DA00101751-002

WAVE FACTORY

MULTIFUNCTION GENERATOR

WF198x series

Instruction Manual (Operations)

NF Corporation

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Preface

Thank you very much for purchasing our “Multifunction Generator WF198x series”.

To use this instrument in a safe and correct manner, please first read the next section titled ☞「Safety Precautions」.

● Caution symbols used in this manual

The following caution symbols are used in this manual. Be sure to observe them and their accompanying information to ensure the safety of the user and avoid damage to the instrument.

⚠ WARNING

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

⚠ CAUTION

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

● This manual has the following chapter organization.

The instructions for remote control (USB, LAN, and GPIB*) are provided in a separate file.
If using this instrument for the first time, start with “1. Overview”.

1. Overview ☞ P.1-1
   This chapter describes the overview and brief operating principles of this product.
2. Preparations Before Use ☞ P.2-1
   This chapter describes important preparations before installation and operation.
3. Panels and I/O Terminals ☞ P.3-1
   This chapter describes the functions and operations of the switches and I/O terminals on the panels.
4. Basic Operations ☞ P.4-1
   This chapter describes basic operations.
5. Saving and Recalling Settings ☞ P.5-1
   This chapter describes how to save and recall the settings.
6. Parameter variable Waveforms (PWF) ☞ P.6-1
   This chapter describes the meaning of each parameter and examples of parameter variable waveforms.
7. Creating Arbitrary (ARB) Waveforms ☞ P.7-1
   This chapter describes how to input and edit arbitrary waveforms from the panel.

*) GPIB interface is not present on WF1982/WF1981

8. Convenient Use of 2-channel Equipment (WF1984/WF1982) ☞ P.8-1
   This chapter describes how to coordinate the settings of two channels.

9. Synchronizing Multiple Units ☞ P.9-1
   This chapter describes how to configure a multi-phase oscillator by connecting multiple units of this product.

10. Using External Frequency Reference ☞ P.10-1
    This chapter describes how to use an external frequency reference.

11. Using Sequence Oscillation ☞ P.11-1
    This chapter describes how to set and operate sequence oscillation.

12. Using User-defined Units ☞ P.12-1
    This chapter describes the units which users can define by themselves.

13. Other Utility Settings ☞ P.13-1
    This chapter mainly describes how to set up utilities that have not been explained.

14. Troubleshooting ☞ P.14-1
    This chapter describes the error messages and measures to take when problems occur.

15. Maintenance ☞ P.15-1
    This chapter describes how to perform operation inspections and performance tests.

16. List of Initial Settings ☞ P.16-1
    This chapter describes the initial settings.

17. Specifications ☞ P.17-1
    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 instrument (with protective conductor terminals) that conforms to the JIS and IEC insulation standards.

- **Be sure to follow the instructions in the instruction manual.**
  This instruction manual contains instructions for safe operation and use of this product.
  Please read this manual first before using the product.
  All of the warning items contained in this instruction manual are intended for preventing risks that may lead to serious accidents. Be sure to observe these warnings.

- **Be sure to ground the product.**
  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-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 section “2.3 Grounding and Power Supply Connection” in this instruction manual.
  Prior to connecting the power supply, check that the outlet voltage matches the rated power voltage of the product.

- **If you suspect a problem**
  If this product emits smoke, strange odor, or unusual sound, immediately disconnect the power cable and stop using the product.
  If such an abnormality occurs, do not let anyone use 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 in an explosive atmosphere.**
  An explosion or other hazard may occur.

- **Do not remove the cover.**
  This product contains high-voltage components. Do not remove its cover.
  Inspections of the product's interior should only be performed by service technicians authorized by NF Corporation.

- **Do not modify the product.**

  Do not modify the instrument under any circumstances. Modification of the instrument could cause unexpected accidents or failures. NF Corporation has the right to refuse to repair any instruments modified by unauthorized persons.

- **Take care that water does not get inside the product or the product does not get wet.**

  Using the product while it is wet may cause electric shock or fire. If water or other liquid has entered inside the product, immediately disconnect the power cable and contact NF Corporation or one of our representatives.

- **If a thunderstorm occurs nearby, turn off the power switch and disconnect the power cable.**

  A thunderstorm may cause electric shock, fire, or failure.

- **Electromagnetic compatibility**

  Applicable EMC standard: EN 61326-1

  Electromagnetic environment in which intended to be used: Industrial electromagnetic environment.

  When this product is connected to a measurement target, emissions exceeding the level required by the applicable EMC standard may be generated.

  This product is a CISPR 11 Group 1 Class A compliant device.

  If used in a residential environment, this product may cause interference. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent radio frequency interference.

  To ensure compliance with EMI tolerance requirements, cables with high shielding effect such as multi-shielded cables must be used.

- **Safety-related symbols**

  The general definitions of the safety-related symbols used on this product and in its instruction manual are provided below.

  

  Instruction Manual Reference Symbol

  This notifies the user of potential hazards and indicates the need to refer to the instruction manual.

  

  Electric Shock Danger Symbol

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

⚠ WARNING

Warning Symbol

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

⚠ CAUTION

Caution Symbol

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

Disassembly Prohibited Symbol

This symbol is displayed on the main unit. It indicates that disassembling this product may result in electric shock or other injury.

Electric Shock Danger Symbol

This symbol is displayed on the main unit. It indicates that not grounding this product may result in electric shock.

Standby Symbol

This symbol is displayed on the main unit. It indicates that the instrument contains components that cannot be completely cut off from the power supply source.

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.
However, it indicates that the potential difference from the grounding potential is restricted to 42Vpk or less for safety reasons (since this product is grounded when being used, the potential of the enclosure equals the grounding potential).

- **Requesting waste disposal**

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

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Figures and Tables

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1. Overview

1.1 Features

The WAVE FACTORY WF198x Multifunction Generator are digital multifunctional oscillators. The WF1983/WF1981 is a single channel, the WF1984/WF1982 is a two channel.

- Maximum frequency:
  60MHz for sine wave, 30MHz for square wave, pulse (WF1984/WF1983)
  30MHz for sine wave, 15MHz for square wave, pulse (WF1981/WF1982)
- Frequency accuracy: ± (1ppm+4pHz), minimum resolution 0.01μHz. Supports a 10MHz external frequency reference.
- Maximum output voltage: 21Vp-p / open, 10.5Vp-p / 50Ω
- Many standard waveforms with flexibly variable parameters: Sine wave, square wave (variable duty), pulse (variable pulse width/duty, leading edge time, trailing edge time and transition waveform), ramp wave (variable symmetry), CF control sine wave (variable crest factor), staircase sine wave (variable number of steps), Gaussian pulse (variable σ), Sin(x)/x (variable number of zero crossings), exponential rise/fall (variable time constant), damped oscillation (variable oscillation frequency and damping time constant), pulse surge (variable rising and duration time), trapezoid wave (variable rise, fall, and upper base width), etc.
- Synclator function that outputs an external input signal at the same or its fractional frequency.
- Output waveform resolution: approximately 16bit (retains high resolution across a wide range of output voltages down to 8mVp-p/open)
- High-capacity arbitrary waveform memory:
  Maximum 64Mi words (WF1983/WF1984)
  Maximum 32Mi words (WF1981/WF1982)
- Continuous phase and uninterrupted waveform during frequency change and frequency sweep.
- Various oscillation modes (Modulation can be applied simultaneously with sweep or burst oscillation)
  - Continuous oscillation
  - Modulation function: FM, FSK, PM, PSK, AM, DC offset modulation, PWM
  - Sweep mode: Frequency, phase, amplitude, DC offset, and duty
  - Burst mode: Auto burst, trigger burst, gate, triggered gate
- Sequence function included for easy test waveform creation and editing.
  Allows flexible waveform generation by combining standard waveforms and arbitrary waveforms. Supports rapid change and sweep of frequency, phase, amplitude, etc.
  (Jump, repeat, hold, branch possible)
- Channel coordination with 2 phases, constant frequency difference, constant frequency ratio, etc. (WF1984/WF1982)
- The ground floating from the enclosure for each channel to reduce the effect of ground loop.
- Supports the synchronization of multiple units to configure a multiphase oscillator.
- Storage of settings, arbitrary waveforms, and other data in USB flash drive.
- Supports outputting a different frequency and waveform from each channel's sub output than each main output.
- Includes USB, GPIB, and LAN interfaces (Only WF1983/WF1984 has GPIB)
- Slim and lightweight with approximate height of 9cm and weight of 1.8kg

1.2 Operating Principles

A block diagram of WF1983/WF1981 is shown in Figure ☞ Figure 1-1, and block diagram of WF1984/WF1982 is shown in Figure ☞ Figure 1-2.

■ Analog Section

- PLL generates various clocks from the 20MHz clock from the system controller.
- The FPGA for waveform generation generates various types of oscillations and waveforms. It generates a sampling signal when the waveform is an arbitrary waveform. Modulation, sweeps, and bursts are also processed inside this FPGA.
- The digital waveforms generated 240MS/s (WF1983/WF1984) are controlled to the specified polarity (normal or inversed) and amplitude range (-FS/0, ±FS, 0/+FS), and then input into the D/A converter.
- After 2× oversampling, the D/A performes amplitude control and the waveform is converted to an analog signal, whitch is then smoothed by the LPF (lowpass filter).
- The amplitude is controlled in 10dB steps by the PG AMP (variable gain amp).
- An external addition signal and DC offset are added to the PG AMP output. If an output voltage of ±0.4V/open or less is sufficient, output is via a ×1/5 attenuator. If an output voltage greater than ±2V/open is required, output is via a ×5 amplifier.
- The maximum output voltage of this product is 21Vp-p, 4Vp-p, or 0.8Vp-p depending on whether or not the ×1/5 attenuator or the ×5 amplifier is used. Correspondingly, the external addition gain changes to ×10, ×2, or ×0.4.
- The DC offset is selected from 0dB or -14dB range to provide optimum resolution.
- The external modulation signal is passed through the LPF, and then converted from analog to digital and input into the FPGA.
- The analog section is isolated from the system controller section which is at enclosure potential.
- In the WF1984/WF1982, there are analog sections for two channels that are each independent and insulated from the enclosure potential.

■ System Controller

- This section handles the display, panel key processing, remote control (USB, LAN, and GPIB*), trigger inputs and performs frequency reference control, waveform generation FPGA control and analog section contlrole such as amplitude, and DC offset.
- A 20MHz temperature-compensated crystal oscillator is used as the source for waveform generation.
- The signal to synchronize multiple units is sent to REF OUT (frequency reference output), and also an inter-channel synchronization signal is sent to the analog section of each channel.

■ Power Supply

- The AC/DC source directly connected to the power input is in a constantly powered state.
- The startup, shutdown, and other control of the power supply circuit of each section is performed by power switch operation.

