potential.

■ System controller block

- This block performs the control of analog block, including the display, panel key processing, remote control (GPIB, USB) processing, trigger input processing, frequency reference control, DDS control, amplitude, and DC offset.
- A 20 MHz crystal oscillator is used as the reference oscillator for the DDS.
- This block sends the signal for synchronization of multiple units to REF OUT (frequency reference output), and the signal for synchronization between channels (only WF1948) to the analog block of each channel.

■ Power supply block

- The equipment continues to drow power even if the power switch is in standby.
- Control (reset, shut-down, etc.) of each power supply circuit in WF1947/WF1948 is performed by operating the power switch.

2. Preparations before Use

2.1 Checking Before Use

a) Ensuring safety

To ensure equipment operator's safety, be sure to read the following sections of the instruction manual at the beginning.

•"Safety Precautions" (provided at the beginning of this instruction manual)

•"2.3 Grounding and Power Supply Connection"

b) Inspection of external appearance and accessories

If you find anything wrong (e.g., any damages or dents) on the outside surface of the cardboard box container, please be extremely careful to ensure that the equipment has not been affected, when you open the container and take out the content.

Please inspect the equipment carefully after taking it out from the cardboard container.

If you find any damages in external appearance or anything missing for accessories, please contact NF Corporation or NF's agent/dealer.

• Appearance check

Check whether or not the equipment has any damages or dents on the panel surface, or at knobs or connectors.

• Configuration and accessories check

The configuration of this product is shown below. Ensure that there is nothing missing and nothing damaged for the accessories.

Main unit..... 1
Instruction Manual..... 1
CD (PDF instruction manuals, application software)..... 1
PDF instruction manuals:
Operations, External Control
Arbitrary Waveform Editing Software
Application Software:
Arbitrary Waveform Editing Software, LabVIEW driver,
Sample program
Set of power cords (2m, with 3-pole plug)..... 1

⚠ WARNING

This product has high-voltage portions inside. Absolutely never remove its cover. No one except the service technicians certified by NF Electronic Instruments are allowed to check or touch the inside of this equipment. Do not touch the inside by yourself in any case.

c) Repackaging

When you re-pack the equipment for transportation, etc., use a box with appropriate strength and size margin and some padding which can support the weight, to protect the equipment sufficiently.

d) Rack mount adapters (optional)

Adapters for mounting the equipment on a 19-inch IEC, EIA standard rack, or JIS standard rack.

There are four types of adapter in total, adapter for one unit and adapter for two units (for side-by-side mounting) for each product model.

They must be purchased separately.

2.2 Installation

a) Installation location

Do not place the equipment with the rear side down. It may damage the connectors and hinder ventilation. Install the equipment with all the four rubber feet and stands on the level plane such as a desk, so that the equipment will be stationed stable.

b) Installation conditions

- This product uses a forced air cooling system with a fan, and for this purpose it has air intake and outlet ports on the bottom and rear sides. Be sure to install the equipment with its bottom and rear surfaces 10 cm apart from the wall at minimum to secure air circulation.
- Install the equipment in a location where the temperature and humidity meet the following conditions:

  Operating conditions: 0 ~ 40 °C, 5 ~ 85 %RH

  Storage conditions: –10 ~ 50 °C, 5 ~ 95 %RH

  Use the equipment without condensation. For limitations related to absolute humidity, refer to the specifications in this manual.
- This equipment is designed to be safe at an altitude up to 2000 m.
- Do not install the device in the following locations:
  - Place exposed to inflammable gas

    This may pose a risk of explosion. Never install, use or operate the equipment in such environment.
  - Outdoors, place exposed to direct sunlight, or place near fire or heat source

    If the equipment is installed in such environment, it may not meet the performance specifications or equipment failures may be induced.
  - Environment with corrosive gas, moisture or dust, or with high humidity

    The equipment could be corroded or damages could be induced due to such environment.
  - Place near electromagnetic field source, high-voltage equipment, or power line

    This may cause malfunction.
  - Place of frequent vibration

    Operating the equipment in such environment could cause malfunctions and/or failures.

c) Maintenance of the panel and housing

When the panel/housing surface needs cleaning, wipe it with a soft cloth. To remove persistent contamination, wipe it with a soft cloth soaked with neutral detergent and wrung out.

Never use such volatile solvent as thinner or benzine, or chemically treated towels, to wipe the equipment surface. Otherwise, the surface treatment might be altered and/or its paint might be damaged.

d) Rack mounting method

This product can be mounted on the 19-inch IEC, EIA standard rack, or JIS standard rack by using a rack-mount adapter (option). In a rack, you can mount only one unit, or two units side by side.

First, attach the rack mount adapter to the main unit, and then mount the main unit in the rack.

For the rack mount adapter handling method, refer to the manual included with the adapter. Following attention should be drawn when you mount the equipment in the rack:

- Support this product by all means by installing some supports such as rails on the rack.
- Do not mount this product on an enclosed rack; otherwise, internal temperature rises high enough to induce operational failures.

  Prepare ventilation openings on the rack, or install an air flow system in the rack by using a fan.

For the dimensional drawings for rack mounting, refer to:

Inch rack mount (for 1 unit) ☞ P.15-23

Inch rack mount (for 2 units) ☞ P.15-24

Millimeter rack mount (for 1 unit) ☞ P.15-25

Millimeter rack mount (for 2 units) ☞ P.15-26

2.3 Grounding and Power Supply Connection

a) Grounding

Be sure to ground the product.

⚠ WARNING

This product uses a line filter, which may cause electric shock if the product is not grounded.
To prevent electric shock accidents, connect the product to ground.

This product is grounded automatically by connecting a three-pole power supply plug to a three-pole power supply outlet with a protective earth contact.

b) Power supply conditions

Voltage range: 100 V AC to 230 V AC ± 10% (250 V or lower)

Frequency range: 50 Hz/60 Hz

Power consumption: WF1947: 55 VA or lower, WF1948: 75 VA or lower

c) Connection procedure of the power source

1) Confirm that the commercial power source voltage is within the allowable voltage range of this product.
2) Connect the power cord into the power supply inlet on the rear side of this product.
3) Connect the power cord into the three-pole power source outlet.

To connect the mains supply, use this power cord or equivalent one.

The detachable power cord is the equipment disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the equipment.

⚠ WARNING

Install the equipment so that the detachable power cord is readily identifiable and easily reached by the operator.

⚠ CAUTION

The accessory power supply cable set is designed to be used for this product only. Do not use it for any other product or purposes.

2.4 Calibration

Although somewhat contingent on the usage environment and how often the product is used, conduct the performance test at least once a year. The performance tests are also recommended immediately before using the equipment for important measurements or testing.

Performance tests should be conducted by technicians possessing experience in operating measuring equipment and have a good general knowledge of equipments.

For details on the performance test, ☞ P.13-1

3. Panels and I/O Terminals

3.1 Panel Component Names and Functions

This section describes the names and functions of the components on the front panel and rear panel.

3.1.1 Front Panel of WF1947

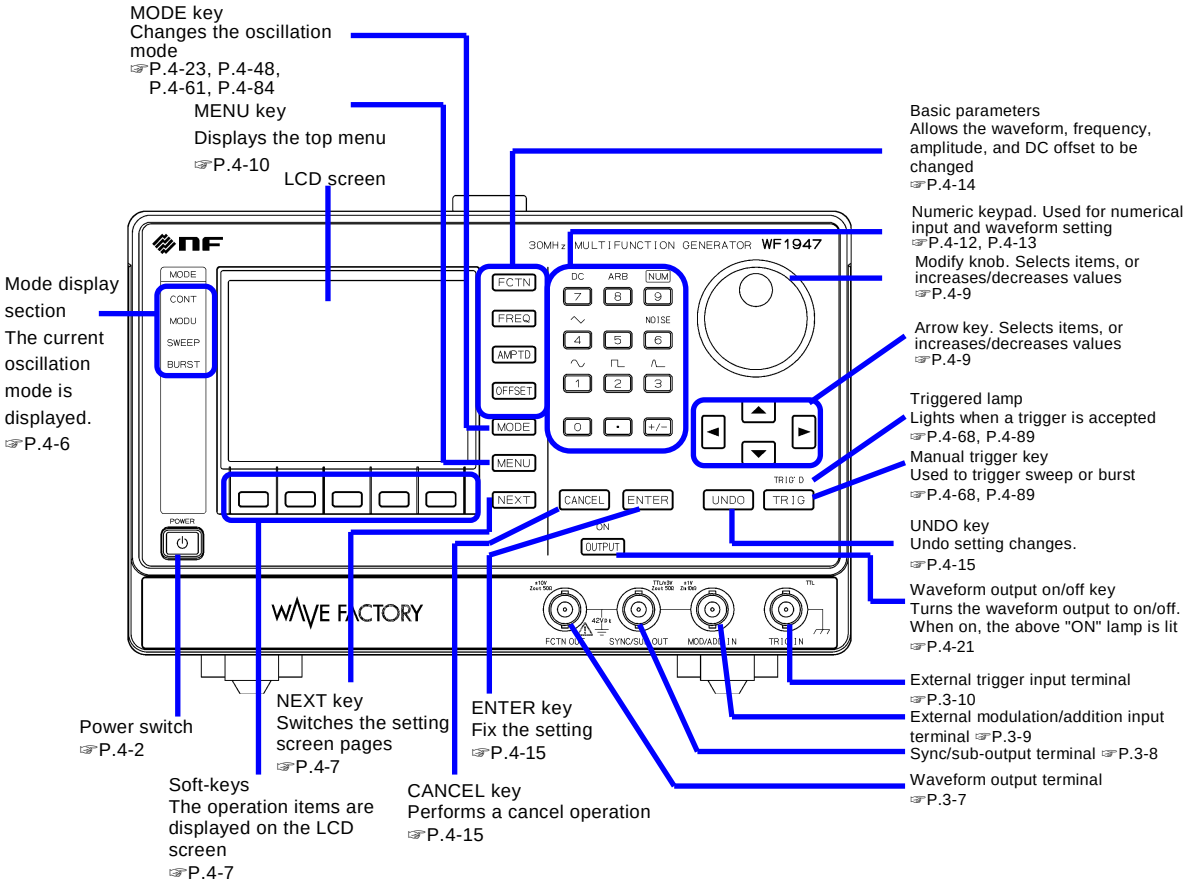


Figure 3-1 Front Panel of WF1947

3.1.2 Rear Panel of WF1947

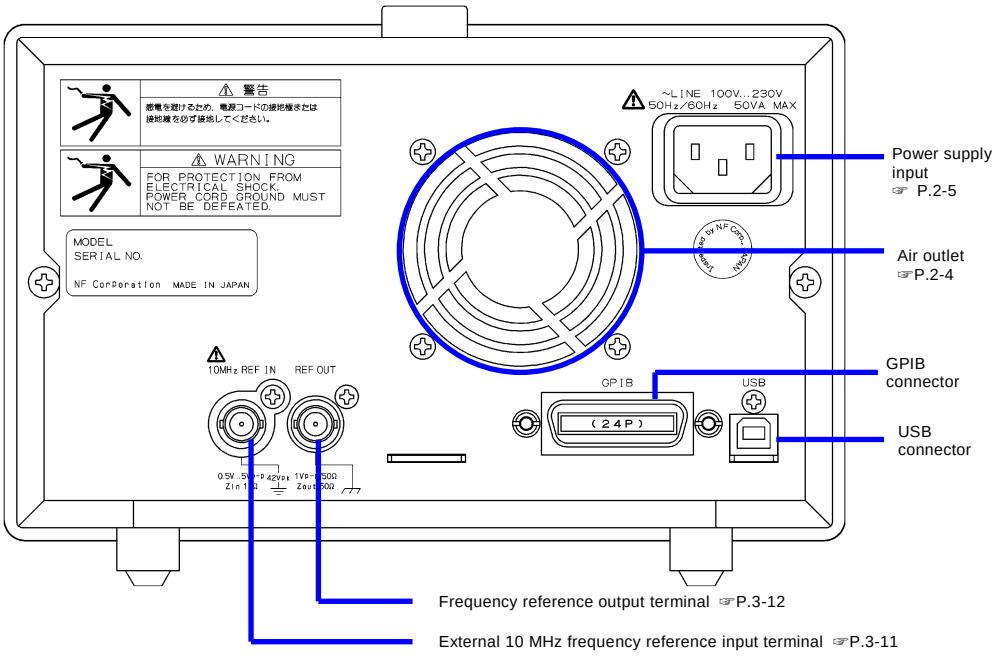


Figure 3-2 Rear Panel of WF1947

3.1.3 Front Panel of WF1948

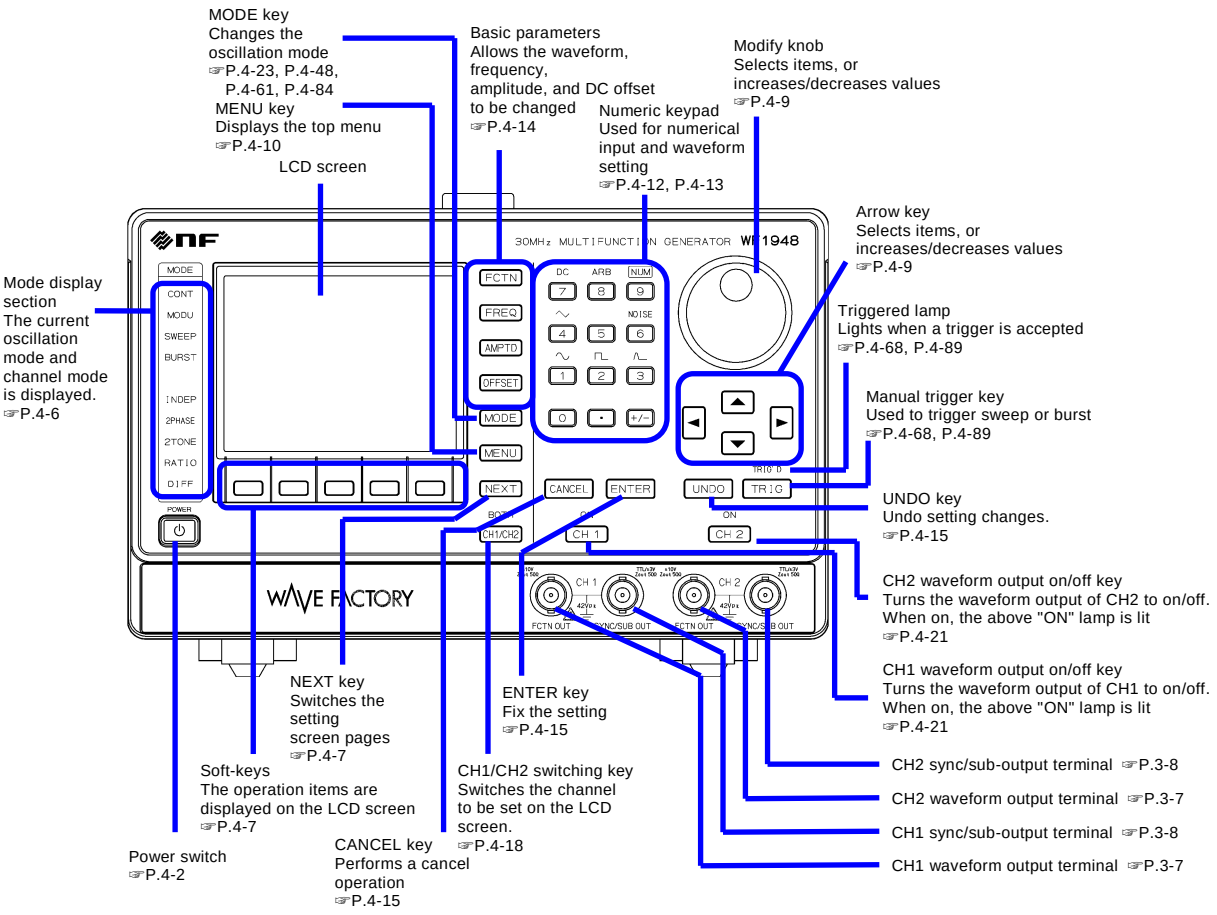


Figure 3-3 Front Panel of WF1948

3.1.4 Rear Panel of WF1948

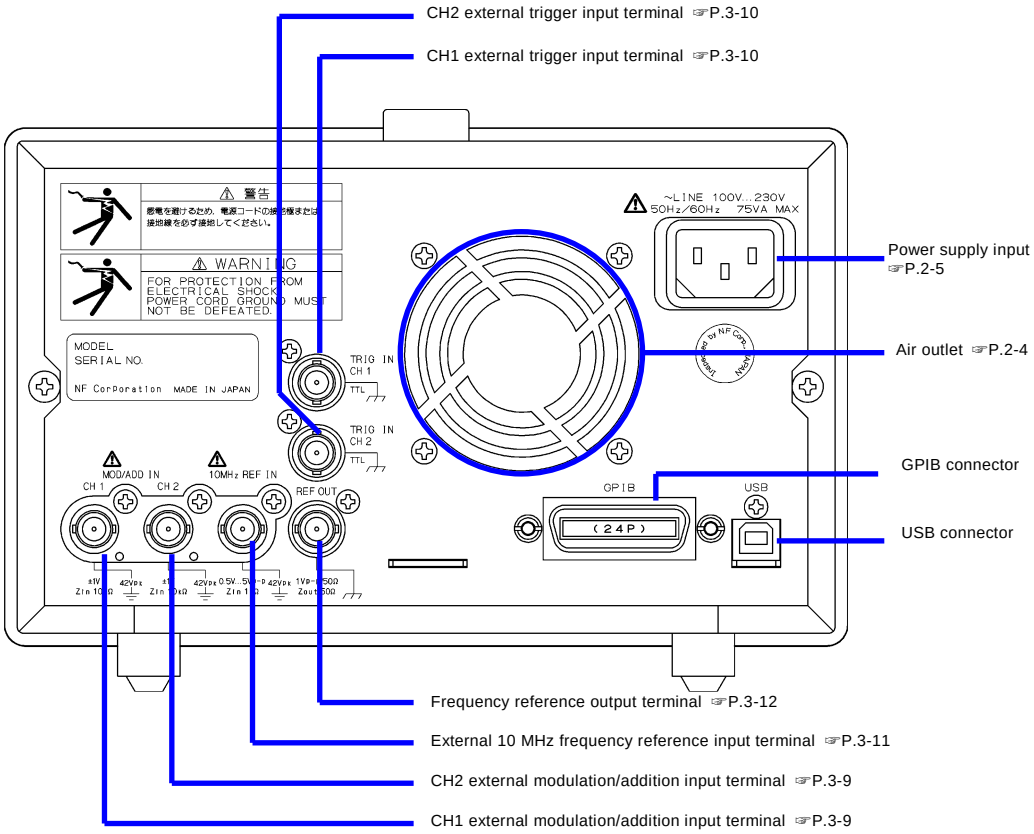


Figure 3-4 Rear Panel of WF1948

3.2 I/O Terminals

⚠ WARNING

To prevent electric shocks, do not apply a voltage exceeding 42 Vpk (DC + AC peak) between the ground of the BNC connectors insulated from the enclosure and the enclosure.
Also, do not apply a voltage exceeding 42 Vpk (DC + AC peak) between the grounds of the BNC connector groups insulated from the enclosure. "BNC connector groups" used here, indicates multiple BNC connectors that are connected to a common ground.
If such a high voltage is applied, the internal voltage limiting elements will try to reduce the voltage, but a too high voltage may cause the product to be burned.
☞ P.2-5

⚠ CAUTION

Do not apply a voltage from external to the output terminals.
This may damage the product.

⚠ CAUTION

Do not apply a voltage exceeding the maximum allowable voltage to the input terminal. This may damage the product.

⚠ CAUTION

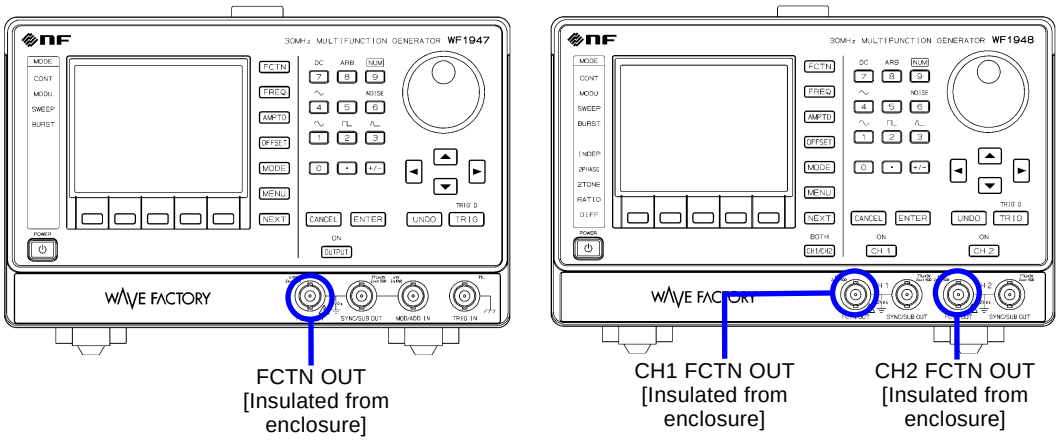
If a difference in potential exists between the ground of a BNC connector insulated from the enclosure and the enclosure, do not short-circuit the hot side of that BNC connector and the enclosure. This may damage the product.

⚠ CAUTION

If a difference in potential exists between the grounds of BNC connectors, do not short circuit these BNC connector grounds. This may damage the product.

3.2.1 Waveform Output (FCTN OUT)

WF1947 WF1948



This is the main output.

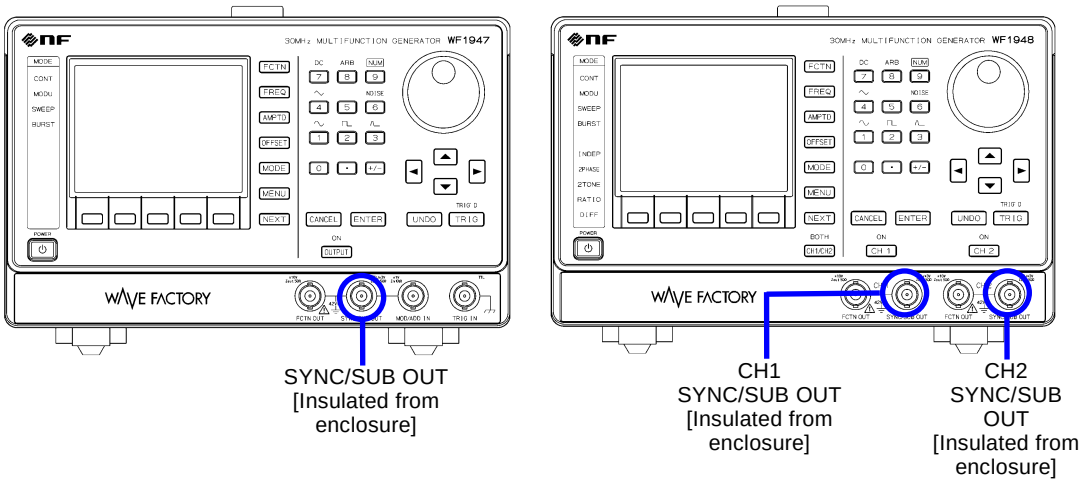
As a mechanical switch is used to turn the waveform output on or off, chattering may occur when turning the output on/off, and this may cause unintended waveforms to be output. If you connect the product to an equipment which may malfunction due to chattering, keep the waveform output always on, and use the burst oscillation and gate oscillation to start/stop the oscillation.

■ Output Characteristics

Output voltage	Maximum ±10 V/open
Output impedance	50Ω
Load impedance	0Ω or higher (short-circuit protection provided)
Signal GND	Insulated from the enclosure (maximum 42 Vpk). In WF1948, also insulated between channels (maximum 42 Vpk)

3.2.2 Synchronization/Sub-output (SYNC/SUB OUT)

WF1947 WF1948



A synchronization signal is output according to the waveform or oscillation status. This signal can be used as the synchronization signal for oscilloscope. As shown in the following table, the output signal can be selected according to the oscillation mode.

Table 3-1 Signals Selectable for Synchronization/Sub-output

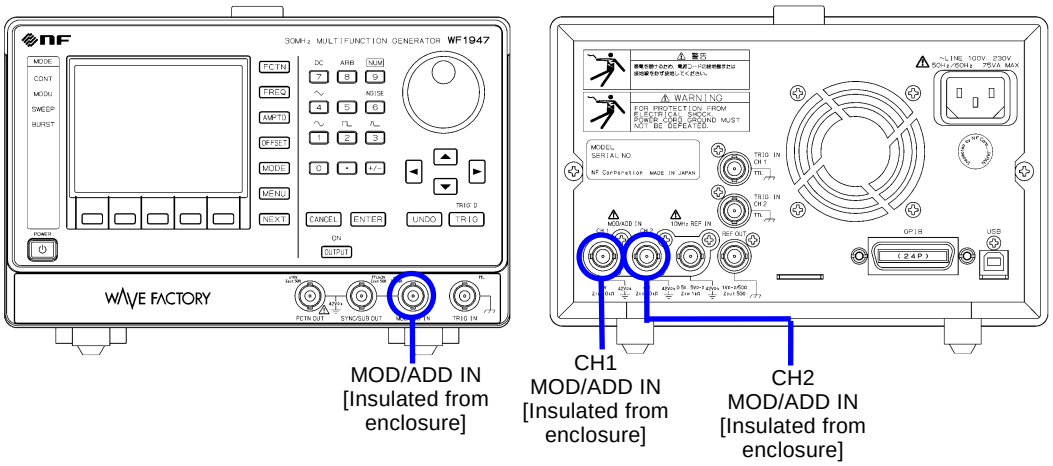
Oscillation mode	Selectable output signal
All	50% duty TTL level logic signal that rises at zero degrees reference phase of waveform output (hereinafter, reference phase synchronization signal). The phase relationship with waveform output can be changed ☞ P.4-24
Modulation mode with internal modulation source ☞ P.4-48	•Reference phase synchronization signal •Internal modulation signal (-3 V to +3 V/open) •TTL level logic signal synchronized with internal modulation signal
Sweep oscillation mode ☞ P.4-70	•Reference phase synchronization signal •Sweep X drive signal (0 V to +3 V/open) •TTL level logic signal synchronized with sweep, marker signal mixing possible
Burst oscillation mode ☞ P.4-86, P.4-90, P.4-94, P.4-99	•Reference phase synchronization signal •TTL level logic signal synchronized with burst oscillation

■ Output Characteristics

Output voltage	TTL level (low: 0.4 V or lower, high: 2.7 V or higher), -3 V to +3 V/open, 0 V to +3 V/open
Output impedance	50Ω
Load impedance	50Ω or higher recommended
Signal GND	Same potential as the same channel waveform output, insulated from the enclosure (maximum 42 Vpk). In WF1948, also insulated between channels (maximum 42 Vpk)

3.2.3 External Modulation/Addition Input (MOD/ADD IN)

WF1947 WF1948



When the modulation source is external in the modulation mode except FSK and PSK, an external modulation signal is input. In the FSK or PSK modulation mode, the external trigger input is used as external modulation signal input.

When not used as external modulation signal input, this terminal can be used as the external addition signal input to the waveform output. The gain during external addition is x0.4, x2, or x10.

External modulation input ☞ P.4-49

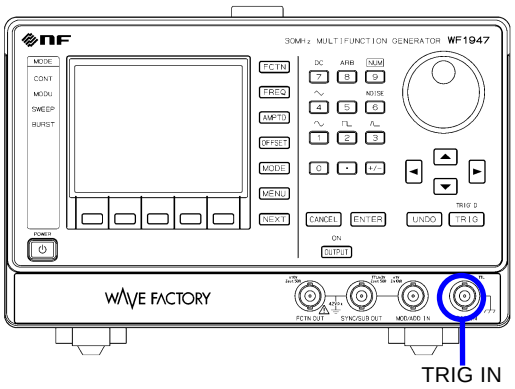
External addition input ☞ P.4-36

■ Input Characteristics

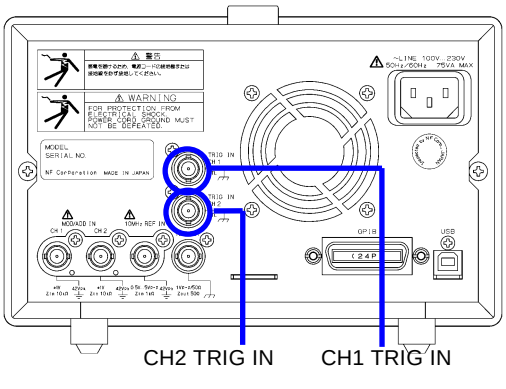
Input voltage	±1 V full scale
Maximum allowable input	± 2V
Input impedance	10kΩ
Input frequency	During modulation: DC to 40 kHz (-3 dB) During addition: DC to 10 MHz (-3 dB)
Signal GND	Same potential as the same channel waveform output, insulated from the enclosure (maximum 42 Vpk). In WF1948, also insulated between channels (maximum 42 Vpk)

3.2.4 External Trigger Input (TRIG IN)

WF1947



WF1948



This terminal can be used as external trigger input in the following cases. The polarity setting can be changed.

- Start trigger of single-shot sweep ☞ P.4-68
- Start trigger of gated single-shot sweep ☞ P.4-68
- Start trigger of trigger burst oscillation ☞ P.4-89
- Gate of gated oscillation ☞ P.4-93
- Trigger of triggered gate oscillation ☞ P.4-99

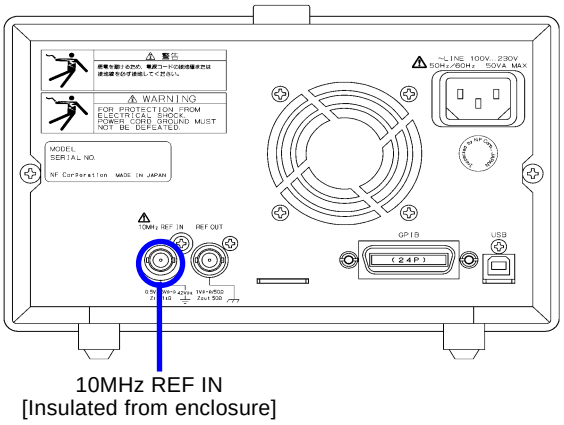
It can also be used as the external modulation input for FSK and PSK.☞ P.4-49

■ Input Characteristics

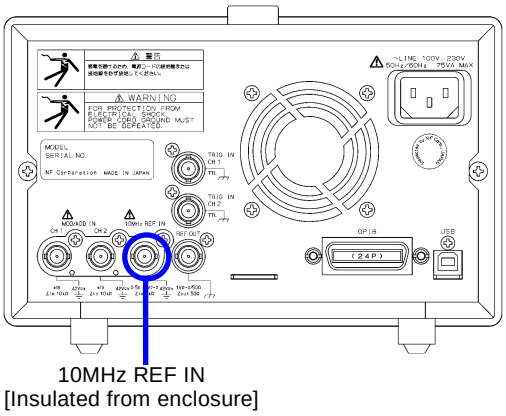
Input voltage	TTL level (low: 0.8 V or lower, high: 2.6 V or higher)
Maximum allowable input	-0.5V ~ +5.5V
Input impedance	10 kΩ, pull up to +3.3 V
Signal GND	Same potential as the enclosure

3.2.5 External 10 MHz Frequency Reference Input (10 MHz REF IN)

WF1947



WF1948



This terminal can be used for the following purposes.

■ When frequency accuracy higher than the specification of this product is required, or when you want to use the same frequency reference as a different signal generator

Input the 10 MHz reference signal from an external frequency standard or another signal generator.

Turn the external frequency reference setting to enable. ☞ P.9-4

■ To unify the frequency and phase of multiple WF1947/WF1948 units

Connect the frequency reference output of the master unit in a synchronous connection of multiple units or the higher-level WF1947/WF1948 to the external 10 MHz frequency reference input of the lower-level WF1947/WF1948.

Set the frequency setting of each unit to the same value.

Also, enable the external frequency reference setting of the lower-level equipment, and perform the phase synchronization on the master unit. ☞ P.8-4

The frequency accuracy of the connected WF1947/WF1948 units are all the same as that of the master unit.

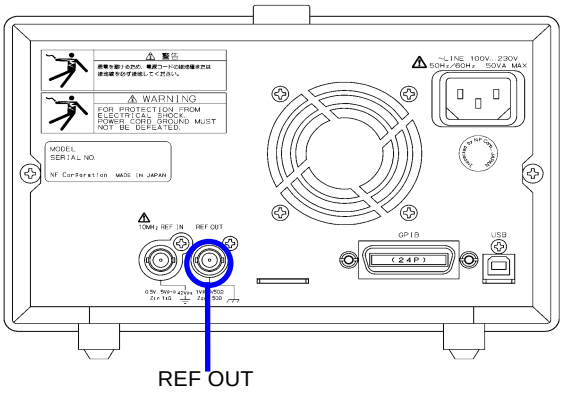
An external frequency standard can be used as the master unit.

■ Input Characteristics

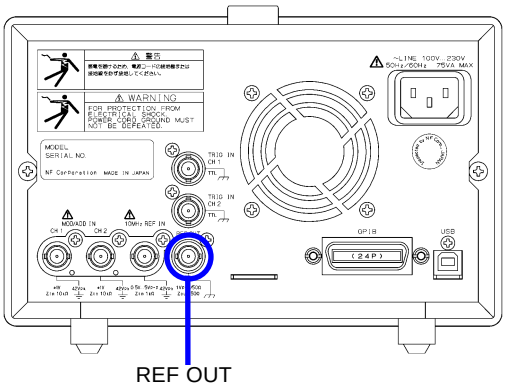
Input voltage	0.5Vp-p ~ 5Vp-p
Maximum allowable input	10Vp-p
Input impedance	1kΩ, AC coupled
Input frequency	10MHz (± 0.5%(± 50kHz))
Input waveform	Sine or square wave (50 ±5% duty)
Signal GND	Insulated from the enclosure and each channel waveform output (maximum 42 Vpk)

3.2.6 Frequency Reference Output (REF OUT)

WF1947



WF1948



This terminal is used to unify the frequency and phase of multiple WF1947/WF1948 units.
Connect the frequency reference output of the master unit in a synchronous connection of multiple units or the higher-level WF1947/WF1948 to the external 10 MHz frequency reference input of the lower-level WF1947/WF1948. ☞ P.8-2

■ Output Characteristics

Output voltage	1Vp-p / 50Ω
Output impedance	50Ω, AC coupled
Output frequency	10MHz
Output waveform	Square wave
Signal GND	Same potential as the enclosure

Check

Do not connect any equipment other than WF1947, WF1948, and the equipment specified by NF Corporation to the frequency reference output.

The special signal that is output from this terminal during synchronization may make the operation of such connected equipment unstable.

3.3 Cautions on Floating Ground Connection

The signal ground of the BNC terminals for waveform output, synchronization/sub-output, and external modulation/addition input is shared, but since it is insulated from the enclosure (ground potential), it can be connected to an equipment that has a different potential. Moreover, when the equipment is mounted in a rack, the signal ground is not affected by the potential of the rack .

In WF1948. the above-mentioned BNC terminals are also insulated between channels.

Further, the signal ground of the external 10 MHz frequency reference input is also insulated from the enclosure. Therefore, noise caused by ground-loop does not affect the connection with a frequency standard.

Nor does noise caused by ground-loop affect the connection even when synchronously connecting multiple units of WF1947 and WF1948.

Note that, in all cases, the floating voltage should be limited to 42 Vpk (DC + AC peak) or lower to prevent electric shocks.

The other signal grounds are all connected to the enclosure. The enclosure itself is connected to a protective earth terminal of the power supply input.

⚠ WARNING

To prevent electric shocks, do not apply a voltage exceeding 42 Vpk (DC + AC peak) between the ground of the BNC connectors insulated from the enclosure and the enclosure.
Also, do not apply a voltage exceeding 42 Vpk (DC + AC peak) between the grounds of the BNC connector groups insulated from the enclosure. "BNC connector groups" used here, indicates multiple BNC connectors that are connected to a common ground.
If such a high voltage is applied, the internal voltage limiting elements will try to reduce the voltage, but a too high voltage may cause the product to be burned.

⚠ CAUTION

If a difference in potential exists between the ground of a BNC connector insulated from the enclosure and the enclosure, do not short-circuit the hot side of that BNC connector and the enclosure. This may damage the product.

⚠ CAUTION

If a difference in potential exists between the grounds of BNC connectors, do not short circuit these BNC connector grounds. This may damage the product.

■ Cautions on floating ground connection for WF1947

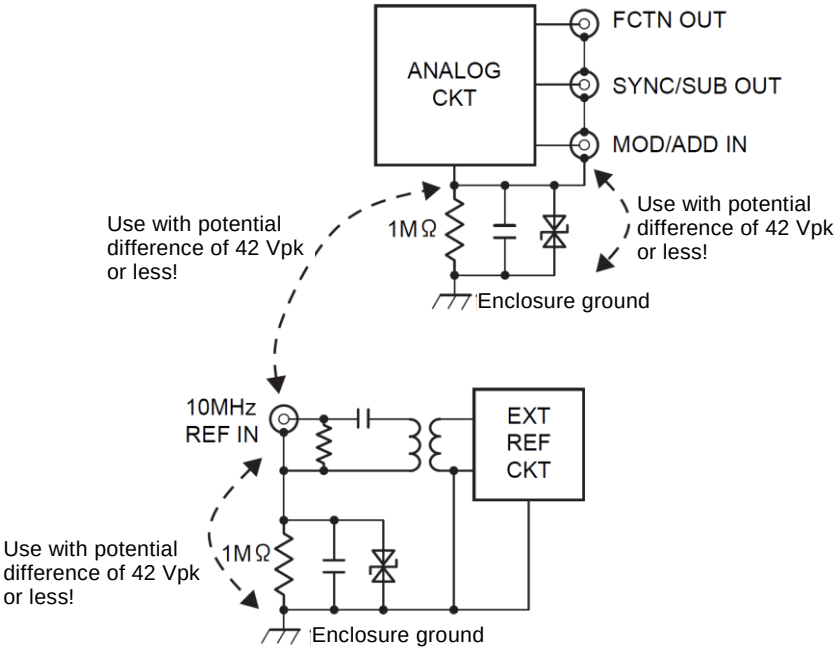


Figure 3-5 Cautions on Floating Ground Connection for WF1947

■ Cautions on floating ground connection for WF1948

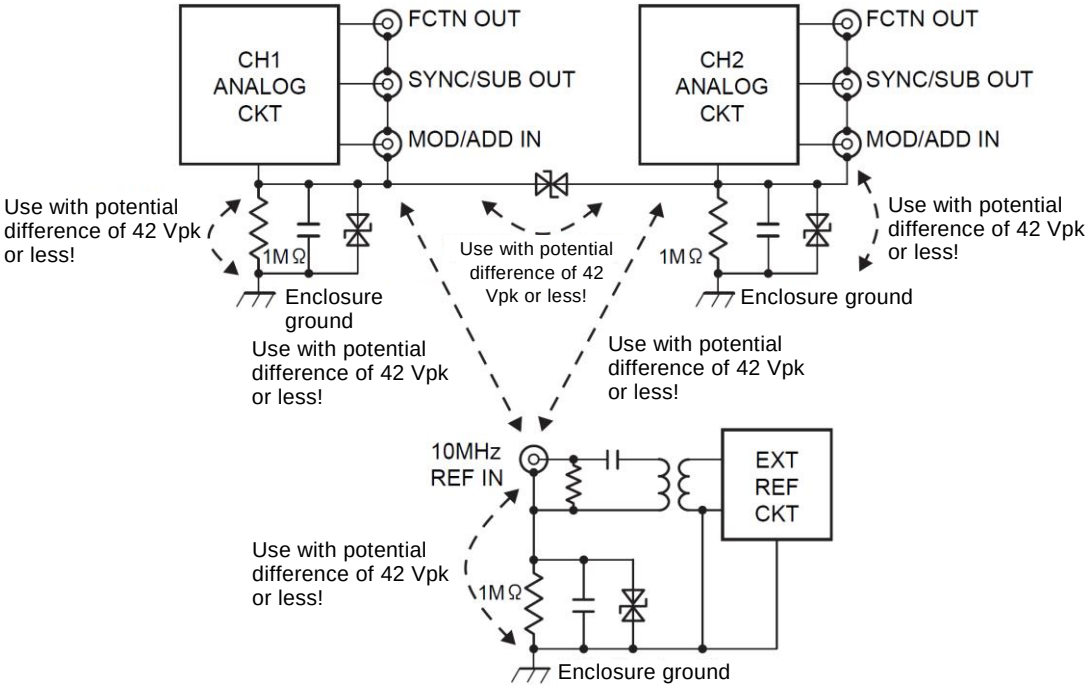


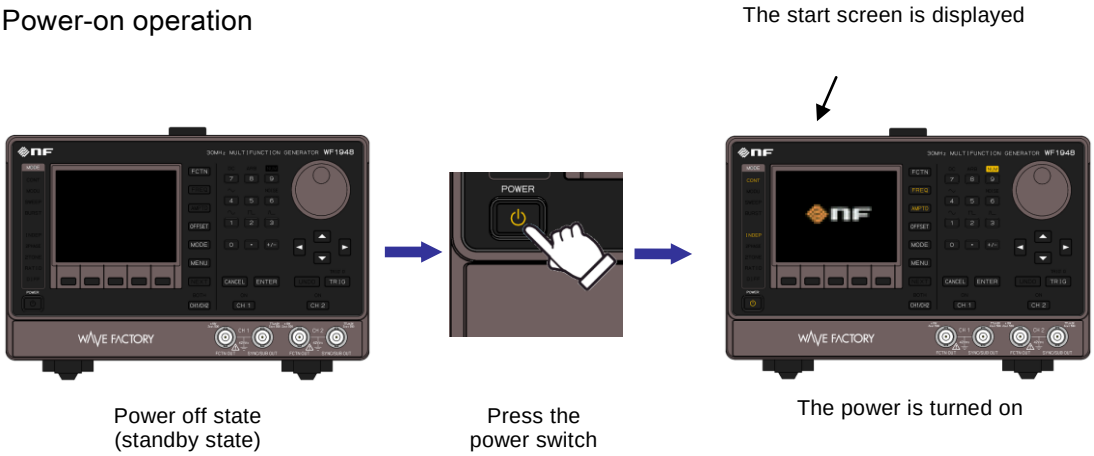
Figure 3-6 Cautions on Floating Ground Connection for WF1948

4. Basic Operation

4.1 Power On/Off and Restoration of Settings

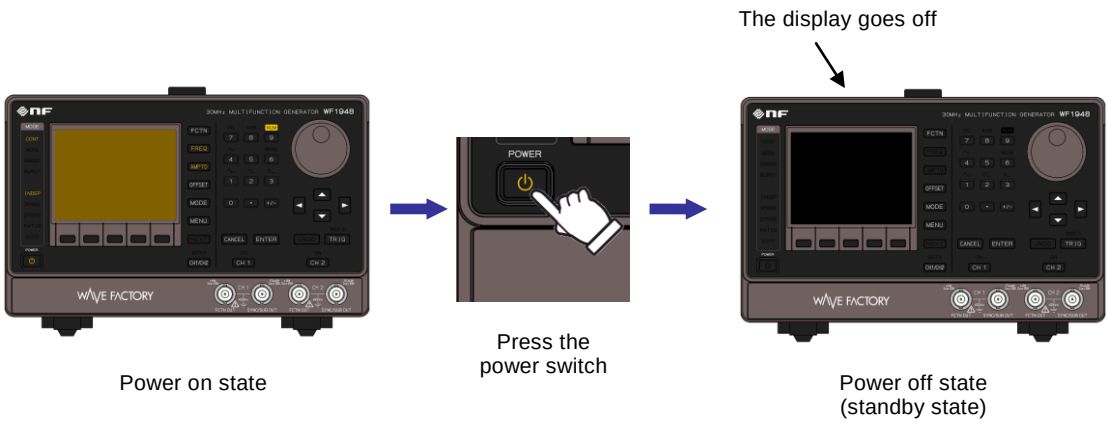
4.1.1 How to Turn Power On/Off

■ Power-on operation



Once the power is turned on, a self diagnosis test is automatically executed, and then the equipment becomes operable.

■ Power-off operation



4.1.2 Restoration of Settings at Power-on

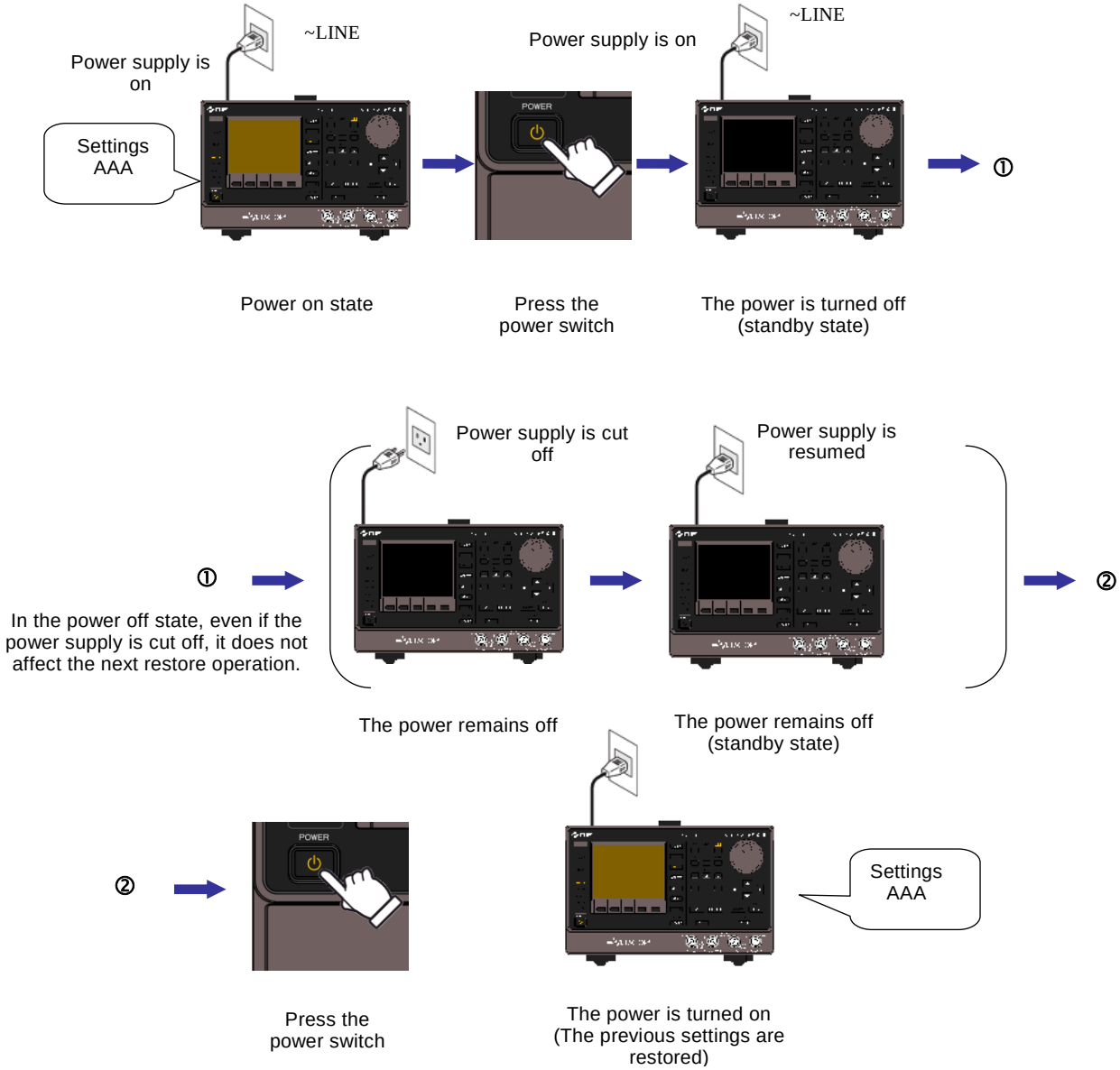
When the power is turned on/off using the power switch, the settings before the previous power-off are restored when the power is turned on again.

The output on/off setting at power on can be set on the Utility screen. ☞ P.4-19

However, if the power supply to the product is directly cut off while the power is on, the settings are set to the contents of the setting memory number 1 when the power supply is resumed.

a) Restoration of settings when the power switch is turned on/off while the power supply is on

The most general case is illustrated below.



While the power is off, if the power supply is cut off due to the disconnection of the power cord or the shutoff of the connected breaker, this does not affect the restore operation the next time the power is turned on again.

- The settings before the previous power-off are restored.
- The output on/off setting at power on can be changed on the Utility screen. ☞ P.4-19

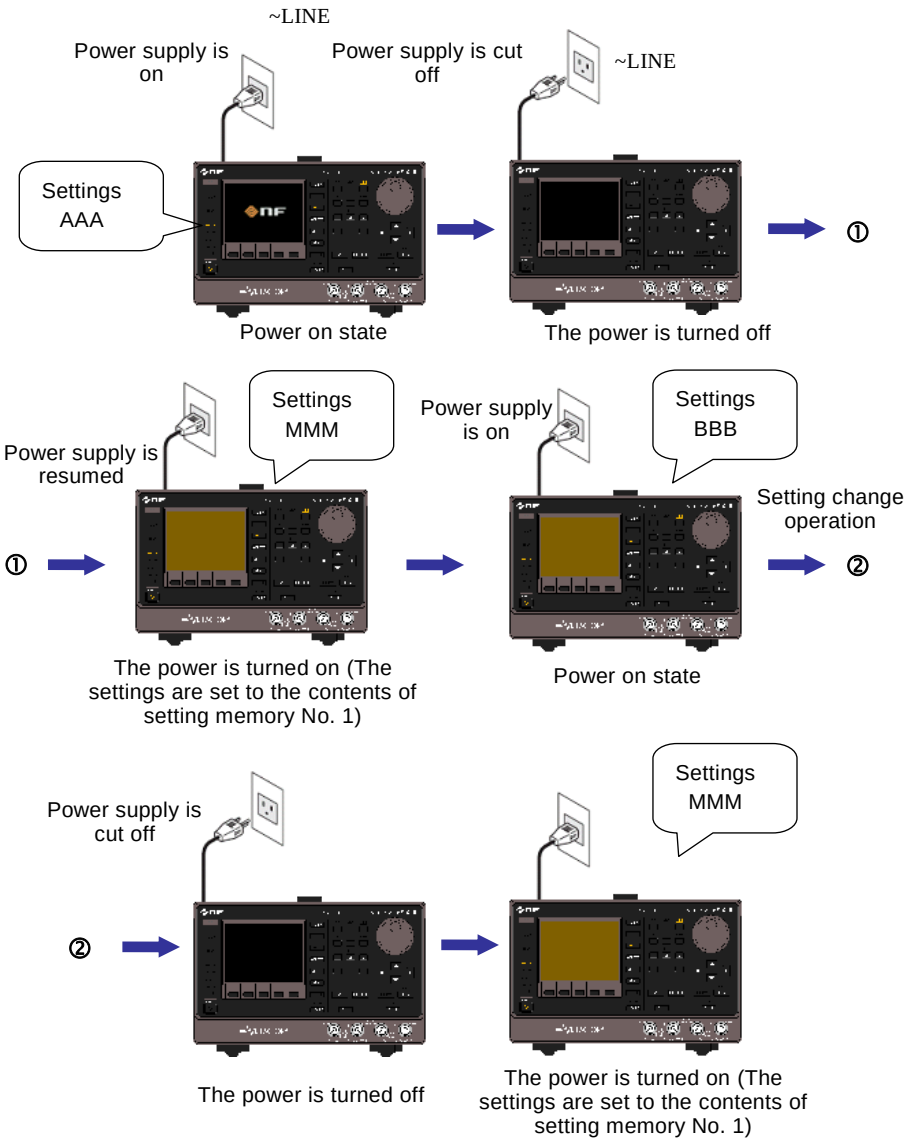
Check

The settings immediately before the power-off can be restored only if the power is turned off using the power switch.

b) Restoration of settings at power supply on/off

This is the case when you collectively turn on/off the power supply for this product and other devices which are mounted in a rack.

When the power supply is cut off while the power is on, the power is automatically turned on the next time the power supply is resumed.



- The settings before the power-off are not restored.
- The contents of setting memory number 1 are set. ☞ P.5-2
- The output on/off setting at power on can be changed on the Utility screen. ☞ P.4-19

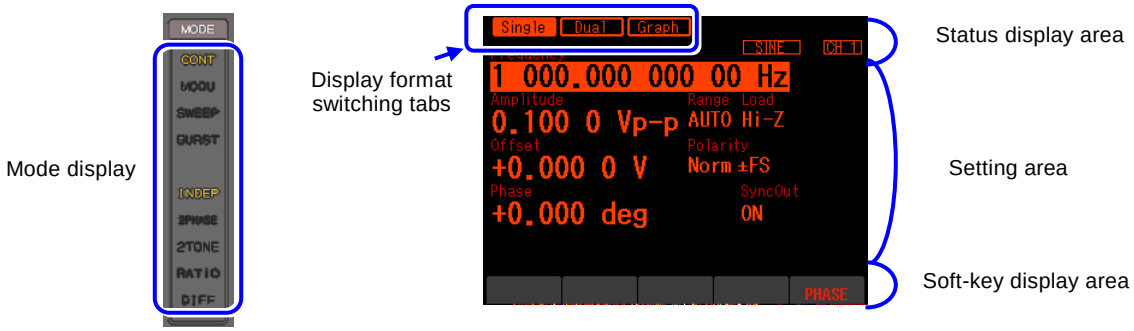
Check

As the settings before the power supply is cut off are not restored, specify the contents of setting memory number 1 in advance if needed. ☞ P.5-2

4.2 Screen Configuration and Operation

4.2.1 Screen Configuration

The LCD screen consists of three areas, as shown in the following figure. There is also the mode display section on the left side of the screen.



■ Status display area

Displays the status of the product. The following items are displayed.

• Uncalibrated status UCAL

Displayed when the calibration information of the product is lost due to a problem, and the prescribed performance cannot be maintained. As this indicates a failure, please contact NF Corporation or one of our representatives.

• Overheating status TEMP

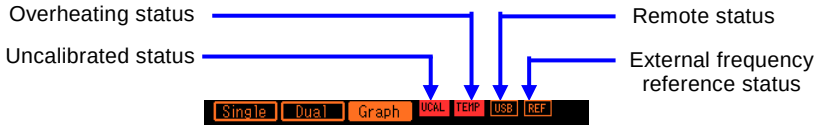
Displayed when the internal temperature of the product is abnormally high. If this status is displayed when the product is used at an ambient temperature of 40°C or less, it indicates a failure, so please contact NF Corporation or one of our representatives.

• Remote status USB GPIB

Displayed when the product is controlled via USB or GPIB.

• External frequency reference status REF

Displays whether a valid signal is input or not, when the external frequency reference is enabled.



■ Mode display section

Displays the oscillation mode and the channel mode (WF1948 only) of this product.

•Oscillation mode

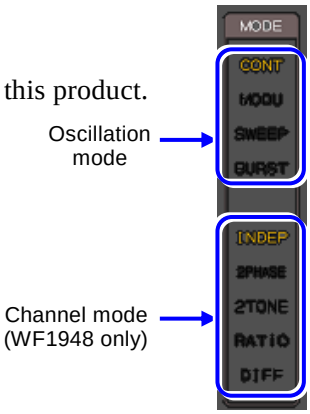
The current oscillation mode is displayed.

CONT (continuous oscillation)/MODU (modulated oscillation)/ SWEEP (sweep oscillation)/BURST (burst oscillation)

For details on the oscillation mode setting, ☞ P.4-23

•Channel mode (WF1948 only)

The current channel mode is displayed.



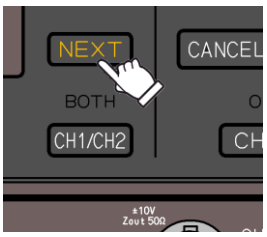
INDEP (independent)/2PHASE (2-phase)/
2TONE (constant frequency difference)/RATIO (constant frequency ratio)/
DIFF (differential output)
For details on the channel mode setting, ☞ P.7-2

■ Setting area

This area is used to display and set the various parameters.
When multiple display formats can be selected, the display format switching tabs are displayed on the left side of the screen. ☞ P.4-8

As there are a lot of setting parameters for modulation, sweep, and burst oscillation, the setting screen consist of two or three pages.
The setting screen pages can be switched with the NEXT key.

NEXT key for switching the setting screen pages

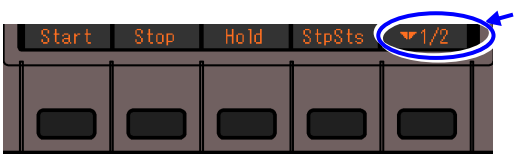


Setting screen page position display icon

When there are several setting screen pages, an icon indicating which page is displayed appears at the top center of the screen.
In the left example, the icon indicates that there are two setting screen pages in total and the second page is currently displayed.

■ Soft-key display area

This area displays the functions of the soft-keys which are allocated according to the situation.
If six or more soft-keys are allocated, "▼ n/m" is displayed on the right-most soft-key. This indicates that the set of soft-keys belonging to the current setting screen consists of m stages in total, and that the set for the nth stage is currently displayed. When you press this right-most key, the soft-key set for the next stage is displayed.



Indicates that the first of two stages of soft-keys is displayed.
When this key is pressed, the soft-keys for the next stage is displayed.

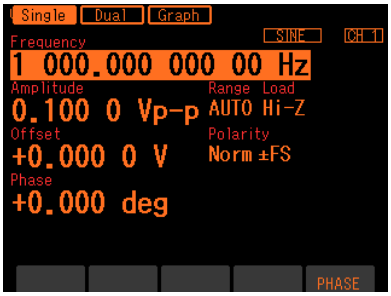
4.2.2 Switching Display Format with Tabs (To Display Waveform Graph)

When multiple display formats can be selected, the display format switching tabs are displayed on the left side of the screen. For example, if the [Graph] tab screen is displayed, you can set the parameters while checking the image of the output waveform.

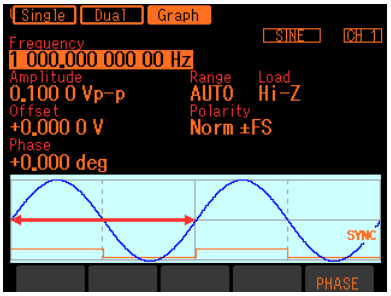
a) Display format types

The following three types of display formats are provided.

■Text display [Text] (WF1947)
or [Single] (WF1948)
Displays the settings for one channel in text format

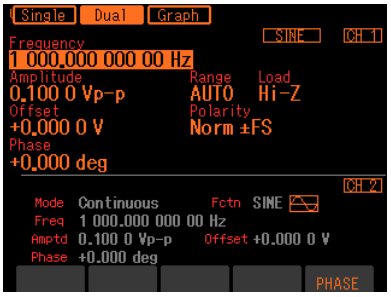


■ Graph display [Graph]
Displays the settings for one channel in both text and graph formats. You can grasp the image of the output waveform.



■ 2-channel simultaneous display [Dual] (WF1948 only)

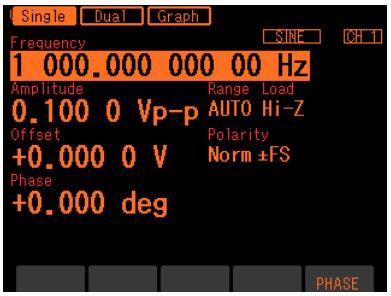
Displays the settings of channel 1 and channel 2 in text format, by stacking them vertically.



The channel to be set can be switched by using the CH 1/CH 2 key.

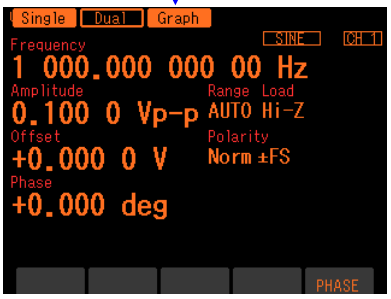
b) To switch the display format

The Single tab screen is displayed



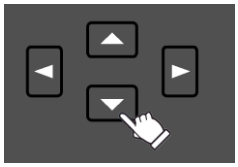
1. In the left example, the Single tab screen is displayed.
On this screen, the settings are displayed in text format.

The Graph tab is selected

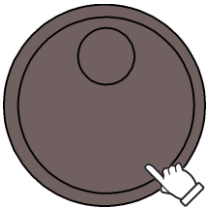


2. Select the Graph tab by using the arrow keys or the modify knob.

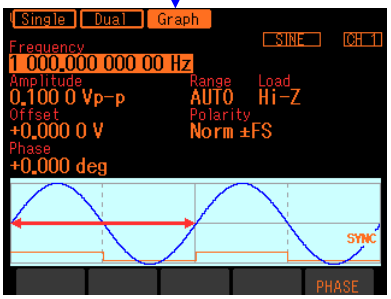
Tab selection



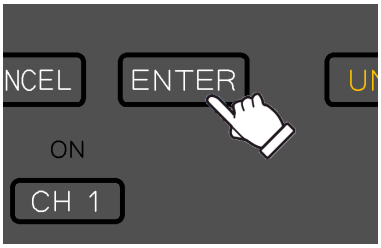
or



The Graph tab screen is displayed



3. Press the ENTER key to switch to the Graph tab screen. On this screen, you can set the parameters while checking the image of the output waveform.



Check

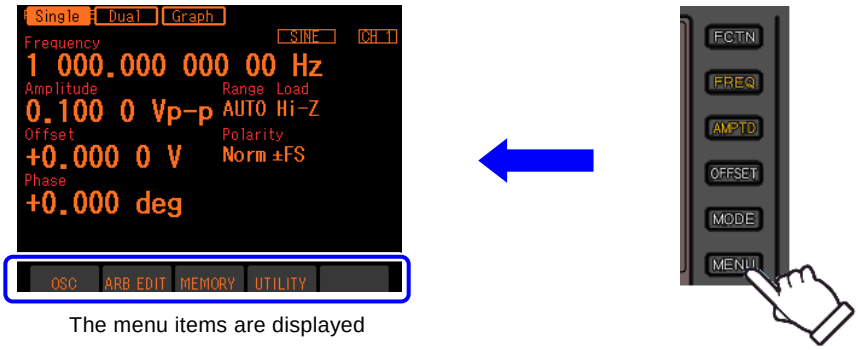
In WF1948, the display can be switched between 2-channel simultaneous display and 1-channel display by using the tab.

4.2.3 Top Menu

Arbitrary waveform editing, various system settings, saving and recalling settings and others can be done by selecting the desired item from the top menu.

a) To display the top menu

When you press the MENU key, the menu items are displayed on the soft-keys.



The menu items are displayed

When you press the soft-key corresponding to a menu item, the setting screen for that menu item appears.

b) Operations available using top menu items

In the setting screen for each menu item, the following settings and operations can be performed.

■ OSC

Opens the Oscillator setting screen where you can perform almost all settings and operations other than arbitrary waveform editing. At power on, the Oscillator setting screen is always displayed.

■ ARB EDIT

Arbitrary waveform editing can be done. ☞ P.6-4

■ MEMORY

The settings can be saved to/recalled from the setting memory. ☞ P.5-2

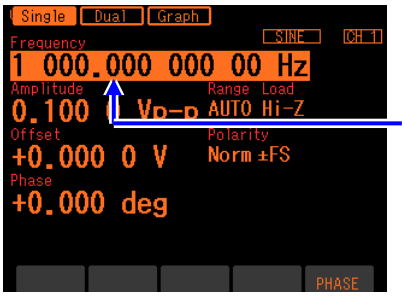
■ UTILITY

Various settings and operations can be done. ☞ P.4-19

4.3 Basic Settings and Operations

4.3.1 To Change Frequency, Amplitude, and Other Values

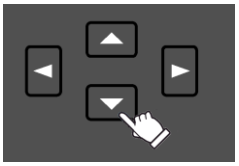
a) To change a value with the up/down arrow keys (or the modify knob)



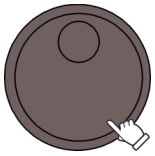
The frequency is selected
The current frequency value is displayed

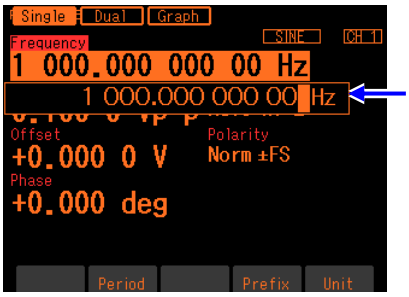
1. Select the desired item with the arrow keys or the modify knob.
In the left example, the [Frequency] field is selected.

Item selection



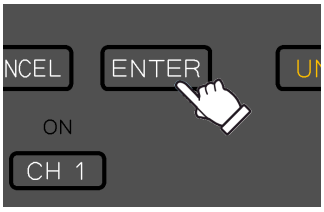
or

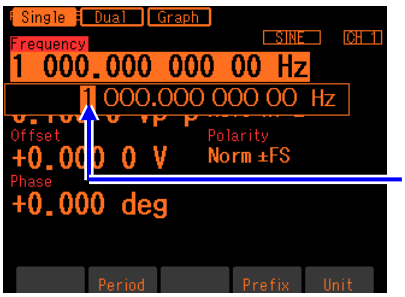




The input field is opened

2. When you press the ENTER key, the input field is opened below or above the selected item, and you can change the current value of the selected item. In this state, you can enter a value using the numeric keypad.

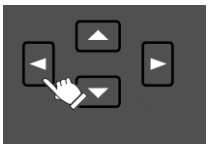


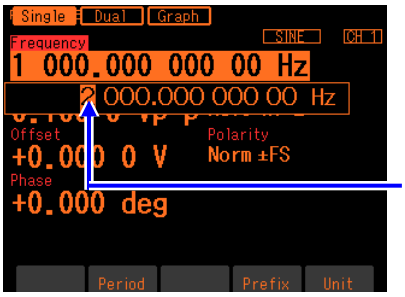


The 1 kHz digit is to be changed.

3. Press the left/right arrow keys to move the cursor to the digit to change the value.
In the left example, the cursor is moved to the 1 kHz digit.

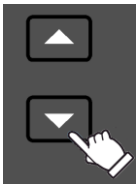
Moving the cursor





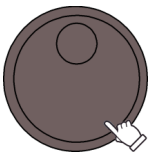
The value of the digit is now 2

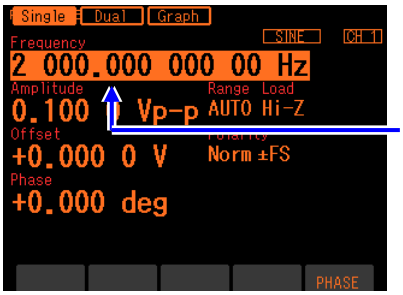
4. Increment or decrement the value of the digit to be changed using the up/down arrow keys or the modify knob.
In the left example, the value is changed to 2 kHz.
The change is immediately applied to the output.



Incrementing/decrementing the value

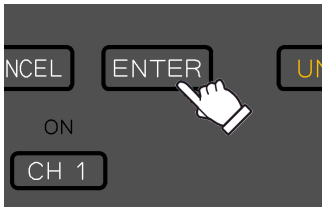
or





The input field has closed

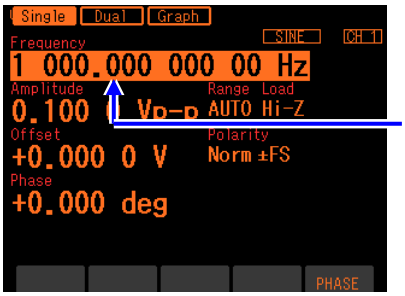
5. Press the ENTER key to close the input field.



If you press the CANCEL key instead of ENTER key, the changed value is discarded and the setting before the change is restored.

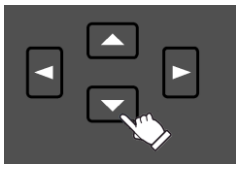
b) To change a value with the numeric keypad

1. Select the desired item with the arrow keys or the modify knob.
In the left example, the [Frequency] field is selected.

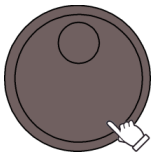


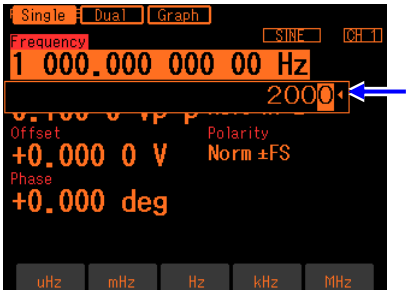
The frequency is selected. The current frequency is displayed.

Item selection



or

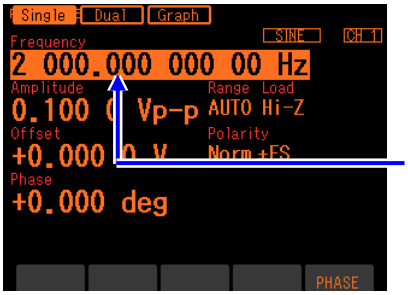




The input field is opened and a value is input

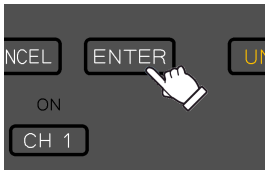
2. When you press a key of the numeric keypad, the input field is opened below or above the selected item, and the numeric value is input. While inputting numeric values, the left arrow key serves as the delete key, and the right arrow key as the zero input key.

Inputting values

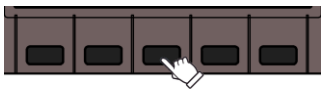


The setting is changed, and the input field has closed

3. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output.
If you press the ENTER key, the value is set without prefix such as "k" or "m".



or



> **Check**
> While inputting numeric values, the left arrow key serves as the delete key, and the right arrow key as the zero input key.

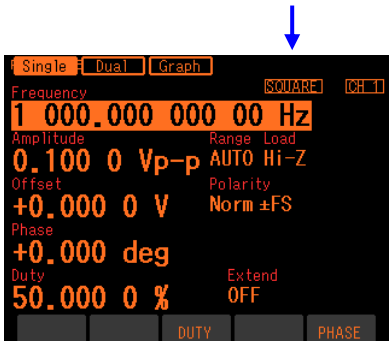
> **Check**
> If a setting item is displayed on a soft-key, you can open the input field for that item by pressing that soft-key.

4.3.2 To Change Waveforms

1. When you press the FCTN key, the available waveforms flash on the numeric keypad.

2. When you press the key under the flashing waveform on the numeric keypad, that waveform is selected and applied to the output.
As shown in the left figure, pressing the [2] key selects the square wave.
The selected waveform continues to be displayed after setting the waveform.

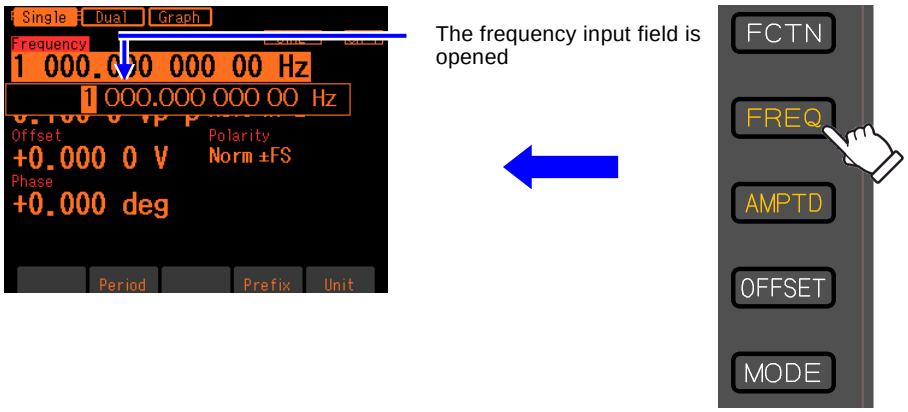
The waveform is set to square wave



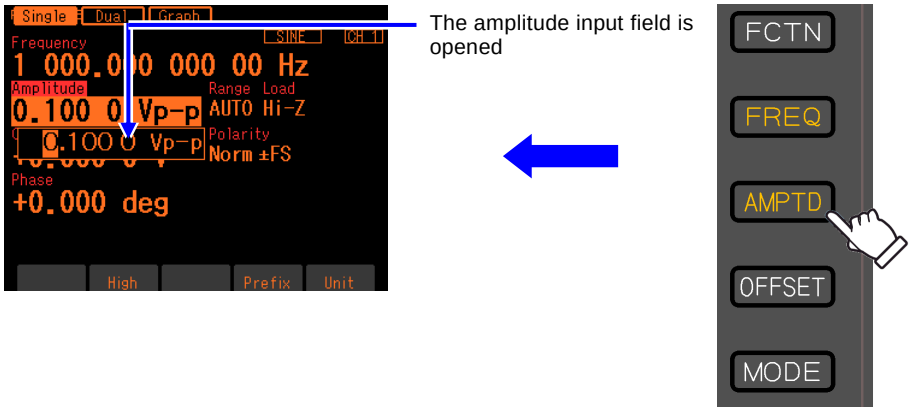
4.3.3 Shortcut Keys for Changing Basic Parameters

The selection list or input field for frequency, amplitude, and DC offset can be immediately opened by using the corresponding basic parameter shortcut key.

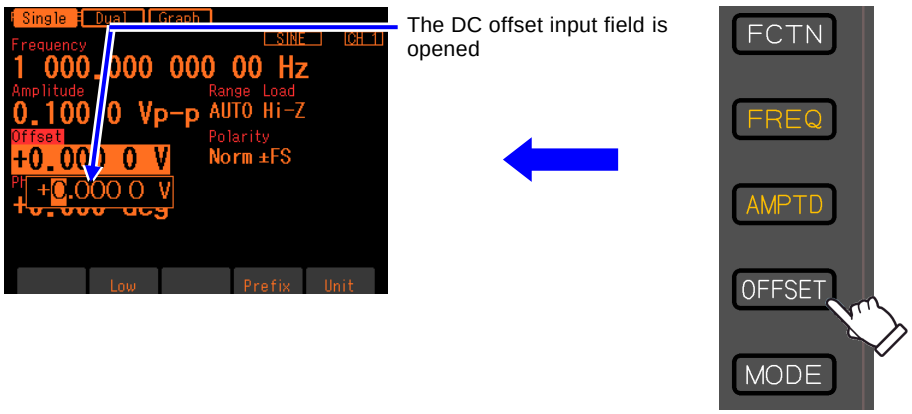
■ Frequency



■ Amplitude



■ DC Offset



4.3.4 Functions of ENTER/CANCEL/UNDO Key

■ Functions of ENTER key

The ENTER key can be used to perform the following actions.

•Open the input field or selection list for the selected item.

•Set the value input from the numeric keypad.

•Perform the function of the button displayed on the screen.

■ Functions of CANCEL key

The CANCEL key can be used to perform the following cancellations. Note that once a setting has been changed, the original setting cannot be restored with this key (can be restored with the UNDO key described next).

•Close an input field or selection list.

•Discard the value input from the numeric keypad.

•Restore the value changed by using the modify knob.

•Close a setting window or dialog box.

■ Functions of UNDO key

The UNDO key can be used to restore the settings changed by using the ENTER key or the modify knob. This key also can restore the setting change that has been automatically executed as the result of the user's operation.

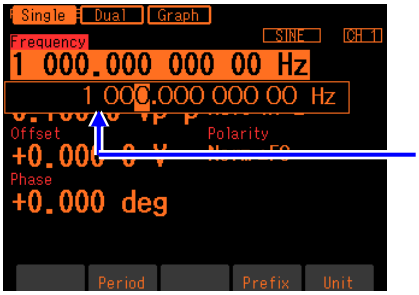
When you press the UNDO key again immediately after the undo operation, the setting before the undo operation is restored.

Note that undo may not work for some operations.

4.3.5 To Change Display Unit

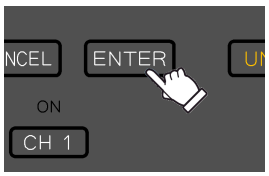
a) To change the prefix (unit prefix: k, m, M, etc.)

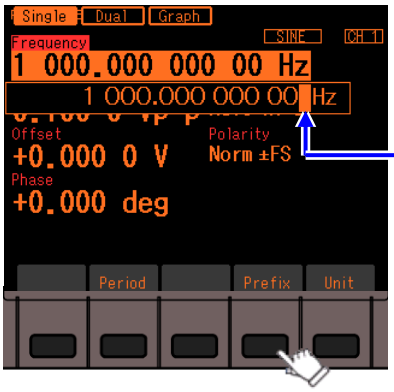
Frequency is used as an example here. For amplitude and pulse width, you can use a similar way.



The input field is opened

1. Select frequency and then press the ENTER key to open the input field.



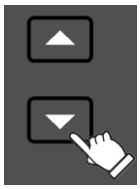


Pressing [Prefix] moves the cursor to before "Hz"

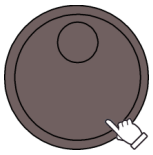
2. Press the [Prefix] soft key and the cursor will move to before "Hz". The right arrow key can also be used to move the cursor to before "Hz".

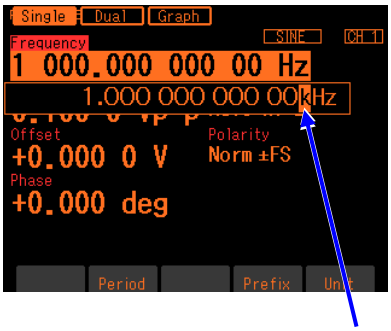
3. You can use the up/down arrow keys or the modify knob to change the unit to MHz, kHz, Hz, mHz, or uHz. This just changes the display unit and decimal point position, and the setting value itself does not change.

Changing prefix

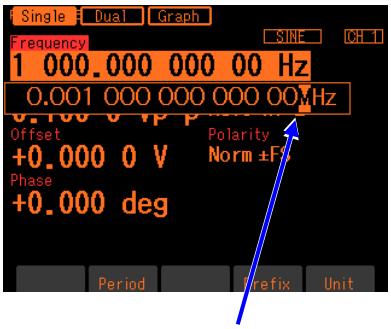


or





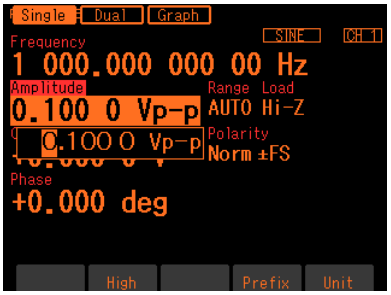
kHz display



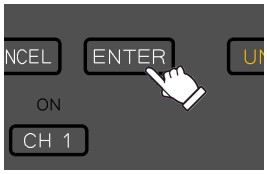
MHz display

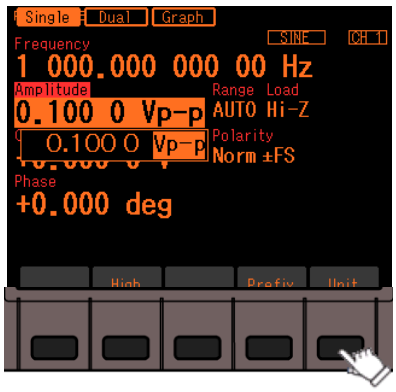
b) To change Vp-p, Vrms, user-defined unit, etc.

Amplitude is used as an example here. For frequency and pulse width, you can use a similar way.



1. Select amplitude and then press the ENTER key to open the input field.

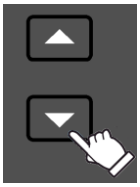




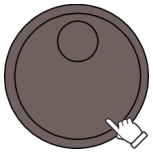
2. Press the [Unit] soft-key to move the cursor to "Vp-p".
You can also press the right arrow key to move the cursor to "Vp-p".

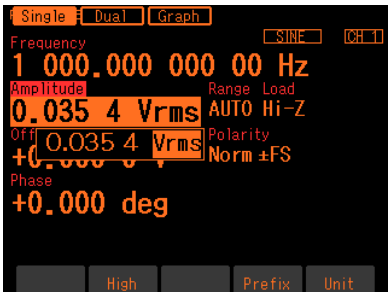
3. You can use the up/down keys or the modify knob to change the unit to Vrms, dBV, or a user-defined unit (in the case of sine wave and load impedance Hi-Z). This just changes the display unit and numeric value, and the output value itself does not change.

Changing unit



or





Vrms display

dBV display

Also refer to the followings:

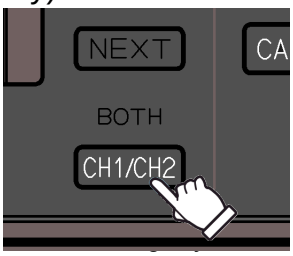
- Changing the frequency and period setting ☞ P.4-24, P.4-25.
- Changing the amplitude unit (Vp-p, Vpk, Vrms, dBm, dBV) ☞ P.4-28.
- Changing the pulse width time and duty settings ☞ P.4-40.
- Setting user-defined units ☞ P.10-2.

4.3.6 CH1/CH2 Switching Key and Active Channel (WF1948 Only)

Each time the CH1/CH2 switching key is pressed, the channel to be set is switched.

This key is disabled on the setting screens that are not dependent on the channel.

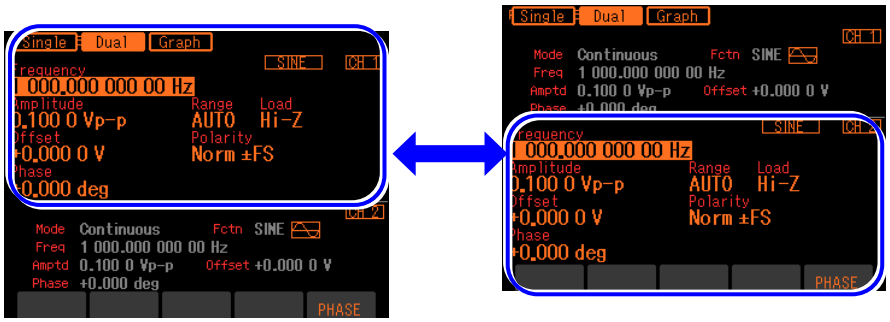
The channel that is to be set is called "active channel" in this product. In the burst oscillation mode, etc., the TRIG key works for the active channel. Even if the screen is changed to a channel-independent setting screen, the channel that was active up to that point is saved.

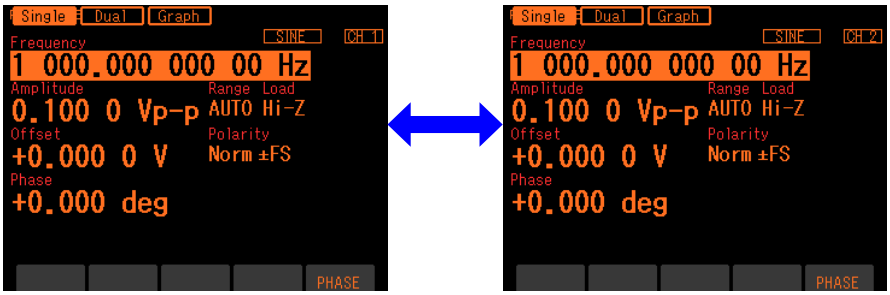


CH1/CH2 switching key

CH1 active
(CH1 is to be set)

CH2 active
(CH2 is to be set)





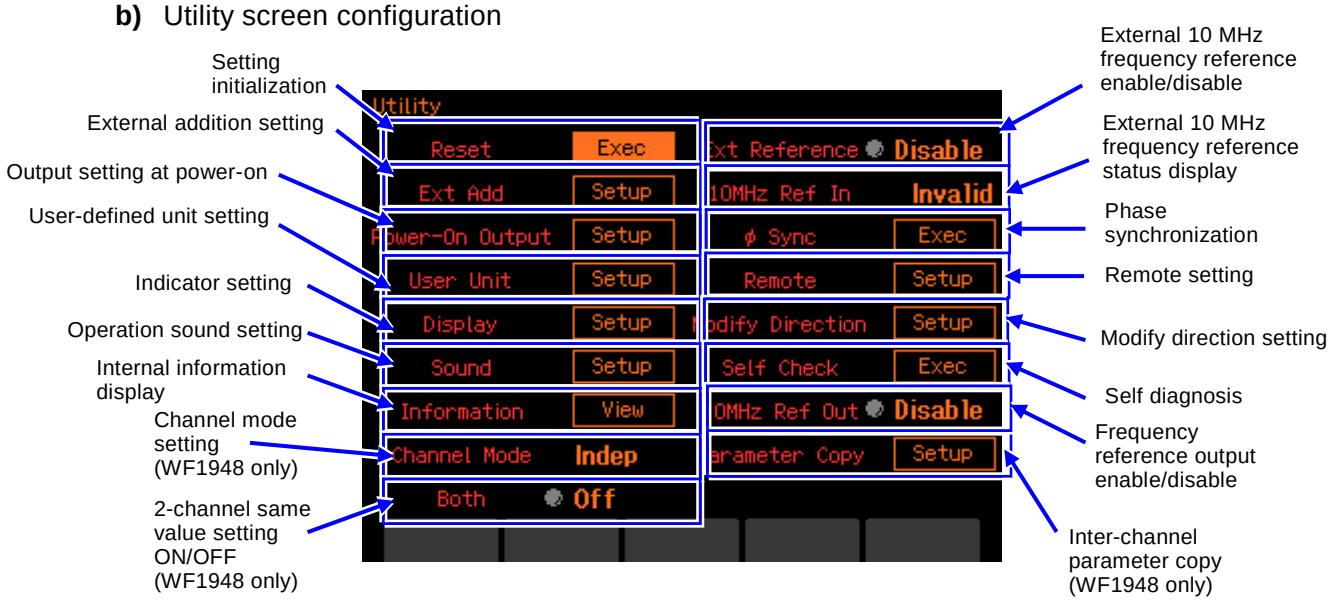
The current active channel is displayed at the top right corner on the Oscillator screen

4.3.7 Operations Available on Utility Screen

a) To display the Utility screen

When you press the MENU key, the top menu is displayed in the soft-key area. In this area, press the soft-key corresponding to [UTILITY]. This opens the Utility screen.

b) Utility screen configuration



•Setting initialization [Reset]

Initializes the settings. The initial settings are continuous oscillation, sine wave, 1 kHz, 0.1 Vp-p/open, and output off. ☞ P.4-21

•External 10 MHz frequency reference enable/disable [Ext Reference]

Enable/disable the external 10 MHz frequency reference. ☞ P.9-4

•External addition setting [Ext Add]

Sets the external addition gain. The setting can be selected from off, x0.4, x2, and x10.

☞ P.4-36

•External 10 MHz frequency reference input status display [10MHz Ref In]

Displays whether a signal that is valid for the external 10 MHz frequency reference input is input. ☞ P.9-4

•Output setting at power-on [Power-On Output]

Sets the output on/off setting at power-on. ☞ P.4-21

•Phase synchronization [φSync]

Performs the inter-unit synchronization during the synchronous connection of multiple units and the inter-channel synchronization in WF1948.

☞ P.7-6, P.8-4

•User-defined unit setting [User Unit]

Set the user-defined units. ☞ P.10-3

•Remote setting [Remote]

Select GPIB/USB and sets the GPIB address. The USB ID is also displayed.

☞ P.11-2

•Indicator setting [Display]

Sets the backlight of the display.☞ P.11-2

•Modify direction setting [Modify Direction]

Sets the item movement direction when the modify knob is turned.☞ P. 11-2

•Operation sound setting [Sound]

Sets the operation sound.☞ P.11-3

•Self Diagnosis [Self Check]

Checks the internal status.☞ P. 11-3

•Internal information display [Information]

Displays the firmware version and the latest calibration date. ☞ P. 11-3

•Frequency reference output enable/disable [10MHz Ref Out]

Turns the 10 MHz reference output terminal on/off ☞ P. 8-4

•Channel mode setting [Channel Mode] (WF1948 only)

Sets the type of 2-channel coordination operation. You can select the type from independent, 2-phase, constant frequency difference, constant frequency ratio, and differential output.☞ P.7-7, P.7-9, P.7-11, P.7-13

•Inter-channel parameter copy [Parameter Copy] (WF1948 only)

Copies the settings between channels.☞ P.7-3

•2-channel same value setting On/Off [Both] (WF1948 only)

Turn on/off the operation of setting the same value for both channels.☞ P.7-5

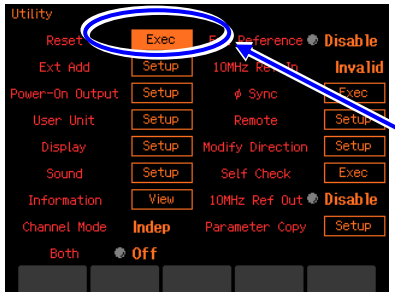
4.3.8 To Restore Initial Settings

The initial settings can be restored on the Utility screen.

The initial settings are continuous oscillation, sine wave, 1 kHz, 0.1 Vp-p/open, and output off.

For the list of the initial settings, ☞ P.14-1.

1. When you press the MENU key, the top menu is displayed in the soft-key area. In this area, press the [UTILITY] soft-key. This opens the Utility screen.



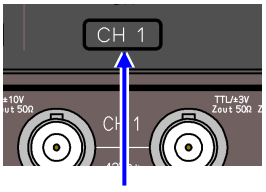
On the Utility screen, select [Reset] and then press the ENTER key

2. On the Utility screen, select the [Reset] field and then press the ENTER key.
This initializes the settings.

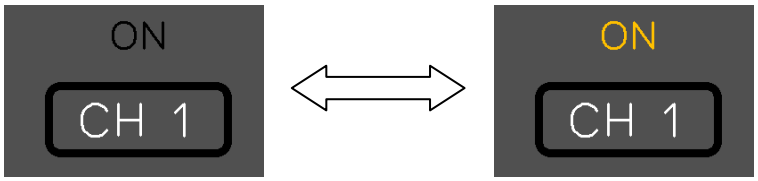
4.3.9 Output On/Off Operation

a) Operation method on the panel

Each time the waveform output on/off key is pressed, the waveform output is switched between on and off. When the output is on, the [ON] lamp above the key is lit.



Output on/off key



When the output is off, the output terminal is open. When the output is on, the output impedance is 50Ω. The synchronization/sub-output is always on regardless of the on/off setting of the waveform output. The waveform output is turned on/off by using a mechanical switch. This generates chattering when the waveform output is turned on/off. Please be careful when you connect the product to an equipment which may malfunction due to chattering.☞ P.3-7

b) Setting at power-on

You can specify the waveform output on/off status when the power is turned on.

The output setting at power-on can be selected from the following three.

• Off [Off]

The output is off.

• On [On]

The output is on.

• Returns to previous setting [Last State]

The behavior differs as follows according to how the power is turned off the last time.

If the power was turned off the last time with the power switch on the panel

☞ The settings before the previous power-off are restored.

If the power was turned off the last time by cutting off the power supply

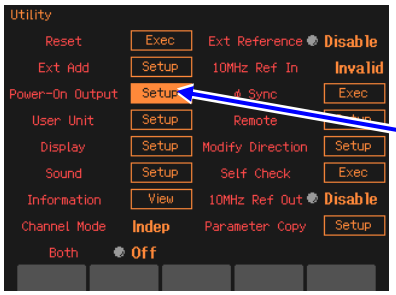
☞ The output is off.

This is the case when you collectively turn on/off the power supply for this product and other devices which are mounted in a rack.

The operation is done on the Utility screen.

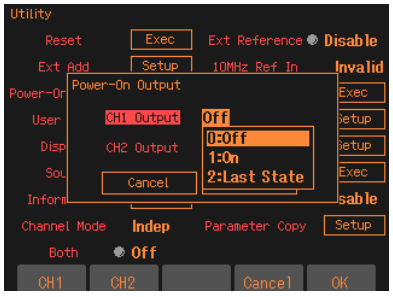
Select [UTILITY] in the top menu

1. When you press the MENU key, the top menu is displayed in the soft-key area. In this area, press the [UTILITY] soft-key. This opens the Utility screen.

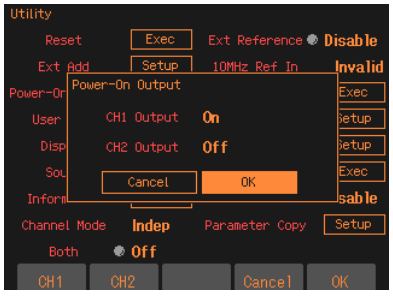


On the Utility screen, select [Power-On Output] and then press the ENTER key

2. On the Utility screen, select the [Power-On Output] field and then press the ENTER key.



3. The power-on output setting window is opened, so select the desired item and then press the ENTER key.
The selection list of the output setting conditions is displayed, so select the desired item and then press the ENTER key.



4. When the power-on output setting is completed, select [OK] at the bottom of the window, and then press the ENTER key. The change of the power-on output setting is applied, and the window is closed.
When you do not want to apply the change of the power-on output setting, select [Cancel] at the bottom of the window and press the ENTER key, or press the CANCEL key.

4.4 Setting Methods for Main Items

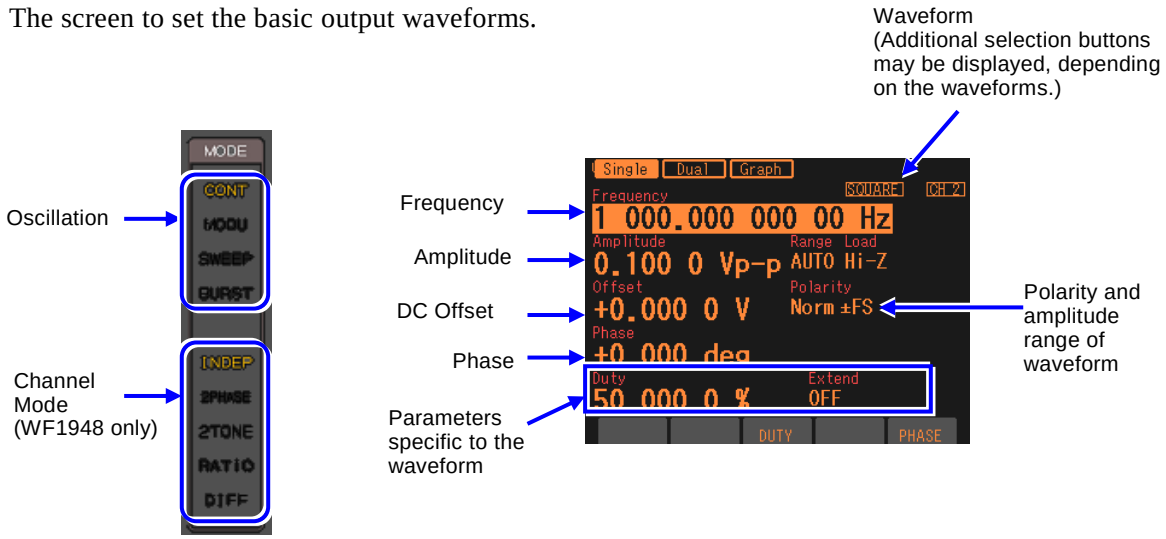
This section describes how to set the main items that are set in the Oscillator system setting window.

When you press the MENU key while another screen is displayed, the Top menu is displayed. Select [OSC].

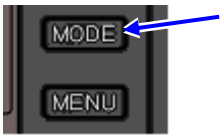
We explain by using the text display screen (1-channel display) in the continuous oscillation mode as an example. The setting screen is 1 page only.

4.4.1 Configuration of Text Display Screen in Continuous Oscillation Mode

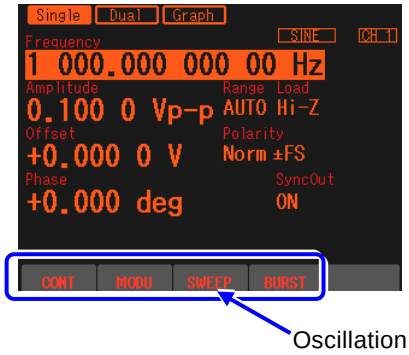
The screen to set the basic output waveforms.

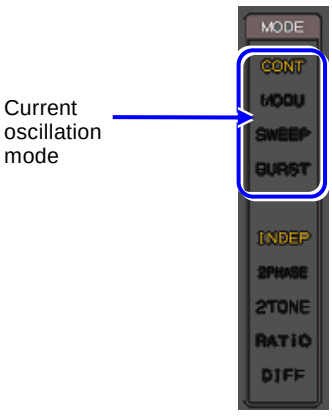


4.4.2 To Set Oscillation Mode



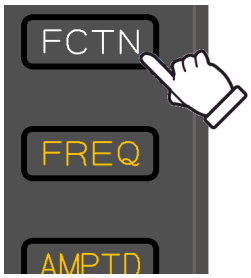
When you press the MODE key, Oscillation mode list, continuous oscillation (CONT), modulated oscillation (MODU), sweep oscillation (SWEEP), and burst oscillation (BURST) are displayed in the soft-key display area.





When you press the soft-key under the desired oscillation mode, the oscillation mode is changed, and the current oscillation mode is displayed on the left indicator.

4.4.3 To Set Waveforms



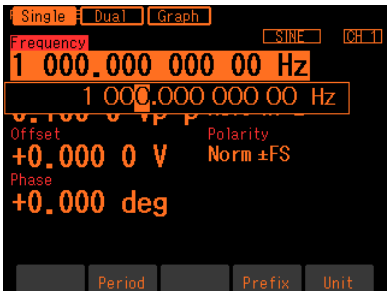
When you press the FCTN key, the [Waveform] icon is displayed on numeric keypad. Pressing the numeric key corresponding to the desired waveform sets the waveform.

The correspondence of each numeric key and the waveform is shown below:

[1] Key: Sine wave [SINE]
[2] Key: Square wave [SQUARE]
[3] Key: Pulse wave [PULSE]
[4] Key: Ramp wave [RAMP]
[6] Key: Noise [NOISE]
[7] Key: DC [DC]
[8] Key: Arbitrary wave [ARB]

The output waveform can be checked with the LED display on the numeric keypad, as well as the characters at the top right of the screen.
When you set the waveform as arbitrary wave, the arbitrary waveform stored in the main unit is selected.☞ P.4-44

4.4.4 To Set Frequency



1. Press the FREQ key to open the input field of Frequency. Alternatively, select the [Frequency] field and then press the ENTER key to open the input field.
If there are two or more system setting windows opened, [Frequency] is always displayed at the top left on the first page.
If [Period] is displayed in [Frequency] that shows "Period" instead of "Frequency", press the FREQ key again or press the soft-key [Freq]. The display switches to the frequency display.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) ([uHz], [mHz], [Hz], [kHz], or [MHz]) to set the input value and apply it to the output. When the ENTER key is used, Hz is set as the unit.

4.4.5 To Set Period

Settings can be performed using the period instead of the frequency.

The following two methods are available to change from the frequency display to the period display:

○ Use the soft-key [Freq]/[Period] to change to the period display

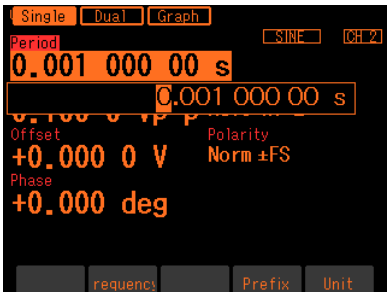
The input field of Frequency opens. When the current Frequency is displayed, the soft-key [Period] is displayed. Press the key opens the input field of Period, and the display changes from [Frequency] to [Period].

The soft-key [Period] changes to [Freq]. When the soft-key [Freq] is pressed, then the input field of Frequency is opened.

○ Press the FREQ key twice to change to the Period display

When the shortcut-key FREQ is pressed twice without opening the input field of Frequency, the input field of Synchronization is opened.

While the input field of Frequency or Period is opened, the display is switched between Frequency and Period as the FREQ key is pressed.



When the input field of Period appears, set in the same way as the one for Frequency.

When a numeric value is entered by using the numeric keypad, the unit key for period setting is displayed on the soft-key. When changed to the period display, the displayed is changed as follows.

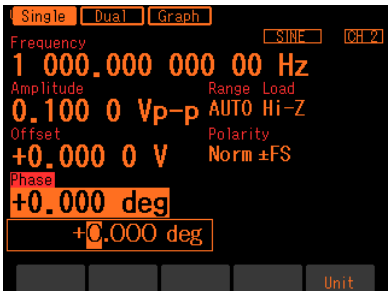
Items: Frequency → Period

Unit display: Hz → s

Soft-keys: Period → Freq

4.4.6 To Set Phase

a) Setting procedure



1. Select the [Phase] field and then press the ENTER key to open the phase input field. If there are two or more system setting windows opened, [Phase] is always displayed at the lower left on the first page.

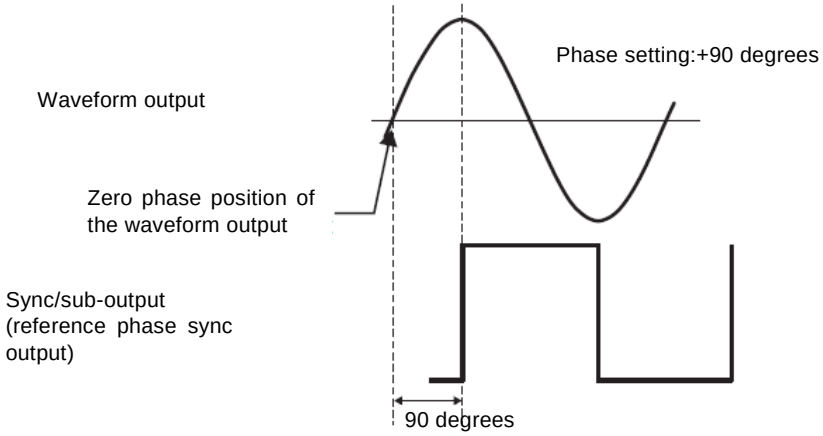
2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) ([deg]) to set the input value. When the ENTER key is used, deg is set as the unit.

b) Items changed in the phase setting

The following items can be changed in the phase setting.

■ The phase difference between phase sync output of Sync/Sub terminal and waveform output can be changed.

The following figure shows the example of the phase setting of +90 degree. At this time, the zero relative position of waveform output precedes 90 degree from the rising position of the reference phase sync output.



■ The oscillation start/stop phase is changed in burst oscillation or gated single-shot sweep.

The following figure shows the example of the burst oscillation at the oscillation start/stop position of +30 degree. At this time, the oscillation starts at +30 degree position, and stops also at +30 degree position.

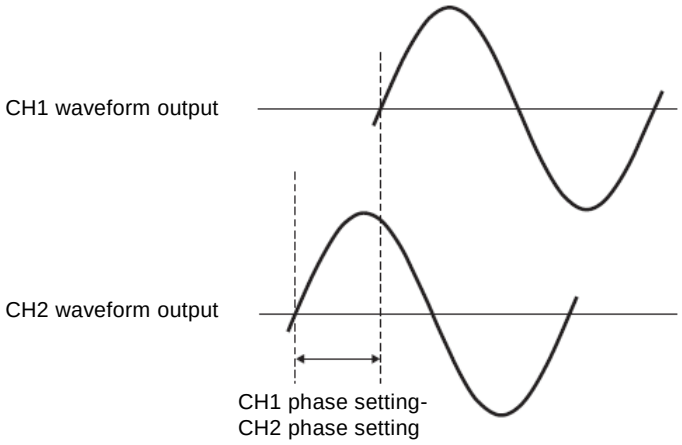
Burst oscillation ☞ P.4-84, gated sweep ☞ P.4-67.

■ The phase difference between channels can be changed in synchronous oscillation and 2 phase oscillation (WF1948 only)

The difference between the phase setting of each channel is the phase difference between the channels.

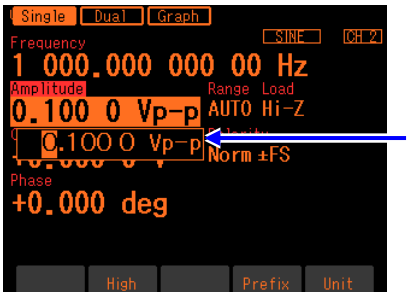
When [Phase setting of CH2 - Phase setting of CH1] is positive, the waveform of CH2 precedes the waveform of CH1 as shown in the following figure.

For synchronous oscillation and 2 phase oscillation, ☞ P.7-6, P.7-7



4.4.7 To Set Amplitude

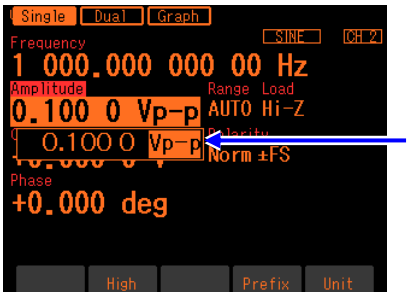
a) Setting procedure



1. Press the shortcut-key AMPTD to open the amplitude input field. Or select the [Amplitude] field and then press the ENTER key to open the amplitude input field.
   If there are two or more system setting windows opened, [Amplitude] is always displayed at the top left on the first page.
   [High] is displayed in the [Amplitude] field. If the high level instead of amplitude is displayed, press the AMPTD key again.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
   Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output.

b) To change unit (Vp-p, Vpk, Vrms, dBV, dBm, User-defined unit)



1. When the input field of amplitude opens, press the soft-key [Unit] to move the cursor to the unit position at the right end.
2. The unit can be changed by using the up or down arrow key/modify knob (unavailable units are not displayed). Only the display unit is changed without changing the actual output value.

c) Available units differs depending on the waveform.