*) GPIB interface is not present on WF1982/WF1981

■ WF1983/WF1981 block diagram

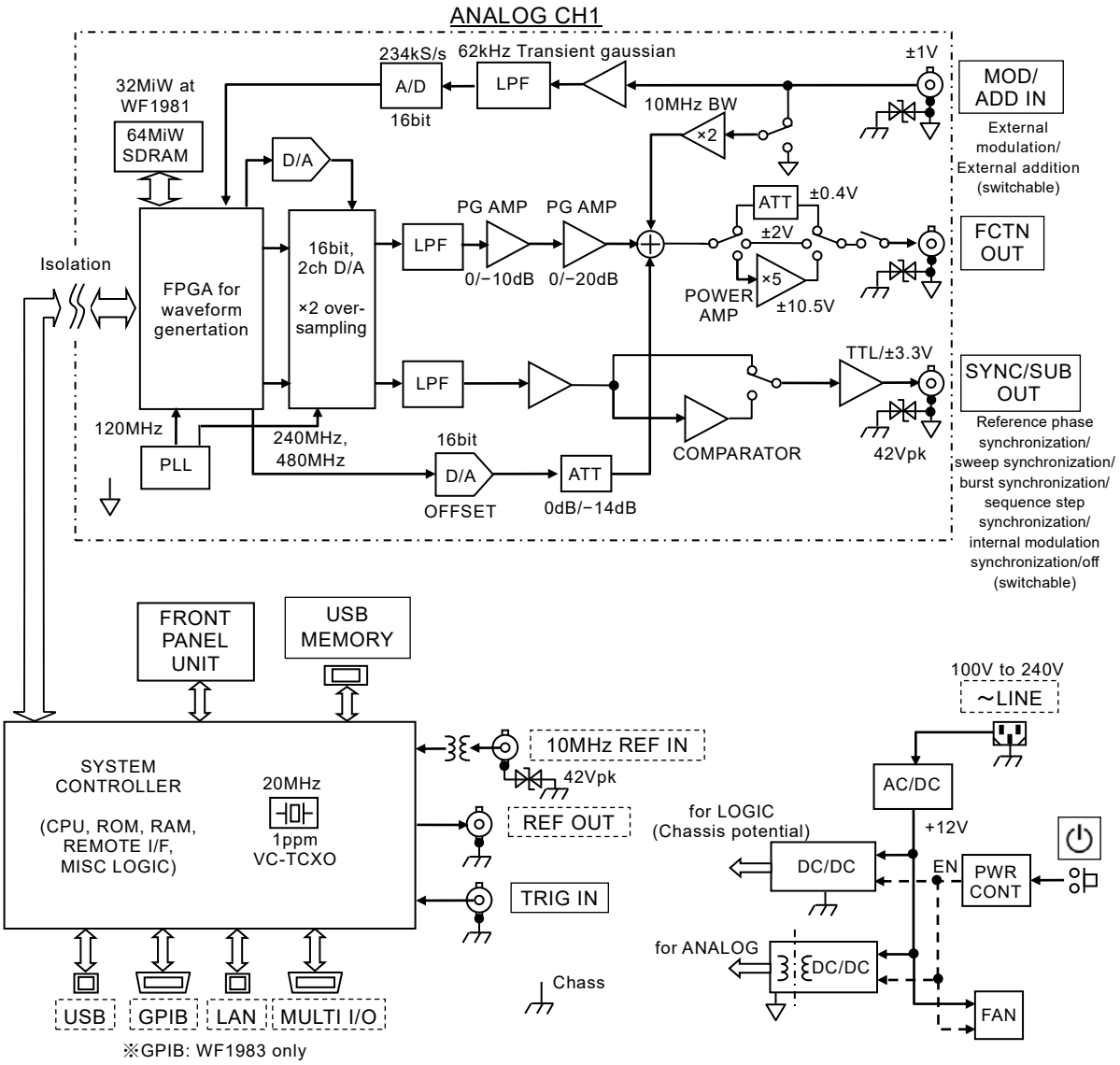


Figure 1-1 WF1983/WF1981 block diagram

■ WF1984/WF1982 block diagram

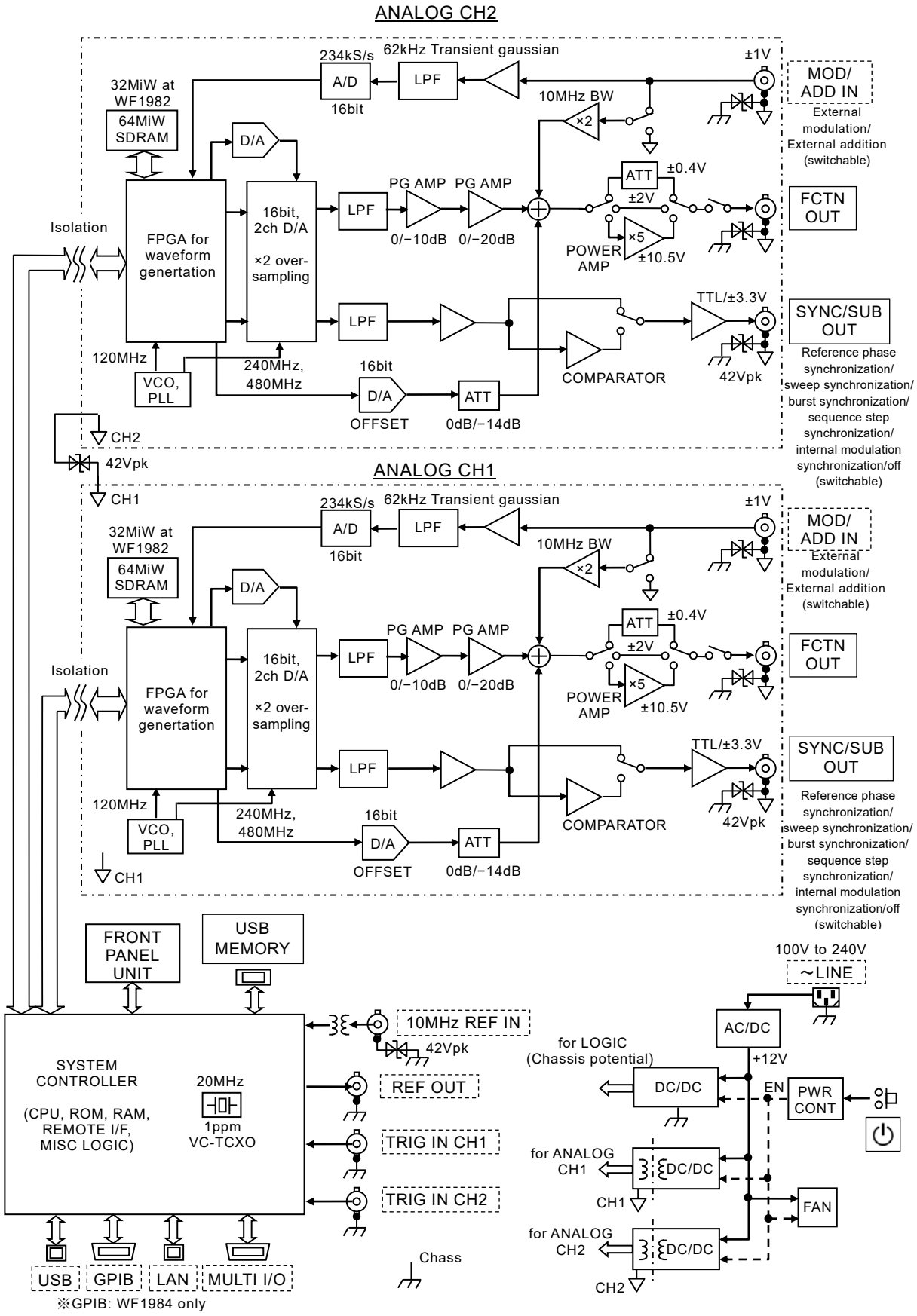


Figure 1-2 WF1984/WF1982 block diagram

2. Preparations Before Use

2.1 Checking Before Use

a) Safety check

For your own safety, please be sure to first read the following sections of this manual.

- ☞「Safety Precautions」(It is listed at the beginning of this instruction manual.)
- ☞「2.3 Grounding and Power Supply Connection」

b) Checking the Exterior and Accessories

If the exterior of the cardboard container appears to be damaged (scrapes, dents, etc.), carefully check the product for any signs of damage after taking it out of the container.

Check all of the items that were taken out of the container.

If there are any signs of damage to the exterior of the product, missing accessories, or other problems, contact NF Corporation or one of our representatives.

- **Checking the Exterior**

  Check that the panels, knobs, connectors, and other parts are not damaged or dented.

- **Checking the Configuration and Accessories**

  This product is configured as follows: Please confirm that no items are missing or damaged.

Main unit 1
Accessories
  Power cable set (2m with 3-pin plug) 1
  Safety Information 1
  Quick start guide 1

⚠ WARNING

This product contains high-voltage components. Do not remove its cover. Inspections of the product's interior should only be performed by service technicians authorized by NF Corporation.

c) Options

The following options are available. Please purchase them separately.

- Multi-I/O Cable (PA-001-1318)

  This cable is used when using the multi-I/O connector on the rear panel.
  A 2m multi-core shielded cable is connected to the mini-Dsub 15-pin connector. The opposite end is cut off, so process it according to the connection target.
  For details on connector pin assignment and cable differentiation, ☞ P.3-14

- Rack Mounting Kit

  This kit contains adapters for mounting the instrument in a 19-inch IEC and EIA standard rack or JIS standard rack. There are four types of adapter in total, an adapter for one unit and an adapter for two units (for side-by-side mounting) for each product model.

2.2 Installation

a) Installation location

Do not place the instrument with the rear panel facing downward. The connectors may be damaged and ventilation will be blocked. Place the instrument on a flat surface such as on a desk so that the four rubber feet and stands on the bottom rest on that surface.

b) Installation conditions

- **This product uses forced-air cooling by fan.**
  There are air intake and exhaust vents on the sides and rear panel. Install the instrument with its sides and rear panel at least 10cm away from walls and other obstructions to so that the air circulation will not be blocked.
- **Install the instrument in a location where the temperature and humidity meet the following conditions.**
  Operation: 0 to 40℃, 5 to 85%RH
  Storage: −10 to 50℃, 5 to 95%RH
  Use the instrument in a condensation-free state. For limitations related to absolute humidity, refer to the specifications in this manual.
- **Install the instrument at an altitude of 2 000m or less.**
- **Do not install the instrument in the following locations:**
  - Location where inflammable gas is present
    There is a risk of an explosion. Never install and use the instrument in such an environment.
  - Outdoors, location exposed to direct sunlight, or located near fire or a heat source
    The instrument may not meet the performance specifications or may fail.
  - Place with corrosive gas, moisture, dirt, or dust, place with high humidity, or place with high salinity
    The instrument may corrode or fail.
  - Place near an electromagnetic field source, high-voltage equipment, or power line
    The instrument may malfunction.
    Powerful electromagnetic radio frequencies may mix with the output.
  - Location with excessive vibration
    The instrument may malfunction or fail.

c) Rack mounting method

This product can be mounted in a 19-inch IEC and EIA standard rack or JIS standard rack using a rack mounting kit (optional). There is a kit for one unit and a kit for two units.

First, attach the rack mounting kit to the main unit, and then mount the unit in the rack. For how to use the rack mounting kit, refer to the manual included with the kit. Pay attention to the following points when mounting the instrument in a rack.

- Be sure to install rails in the rack to support the instrument.
- Do not mount this product in a fully enclosed rack as the internal temperature may rise high enough to cause a failure.

  Provide sufficient ventilation holes in the rack, or provide forced-air cooling by fan.

For the dimensional drawings for rack mounting, refer to:

Rack mount (EIA, for 1 unit PA-001-3838)	☞ P.17-30
Rack mount (EIA, for 2 unit PA-001-3839)	☞ P.17-31
Rack mount (JIS, for 1 unit PA-001-3840)	☞ P.17-32
Rack mount (JIS, for 2 unit PA-001-3841)	☞ P.17-33

2.3 Grounding and Power Supply Connection

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, be sure to ground this product so that the ground resistance is 100Ω or less.

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

a) Power supply conditions

Rated voltage: AC 100V to 240V

Rated frequency: 50Hz / 60Hz ±2Hz

Power consumption: WF1983/WF1981: 50VA or lower, WF1984/WF1982: 75VA or lower

b) Connection procedure of the power source

1) Confirm that the voltage of the commercial power source to be connected is within the allowable voltage range of this product.
2) Connect the power cord to the power supply inlet on the rear panel of this product.
3) Connect the power cord to a three-pin power supply outlet.

⚠ CAUTION

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

⚠ WARNING

Maintain enough space around the inlet to enable the connector of the power cord to be removed from the inlet or use a power outlet located at a convenient place with adequate space around it so that the plug can be removed from the outlet.

The power cable set can be used to separate the product from the commercial power supply in case of emergency.

2.4 Various Downloads

Search for the latest firmware and instruction manuals for this product as well as the application software for editing arbitrary waveforms and sequences from the support page of our website (https://www.nfcorp.co.jp/english/).

For how to check the firmware version of the product, see section 13.4. ☞ P. 13-4

2.5 Calibration

Although dependent on the operating environment and frequency of use, this product should undergo performance testing at least once a year. In addition, we recommend performing a performance test immediately before carrying out important measurements and tests.