Vp-p, Vpk, Vrms, dBV, dBm, and user-defined units can be used as the units for amplitude. However, the waveforms to which the units can be applied are restricted as follows (DC is excluded).

Unit	Applied waveform
Vp-p	Standard waveforms with amplitude rage of ±FS and arbitrary waveforms
Vpk	Standard waveforms with amplitude rage of 0/+FS, -FS/0 and arbitrary waveforms
Vrms	Sine wave and noise
dBV	Noise of sine wave. 1Vrms shall be 0dBV.
dBm	Sine wave and noise. The voltage that is 1mW at the specified load impedance shall be 0dBm. For example, when the load impedance is set as 50 Ω, dBm=223.6mVrms/50Ω. It is not available when the load impedance is set as Hi-Z.
User-defined Unit	All waveforms. For user-defined units, ☞ P.10-2.

d) Restriction on AC + DC

The maximum value of total of AC amplitude and DC offset is restricted to ±10V/open.

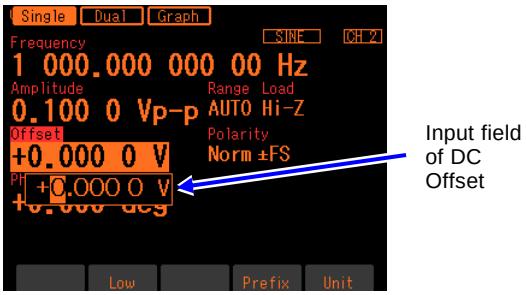
For example, when the AC amplitude is 5Vp-p/open, DC offset is restricted to the range from -7.5V/open to +7.5V/open.

The maximum value also differs depending on the range setting of output voltage or Ext Add setting.

☞ P.4-32, P.4-34

4.4.8 To Set DC Offset

a) Setting procedure



1. Press the shortcut-key OFFSET to open the DC offset input field. Or select the [Offset] field and then press the ENTER key to open the DC offset input field.
If there are two or more system setting windows opened, [Offset] is always displayed at the top left on the first page.
[Low] is displayed in the [Offset] field. If the low level instead of DC offset is displayed, press the OFFSET key again.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output.

b) Restriction on AC + DC

The maximum value of total of AC amplitude and DC offset is restricted to ±10V/open.

For example, when the AC amplitude is 5Vp-p/open, DC offset is restricted to the range from -7.5V/open to +7.5V/open.

The maximum value also differs depending on the range setting of output voltage or Ext Add setting.

☞ P.4-34, P.4-37

4.4.9 To Set Output Level with High/Low Level

The output level can be set with the top end value (high level) and the bottom end value (low level) of a waveform instead of amplitude and DC offset.

a) To change Amplitude/DC offset display to High/Low display

There are the following three methods to change the amplitude/DC offset display to high/low display:

○ To change to the high/low display by using the soft-key [High]/[Low]

The input field of Amplitude or DC offset opens. When the current value is displayed, the soft-key [High] or [Low] is displayed. When this soft-key is pressed, the input field of high level or low level opens, and the display is changed from [Amplitude], [Offset] to [High], [Low] respectively.

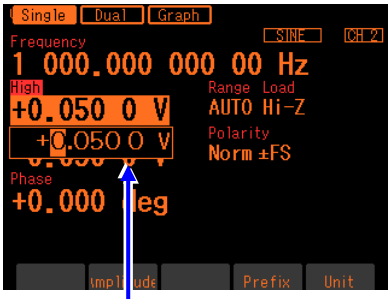
The soft-key [High], [Low] changes to [Ampl], [Offset] respectively. When the soft-key [Ampl], [Offset] is pressed, then the input field of Amplitude or DC offset is opened.

○ To change to the High/Low display by pressing the AMPTD key twice

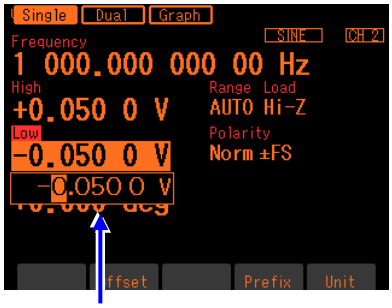
When the shortcut-key AMPTD is pressed twice without opening the input field of Amplitude, the input field of High level is opened. While the input field of high level opens, the display is switched between the amplitude/DC offset as the AMPTD key is pressed.

○ To change to the High/Low display by pressing the OFFSET key twice

When the shortcut-key OFFSET is pressed twice without opening the input field of DC offset, the input field of Low level is opened. While the input field of low level opens, the display is switched between the amplitude/DC offset as the OFFSET key is pressed.



Input field of high level



Input field of low level

When the input field of high level or low level appears, set in the same way as the one for DC offset. When a numeric value is entered by using the numeric keypad, the unit key for high level/low level setting is displayed on the soft-key.

When changed to the high level/low level display, the displayed is changed as follows.

Items: Amplitude → High, Offset → Low

Unit display: Vp-p, Vpk, Vrms, dBV, dBm, V → V

Soft-keys: High → Ampl, Low → Offset

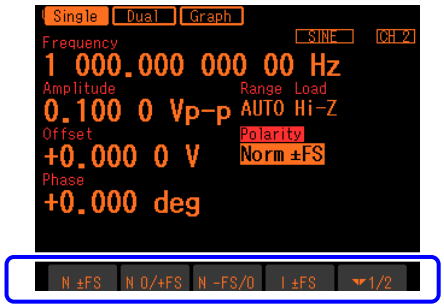
b) Restriction on AC + DC

The high level and low level are restricted to the range from -10V to +10V/open.

The maximum range also differs depending on the range setting of output voltage or Ext Add setting. ☞ P.4-34, P.4-37

4.4.10 To Set Waveform Polarity and Amplitude Range

a) Setting procedure



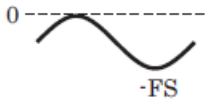
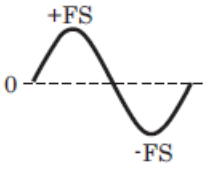
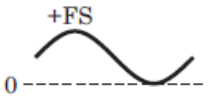
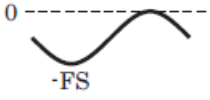
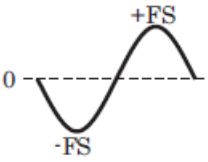
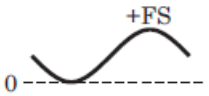
Selection list (soft-key)

1. Select the [Polarity] field and then press the Enter key to open the selection list in the soft-key area.
2. Select the desired polarity and amplitude range from the selection list. When the corresponding soft-key is pressed, the polarity and the amplitude range are set and they are applied to the output. The first character of the soft-key is "N" when the polarity is normal.
   The first character is "I" in the case of polarity reverse. If you want to cancel the setting, press the [Cancel] key to close the selection list without changing the setting.

b) What are polarity and amplitude range

You can reverse the polarity or change the amplitude range to single-polarity for each waveform.

The following figure shows the cases with sine waves:

Polarity	Amplitude range		
	-FS/0	± FS	0/+FS
Normal [Norm]			
Inverted [Inv]			

"Reverse" only reverses a waveform without changing the sign of output DC offset.

> **Check**
> The polarity setting and amplitude range setting are separate settings for each waveform.

c) How to determine amplitude range

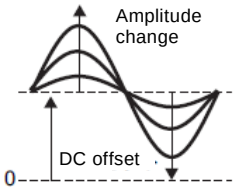
Pay attention how the waveform changes as the amplitude is changed, and decide the amplitude range.

By default, a waveform that swings to both polarities is set as ±FS, a waveform with single polarity is set as
0/+FS.

■ Example with sine wave and the amplitude range of ±FS

When the amplitude is changed, the amplitude of waveform changes into the positive and negative symmetry based on the DC offset position.

It is usually convenient to set a waveform that swings to both polarities around zero as ±FS.



d) Restriction by amplitude range

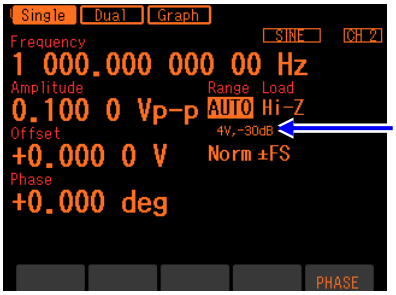
- When the amplitude range is -FS/0 or 0/+FS, the maximum amplitude is half of ±FS.
- When the amplitude range is -FS/0 or 0/+FS, it is equivalent to use only the upper/lower half of waveform memory. Therefore, the amplitude resolution power decrease by 1bit, compared with ±FS.
- The amplitude range for ±FS is set as Vp-p, or set as Vpk for -FS/0 or 0/+FS. Both are the nominal size of peak to-peak of waveform.

4.4.11 How to Use Auto Range/Range Hold for Output Voltage

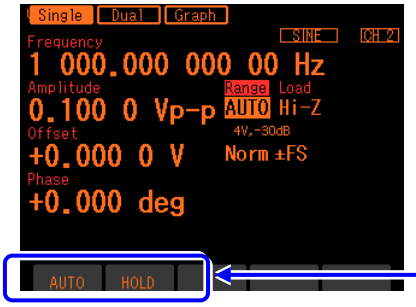
Auto-range is selected by default. The best range is automatically selected according to the amplitude and DC offset (including high/low level settings) settings. When the range is changed, a transitional voltage is generated. Therefore, it is controlled so as not to be an excessive voltage.

If the transitional voltage generated on range switching is undesirable, you can fix the range. However, amplitude precision and a waveform fineness decrease as the amplitude is reduced with the range fixed.

a) Setting procedure



When selecting the range field, the current range is displayed.



Selection list (soft-key)

1. When the range field at the right of the amplitude display is selected, the current range is displayed under the range field. It is expressed as a combination of the maximum output voltage [Vp-p] and amplitude attenuator.
   When the ENTER key is pressed, the selection list for range processing is opened in the soft-key area.
2. When [AUTO] is selected from the selection list, it is set as Auto range. Selecting [HOLD] fixes the range at that time.
   Select the desired range processing, and then press the ENTER key.

b) Maximum values of Amplitude/DC offset for fixed range

When a range is fixed, the maximum values of amplitude and DC offset, and Ext Add gain are fixed as shown in the following table.

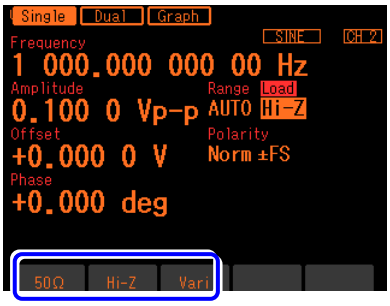
Range (Maximum output voltage Vp-p, Amplitude attenuator)	Amplitude Max (Load open valued)	DC Offset Max (Load open valued)	AC+DC Max (Load open valued)	External Add gain (Rated ±1V)
20V, 0dB	20Vp-p	±10V	±10V	×10 or Off
20V,-10dB	6.325Vp-p	±10V	±10V	×10 or Off
20V,-20dB	2Vp-p	±10V	±10V	×10 or Off
20V,-30dB	0.6325Vp-p	±10V	±10V	×10 or Off
4V, 0dB	4Vp-p	±2V	±2V	×2 or Off
4V,-10dB	1.265Vp-p	±2V	±2V	×2 or Off
4V,-20dB	0.4Vp-p	±2V	±2V	×2 or Off
4V,-30dB	0.1265Vp-p	±2V	±2V	×2 or Off
0.8V, 0dB	0.8Vp-p	±0.4V	±0.4V	×0.4 or Off
0.8V,-10dB	0.253Vp-p	±0.4V	±0.4V	×0.4 or Off
0.8V,-20dB	0.08Vp-p	±0.4V	±0.4V	×0.4 or Off
0.8V,-30dB	0.0253Vp-p	±0.4V	±0.4V	×0.4 or Off

4.4.12 To Set Load Impedance

By matching the setting value of the load impedance to an actual loading condition, the amplitude and the DC offset (including the setting according to high level and low level) can be set with the voltage that appears to the load end.

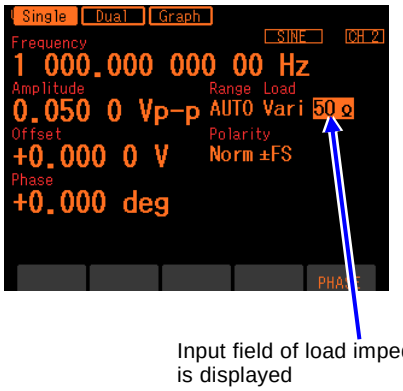
The value of the load impedance can be set to the range of 1Ω -10kΩ , 50Ω or open (Hi-Z). However, if the setting value of load impedance is changed, only the amplitude setting value and DC offset displayed value are changed. The output voltage when the load is opened does not change.

a) Setting procedure



Selection list (soft-key)

1. When the load impedance field at the right of the range field is selected and the ENTER key is pressed, the selection list is displayed in the soft-key area.



Input field of load impedance is displayed

2. Select the desired load impedance condition from the selection list, and then press the corresponding soft-key. When [Vari] is selected, a value of the load impedance can be set. In this case, the input field of load impedance value is displayed at the right of the load impedance field.
   If nothing is changed, press the CANCEL key.

b) Conversion formula

Converted by the following formula:

Load impedance setting value: Rload (Ω)

Output voltage when load is opened: Vopen

Output voltage setting value (load end voltage): Vload

$$Vload = \frac{Rload}{50 + Rload} \times Vopen$$

Check

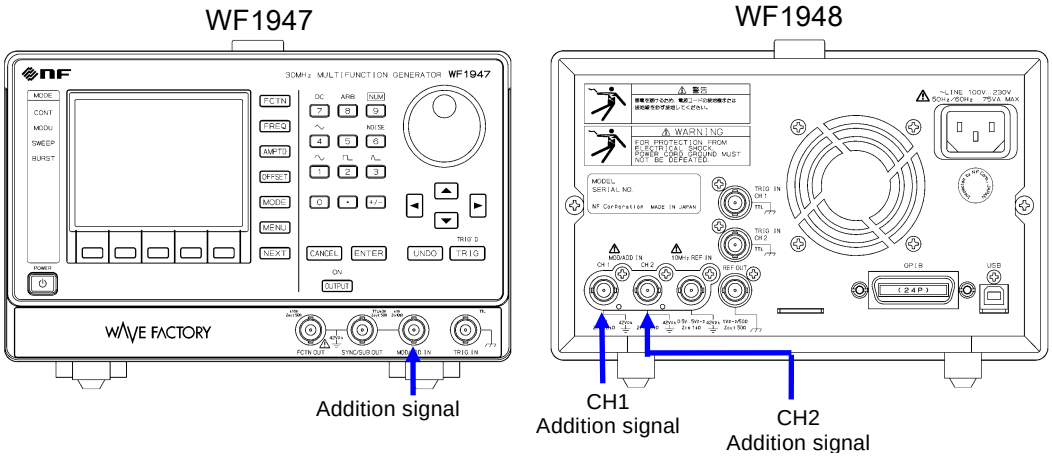
- Output impedances is constantly 50Ω.
- Neither the output impedance error nor the output voltage error are corrected. The precision specification of the output voltage is a value when the load is opened.

4.4.13 To Add External Signal

It is possible to output by adding an external signal to a waveform output of this product.

a) To Connect addition signal

Connect an addition signal to the external modulation/addition input (MOD/ADD IN) BNC terminal on the front panel of WF1947 or on the rear panel of WF1948.



For the input characteristic, ☞ P.3-9.

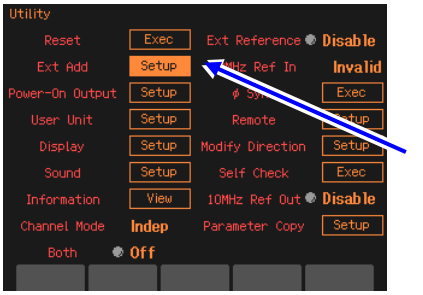
This BNC terminal is insulated from the chassis, and the same ground electrical potential as the waveform output of the identical channel. For the floating ground connection, ☞ P.3-13.

b) To activate an addition signal

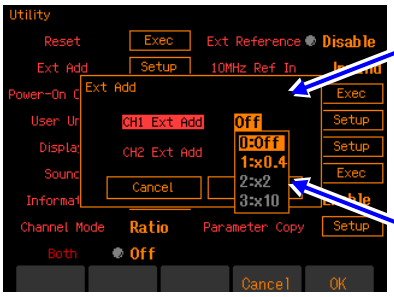
Ext Add is set in the Utility screen.

1. When the MENU key is pressed, the top menu opens in the soft-key area. In this area, press the soft-key corresponding to [UTILITY]. This opens the Utility screen.

2. On the Utility screen, select the [Ext Add] field and then press the Enter key.



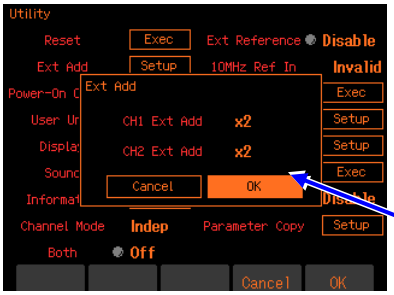
Select [Ext Add] on the Utility screen, and then press the ENTER key



External addition setting window is opened

Set the external addition condition.

3. The external addition setting window opens. Select the item and then press the ENTER key.
The selection list of the external addition conditions is opened, so select the desired condition and then press the ENTER key. [x0.4][x2][x10] represents the addition gain.



Select [OK] and then press the ENTER key.

4. When the external addition setting is completed, select [OK] at the bottom of the window, and then press the ENTER key. The change of the external addition setting is applied, and the window is closed.
When you do not want to apply the change of the external addition setting, select [Cancel] at the bottom of the window and press the ENTER key, or press the CANCEL key.

c) If the desired external addition condition cannot be selected

■ External addition cannot be ON (set as × 0.4, × 2, × 10)

An external addition is used.

To use the external addition, change the modulation source to Internal.

The external addition input terminal is sharing with the external modulation input terminal. Therefore, when External is specified as a modulation source for modulated oscillation except FSK and PSK, the external addition cannot be used. The external addition setting at this time is always becomes [Off].

Similarly, when an external addition is used, the external modulation cannot be used (excluding FSK and PSK).

■ External addition gain cannot be set as the desired value

The gain of the external addition is decided by the output voltage range.

To increase the external addition gain by a factor of 0.4, set the amplitude and the DC offset setting so that the output voltage range is 0.8V.

To increase the external addition gain by a factor of 2, set the amplitude and the DC offset setting so that the output voltage range is 4V.

To increase the external addition gain by a factor of 10, set the amplitude and the DC offset setting so that the output voltage range is 20V.

Because the external addition adds to the final stage of a waveform output (☞ P.1-3), the addition gain is closely related to the output voltage range. It is fixed to ten times when the maximum output voltage of the range is 20V, fixed to twice for 4V, fixed to 0.4 times for 0.8V, and other addition gains cannot be selected.

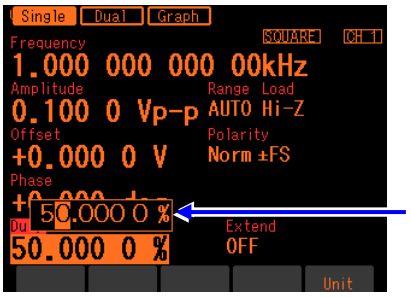
Oppositely, when the external addition is used, the maximum output voltage of the range is fixed by the addition gain. Especially, note that the fineness of the amplitude precision and the waveform might decrease when the amplitude is reduced because it is fixed to 20V range when the addition gain is ten times.

4.4.14 To Set Duty of Square Wave

The waveform is assumed to be set as square wave [Square]. For how to set the waveform, ☞ P.4-13.

The setting unit for duty is % only, and it is not possible to set or display with time.

a) How to set duty

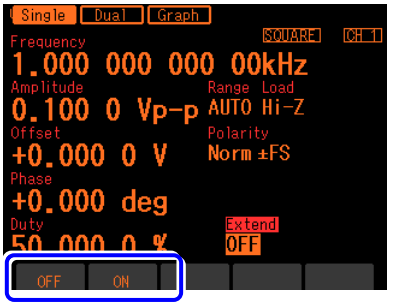


1. When the [Duty] field is selected and the ENTER key is pressed, the input field of duty opens.
   If there are two or more system setting windows opened, [Duty] is always displayed on the first page.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
   Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) ([%]) to set the input value and apply it to the output. Even if the ENTER key is used, an output is set with %.

b) How to switch duty variable range

Normally, it should be used with Off (standard range).



Selection list (soft-key)

1. When the [Extend] field is selected and the ENTER key is pressed, The selection list for duty variable range enhancement On/Off opens in the soft-key area.
   If there are two or more system setting windows opened, [Extend] is always displayed on the first page.

2. Set and applied in the output, when the desired condition is selected from the selection list, and the corresponding soft-key is pressed.

c) Difference between standard and enhanced duty variable range

Variable range	Features
Standard	Setting range: 0.0100% ~ 99.9900% • Duty can be changed within the range where jitter is low and a pulse does not disappear. • The setting range of the duty narrows as the frequency rises.. • The duty is fixed to 50% at 20MHz.
Enhanced	Setting range: 0.0000% to 100.0000% (independent from frequency) • There is jitter of 2.5ns rms or lower typ., and the duty can be always changed from 0% to 100%. • The pulse might sometimes disappear when the pulse width of the high level or the low level is narrower than that of 8.4ns. However, it becomes equal to the specified duty on average, when there is no oscillating frequency in ratio-of-integers relations to 120 MHz. (The uncertainty for about 8.3 ns arises at edge time, when oscillating frequency has a ratio-of-integers relation.) • When 0% is set, the waveform is fixed to the low level side, and when 100% is set, the waveform is fixed to the high-level side, and in any case, the pulse is not output.

d) Restriction of duty and frequency when duty variable range is standard

The setting range of the duty is limited by the frequency within the following ranges:

Frequency (Hz)/400,000 ≦Duty (%) ≦100 - Frequency (Hz)/400,000

For example, the variable range at 4MHz is limited to the range from 10% to 90%.

If the above-mentioned restriction is not filled by setting the frequency, the duty is adjusted.

Check

When the duty variable range is enhanced, the frequency might become lower than the setting because the pulse might sometimes disappear. Do not use it for the usage in which the frequency should be kept constant.

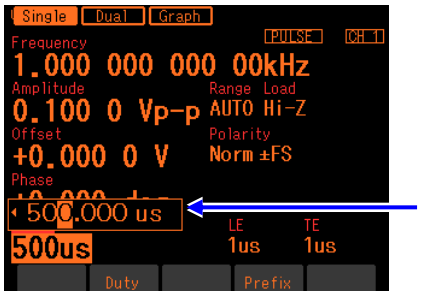
4.4.15 To Set Pulse Width and Leading/Trailing Time of Pulse Wave

The waveform is assumed to be set as pulse wave [Pulse]. For how to set the waveform, ☞ P.4-13.

The pulse width can be set with either time or duty.

The Leading time and the Trailing time can be set with time only.

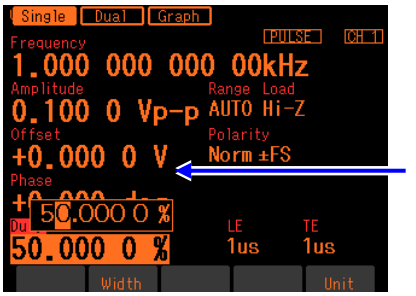
a) How To Set Pulse Width Time



1. When the [Width] field is selected and the ENTER key is pressed, the input field of pulse width time opens.
   If there are two or more system setting windows opened, [Width] is always displayed on the first page.
   [Duty] is displayed in the [Width] field. If a pulse width duty is displayed instead of pulse width time, press the soft-key [Width] while the input field of the duty opens. It is switched to the pulse width time display.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
   Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output. When the ENTER key is pressed, s is set as the unit.

b) How to set pulse width duty



1. When the [Duty] field is selected and the ENTER key is pressed, the input field of pulse width duty opens.
   If there are two or more system setting windows opened, [Duty] is always displayed on the first page.
   [Width] is displayed in the [Duty] field. If a pulse width duty is displayed instead of pulse width time, press the soft-key [Duty] while the input field of the duty opens. It is switched to the pulse width duty display.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
   Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output. When the ENTER key is pressed, % is set as the unit.

c) To toggle pulse width time and pulse width duty

○ Pulse width time → Pulse width duty

The input field of pulse width time opens. When the current pulse width time is displayed, the soft-key [Duty] is displayed. Press the key opens the input field of Pulse width duty, and the display changes from [Width] to [Duty]. The soft-key [Duty] changes to [Width].

○ Pulse width duty → Pulse width time

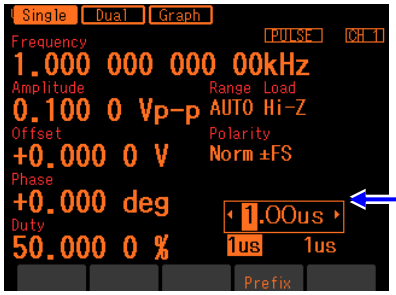
The input field of pulse width duty opens. When the current pulse width duty is displayed, the soft-key [Width] is displayed. Press the key opens the input field of Pulse width time, and the display changes from [Duty] to [Width]. The soft-key [Width] changes to [Duty].

d) Difference between pulse width time setting and duty setting

The following different actions occur, depending on whether to set the pulse width with time or duty.

e) How to set Leading/Trailing time

The Leading time [LE] and the Trailing time [TE] can be set with time only.

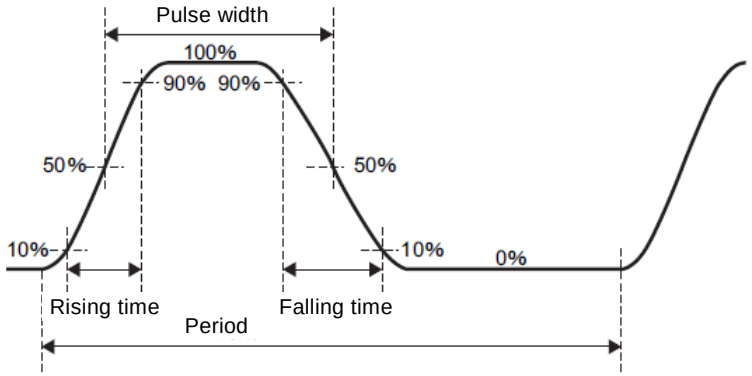


1. To set the Leading time, select the [LE] field, and then press the ENTER key. The input field of Leading time opens.
   To set the Trailing time, select the [TE] field, and then press the ENTER key. The input field of Trailing time opens.
   If there are two or more system setting windows opened, [LE][TE] is always displayed on the first page.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
   Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output. When the ENTER key is pressed, s is set as the unit.

f) Definition and restriction of pulse width, Leading time and Trailing time

The definitions of pulse width, Leading time and Trailing time are shown in the following figure.



However, the setting range is restricted mutually as for pulse width, Leading time, Trailing time,

and frequency as shown below.
If the following restriction is not filled by setting the frequency or the pulse width, the Leading and Trailing times are first adjusted, and then the pulse width are adjusted.

■ Limitations on Leading/Trailing time

The Leading time, the Trailing time and the frequency or the period are limited within the following ranges:

Large one either 0.01% of period or 15ns ≦Rising time
Large one either 0.01% of period or 15ns ≦Falling time

For example, the Leading time and the Trailing time are limited to 100ns or longer at 1kHz.

■ Restriction of pulse width, Leading time and Trailing time

The pulse width time, the Leading time, the Trailing time and the frequency or the period are limited within the following ranges: When the pulse width is set with duty, the value converted into time shall be the pulse width time.

$$\left(\text{Rising time} + \text{Falling time}\right) \times 0.8 \leqq \text{pulse width time} \leqq \text{period} - \left(\text{Rising time} + \text{Falling time}\right) \times 0.8$$

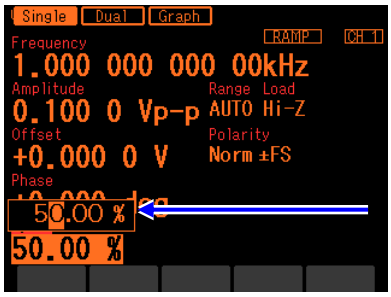
For example, when the Leading time and the Trailing time are set as 100ns at 1kHz, the pulse width time is variable within the range from 160ns to 999.84μs.

4.4.16 To Set Ramp Wave Symmetry

The waveform is assumed to be set as ramp wave [Ramp]. For how to set the waveform, ☞ P.4-13.

The setting unit for symmetry is % only, and it is not possible to set or display with time.

a) Setting Method of Symmetry

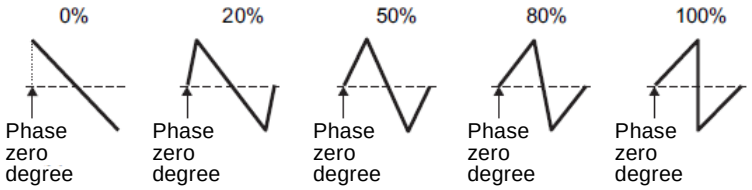


1. When the [Symm] field is selected and the ENTER key is pressed, the input field of symmetry opens.
   If there are two or more system setting pages, [Symm] is always displayed on the first page.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
   Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output. When the ENTER key is pressed, % is set as the unit.

b) Relation between symmetry and waveform

The waveform for one cycle changes as follows by the symmetry setting. The total ratio in the beginning and the last rising part is symmetry. The phase 0 degree is fixed to zero center positions of the amplitude, excluding the case that symmetry is 0%.



4.4.17 To Inhibit Synchronization Output Signal (in Continuous Oscillation Mode and Sine Wave is Selected)

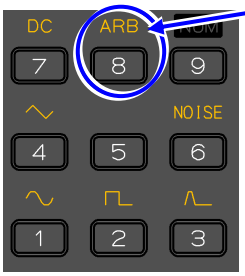
When the sine wave is selected in continuous oscillation mode, a sync output signal can be inhibited by sync signal output [SyncOut] setting of the Oscillator setting screen.

It is possible to reduce interference due to common GND in equipments connected to outside and jump from sync output signals by inhibiting a sync output signal.

Regardless of this setting, a sync output signal is output except for continuous oscillation mode and sine wave.

4.5 Using Arbitrary Waveforms

a) To output an arbitrary waveform



Press the [8] key of the numeric keypad to set an arbitrary waveform (ARB) output.

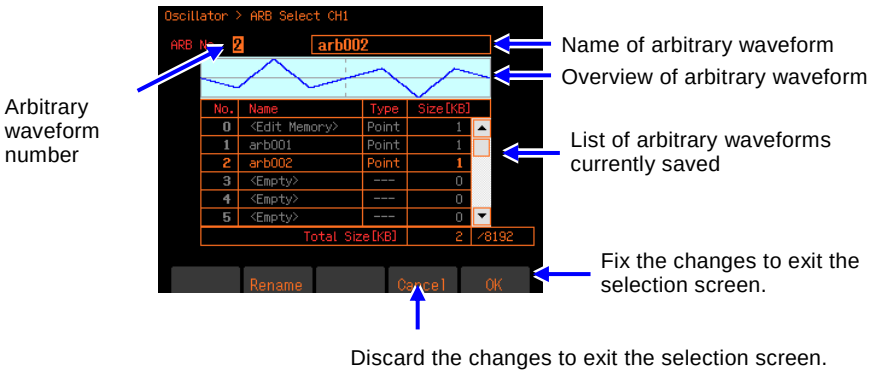
Press the FCTN key to display a waveform on the numeric keypad, and then press the key ([8] key) corresponding to an arbitrary waveform (ARB).
The wave that is currently set as an arbitrary waveform appears in the output.
The polarity and the amplitude range of the waveform can be changed as is the case with other waveforms.

b) To change a waveform of arbitrary waveform

When [>] is selected, the selected arbitrary waveform is displayed immediately under the field.

1. When a waveform is set as arbitrary waveform [ARB], [>] appears to just right of [ARB] that indicates the waveform setting. When selecting here by using the up or down arrow key/the modify knob, the arbitrary waveform that is currently selected is displayed as shown in the left figure. When pressing the ENTER key under such condition, then navigates to the selection screen of arbitrary waveforms.

2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to increment the value. The change is immediately applied to the output.
Or use the numeric keypad to enter the value. Press the ENTER key or the unit key (soft-key) to set the input value and apply it to the output.



The changes is not applied to output waveforms until you fix it by using the soft-key [OK].
Arbitrary waveform cannot be created through this screen. For creation of arbitrary waveform, data format, and memory capacity, ☞ P.6-6.
How to rename is the same as to setting memory. Up to 20 characters can be set.

3. To fix the change and exit the selection screen, press the soft-key [OK].
To discard the change and exit the selection screen, press the soft-key [Cancel].
When the shortcut key for changing basic parameter is pressed, the change is discarded and exit the selection screen.

4.6 Setting and Operation of Modulation

4.6.1 Modulation Types

The following 8 types of modulations are available.

• FM: Frequency Modulation ☞ P.4-51

• FSK: Frequency Shift Keying
Binary frequency deviation modulation. ☞ P.4-52

• PM: Phase Modulation ☞ P.4-53

• PSK: Phase Shift Keying
Binary phase deviation modulation. ☞ P.4-54

• AM: Amplitude Modulation ☞ P.4-55

• AM(DSB-SC): Amplitude Modulation (Double Side Band - Suppressed Carrier)
AM without carrier frequency element. ☞ P.4-57

• DC offset modulation: Offset Modulation ☞ P.4-59

• PWM: Pulse Width Modulation ☞ P.4-60

4.6.2 Screen for Setting and Operation of Modulation

This section describes the common screen structure in the modulation oscillation mode.

Settings and operations are performed in the settings and operations are performed in the Oscillator setting screen. When you press the MENU key while another screen is displayed, the Top menu is displayed. Select [OSC] and then press the ENTER key.

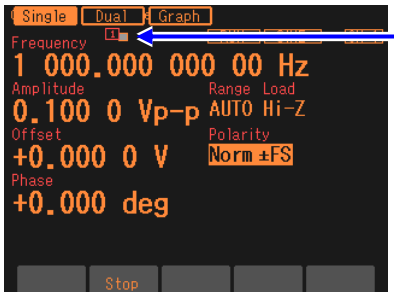
a) To set the oscillation mode to modulations

Set the oscillation mode to [MODU]

Press the MODE key, and then select [MODU] by using the soft-key to light "MODU" ” in the operation mode display section on the front panel of the main unit. (☞ P.4-23) This changes into the modulated oscillation mode. There are total 2 pages of the setting screens in the modulation oscillation mode. You can switch them by using the NEXT key.

b) First page of the setting screen: Screen To Set Carrier Signal

These are common items independent from oscillation mode. The setting screen for the modulation carrier signals.

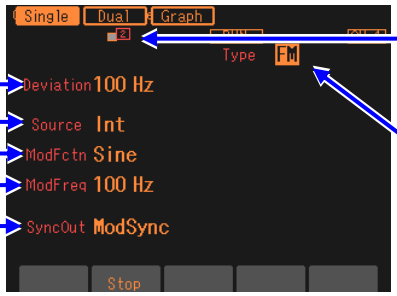


Indicates that the first page is displayed

Pressing the NEXT key switches the display to the second page.

c) Second page of the setting screen: Screen for setting the modulation

The following figure is the example of selecting FM as a modulation type.



Indicates that the second page is displayed

Modulation width

Modulation source

Internal modulation waveform

Internal modulation frequency

Synchronization output

Modulation type

Pressing the NEXT key switches the display to the first page.

Modulation type [Type]

The types of modulation. Select from FM, FSK, PM, PSK, AM, AM(DSB-SC), DC offset modulation, and PWM. ☞ P.4-48

Modulation width [Deviation, Depth, HopFreq]

Modulation width. The item name depends on the type of modulation. ☞ P.4-48

Modulation source [Source]

Select the modulation source from the inside or outside. ☞ P.4-49

Internal modulation waveform [ModFctn]

The waveform of the internal modulation source. Select from sine wave, square wave, triangular wave, rising ramp wave, falling ramp wave, noise, and arbitrary wave. ☞ P.4-48

Internal modulation frequency [ModFreq]

The frequency of the internal modulation source. ☞ P.4-48

Sync output [SyncOut]

The output signal from a sync/sub-output terminal. Select from waveform reference phase sync signal, internal modulation sync signal, and internal modulation waveform. ☞ P.4-49

4.6.3 Common Setting and Operation of Modulation

This section describes the common settings and operations regardless of the types of modulation all together.

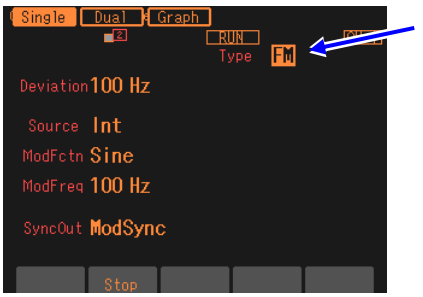
a) To modulate oscillation mode ☜ Oscillation mode setting

Set the oscillation mode to [MODU]

Press the MODE key, and then select [MODU] by using the soft-key to light "MODU" in the operation mode display section on the front panel of the main unit. (☞ P.4-23) This changes into the modulated oscillation mode. There are total 2 pages of the setting screens in the modulation oscillation mode. You can switch them by using the NEXT key.

b) To select an oscillation type ☜ Oscillation type setting

Select from the following eight types in the modulation types [Type] on the second page of the setting screen.



Modulation type

- •FM[FM] ☞ P.4-51
- •FSK[FSK] ☞ P.4-52
- •PM[PM] ☞ P.4-53
- •PSK[PSK] ☞ P.4-54
- •AM[AM] ☞ P.4-55
- •AM(DSB-SC)[AM(SC)] ☞ P.4-57
- •DC offset modulation[OFSM] ☞ P. 4-59
- •PWM[PWM] ☞ P.4-60

c) To set the carrier condition

Set each parameter of the carrier signals on the first page of the setting screen.

d) To set the modulation width

Set in the modulation width on the second page of the setting screen. The name of displayed item differs among [Deviation], [Depth], and [HopFreq] depending on the modulation type.

For details, see the description of each modulation type.

e) To modulate with internal signal source

Set the modulation source [Source] as internal [Int] on the second page of the setting screen.

It is necessary to set the internal modulation waveform [ModFctn] and the internal modulation frequency [ModFreq].

Select the internal modulation waveform [ModFctn] from the following seven types:

- • Sine wave [Sine]
- • Square wave (duty 50%) [Square]
- • Triangular wave (symmetry 50%) [Triangle]
- • Rising ramp wave [UpRamp]
- • Falling ramp wave [DnRamp]
- • Noise[Noise]
- • Arbitrary wave[ARB]

If the internal modulation waveform is noise, the internal modulation frequency cannot be set.

When the modulation type is FSK or PSK, the internal modulation waveform is fixed to the square wave with duty 50%. Therefore, the internal modulation waveform cannot be selected.

When the arbitrary wave is selected as the internal modulation waveform, data is used that is simply thinned out 4096 points from the head in the arbitrary wave in array format. The arbitrary waves where [RAW] is displayed in the [Type] field of the selection screen of arbitrary wave are in array format. The arbitrary waveforms with a value of 17(KB) or higher in the

[Size] field have original wave size of 4096 points or higher. On the other hand, arbitrary wave where [Point] is displayed in the [Type] field are in control point format. In arbitrary waves in this format, the entire wave is developed with 4096 points so that the feature of the waveform may remain as much as possible. For details of an arbitrary waveform, ☞ P.6-9.

f) To modulate with external signal source

Set the modulation source [Source] as external [Ext] on the second page of the setting screen.

The input terminal of the external modulation signal is different according to the modulation type as follows:

■ Modulation type is FM, PM, AM, AM(SC), OSFM, PWM

Enter a modulation signal to the external modulation/addition input terminal. The setting of modulation width is the value for signal level of ±1V. Note that if the input level is ±1V or lower, the modulation width is lower than the specified value.

When the external modulation/addition input terminal is used for the external addition input, the external modulation function cannot be used.

■ Modulation type is FSK or PSK

Enter a modulating signal (TTL level) to the external triggering input terminal.

The polarity can be set on the screen.

g) To start modulation ☜ Automatically started Restarted with the soft-key [Start].

The modulated oscillation starts automatically when entering into the modulated oscillation mode.

However, if the modulation setting is not appropriate, the modulation oscillation does not start ([Conflict] is displayed at the top center of the screen). When pressing the soft-key [?] displayed on the left end, the message concerning an improper setting appears. When that is changed to a proper setting, modulated oscillation starts. ☞ P.12-7

When the modulation is temporarily stopped, press the soft-key [Start] to restart the modulation.

h) To stop modulation ☜ Soft-key [stop]

The soft-key [Stop] pauses modulation.

When the soft-key [Stop] is pressed under modulation, carrier signals are output without being modulated. The oscillation mode remains in modulated oscillation mode.

i) To output modulated sync signal and modulation waveform signal ☜ In sync output setting

Set in the sync output [SyncOut] on the second page of the setting screen. Select from the following three options:

•Signal that synchronizes with reference phase of waveform [Sync]

•Signal that synchronizes with internal modulation waveform [ModSync]

•Internal modulation waveform [ModFctn]

■ When [Sync] is selected,

Signals with TTL level that are rising at the reference phase of waveform are output from the synchronization/sub-output terminal.

■ When [ModSync] is selected,

Signals with TTL level that synchronize with the internal modulation waveform are output from the synchronization/sub-output terminal. A square wave with duty 50% rising at the zero phase

of the internal modulation waveform. When the internal modulation waveform is a noise, it is fixed to the low level.

When a signal under modulation is observed with the oscilloscope etc., it can be used as a trigger signal of the oscilloscope.

■ When [ModFctn] is selected,

The internal modulation waveform is output from synchronization/sub-output terminal. The signal level is ±3V/open.

When the modulation type is FSK or PSK, it cannot be selected.

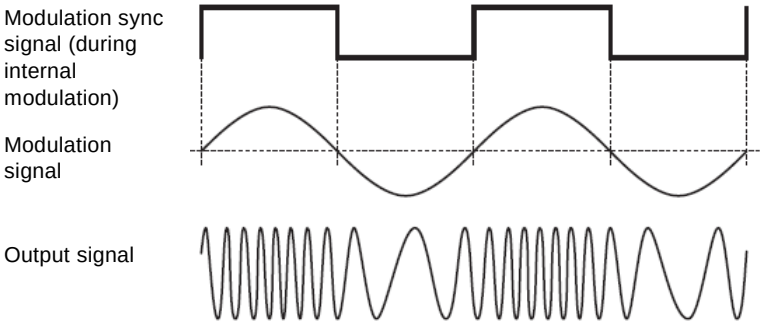
4.6.4 Setting FM

The output frequency changes according to the instantaneous value of modulation signal.

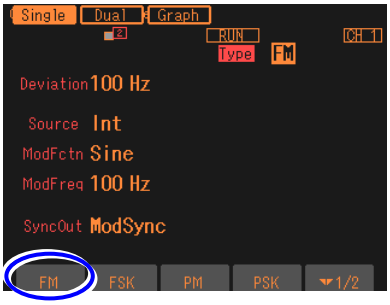
For the modulation setting screen and the common operation method, P.4-46, P.4-48

a) Example of FM

When the modulating signal swings to a positive side, the frequency shift of the output signal increases.



b) To select FM



In the modulation type setting menu, select [FM].

When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key FM[FM] is pressed, FM is set.

c) Waveform where FM is unavailable

Noise, pulse wave, and DC cannot perform FM.

d) Setting items necessary for FM

Set the carrier frequency [Freq] on the first page of the setting screen.

Set the peak frequency deviation [Deviation] on the second page of the setting screen.

The output frequency changes within the range of carrier frequency ± peak frequency deviation.

When the modulation source [Source] is internal [Int], set the modulation waveform [ModFctn] and modulation frequency [ModFreq].

When the modulation source [Source] is external [Ext], enter the modulating signal to external modulation/addition input terminal. It reaches the specified peak frequency deviation at ±1V input.

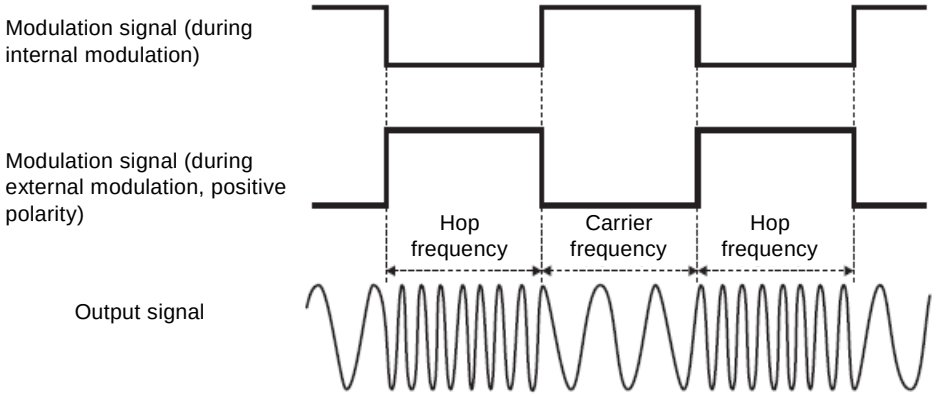
4.6.5 Setting FSK

A binary frequency deviation modulation that output frequency is switched between the carrier frequency and the hop frequency according to the modulating signal.

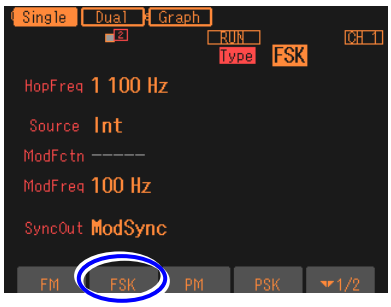
For the modulation setting screen and the common operation method, P.4-46, P.4-48

a) Example of FSK

The phase continuity of output signals is maintained though the frequency changes abruptly.



b) To select FSK



In the modulation type setting menu, Select [FSK].

When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key FSK[FSK] is pressed, FSK is set.

c) Waveform where FSK is unavailable

Noise, pulse wave, and DC cannot perform FSK.

d) Setting items necessary for FSK

Set the carrier frequency [Freq] on the first page of the setting screen.

Set the hop frequency [HopFreq] on the second page of the setting screen.

The carrier frequency and the hop frequency appear alternately in the output frequency.

When the modulation source [Source] is internal [Int], set the modulation frequency [ModFreq].

Set the polarity of the trigger when the modulation source [Source] is external [Ext], and then enter the modulation signal (TTL level) to the external trigger input terminal. When the polarity is set as positive [High], the carrier frequency is output for low-level input, and the hop frequency is output for high-level input. When the polarity is set as negative [Low], that is reversed.

4.6.6 Setting PM

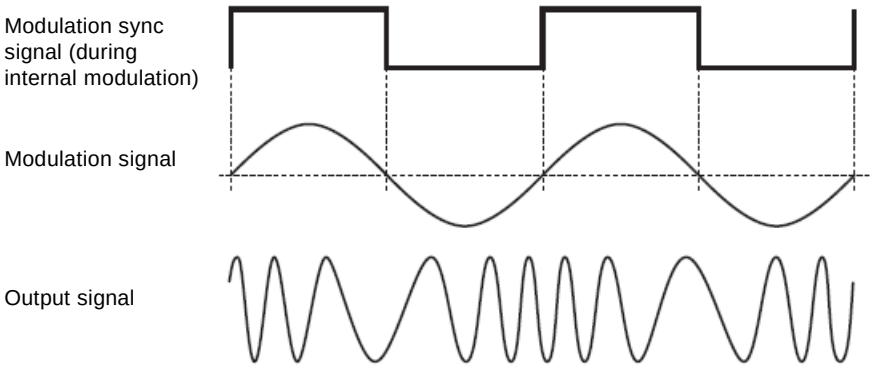
The output phase changes according to the instantaneous value of modulation signal.

For the modulation setting screen and the common operation method, P.4-46, P.4-48

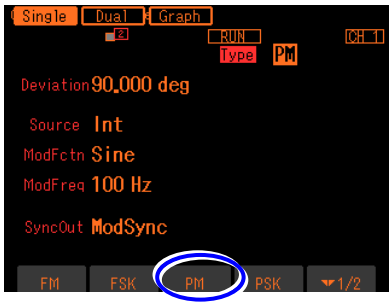
a) Example of PM

When the modulating signal swings to a positive side, the phase shift of the output signal increases.

The instantaneous frequency also changes at the same time because the phase changes with time.



b) To select PM



In the modulation type setting menu, Select [PM].

When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key PM[PM] is pressed, PM is set.

c) Waveform where PM is unavailable

Noise and DC cannot perform PM.

d) Setting items necessary for PM

Set the peak phase deviation [Deviation] on the second page of the setting screen.

The output phase changes within the range of ± peak phase deviation.

When the modulation source [Source] is internal [Int], set the modulation waveform [ModFctn] and modulation frequency [ModFreq]. When the modulation source [Source] is external [Ext], enter the modulating signal to external modulation/addition input terminal. It reaches the specified peak phase deviation at ±1V input.

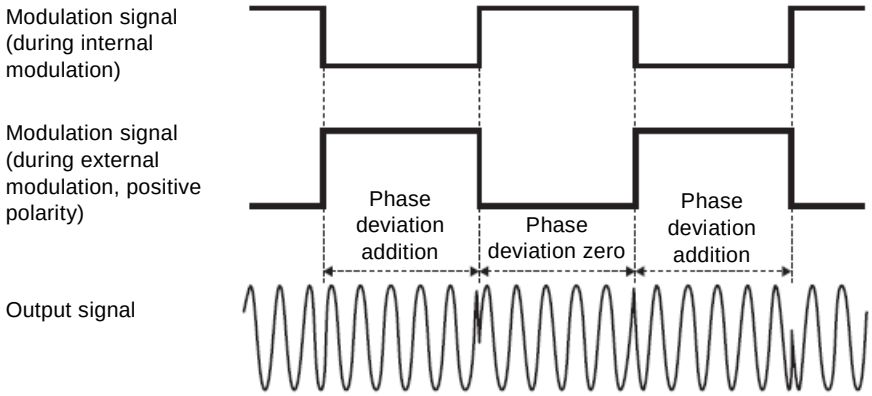
4.6.7 Setting PSK

A binary frequency deviation modulation that the output phase offsets according to the modulation signal.

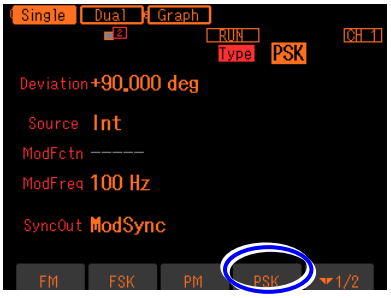
For the modulation setting screen and the common operation method, P.4-46, P.4-48

a) Example of PSK

Because the phase changes abruptly, the output signal waveform is discontinuous.



b) To select PSK



In the modulation type setting menu, Select [PSK].

When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key PSK[PSK] is pressed, PSK is set.

c) Waveform where PSK is unavailable

Noise and DC cannot perform PSK.

d) Setting items necessary for PSK

Set the phase deviation [Deviation] on the second page of the setting screen.

The state of phase deviation zero and the state of a specified phase deviation appear alternately in the output.

Note that the phase does not change within the range of ± phase deviation.

When the modulation source [Source] is internal [Int], set the modulation frequency [ModFreq].

Set the polarity of the trigger when the modulation source [Source] is external [Ext], and then enter the modulation signal (TTL level) to the external trigger input terminal. When the polarity is set as positive [High], the phase deviation of zero is output for low-level input, and the specified phase deviation is output for high-level input. When the polarity is set as negative [Low], that is reversed.

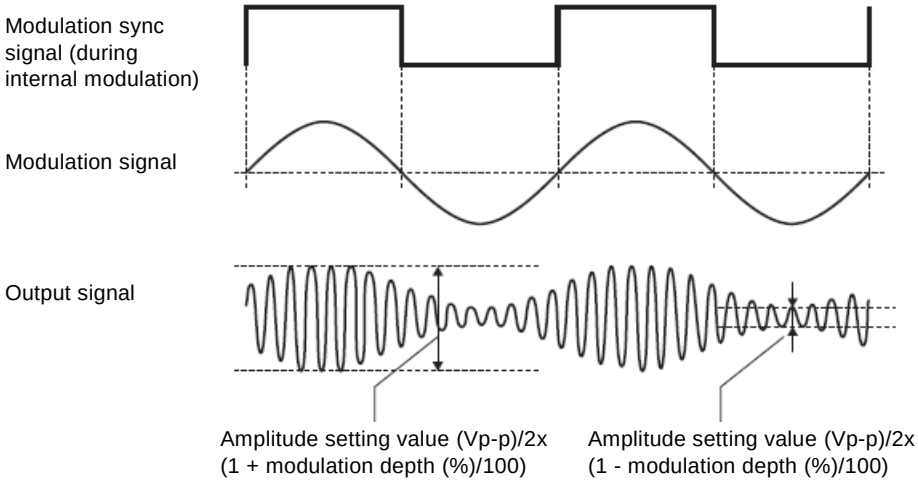
4.6.8 Setting AM

The output amplitude changes according to the instantaneous value of modulation signal.

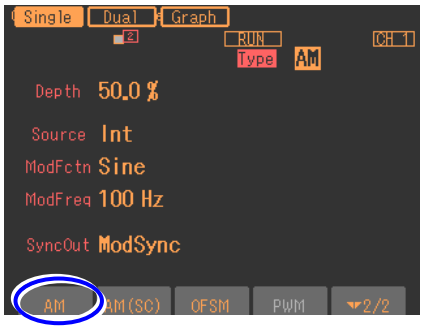
For the modulation setting screen and the common operation method, P.4-46, P.4-48

a) Example of AM

When the modulating signal swings to a positive side, the amplitude of the output signal increases.



b) To select AM



Select [AM] in the modulation type setting menu.

When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key AM [AM] in [2/2] of the selection list is pressed here, AM is set.

c) Waveform where AM is unavailable

AM cannot be performed with DC.

d) Setting items necessary for AM

Set the carrier amplitude [Amplitude] on the first page of the setting screen.

Set the modulation depth [Depth] on the second page of the setting screen.

The output amplitude changes within the range of career amplitude setting value (Vp-p) / 2 x (1 ± modulation depth (%) / 100). When the modulation depth is 0% or the modulation is stopped, the output amplitude is half of that in the continuous oscillation mode.

When the modulation depth is 100%, the maximum value of the output amplitude envelope is equal to the career amplitude setting value.

When the modulation source [Source] is internal [Int], set the modulation waveform [ModFctn] and modulation frequency [ModFreq]. When the modulation source [Source] is external [Ext],

enter the modulating signal to external modulation/addition input terminal. It is at the specified modulation depth when ±1V is entered.

4.6.9 Setting AM (DSB-SC)

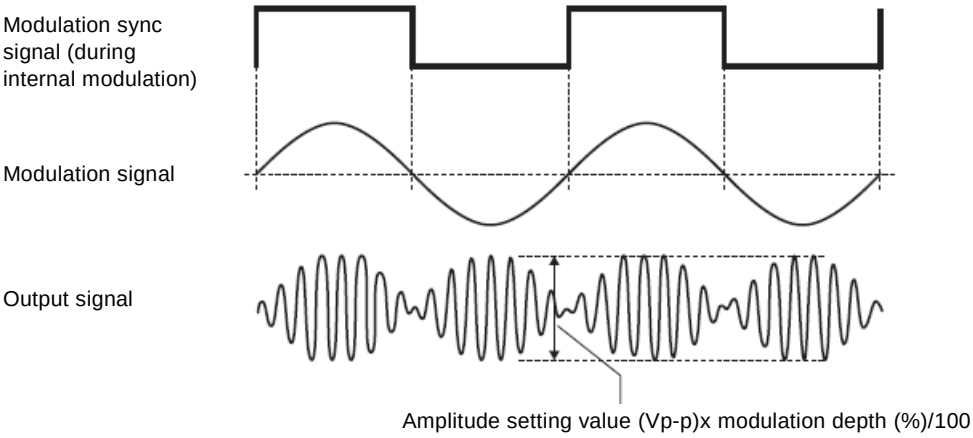
The output amplitude changes according to the instantaneous value of modulation signal. AM without carrier frequency element.

DSB-SC is abbreviation of Double Side Band - Suppressed Carrier.

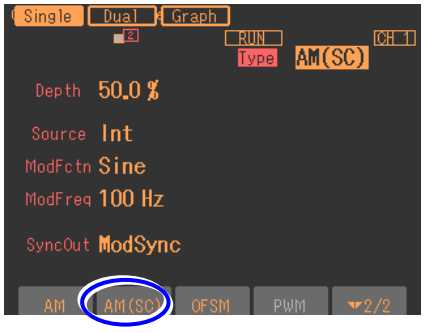
For the modulation setting screen and the common operation method, P.4-46, P.4-48

a) AM (DSB-SC) example

The amplitude of output signal increases when the absolute value of the amplitude of modulation signal is large. The polarity of the output signal reverses when the modulation signal is negative.



b) To select AM (DSB-SC)



Select [AM(SC)] in the modulation type setting menu.

When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key AM (DSB-SC)[AM(SC)] in [2/2] of the selection list is pressed here, AM (DSB-SC) is set.

c) Waveform where AM (DSB-SC) is unavailable

AM(DSB-SC) cannot be performed with DC.

d) Setting items necessary for AM (DSB-SC)

Set the carrier amplitude [Amplitude] on the first page of the setting screen.

Set the modulation depth [Depth] on the second page of the setting screen.

The output amplitude changes within the range of career amplitude setting value (Vp-p) x modulation depth (%) / 100.

When the modulation depth is 100%, the maximum value of the output amplitude envelope is equal to the career amplitude setting value.

When the modulation source [Source] is internal [Int], set the modulation waveform [ModFctn]

and modulation frequency [ModFreq]. When the modulation source [Source] is external [Ext], enter the modulating signal to external modulation/addition input terminal. It is at the specified modulation depth when ±1V is entered.

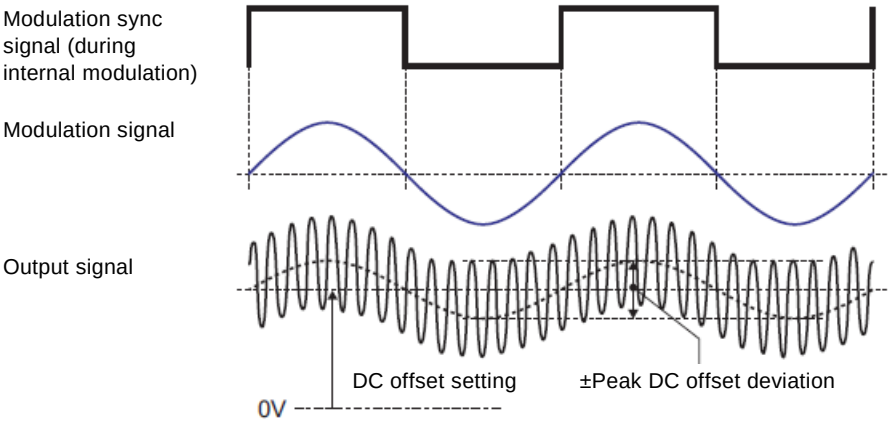
4.6.10 Setting DC Offset Modulation

The DC offset changes according to the instantaneous value of modulation signal.

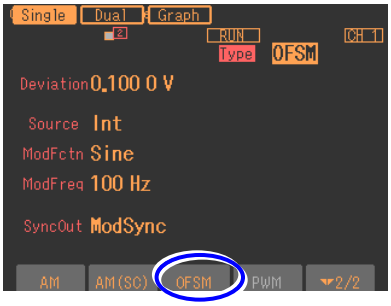
For the modulation setting screen and the common operation method, P.4-46, P.4-48

a) DC offset modulation example

When the modulating signal swings to a positive side, the DC offset of the output signal increases.



b) To select dc offset modulation



In the modulation type setting menu, Select [(OFSM)]

When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key for DC offset modulation [OFSM] that is in the selection list [2/2] is pressed here, DC offset modulation is set.

c) Waveform that dc offset modulation is unavailable

None. All waveforms are included.

d) Setting items necessary for dc offset modulation

Set the carrier DC offset [Offset] on the first page of the setting page.

Set the peak DC offset deviation [Deviation] on the second page of the setting page.

The output DC offset changes within the range of career DC offset setting ± peak DC offset deviation.

When the modulation source [Source] is internal [Int], set the modulation waveform [ModFctn] and modulation frequency [ModFreq]. When the modulation source [Source] is external [Ext], enter the modulating signal to external modulation/addition input terminal. It reaches the specified peak DC offset deviation at ± 1V input.

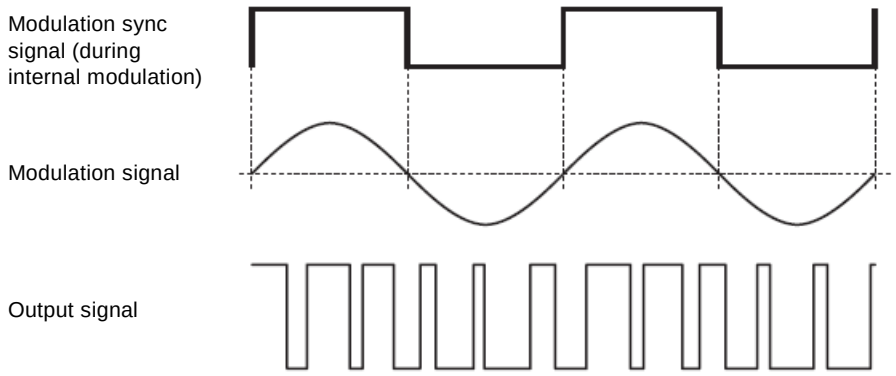
4.6.11 Setting PWM

The duty of the square wave and the pulse wave is changed depending on instantaneous value of the modulation signal.

For the modulation setting screen and the common operation method, P.4-46, P.4-48

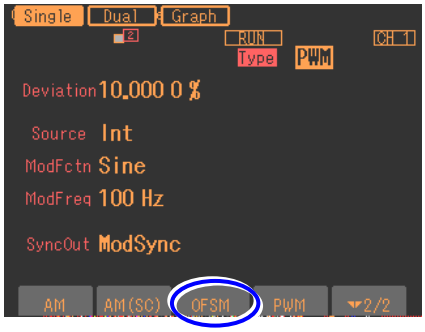
a) Example of PWM

When the modulating signal swings to a positive side, the duty of the output signal increases.



b) To select PWM

Select [PWM] in the modulation type setting menu.



When the oscillation mode [Mode] is set as modulation [MODU], select the modulation type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key for PWM [PWM] that is in the selection list [2/2] is pressed here, PWM is set.

c) Waveform where PWM is unavailable

PWM can be processed only to the square wave and the pulse wave.
PWM is not available for other waveforms.

d) Setting items necessary for PWM

Set the carrier duty [Duty] on the first page of the setting screen.
Set the peak duty deviation [Deviation] on the second page of the setting page.
The output duty is changed within the range of career duty ± peak duty deviation.
When the pulse-wave is used, The pulse width of the career is fixed to the duty setting and cannot be set with time.
When the modulation source [Source] is internal [Int], set the modulation waveform [ModFctn] and modulation frequency [ModFreq]. When the modulation source [Source] is external [Ext], enter the modulating signal to external modulation/addition input terminal. It reaches the specified peak duty deviation at ± 1V input.

4.7 Setting and Operation of Sweep

4.7.1 Sweep Types

Sweep can be done for the following five types of items:

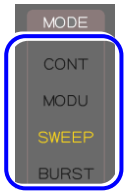
- Frequency sweep, ☞ P.4-73
- Phase sweep ☞ P.4-75
- Amplitude sweep ☞ P.4-77
- DC offset sweep ☞ P.4-79
- Duty sweep ☞ P.4-81

4.7.2 Screen for Setting and Operation of Sweep

This section describes the common screen structure in the sweep oscillation mode.

Settings and operations are performed in the Oscillator setting screen. When you press the MENU key while another screen is displayed, the Top menu is displayed. Select [OSC] and then press the ENTER key.

a) To set the oscillation mode to sweep

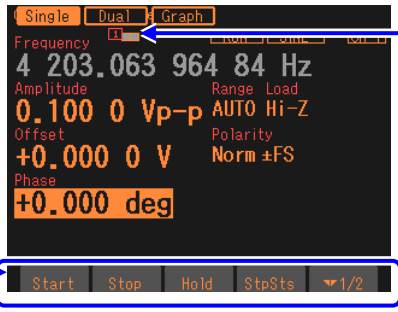


Set the oscillation mode to [SWEEP]

Press the MODE key, and then select [SWEEP] by using the soft-key to light "SWEEP" ” in the operation mode display section on the front panel of the main unit. (☞ P.4-23) This switches to the sweep oscillation mode.
There are total 3 pages of the setting screens in the sweep oscillation mode. You can switch them by using the NEXT key.

b) First page of the setting screen: Screen for basic parameter setting

These are common items independent from oscillation mode. Some settings are invalid depending on the sweep type.



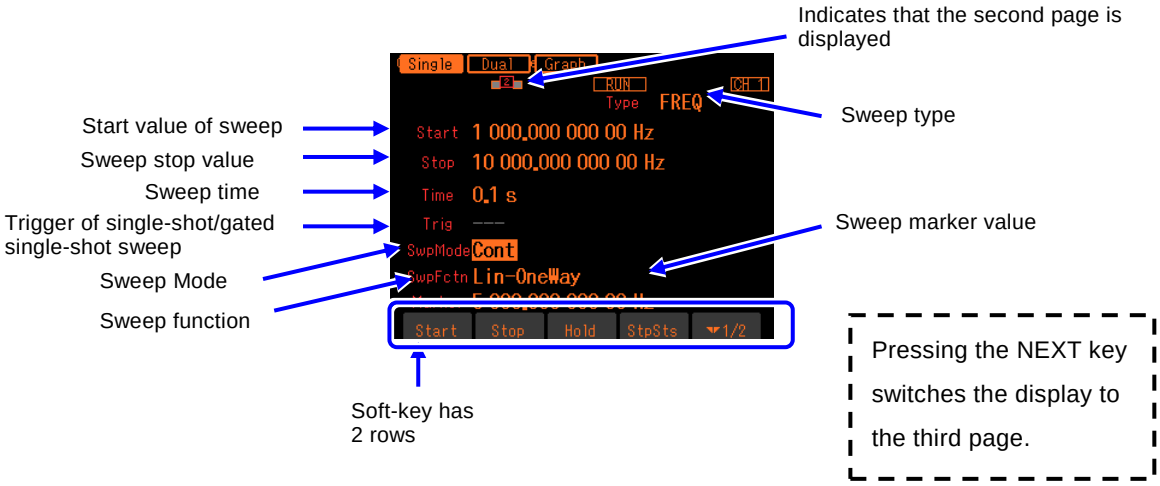
Indicates that the first page is displayed

Soft-key has 2 rows

Pressing the NEXT key switches the display to the second page.

c) Second page of the setting screen: Screen for setting the sweep (1)

The following figure is the example of selecting frequency as a sweep type.



Sweep type [Type]

Item to sweep. Select one from among frequency, phase, amplitude, DC offset, and duty.☞ P.4-64

Start value [Start] of sweep

The starting value of sweep.

Sweep stop value [Stop]

The stop value of sweep.

Sweep time [Time]

Transition time to sweep from the starting value to the stop value.

Sweep Mode [SwpMode]

The oscillation mode of sweep. Select from continuous sweep, single-shot sweep, and gate single-shot sweep.☞ P.4-65

Trigger [Trig]

The trigger condition of single-shot sweep and gated single-shot sweep. Select as a trigger source from the inside or outside.☞ P.4-68

Sweep function [SwpFctn]

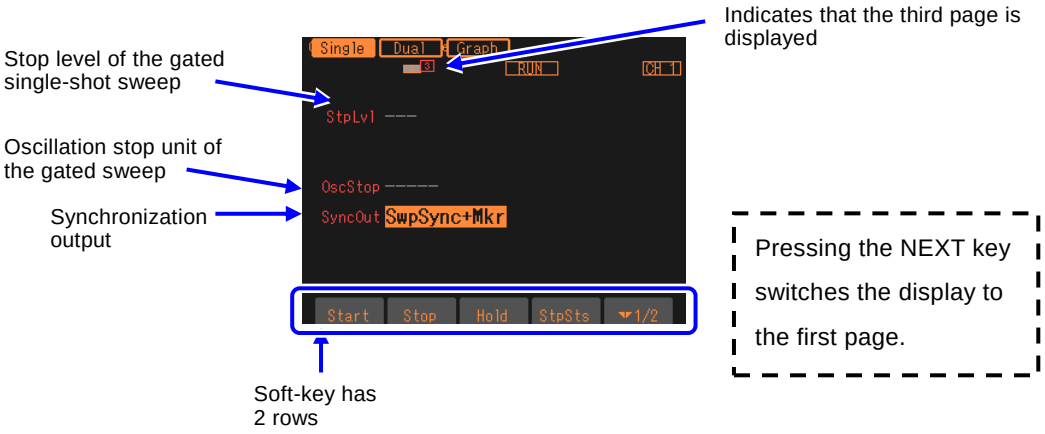
Sweep form. Select from one-way, shuttle. Linear and log are available only when the sweep type is frequency.☞ P.4-65

Sweep marker value [Marker]

The marker value of sweep.☞ P.4-70

d) Third page of the setting screen: Screen for setting the sweep (2)

The following figure is the example of selecting frequency as a sweep type.



Stop level [StpLvl]

The signal level when gated single-shot sweep is stopped. Set the level by specifying Off or On. Usually, set to Off.☞ P.4-67

The oscillation stop unit [OscStop] in the gated single-shot sweep

The oscillation stop unit in the gated single-shot sweep. Select from 1 cycle unit and half period unit. Usually, set to 1 cycle unit.☞ P.4-67

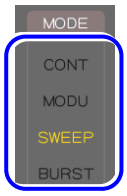
Synchronization output [SyncOut]

The output signal from a sync/sub-output terminal. Select from waveform reference phase synchronization, sweep synchronization, sweep marker, and sweep X drive.☞ P.4-70

4.7.3 Common Setting and Operation of Sweep

This section describes the common settings and operations regardless of the items to sweep all together.

a) To sweep oscillation mode ☜ Oscillation mode setting



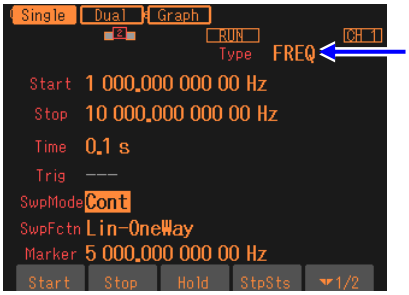
Set the oscillation mode to [SWEEP]

Press the MODE key, and then select [SWEEP] by using the soft-key to light "SWEEP" ” in the operation mode display section on the front panel of the main unit. This switches to the sweep oscillation mode.

There are total 3 pages of the setting screens in the sweep oscillation mode. You can switch them by using the NEXT key.

b) To select sweep item ☜ In sweep type setting

Select the items to sweep in the sweep types [Type] on the second page of the setting screen from the following five items:



Sweep Type

- Frequency sweep [Freq], ☞ P.4-73
- Phase sweep[Phase] ☞ P.4-75
- Amplitude sweep [Amptd] ☞ P.4-77
- DC offset sweep [Offset]☞ P.4-79
- Duty sweep[Duty] ☞ P.4-81

c) To set range and time to sweep

Set the following items on the second page of the setting screen.

- Starting value [Start]
- Stop value[Stop]
- Sweep time [Time]: Time to change from the starting value to the stop value.

For details, see the description of each sweep type.

d) To set sweep range with center and span

When the input field of the starting/stop value is opened and the current value is displayed on the second page of the setting screen, the soft-key [Center] or [Span] is displayed. When this key is pressed, the input field of the center/span value is opened, and the displayed items are changed from [Start], [Stop] to [Center], [Span] respectively.

The soft-key [Center], [Span] is also changed to [Start], [Stop]. When the soft-key [Start], [Stop] is pressed here, then the input field of the starting/stop value is opened.

The center value is the average of the starting and stop values. The span value is the absolute value of difference of the starting and stop values. If the log sweep of the frequency is selected, the center value is a linear average value of the starting and the stop value.

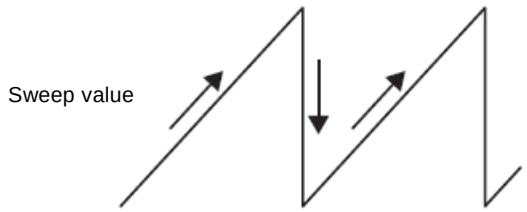
If it is changed to the center value or span value, the size correlation of the starting value and the stop value is maintained.

e) To sweep as sawtooth wave ☜ In one-way sweep

Set the sweep function [SwpFctn] on the second page of the setting screen as One-way [OneWay].

For frequency sweep, linear [Lin.OneW] or log [Log.OneW] is available for the slope.

One-way sweep

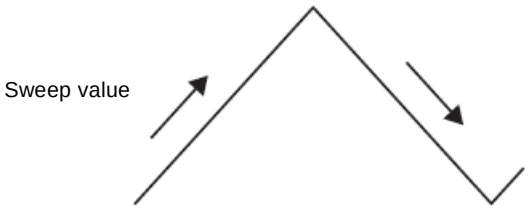


f) To sweep as triangular waveform ☜ In shuttle sweep

Set the sweep function [SwpFctn] on the second page of the setting screen as Shuttle [Shuttle].

For frequency sweep, linear [Lin.Shtl] or log [Log.Shtl] is available for the slope.

Shuttle sweep



g) To change upward/downward direction of sweep ☜ Starting/stop value with large/small

Sweep from the starting value toward the stop value for sweep with sawtooth waveform (one-way sweep). The value increases during sweep, when the starting value < stop value during sweep. Oppositely, the value decreases during sweep, when the starting value > stop value during sweep.

When the soft-key [St<>Sp] of the soft-key set (displayed as [▼ 2/2] on the right end soft-key) on the second raw of the second page of the setting screen is pressed, the starting value and the stop value can be swapped.

h) To repeat sweep continuously ☜ In continuous sweep

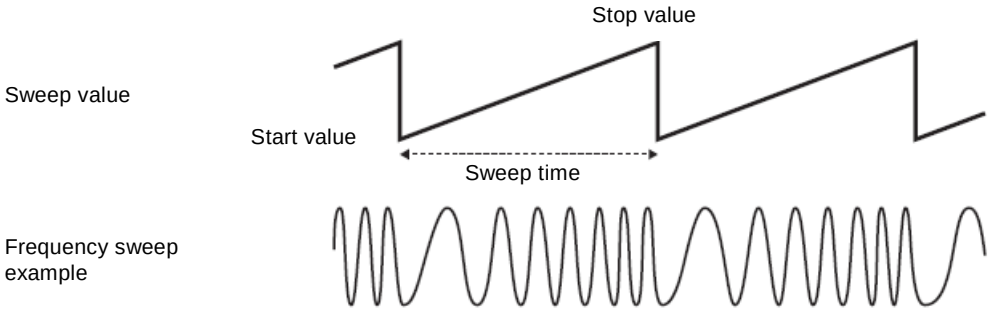
Set the sweep mode [SwpMode] on the second page of the setting screen as continuous [Cont].

A trigger signal is not necessary.

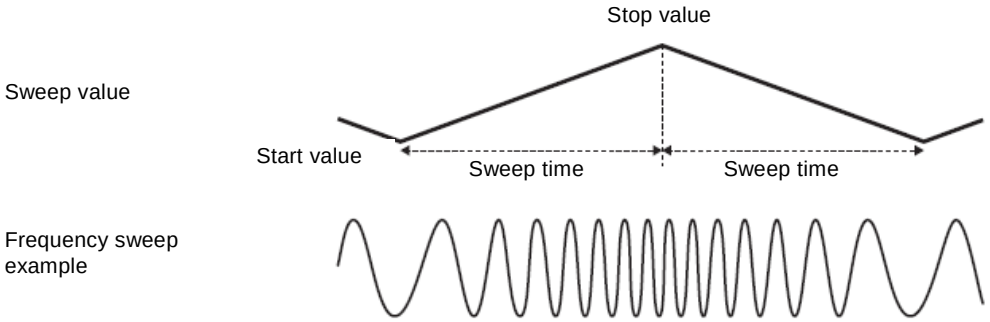
Set the change time from the starting value to the stop value with sweep time [Time] on the same 2nd page.

Because the sweep time is the change time from the starting value to the stop value, the repeating period is twice the sweep time setting as shown in following figure, when the sweep function is shuttle.

Continuous one-way sweep



Continuous shuttle sweep



i) To start sweep synchronizing with trigger ✍ In single-shot sweep

Set the sweep mode [SwpMode] on the second page of the setting screen as single-shot [Single] .

Because a trigger signal is necessary, set a trigger in trigger [Trig] on the same 2nd page. For trigger setting, ☞ P.4-68.

Set the change time from the starting value to the stop value with sweep time [Time] on the same 2nd page.

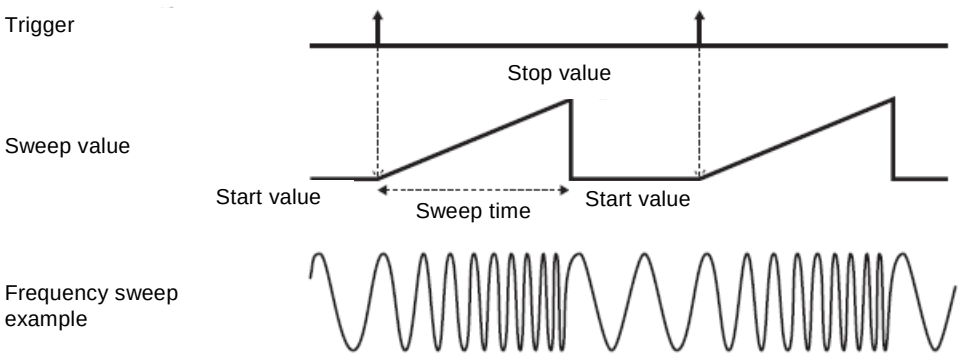
Sweep once in single-shot sweep every time a trigger is accepted.

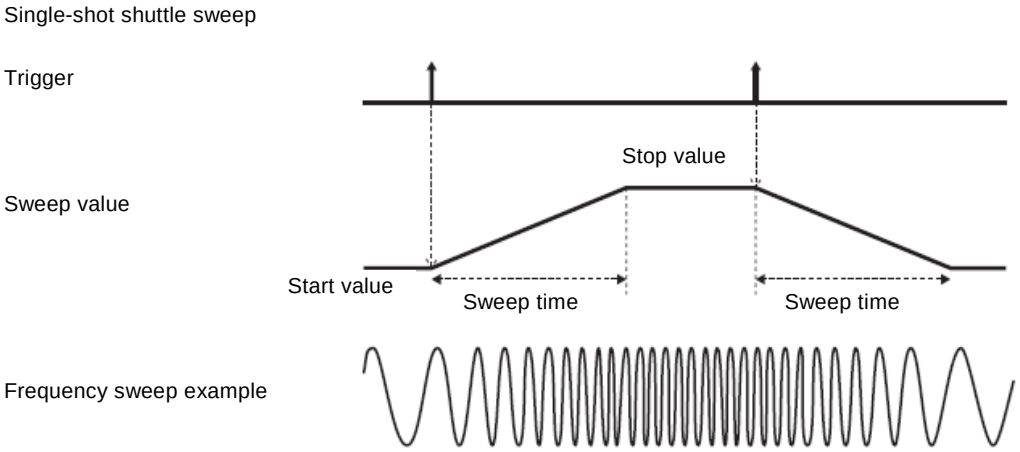
The appearance of the change is different as shown in the following figure depending on whether it is one-way or shuttle sweep function.

In case of one-way sweep, it returns to the start value immediately after the sweep ends.

In case of shuttle sweep, it stands by in sweep terminated state after the sweep ends.

Single-shot one-way sweep





j) To output waveform only when sweep running ☜ In gated single-shot sweep

Set the sweep mode [SwpMode] on the second page of the setting screen as gated single-shot [Gated]. This is an operation that combines gate oscillation with sweep. Sweeps synchronizing with a trigger. Because a trigger signal is necessary, set a trigger in trigger [Trig] on the same 2nd page. For trigger setting, ☞ P.4-68.

■ Oscillation start/stop phase

Set oscillation start/stop phase in the phase [Phase] on the first page of the setting screen.

However, in phase sweep, the start phase setting is the oscillation starting phase, and the stop phase setting is the oscillation stop phase.

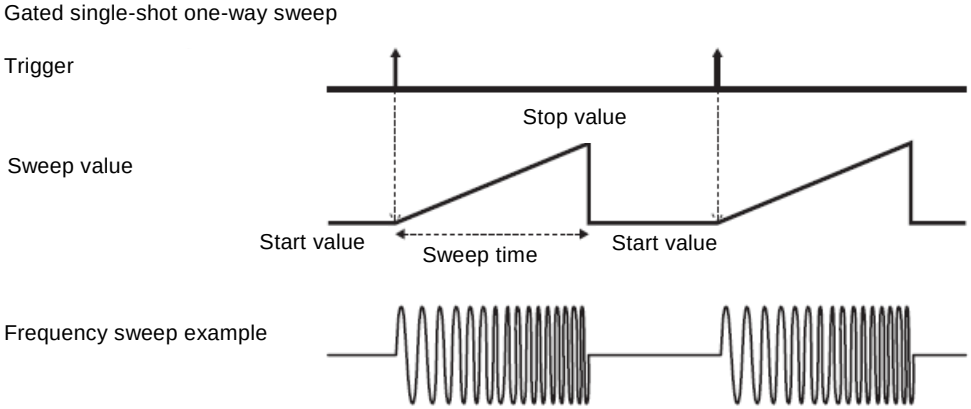
■ Stop level (usually set as Off [Off])

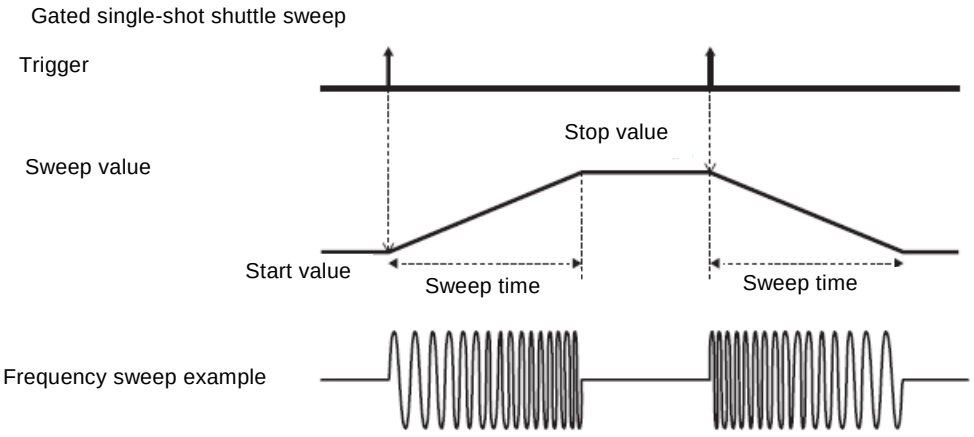
When you want to decide the level while oscillation is stopped apart from the phase, set the stop level [StpLvl] on the third page of the setting screen as On [On], and then set the level with % value based on the amplitude full scale. Usually, set to Off [Off]. When [Off] is selected, the signal level while oscillation is stopped is decided by the phase set in [Phase] on the first page of the setting screen. For stop level, ☞ P.4-90.

■ Oscillation stop unit (usually set as 1 cycle [Cycle])

When you want to stop oscillation every half cycle, set the oscillation stop unit [OscStop] as half cycle [HalfCycle] on the third page of the setting screen. Usually, set to 1 cycle [Cycle]. When it is set as 1 cycle [Cycle], it is oscillation with integer cycle.

Because it ends without fail by every one cycle or half cycle according to the oscillation stop unit [OscStop] setting, the oscillation time is usually longer than the time set in the sweep time setting.





Check

In phase sweep, the start phase setting is the oscillation starting phase, and the stop phase setting is the oscillation stop phase.

k) To set trigger condition of single-shot sweep and gated single-shot sweep

Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger.

When a trigger is accepted, the TRIG'D lamp on the TRIG key illuminates.

A trigger condition is set in the trigger [Trig] on the second page of the setting screen.

■ Trigger source setting

A trigger source can be selected from internal [Int] or external [Ext].

When a trigger source is internal [Int], a trigger period can be set.

When a trigger source is external [Ext], the polarity of a trigger can be set.

When a trigger source is external [Ext], enter a trigger signal with TTL level to the external trigger input terminal (TRIG IN).

■ How to use manual and remote triggers

Manual trigger operation and remote trigger operation is effective, regardless of the trigger source setting.

The soft-key [Start] and TRIG key can be used for manual trigger operation.

However, in case of WF1948, the TRIG key only works on the channel side where display is active. For the channel where display is active, ☞ P.4-18

When only manual trigger operation and remote trigger operation are used for a trigger, set the trigger source as external [Ext]. Moreover, we will recommend that the polarity is set as [Off] to avoid malfunctions caused by exogenous noise.

l) To start sweep ✍ With the soft-key [start] or trigger

In continuous sweep, sweep oscillation mode starts automatically the sweep process. However, if the sweep setting is not appropriate, the sweep oscillation does not start ([Conflict] is displayed at the top center of the screen). When pressing the soft-key [?] displayed on the left end, the message concerning an improper setting appears. When that is changed to a proper setting, sweep oscillation starts.☞ P.12-8

If sweep is stopped, press the soft-key [Start] to start the sweep. If the soft-key [Start] is not displayed, press the right end soft-key [▼2/2] to toggle the soft-key set.

In case of single-shot sweep or gated single-shot sweep, when a trigger is accepted, the sweep is started. However, if the sweep setting is not appropriate, trigger cannot be accepted ([Conflict] is displayed at the top center of the screen). When pressing the soft-key [?] displayed on the left end, the message concerning an improper setting appears. When it is changed to the correct setting, a trigger can be accepted.☞ P. 12-8

The soft-key [Start] and the manual trigger key on the panel operate as manual trigger operation, regardless of the trigger source setting.

m) To pause sweep ✍ With soft-key [stop]

When the soft-key [Stop] is pressed while sweep is running, the sweep stops and enter the state to output a sweep starting value (not to output a stop value). If the soft-key [Stop] is not displayed, press the right end soft-key [▼2/2] to toggle the soft-key set. However, in case of single-shot sweep or gated single-shot sweep, when a new trigger is accepted, the sweep is started again.

n) To pause sweep temporarily ✍ With soft-key [hold]

When pushing [Hold] soft-key while a sequence is executed, the sequence is paused. Afterwards, when the soft-key [Resume] is pushed, the sweep is restarted at the point where it is paused. If the soft-key [Hold] or [Resume] is not displayed, press the right end soft-key [▼2/2] to toggle the soft-key set.

However, in case of single-shot sweep or gated single-shot sweep, when a new trigger is accepted during being held, the sweep is started from the beginning.

The soft-key [Hold] and [Resume] are displayed as [Hold] during sweep, and as [Resume] during pause, at the same position.

o) To output sweep starting value ☜ With the soft-key [SttState]

When the soft-key [SttState] is pressed, it enters into the status to output the sweep starting value.

You can check the status of tested equipment with sweep starting value.

The soft-key [SttState] is displayed in the status to output the sweep starting value or stop value. If the soft-key [SttState] is not displayed, press the right end soft-key [▼2/2] to toggle the soft-key set.

In case of gated single-shot sweep, it is in oscillation status with starting value. To stop the oscillation, press the soft-key [Stop].

p) To output sweep stop value ☜ With the soft-key [StpState]

When the soft-key [StpState] is pressed, it enters into the status to output the sweep stop value.

You can check the status of tested equipment with sweep stop value.

The soft-key [StpState] is always displayed in sweep mode. If the soft-key [StpState] is not displayed, press the right end soft-key [▼2/2] to toggle the soft-key set.

In case of gated single-shot sweep, it is in oscillation status with stop value. To stop the oscillation, press the soft-key [Stop].

q) To output sweep sync signal, sweep marker signal, sweep x drive signal ☜ in synchronization setting

Set in the sync output [SyncOut] on the third page of the setting screen. Select from the following four options:

• Signal that synchronizes with reference phase of waveform [Sync]

• Signal that synchronizes with sweep [SwpSync]

• Signal that matches a marker signal to a signal that synchronizes with sweep [SwpSync+Mkr(SwS+Mk)]

• X drive signal of sweep [X-Drive]

■ When [Sync] is selected,

Signals with TTL level that are rising at the reference phase of waveform are output from the synchronization/sub-output terminal.

■ When [SwpSync] is selected,

A TTL level signal that synchronizes with sweep is output from the synchronization/sub-output terminal. It changes from high to low at the time of starting sweep.

When a signal under sweep is observed with the oscilloscope etc., it can be used as a trigger signal of the oscilloscope.

■ When [SwpSync+Mkr] is selected,

The rising of sweep sync output is a marker signal. The sweep sync output is low until it reaches the marker value from the sweep starting value. A sync output does not change in the outward of shuttle sweep.

Timing for the signal under sweep to pass the marker value can be known.

However, there are the following restrictions for time zone when a synchronous sweep output is low.

• Time zone is limited from about 0.05% to 99.95% of the sweep time. Therefore, the time one does not change even if the marker value is changed if the marker value is close to the starting value or the stop value.

• Resolution of time zone is limited to the larger one of either 1/32768 of the sweep time or 8.33ns. Therefore, the time zone does not necessarily change even if the marker value is changed finely.

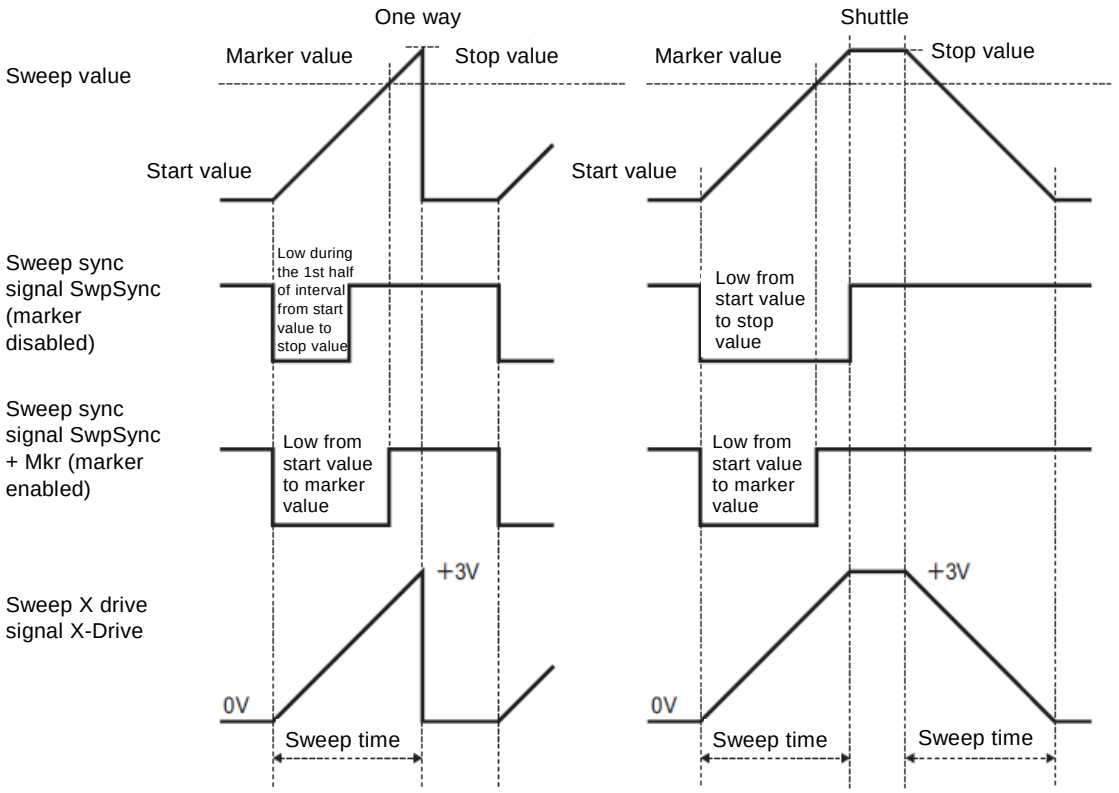
■ When [X-Drive] is selected,

A signal with the value of 0 to +3V/open corresponding to sweep is output from the synchronization/sub-output terminal. The voltage changes linearly in proportion to sweep elapsed time. The voltage also changes linearly in proportion to sweep elapsed time, even if log [Log-OneWay] and [Log-Shuttle] is selected as the sweep function in frequency sweep.

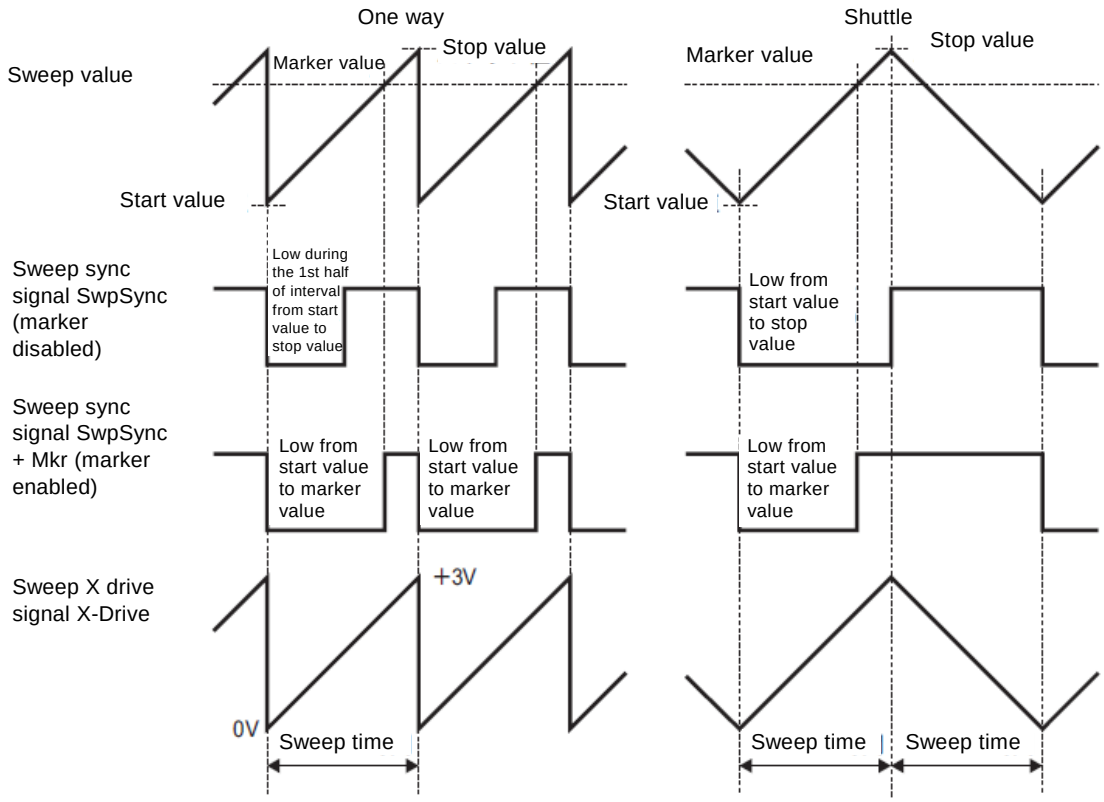
When a signal during sweep is observed with oscilloscope with X-Y display or X-Y recorder, it can be used as a signal of the X axis.

The following figure shows the relation between a sweep value and each signal. When the stop value < the starting value, the slope of the sweep X drive output is contrary to the figure.

One-way sweep, gated one-way sweep



Continuous sweep



r) To assign a marker value for a center value, or to assign a center value for a marker value

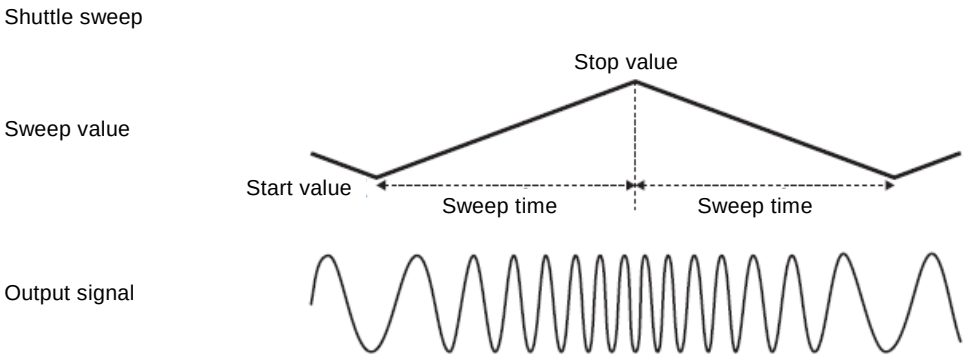
When the soft-key [Ct>Mk] is pressed on the second page, a center value is assigned for a marker value. When the soft-key [Mk>Ct] is pressed, the marker value is assigned for the center value oppositely. If these soft-keys on the second page of the setting screen are not displayed, press the right end soft-key [▼1/2] to toggle the soft-key set.

4.7.4 Setting Frequency Sweep

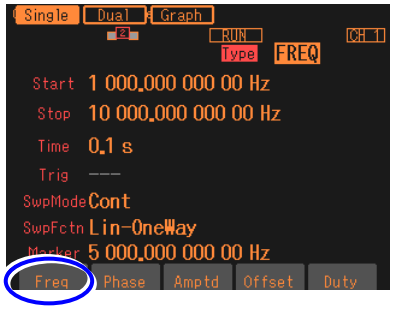
For the sweep setting screen and the common operation method, P.4-61, P.4-64

a) Frequency sweep example

Examples of a continuous sweep and linear shuttle.



b) To select frequency sweep



In the sweep type setting menu, Select [Freq].

When the oscillation mode [Mode] is set as sweep [SWEEP], select the sweep type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key frequency [Freq] is pressed, frequency sweep is set.

c) Waveform that frequency sweep is unavailable

Noise, pulse, and DC cannot perform frequency sweep.

d) Items necessary for frequency sweep

Set the following items on the second page of the setting screen. The frequency setting on the first page of the setting screen is invalid.

- Starting frequency [Start]

  The frequency range depends on a waveform.
- Stop frequency [Stop]

  The frequency range depends on a waveform.
- Sweep time [Time]

  Time to change from the starting frequency to the stop frequency.☞ P.4-64
- Sweep Mode [SwpMode]

  Select from continuous, single-shot, or gated single-shot.☞ P.4-65
- Sweep function [SwpFctn]

  Select from one-way/shuttle or linear/log.☞ P.4-65

It is possible to set with center frequency [Center], and span frequency [Span], instead of start frequency, and stop frequency.☞ P.4-64

When sweep mode is single-shot or gated single-shot, it is necessary to set the trigger condition [Trig].☞ P.4-68

Set the following items as needed:

• Marker frequency[Marker] (the second page of the setting screen) ☞P.4-70

• Stop level [StpLvl] (the third page of the setting screen) ☞P.4-67

The setting used for gated single-shot sweep only.

• Oscillation stop unit of gated single-shot sweep [OscStop] (the third page of the setting screen) ☞ P.4-67

The setting used for gated single-shot sweep only.

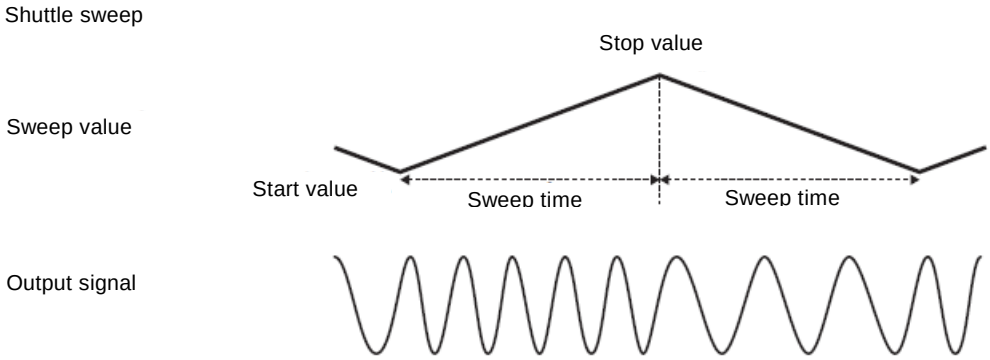
• Sync output [SyncOut] (the third page of the setting screen) ☞ P.4-70

4.7.5 Setting Phase Sweep

For the sweep setting screen and the common operation method, P.4-61, P.4-64

a) Phase sweep example

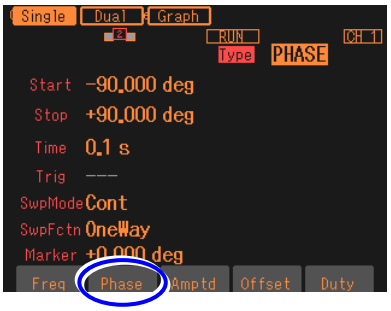
Examples of a continuous sweep and linear shuttle.



When the phase increases, the frequency rises as by the following figure. When the phase decreases, Stop phase falls by following value.

$$\frac{\left|\text{Stop phase (deg)} - \text{Starting phase (deg)}\right|}{360} \times \frac{1}{\text{Sweep time (sec)}}$$

b) To select phase sweep



In the sweep type setting menu, Select [Phase].

When the oscillation mode [Mode] is set as sweep [SWEEP], select the sweep type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key phase [Phase] is pressed, phase sweep is set.

c) Waveform that phase sweep is unavailable

Noise and DC cannot perform phase sweep.

d) Items necessary for phase sweep

Set the following items on the second page of the setting screen. The phase setting on the first page of the setting screen is invalid.

- Starting phase [Start]
- Stop phase [Stop]
- Sweep time [Time]

Time to change from the starting phase to the stop phase.☞P.4-64

• Sweep Mode [SwpMode]
  Select from continuous, single-shot, or gated single-shot.☞ P.4-65
• Sweep function [SwpFctn]
  Select from one-way/shuttle.☞ P.4-65

It is possible to set with center phase [Center], and span phase [Span], instead of start phase, and stop phase.☞ P.4-64
When sweep mode is single-shot or gated single-shot, it is necessary to set the trigger condition [Trig].☞ P.4-68

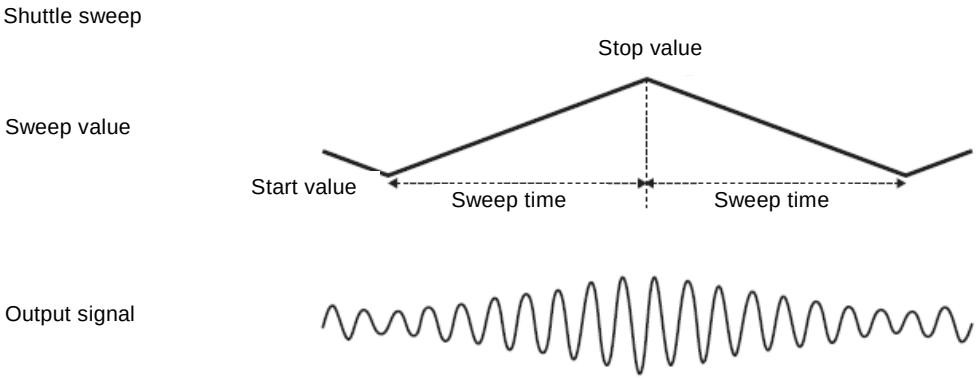
Set the following items as needed:
• Marker phase[Marker] (the second page of the setting screen) ☞P.4-70
• Stop level [StpLvl] (the third page of the setting screen) ☞P.4-67
  The setting used for gated single-shot sweep only.
• Oscillation stop unit of gated single-shot sweep [OscStop] (the third page of the setting screen) ☞ P.4-67
  The setting used for gated single-shot sweep only.
• Sync output [SyncOut] (the third page of the setting screen) ☞ P.4-70

4.7.6 Setting Amplitude Sweep

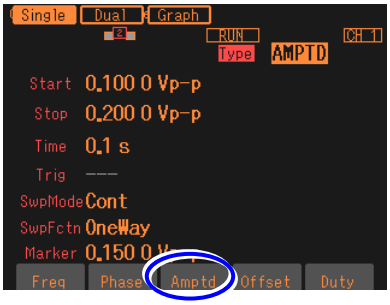
For the sweep setting screen and the common operation method, P.4-61, P.4-64

a) Amplitude sweep example

Examples of a continuous sweep and linear shuttle.



b) To select amplitude sweep



In the sweep type setting menu, Select [Amptd].

When the oscillation mode [Mode] is set as sweep [SWEEP], select the sweep type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key amplitude [Amptd] is pressed, amplitude sweep is set.

c) Waveform that amplitude sweep is unavailable

Amplitude sweep cannot be performed with DC.

d) Items necessary for amplitude sweep

Set the following items on the second page of the setting screen. The amplitude setting on the first page of the setting screen is invalid.