Performance testing should be performed by a person with experience operating and general knowledge about measuring instruments.

For details on performance testing, ☞ P.15-5

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.
In the following text, the keys on the panel will be expressed as [ENTER], [0] ... [9].

3.1.1 Front panel of WF1983/WF1981

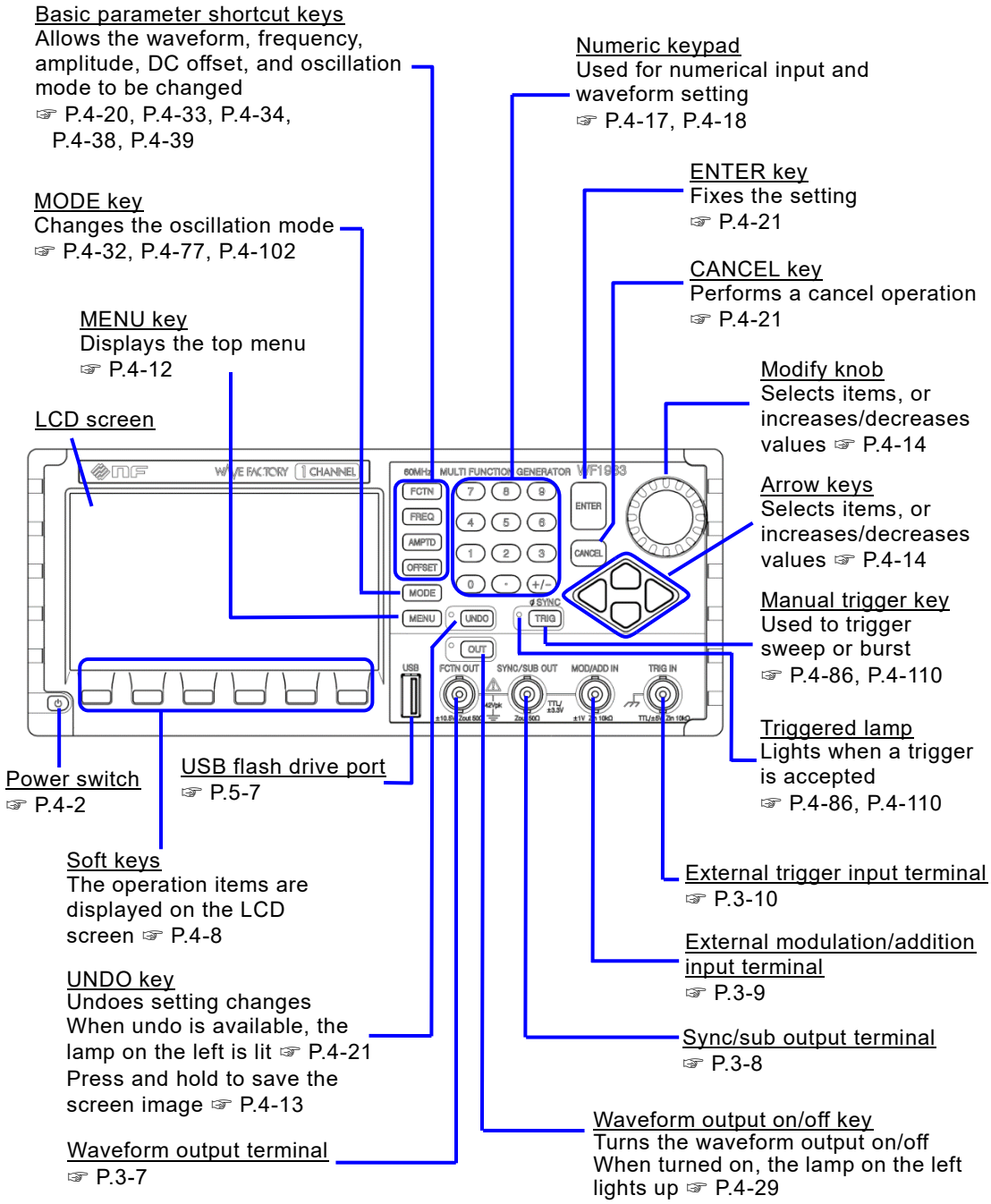
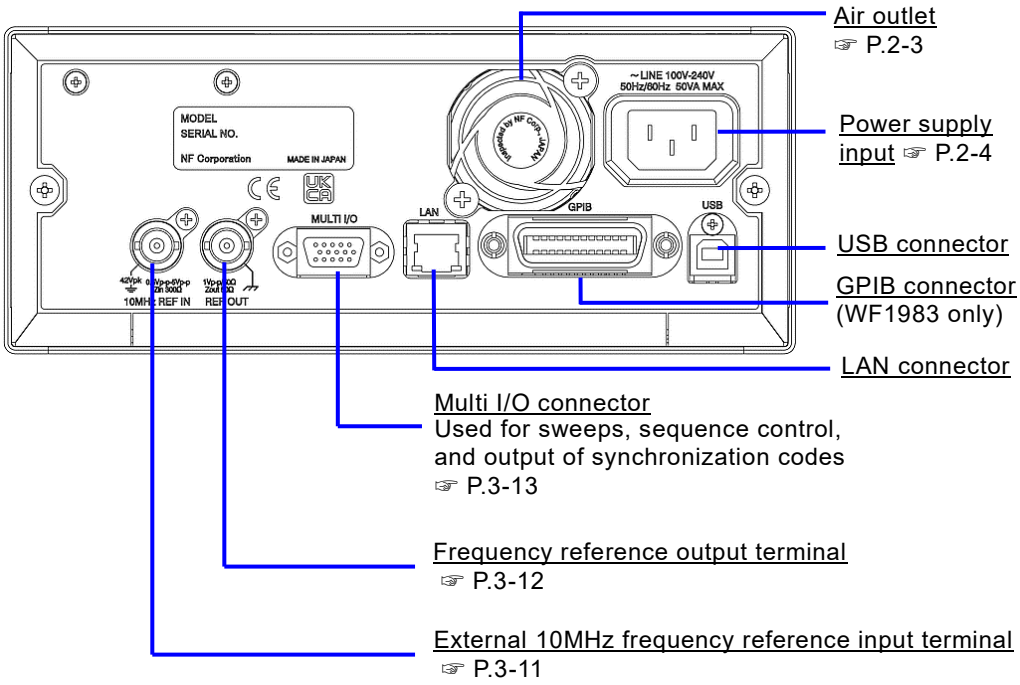


Figure 3-1 Front panel of WF1983/WF1981

3.1.2 Rear panel of WF1983/WF1981



Air outlet
☞ P.2-3

Power supply input ☞ P.2-4

USB connector

GPIB connector
(WF1983 only)

LAN connector

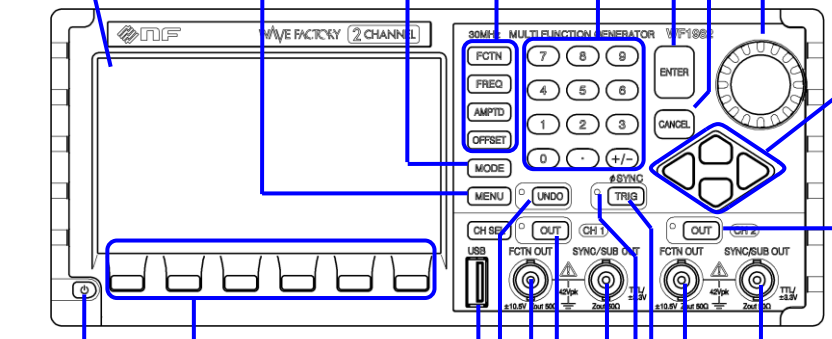
Multi I/O connector
Used for sweeps, sequence control, and output of synchronization codes
☞ P.3-13

Frequency reference output terminal
☞ P.3-12

External 10MHz frequency reference input terminal
☞ P.3-11

Figure 3-2 Rear panel of WF1983/WF1981

3.1.3 Front panel of WF1984/WF1982



Basic parameter shortcut keys
Allows the waveform, frequency, amplitude, DC offset, and oscillation mode to be changed
☞ P.4-20, P.4-33, P.4-34, P.4-38, P.4-39

MODE key
Changes the oscillation mode
☞ P.4-32, P.4-77, P.4-102

MENU key
Displays the top menu
☞ P.4-12

LCD screen

Power switch
☞ P.4-2

Soft keys
The operation items are displayed on the LCD screen ☞ P.4-8

UNDO key
Undoes setting changes
When undo is available, the lamp on the left is lit ☞ P.4-21
Press and hold to save the screen image ☞ P.4-13

CH1 Waveform output terminal
☞ P.3-7

USB flash drive port
☞ P.5-7

Numeric keypad
Used for numerical input and waveform setting
☞ P.4-17, P.4-18

ENTER key
Fixes the setting
☞ P.4-21

CANCEL key
Performs a cancel operation
☞ P.4-21

Modify knob
Selects items, or increases/decreases values ☞ P.4-14

Arrow keys
Selects items, or increases/decreases values ☞ P. 4-14

CH2 waveform output on/off key
Turns the CH2 waveform output on/off.
When turned on, the lamp on the left lights up
☞ P.4-29

CH2 Sync/sub output terminal
☞ P.3-8

CH2 Waveform output terminal
☞ P.3-7

Manual trigger key
Used to trigger sweep or burst
☞ P.4-86, P.4-110

Triggered lamp
Lights when a trigger is accepted
☞ P.4-86, P.4-110

CH1 Sync/sub output terminal
☞ P.3-8

CH1 waveform output on/off key
Turns the CH1 waveform output on/off
When turned on, the lamp on the left lights up ☞ P.4-29

Figure 3-3 Front panel of WF1984/WF1982

3.1.4 Rear panel of WF1984/WF1982

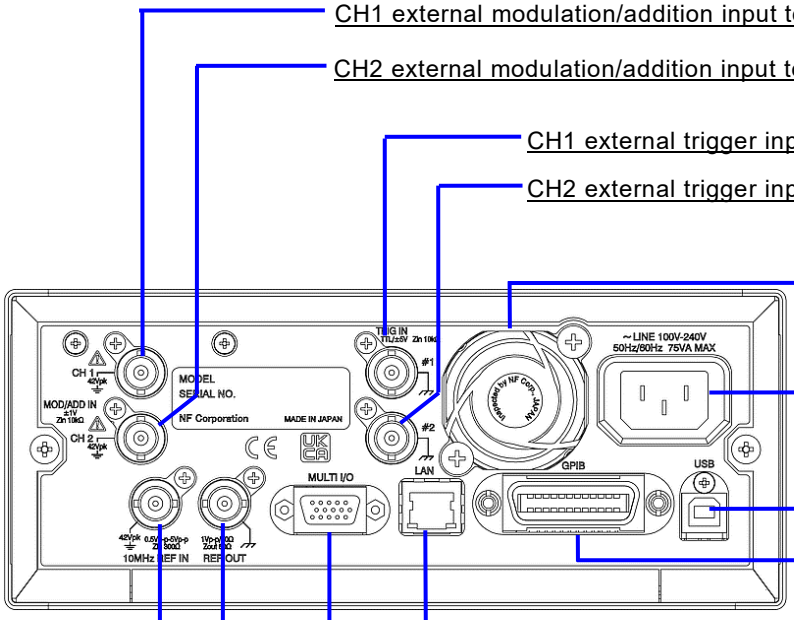


Figure 3-4 Rear panel of WF1984/WF1983

3.2 I/O Terminals

⚠ WARNING

To prevent electric shocks, do not apply a voltage exceeding 42Vpk (DC + AC peak) between the ground of the BNC connectors insulated from the enclosure and the enclosure.
Also, do not apply a voltage exceeding 42Vpk (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 voltage that is too high may cause the product to burnout.
☞ P.3-15

⚠ 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

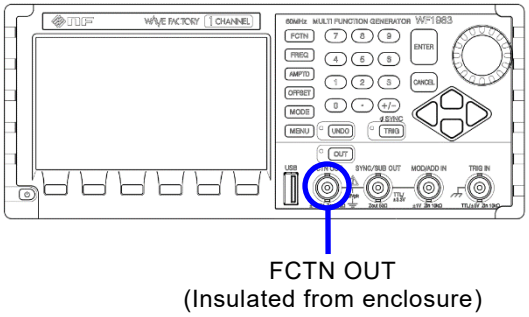
If a difference in potential exists between the ground of a BNC connector insulated from the enclosure and the enclosure, do not short-circuit the hot side of that BNC connector and the enclosure. This may damage the product.

⚠ CAUTION

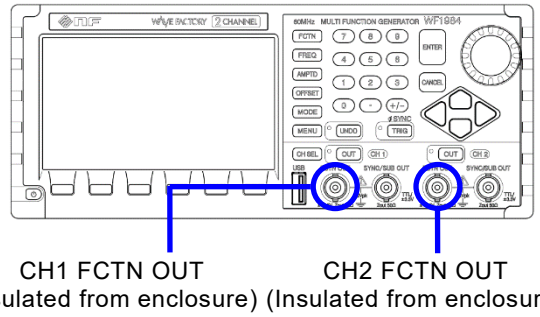
If a difference in potential exists between the grounds of BNC connectors, do not short circuit these BNC connector grounds. This may damage the product.

3.2.1 Waveform Output (FCTN OUT)

WF1983/WF1981



WF1984/WF1982



A signal with the set waveform, frequency, and amplitude is output.

■ Output characteristics

Output voltage	Maximum ±10.5V/open
Output impedance	50Ω
Load impedance	0Ω or higher (can be short-circuited)
Signal GND	Insulated from the enclosure (maximum 42Vpk). In WF1984/WF1982 also insulated between channels (maximum 42Vpk)

Check

- A mechanical relay is used for the on/off setting of FCTN OUT waveform output. This causes chattering to occur when the waveform output is switched on or off. Please use the trigger burst or gate oscillation mode when connecting to equipment which might malfunction due to chattering. ☞ P.4-108, P.4-112
- The relay inside the instrument for switching output on/off is a part with a limited life. Switching output on/off frequently may lead to a failure early and even within the warranty period of the product. The life expectancy of the relay is about 100 000 times. Also consider using the trigger burst and gate oscillation modes instead of on/off. ☞ P.4-108, P.4-112
- When external addition is on (☞ P.4-46), depending on the input signal applied to the addition input terminal, an output voltage exceeding ±10.5V/open may be output.

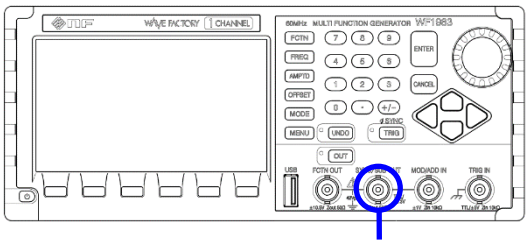
■ Operation during overload

If excessive voltage is applied from the outside, “Output overload detected (CH:<CH>-FCTN OUT)” will be displayed and the output will be turned off. Press the OUT button to turn it on again.

Do not apply external voltage as this may cause malfunction.

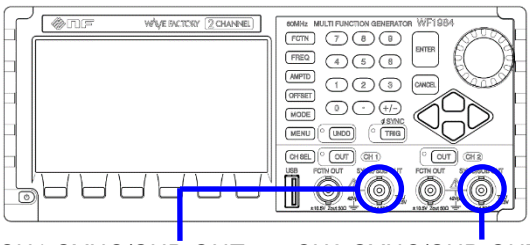
3.2.2 Synchronization/Sub-output (SYNC/SUB OUT)

WF1983/WF1981



SYNC/SUB OUT
(Insulated from enclosure)

WF1984/WF1982



CH1 SYNC/SUB OUT
(Insulated from enclosure)

CH2 SYNC/SUB OUT
(Insulated from enclosure)

A synchronization signal is output according to the waveform or oscillation status. This signal can be used as the synchronization signal for oscilloscope.

An internal modulation signal or sub waveform can also be output. If a synchronization signal is not required, you can use it as an additional channel.

As shown in the following table, the output signal can be selected according to the oscillation mode and operation mode.

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

Oscillation Mode		Selectable output signal
Other than sweep / burst mode ☞ P.4-68	Modulation function is off or modulation source is external	• Reference phase synchronization signal (see the table below, TTL level) • Sub waveform reference phase synchronization signal (TTL level) • Sub waveform (maximum -3.3V to +3.3V/open) ☞ P.4-123
	Modulation function is on and modulation source is internal	• Reference phase synchronization signal (TTL level) • Internal modulation waveform reference phase synchronization signal (TTL level) • Internal modulation signal (maximum -3.3V to +3.3V/open) ☞ P.4-66
Sweep mode ☞ P.4-88		In addition to options other than sweep/burst mode: • Sweep synchronization signal (TTL level) • Combination of marker and sweep synchronization signal (TTL level)
Burst mode ☞ P.4-107, P.4-111, P.4-114, P.4-118		In addition to options other than sweep/burst mode: • Burst synchronization signal (TTL level)
Sequence oscillation ☞ P.11-11		• Reference phase synchronization signal (TTL level) • LSB of step synchronization code (TTL level)

■ About reference phase

The reference phase is an internal timing signal that becomes the base for generating the waveforms that are output to the waveform output. There is also a reference phase for sub-waveforms and internal modulation signals that is independent of the waveform output.

With the WF1984/WF1982, the reference phase of each channel is independent. Each of the reference phases can be first zeroed by the phase synchronization operation. ☞ P.8-6

■ About reference phase synchronization signal

The reference phase synchronization output is a 50% duty TTL level logic signal that rises at 0º of the reference phase. If the phase setting is changed, the phase between the reference phase synchronization signal and waveform output can be changed. ☞ P.4-36

At high frequencies, there is a phase difference equivalent to about 10ns even with a 0º setting due to the difference in the propagation delay time of the output circuits of the waveform output and synchronization/sub output. This phase difference can be adjusted by setting the phase.

■ Output characteristics

Output voltage	TTL level (low ≤ 0.4V, high 2.7V ≤ , 0 or 3.3V/open), Maximum -3.3V to +3.3V/open (variable)
Output impedance	50Ω
Load impedance	50Ω or higher is recommended
Signal GND	Same potential as the same channel waveform output, and insulated from the enclosure (maximum 42Vpk). In WF1984/WF1982, also insulated between channels (maximum 42Vpk)

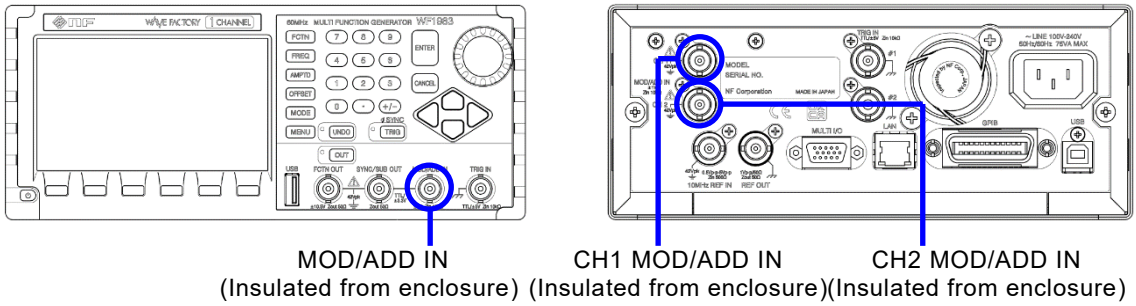
■ Operation during overload

If excessive voltage is applied from the outside, “Output overload detected (CH:<CH>-SUB OUT)” is displayed and the output impedance becomes approximately 160Ω. When the applied voltage is removed, the output impedance returns to 50Ω.

Do not apply external voltage as this may cause malfunction.

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

WF1983/WF1981 WF1984/WF1982



When the modulation source is external, except for ‘FSK’ and ‘PSK’, an external modulation signal is input. For ‘FSK’ and ‘PSK’, the external trigger input (TRIG IN) is used as the 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 (Gain from input terminal to waveform output terminal when load is open) is ×0.4, ×2, or ×10.

- External modulation input ☞ P.4-67
- External addition input ☞ P.4-46

For WF1984/WF1982, each channel uses a dedicated MOD/ADD IN terminal.

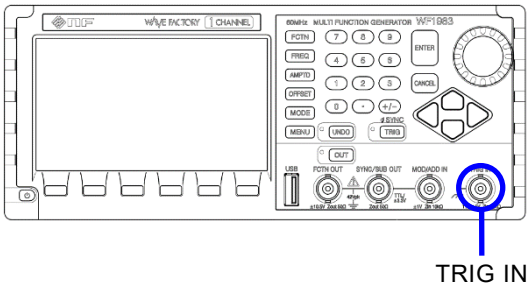
■ Input characteristics

Input voltage	±1V full scale
Maximum allowable input	±2V
Input impedance	10kΩ
Input frequency	During modulation: DC to 50kHz (-3dB) During addition: DC to 10MHz (-3dB)
Signal GND	Same potential as the same channel waveform output, insulated from the enclosure (maximum 42Vpk). In WF1984/WF1982, also insulated between channels (maximum 42Vpk)

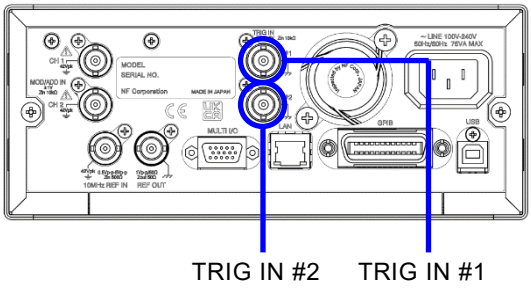
Check

Even if the external modulation/addition setting is off, do not input a voltage exceeding ±1V to the external modulation/addition input (MOD/ADD IN) BNC terminal. The input signal may be mixed into the output, causing overload or distortion of the output signal.

WF1983/WF1981



WF1984/WF1982



3.2.4 External Trigger Input (TRIG IN)

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

- Start trigger of single sweep ☞ P.4-86
- Start trigger of gated single sweep ☞ P.4-86
- Start trigger of trigger burst oscillation ☞ P.4-110
- Gate of gate oscillation ☞ P.4-113
- Trigger of triggered gate oscillation ☞ P.4-117
- Start trigger of sequence oscillation ☞ P.11-11

It can also be used as an input in the following cases, and the polarity and threshold can be changed in the same way.

- 'FSK', 'PSK' external modulation input ☞ P.4-67
- Sync source for synclator function ☞ P.4-120

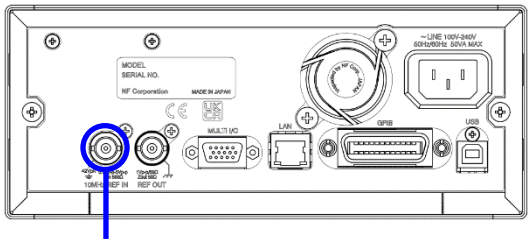
With WF1984/WF1982, you can select whether to use TRIG IN #1 or #2 for each channel.

■ Input characteristics

Input voltage	TTL level (low ≤ 0.8V, high 2.6V ≤) or Variable (Threshold variable range -5.0V to +5.0V, resolution 0.1V)
Maximum allowable input	−7V to +7V
Input impedance	10kΩ (pull up to +3V when TTL, pull down to GND when variable)
Signal GND	Same potential as the enclosure

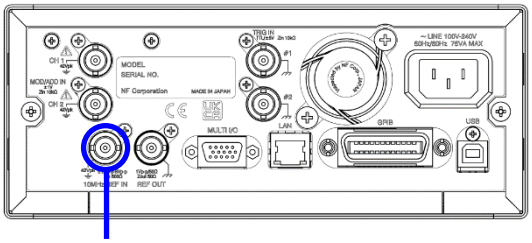
3.2.5 External 10MHz Frequency Reference Input (10MHz REF IN)

WF1983/WF1981



10MHz REF IN
(Insulated from enclosure)

WF1984/WF1982



10MHz REF IN
(Insulated from enclosure)

This terminal can be used for the following purposes.