- Starting amplitude [Start]
- Stop amplitude [Stop]
- Sweep time [Time]
  Time to change from the starting amplitude to the stop amplitude.☞ P.4-64
- Sweep Mode [SwpMode]
  Select from continuous, single-shot, or gated single-shot.☞ P.4-65
- Sweep function [SwpFctn]
  Select from one-way/shuttle.☞ P.4-65

It is possible to set with center amplitude [Center], and span amplitude [Span], instead of start amplitude, and stop amplitude.☞ P.4-64

When sweep mode is single-shot or gated single-shot, it is necessary to set the trigger condition [Trig].☞ P.4-68

Set the following items as needed:

• Marker amplitude[Marker] (the second page of the setting screen) ☞P.4-70

• Stop level [StpLvl] (the third page of the setting screen) ☞P.4-67

The setting used for gated single-shot sweep only.

• Oscillation stop unit of gated single-shot sweep [OscStop] (the third page of the setting screen) ☞ P.4-67

The setting used for gated single-shot sweep only.

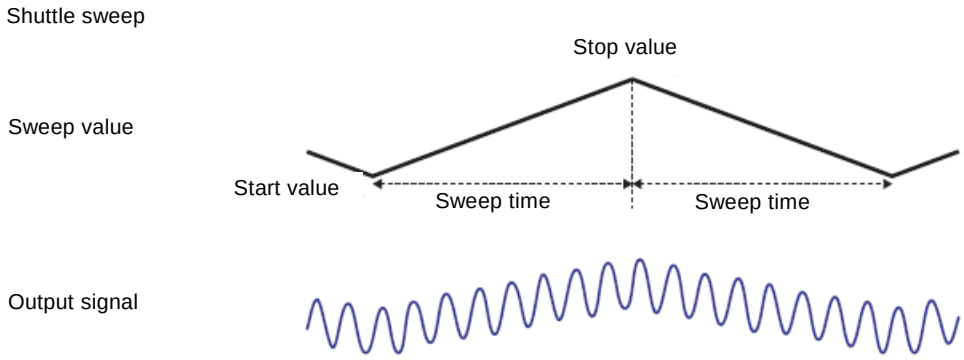
• Sync output [SyncOut] (the third page of the setting screen) ☞ P.4-70

4.7.7 Setting DC Offset Sweep

For the sweep setting screen and the common operation method, P.4-61, P.4-64

a) DC offset sweep example

Examples of a continuous sweep and linear shuttle.



b) To select dc offset sweep

In the sweep type setting menu, Select [Offset].

When the oscillation mode [Mode] is set as sweep [SWEEP], select the sweep type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key DC offset [Offset] is pressed, DC offset sweep is set.

c) Waveform that dc offset sweep is unavailable

None. However, when DC is selected as a waveform, the DC level itself is sweeped. In addition, when DC is selected as a waveform, gated single-shot sweep cannot be performed.

d) Items necessary for DC offset sweep

Set the following items on the second page of the setting screen. The DC offset setting on the first page of the setting screen is invalid.

- Start DC offset [Start]
- Stop DC offset [Stop]
- Sweep time [Time]

  Time to change from the starting DC offset to the stop DC offset.

  ☞ P.4-64
- Sweep Mode [SwpMode]

  Select from continuous, single-shot, or gated single-shot.☞ P.4-65
- Sweep function [SwpFctn]

  Select from one-way/shuttle.☞ P.4-65

  It is possible to set with center DC offset [Center], span DC offset[Span], instead of start DC offset, stop DC offset.☞ P.4-64

When sweep mode is single-shot or gated single-shot, it is necessary to set the trigger condition [Trig].☞ P.4-68

Set the following items as needed:

• Marker DC offset[Marker] (the second page of the setting screen) ☞P.4-70

• Stop level [StpLvl] (the third page of the setting screen) ☞P.4-67

The setting used for gated single-shot sweep only.

• Oscillation stop unit of gated single-shot sweep [OscStop] (the third page of the setting screen) ☞ P.4-67

The setting used for gated single-shot sweep only.

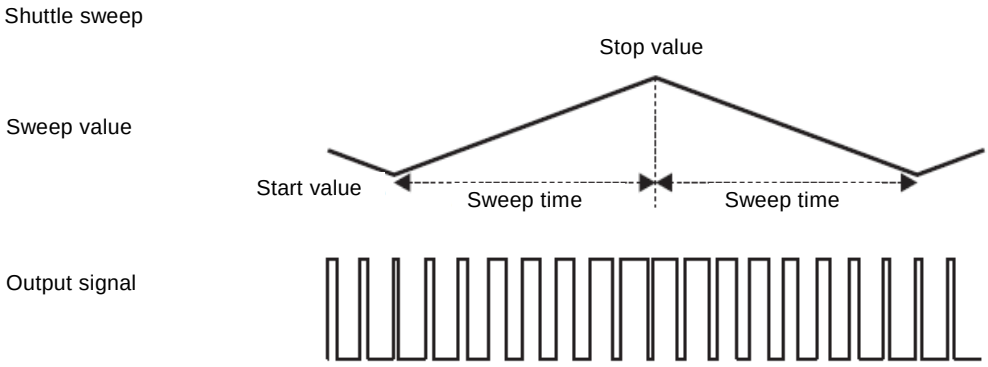
• Sync output [SyncOut] (the third page of the setting screen) ☞ P.4-70

4.7.8 Setting Duty Sweep

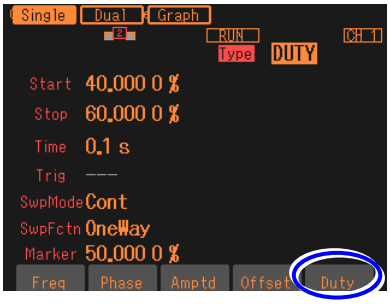
For the sweep setting screen and the common operation method, P.4-61, P.4-64

a) Duty sweep example

Examples of a continuous sweep and linear shuttle.



b) To select duty sweep



In the sweep type setting menu, Select [Duty].

When the oscillation mode [Mode] is set as sweep [SWEEP], select the sweep type [Type] on the second page of the setting screen, and then press the Enter key to display the selection list in the soft-key area. When the soft-key duty [Duty] is pressed, duty sweep is set.

c) Waveform that duty sweep is unavailable

Only square wave and pulse wave are the target of duty sweep.

d) Setting items necessary for duty sweep

Set the following items on the second page of the setting screen. The duty setting on the first page of the setting screen is invalid.

- Start duty [Start]
  The range of duty depends on the frequency. Pulse wave further depends on the Leading and Trailing times.☞ P.4-38, P.4-40
- Stop duty [Stop]
  The range of duty depends on the frequency. Pulse wave further depends on the Leading and Trailing times.☞ P.4-38, P.4-40
- Sweep time [Time]
  Time to change from the starting duty to the stop duty.☞ P.4-64
- Sweep Mode [SwpMode]
  Select from continuous, single-shot, or gated single-shot.☞ P.4-65
- Sweep function [SwpFctn]
  Select from one-way/shuttle.☞ P.4-65

It is possible to set with center duty [Center] and span duty [Span], instead of start duty and stop duty.☞ P.4-64
When sweep mode is single-shot or gated single-shot, it is necessary to set the trigger condition [Trig].☞ P.4-68

Set the following items as needed:

• Marker duty[Marker] (the second page of the setting screen) ☞P.4-70
• Stop level [StpLvl] (the third page of the setting screen) ☞P.4-67
  The setting used for gated single-shot sweep only.
• Oscillation stop unit of gated single-shot sweep [OscStop] (the third page of the setting screen) ☞ P.4-67
  The setting used for gated single-shot sweep only.
• Sync output [SyncOut] (the third page of the setting screen) ☞ P.4-70

4.8 Setting and Operation of Burst

4.8.1 Burst Oscillation Types

The following 4 types of burst oscillations are available.

• Auto Burst

Repeat oscillation and stop automatically at the specified by wave number respectively. A trigger signal is not necessary.☞ P.4-84

• Trigger Burst

Every time a trigger is accepted, perform oscillation specified wave number.☞ P.4-87

• Gate Oscillation

While the gate is On, performs oscillation with integer half-cycle or half-cycle unit.☞ P.4-92

• Triggered Gate Oscillation

Gate oscillation that turns the gate On/Off every time a trigger is accepted.☞ P.4-97

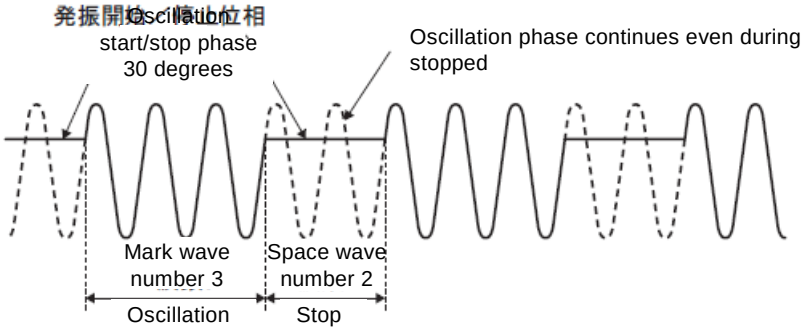
4.8.2 Auto Burst

Repeat oscillation and pause automatically at the specified by wave number respectively. A trigger signal is not necessary.

Settings and operations are performed in the Oscillator setting screen. When you press the MENU key while another screen is displayed, the Top menu is displayed. Press the [OSC] soft-key.

a) Auto burst example

Mark wave number (oscillation wave number): 3 waves, space wave number (stop oscillation wave number): 2 waves, oscillation start/stop phase: 30 degree, stop level: Off.



b) To set oscillation mode as auto burst

MODE key
→Set the oscillation mode of as burst
(☞ P.4-23)

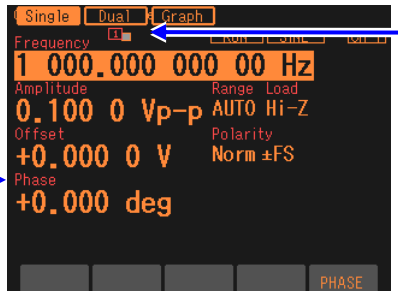
Press the MODE key, and then select [BURST] by using the soft-key to light "BURST" in the operation mode display section on the front panel of the main unit. This switches to burst oscillation mode. There are total 2 pages of the setting screens in the burst oscillation mode. You can switch them by using the NEXT key. Then select burst mode [BrstMode] on the second page of the setting screen, and then press the ENTER key. The selection list appears in the soft-key area. When the soft-key auto [Auto], auto burst is set.

Select [Auto] on the burst mode setting menu.

c) Screen for auto burst setting

■ First page: Screen for basic parameter setting

These are common items independent from oscillation mode.

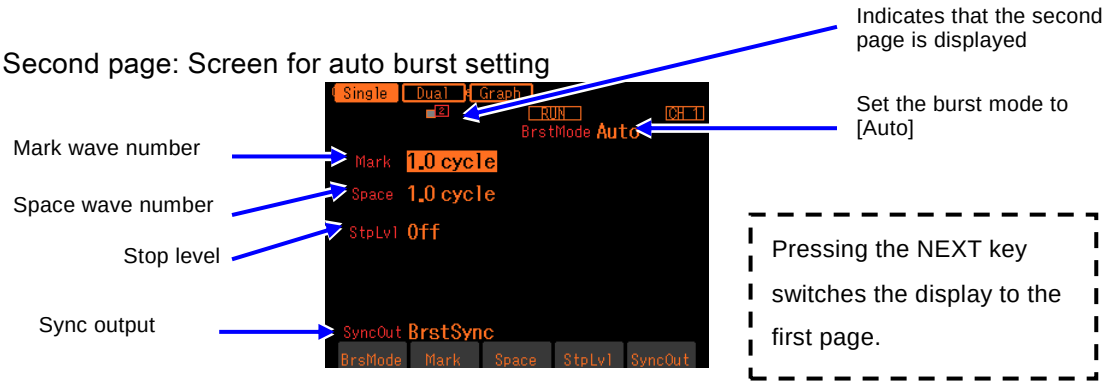


Indicates that the first page is displayed

Setting of oscillation start/stop phase

Pressing the NEXT key switches the display to the second page.

■ Second page: Screen for auto burst setting



Mark wave number [Mark]

The wave number of oscillation. This can be set in 0.5 cycle unit. Usually, set to 1 cycle unit.

Space wave number [Space]

The wave number to stop oscillation. This can be set in 0.5 cycle unit. Usually, set to 1 cycle unit.

Stop level [StpLvl]

The signal level while oscillation is stopped. Set the level by specifying Off or On. Usually, set to Off.☞ P.4-86

Sync output [SyncOut]

The output signal from a SYNC/SUB OUT terminal. Select from waveform reference phase synchronization and burst synchronization.☞ P.4-86

d) Waveform that auto is unavailable

Noise and DC cannot perform auto burst.

e) Setting items necessary for auto burst

Set the oscillation start/stop phase [Phase] on the first page of the setting screen.

Set mark wave number [Mark] and space wave number [Space] on the second page of the setting screen.

Each wave number is usually set as integer value.

The stop level [StpLvl] on the second page of the setting screen is usually set as Off [Off].

☞ P. 4-90

f) To start auto burst ☜ Started automatically

In auto burst mode, burst starts automatically when entering in burst-oscillation mode. However, if the burst setting is not appropriate, the burst oscillation does not start ([Conflict] is displayed at the top right of the screen). When pressing the soft-key [?] displayed on the left end, the message concerning an improper setting appears. When that is changed to a proper setting, burst oscillation starts.☞ P.12-9

g) To stop auto burst ☜ Cannot

Oscillation cannot be stopped while in auto burst mode.

To stop oscillation, set the burst mode [BrstMode] as other than auto [Auto] on the second page of the setting screen to prevent a trigger or gate signal from arriving.

To set as continues oscillation, change the oscillation mode to [CONT].

h) To output burst sync signal ☜ In sync output setting

Set in the sync output [SyncOut] on the second page of the setting screen. Select from the following two options:

• Signal that synchronizes with reference phase of waveform [Sync]

• Signal that synchronizes with burst oscillation [BrstSync]

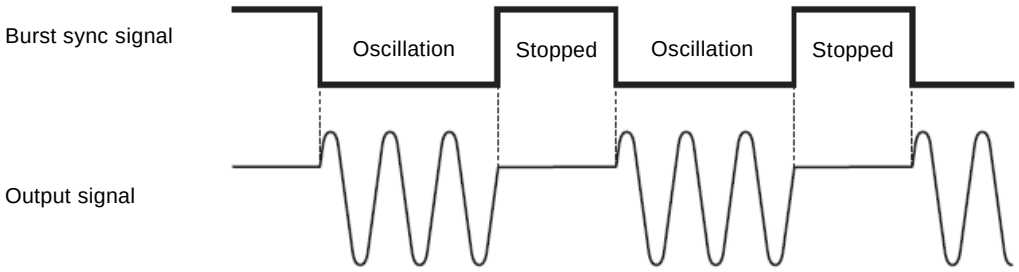
■ When [Sync] is selected,

Signals with TTL level that are rising at the reference phase of waveform are output from the SYNC/SUB OUT terminal.

■ When [BrstSync] is selected,

Signals with TTL level that synchronize with the burst oscillation are output from the SYNC/SUB OUT terminal. It is low during oscillation, and high while oscillation is stopped, as show in the following figure.

When a signal under burst is observed with the oscilloscope etc., it can be used as a trigger signal.



i) How to use stop level

The level while oscillation is stopped is usually set by oscillation start/stop phase. It is also possible to set by the ratio to the full scale of the amplitude independently.

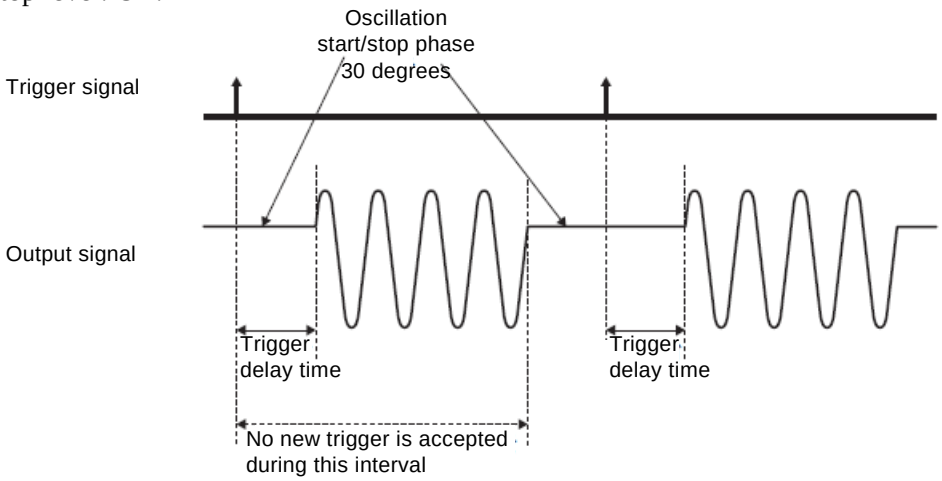
Set the stop level [StpLvl] as On [On] on the second page of the setting screen, and set the level with % value.☞ P.4-90

4.8.3 Trigger burst

Every time a trigger is accepted, perform oscillation with the specified wave number.
Settings and operations are performed in the OSC setting screen. When you press the MENU key while another screen is displayed, the Top menu is displayed. Press the [OSC] soft-key.

a) Trigger burst example

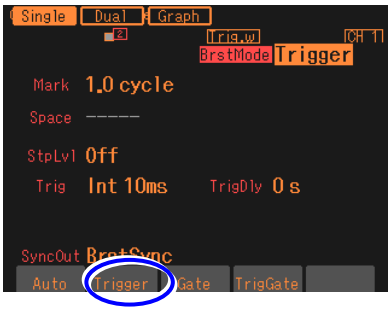
Mark wave number (oscillation wave number): 4 waves, oscillation start/stop phase: 30 degree, stop level: Off.



b) To set oscillation mode as trigger burst

MODE key
→Set the oscillation mode of as burst
(☞ P.4-23)

Press the MODE key, and then select [BURST] by using the soft-key to light "BURST" in the operation mode display section on the front panel of the main unit. This switches to burst oscillation mode. There are total 2 pages of the setting screens in the burst oscillation mode. You can switch them by using the NEXT key. Then select burst mode [BrstMode] on the second page of the setting screen, and then press the ENTER key. The selection list appears in the soft-key area. When the soft-key trigger burst [Trigger] is pressed, trigger burst is set.

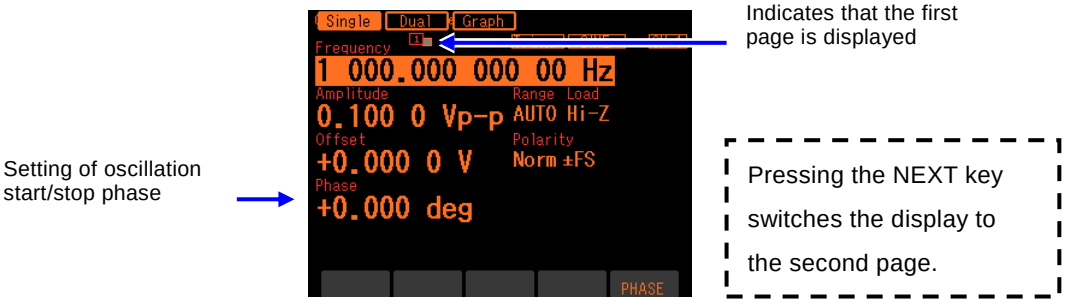


Select [Trigger] on the burst mode setting menu.

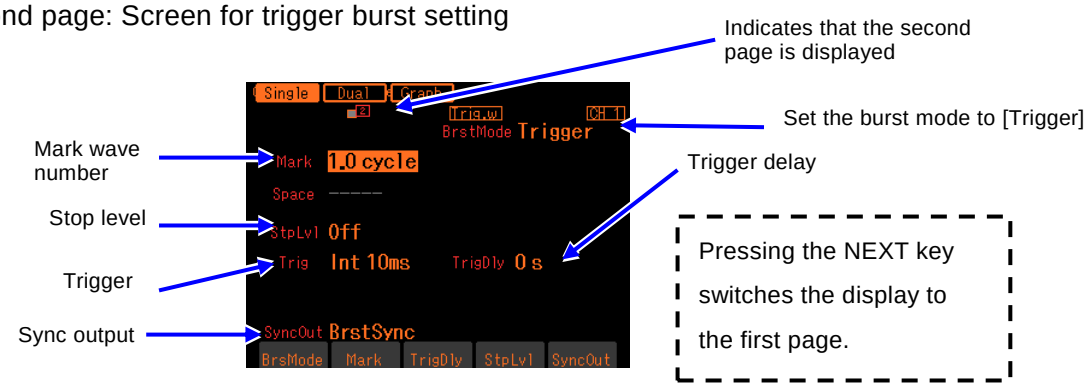
c) Screen for trigger burst setting

■ First page: Screen for basic parameter setting

These are common items independent from oscillation mode.



■ Second page: Screen for trigger burst setting



Oscillation start/stop phase [Phase]

The phase to start/stop oscillation.

Mark wave number [Mark]

The wave number oscillating every time a trigger is accepted. This can be set in 0.5 cycle unit.

Stop level [StpLvl]

The signal level while oscillation is stopped. Set the level to turn on or turn off. Usually, set to Off.☞ P.4-90

Trigger [Trig]

The trigger condition. Select as a trigger source from the internal or external.☞ P.4-89

Trigger delay [TrigDly]

Trigger delay time. Start oscillation when the specified time elapses after accepting a trigger.

☞ P.4-89

Sync output [SyncOut]

The output signal from a sync/sub-output terminal. Select from waveform reference phase synchronization and burst synchronization.☞ P.4-90

d) Waveform that trigger is unavailable

Noise and DC cannot perform trigger burst.

e) Setting items necessary for trigger burst

Set the oscillation start/stop phase [Phase] on the first page of the setting screen.

Set mark wave number [Mark] on the second page of the setting screen. Usually set as integer value.

The stop level [StpLvl] on the second page of the setting screen is usually set as Off [Off].

☞ P.4-90

A trigger is necessary for trigger burst. See the next section.

f) Trigger setting for trigger burst

Internal trigger oscillator, external signal, manual trigger key operation, and remote trigger can be used as a trigger.

When a trigger is accepted, the TRIG'D lamp on the TRIG key illuminates.

Set the trigger source in the trigger [Trig] on the second page of the setting screen

■ Trigger source setting

A trigger source can be selected from internal [Int] or external [Ext].

When a trigger source is internal [Int], a trigger period can be set.

When a trigger source is external [Ext], the polarity of a trigger can be set.

When a trigger source is external [Ext], enter a trigger signal with TTL level to the external trigger input terminal (TRIG IN).

■ How to use manual and remote triggers

Manual trigger operation and remote trigger operation is effective, regardless of the trigger source setting.

The TRIG key can be used for manual trigger operation.

However, in case of WF1948, the TRIG key only works on the channel side where display is active. For the channel where display is active, ☞ P.4-18.

When only manual trigger operation and remote trigger operation are used for a trigger, set the trigger source as external [Ext]. Moreover, we will recommend that the polarity is set as [Off] to avoid malfunctions caused by noise.

■ Trigger delay setting

Set the trigger delay time in the trigger delay [TrigDly] on the second page of the setting screen. Start oscillation when the specified time elapses after accepting a trigger. The setting of trigger delay time is effective for all trigger sources.

The delay inside the equipment is minimized when the trigger delay time is set as zero, however, there is a delay in the waveform actually output.☞ P.15-12

A new trigger is not accepted until oscillation of the specified number of mark waves completes.

g) To start trigger burst ☜ With trigger

When a trigger is accepted, start oscillation with the specified wave number.

Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger.

h) To output burst sync signal ☜ In sync output setting

Set in the sync output [SyncOut] on the second page of the setting screen. Select from the following two options:

• Signal that synchronizes with reference phase of waveform [Sync]

• Signal that synchronizes with burst oscillation [BrstSync]

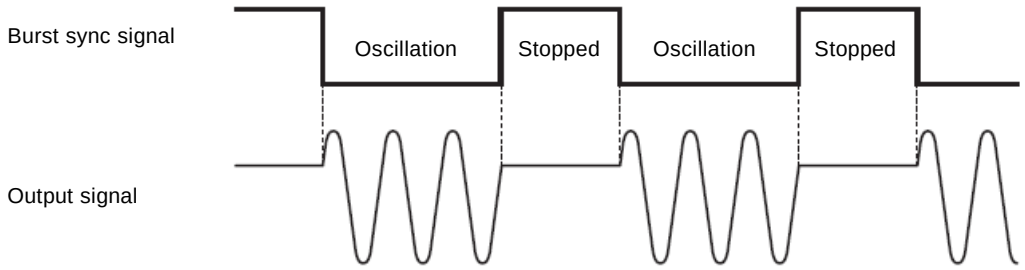
■ When [Sync] is selected,

Signals with TTL level that are rising at the reference phase of waveform are output from the SYNC/SUB OUT terminal.

■ When [BrstSync] is selected,

Signals with TTL level that synchronize with the burst oscillation are output from the SYNC/SUB OUT terminal. It is low during oscillation, and high while oscillation is stopped, as show in the following figure.

When a signal under burst is observed with the oscilloscope etc., it can be used as a trigger signal.

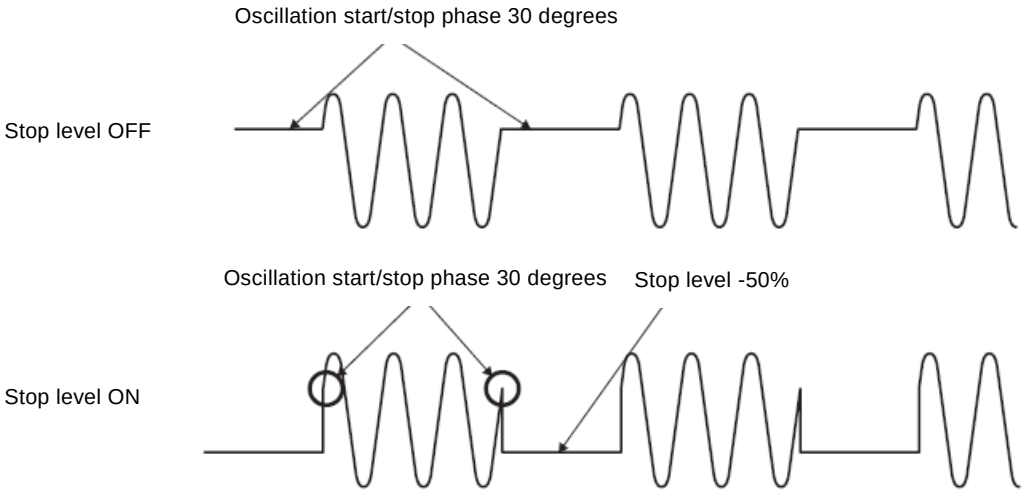


i) How to use stop level

The level while oscillation is stopped is usually set by oscillation start/stop phase. It is also possible to set by the ratio to the full scale of the amplitude independently.

Set the stop level [StpLvl] as On [On] on the second page of the setting screen, and set the level with % value.

The example in the following figure is for mark wave number, : 3 waves, oscillation start/stop phase: 30 degree, stop level: OFF and ON with -50%. Note that oscillation start/stop phase is still effective.



When you the stop level is applied to the square wave, a square wave with three values can be output as shown in the following figure.

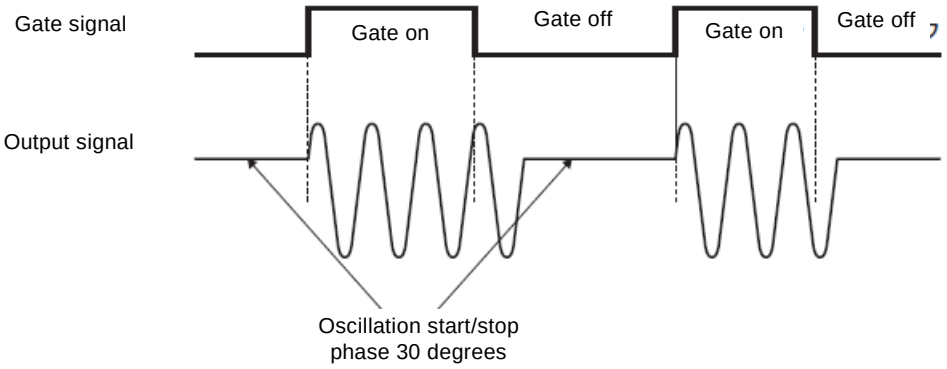
In the example of the figure, the stop level is set as 0%, oscillation start/stop phase are set as 0°(both the standard and enhanced duty variable ranges are available). If the stop level is not applied, the level of square wave while oscillation is stopped is always either of low level or high level.

4.8.4 Gate Oscillation

While the gate is On, performs oscillation with integer half-cycle or half-cycle unit. Settings and operations are performed in the Oscillator setting screen. When you press the MENU key while another screen is displayed, the Top menu is displayed. Press the [OSC] soft-key.

a) Gate oscillation example

Oscillation start/stop phase: 30 degree, oscillation stop unit: 1 cycle, stop level: Off. The oscillation is stopped when reaching the oscillation start/stop phase after the gate signal is Off.



b) To set oscillation mode as gate oscillation

MODE key
→Set the oscillation mode of as burst
(☞ P.4-23)

Press the MODE key, and then select [BURST] by using the soft-key to light "BURST" in the operation mode display section on the front panel of the main unit. This switches to burst oscillation mode. There are total 2 pages of the setting screens in the burst oscillation mode. You can switch them by using the NEXT key.

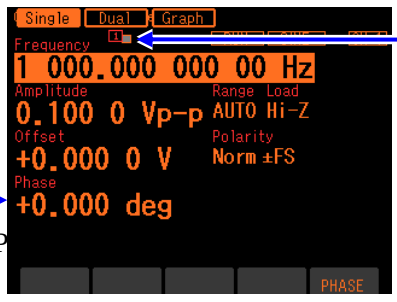
Select [Gate] on the burst mode setting menu.

Then select burst mode [BrstMode] on the second page of the setting screen, and then press the ENTER key. The selection list appears in the soft-key area. When the soft-key gate [Gage], gate oscillation is set.

c) Screen for gate oscillation setting

■ First page: Screen for basic parameter setting

These are common items independent from oscillation mode.



Indicates that the first page is displayed

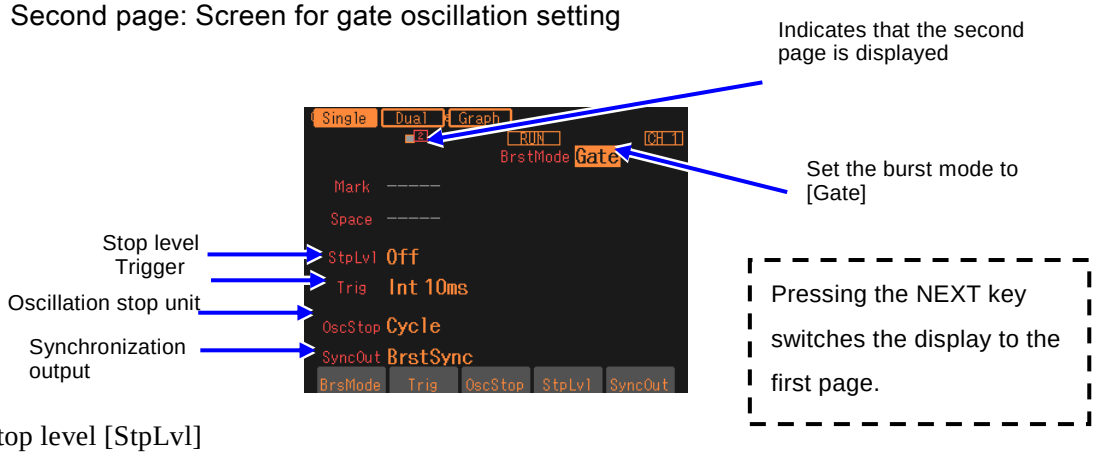
Setting of oscillation start/stop phase

Oscillation start/stop phase [P

Pressing the NEXT key switches the display to the second page.

The phase to start/stop oscillation.

■ Second page: Screen for gate oscillation setting



Stop level [StpLvl]

The signal level while oscillation is stopped. Set the level to turn on or turn off. Usually, set to Off.☞ P.4-95

Trigger [Trig]

The trigger condition (gate condition). Select as a trigger source from the internal or external. ☞ P.4-94

Oscillation Stop Unit [OscStop]

The oscillation stop unit. Select from 1 cycle and half period. Usually, set to 1 cycle . ☞ P.4-95

Synchronization output [SyncOut]

The output signal from a SYNC/SUB OUT terminal. Select from waveform reference phase synchronization and burst synchronization.☞ P.4-94

d) Waveform that gate oscillation is unavailable

DC cannot perform gate oscillation. Noise can perform gate oscillation, however, the action differs from other waveforms.☞ P.4-96

e) Setting items necessary for gate oscillation

Set the oscillation start/stop phase [Phase] on the first page of the setting screen.

The stop level [StpLvl] on the second page of the setting screen is usually set as Off [Off]. ☞ P.4-95

The oscillation stop unit [OscStop] on the second page of the setting screen is usually set as 1 cycle [Cycle].☞ P.4-95

A trigger (gate) is necessary for gate oscillation. See the next section.

f) Trigger (gate) setting for gate oscillation

Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger (gate).

While a gate signal is On, the TRIG'D lamp on the TRIG key illuminates.

Set the trigger source in the trigger [Trig] on the second page of the setting screen The trigger delay is fixed to the minimum value.

■Trigger source setting

A trigger source can be selected from internal [Int] or external [Ext].
When a trigger source is internal [Int], a trigger period can be set. At this time, the gate signal is square waves with duty 50%.
When a trigger source is external [Ext], the polarity of a trigger can be set.

■How to use manual and remote triggers

Manual trigger operation and remote trigger operation is effective, regardless of the trigger source setting.
The TRIG key can be used for manual trigger operation.
While the TRIG key is pressed, the gate signal is On. However, in case of WF1948,
the TRIG key works for the channel whose display is active.
For the channel where display is active, ☞ P.4-18.
When only manual trigger operation and remote trigger operation are used for a trigger, set the trigger source as external [Ext]. Moreover, we will recommend that the polarity is set as [Off] to avoid malfunctions caused by noise.

g) To start gate oscillation ☜ With trigger (gate signal)

When gate signal On is accepted, oscillation starts.
Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger.

h) To output burst sync signal ☜ In sync output setting

Set in the sync output [SyncOut] on the second page of the setting screen. Select from the following two options:

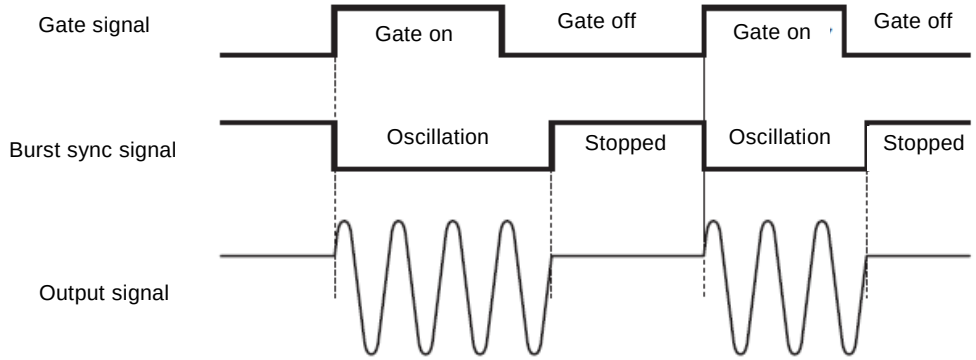
- Signal that synchronizes with reference phase of waveform [Sync]
- Signal that synchronizes with burst oscillation [BrstSync]

■ When [Sync] is selected,

Signals with TTL level that are rising at the reference phase of waveform are output from the SYNC/SUB OUT terminal.

■ When [BrstSync] is selected,

Signals with TTL level that synchronize with the gate oscillation are output from the SYNC/SUB OUT terminal. It is low during oscillation, and high while oscillation is stopped, as show in the following figure. Note that it is different from a gate signal.
When a signal under burst is observed with the oscilloscope etc., it can be used as a trigger signal.



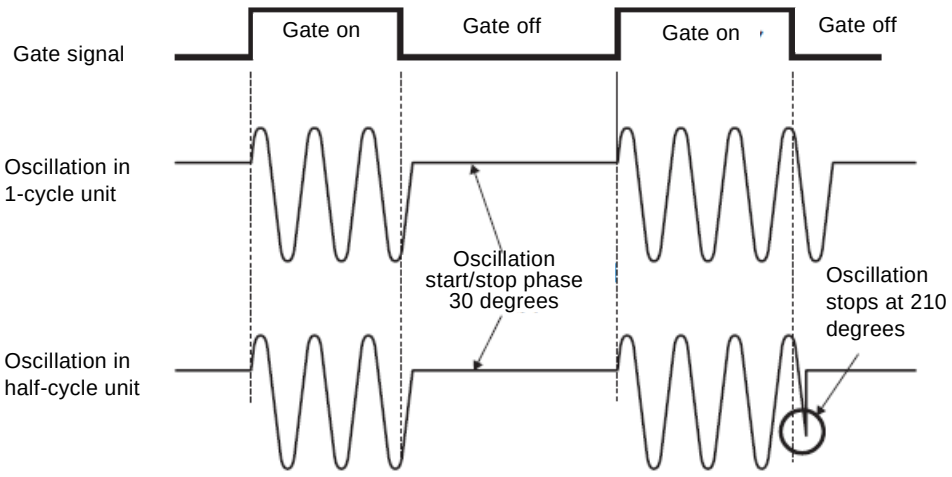
i) To oscillate in half cycle ☜ Oscillation stop unit as half cycle

When you want to stop oscillation every half cycle, set the oscillation stop unit [OscStop] as half cycle [HalfCycle] on the second page of the setting screen. Usually, set to 1 cycle [Cycle]. When it is set as 1 cycle [Cycle], it is oscillation with integer cycle.

The following figure shows the comparison for the cases of one cycle and half cycle. Oscillation start/stop phase: 30 degree, stop level: OFF.

In case of 1 cycle unit, the oscillation is stopped when reaching to the oscillation start/stop phase after gate is Off.

In case of half cycle unit, the oscillation is stopped when reaching to the oscillation start/stop phase or the oscillation start/stop phase + 180 degree (or –180 degree) after gate is Off, and then it transits to oscillation start/stop phase.



j) How to use stop level

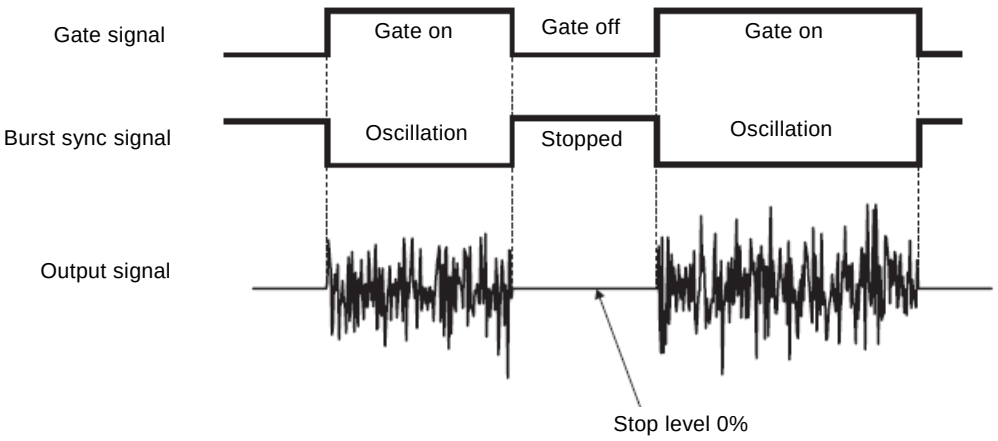
The level while oscillation is stopped is usually set by oscillation start/stop phase. It is also possible to set by the ratio to the full scale of the amplitude independently.

Set the stop level [StpLvl] as On [On] on the second page of the setting screen, and set the level with % value.☞ P.4-90

k) Noise gate oscillation

Because noise has no cycle, the gate On zone is the oscillation zone directly, and the gate Off zone is the oscillation zone directly. In addition, because noise has no phase, a stop level setting is always effective.

The following figure shows the example of noise gate oscillation. That is the case with stop level of 0%.



4.8.5 Triggered Gate Oscillation

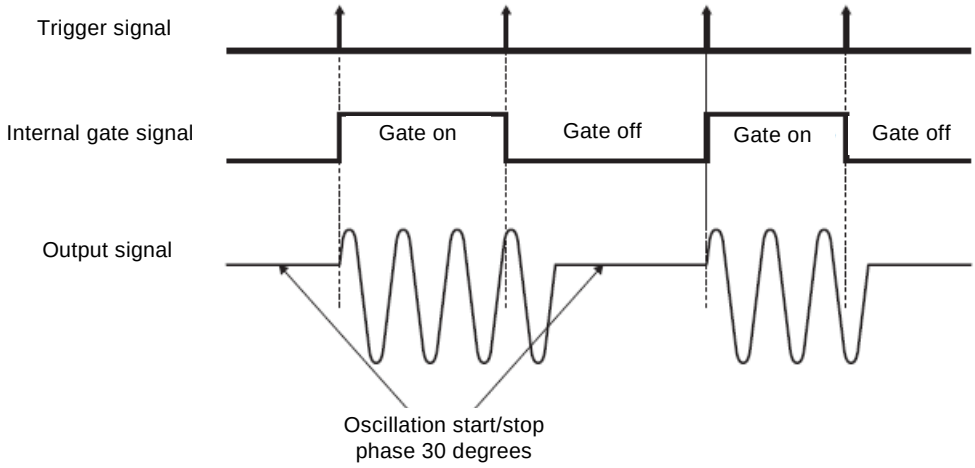
Gate oscillation that turns the gate On/Off every time a trigger is accepted.

Settings and operations are performed in the Oscillator setting screen. When you press the MENU key while another screen is displayed, the Top menu is displayed. Press the [OSC] soft-key.

a) Triggered gate oscillation example

Oscillation start/stop phase: 30 degree, oscillation stop unit: 1 cycle, stop level: Off.

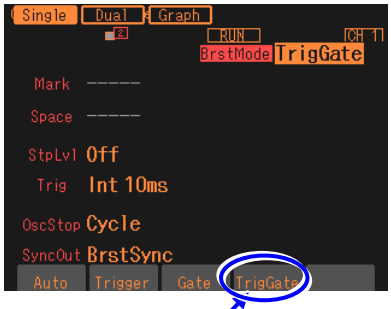
The oscillation is stopped when reaching the oscillation start/stop phase after the gate signal is Off.



b) To set oscillation mode as triggered gate oscillation

MODE key
→Set the oscillation mode of as burst
(☞ P.4-23)

Press the MODE key, and then select [BURST] by using the soft-key to light "BURST" in the operation mode display section on the front panel of the main unit. This switches to burst oscillation mode. There are total 2 pages of the setting screens in the burst oscillation mode. You can switch them by using the NEXT key. Then, select the burst mode [BrstMode] on the second page of the burst mode setting screen, and then press the Enter key. The selection list is displayed in the soft-key area. When the soft-key triggered gate oscillation [TrigGate] is pressed, triggered gate oscillation is set.

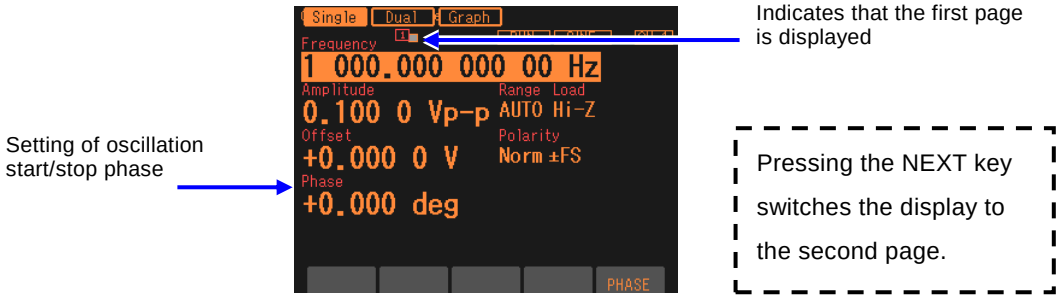


Select [TrigGate] on the burst mode setting menu.

c) Screen for triggered gate oscillation setting

■ First page: Screen for basic parameter setting

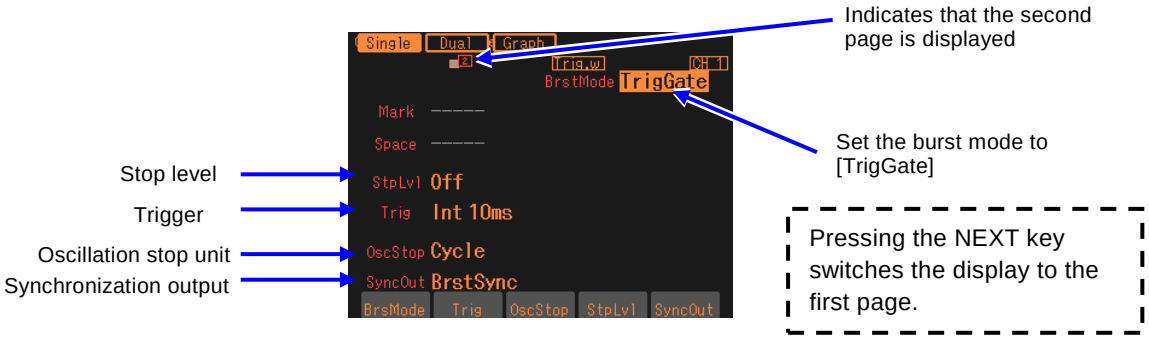
These are common items independent from oscillation mode.



Oscillation start/stop phase [Phase]

The phase to start/stop oscillation.

■ Second page: Screen for triggered gate oscillation setting



Stop level [StpLvl]

The signal level while oscillation is stopped. Set the level to turn on or turn off. Usually, set to Off.☞ P.4-100

Trigger [Trig]

The trigger condition.

Select as a trigger source from the internal or external.☞ P.4-99

Oscillation Stop Unit [OscStop]

The oscillation stop unit. Select from 1 cycle unit and half period unit. Usually, set to 1 cycle unit.☞ P.4-100

Synchronization output [SyncOut]

The output signal from a SYNC/SUB OUT terminal. Select from waveform reference phase synchronization and burst synchronization.☞ P.4-99

d) Waveform that trigger gate oscillation is unavailable

DC cannot perform triggered gate oscillation.

Noise can perform triggered gate oscillation, however, the action differs from other waveforms. ☞ P.4-100

e) Setting items necessary for triggered gate oscillation

Set the oscillation start/stop phase [Phase] on the first page of the setting screen.

The stop level [StpLvl] on the second page of the setting screen is usually set as Off [Off].

☞ P.4-100

The oscillation stop unit [OscStop] on the second page of the setting screen is usually set as 1 cycle [Cycle].☞ P.4-100

A trigger is necessary for triggered gate oscillation. See the next section.

f) Trigger setting of triggered gate oscillation

Internal trigger oscillator, external signal, manual trigger key operation, and remote trigger can be used as a trigger.

When a trigger is accepted, the TRIG'D lamp on the TRIG key illuminates.

Set the trigger source in the trigger [Trig] on the second page of the setting screen The trigger delay is fixed to the minimum value.

■ Trigger source setting

A trigger source can be selected from internal [Int] or external [Ext].

When a trigger source is internal [Int], a trigger period can be set.

When a trigger source is external [Ext], the polarity of a trigger can be set.

When a trigger source is external [Ext], enter a trigger signal with TTL level to the external trigger input terminal (TRIG IN).

■ How to use manual and remote triggers

Manual trigger operation and remote trigger operation is effective, regardless of the trigger source setting.

The TRIG key can be used for manual trigger operation.

However, in case of WF1948, the TRIG key only works on the channel side where display is active. For the channel where display is active, ☞ P.4-18.

When only manual trigger operation and remote trigger operation are used for a trigger, set the trigger source as external [Ext]. Moreover, we will recommend that the polarity is set as [Off] to avoid malfunctions caused by noise.

g) To start triggered gate oscillation ✍ With trigger

When the trigger is accepted and the internal gate signal is On, oscillation starts.

Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger.

h) To output burst sync signal ✍ In sync output setting

Set in the sync output [SyncOut] on the second page of the setting screen. Select from the following two options:

•Signal that synchronizes with reference phase of waveform [Sync]

•Signal that synchronizes with burst oscillation [BrstSync]

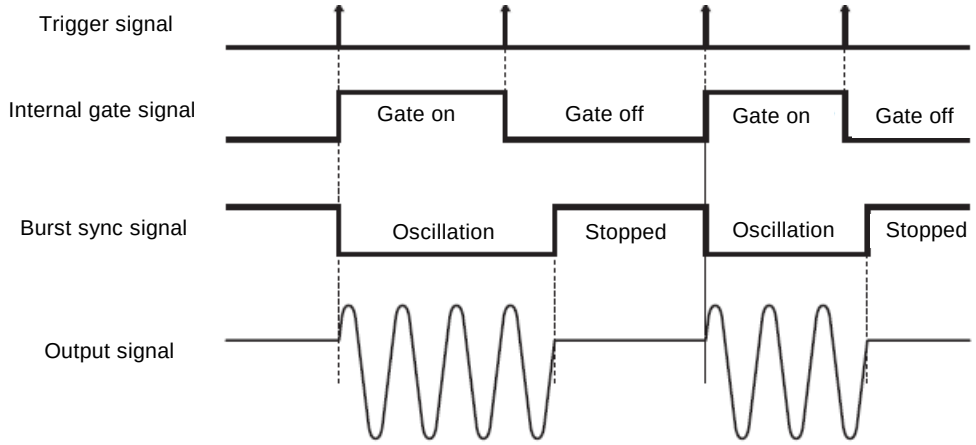
■ When [Sync] is selected,

Signals with TTL level that are rising at the reference phase of waveform are output from the SYNC/SUB OUT terminal.

■ When [BrstSync] is selected,

Signals with TTL level that synchronize with the gate oscillation are output from the SYNC/SUB OUT terminal. It is low during oscillation, and high while oscillation is stopped, as show in the following figure. Note that it is different from a gate signal.

When a signal under burst is observed with the oscilloscope etc., it can be used as a trigger signal.



i) To oscillate in half cycle ☜ Oscillation stop unit as half cycle

When you want to stop oscillation every half cycle, set the oscillation stop unit [OscStop] as half cycle [HalfCycle] on the second page of the setting screen. Usually, set to 1 cycle [Cycle]. When it is set as 1 cycle [Cycle], it is oscillation with integer cycle.

j) How to use stop level

The level while oscillation is stopped is usually set by oscillation start/stop phase. It is also possible to set by the ratio to the full scale of the amplitude independently.

Set the stop level [StpLvl] as On [On] on the second page of the setting screen, and set the level with % value.☞ P.4-90

k) Trigger gate oscillation of noise

Because noise has no cycle, the gate On zone is the oscillation zone, and the gate Off zone is the oscillation zone. In addition, because noise has no phase, a stop level setting is always effective. ☞ P.4-96

5. Saving and Recalling Settings

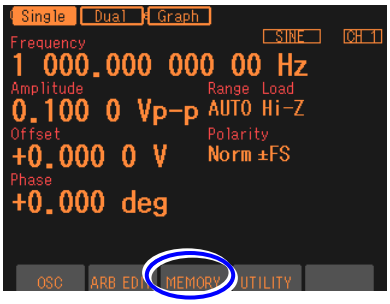
You can save the current setting condition in the setting memory, and recall it to use later.

You can make operations to save the setting and recall it in the Memory screen.

The setting memory 1 is used to startup after power failure. ☞ P.4-5

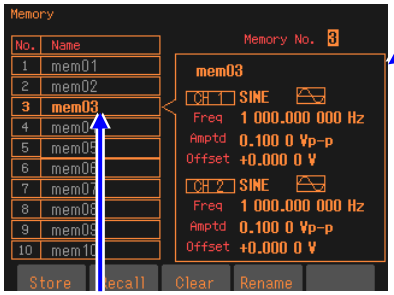
Factory defaults are saved in all the setting memories at factory shipment.

5.1 Procedure to Save Settings



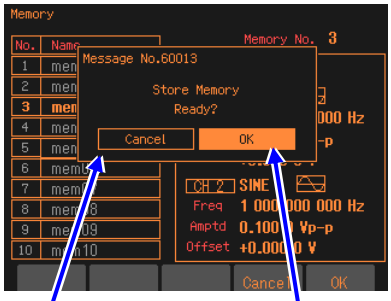
In the top menu, select [MEMORY]

Select [Memory No.] on the top right of the screen, and then press the ENTER key to open the input field of the setting memory number to save



The overview of the setting in the specified setting memory number is displayed

The specified setting memory number and the setting name are highlighted



Press the [Store] soft-key to open the dialog box to confirm the save operation.