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

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

Switch the external frequency reference setting to 'Enable'. ☞ P.10-4

■ To unify the frequency and phase of multiple WF198x units

Connect the frequency reference output of the primary unit when multiple units are connected together with a synchronous connection, or the primary WF198x to the external 10MHz frequency reference input of the secondary WF198x.

Also, switch the external frequency reference setting of the secondary units to 'Enable', and perform the ΦSync reference phase initialization operation on the primary unit. ☞ P.9-4

The connected WF198x units all have the same frequency accuracy as the primary unit. A signal from an external frequency standard can be used for the primary unit.

■ Input Characteristics

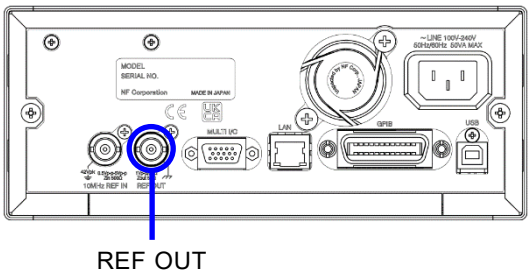
Input voltage	0.5Vp-p to 5Vp-p
Maximum allowable input	10Vp-p
Input impedance	300Ω, unbalanced, AC coupled
Input frequency	10MHz ± 50kHz
Input waveform	Sine or square wave (50±5% duty)
Signal GND	Insulated from enclosure and each channel waveform output (maximum 42Vpk).

Check

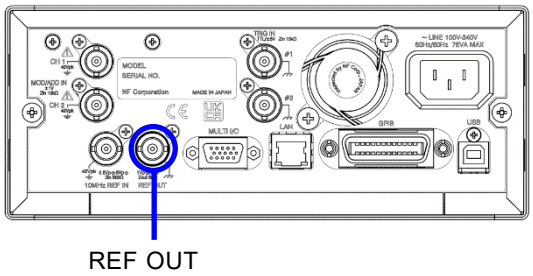
- When not using frequency reference input, do not input a signal to this terminal. The instrument may malfunction.
- Do not connect REF OUT and 10MHz REF IN of the same enclosure. The instrument will malfunction.

3.2.6 Frequency Reference Output (REF OUT)

WF1983/WF1981



WF1984/WF1982



This terminal is used to unify the frequency and phase of multiple WF198x units.
Connect the frequency reference output of the primary unit when multiple units are connected together with a synchronous connection, or the primary WF198x, to the external 10MHz frequency reference input of the secondary WF198x. ☞ P.9-2

■ Output Characteristics

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

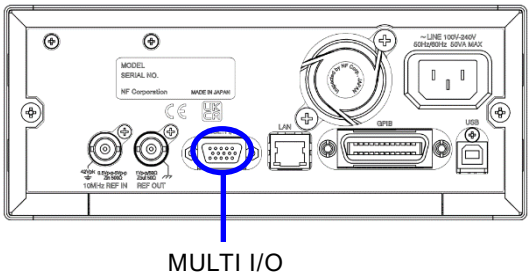
Check

We do not recommend connecting any equipment other than our specified equipment (WF198x series, etc.) to the frequency reference output.

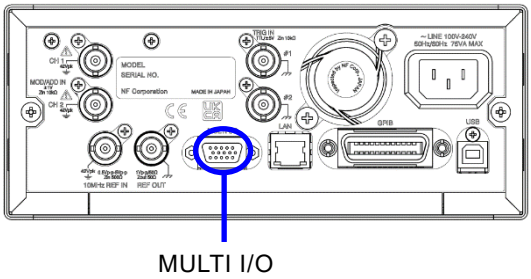
The special signal that is output from this terminal during synchronization (☞ P.9-5) may make the operation of such connected equipment unstable.

3.2.7 Multi-I/O (MULTI I/O)

WF1983/WF1981



WF1984/WF1982



This terminal can be used for sweep and sequence control. It outputs the step synchronization code for the sequence. Can also be used as a 4-bit general-purpose input and 4-bit general-purpose output port with remote commands.

■ Control Input for sweep mode

Sweep oscillation can be controlled as follows using 3-bit logic input. ☞ P.4-90

Start	Starts the sweep from beginning by fall input. ORed with external trigger input.
Stop	Stops the sweep by fall input.
Hold/Resume	Holds the sweep by fall input during sweep execution. Resumes the sweep from the hold point by fall input during a hold.

■ Control Input for sequence oscillation

Sequence oscillation can be controlled as follows using 4-bit logic input. ☞ P.11-11

Start or State branch	You may choose start control or state branch control. During start control, the sequence is started from the beginning by fall input. ORed with external trigger input. During state branch control, the sequence is branched to the designated destination step by low level input at the end of the step.
Stop	Stops the sequence by fall input.
Hold/Resume	Holds the sequence by fall input during sequence execution. Resumes the sequence from the hold point by rise input during a hold.
Event Branch	Branches the sequence to the designated destination step by fall input.

■ Step synchronization code output for sequence oscillation

The 4-bit step synchronization code specified for each step is output.

The step synchronization code output has a time delay of approximately ±1µs and a jitter of approximately 200ns.

Check

When control input of the multi I/O will not be used, we recommend disabling control input to prevent a malfunction due to external noise. ☞ P.4-90

Also, apply a signal with chattering removed to the input pin.

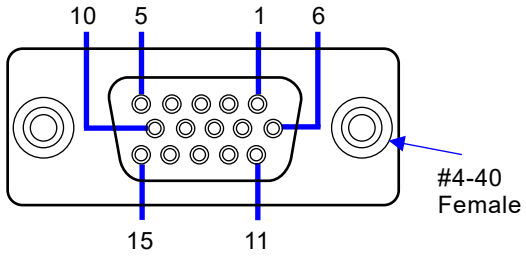


Figure 3-5 Multi-I/O connector pin configuration diagram

Table 3-2 Multi-I/O connector pin assign

Pin No.	I/O	Sweep mode	Sequence oscillation	General purpose I/O (Note 2)	Insulation color / marking (Note 3)
1	Output	Not in use	Step synchronization code D0 (LSB)	General-purpose output 0	Light brown / Black
2	Output	Not in use	Step synchronization code D1	General-purpose output 1	Light brown / Red
3	Output	Not in use	Step synchronization code D2	General-purpose output 2	Yellow / Black
4	Output	Not in use	Step synchronization code D3 (MSB)	General-purpose output 3	Yellow / Red
5	Output	Do not connect anything.	Do not connect anything.	Do not connect anything.	Bright green / Black
6	GND	—	—	—	Bright green / Red
7	GND	—	—	—	Gray / Black
8	GND	—	—	—	Gray / Red
9 Note 1	Reserved	Do not connect anything.	Do not connect anything.	Do not connect anything.	White / Black
10	GND	—	—	—	White / Red
11	Input	Not in use	Event branch	General-purpose input 0	Light-brown / Black Black
12	Input	Hold/resume	Hold/resume	General-purpose input 1	Light-brown / Red Red
13	Input	Stop	Stop	General-purpose input 2	Yellow / Black Black
14	Input	Start	Start or state branch	General-purpose input 3	Yellow / Red Red
15	Input	Not in use	Not in use	Not in use	Bright green / Black Black
Shell	—	—	—	—	Bright green / Red Red

Note 1: +5V is output to pin no.9, but do not connect the pin to anything because it is for production. The product may become unstable if this pin is used.

Note 2: This can be used as the input and output of each 4 bits that can be read and written by external control. For details, refer to “Enable of Multi I/O Connector (W/R)” in Instruction Manual (Remote Control).

Note 3: Indicates an optional connection cable. ☞ P.17-25
Please contact us or our agent.

■ I/O Characteristics

Input voltage	TTL level (low ≤ 0.8V, high 2.6V ≤)
Maximum allowable input	−0.5V to +5.5V
Input impedance	10kΩ, pull up to +5V
Output voltage	TTL level (low ≤ 0.4V, high 2.7V ≤ , 0 or 3.3V/open)
Signal GND	Same potential as the enclosure
Connector	Mini D-sub 15-pin

3.3 Cautions on Floating Ground Connection

The signal ground of the BNC terminals for waveform output, synchronization/sub-output, and modulation/addition input is shared, but since it is insulated from the enclosure (ground potential), it can be connected to equipment that has a different potential. It also reduces the influence of rack potential during rack mounting.

In WF1984/WF1982, the above-mentioned BNC terminals are also insulated between channels.

Furthermore, the signal ground of the 10MHz frequency reference input is also insulated from the enclosure. This reduces the effects of noise caused by ground loops when connecting to frequency standards.

Even when multiple WF198x series units are connected synchronously, the effects of noise caused by ground loops are reduced.

Note that, in all cases, the floating voltage should be limited to 42Vpk (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 conductor terminal of the power supply input.

⚠ WARNING

To prevent electric shocks, do not apply a voltage exceeding 42Vpk (DC + AC peak) between the ground of the BNC connectors insulated from the enclosure and the enclosure.
Also, do not apply a voltage exceeding 42Vpk (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 voltage that is too high may cause the product to burnout.

⚠ 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 WF1983/WF1981**

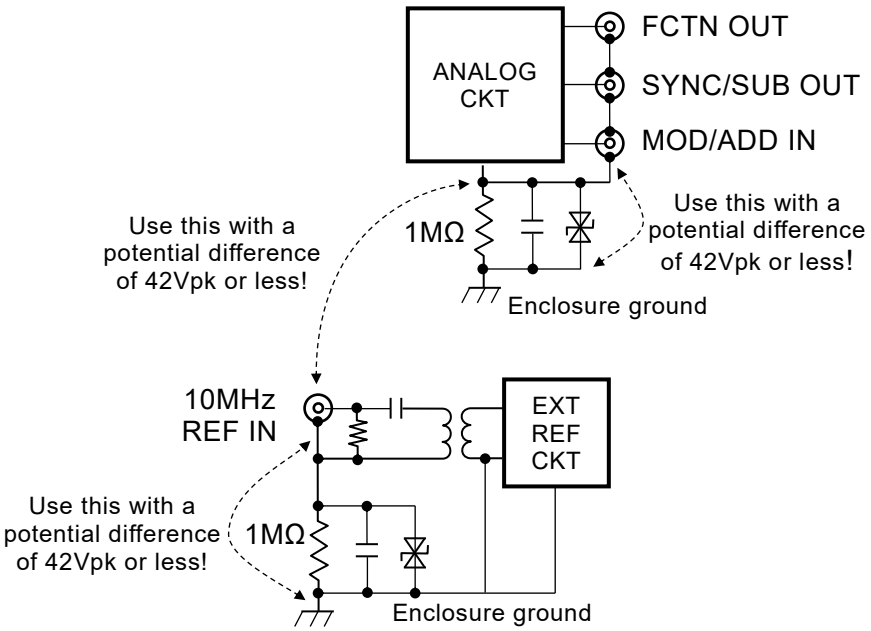


Figure 3-6 Cautions on floating ground connection for WF1983/WF1981

■ **Cautions on floating ground connection for WF1984/WF1982**

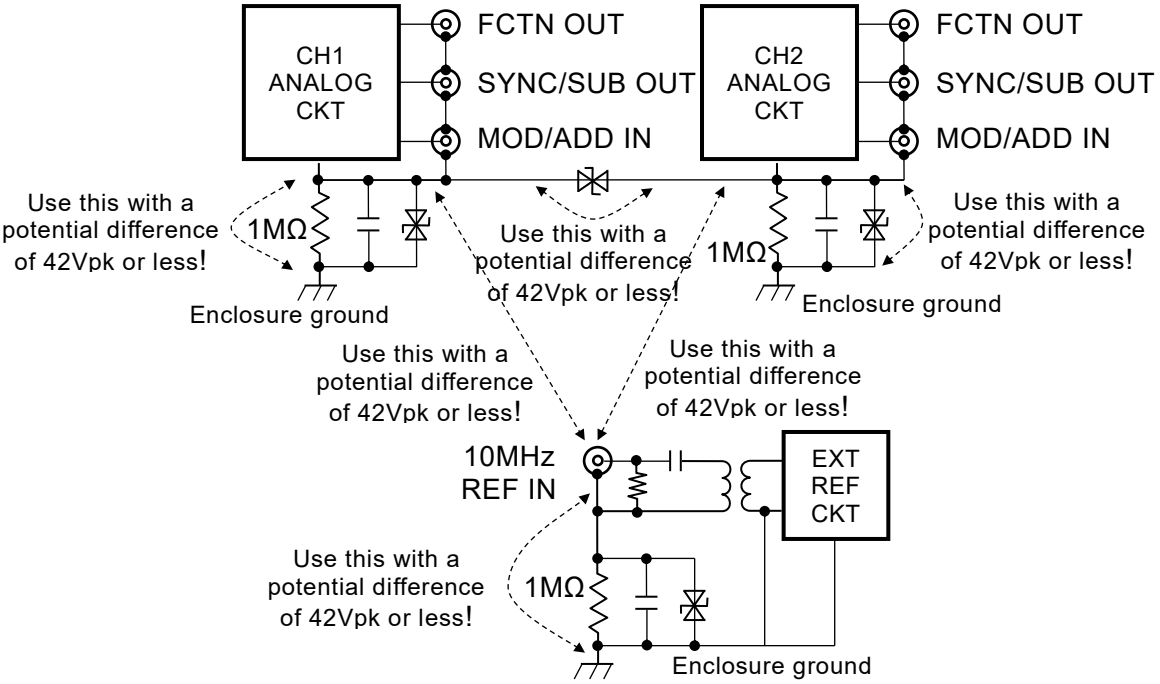


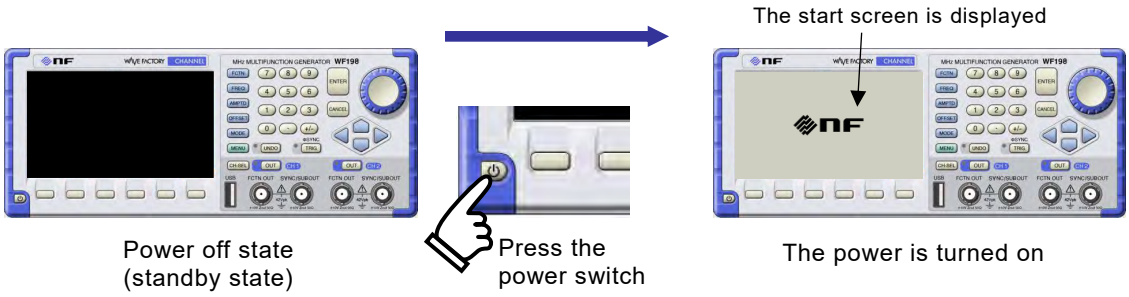
Figure 3-7 Cautions on floating ground connection for WF1984/WF1982

4. Basic Operations

4.1 Power On/Off and Restoration of settings

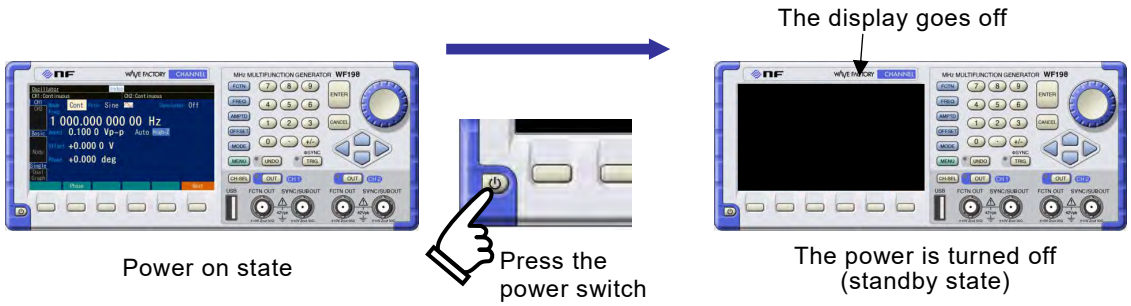
4.1.1 How to Turn Power On/Off

■ Power-on operation



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

■ Power-off operation



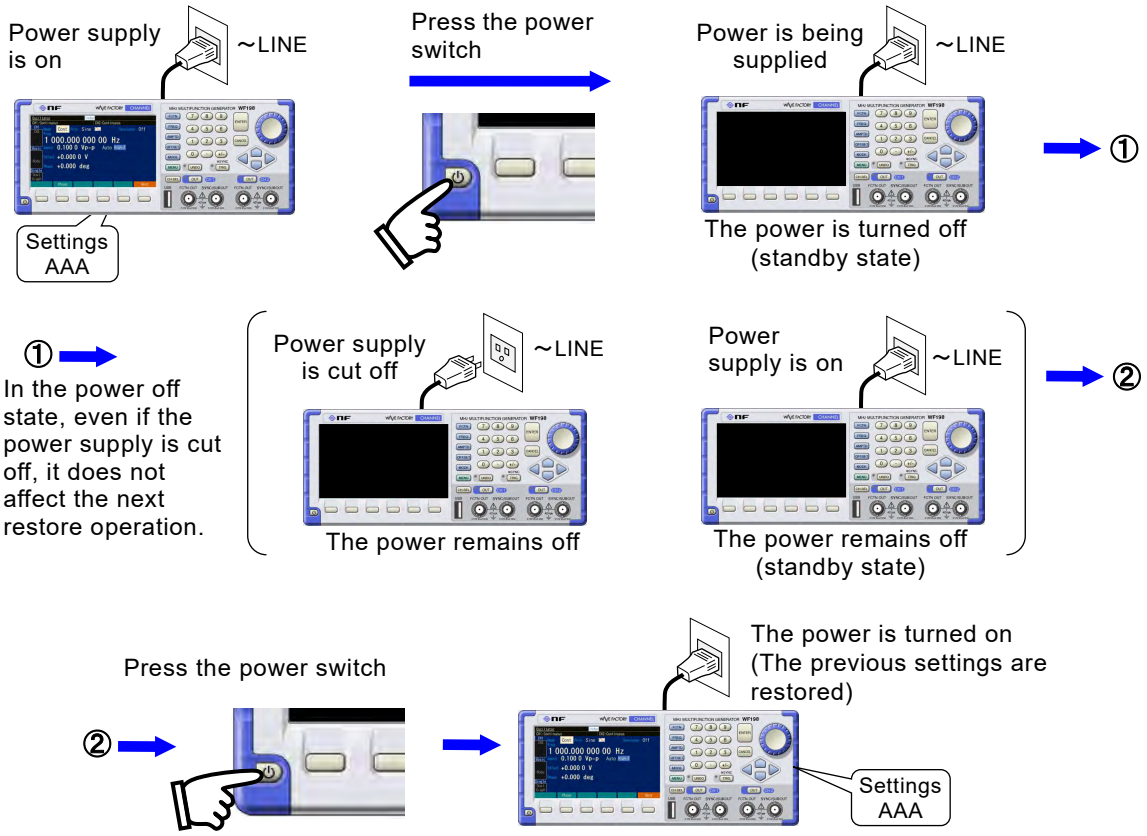
4.1.2 Restoration of Settings at Power-on

When the power is turned on by the power switch, the settings when the power switch was last turned off are restored. However, the output on/off and normal/sequence oscillation mode settings at power-on can be set on the Utility screen. ☞ P.4-29

If the power supply is directly cut off without operation of the power switch, it will be set to setting memory #1 if the operating mode at power-on is normal oscillation, or to sequence memory #1 if the operating mode is sequence oscillation. (Output on/off setting is set in Utility)

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

The most general case is illustrated below.



While the power is off, even if the power supply is cut off by, for example, shutting off the breaker or even if the power cable is disconnected, this will not affect the restore operation when the power is turned on again next time.

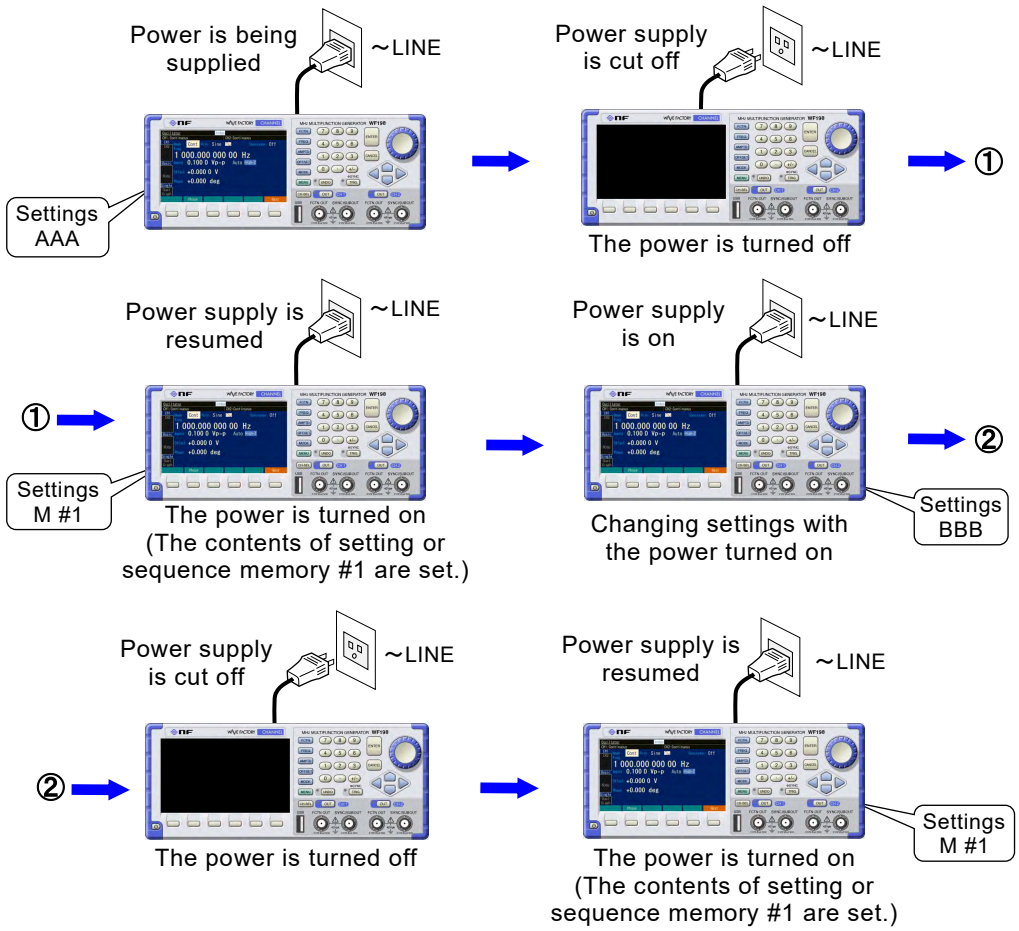
- The settings before the last power-off are restored. (If the operation mode when the power is turned on is 'Last State')
- The output on/off settings and operation mode (Normal/Sequence oscillation) settings when the power is turned on can be changed on the Utility screen. ☞ P.4-29
- In sequence oscillation mode, if it has already been compiled, it will return to Rdy state.

Check

The previous settings are restored only when 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.
In this case, whether the operating mode is normal oscillation or sequence oscillation is determined by the operating mode setting at power-on on the Utility screen. ☞ P.4-29



- The settings immediately before are not restored. The contents of the arbitrary waveform edit memory and sequence being edited will also be lost.
- The output on/off settings and operation mode (Normal/Sequence oscillation) settings when the power is turned on can be changed on the Utility screen. ☞ P.4-29
- In case of normal oscillation mode, the contents of setting memory #1 are set. ☞ P.5-2
- In case of sequence oscillation mode, the contents of sequence memory #1 are automatically compiled (to Rdy state) ☞ P.11-16

Check

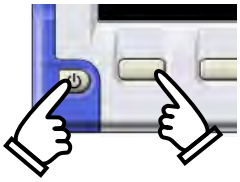
Since the settings before the power supply is cut off are not restored, specify the contents of setting memory #1 or sequence memory #1 in advance. ☞ P.5-2, P.11-22
The operating mode (normal oscillation/sequence oscillation) upon recovery must be set in advance on the Utility screen. ☞ P.4-29

c) To check RAM at startup

During normal startup, the RAM in the system controller is not checked.