Select [OK], and then press the ENTER key to make a save

1. When you press the MENU key, the top menu is displayed in the soft-key area. Then, press the [MEMORY] soft-key. This opens the Memory screen.

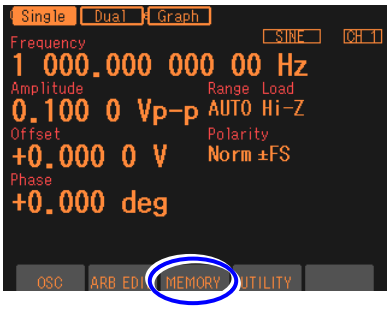
2. In the Memory screen, select [Memory No.] field on the top right of the screen, and then press the ENTER key to open the input field of the setting memory number to save

3. Use the up/down arrow key or the modify knob to increment or decrement the setting memory number.
In the left side of the screen, the specified setting memory number and its setting name are highlighted. In the right side of the screen, the overview of the setting saved in the specified setting memory number is displayed.

4. Select a setting memory number to save, and then press the ENTER key to close the input field of the setting memory number.

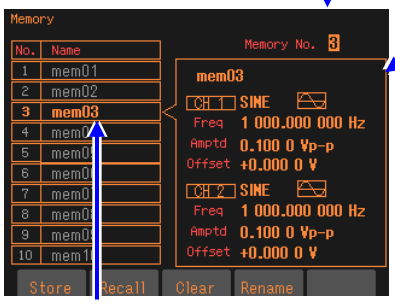
5. Press the [Store] soft-key to open the dialog box to confirm the save operation.
If you want to make a save, select [OK], and then press the ENTER key. The save is made and the setting saved previously in the setting memory number is overwritten by the new setting

5.2 Procedure to Recall Settings



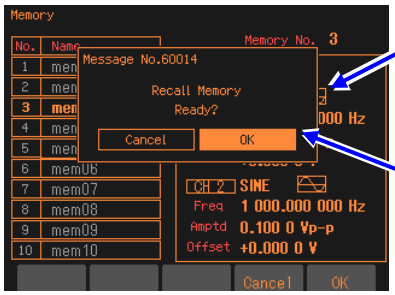
In the top menu, select [MEMORY]

Select [Memory No.] on the top right of the screen, and then press the ENTER key to open the input field of the setting memory number to save



The overview of the setting in the specified setting memory number is displayed

The specified setting memory number and the setting name are highlighted

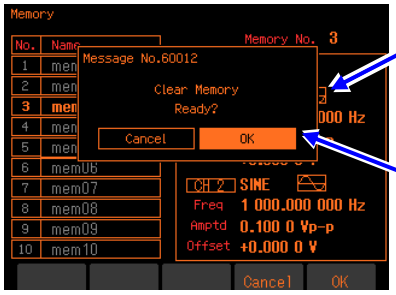


Press the [Recall] soft-key to open the dialog box to confirm the recall operation

Select [OK], and then press the ENTER key to make a recall

1. When you press the MENU key, the top menu is displayed in the soft-key area. Then, press the [MEMORY] soft-key. This opens the Memory screen.
2. In the Recall Memory screen, select [Memory No.] field on the top right of the screen, and then press the ENTER key to open the input field of the setting memory number to recall
3. Use the up/down arrow key or the modify knob to increment or decrement the setting memory number. In the left end of the screen, the specified setting memory number and its setting name are highlighted. In the right side of the screen, the overview of the setting saved in the specified setting memory number is displayed.
4. Select a setting memory number to recall, and then press the ENTER key to close the input field of the setting memory.
5. Press the [Recall] soft-key to open the dialog box to confirm the recall operation.
   If you want to make a recall, select [OK], and then press the ENTER key. The recall is made, and then the current setting is changed.

5.3 Restoring Saved Contents to Initial Settings

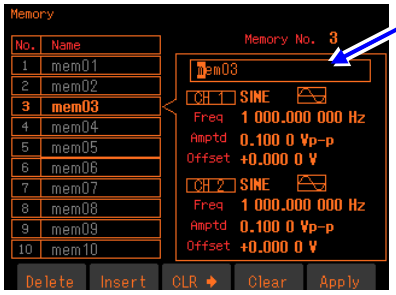


Press the [Clear] soft-key to open the dialog box to confirm the initialization operation.

Select [OK], and then press the ENTER key to reset the setting to the initial setting

As with the save operation, after setting the setting memory number, press the [Clear] soft-key. The dialog box to confirm the initialization operation is opened.
If you want to make an initialization, select [OK], and then press the ENTER key. The setting saved previously in the setting memory number is overwritten by the initial setting.

5.4 Changing Setting Memory Name



Press the [Rename] soft-key to open the input field of the setting memory name

1. As with the save operation, after setting the setting memory number, press the [Rename] soft-key.
   The input field of the setting memory name is opened.
2. Select the digit to be changed by using the right or left arrow key, and then use the up or down arrow key/the modify knob to change the character. You can enter uppercase and lowercase alphabetic characters, numbers, and symbols. You can directly enter numbers using the numeric keypad.
   Press the [Delete] soft-key to delete a character at the cursor position and shift a string at the right side of the cursor to the left by one character.
   Press the [Insert] soft-key to insert a space at the cursor position.
   Press the [CLR =>] soft-key to delete a string at the right side (excluding the cursor position) of the cursor.
   Press the [Clear] soft-key to clear all characters.
   The maximum number of characters of a name can be 20.
3. Press the [Apply] soft-key or the ENTER key to fix the changed name and close the input field of the setting memory name.
   Press the CANCEL key to leave the name as it is and close the input field of the setting memory name.

Also you can change a setting memory name in the Recall Memory screen.

Check

You can use the following characters for a setting memory 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

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

! # $ % & ' ( ) * + , - . / : ; < = > ? @ [ ] ¥ ^ _ ` { | } ~

Space

6. Creating Arbitrary Waveforms

6.1 Basics

There are the following two types of methods to create arbitrary waveforms:

- Use the accompanying arbitrary waveform editing software to create arbitrary waveforms on a PC.
- Enter waveform data on a panel.

This section describes the method to create arbitrary waveforms using operations on the panel of the main unit.
Before doing it, you must understand some of arbitrary waveforms of this product.

■ Two types of data formats

There are the following two types of data formats for the arbitrary waveform data of this product:

- Array format

  Data array itself corresponding to the address of a waveform memory.
  Waveforms imported by the digital oscilloscope are used as arbitrary waveforms as they are.
  Waveforms imported by the digital oscilloscope can be transferred to this product using the accompanying arbitrary waveform editing software.
  Array format data cannot be created/edited on the panel.
  Waveform length of the array format is 4 K- to 512 K-word (2^n, n = 12 to 19).

- Control point format

  A waveform is created by interpolating between the specified control points (control points) with a straight line.
  Data value for each memory address cannot be specified directly.
  A relatively simple arbitrary waveform can be created/edited manually on the panel.
  The number of control points in the control point format can be 2 to 10,000 points.
  For a waveform to be created, its time axis direction is fixed to 0 to 1 per a cycle and the amplitude direction is fixed to ± 1 (equivalent to ± FS of a waveform memory).

■ Save location of arbitrary waveforms

There are the following two save locations of arbitrary waveform data (separately from the 512 K-word length output waveform memory): Each memory shares two channels for WF1948.

- Save memory

  Non-volatile memory to save arbitrary waveforms.
  The non-volatile memory can save arbitrary waveforms up to 128-waveform or 4 M-word (8192 K-byte).
  It can save arbitrary waveform data in any of array and control point formats.
  For memory capacity required for save, ☞ P.6-9

- Edit memory

  Volatile memory to create an arbitrary waveform in the control point format. You can change

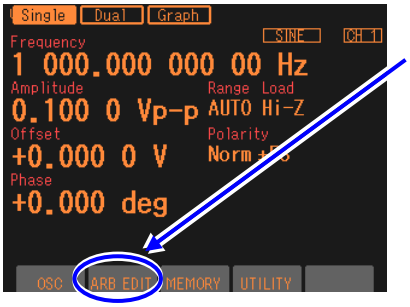
the number of control points between 2 and 10,000 points.
When you create/edit an arbitrary waveform on the panel, you operate data on this edit memory. Only one waveform can be treated on the edit memory.

■ Selection of arbitrary waveforms to be output

If you select an arbitrary waveform as an output waveform in the Oscillator setting screen, you can select an output wave of all the saved arbitrary waveforms. You can select any of waveforms saved in the above save memory or a waveform on the edit memory.
The selected waveform is written to the output waveform memory of the maximum 512 K-word length.
If you select an output waveform on the edit memory, a waveform you are creating/editing appears as it is in the output.

6.2 Display Procedure and Overview of Screen for Creating/Editing Arbitrary Waveforms

An arbitrary waveform is created/edited in the ARB Edit screen.



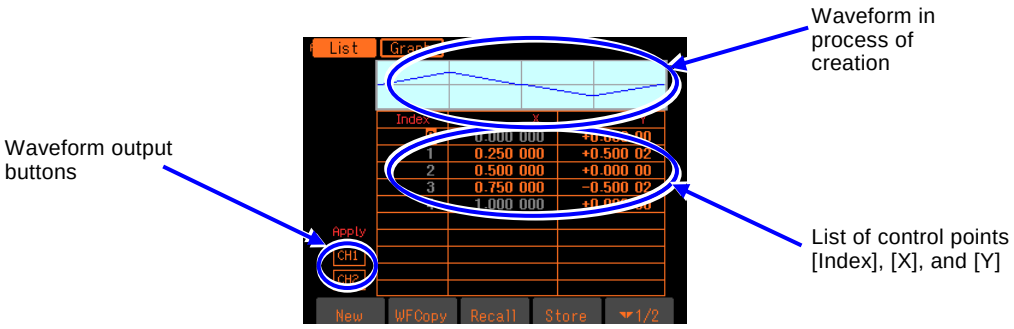
Select [ARB EDIT].

1. Press the MEMU key to show the soft-keys at the bottom of the screen. Then, select the [ARB EDIT] soft-key. This opens the ARB Edit screen.

2. The ARB Edit screen has two types of display formats.
They are a list display, which displays values side by side, and graph display. You can switch a display between them using tabs at the top left end of the screen.
[Index] shows numbers of control points, beginning with zero (0). Start point is fixed to X = 0.000000. End point is fixed to X = 1.000000, and the paired Y values of both the start and end points are the same (the same point).
If an output waveform is set to the arbitrary waveform on the edit memory, a waveform in process of creation appears as it is in the output. If the output waveform is set to other waveform, when you select the [Apply] button and press the ENTER key, the setting of output waveform is changed to the arbitrary waveform on the edit memory, and a waveform in process of creation appears in the output.

■List display

For the list display, a waveform in process of creation and a list of control points are displayed. A shape of waveform is created by setting X and Y values for each control point.

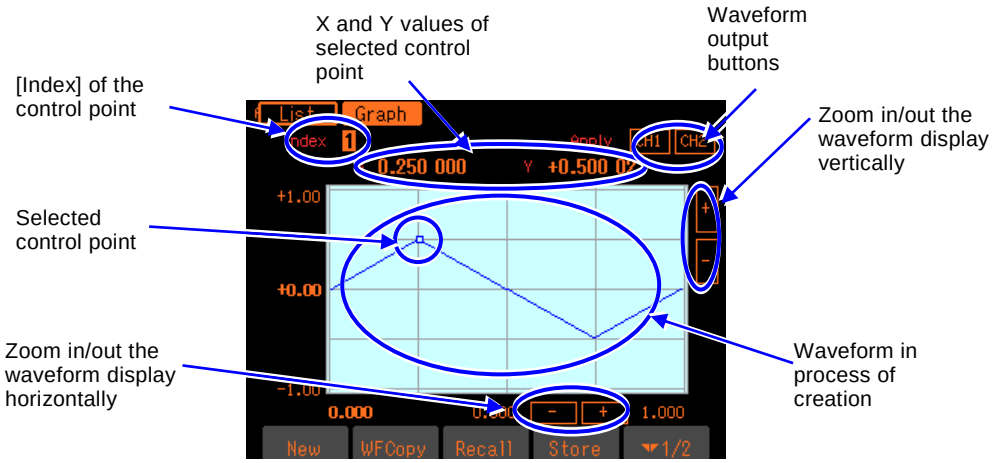


■ Graph display

For the graph display, a waveform in process of creation is enlarged. X and Y values of the selected one control point are displayed.

As with the list display, a shape of waveform is created by setting X and Y values for each control point.

You can enlarge a waveform display both horizontally and vertically with a focus on the selected control point.



■ Soft-keys

First row ([▼ 1/2] appears to the right end)

[New]: Clears the edit memory and makes it an initial state.

[WF Copy]: Copies a standard waveform onto the edit memory.

[Recall]: Copies the already saved arbitrary waveform in the control point format onto the edit memory.

[Store]: Saves a waveform on the edit memory.

Second row ([▼ 2/2] appears to the right end)

[Index -1]: Decrements a value of [Index] by one (1)

[Index +1]: Increments a value of [Index] by one (1)

[Delete]: Deletes the selected control point.

[Insert]: Inserts a new control point at the center of between the selected control point and the control point just before the selected point

6.3 Creating New Arbitrary Waveform

There are the following three types of methods to newly create an arbitrary waveform:

- Create a new arbitrary waveform thoroughly

  First, press the [New] soft-key to clear the edit memory. Then, enter control points. The next section describes the example of creation.

- Based on the standard waveform, modify it to create a new arbitrary waveform

  First, press the [WF Copy] soft-key to copy a standard waveform to the edit memory. Then, modify control points. How to operate control points is the same as the case of creating a new arbitrary waveform thoroughly.

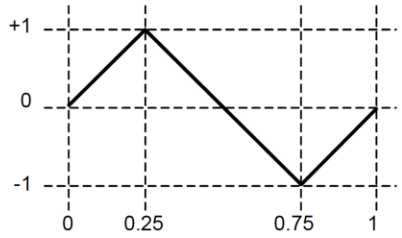
  However, noise and DC of the standard waveform cannot be copied. Square and pulse waves are copied as ideal square waves that keep duty.

- Based on the saved arbitrary waveform, modify it to create a new arbitrary waveform

  First, press the [Recall] soft-key to copy the saved arbitrary waveform in the control point format onto the edit memory. Then, modify control points. How to operate control points is the same as the case of creating a new arbitrary waveform thoroughly.

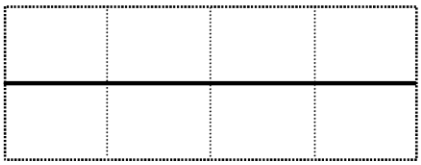
6.4 Simple Arbitrary Waveform Creating Example

This section creates a simple arbitrary waveform actually. Use the list display to explain the example. Arbitrary waveform to create is a triangular wave as shown below. The number of control points of this waveform are three points, but in this section, it begins with two points and then changes to three points on the way.



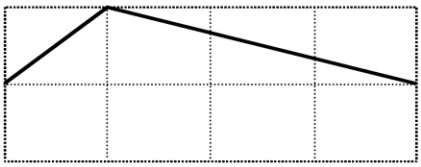
1. When you press the soft-key [Index] and set the number of control points to 2, it will be the following settings.

Index	X	Y
0	0.000000	+0.00000
1	0.500000	+0.00000
2	1.000000	+0.00000



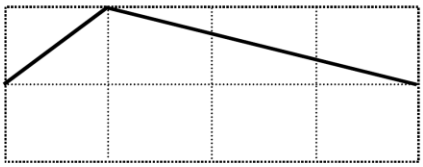
2. Change the setting of Index=1 to X=0.25 and Y=+1.

Index	X	Y
0	0.000000	+0.00000
1	0.250000	+1.00000
2	1.000000	+0.00000



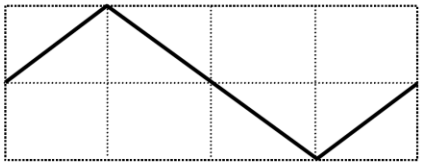
3. Select the Y-value field at the end line (Index=2, X=1) and press soft-key [Insert]. A new control point of X=0.625000, Y=+0.49998 is created. A Y value is rounded to 16-bit resolution which ±32767 is ±1.

Index	X	Y
0	0.000000	+0.00000
1	0.250000	+1.00000
2	0.625000	+0.49998
3	1.000000	+0.00000



4. Change the setting of Index=2 to X=0.25 and Y=-1. Now it is finished.

Index	X	Y
0	0.000000	+0.00000
1	0.250000	+1.00000
2	0.750000	–1.00000
3	1.000000	+0.00000



Check

- A X value can be changed within a range between the control point just before the X value and the control point just after the X value.
- A Y value is rounded to 16-bit resolution.
- If you change a Y value to the form of a step, set the variation width between adjacent X values to the minimum value, 0.000001.

6.5 Outputting Created Arbitrary Waveform

Select the [Apply] button (by CH for WF1948) on the screen, and then press the ENTER key.
The setting of output waveform is changed to the arbitrary waveform on the edit memory, and a waveform in process of creation appears in the output.
If an output waveform is set to the arbitrary waveform on the edit memory, a waveform in process of creation appears as it is in the output.

6.6 Saving Created Arbitrary Waveform

Press the [Store] soft-key to open a window to save. Select a memory number between 1 to 128 to operate a save. You can name a waveform.

6.7 Identifying Memory Space Required for Saving Arbitrary Waveforms

The non-volatile memory can save arbitrary waveforms up to 128-waveform or 4 M-word (8192 K-byte).

The memory capacity (K-byte) required when saving an arbitrary waveform in the array format and control point format, respectively is calculated by the following formula:

Array format: (2 x waveform length (word) + 768) / 1024 (rounding up the fractional part)

Control point format: (8 x the number of control points + 768) / 1024 (rounding up the fractional part)

The memory capacity required when saving an arbitrary waveform in the array format is shown in the following table:

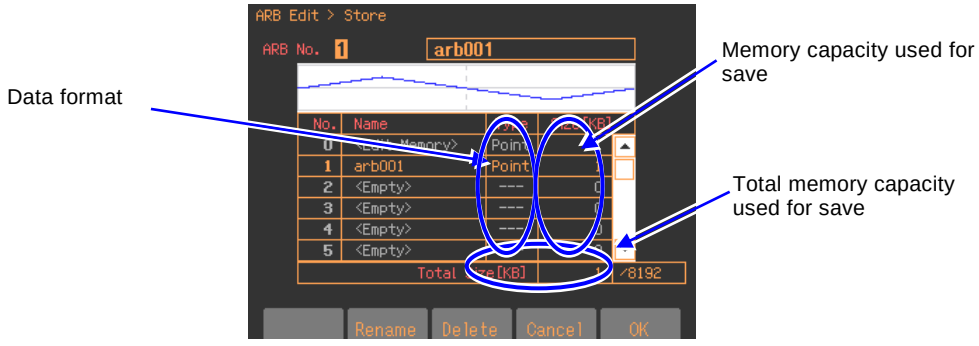
Waveform size	4KW	8KW	16KW	32KW	64KW	128KW	256KW	512KW
Memory capacity required for save	9KB	17KB	33KB	65KB	129KB	257KB	513KB	1025KB

The example of memory capacity required when saving an arbitrary waveform in the control point format is shown in the following table:

Number of control points	2	10	100	300	1,000	2,000	5,000	10,000
Memory capacity required for save	1KB	1KB	2KB	4KB	9KB	17KB	40KB	79KB

In the selection screen of the arbitrary waveform (common to both the recall and save), the following items are displayed in addition to the waveform number, [No.], and waveform name, [Name]:

- Data format [Type]: The waveforms in the array and control point formats are displayed as [RAW] and [Point], respectively. The edit memory with No.0 is displayed as [Point] because of the control point format.
- Save memory capacity [Size]: For arbitrary waveforms between No.1 to 128, memory capacity used for save is displayed in K-byte. For the edit memory with No.0, memory capacity required if it is saved is displayed in K-byte.
- Total save memory capacity [Total Size]: Total memory capacity currently used for save of arbitrary waveforms between No.1 to 128 is displayed in K-byte. The size of edit memory with No.0 is excluded from the total capacity.



MEMO

7. Convenient Use of 2-channel Equipment (WF1948 Only)

7.1 Overview

You can use 2-channel equipment, WF1948, not only as the two independent oscillators but also as the 2-channel coordination setting and operation.

Functions specific to 2-channel equipment are as follows:

• Parameter copy function

One's channel setting can be copied to another's channel setting.

Channel settings can be changed each other.☞ P.7-3

• 2-channel equivalence setting function

Various values such as the amplitude and DC offset can be set to the same values between two channels. Output on/off can be operated simultaneously between two channels.☞ P.7-5

• Phase synchronization function

Oscillation phase for each channel can be initialized. This function is used for 2-channel independent operation with the continuous oscillation mode.☞ P.7-6

• 2-channel coordination operation: 2-phase function

The synchronization relationship with the same frequency can be kept. This function controls to keep the synchronization relationship with the same frequency also during the frequency modulation or frequency sweep.☞ P.7-7

• 2-channel coordination operation: function with constant frequency difference

The frequency can be changed with the frequency difference kept constant. This function controls to keep the frequency difference constant also during the frequency modulation or frequency sweep.☞ P.7-9

• 2-channel coordination operation: function with constant frequency ratio

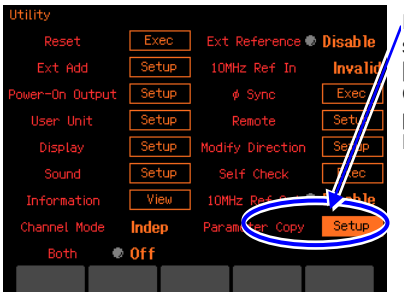
The frequency can be changed with both the frequency ratio and synchronization relationship kept constant. This function controls to keep the frequency ratio constant also during the frequency modulation or frequency sweep.☞ P.7-11

• 2-channel coordination operation: differential output function

The reverse phase waveform can be output with the same frequency, amplitude, and DC offset. This function controls to keep the reverse phase waveform also during the frequency modulation or frequency sweep.☞ P.7-13

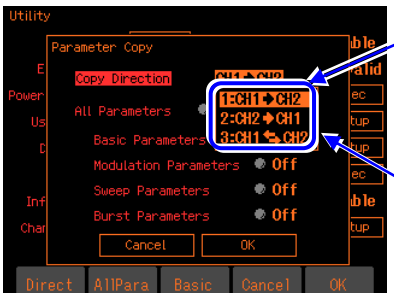
7.2 Copying Setting between Channels

Copying the settings between channels can be done on the Utility screen.



In the Utility screen, select [Parameter Copy], and then press the ENTER key

1. Select [Parameter Copy] on the Utility screen, and then press the ENTER key.



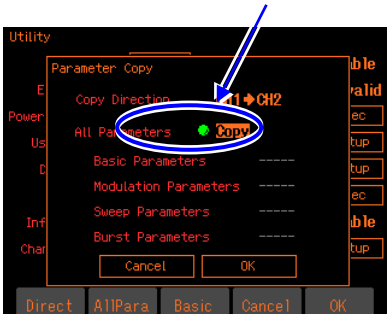
The Parameter copy window is opened

Select a copy direction

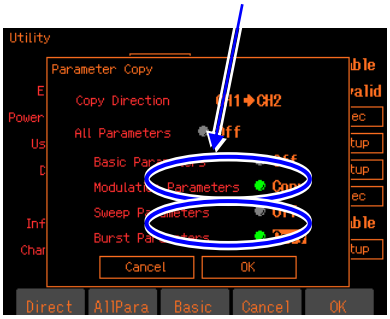
2. After the Parameter copy window is opened, select the [Copy Direction] field, and then press the ENTER key.
The selection list to show the copy direction is opened.
You can select a copy direction from the following three types: [CH1→CH2] (CH1 to CH2), [CH2→CH1] (CH2 to CH1), and [CH1→CH2] (exchange with each other between CH1 and CH2).
Select a direction you want, and then press the ENTER key.

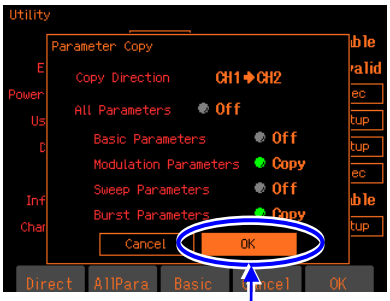
3. Next, select a parameter type to copy.
If you copy all parameters, select [All Parameters]. Otherwise, select parameters for each oscillation mode. There are the following four types of parameters as parameters for each oscillation modes: continuous oscillation mode parameters, [Basic Parameters], modulated oscillation mode parameters, [Modulation Parameters], sweep oscillation mode parameters, [Sweep Parameters], and burst oscillation mode parameters [Burst Parameters].
Select a parameter type you want and press the ENTER key, then the parameter type is set as the copy target and [Copy] is shown next to it. Press the ENTER key again, then the parameter type is excluded from the copy target and [Off] is shown next to it.

Copy all parameters



Copy the modulation and burst parameters





Select [OK], and then press the ENTER key to make a copy.

4. When the above setting is completed, select [OK] at the bottom of the window, and then press the ENTER key. The copy operation is performed.

When you do not want to copy, select [Cancel] at the bottom of the window and press the ENTER key, or press the CANCEL key.

■ Remarks

Copying all of [Basic Parameters], [Modulation Parameters], [Sweep Parameters], and [Burst Parameters] is not equivalent to copying [All Parameters].

The following items are copied only when copying [All Parameters]:

- Output on/off state
- Oscillation mode
- External addition setting
- User-defined unit
- Start-up output on/off setting
- Waveform parameters setting for all waveforms (for the copy of [Basic Parameters], the waveform parameters setting is copied only for the currently used waveforms at the copy source)
- Amplitude/DC offset setting or high level/low level setting

7.3 Unifying Settings of 2 Channels

■Procedure and operation

First, set the 2-channel equivalence setting function to on in the Utility screen.

Next, set items to which you want to set the same setting. When you set setting for one channel, the same settings are set to the same items for another channel. In addition to the frequency, phase, amplitude, and DC offset, this is applied to the oscillation mode and waveforms. This is also applied to the output on/off, burst trigger, sweep start/stop operation.

This function is enabled until the 2-channel equivalence setting function is reset to off.

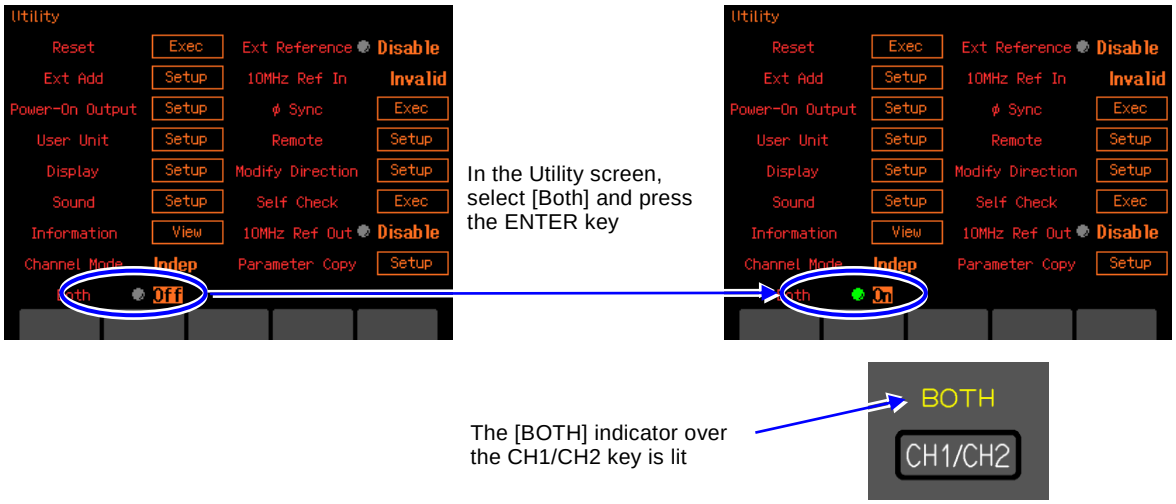
■ To turn on/off 2-channel equivalence setting function

Turning on/off 2-channel equivalence setting function is performed in the Utility screen.

In the Utility screen, select [Both], and then press the ENTER key to switch an indicator to [On] from [Off].

This turns 2-channel equivalence setting function on.

If you want to reset to [Off], press the ENTER key again.



Other than in the Utility screen, you can switch on/off by holding down the CH1/CH2 key for 2 or more seconds.

7.4 Phase Synchronization between Channels

Even if you set the frequency and phase to the same values using the 2-channel equivalence setting function, the phase relationship between the output waveforms from the 2 channels is changed accordingly. To synchronize the phases, the phase synchronous operation is required.
This synchronous operation is used for 2-channel independent operation (the channel mode setting is set to [Indep]).

If you want to always keep the same frequency or frequency ratio and need a phase synchronization state, use the 2-channel coordination function.☞ P.7-7, P.7-11
For synchronization of multiple units, ☞ P.8-2

■ Performing synchronization

In the Utility screen, select [Sync], and then press the ENTER key to run the phase synchronization

First, set the channel mode to [Indep] and set the frequency setting for both channels to the same value.

The synchronous operation is performed in the Utility screen.
Select [Sync] on the Utility screen, and then press the ENTER key.
This runs the phase synchronization.
At this time, the phase will be discontinuous temporarily because both channels stop the oscillation once.

■ Phase relationship after synchronous operation

The oscillation phase for each channel is initialized by the synchronous operation. The phase difference of the output waveform appears as the difference of the phase setting for each channel. Even if you make a synchronous operation, changing a frequency later loses the synchronization relationship. If necessary, make a synchronous operation accordingly.

■ Operational restrictions

There are restrictions shown in the following table to the synchronous operation: The synchronous operation is used for 2-channel independent operation. Even if the synchronous operation is disabled, making a synchronous operation causes both channels to stop the oscillation once.

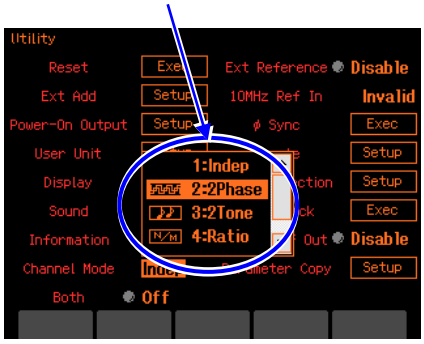
Item	Restriction
Waveform	Disabled for noise and DC.
Modulated oscillation mode	Disabled for FM and FSK.
Sweep oscillation mode	Disabled for frequency sweep. Disabled for gated single-shot sweep.
Burst oscillation mode	Disabled.

7.5 Maintaining Both Channels to Same Frequency (2-Channel Coordination, 2-Phase)

If the channel mode is [2Phase], you can change the frequency with the frequencies for both channels kept the same value while the synchronization relationship is kept. In coordination with the change of frequency of the channel 1, the frequency of the channel 2 is automatically changed. The channel 2 coordinates with the channel 1 also during the frequency modulation or frequency sweep. This function is disabled for the burst oscillation and gated single-shot sweep.

■ Selecting 2-channel coordination

Set [Channel Mode] to [2Phase]



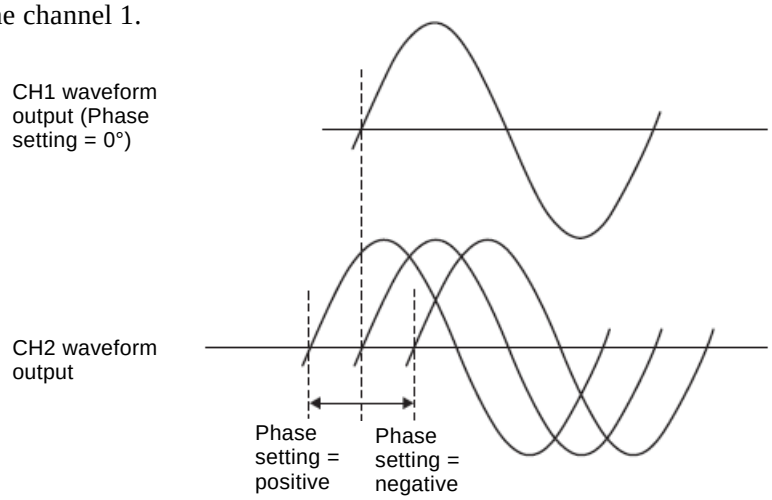
2PHASE indicator is lit

In the Utility screen, set [Channel Mode] to [2Phase] ([Indep] is normally set). This makes the channel mode an oscillation with 2-phase.

Frequencies for both channels will be the same and the phase synchronization is automatically run. Even if changing the frequency, the synchronization relationship is kept.
This function controls to keep the synchronization relationship with the same frequency also during the frequency modulation or frequency sweep.
For the 2-phase oscillation, the setting relating to the frequency can be set only for the channel 1.

■Changing phase difference between channels

You can set a phase for each channel in the Oscillator setting screen. The phase between channels appears as the difference for each phase setting.
Normally, set the phase of the phase reference channel (for example, channel 1) to 0 degree and change only the phase setting of the channel 2. At this time, the phase setting of the channel 2 is a phase of the channel 2 based on the channel 1. As shown in the figure below, if the phase setting of the channel 2 is positive, the channel 2 precedes the channel 1 and if it is negative, the channel 2 lags behind the channel 1.



■ Operational restrictions

There are restrictions shown in the following table to keep the synchronization relationship and the same frequency:

Item		Restriction
Waveform		Disabled for noise and DC.
Modulated oscillation mode	FM	Both CHs are FM. Peak deviation is common. Modulation source is internal only. Internal modulation waveform and internal modulation frequency are common.
	FSK	Both CHs are FSK. Hop frequency is common. Modulation source is internal only. Internal modulation frequency is common.
	PM	Both CHs are PM. Modulation setting is independent for each CH.
	PSK	Both CHs are PSK. Modulation setting is independent for each CH.
	AM	Both CHs are AM. Modulation setting is independent for each CH.
	DC offset modulation	Both CHs are DC offset modulation. Modulation setting is independent for each CH.
	PWM	Both CHs are PWM. Modulation setting is independent for each CH.
Sweep oscillation mode	Frequency sweep	Both CHs are frequency sweep. Sweep function, sweep range, sweep time, and sweep mode are common. Gated single-shot sweep unavailable. Single-shot sweep trigger source and sweep internal trigger oscillator are common. External trigger source is enabled only for CH1 side.
	Phase sweep	Both CHs are phase sweep. Sweep setting is independent for each CH.
	Amplitude sweep	Both CHs are amplitude sweep. Sweep setting is independent for each CH.
	DC offset sweep	Both CHs are offset sweep. Sweep setting is independent for each CH.
	Duty sweep	Both CHs are duty sweep. Sweep setting is independent for each CH.
Burst oscillation mode		Disabled

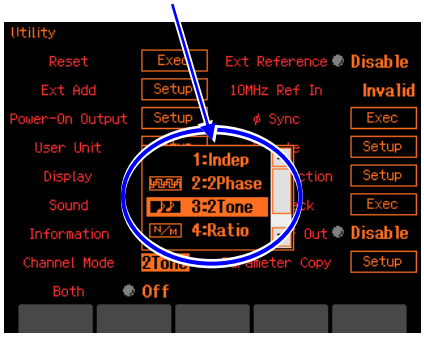
Both channels have the same type of modulation or sweep during the modulation or sweep. If another channel does not need the modulation (other than FM and FSK) or sweep (other than the frequency sweep), set the modulation width or sweep width of the channel to zero (0).

7.6 Keeping Frequency Difference Constant (2-Channel Coordination, 2-Tone)

If the channel mode is [2Tone], you can change the frequency with the frequency difference between both channels kept constant. In coordination with the change of frequency of the channel 1, the frequency of the channel 2 is automatically changed. The channel 2 coordinates with the channel 1 also during the frequency modulation or frequency sweep. This function is disabled for the burst oscillation and gated single-shot sweep.

■ Selecting **2**-channel coordination

Set [Channel Mode] to [2Tone]



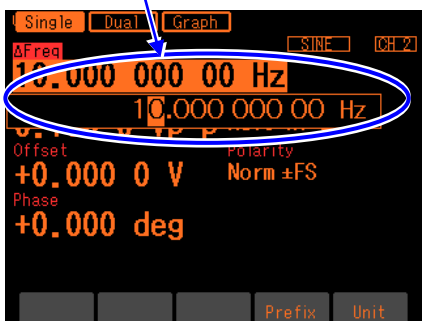
2TONE indicator is lit

In the Utility screen, set [Channel Mode] to [2Tone] ([Indep] is normally set). This makes the channel mode an oscillation with constant frequency difference.

The frequency difference between both channels is kept constant. This function controls to keep the frequency difference constant also during the frequency modulation or frequency sweep. For the oscillation with the constant frequency difference, you cannot set the frequency of the channel 2 directly.

■ To set the frequency difference

Set [Freq] of CH2



In the Oscillator screen, set the frequency difference in [Freq] of channel 2. The frequency of channel 2 results from adding this frequency difference to the frequency of channel 1.

■ Operational restrictions

There are restrictions shown in the following table to keep the frequency difference:

Item		Restriction
Waveform		Disabled for noise and DC
Modulated oscillation mode	FM	Both CHs are FM. Peak deviation is common. Modulation source is internal only. Internal modulation waveform and internal modulation frequency are common.
	FSK	Both CHs are FSK. Hop frequency follows the frequency difference. Modulation source is internal only. Internal modulation frequency is common.
	PM	Both CHs are PM. Modulation setting is independent for each CH.
	PSK	Both CHs are PSK. Modulation setting is independent for each CH.
	AM	Both CHs are AM. Modulation setting is independent for each CH.
	DC offset modulation	Both CHs are DC offset modulation. Modulation setting is independent for each CH.
	PWM	Both CHs are PWM. Modulation setting is independent for each CH.
Sweep oscillation mode	Frequency sweep	Both CHs are frequency sweep. Sweep range follows the frequency difference. Sweep function, sweep time, and sweep mode are common. Gated single-shot sweep unavailable. Single-shot sweep trigger source and sweep internal trigger oscillator are common. External trigger source is enabled only for CH1 side.
	Phase sweep	Both CHs are phase sweep. Sweep setting is independent for each CH.
	Amplitude sweep	Both CHs are amplitude sweep. Sweep setting is independent for each CH.
	DC offset sweep	Both CHs are offset sweep. Sweep setting is independent for each CH.
	Duty sweep	Both CHs are duty sweep. Sweep setting is independent for each CH.
Burst oscillation mode		Disabled

Both channels have the same type of modulation or sweep during the modulation or sweep. If another channel does not need the modulation (other than FM and FSK) or sweep (other than the frequency sweep), set the modulation width or sweep width of the channel to zero (0).

The frequency difference of the hop frequency in FSK is restricted to the setting resolution of the hop frequency.

If you select the logarithmic sweep as the frequency sweep, the channel 1 performs the logarithmic sweep, but the channel 2 does not perform the logarithmic sweep because the channel 2 follows with the constant frequency difference.

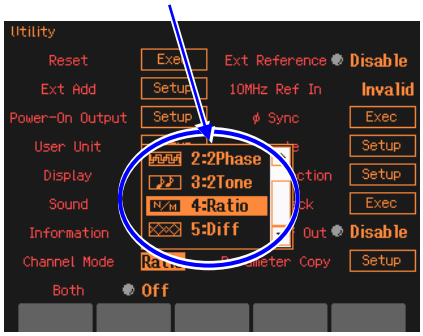
7.7 Keeping Frequency Ratio Constant (2-Channel Coordination, Ratio)

If the channel mode is [Ratio], you can change the frequency with the frequency ratio between both channels kept constant. In coordination with the change of frequency of the channel 1, the frequency of the channel 2 is automatically changed.

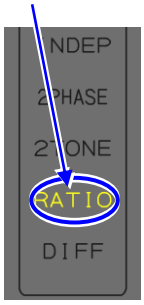
The channel 2 coordinates with the channel 1 also during the frequency modulation or frequency sweep. This function is disabled for the burst oscillation and gated single-shot sweep.

■ Selecting **2**-channel coordination

Set [Channel Mode] to [Ratio]



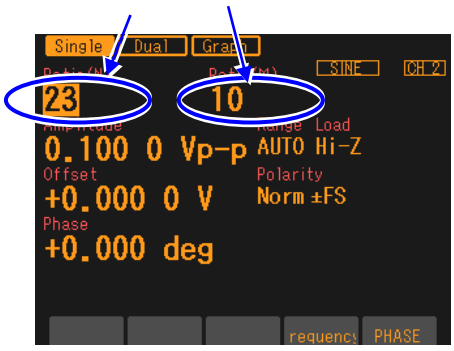
RATIO indicator is lit



In the Utility screen, set [Channel Mode] to [Ratio] ([Indep] is normally set).
This makes the channel mode an oscillation with constant frequency ratio.
The frequency ratio between both channels is kept constant.
This function controls to keep the frequency ratio constant also during the frequency modulation or frequency sweep.
For the oscillation with the constant frequency ratio, you cannot set the frequency of the channel 2 directly.

■ To set the frequency ratio

Set [Ratio(N)] and [Ratio(M)] of CH2



In the Oscillator screen, set the frequency ratio in [Ratio(N)] and [Ratio(M)] of the channel 2.
Frequency of channel 2: frequency of channel 1 will be N : M.
If you change the frequency ratio, the phase will be discontinuous temporarily because both channels stop the oscillation once.

■ Operational restrictions

There are restrictions shown in the following table to keep the frequency ratio:

Item		Restriction
Waveform		Disabled for noise and DC
Modulated oscillation mode	FM	Both CHs are FM. Peak deviation follows the frequency ratio. Modulation source is internal only. Internal modulation waveform and internal modulation frequency are common.
	FSK	Both CHs are FSK. Hop frequency follows the frequency ratio. Modulation source is internal only. Internal modulation frequency is common.
	PM	Both CHs are PM. Modulation setting is independent for each CH.
	PSK	Both CHs are PSK. Modulation setting is independent for each CH.
	AM	Both CHs are AM. Modulation setting is independent for each CH.
	DC offset modulation	Both CHs are DC offset modulation. Modulation setting is independent for each CH.
	PWM	Both CHs are PWM. Modulation setting is independent for each CH.
Sweep oscillation mode	Frequency sweep	Both CHs are frequency sweep. Sweep range follows the frequency ratio. Sweep function, sweep time, and sweep mode are common. Gated single-shot sweep unavailable. Single-shot sweep trigger source and sweep internal trigger oscillator are common. External trigger source is enabled only for CH1 side.
	Phase sweep	Both CHs are phase sweep. Sweep setting is independent for each CH.
	Amplitude sweep	Both CHs are amplitude sweep. Sweep setting is independent for each CH.
	DC offset sweep	Both CHs are offset sweep. Sweep setting is independent for each CH.
	Duty sweep	Both CHs are duty sweep. Sweep setting is independent for each CH.
Burst oscillation mode		Disabled

Both channels have the same type of modulation or sweep during the modulation or sweep. If another channel does not need the modulation (other than FM and FSK) or sweep (other than the frequency sweep), set the modulation width or sweep width of the channel to zero (0).

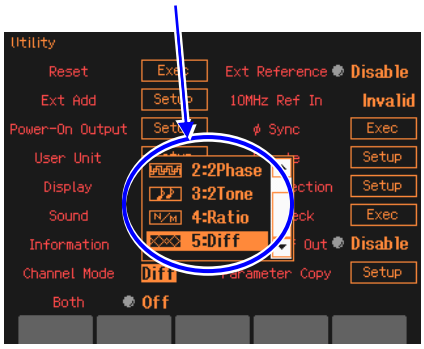
The peak deviation in FM and the frequency ratio of the hop frequency in FSK are restricted to individual frequency setting resolution.

7.8 Obtaining Differential Output (2-Channel Coordination, Differential)

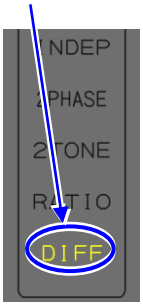
If the channel mode is [Diff], you can change the setting with the differential output of both channels being kept. In coordination with the change of setting of the channel 1, the setting of the channel 2 is automatically changed. Coordination is performed also during various modulations or sweeps. This function is disabled for the burst oscillation and gated single-shot sweep.

■ Selecting 2-channel coordination

Set [Channel Mode] to [Diff]



DIFF indicator is lit



In the Utility screen, set [Channel Mode] to [Diff] ([Indep] is normally set).
This makes the channel mode an oscillation with differential output.

The frequency, phase, amplitude, and DC offset settings of both channels are the same and the reverse phase waveform appears in the output. Even if changing the various setting, the differential output relationship is kept.
This function controls to keep the differential output relationship also during various modulations or sweeps.
For the differential output oscillation, the setting can be set only for the channel 1 (behaves as the oscillator for one-channel).

■ Operational restrictions

There are restrictions shown in the following table to keep the differential output:

Item	Restriction
Waveform	Disabled for noise and DC
Modulated oscillation mode	Modulation source is internal only
Sweep oscillation mode	Gated single-shot sweep unavailable. External trigger source is enabled only for CH1 side.
Burst oscillation mode	Disabled
External addition	Disabled

Check

For DC offset of output, both channels have the same value and polarity. Differential output is made for AC, but it is not made for DC.

MEMO

8. Synchronizing Multiple Units

Synchronizing multiple units of WF1947 or WF1948 can configure up to 12-phase oscillators (for 6 units of WF1948). You can change a phase and amplitude for each phase independently.
Set the same frequency for all units and channels.

8.1 Connection Procedure

WF1947 or WF1948 as the synchronous reference is called a "master unit." Other WF1947 or WF1948 is called a "slave unit."

■ Used connectors

External 10 MHz frequency reference input (10MHz REF IN) and frequency reference output (REF OUT) on the rear panel are used.

■ Cables used for connection

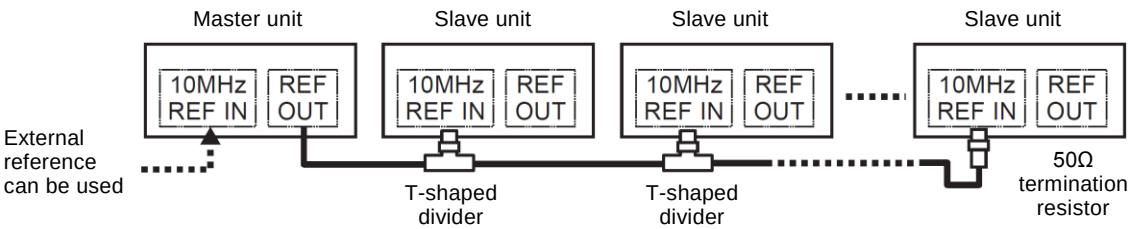
Cable type: Characteristic impedance 50 Ω series coaxial cable with BNC connector (RG-58A/U etc.)
Restriction to cable length: 1 m or less between units, total cable length is 3 m or less

■ Connection method

There are two types of connection methods (connection method 1 and connection method 2).
If the number of units is many, using the connection method 1 can reduce the time difference between slave units. However, in addition to the coaxial cable, T-type divider and 50Ω terminating resistor are required.
The connection method 2 is easy to connect because it can make the connection using only coaxial cable. However, the time difference between slave units is larger than that of the connection method 1. The maximum connection number of units is fewer than that of the connection method 1.
Any of the built-in crystal oscillator or external 10 MHz clock can be used as the frequency reference for the master unit. If you use the external 10 MHz as the reference, the frequency of the slave unit will also be the same accuracy as the external reference.

・ Connection method 1

Connect the reference output for the master unit to the reference input for the slave unit in parallel using the T-type divider.
Use the 50Ω terminating resistor for the reference input for the terminal slave unit.
Time difference between slave units varies depending on the connection cable length (approximately 6 ns/m).
The maximum number of 6 units can be connected, including master and slave units.

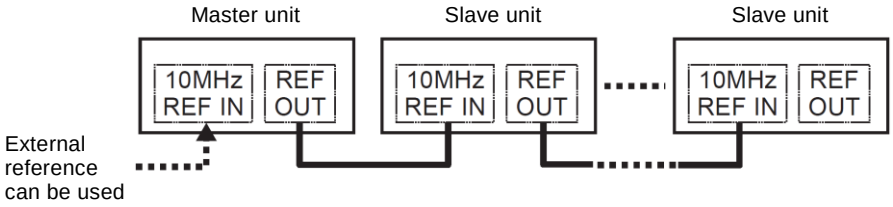


・ Connection method 2

Connect the reference output for the master unit or slave unit to the reference input for the next slave unit.

Time difference between slave units varies depending on the delay within units (approximately 25 ns) and connection cable length (approximately 6 ns/m).

The maximum number of 4 units can be connected, including master and slave units.



8.2 Performing Synchronization

■ Before synchronization

After connection among the master unit and slave units is finished, perform the setting as follows:

Master units

• Select 2-channel independent operation or 2-phase operation (in the Utility screen, set the channel mode setting to [Indep] or [2Phase]) (WF1948 only).

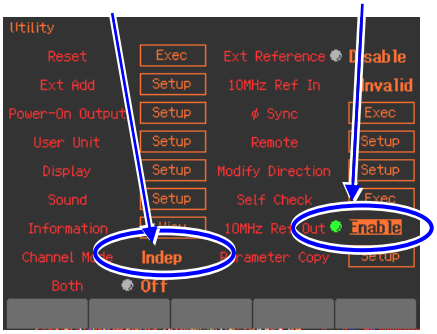
•Enable the frequency reference output (in the Utility screen, set 10MHz Ref Out to [Enable]).

• Set the frequency for each channel to the frequency used for synchronous operation of multiple units.

• If you use the external for the frequency reference for the master unit, enable the external frequency reference (in the Utility screen, set the external reference to [Enable]).☞ P.9-4

Set [Channel Mode] to [Indep] or [2Phase] (WF1948 only)

Set 10MHz Ref Out to [Enable]



Slave units

• Select 2-channel independent operation or 2-phase operation (in the Utility screen, set the channel mode setting to [Indep] or [2Phase]) (WF1948 only).

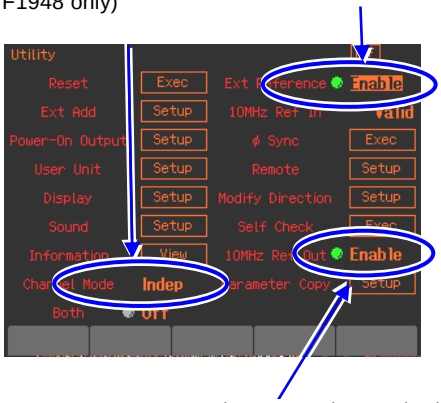
•Enable the external frequency reference (in the Utility screen, set the external reference to [Enable]).

• Set the frequency for each channel to the frequency used for synchronous operation of multiple units (common to all units and channels).

• For the connection method 2, enable the frequency reference output (in the Utility screen, set 10MHz Ref Out to [Enable]).

Set [Channel Mode] to [Indep] or [2Phase] (WF1948 only)

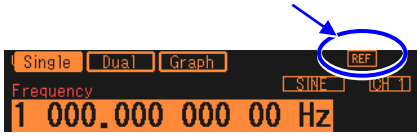
Set [Ext Reference] to [Enable]



For the connection method 2, set 10MHz Ref Out to [Enable]

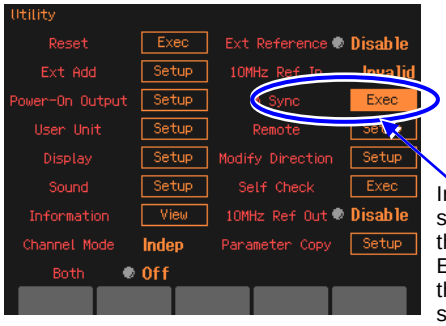
Check that all slave units operate based on the external frequency reference. If the [Ref] icon is lit without flashing on the status display area in the top of the screen, they operate based on the external frequency reference.

If they operate based on the external frequency reference, the [Ref] icon is lit without flashing



■ Performing synchronization

Synchronous operation is performed in the master unit.



In the Utility screen, select [Sync], and then press the ENTER key to run the phase synchronization

Synchronous operation is performed in the Utility screen of the master unit. Select [Sync] on the Utility screen, and then press the ENTER key.
This runs the phase synchronization.

At this time, the phase will be discontinuous temporarily because all channels stop the oscillation once.

When the phase synchronization is run, a message is displayed on each unit.

■ Phase relationship after synchronous operation

The oscillation phase for each channel is initialized by the synchronous operation. The phase difference of the output waveform appears as the difference of the phase setting for each channel.
Even if you make a synchronous operation, changing a frequency later loses the synchronization relationship. Even if the synchronization relationship is lost, no message is displayed. If necessary, make a synchronous operation accordingly.

The synchronization relationship is lost when the connection cable between the master unit and slave unit or between slave units is removed. If you change the setting of channel mode or external frequency reference, the synchronization relationship is lost.