To check the RAM at startup, press the power switch while holding down the soft key to the right of the power switch.

This can be used to diagnose when the instrument is malfunctioning.



While pressing the soft key next to the power switch, press the power switch.

4.2 Screen Configuration and Operation

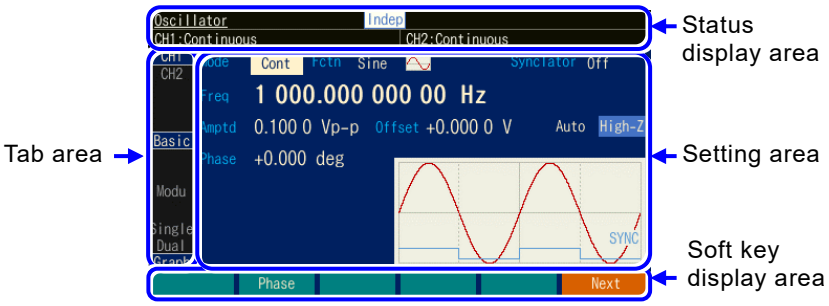
In the following text, the keys on the panel will be expressed as [ENTER], [0] ... [9].

When the name of a soft key is "Next", it is written as [Next]. (See the right edge of the following figure)

In addition, if a dialog is displayed and has an OK button, it is also written as [OK].

4.2.1 Screen Configuration

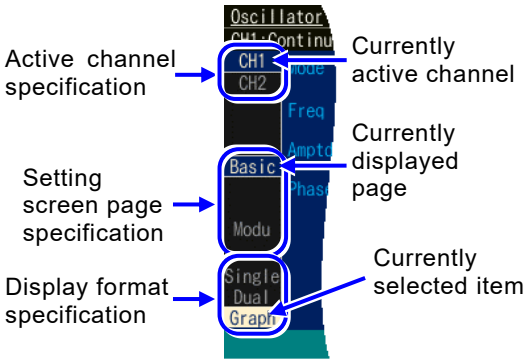
The LCD screen consists of four areas, as shown in the following figure.



a) Tab area

These tabs are for switching the setting parameters to display in the setting area. To switch, select the desired tab and press the [ENTER] key.

The tabs are split into three groups, and the settings that are displayed vary depending on the combination of the three tabs. The three groups indicate the active channel specification, setting screen page specification, and display format specification, respectively.



- Active channel specification (WF1984/WF1982)

  This indicates the channel to be displayed / operated in the setting area. Instead of selecting tabs and switching them with the [ENTER] key, also switch with the [CH SEL] key. ☞ P.4-24

- Setting screen page specification

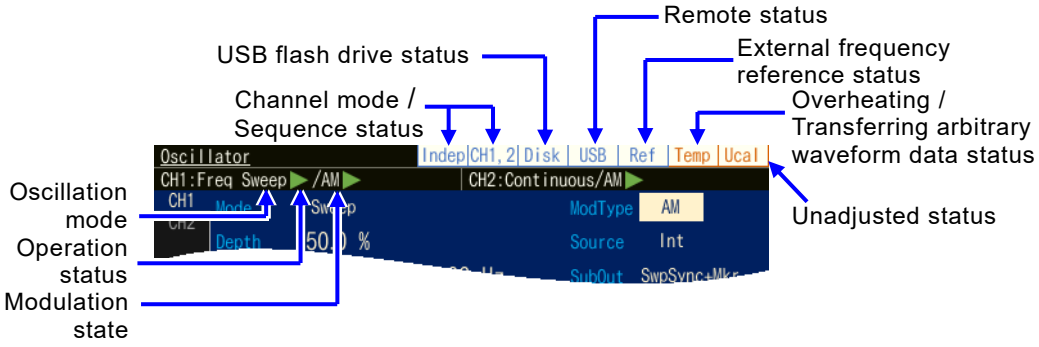
  This allows you to switch the page to be displayed in the setting area, also switch using the [Next] soft key. ☞ P.4-9 This tab group does not appear in sequence oscillation mode.

- Display format switching

  This allows you to switch the format for the setting parameters displayed in the setting area. ☞ P.4-10 The settings displayed are the same regardless of the display format.

b) Status display area

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



In the following text, the icon in the first row of the status display is expressed as the <name>.

- Channel mode: When the operating mode is normal oscillation (WF1984/WF1982)

  Displays the current channel mode.

  Indep(independent) / Phas(2-phase) / Tone(constant frequency difference) / Ratio(constant frequency ratio) / Diff(differential output) / Diff2(voltage doubler output)

  In addition, CH1,2 are displayed when the channel equivalency setting function (CH LINK) is enabled.

  Channel mode ☞ P.8-2, Channel equivalency setting function ☞ P.4-24, P.8-5

- Sequence state: When the operating mode is sequence oscillation (☞ P.11-1)

  Displays the current sequence status.

  Edit (Create/Edit) / Rdy (Executable) / Run (Running)

- USB flash drive status: Disk

  Displayed when a valid USB flash drive is inserted.

- Remote status: USB, LAN, GPIB

  Displayed when the product is controlled via USB, LAN, or GPIB (WF1983/WF1984 only).

- External frequency reference status: Ref

  Displays whether a valid signal is input or not when the external frequency reference is enabled. And flashes when no valid signal is input.

- 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 40ºC or less, it indicates a failure, so please contact NF Corporation or one of our representatives.

- Transferring arbitrary waveform data status: ARB

  This icon blinks when transferring arbitrary waveform data to waveform memory. While this is displayed, the waveform being rewritten is output.

- Unadjusted status: Ucal

  Displayed when the correction values of the product are lost for some reason, and the prescribed performance cannot be maintained. As this indicates a failure, please contact NF Corporation or one of our representatives.

- Oscillation mode

  Displays the current oscillation mode.

  “Continuous”(continuous oscillation) / “Freq Sweep”(frequency sweep) / “Phase Sweep”(phase sweep) / “Amptd Sweep”(amplitude sweep) / “Offset Sweep”(DC offset sweep) / “AutoBurst”(auto burst) / “Trigger”(trigger burst) / “Gate”(gate oscillation) / “TrigGate”(trigger gate oscillation)

  For details on the oscillation mode setting see ☞ P.4-32

  If the specified oscillation cannot be performed due to a conflict in settings, “Conflict” will appear here, blinking.

- Operation status

  Displays the oscillation status when in sweep mode and burst mode.

  : waiting for trigger, ■: waiting for trigger dealy, ▶: executing, and ▮▮: paused.

- Modulation state

  When the modulation type ☞ P.4-63 is not ‘Off’, displays the modulation function status.

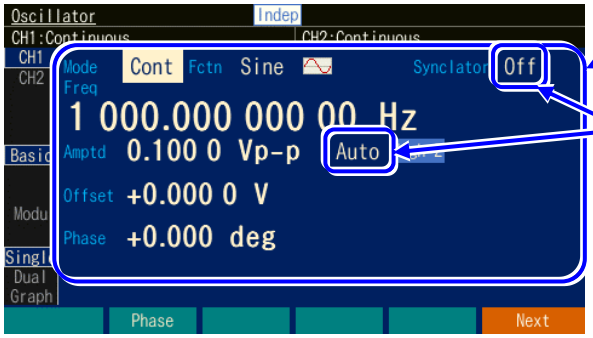
  ■: stopped, ▶: executing.

c) Setting area

This area is used to display and set the parameters. The settings displayed in the setting area vary depending on which of the tabs in the tab area are selected.

In the following example, the basic parameters of “CH1” are displayed in “Single” format.

For details on switching the tabs, ☞ P.4-9



Setting area: The display contents of this area change depending on the selected tab

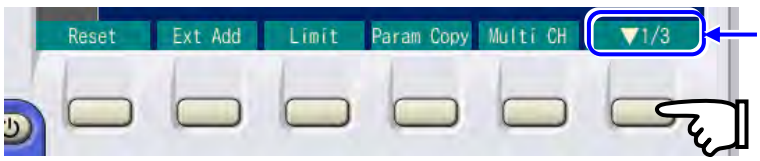
For such areas, select this area and press the ENTER key to display options

There are lower settings items here, select and Press ENTER to move to another screen

d) Soft key display area

This area displays the functions and names of the soft keys which are allocated according to the situation. If more than six 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 rows in total, and that the set for the nth row is currently displayed. When you press this right-most key, the soft key set for the next row is displayed.

In the following text, when the soft keys are named “Reset” or “Limit”, they will be expressed as [Reset] or [Limit].



Indicates that the first of 3 rows of soft keys are displayed. The soft keys for the next row are displayed with each press

4.2.2 Setting screen page switching

The setting screen has a total of four pages, and the names “Basic”, “Sweep”, “Burst”, and “Modu” are displayed respectively for them in the tab area. (This page switching does not occur when the operation mode is sequence oscillation.)

Page 1 “Basic” and page 4 “Modu” are always displayed, and page 2 “Sweep” is displayed additionally when in sweep mode and page 3 “Burst” is displayed additionally when in burst mode.

There are page 1 and page 4, and page 1 is displayed in the setting area

The page of the setting screen can be switched with the [Next] soft key

Press the [Next] soft key to switch pages. Or, select the tab you want to switch using the modify knob or arrow keys, and press the ENTER key.

In the example on the left, there are page 1 “Basic” and page 4 “Modu”, and an indication shows that page 1 is being displayed.

If you press the soft key [Next], tabs that are not displayed at that time will be skipped.

a) Setting screen types

■ Page 1: “Basic”

This page is for displaying the frequency, amplitude, DC offset, and other basic parameters. The number of displayed items may increase depending on the waveform.

The page is indicated by the name “Basic” in the tab area. This page can always be selected.

■ Page 2: “Sweep”

This page is for displaying the sweep start value, sweep time, and other parameters specific to the sweep mode.

The page is indicated by the name “Sweep” in the tab area. This page is displayed only when in the sweep mode.

■ Page 3: “Burst”

This page is for displaying the mark wave number, trigger source selection, and other parameters specific to the burst mode.

The page is indicated by the name “Burst” in the tab area. This page is displayed only when in the burst mode.

■ Page 4: “Modu”

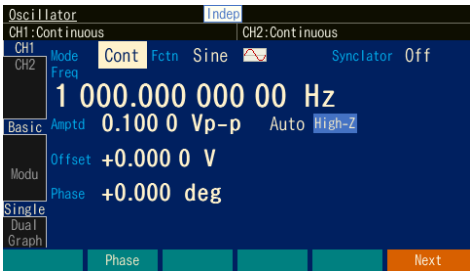
This page is for displaying modulation parameters such as modulation type and modulation source, and synchronization/sub-output parameters. The displayed items vary depending on the waveform and modulation type.

The page is indicated by the name “Modu” in the tab area. This page can always be selected.

4.2.3 Switching Display format with Tabs

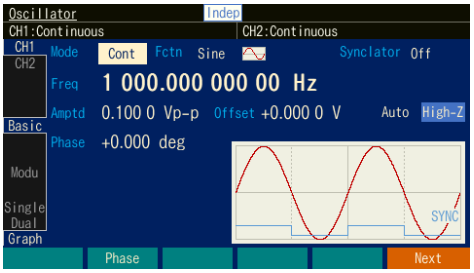
When multiple display formats can be selected, the display format switching tabs are displayed on the left side of the screen. For example, if the "Graph" tab screen is displayed, you can set the parameters while checking the image of the output waveform. For WF1984/WF1982, the channel to be set can be switched using the CH SEL key in any case. ☞ P.4-24

a) Display format during normal oscillation



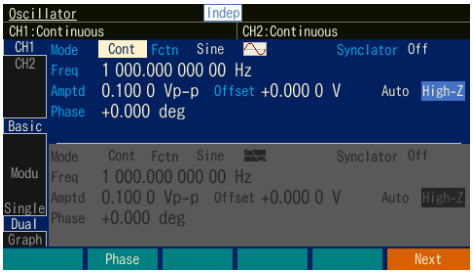
■ Text display "Single"

Displays the settings for one channel in text format.
This display format has the largest font for excellent visibility.