■ Operational restrictions

There are restrictions shown in the following table to the synchronous operation: Even if the synchronous operation is disabled, making a synchronous operation causes all channels to stop the oscillation once.

Item	Restriction
Waveform	Disabled for noise and DC
Modulated oscillation mode	Disabled for FM and FSK
Sweep oscillation mode	Disabled for frequency sweep. Disabled for gated single-shot sweep.
burst oscillation mode	Disabled

MEMO

9. Using External Frequency Reference

9.1 Purpose of Using External Frequency Reference

This product uses a built-in crystal oscillator as the frequency reference, but you can also use the external 10 MHz clock as the frequency reference.

Generally, the external frequency reference is used for the following purposes:

- Use the higher accuracy of the frequency reference (for example, a rubidium frequency standard) than that of the frequency reference built in this product to improve the accuracy and stability of the frequency.
- Use the common frequency reference with other units to share the common frequency accuracy.
- Synchronize with other WF1947 or WF1948. For this synchronous operation of multiple units,

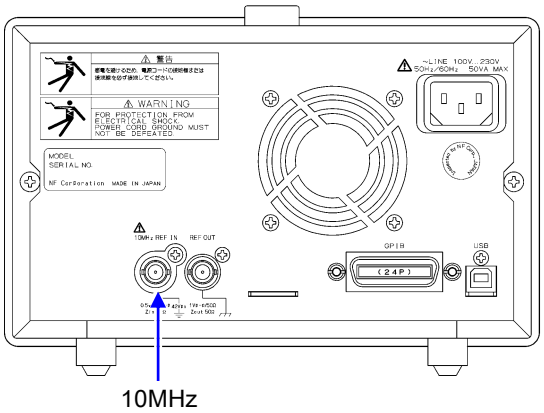
☞ P.8-2

9.2 Connection and Usage Procedure of External Frequency Reference

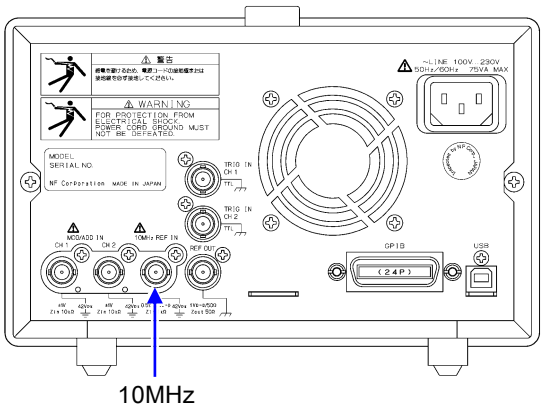
■ To connect **10MHz** signal

Connect the external 10 MHz signal to the external 10 MHz frequency reference input (10MHz REF IN) BNC terminal on the rear panel.

WF1947



WF1948



Input characteristics are as follows:

Input voltage	0.5Vp-p ~ 5Vp-p
Maximum allowable input	10Vp-p
Input impedance	1kΩ, AC coupled
Input frequency	10MHz (± 0.5%(± 50kHz))
Input waveform	Sine or square wave (50 ±5% duty)
Signal GND	Insulated from the enclosure and each channel waveform output (maximum 42 Vpk)

If reflection is problem, use the terminating resistor since the input impedance is not 50▶.

The signal ground of the external 10 MHz frequency reference input is insulated from the enclosure. Therefore, noise caused by ground-loop does not affect the connection with a frequency standard.

Nor does noise caused by ground-loop affect the connection even when synchronously connecting multiple units of WF1947 and WF1948.

Note that, in all cases, the floating voltage should be limited to 42 Vpk (DC + AC peak) or lower to prevent electric shocks.

For the caution for the floating ground connection, ☞"3.3 Cautions on Floating Ground Connection".

⚠ WARNING

To prevent electric shocks, do not apply a voltage exceeding 42 Vpk (DC + AC peak) between the ground of the BNC connectors insulated from the enclosure and the enclosure.
Also, do not apply a voltage exceeding 42 Vpk (DC + AC peak) between the grounds of the BNC connector groups insulated from the enclosure. "BNC connector groups" used here, indicates multiple BNC connectors that are connected to a common ground.
If such a high voltage is applied, the internal voltage limiting elements will try to reduce the voltage, but a too high voltage may cause the product to be burned.

⚠ CAUTION

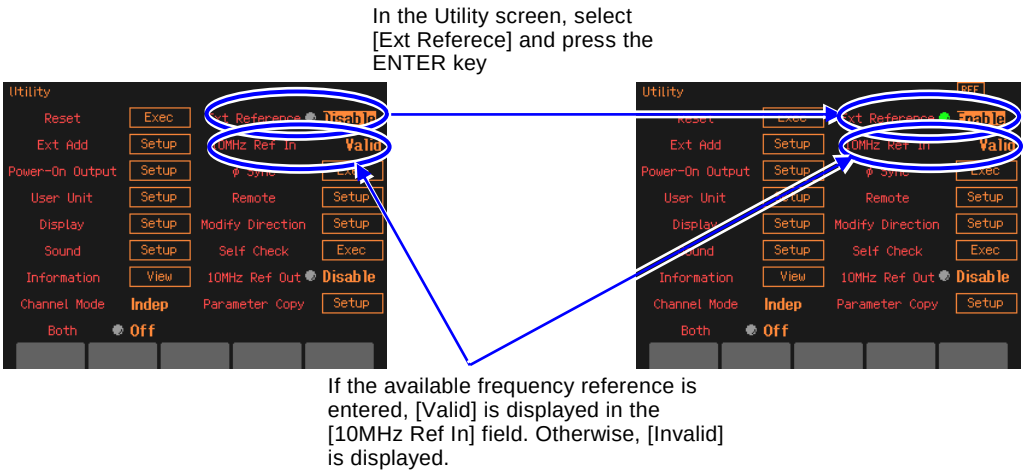
If a difference in potential exists between the ground of a BNC connector insulated from the enclosure and the enclosure, do not short-circuit the hot side of that BNC connector and the enclosure. This may damage the product.

⚠ CAUTION

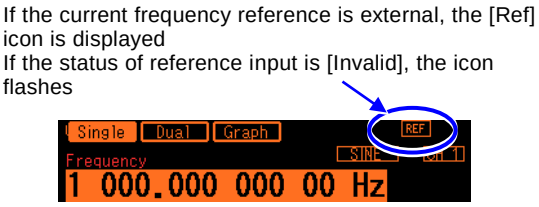
If a difference in potential exists between the grounds of BNC connectors, do not short circuit these BNC connector grounds. This may damage the product.

■ Enabling external frequency reference

You can switch the enabled/disabled for the external frequency reference in the Utility screen.
In the Utility screen, select [Ext Reference], and then press the ENTER key to switch an indicator to [Enable] from [Disable]. This enables the external frequency reference.
If you want to go back to [Disable], press the ENTER key again.



If the setting of [Ext Reference] is [Enable] and the status of [10MHz Ref In] is [Valid], then this product operates using the signal input to the external 10 MHz frequency reference terminal as the frequency reference.
If the external frequency reference signal breaks on the way, the frequency reference is automatically switched to the built-in frequency reference. After that, if the external frequency reference signal returns, this product operates using it again as the frequency reference.
What is used as the frequency reference is always displayed on the status display area in the top of the screen.



10. Using User-defined Units

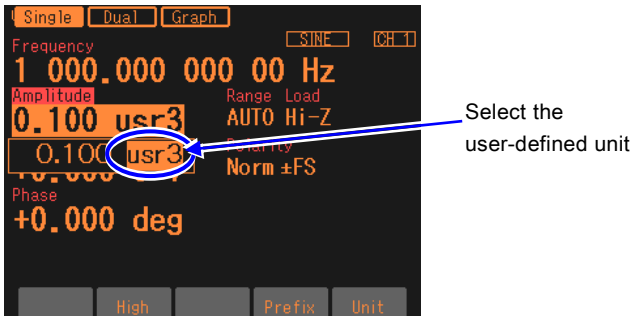
10.1 About User-defined Unit

For example, you can set the frequency in units of rpm (number of rotations per minute) instead of Hz. You can set a value converted to the mechanical deviation quantity or a value converted to the output voltage after the power amplifier output instead of voltage.

Defining these mutual conversion formulas enables you to use them like the usual units. In this product, these units are called "user-defined unit."

The user-defined unit can be used for the following six parameters:
Frequency, period, amplitude, DC offset, phase, and duty

10.2 Display and Setting in User-defined Unit

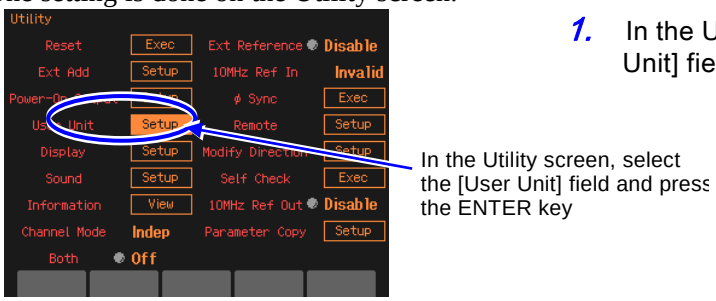


When an input field for each parameter opens, you can change the unit by putting the cursor on the unit at the right end and using the up/down arrow key or the modify knob. The unit name displayed here can be setting arbitrarily. Only the display unit is changed without changing the actual output value, when the unit is changed.

10.3 Defining User-defined Units

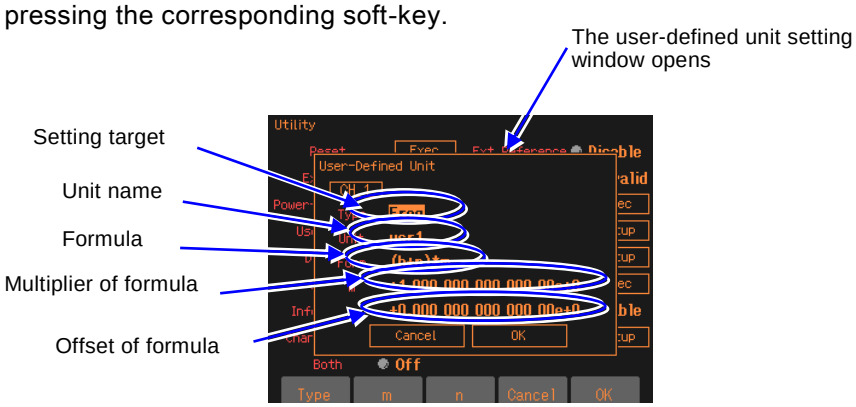
■ Setting screen

The setting is done on the Utility screen.



1. In the Utility screen, select the [User Unit] field and press the ENTER key.

2. The user-defined unit setting window opens. Select each item, and then press the ENTER key to set the user-defined unit. Alternatively, you can open the input field by pressing the corresponding soft-key.



The following items can be set in this window:

Setting target [Type]

Select one from among frequency, period, amplitude, DC offset, phase, and duty.

Unit name [Unit]

Sets the unit name with up to 4 characters. Enter a character one by one at the cursor position using the up/down arrow key, the modify knob, or the numeric keypad.

Formula [Form]

Select either one of [(h+n)*m] or [(log(h)+n)*m] as the unit conversion formula. Where, h is an original value of the setting target. The value converted by this formula is displayed on the screen when the user-defined unit is actually used.

The unit of h is defined as shown in the following table depending on the setting target:

Setting target	Unit of h
Frequency	Hz
Period	sec
Amplitude	If amplitude range is ± FS, then Vp-p If amplitude range is 0/+FS, -FS/0, then Vpk A value under the designated load impedance condition in each case
DC offset	V A value under the designated load impedance condition
Phase	deg
Duty	%

log is a common logarithm whose base is 10. You need to pay attention to when you use a log formula for a value with the possibility of negative value such as the DC offset and phase. If a value before changing to the user-defined unit is zero (0), "-Inf" is displayed when changing to the user-defined unit using the log. Similarly, if a value before changing to the user-defined unit is negative, "Over" is displayed when changing to the user-defined unit using the log.

Multiplier and offset of formula [m], [n]

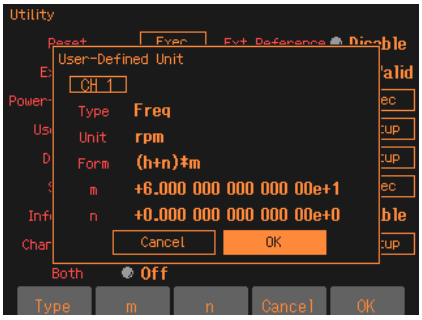
Select the multiplier [m] and offset [n] in the selected formula.

After setting each parameter, select [OK] at the bottom of the window and press the ENTER key.

> **Check**
> When you use the user-defined unit, the setting resolution may be rough depending on the setting of multiplier or offset.

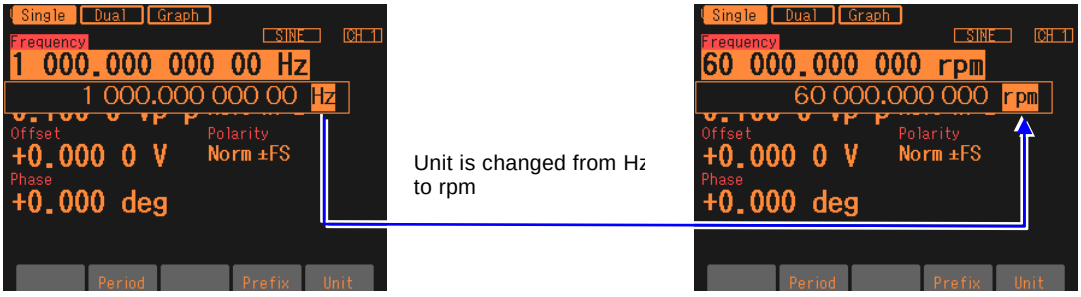
■ To set the frequency in **rpm**

For example, to display and set the frequency in 1 Hz as the frequency in 60 rpm, set the followings and select [OK]:



Type: Freq
Unit: rpm
Form: (h+n)*m
m: 60
n: 0

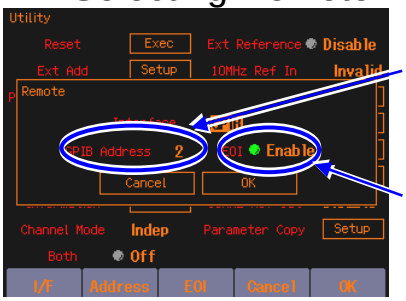
Next, in the Oscillator screen, open the input field for the frequency, and then change the unit from Hz to rpm.



This can display and set a value in units of rpm.

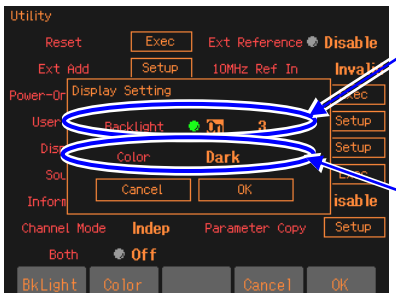
11. Other Utility Settings

11.1 Selecting Remote Interface [Remote]



Select the external control interface from USB or GPIB.
When you select USB, USB ID is displayed.
When you select GPIB, set GPIB address within the range of 0 to 30, and select EOI from Enable or Disable.
For more information about EOI, refer
☞Instruction manual (External Control)

11.2 Display Setting [Display]

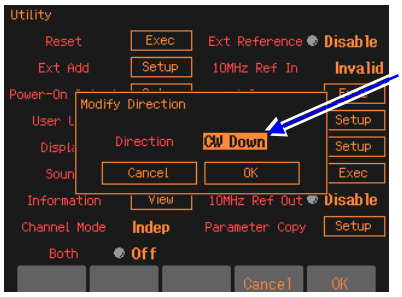


Set the backlight on/off and the brightness when the backlight is on.

You can switch whether bright color characters are displayed on a dark background or dark color characters are displayed on a bright background as a color tone.

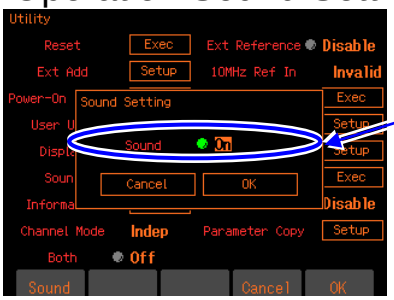
If the backlight is hidden due to the backlight off, hold down the [MENU] key for a while to forcibly turn on the backlight.

11.3 Modify Knob and Modify Direction Setting [Modify Direction]



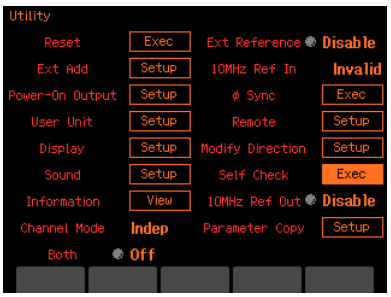
Select whether the item selection moves up or moves down when you turn the modify knob clockwise (CW) while the oscillation mode or the waveform selection list is displayed.

11.4 Operation Sound Setting [Sound]



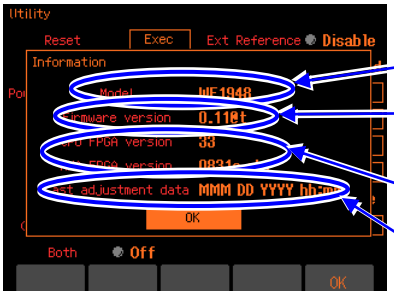
Set whether or not the beep sounds when performing key operations, modify knob operation, or an error occurs.

11.5 Self Diagnosis [Self Check]



Checks the internal status. Before check, remove all cables other than the power cable from this product.
If there is any problem, contact us or our agents.

11.6 Product Information Display [Information]



The model name, firmware version, etc. of this product are displayed.
There is no items to be set.

MEMO

12. Troubleshooting

12.1 Error Messages at Power-on

At power-on, self-diagnosis is performed and an error message is displayed if there are any problems. If you encounter any failure, contact us or our representatives. When a message that tells you machine is shut down due to overheat, check installation environment if the environment is not in hot so that the product become over heat.

Hardware initialization failed

This is an internal error. This is a failure of this equipment.

OSC-Block error

This is an internal error. This is a failure of this equipment.

RAM error

This is an internal memory error. This is a failure of this equipment.

ROM error

This is an internal memory error. This is a failure of this equipment.

Last shutdown caused by overheat

The last power-off was caused by internal overheat.

Check the operating environment and status of this equipment.

Output not turned on due to overload

The output did not become on, because overload of the synchronization/sub-output was detected even though the output settings was on.

The output terminal may connect to an outer voltage supply. Check the connection. Exit the overload states before make the output turn on.

Output overload detected; Output turned off

The output became off because overload of the waveform output or synchronization/sub-output is detected even though the output became on based on the output setting at once.

The output terminal may connect to an outer voltage supply. Check the connection. Exit the overload states before make the output turn on.

12.2 Error Messages during Operation

Often run-time error messages are displayed when the setting exceeds the allowable output range. For example, when a rectangular wave is output and you try to set the frequency to 30MHz, an error is displayed and the frequency is set to the maximum frequency of a rectangular wave.

Error messages are also displayed for internal overheat and output overload.

This section describes errors displayed on the dialogue window in order of the error number.

12005: Internal overheat detected

The inside of the equipment is overheated.

The ambient temperature may be too high or the equipment may be faulty. It is recommended to turn the equipment off.

14006: Internal temperature too high; Auto-shutdown will occur

Internal overheat reaches the limit. The equipment is automatically turned off.

The ambient temperature may be too high or the equipment may be faulty.

22017: Function changed to Sine by changing Channel Mode

Any of 2 channels coordination modes was selected when the waveform is noise or DC. The waveform of this channel is changed to sine wave.

22018: Mode changed to Continuous by changing Channel Mode

Any of 2 channels coordination modes was selected in the BURST mode. It is changed to the CONT mode.

The BURST mode cannot be used in 2 channels coordination modes.

22019: Modulation Source changed to Internal due to Channel Mode

The modulation source is changed to internal due to any of 2 channels coordination modes.

Any of 2 channels coordination modes is selected, the modulation source is set to the internal regardless of the modulation type.
When the channel mode is 2 phases, constant frequency difference, or constant frequency ratio, the modulation source for FM and FSK is limited to internal. The other types of source are not affected by this restriction. Try to set up again. When the channel mode is DIFF, source is limited to internal regardless of the modulation type.

22020: External addition turned off by changing Channel Mode

DIFF mode was selected as the channel mode. Ext Add is turned to off.

External addition cannot be used in the DIFF mode.

22021: SwpMode changed to Single by changing Channel Mode

2 phases, constant frequency difference, constant frequency ratio, or differential was selected when SwpMode was single-shot Gated, it is changed to Single sweep.

In any of 2 channels coordination modes, Gated sweep cannot be used.

22022: Mode changed to Continuous by changing Function

Waveform that does not match the current oscillation condition was selected in the MODU, SWEEP, or BURST mode, the mode is changed to the Continuous.

For example, when the waveform is changed from pulse wave to sine wave during PWM, the mode is changed to continuous because PWM is not available for sine.

22024: Start-locked occurred due to setting conflict

The operation setting is not adequate in the MODU, SWEEP, or BURST mode. A given oscillation cannot be started.

When pressing the soft-key [?] on the left end, the message concerning an improper item appears.

22025: SyncOut selection changed to Sync by selection of external modulation

Modulation is changed from internal to external. synchronization/sub-output is set as reference phase synchronization (Sync).

Modulation synchronization (ModSync) and modulation waveform (ModFctn) can be selected as synchronization/sub-output for internal modulation.

22028: Edge time changed due to Width

A given pulse width time cannot be achieved with the current edge time (LE, TE). The edge time becomes shorter.

The pulse width time takes precedence over the edge time.

22029: Edge time changed due to Duty

A given pulse width duty cannot be achieved with the current edge time (LE, TE). The edge time becomes shorter.

The pulse width duty takes precedence over the edge time.

22030: Edge time and/or Width changed due to Frequency

The specified frequency cannot be achieved with the current edge time (LE, TE) and pulse width time. The edge time and the pulse width time are changed.

The Frequency takes precedence over the pulse width time and the edge time.

22031: Edge time and/or Duty changed due to Frequency

The specified frequency cannot be achieved with the current edge time (LE, TE) and pulse width duty. The edge time and the pulse width duty are changed.

The Frequency takes precedence over the pulse width duty and the edge time.

22032: Selected ARB is missing; Edit Memory ARB assigned

The specified arbitrary waveform does not exist. An arbitrary waveform in the edit memory is assigned instead of it.

This error happens when an arbitrary waveform used before has been deleted during not used. An arbitrary waveform is identifies only with the number.

22033: Too narrow or too wide Duty specified; Amplitude may decrease or pulse may be lost

The duty setting is too narrow or too wide. Amplitude may decrease or pulse may be lost.

This event happens when a square whose variable range is extended has the pulse width less than approximately 8.4 ns on the low or high side.

22034: Frequency reduced due to Function

The frequency is changed to the lower value based on the waveform.

The upper limit of waveform depends on the waveform.

22035: Duty changed due to Extend-Off

The duty variable range of a square is changed to standard. The duty is changed to the value restricted by the frequency.

When the duty variable range is standard, it is changes based on the frequency.

22036: Duty changed due to Frequency

The duty variable range of a square is standard. The duty is changed to the value restricted by the frequency.

When the duty variable range is standard, it is changes based on the frequency.

22037: High level changed due to Low level

The change to the low level also changes the high level based on the possible output range.

22038: Low level changed due to High level

The change to the high level also changes the low level based on the possible output range.

22039: Not acceptable due to another CH limitation

The specified setting cannot be set due to another channel restriction in 2-channel equivalence setting.

22040: Frequency and/or DeltaFreq changed due to Function

The frequency and the frequency difference are changed based on the upper frequency of waveform when the channel mode is 2TONE.

22041: Frequency of CH1 changed due to DeltaFreq

The frequency of CH1 is changed to maintain the frequency difference when the channel mode is 2TONE.

The frequency difference takes precedence over the frequency of CH1.

22042: Frequency changed due to Function

The frequency is changed based on the upper frequency of waveform when the channel mode is RATIO.

22043: Frequency of CH1 changed due to Ratio

The frequency of CH1 is changed to maintain the frequency ratio when the channel mode is RATIO.

The frequency ratio takes precedence over the frequency of CH1.

22044: Output not turned on due to overload

Overload is detected in synchronization/sub-output. The output did not become on.

The output terminal may connect to an outer voltage supply. Check the connection. Exit the overload states before make the output turn on.

22149: Modulation Source of CH2 changed to Internal by changing CH1 or CH2 setting

The modulation source of CH2 was set to CH1 external for FSK or PSK. The source is changed to Internal due to the setting change of CH1 or CH2.

The CH2 modulation source can be set to CH1 external only if CH1 and CH2 are same types and external is selected as the modulation source of CH1.

22150: Trigger of CH2 changed to Internal by changing CH1 or CH2 setting

The trigger source of CH2 was set to CH1 external for sweep or burst. The trigger source is changed to Internal due to the setting change of CH1 or CH2.

The trigger source of CH2 can be set to CH1 external only when external is selected as the trigger source of CH1 in the following conditions.

• CH1 and CH2 have the same sweep type. CH1 and CH2 are in the same sweep mode (except for Cont).

• CH1 and CH2 are in the same burst mode (except for auto burst).

23045: Data out of range; Data discarded

You tried to enter a value outside of setting range. The value entered is discarded.

23129: MOD/ADD IN connector used by external addition now

The MOD/ADD IN connector is used for external addition. Cannot use if with external modulation at a time.

23130: MOD/ADD IN connector used by external modulation now

The MOD/ADD IN connector is used for external modulation. Cannot use if with external addition at a time.

23133: Output overload detected; Output turned off

Overload is detected in waveform output or synchronization/sub-output. The output turned to off.

The output terminal may connect to an outer voltage supply. Check the connection. Exit the overload states before make the output turn on.

23134: Self Check failed; Auto-shutdown will occur

The result of the self check failed. Turn the power off.

The equipment may have a failure.

32004: Not able to delete this ARB; This ARB is in current use

An arbitrary wave that is currently output or used cannot be deleted.

In the MODU mode, an arbitrary waveform that is used as an internal modulation wave cannot be deleted.

35005: File-system error

This is an internal error. This is a failure of this equipment.

60002: ARB waveform under editing not stored; Shutdown?

The arbitrary waveform being edited has not been stored yet.

It will be cleared when the power turns off. Store it as needed.

61056: Data beyond lower limit; Value clipped to lower limit

You are trying to set the value beyond under limit. The value is set to the lower limit.

61057: Data beyond upper limit; Value clipped to upper limit

You are trying to set the value beyond upper limit. The value is set to the upper limit.

61058: Zero data not allowed

Zero cannot be set in this parameter.

61059: Invalid operation

This operation is invalid. You are trying to insert a control point into the impossible place while editing arbitrary wave.

61060: Invalid operation

This operation is invalid. You are trying to delete a control point that cannot be deleted while editing an arbitrary wave.

12.3 Conflict Messages for Modulation

This is a message by pressing soft-key (?), when the specified modulation cannot be performed due to inadequate settings. This message explains improper settings.

HopFreq beyond upper limit for current Function

The hop frequency is beyond the allowable range of the current waveform to output in FSK.

Lower the hop frequency.

MOD/ADD IN connector used by external addition now

The MOD/ADD IN connector is currently used for external addition. It cannot be used for external modulation.

Turn the external addition function off.

Modulated peak or bottom value out of range

[The carrier value + the deviation] or [the carrier value - the deviation] is beyond the allowable range to output in FM, PM, OFSM, PWM.

Change the carrier value or make the deviation low.

Modulated peak or bottom phase out of range

[The carrier value + the deviation] is beyond the allowable range to output in PSK.

Change the carrier value or make the deviation low.

Modulation Type not compatible with current Function

The modulation type is not adequate for the current waveform. For example, PWM is specified for the sine wave.

Change the modulation type.

12.4 Conflict Message for Sweep

This is a message by pressing soft-key (?), when the specified sweep cannot be performed due to inadequate settings. This message explains improper settings.

Frequency beyond upper limit for Gated sweep

The frequency is beyond the upper frequency of gated sweep.

Lower the frequency.

Gated sweep not available for DC

Gated sweep is no available for DC waveform.

Change the sweep mode to continuous or single-shot.

Start value out of range

The start value is beyond the allowable range to output.

Change the value so that it falls within the range.

Stop value out of range

The stop value is beyond the allowable range to output.

Change the value so that it falls within the range.

Sweep Type not compatible with current Function

The sweep type is not adequate for the current waveform. For example, duty sweep is specified for the sine wave.

Change the sweep type.

12.5 Conflict Message for Burst

This is a message by pressing soft-key (?), when the specified burst cannot be performed due to inadequate settings. This message explains improper settings.

BrstMode not compatible with current Function

The burst oscillation mode is not adequate for the current waveform. For example, trigger burst is specified for noise.

Change the burst oscillation mode.

Frequency beyond upper limit for current Function

The frequency is beyond the upper frequency of the current waveform.

Lower the frequency.

12.6 Suspected Failure

When an anomaly is suspected, perform one of the actions listed below. If this fails to correct the problem, contact NF Corporation or the distributor.

Contents	Possible Cause	Action	Reference page
Power supply is not turned on.	The power supply out of rated range is used.	Use the power supply within the rated range.	2.3 Grounding and power supply connection
	The operation is not normal due to external noise, etc.	Install the equipment in quiet environment far from noise sources.	"2.2 Installation"
The panel operation is not available	In the Remote state	Change to the Local state	—
	Keys and/or modify knobs are deteriorated	Contact NF Corporation to ask repair	—
Output level is Abnormal	The ambient temperature/humidity range is out of the performance guaranteed range.	Use in the environment within the specified range.	"2.2 Installation"
	Warming up is not enough	Perform warming up for more than 30 minutes after the power turns on	—
	DC offset is added	Make the DC offset to 0V	"4.4.8 To Set DC Offset"
	A user-defined unit is used	Select a standard unit	"4.4.7 To Set Amplitude"
	The load impedance function is used	Change the setting to Hi-Z	"4.4.12 To Set Load Impedance"
Settings with the remote control are not available.	The interface setting is not adequate.	Use the setting that matches the interface to use.	P.11-2
	The GPIB address and the USB ID are different from the program.	Make the GPIB address and the USB ID match the program.	P.11-2
	The GPIB address and the USB ID is same as other equipment.	Set the GPIB address and the USB ID again so that it does not coincide with that of equipment.	P.11-2
Does not become same as described in Instruction manual	Initialization has not been done.	Description presumes settings were initialized. Perform initialization.	"4.3.8 To Restore Initial Settings"
	The channel to operate is opposite.	Check whether the channel is CH1 or CH2.	"4.3.6 CH1/ CH2 Switching Key and Active Channel (WF1948 Only)"

13. Maintenance

13.1 Overview

■What TO DO

To use the equipment under the best condition, following maintenance tasks are needed.

- ●Operation Inspection — Check to see if the equipment is operating correctly.
- ●Performance Test — Check to see if the equipment satisfies the ratings.
- ●Adjustment and calibration — If any rating is not satisfied, we will perform adjustment or calibration to recover the performance.
- ●Troubleshooting — Should no improvement result, we will investigate into the cause and failed portion to repair it.

This Instruction Manual describes the operation inspection and the performance testing method that can be easily performed.

For advanced inspections, adjustments, calibrations, and troubleshooting, contact us or our representative.

⚠ WARNING

High voltages appear inside of the equipment. Never remove the cover.
No one except the trained service technicians who are thoroughly experienced in the hazard prevention is allowed to check or touch the inside of this equipment. Do not touch the inside by yourself in any case.

■Equipment Used

To perform the operation inspection and performance test, following equipments.

	Requirement	Example	Intended Purpose
Digital Multi-meter	AC Voltage TrueRMS Accuracy: ± 0.1% (1kHz ~ 100kHz) DC voltage Accuracy: ± 0.1%	Agilent 3458A	Measurement of AC/DC voltage less than 100kHz
Power meter and Power sensor	100kHz ~ 30MHz 5µW ~ 250mW (-23dBm ~ +24dBm) Accuracy: 0.02dB Resolution: 0.01dB	R&S NRVS, NRV-Z5	Measurement of AC voltage more than 100kHz
Universal Counter	Accuracy: 0.1ppm	Agilent 53131A Opt 010 (High Stability Oven TB)	Measurement of frequency, duty, time interval between channels
Oscilloscope	More than 300MHz 2GS/s, 50Ω input	Agilent DSO6032A	Measurement of Leading and Trailing time
Audio analyzer	Measurement of less than 0.01%, THD	levear VP-7722A	Harmonic distortion measurement
Spectrum Analyzer	10kHz ~ 1GHz Resolution: 100Hz	Agilent E4411B Opt 1DR (narrow RBW)	Measurement of non-harmonic spurious
BNC cable	Characteristics impedance: 50Ω Length: 1m		—
BNC(f)-banana adapter	—	—	
BNC(f)-N(m) adapter	Characteristics impedance: 50Ω		To Connect a BNC cable to a spectrum analyzer
BNC(f)-N(f) adapter	Characteristics impedance: 50Ω	—	To Connect a BNC cable to a power sensor

13.2 Operation Inspection

■Check Before Operation inspection

Check followings before the operation inspection.

- ●The power supply voltage is within the rated range.
- ●Ambient temperature is within the range of 0 to +40°C.
- ●Ambient relative temperature is within the range of 5 to 85%RH (further more, the absolute temperature is 1 to 25g/m3).
- ●non-condensing.

■Function check

●Check at power-on

Make sure that no error message appears at power-on.

When an error message appears ☞ P. 12-2

When the display shows any problems at the power-on, turn the power off, wait for at least 5 seconds and turn the power-on again.

●Self diagnosis

Perform Self Check on the Utility screen.

☞P. 11-3

●Check of major functions

To avoid mis-setting, perform initialization (Perform Reset on the Utility screen).

Then, connect the FCTN OUT to the oscilloscope using characteristic impedance 50Ω series coaxial cable.

Change following settings some times and check they work properly. For items that set numeric values like the frequency, check become more reliable by operating both a numeric keypad and modify knobs.

- • Waveform (shortcut key: FCTN key FCTN)
- • Frequency (shortcut key: FREQ key FREQ)
- • Amplitude (shortcut key: AMPTD key AMPTD)
- • DC offset (shortcut key: OFFSET key OFFSET)
- • Output on/off (CH 1, CH 2, or OUTPUT)

●Check of GPIB and USB

Perform some of setting changes performed in the check of important function section on the GPIB and USB. Verify that Changes of the output is the same.

In this case, GPIB or USB is displayed on the status display area on the top of the screen.

Check also that pressing soft-key Local while GPIB or USB is displayed on the status clears the status display and returns to the local status (except for during local lockout condition).

13.3 Performance Test

■Performance Test

The performance test is performed as a part of preventive maintenance to prevent the product performance from being deteriorated.
Perform the performance test when an acceptance inspection, a periodic inspection, or a performance check after repaired of this product is needed.
After the performance test, when the product does not meet the specification, it needs to be repaired. Please contact the NF or representatives.

■Check before the performance test

Check followings before the performance test.

- ●The power supply voltage is within the rated range.
- ●Ambient temperature is within the range of +20 to +30°C.
- ●Ambient respective temperature is within 20 to 70%RH .
- ●non-condensing.
- ●warming up for more than 30 minutes is performed.

■Preparations before performance test

- ●Use a coaxial cable whose characteristic impedance is 50Ω , width is RG-58A/U or more, and length is 1m or less and that has BNC connectors on both ends as a signal cable.
- ●For items that 50Ω termination is specified, set the input impedance for connecting equipments to 50Ω .
- ●For equipments that cannot set to 50Ω input, install 50Ω terminator (feed-through terminator) at input of the equipments.
- ●Measure up to 24dBm signals (when amplitude setting 20Vp-p /open). Use a coaxial attenuator separately as needed not to exceed the allowable input of the equipment. Note that the power meter (power sensor) and the spectrum analyzer are specially damaged easily.
- ●Items described here is that they still need to be changed after performing initial setting (perform Reset on the Utility screen) and turn output on.

13.3.1 Frequency Accuracy Test

Connection: FCTN OUT ⇒ Universal counter input (50Ω termination)

Use a coaxial cable.

Setting: Set Frequency to 1MHz and Amplitude to 10Vp-p/open after initial setting.

Measurement: Set universal counter to the frequency measurement mode and measure the frequency.

Judgment: It is normal when the value falls within the following.

However, the equipment may vary across the ages up to ± 1ppm per a year. If one year has passed since the equipment was shipped, it may be deteriorated within ± 4ppm (999.996kHz ≒1.000004MHz).

Rating range
0.999997MHz ~ 1.000003MHz

13.3.2 Sine Wave Amplitude Accuracy Test

Connection : FCTN OUT ↬ Digital multi-meter (AC voltage TrueRMS measurement)
Use a coaxial cable.

Setting : The following table (Frequency is set to 1kHz) shows the amplitude after initial setting.

Measurement : Measure the output voltage for each waveform as the effective value.

Judgment : It is normal when the value falls within the following table.

Amplitude setting (load open value)	Rating range
20Vp-p (7.071Vrms)	7.014Vrms ~ 7.128Vrms
5Vp-p (1.768Vrms)	1.753Vrms ~ 1.783Vrms
3Vp-p (1.061Vrms)	1.051Vrms ~ 1.070Vrms
1Vp-p (353.6mVrms)	350.0mVrms ~ 357.1Vrms
0.3Vp-p (106.1mVrms)	104.5mVrms ~ 107.6mVrms
0.1Vp-p (35.36mVrms)	34.37mVrms ~ 36.35mVrms
0.02Vp-p (7.071mVrms)	6.307mVrms ~ 7.835mVrms

13.3.3 DC Offset Accuracy Test

■ **DC** only

Connection : FCTN OUT ↬ Digital multi-meter (DC voltage measurement)

Setting : Set waveform to DC after initial setting. The following table shows the DC offset.

Measurement : Measure the output voltage as DC.

Judgment : It is normal when the value falls within the following table.

DC offset setting (load open value)	Rating range
± 10V	± 9.895V ~± 10.105V
± 3V	± 2.965V ~± 3.035V
± 1V	± 0.9850V ~± 1.0150V
0V	-5.000mV ~ +5.000mV

■ **AC+DC**

Connection : FCTN OUT ↬ Digital multi-meter (DC voltage measurement)

Setting : Set oscillation mode to BURST, burst mode to GATE, trigger to external off (the oscillation of the sine wave stops at 0 degree).
The following table shows the amplitude. DC offset setting is leave 0 V.

Measurement : Measure the output voltage as DC.

Judgment : It is normal when the value falls within the following table.

Amplitude setting (load open value)	Rating range
6.4Vp-p	-37.00mV ~ +37.00mV
3.5Vp-p	-22.50mV ~ +22.50mV
1.3Vp-p	-11.50mV ~ +11.50mV

13.3.4 Sine Wave Amplitude/Frequency Characteristics Test

■ **100kHz** or lower

Connection : FCTN OUT ↬ Digital multi-meter (AC voltage TrueRMS measurement, and 50Ω termination)

Use a coaxial cable.

Setting : The following table shows the amplitude and frequency after initialization.

Measurement : Measure the output voltage for each frequency as the effective value.

Judgment : For each amplitude setting, it is normal when the measurement error for each frequency based on the measurement values at 1kHz falls within the range of the following table. (The line at right end of the table is used in the next section.)

Amplitude setting (Load open valued)	At 1kHz Measured value	At 50kHz Error	At 100kHz Error	Error of each amplitude at 100kHz is as follows.
20Vp-p	Reference value	± 0.1dB	± 0.1dB	X1(dB)
5Vp-p	Reference value	± 0.1dB	± 0.1dB	X2(dB)
3Vp-p	Reference value	± 0.1dB	± 0.1dB	X3(dB)
1Vp-p	Reference value	± 0.1dB	± 0.1dB	X4(dB)
0.3Vp-p	Reference value	± 0.1dB	± 0.1dB	X5(dB)
0.1Vp-p	Reference value	± 0.1dB	± 0.1dB	X6(dB)

■ More than **100kHz**

Connection : FCTN OUT ↬ Power meter (Power sensor)
Use a coaxial cable. Measure a signal up to approx. 24dBm. Use a coaxial attenuator separately not to exceed the allowable input of the power sensor.

Setting : The following table shows the amplitude and frequency after initialization.

Measurement : Measure the output voltage or the power at each frequency.

Judgment : For each amplitude setting, it is normal when the measurement error for each frequency based on the measurement values at 100kHz falls within the range of the following table.
Add the error Xn(n=1-6), previously measured at 100kHz by the digital multi-meter, to the judgement range.

For example, When X1 is -0.05dB, the judgment range at 20Vp-p and 5MHz is -0.1dB to 0.2dB.

Amplitude setting (Load open valued)	Measured value at 100kHz	Error at 300kHz	Error at 1MHz	5MHz Error at	Error at 10MHz	Error at 20MHz	Error at 30MHz
20Vp-p	Reference value	-X1±0.15dB	-X1±0.15dB	-X1±0.15dB	-X1±0.3dB	-X1±0.3dB	-X1±0.8dB
5Vp-p	Reference value	-X2±0.15dB	-X2±0.15dB	-X2±0.15dB	-X2 ±0.3dB	-X2±0.3dB	-X2 ±0.5dB
3Vp-p	Reference value	-X3±0.15dB	-X3±0.15dB	-X3±0.15dB	-X3 ±0.3dB	-X3±0.3dB	-X3 ±0.5dB
1Vp-p	Reference value	-X4±0.15dB	-X4±0.15dB	-X4±0.15dB	-X4 ±0.3dB	-X4±0.3dB	-X4 ±0.5dB
0.3Vp-p	Reference value	-X5±0.15dB	-X5±0.15dB	-X5±0.15dB	-X5 ±0.3dB	-X5±0.3dB	-X5 ±0.5dB
0.1Vp-p	Reference value	-X6±0.15dB	-X6±0.15dB	-X6±0.15dB	-X6 ±0.3dB	-X6±0.3dB	-X6 ±0.5dB

13.3.5 Sine Wave Total Harmonic Distortion Test

Connection : FCTN OUT → audio analyzer (50Ω termination)
Use a coaxial cable. If the audio analyzer does not have a 50Ω termination, install a 50Ω terminator (feed-through terminator) at the input of the equipment.

Setting : Set Frequency to 20kHz after initial setting. The following table shows the amplitude.

Measurement : Measure the total harmonic distortion (THD). (Note that it is not THD + N.)

Judgment : It is normal when the value falls within the following table.

Amplitude setting (load open value)	Total harmony distortion (THD)
20Vp-p	0.04% or lower
3Vp-p	0.04% or lower
1Vp-p	0.04% or lower

13.3.6 Sine Wave Harmonic Spurious Test

Connection : FCTN OUT ⇝ Spectrum analyzer
Use a coaxial cable. Measure a signal up to approx. 24dBm. Use a coaxial attenuator separately not to exceed the allowable input of the spectrum analyzer.

Setting : The following table shows the amplitude and frequency after initialization.

Measurement : Measure the max value of the harmonious spurious 5 until next.
Make an attenuator of spectrum analyzer high until the relative level of the fundamental wave is stable.

Judgment : It is normal when the value falls within the following table.

Amplitude setting (Load open valued)	The max harmonious spurious level up to 5th at frequency setting 100kHz	The max harmonious spurious level up to 5th at frequency setting 1MHz	The max harmonious spurious level up to 5th at frequency setting 10MHz	The max harmonious spurious level up to 5th at frequency setting 30MHz
20Vp-p	-55dBc or lower	-55dBc or lower	-43dBc or lower	-30dBc or lower
3.5Vp-p	-60dBc or lower	-60dBc or lower	-50dBc or lower	-40dBc or lower

13.3.7 Sine Wave Non-harmonic Spurious Test

Connection : FCTN OUT → Spectrum analyzer
Use a coaxial cable. Measure a signal up to approx. 24dBm. Use a coaxial attenuator separately not to exceed the allowable input of the spectrum analyzer.

Setting : The following table shows the amplitude and frequency after initialization.

Measurement : Measure the max value of the non-harmonious spurious .

Judgment : It is normal when the value falls within the following table.

Amplitude setting (Load open valued)	Max non-harmonious spurious level at the frequency 100kHz	Max non-harmonious spurious level at the frequency setting 1MHz	Max non-harmonious spurious level at the frequency level 3MHz	Max non-harmonious spurious level at the frequency level 30MHz
20Vp-p	-65dBc or lower	-65dBc or lower	-65dBc or lower	-45dBc or lower
3.5Vp-p	-65dBc or lower	-65dBc or lower	-65dBc or lower	-45dBc or lower
1Vp-p	-65dBc or lower	-65dBc or lower	-65dBc or lower	-45dBc or lower

13.3.8 Square Wave Duty Accuracy Test

Connection : FCTN OUT → Universal counter (50▶ termination)
Use a coaxial cable.

Setting : Set the waveform to square and the amplitude to 20Vp-p/open after initial setting. The following table shows the duty variable range setting, the frequency setting, and the duty setting.

Measurement : Set the universal counter to duty measurement mode. Set trigger level of the universal counter to 0V. Average the measured values because they vary due to jitter (especially the duty variable range is extend).

Judgment : It is normal when the value falls within the following table.

■Duty variable range standard

Frequency	Duty		
100kHz	0.9% to 1.1% at 1% setting	49.9% to 50.1% at 50% setting	98.9% to 99.1% at 99% setting
1MHz	4% to 6% at 5% setting	49% to 51% at 50% setting	94% to 96% at 95% setting
3MHz	37% to 43% at 40% setting	47% to 53% at 50% setting	57% to 63% at 60% setting

■Duty variable range extend

Frequency	Duty		
100kHz	0.9% to 1.1% at 1% setting	49.9% to 50.1% at 50% setting	98.9% to 99.1% at 99% setting
1MHz	4% to 6% at 5% setting	49% to 51% at 50% setting	94% to 96% at 95% setting
3MHz	37% to 43% at 40% setting	47% to 53% at 50% setting	57% to 63% at 60% setting

13.3.9 Square Wave Leading/Trailing Time Test

Connection : FCTN OUT → Oscilloscope (50Ω termination)
Use a coaxial cable.

Setting : Set the waveform to square, the frequency to 1MHz, and the amplitude to 20Vp-p/open after initial setting.
The following table shows the duty variable range.

Measurement : Observe the waveform and measure the Leading and Trailing time.

Judgment : It is normal when the value falls within the following table.

Duty variable range	Leading time, Trailing time
Standard	17ns or lower
Extend	17ns or lower

13.3.10 Time Difference Between Channels for 2-Phase (WF1948 Only)

Connection : CH1 FCTN OUT → Universal counter CH1 (50Ω termination)
CH2 FCTN OUT → Universal counter CH2 (50Ω termination)
Use coaxial cables whose length and kind are same.

Setting : Set the channel mode to 2 phases, amplitude to 20Vp-p/open, phase of CH2 to 180deg, and frequency to 10MHz. after initial setting. The following table shows the waveform.

Measurement : Measure the interval between CH1 and CH2 by setting universal counter to the time interval mode CH1 to CH2. Set the trigger level of the universal counter to 0V and the trigger polarity to rising for CH1 and CH2. Measured values vary. Average them.

Judgment : It is normal when the value falls within the following table.

Waveform	Rating range
Sine wave	30ns ~ 70ns
Square (duty variable range standard)	30ns ~ 70ns
Square (Duty variable range extend)	30ns ~ 70ns

14. List of Initial Settings

When initialization is performed on the Utility screen (Reset), settings are initialized as follows. These items are also stored in the setting memory (except for output on/off setting).
The arbitration waveform memory, the setting memory, the user-defined unit setting, the output setting at power-on, the remote setting, and the panel operation settings are not initialized. The user-defined unit setting is not initialized. However, it stored in the setting memory.

■Output setting

Oscillation mode	Continuous oscillation
Waveform	Sine wave
Polarity and amplitude range	Normal, ± FS
Frequency	1kHz
Amplitude	0.1Vp-p
DC offset	0V
Range	Auto
Load impedance	Open
Phase	0 degree
Output Off	
Synchronization/Sub-output	Reference phase synchronization

■Waveform

Square wave duty	Standard range, 50%
Pulse wave duty	50%
Pulse wave Leading/Trailing time	1µs
Ramp wave symmetry	50%

■Modulation

Modulation type	FM
FM peak deviation	100Hz
FSK hop frequency	1.1kHz
PM peak deviation	90°
PSK frequency	90°
AM modulation depth	50%
DC offset modulation peak deviation	0.1V
PWM peak deviation	10%
Modulation source	internal, sine wave, 100Hz
FSK/PSK external modulation input polarity	positive
Synchronization/Sub-output	Internal modulation synchronization

■Sweep

Sweep type	Frequency
Frequency sweep range	1kHz ~ 10kHz
Phase sweep range	-90°~ 90°
Amplitude sweep range	0.1Vp-p ~ 0.2Vp-p
DC offset sweep range	-0.1V ~ 0.1V
Duty sweep range	40% ~ 60%
Sweep time	0.1sec
Sweep Mode	Continuous
Trigger source	Internal, 1sec
External trigger input polarity	Fall
Sweep function	One way, linear
Each marker value	5kHz, 0°, 0.15Vp-p, 0V, 50%
Stop level	Off, 0%
External control input	Disabled
Oscillation stop unit when gated single	1 cycle
Synchronization/Sub-output	Sweep synchronization, marker on

■Burst

Burst mode	Trigger burst
Mark wave number	1 cycle
Space wave number	1 cycle
Trigger source	Internal, 10msec
External trigger input polarity	Fall
Trigger delay	0s
Stop level	Off, 0%
Stop oscillation unit at gate	1 cycle
Synchronization/Sub-output	Burst synchronization

■ 2-Channel Coordination (WF1948 Only)

Channel mode	Independent
Frequency difference	0Hz
Frequency ratio	1:1
Same value setting	OFF

■Others

Use of user-defined unit	Cancel

External 10 MHz frequency reference	Disabled
External addition	OFF

Followings are shipping settings that are not changed with initialization.

■Definition of user-defined unit

Unit name	usr1 ~ usr6
Formula	(h+n)*m
m	1
n	0

■Output setting at power-on, panel operation settings

Output at power-on	OFF
Indicator	Back light on, dark color
Modify direction setting	Right and downward
Operation sound	ON

■Remote setting

Interface	USB
GPIB address	2

MEMO

15. Specifications

Numeric values marked as *1 are guaranteed values. The other numeric values are not guaranteed values but nominal values or typical values (mark as typ.).
If not specified, the condition is that oscillation is continuous, the load is 50Ω, the amplitude setting is 10Vp-p/50Ω, the DC offset setting is 0V, the auto range, the amplitude range of waveform is ±FS, the extend addition is off, and AC voltage is effective value measurement.

15.1 Oscillation mode

Continuous, modulation, sweep, burst

15.2 Waveform

15.2.1 Standard Waveform

Types	Sine, Square, Pulse, Ramp, Noise (Gaussian distribution), DC
Polarity	Normal, invert (Switch) Except for DC
Amplitude range	-FS/0, ±FS, 0/+FS (switch) Except for DC

15.2.2 Arbitrary Waveform

Waveform length	Number of control points 2 to 10,000 or 4K to 512K word (2^n, n=12 to 19) Remarks: Liner interpolation is performed between control points.
Total amount of save waveforms	Maximum 128 waves or 4M words (common in CH1 and 2) Saved in non-volatile memories
Resolution of waveform data amplitude	16bit
Sampling rate	120MS/s
Polarity	Normal, invert (Switch)
Amplitude range	-FS/0, ±FS, 0/+FS (switch)
Output bandwidth	25MHz -3dB

15.3 Frequency, phase

Frequency setting range

Oscillation mode / Waveform	Continuous, modulation, sweep (continuous and single)	Sweep (gated single) Burst
Sine wave	0.01μHz~30MHz	0.01μHz~10MHz
Rectangular wave	0.01μHz~20MHz	0.01μHz~10MHz
Pulse wave	0.01μHz~20MHz	0.01μHz~10MHz
Ramp wave	0.01μHz~5MHz	
Noise	Fixed to equivalent bandwidth 26MHz	
DC	Set the frequency invalid	
Arbitrary waveform	0.01μHz~5MHz	

Frequency setting resolution	0.01μHz
Frequency setting with a period	Setting with frequency that is inverse number of set period
Frequency accuracy at shipping time[*1]	± (3ppm + 2pHz of setting)
Frequency secular change[*1]	±1ppm/ year
Setting range of the phase	-1800.000° to +1800.000° (resolution 0.001°) Except for noise and DC Remarks: A phase setting value at the continuous oscillation mode is corresponding to the phase of the waveform output at synchronization output.

15.4 Output Characteristics

15.4.1 Amplitude

Setting range	0Vp-p～20Vp-p/open 0Vp-p～10Vp-p/50Ω A peak value combined waveform amplitude and DC offset is limited to ±10V or lower/open.
Setting resolution	999.9mVp-p or lower 4 digits or 0.1mVp-p More than 1Vp-p 5 digits of 1mVp-p
Accuracy[*1]	±(Amplitude setting[Vp-p] * 0.8%+2mVp-p)/open Conditions: 1kHz sine wave, amplitude setting 20mVp-p or higher/open
Approval unit	Vp-p, Vpk, Vrms, dBV, dBm
Range	Auto, hold (switch) Maximum output voltage range: 20Vp-p, 4Vp-p, 0.8Vp-p Amplitude attenuator range: 0dB,-10dB,-20dB,-30dB
Resolution of waveform amplitude	16bit Conditions: Amplitude setting 8mVp-p or more/open standard waveform Remarks: When the amplitude is below the setting

described above or during AM/amplitude sweep, the amplitude is reduced digitally, the amplitude resolution become lower.

15.4.2 DC Offset

Setting range	±10V/open, ±5 V/50Ω A peak value combined waveform amplitude and DC offset is limited to ±10V or lower/open.
Setting resolution	±499.9mV or lower 4 digits or 0.1mV ±0.5V or higher 5 digits or 1mV
Accuracy[*1]	± (|1% of the setting of the DC offset [V]|+5mV +Amplitude setting[Vp-p] * 0.5%)/open Conditions: Continuous oscillation, 10MHz or lower, sine wave, load open, auto range, external addition off, and 20°C to 30°C Beyond the temperature range of 20°C to 30°C, add 1mV/°C typ.
Range	Auto, hold (switch) Maximum output voltage range: 20Vp-p, 4Vp-p, 0.8Vp-p When waveform is DC, it applies to DC offset only. Otherwise, common in the amplitude range.

15.4.3 Load Impedance Setting

Function	Set and display the amplitude and the DC offset of the output terminal voltage at a specified load condition.
Setting range	1Ω to 10kΩ (resolution 1Ω), 50Ω, High-Z (load open)

15.4.4 Waveform Output

Output On/Off control	On, off (switch) Output impedance approx. 100kΩ when off
Output impedance	50Ω, Unbalanced
Short protection	Protect against the signal GND short
Output connector	Front panel, BNC receptacle

15.4.5 Synchronization/Sub-output

Output signal	Reference phase synchronization, internal modulation synchronization, burst synchronization, seep synchronization, internal modulation signal, sweep X drive (switch)
Reference phase synchronization output waveform	Square wave that rises at zero degree of reference phase for waveform output and duty 50%. When the waveform is noise or DC, fixed to low level.

Output voltage	TTL level (low level 0.4V or lower, high level 2.7V or higher/open) (each type of synchronized signal) -3V to +3V/open (internal modulation signal) 0V to +3V/open (sweep X drive)
Output impedance	50Ω, Unbalanced
Load impedance	50 Ω or higher recommended
Output connector	Front panel, BNC receptacle

15.5 Signal Characteristics

15.5.1 Sine Wave

Amplitude frequency characteristics[*1]

~100kHz	±0.1dB
100kHz ~5MHz	±0.15dB
5MHz ~20MHz	±0.3dB
20MHz ~30MHz	±0.5dB (amplitude setting 2.8Vp-p or higher/±0.8dB at 50Ω)

Conditions: Amplitude 50mVp-p to 10Vp-p/50Ω, and reference frequency 1kHz

Total harmonic distortion (THD) [*1]

20Hz ~20kHz	0.04% or lower

Conditions: Amplitude setting 0.25Vp-p to 10Vp-p/50Ω

Harmonic spurious[*1]

Conditions: Amplitude setting	0.5Vp-p ~2Vp-p/50Ω	2Vp-p ~10Vp-p/50Ω
~1MHz	-60dBc or lower	-55dBc or lower
1MHz ~10MHz	-50dBc or lower	-43dBc or lower
10MHz ~30MHz	-40dBc or lower	-30dBc or lower

Non-harmonic spurious

~1MHz	-65dBc or lower[*1], -70dBc or lower typ.
1MHz ~3MHz	-65dBc or lower[*1]
3MHz ~30MHz	-65dBc+6dB/oct or lower [*1]

Conditions: Measured at amplitude setting 0.5Vp-p to 10Vp-p/50Ω, 250MHz bandwidth

15.5.2 Rectangular Wave

Duty

Variable range (switch): Standard, extended (switch)

Standard range: Duty can be changed within the range where jitter is low and a pulse does not disappear. The setting range of the duty narrows as the frequency rises.

Duty is fixed to 50% at 20MHz

Duty is variable at the range of 10 to 90% at 4MHz

Extended range: There is jitter of 2.5ns rms or lower typ., and the duty can be always changed at the maximum range. Averagely, pulses are equal to the set duty, even though when the pulse width is narrower than 8.4ns, pulses may disappear.

Setting range	Standard range 0.0100% to 99.9900% (resolution 0.0001%) Extended range 0.0000% to 100.0000% (resolution 0.0001%)
Lower and upper limit of standard range setting	Upper limit (%) 100 - frequency (Hz)/400,000 Lower limit (%) frequency (Hz)/400,000
Duty accuracy[*1]	
≤100kHz	±0.1% of period (duty setting is 1% to 99%)
100kHz<f≤1MHz	±1% of period (duty setting is 5% to 95%)
1MHz<f≤3MHz	±3% of period (duty setting is 40% to 60%)
Leading /Trailing time	17ns or lower[*1], 15.5ns or lower typ. However, for burst oscillation and gated single sweep with a stop level is set, it is approx. 20ns. Conditions: 50Ω load, DC offset setting 0V, and amplitude setting 10Vp-p/50Ω
Overshoot	5% or less typ.
Jitter	Duty variable range standard 300ps rms or less typ. (100Hz or higher) Duty variable range extended 2.5ns rms or less typ.

15.5.3 Pulse Wave

Pulse width

Duty setting range	0.0170% to 99.9830% (resolution 0.0001%)
Time setting range	24.00ns to 99.9830Ms (resolution 0.001% or less of period or 0.01ns) Setting range of pulse width duty and pulse width time are limited by frequency, Leading time and Trailing time.
Upper or lower limit of time setting	Upper limit (s) period - (Leading time + Trailing time) * 0.8 Lower limit (s) (Leading time + Trailing time) * 0.8

	Upper and lower limit of duty setting are computed by upper and lower value/period above.
Leading time, Trailing time	
Setting range	15.0ns to 62.5Ms (resolution 3 digits or 0.1ns) Independent setting of Leading/Trailing time Leading time and Trailing time is limited by frequency, pulse width duty, and pulse width time.
Minimum setting value	Which is lower 0.01% of period or 15ns.
Overshoot	5% or less typ.
Jitter	500ps rms of higher typ. (10kHz or more) 2.5ns rms of higher typ. (less than 10kHz)

15.5.4 Ramp Wave

Setting range of symmetry	0.00% to 100.00% (resolution 0.01%)

15.6 Modulated Oscillation Mode

15.6.1 General

Modulation type	FM, FSK, PM, PSK, AM, DC offset modulation, PWM
Modulation operation	Start and stop
Modulation source	
Except for FSK and PSK	Internal, external (switch) Source of CH2 cannot be same as CH1
FSK, PSK	CH1: Internal, CH1 external input terminal (switch) CH2: Internal, CH1 and CH2 external input terminal (switch) (CH1 external input on CH2 is enabled only when external input is selected on CH1.) External input of FSK and PSK uses an external trigger input terminal.
Internal modulation waveform	
Except for FSK and PSK	Sine wave, square wave (duty 50%), triangle wave (symmetry 50%), rising ramp wave, falling ramp wave, noise, arbitrary wave
FSK, PSK	Square wave (duty 50%)
Internal modulation frequency	
Except for FSK, PSK, and DC offset modulation	0.1mHz to 1MHz (resolution 8 digits or 0.1mHz)
FSK, PSK	0.1mHz to 3MHz (resolution 8 digits or 0.1mHz)
DC offset modulation	0.1mHz to 100kHz (resolution 8 digits or 0.1mHz)
Internal modulation synchronization output	
Output waveform	A square wave with duty 50% rising at the zero phase of the internal modulation waveform.

When internal modulation waveform is noise, the level is fixed to low.

Output connector — Shared with synchronization/sub-out connector

Internal modulation signal output

Output voltage — -3V to +3V/open

Output connector — Shared with synchronization/sub-out connector

External modulation input (except for FSK and PSK)

Input voltage range — ±1V Full scale

Maximum allowable input — ±2V

Input impedance — 10kΩ, Unbalanced

Input frequency — DC～40kHz (-3dB)

input connector — Front panel (WF1947)/ rear panel (WF1948), BNC receptacle

Shared with output addition input. It cannot be used with additional operation at a time

External modulation input (FSK and PSK)

Polarity — Positive, negative (switch)

Input frequency — DC～3MHz

input connector — External trigger input is used

Input signal and input impedance depend on external trigger input specification

Signals Selectable for Synchronization/Sub-output

Reference phase synchronization

Internal synchronization (only when modulation source is internal)

Internal signal (only when modulation source is internal and not FSK and PSK)

15.6.2 FM

Carrier waveform — Standard waveform except for noise, pulse wave, and DC and an arbitrary waveform.

Peak deviation setting range — 0.00μHz to 15MHz or lower (resolution eight digits or 0.01μHz)

Carrier frequency ± peak deviation is limited within the allowable range of frequency for each carrier waveform.

15.6.3 FSK

Carrier waveform — Standard waveform except for noise, pulse wave, and DC and an arbitrary waveform.

Hop frequency setting range — Within the allowable range of frequency for each carrier waveform (resolution 8 digits or 0.01μHz)

15.6.4 PM

Carrier waveform	Standard waveform except for noise and DC and an arbitrary waveform.
Peak deviation setting range	0.000° to 180.000° (resolution 0.001°) Carrier phase ± peak deviation is limited within the range of ±1800°.

15.6.5 PSK

Carrier waveform	Standard waveform except for noise and DC and an arbitrary waveform.
Deviation setting range	-1800.000°to +1800.000°(resolution 0.001°) Carrier phase + deviation is limited within the range of ±1800°.
Remarks	Amplitude frequency characteristic of sine wave during PSK is limited 25MHz to -3dB.

15.6.6 AM

a) Non-DSB-SC

Carrier waveform	Standard waveform except for DC and arbitrary waveform.
Modulation depth setting range	0.0% to 100.0% (resolution 0.1%)
Remarks	When the modulation depth is 0%, amplitude becomes equal to 1/2 of setting.

b) DSB-SC (Double Side Band - Suppressed Carrier)

Carrier waveform	Standard waveform except for DC and arbitrary waveform.
Modulation depth setting range	0.0% to 100.0% (resolution 0.1%)
Remarks	When the modulation depth is 100%, maximum amplitude becomes equal to setting. The component of the carrier frequency is zero during DSB-SC.

15.6.7 DC Offset Modulation

Carrier waveform	Standard waveform and arbitrary waveform.
Peak deviation setting range	0V to 10V/open Carrier DC offset ±peak deviation is limited within the allowable range of DC offset for each carrier waveform

15.6.8 PWM

Carrier waveform	Square wave and pulse wave
Peak deviation setting range	
Rectangular wave	
Duty variable range standard	0.0000% to 49.9900% (resolution 0.0001%)
Duty variable range extend	0.0000% to 50.0000% (resolution 0.0001%)
Pulse wave	0.0000% to 49.9000% (resolution 0.0001%) Carrier duty ± peak deviation is limited within the

allowable range of duty for each carrier waveform.

15.7 Sweep Oscillation Mode

15.7.1 General

Sweep type	Frequency, phase, amplitude, DC offset, and duty
Sweep function	One way (lump waveform), two way (triangular wave) (switch) Linear, logarithmic (switch) Common regardless of sweep type However, logarithmic can use only frequency sweep
Sweep range setting	Specify starting value and stopping value, or center value and span value. However, the center value is also a simple average during frequency logarithmic sweep Assigning to a center value of a marker value is possible (vice versa).
Setting range of Sweep Time	0.1ms to 10,000s (resolution 4 digits or 0.1ms) Common regardless of sweep type
Sweep Mode	Continuous, single, gated single (switch) Common regardless of sweep type For gated single, it oscillates only during running sweep However, when the waveform is DC, gated single is not available.
Operation	Start, stop, hold, resume, starting value output, stopping value output
Trigger source (used for single sweep and gated sweep)	
	CH1: Internal, CH1 external input terminal (switch) CH2: Internal, CH1 and CH2 external input terminal (switch) (CH1 external input on CH2 is enabled only when external input is selected on CH1.) Common regardless of sweep type Trigger delay setting is invalid Manual trigger available
Internal trigger oscillator for sweep (used for single sweep and gated sweep)	
Period setting range	100.0μs to 10,000s (resolution 5 digits or 0.1μs)
Stop level setting (used for gated single sweep)	
Function	Specify the signal level when gated single-shot sweep is stopped.
Setting range	-100.00% to +100.00% (amplitude full-scale reference and resolution 0.01%) or off When stop level is set to off, stops by set starting oscillation/stop phase

	Common regardless of sweep type
Remarks	When the waveform is Noise, oscillation start/stop phase is invalid, stop level is always valid. When the waveform is DC, oscillation start/stop phase is invalid, stop level is invalid. For phase sweep, sweep starting value is oscillation start phase and sweep stop value is oscillation stop phase
Oscillation stop unit when gated single	One wave, 0.5 wave (switch)
Sweep synchronization/marker output	
Marker off at one-way	Low level from sweep staring time to half of sweep time Otherwise, high level
Marker off at two-way	Low level from sweep staring time to sweep stop time Otherwise, high level
Marker on	Low level from sweep staring time to marker value Otherwise, high level
Output connector	Shared with synchronization/sub-out connector
Sweep X drive output	
Output voltage	0V to +3V/open During sweep value rising, 0 to +3V, during falling, +3 to 0V
Output connector	Shared with synchronization/sub-out connector
Sweep outside trigger input (used for single sweep and gated sweep)	
Polarity	Positive, negative, disable (switch)
Input connector	External trigger input is used Input signal and input impedance depend on external trigger input specification
Signals Selectable for Synchronization/Sub-output	
	Reference phase synchronization Sweep synchronization/marker Sweep X drive

15.7.2 Frequency Sweep

Waveform	Standard waveform except for noise, pulse wave, and DC and an arbitrary waveform.
Setting range of start and stop frequency	0.01μHz to 30MHz (resolution 0.01μHz) Limited within the allowed setting range of frequency for each waveform.

15.7.3 Phase Sweep

Waveform	Standard waveform except for noise and DC and an arbitrary waveform.

Setting range of start and stop phase	-1800.000° to 1800.000°(resolution 0.001°) Remarks: The setting value is same as the phase setting for other oscillation mode

15.7.4 Amplitude Sweep

Waveform	Standard waveform except for DC and arbitrary waveform.
Setting range of start and stop amplitude	0Vp-p～20Vp-p/open Limited within the allowed setting range of amplitude for each waveform.

15.7.5 DC Offset Sweep

Waveform	Standard waveform and arbitrary waveform.
Setting range of start and stop DC offset	-10V to +10V/open Limited within the allowed setting range of DC offset for each waveform.

15.7.6 Duty Sweep

Waveform	Square wave and pulse wave
Setting range of start and stop duty	
Rectangular wave	
Duty variable range standard	0.0100% to 99.9900% (resolution 0.0001%)
Duty variable range extend	0.0000% to 100.0000% (resolution 0.0001%)
Pulse wave	0.0170% to 99.9830% (resolution 0.0001%) Limited within the allowed setting range of duty for each waveform.

15.8 Burst oscillation mode

Burst mode	
Auto burst	Repeats oscillating the number of mark wave and stopping the number of space wave. Trigger becomes invalid.
Trigger burst	Oscillates the number of mark wave with synchronizing trigger.
Gate	Oscillates integral multiple of integer cycle or half cycle with synchronizing the gate signal. However, when the waveform is noise, it makes oscillation on/off by the gate signal.
Trigger gate	Gate oscillation making gate on/off based on each trigger.
Target waveform	
Auto and trigger burst	Standard waveform except for noise and DC and an arbitrary waveform.
Auto and trigger gate	Standard waveform except for DC and arbitrary

	waveform.
Mark wave number setting range	0.5 to 999,999.5, 0.5 wave unit
Number of space wave setting range	0.5 to 999,999.5, 0.5 wave unit
Stop oscillation unit at gate	One wave, 0.5 wave (switch)
Setting range of start/stop oscillate	-1800.000° to +1800.000° (resolution 0.001°)
	Remarks: The setting value is same as the phase setting for other oscillation mode
Stop level setting range	
Function	Specify the signal level while oscillation is stopped
Setting range	-100.00% to +100.00% (amplitude full-scale reference and resolution 0.01%) or off
	When stop level is set to off, stops by set starting oscillation/stop phase
Remarks	The waveform is Noise, oscillation start/stop phase is invalid, stop level is always valid.
Trigger source (used for trigger burst)	
	CH1: Internal, CH1 external input terminal (switch)
	CH2: Internal, CH1 and CH2 external input terminal (switch)
	(CH1 external input on CH2 is enabled only when external input is selected on CH1.)
	Manual trigger available
Internal trigger oscillator for burst (used except for auto burst)	
Phase setting range	1.0μs to 1,000s (resolution 5 digits or 0.1μs)
Trigger delay setting range	0.00μs to 100.00s (setting resolution 8 digits or 0.01μs)
	External delay 0.55μs
	Enabled only for trigger burst (disabled for gate and triggered gate)
Trigger jitter	1ns rms or less typ.
Burst synchronization output	
Polarity	Low level during oscillation, otherwise high level
Output connector	Shared with synchronization/sub-out connector
Signals Selectable for Synchronization/Sub-output	
	Reference phase synchronization
	Burst synchronization

15.9 Triggers

External

Application	Used for single sweep, gated single sweep, trigger burst, gate, trigger gate
Input voltage	TTL level (low level 0.8V or lower, high level is 2.6V or higher)
Maximum allowable input[*1]	-0.5V to +5.5V
Polarity	Positive, negative, disable (switch) FSK, PSK, sweep (each is independent setting)
Minimum pulse width[*1]	50ns
Input impedance	10kΩ (pull-up to+3.3V), unbalanced
Input connector	Front panel (WF1947)/ rear panel (WF1948), BNC receptacle
Manual trigger	Panel key operation
Application	Used for single sweep, gated single sweep, trigger burst, gate, trigger gate
Internal trigger oscillation	
	For sweep, burst, and independent among channels See the internal trigger oscillation in each section

15.10 Other I/Os

External 10 MHz frequency reference input

Select frequency reference	Enabled and disabled of external reference (switch)
Input voltage	0.5Vp-p to 5Vp-p
Maximum allowable input[*1]	10Vp-p
Input impedance	1kΩ, unbalanced, AC coupling
Input frequency	10MHz (±0.5%(±50kHz))
Input waveform	Sine or square wave (50±5% duty)
Input connector	Back panel, BNC receptacle

Frequency reference output (WF1947 and WF1948, to synchronize more than one device)

Output voltage	1Vp-p/50Ω Square wave
Output impedance	50 Ω, AC coupling
Output frequency	10MHz
Output connector	Back panel, BNC receptacle

External addition input

Additional gain	0.4 times, 2 times, 10 times, off (switch) When 0.4 times is used, maximum output voltage range is fixed to 0.8Vp-p, when 2 times 4Vp-p, and when 10 times 20Vp-p. During external modulation, it is dedicated to external modulation input.

Input voltage	-1V～+1V
Maximum allowable input[*1]	±2V
Input frequency	DC～10MHz (-3dB)
Input impedance	Balanced/10kΩ, Unbalanced
Input connector	Front panel (WF1947)/ rear panel (WF1948), BNC receptacle Shared with external modulation input. Cannot be used with external modulation and external addition at a time.

15.11 2-Channel Coordination (WF1948 Only)

Channel mode

Channel mode	Action
Independent	Independent setting
2 phase	Keeps same frequency. Also controls to keep same frequency for frequency sweep, internal frequency modulation, and internal FSK. External frequency modulation and external FSK is not allowed. Phase is independent setting among each channel.
Constant frequency difference	Keep Difference of frequency constant. Also controls to keep frequency difference for frequency sweep, internal frequency modulation, and internal FSK. External frequency modulation and external FSK is not allowed.
Constant frequency ratio	Keep Ratio of frequency constant. Also controls to keep frequency ratio for frequency sweep, internal frequency modulation, and internal FSK. External frequency modulation and external FSK is not allowed.
Differential output	Same frequency, amplitude, DC offset. Reverse phase waveform. Controls to keep different output, even for each type of sweep and internal modulation. External modulation is not allowed. External addition is not allowed.

Common restriction conditions for 2 phase, constant frequency difference, constant frequency ratio, and differential output

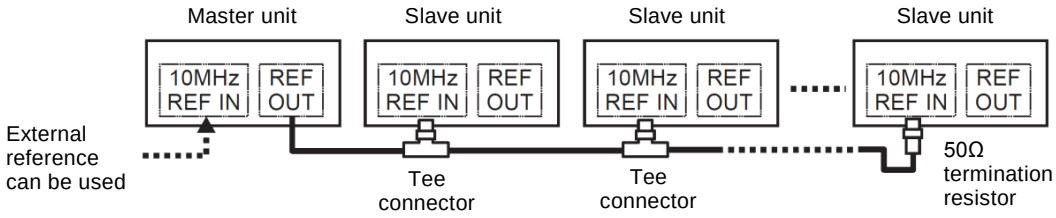
- •Oscillates on the same oscillation mode (for modulation oscillation, modulation type is also same. For sweep oscillation, sweep type is also same).
- •Applies to standard waveform except for noise and DC and an arbitrary waveform.
- •Burst, gated sweep is unavailable.

Same value setting and operation	Capable
Frequency difference setting range	0.00μHz to 30MHz or less (resolution 0.01μHz) CH2 frequency - CH1 frequency
Frequency ratio N:M setting range	1 to 9,999,999 (each of N and M) N:M = CH2 frequency: CH1 frequency Frequency resolution is limited to N × 0.01μHz for CH1, M × 0.01μHz for CH2 (also for frequency sweep, internal frequency sweep, and internal FSK)
Phase synchronization	Auto run when the channel mode is changed
Interval between channels for 2 phase	±20ns or lower [*1], ±10ns or lower typ. Conditions: Same waveform (sine wave and square wave)

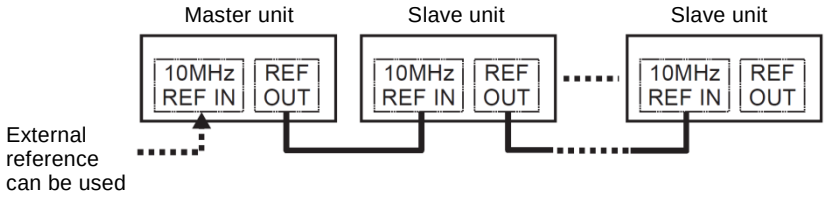
15.12 Synchronization of Multiple Units

Connection

Connection Method 1



Connection Method 2



Connection cables

Cable type	Characteristic impedance 50 ▸ series coaxial cable with BNC connector (RG-58A/U etc.)
Restriction to cable length	1 m or less between units, total cable length is 3 m or less
Maximum connection number	Connection Method 1: 6 units including master unit Connection Method 2: 4 units including master unit
Phase synchronization	Manual operation

Interval of waveforms among equipments

Delay of each channel against each of a master equipment on the Nth slave equipment (1≦N)

Connection Method 1: 31ns+(N-1) x 6ns within ±25ns typ.

Connection Method 2: 31ns+(N-1) x 31ns within ±25ns typ.

Conditions: Continuous oscillation, same frequency, same phase, same waveform (sine wave and square wave), load 50▸, DC offset setting 0V, amplitude setting 10Vp-p/50▸, and connecting cable length of frequency reference output between external frequency reference input is 1m (RG-58A/U)

15.13 User-defined unit

Function	Set and display settings in any unit based on a specified conversion expression
Setting target	Frequency (Hz), period (sec), amplitude (Vp-p, Vpk), DC offset (V), phase (deg), and duty (%)
Conversion formula	[(setting target value) + n] x m, or [$\log_{10}$(setting target value) + n] x m Specify a conversion expression and values of n and m
Unit name string	Maximum 4 characters

15.14 Other Functions

Setting save memory: 10 sets (saved in non-volatile memories)

Parameter setting at power-on operation:

Power-off with front panel operation

- It is restored at power-on to the previous operation state

Shut down with power line disconnect

- The contents of setting memory number 1 are set

Output On/Off setting at power-on operation. Last State, On, Off, switch

Power Off method	Power-On Output setting		
	Last State	On	Off
Panel power supply Off operation	Power Off it is restored the state just before	Output On	Output Off
Shot down with line	Output Off	Output On	Output Off

External Control Interface	GPIB, USBTMC
External control command	SCPI-1999/IEEE-488.2 and (WF194x compatible) own command

15.15 General Characteristics

Indicator 3.5 inch TFT color LCD

I/O ground

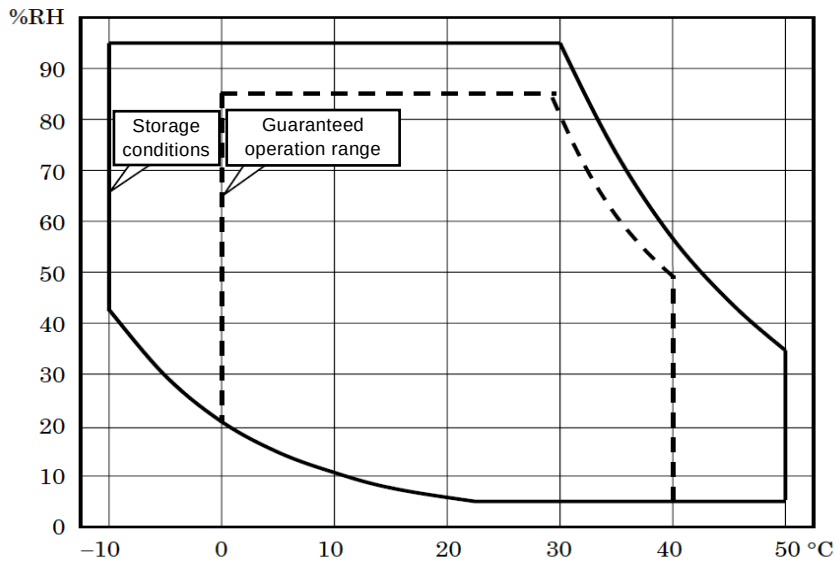
Signal grounds for waveform output (FCTN OUT), synchronize/sub-output (SYNC/SUB OUT), external modulation/add input (MOD/ADD IN) are insulated from the enclosure. These signal grounds within same channel is common.
Signal ground for external 10MHz reference input (10MHz REF IN) is insulated from the enclosure.
Each signal ground for CH1, CH2, and 10MHz REF IN is independent.
Withstand voltage between the enclosure and insulated signal ground is maximum 42Vpk (DC+ACpeak).
The other signal grounds connects to the enclosure.

Power Supply

Power voltage range:	AC100V to 230V ±10% (250V or lower)
Power frequency range:	50Hz/60Hz ±2Hz
Power consumption	WF1947: 55VA or lower
	WF1948: 75VA or lower
Overvoltage category	II

Ambient temperature/humidity range conditions (See next image)

Guaranteed operation range	0°C～+40°C, 5～85%RH Furthermore, AH 1 to 25g g/m^3, no condensation On some specifications, the temperature range limit is more strict.
Storage conditions	-10°C～+50°C, 5～95%RH Furthermore. AH 1 to 29g g/m^3. no condensation

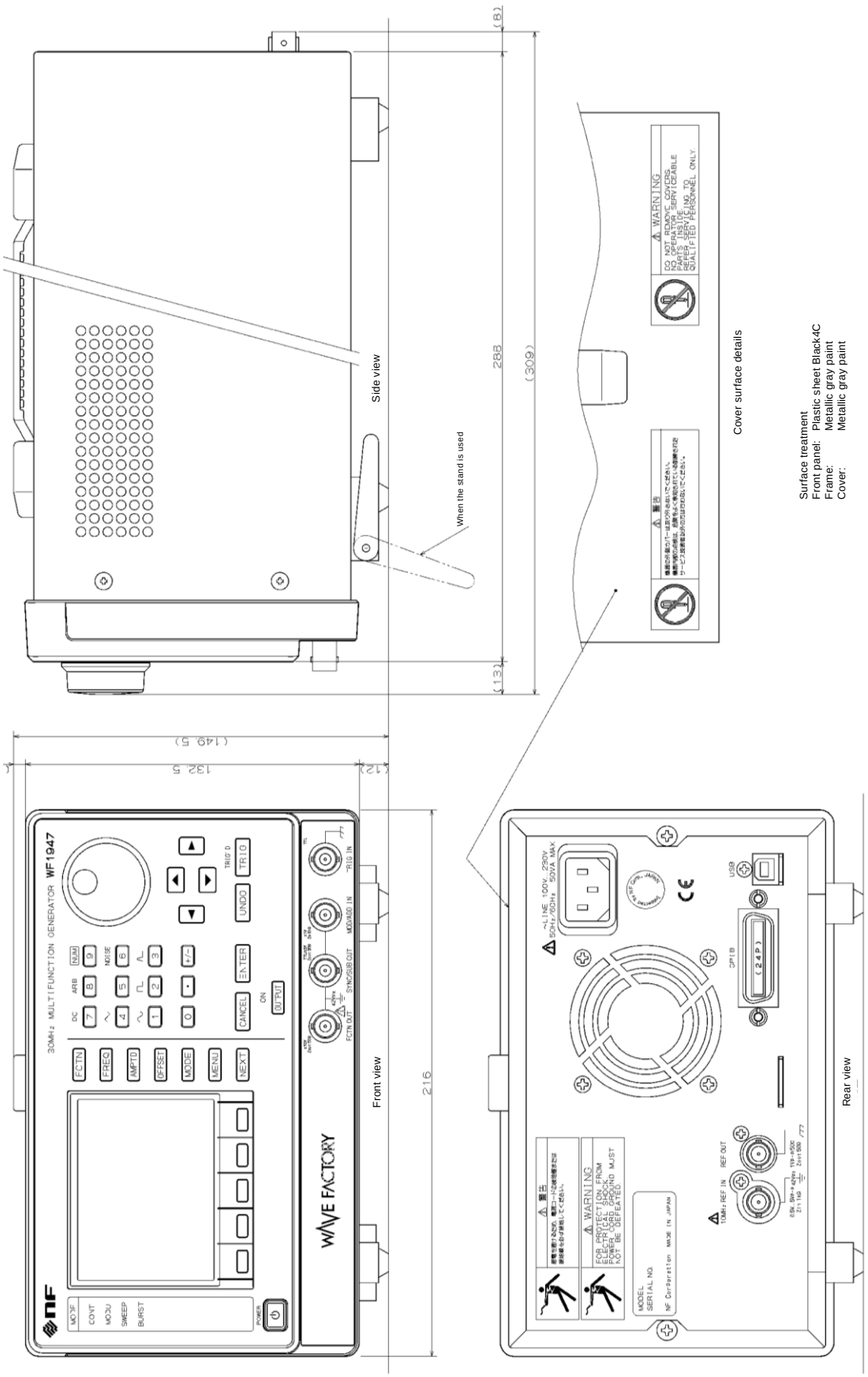


Warm-up time	More than 30 minutes typ.
Pollution degree	2
External dimensions	216 (W) x 132.5 (H) x 288 (D) mm (without protrusions) 216 (W) x 149.5 (H) x 309 (D) mm (maximum dimension)
Weight	Approx. 2.6kg (accessories are not included. The weight of equipment)

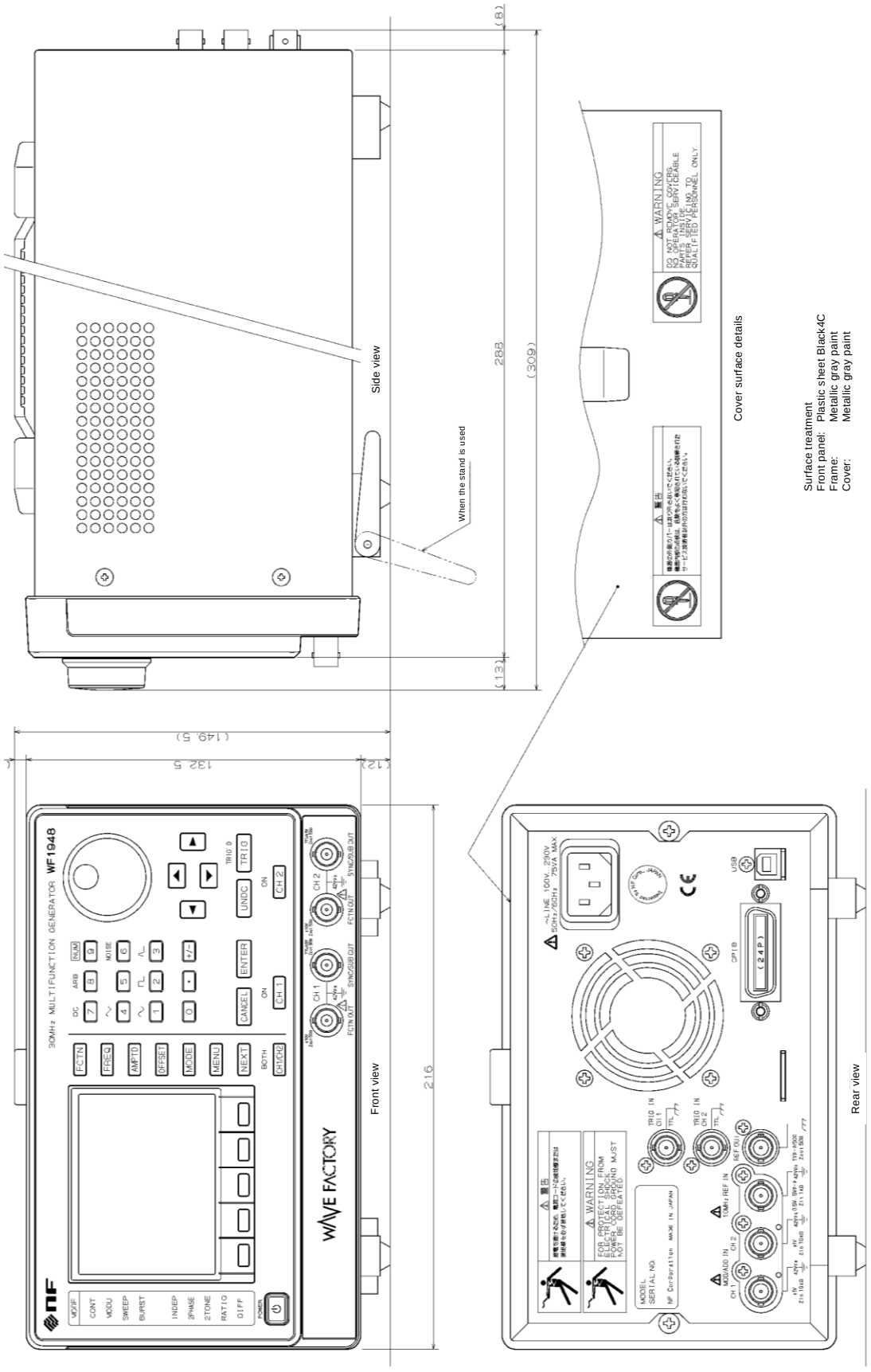
Safety and EMC (Applied only to models with the CE marking displayed on the rear panel)

	EN 61010-1:2010, EN 61326-1:2013(Group 1, Class A) EN 61000-3-2:2014 EN 61000-3-3:2013
RoHS	EN 50581:2012

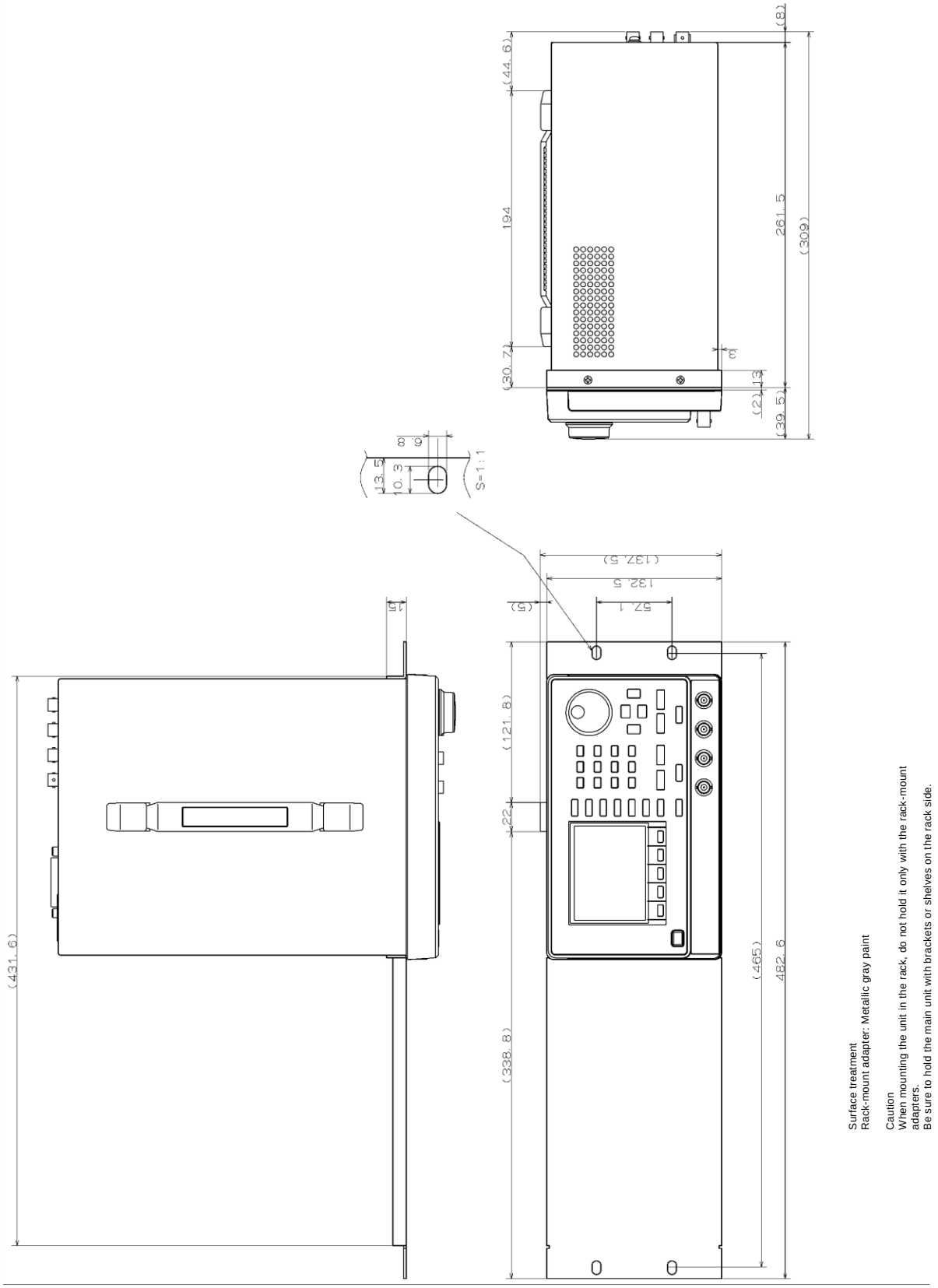
■Outline dimensional drawing (**WF1947**)



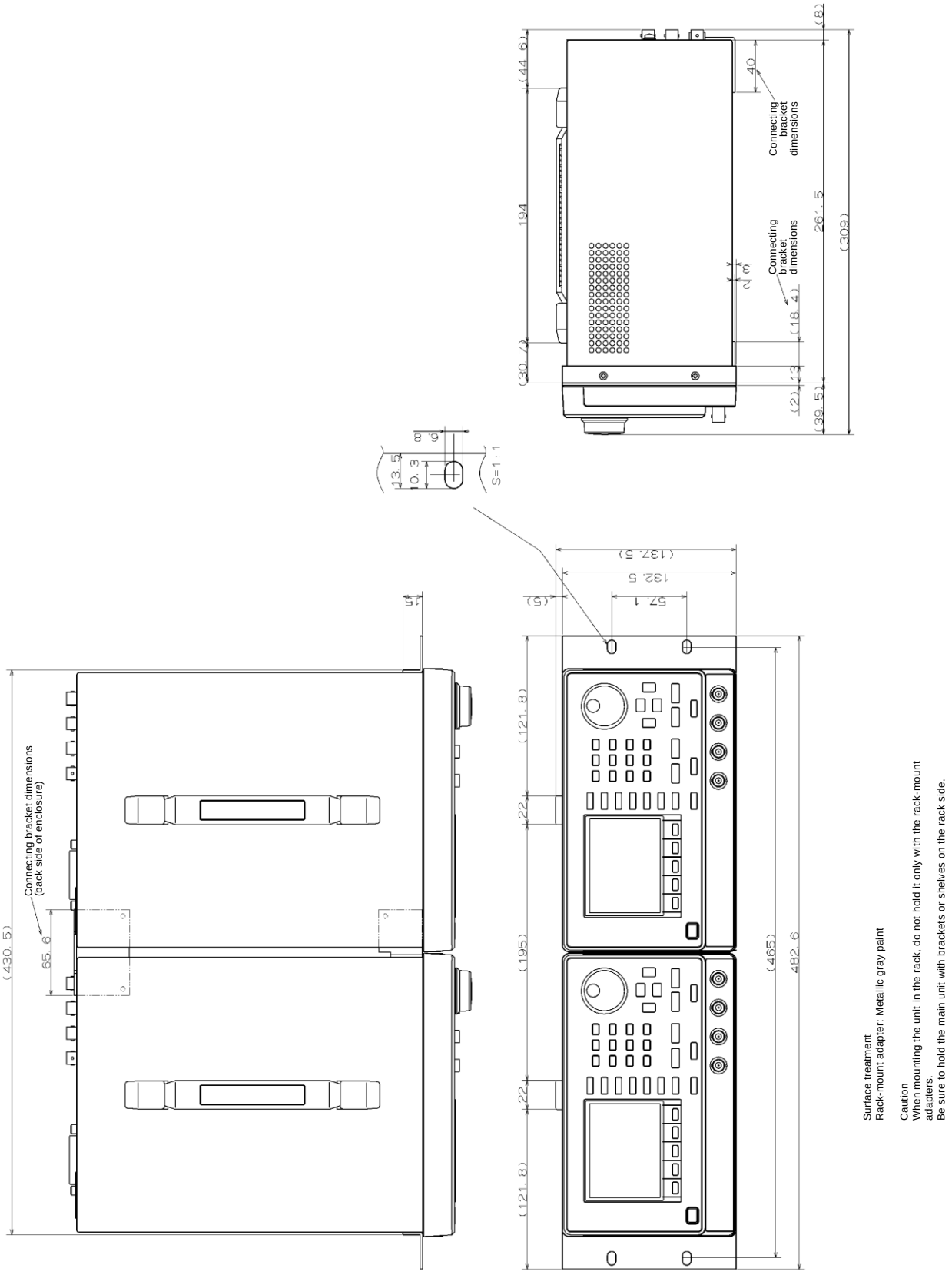
■Outline dimensional drawing (**WF1948**)



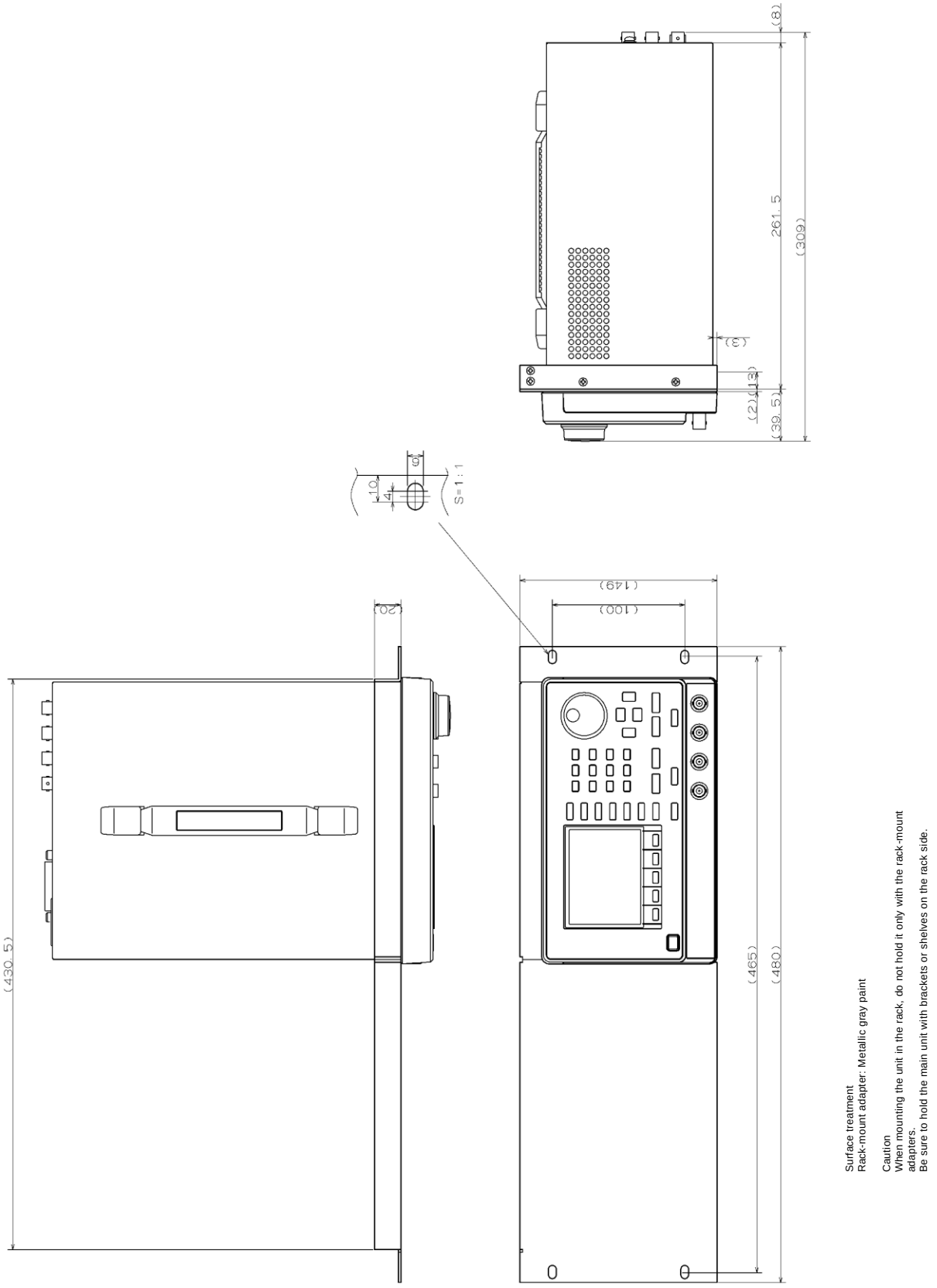
■Inch rack mount dimensional drawing (for **1** unit)



■Inch rack mount dimensional drawing (for **2** units)



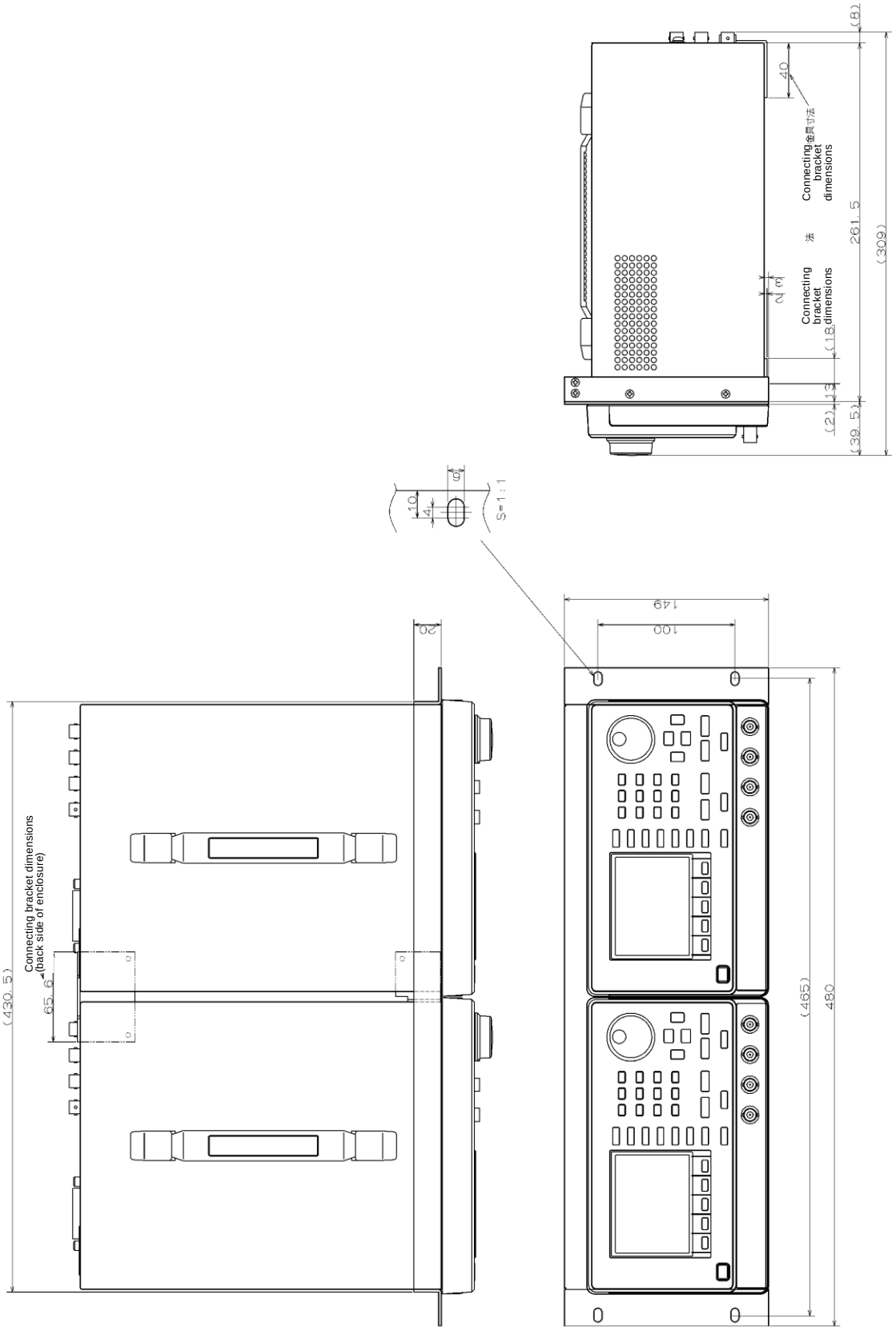
■Millimeter rack mount dimensional drawing (for **1** unit)



Surface treatment
Rack-mount adapter: Metallic gray paint

Caution
When mounting the unit in the rack, do not hold it only with the rack-mount adapters.
Be sure to hold the main unit with brackets or shelves on the rack side.

■Millimeter rack mount dimensional drawing (for **2** units)



WARRANTY

NF Corporation certifies that this product was thoroughly tested and inspected and found to meet its published specifications when it was shipped from our factory.

All **NF** products are warranted against defects in materials and workmanship for a period of one year from the date of shipment. During the warranty period, **NF** will repair the defective product without any charge for the parts and labor. For repair service under warranty, the product must be returned to either **NF** or an agent designated by **NF**. Purchaser shall prepay all shipping charge, duties and taxes for the product to either **NF** or the agent from another country, and shipping charge for the return of the product to purchaser shall be paid by **NF** side.

This warranty shall not apply to any defect, failure or damage caused by a) improper use; b) improper or inadequate maintenance and care; or c) modification by purchaser or personnel other than **NF** representatives.

NF Corporation

REPAIR

When a failure occurred and the product was found to be defective or you have any uncertainty, please get in touch with NF Corporation or one of our representatives.

In such a case, let us know the model name (or product name), serial number (SERIAL No. given on the nameplate), and symptom and operating conditions as detail as possible.

Though we will make efforts to reduce the repair period, when five or more years have passed since you purchased the product, it may take time due to, for instance, the out of stock of repair parts.
Also, if the production of repair parts is discontinued, the product is extremely damaged, or the product is modified, we may decline the repair.

NOTES

- Reproduction of the contents of this manual is forbidden by applicable laws.
- The contents of this manual may be revised without notice.
- Information provided in this manual is intended to be accurate and reliable. However, we assume no responsibility for any damage regarding the contents of this manual.
- Should you notice any doubtful or wrong statement, or lack of description, please contact us or our agent.

WF1947/WF1948 Instruction Manual (Operations)

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