■ Graph display "Graph"

Displays the settings for one channel in both text and graph formats.
This allows you to check an image of the output waveform.



■ 2-channel simultaneous display "Dual" (WF1984/WF1982)

Displays the settings of CH1 and CH2 in text format arranged vertically one above the other.
Settings for both channels can be viewed at the same time, but the channel to be set can be switched using the CH SEL key.

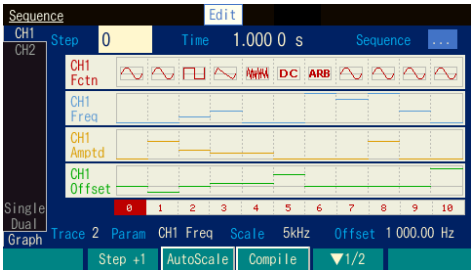
b) Display format during sequence oscillation (☞ P.11-21)

■ Text display "Single"

Displays step control parameters and intra-step channel parameters for one channel.
Sequence common settings can be displayed by selecting [...].

■ 2-channel simultaneous display "Dual" (WF1984/WF1982)

Displays in-step channel parameters for 2 channels instead of step control parameters.



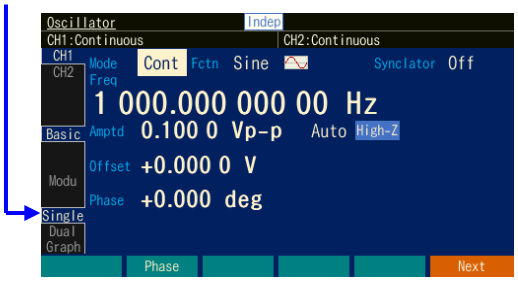
■ Graph display "Graph"

Displays the trend of four specified intra-step channel parameters. However, you cannot change each parameter setting here.
You can capture an image of the output sequence.

c) To switch the display format

The following is an operation when the operation mode is normal oscillation, but it is also the same when the operation mode is sequence oscillation.

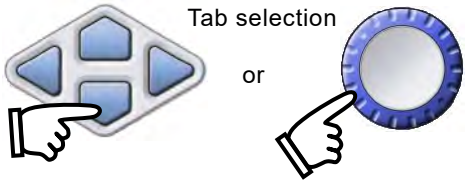
The “Single” tab screen is displayed



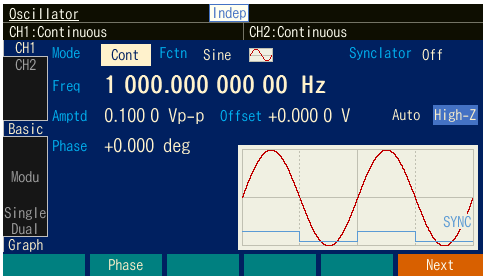
1. In the example on the left, the “Single” tab screen is displayed.
On this screen, the settings are displayed in text format.

The “Graph” tab is selected

2. Use the arrow keys or the modify knob to select the “Graph” tab.



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

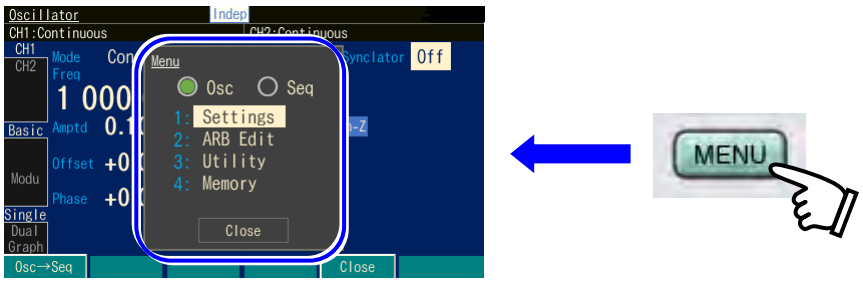
In WF1984/WF1982, the display can be switched between 2-channel simultaneous display (“Dual” tab) and 1-channel display (“Single” tab) with the tabs.

4.2.4 Top Menu

Oscillator/sequence switching, arbitrary waveform editing, system settings, saving and recalling settings, and other tasks can be performed by selecting the desired item from the top menu.

a) To display the top menu

Pressing the MENU key displays the following top menu window.



The menu items are displayed

Select the desired item with the arrow keys or the modify knob and then press ENTER key. The settings screen for that menu item will be displayed.

With the top menu window open, you can use the numeric keypad 1 to 4 to specify menu items.

b) Operations available using top menu items

In the setting screens displayed with each menu item, you can configure the following settings and perform the following operations.

■ Osc/Seq selector buttons

Switches between normal oscillation and sequence oscillation operation mode. ☞ P.4-15

■ Settings 1

Transition to the screen where you can set the parameters for normal oscillation or sequence oscillation.

■ ARB Edit 2

Edits an arbitrary waveform. Also saves and reads arbitrary waveform data. ☞ P.7-5

■ Utility 3

Sets and operates various items. ☞ P.4-25

■ Memory 4

Data is saved to and read from the setting memory during normal oscillation, and from the sequence memory during sequence oscillation.

Saving and recalling settings ☞ P.5-2, P.5-4

Saving and recalling sequence data ☞ P.11-22, P.11-24

Saving and recalling arbitrary waveform data using “ARB Edit 2”. ☞ P.7-10, P.7-12

4.2.5 Saving a Screenshot

Save the current screen to USB flash drive. This function can be used for tasks such as recording setting information when making an inquiry and creating work instructions.

a) Operation

Connect the USB flash drive to save screen image to the front panel. When valid USB flash drive is inserted into the front panel, Disk will be displayed in the status area (☞ P.4-7).

Perform the operation that displays the screen to be saved.

Press and hold the UNDO key for at least 1 second.

"Screen capture is saved" will be displayed, and the image file of the screen at that time will be saved.

b) Save destination

The file is saved in the folder name "<model name>ScreenShot" in the USB flash drive.

(<model name> is, for example, WF1984)

The folder is created if it does not exist.

The file format of a created file is bmp, the number of colors is 65 000, and the size of one file is 256Ki bytes.

The file name is ScreenShot<X>.bmp. The <X> at the end of the file name is an integer value from 00001 to 99999, and increases by 1 each time it is saved, and the value after 99999 is 00001.

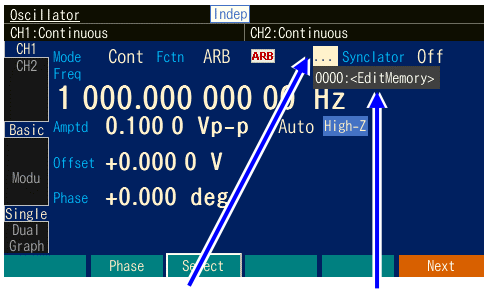
4.3 Basic Settings and Operations

4.3.1 To select the item you want to set

With this device, select an item on the screen other than the status area (☞ P.4-6 for details on each area) using the modify knob or arrow keys, and press the ENTER key to operate/set that item.

You can cycle through all setting items on the current screen with just the modify knob.

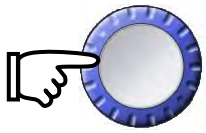
Some settings can be opened directly using shortcut keys (on the front panel ☞ P.4-20 or soft keys).



Currently selected item
Move with modify knob or arrow keys

Example of selected item information (arbitrary waveform name)

Arrow keys



Modify knob

a) Tab area ☞ P.4-6

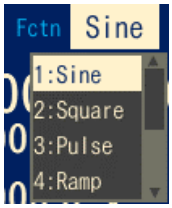
Switch the screen to that tab with the ENTER key. If you want to set an item that is not currently displayed, select that item and press the ENTER key.

b) Setting area ☞ P.4-8

The setting area has the following items: selection list/lower settings/numeric entry/text entry/button. Use the ENTER key to open options, go to the settings screen for that item, or perform that function.

■ **Selection list** (How to operate ☞ P.4-18)

You can switch between items that have options. (Example: “Fctn” ☞ P.4-33) Depending on the item, information about that item will be displayed before pressing ENTER.



■ **Lower settings**

Select this item and press the ENTER key to switch to the screen for setting lower setting items. (Example: [...] when “Fctn” = ‘PWF’ ☞ P.4-59) Depending on the item, information about that item will be displayed before pressing ENTER.

■ **Numeric entry** (How to operate ☞ P.4-16)

Example: “Phase” ☞ P.4-36 (Modify or numeric key entry →)

■ **Text entry** (How to operate ☞ P.4-19)

Example: MENU>Memory [Store], “Name” ☞ P.5-2

c) Soft key display area ☞ P.4-8

The ENTER key performs the same action as pressing that soft key.

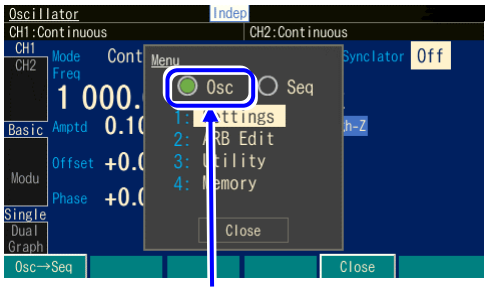
In this text, soft keys with the name “abc” are written as [abc].

Check

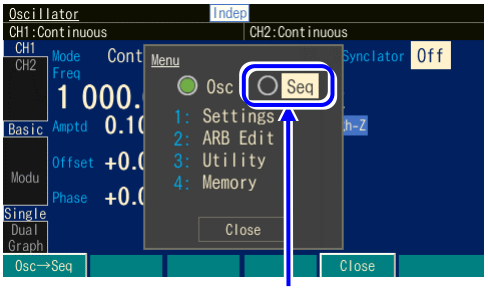
If a setting item name is displayed on a soft key, you can directly select the input field for that item using the soft key.

4.3.2 To switch operating mode (Oscillator or Sequence oscillation)

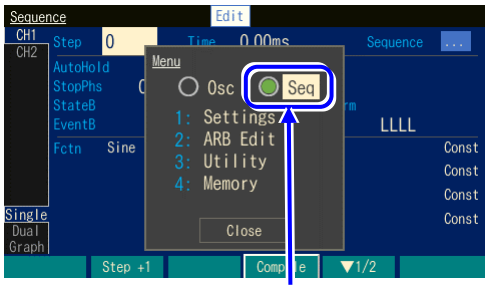
For the two operating modes (normal oscillation/sequence oscillation), please refer to ☞ P.11-4.



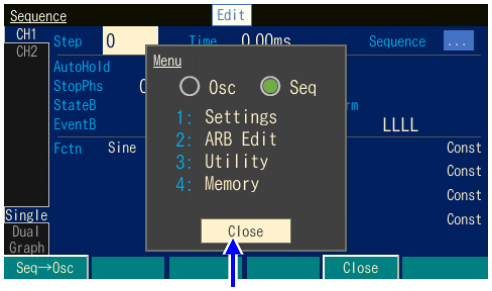
The current operation mode is displayed



Select “Seq” and then press the ENTER key



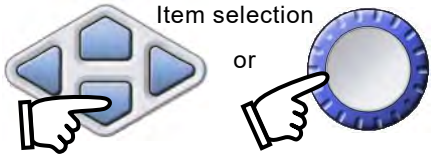
“Seq” selected



Select [Close] and then press the ENTER key.

1. Press the (MENU) key to display the top menu.
The example on the left is for oscillator.
Try switching this to sequence.

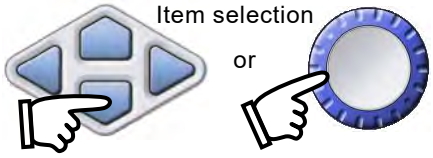
2. Select “Seq” with the right/left arrow keys or the modify knob and then press the (ENTER) key.



Instead of selecting “Seq” and pressing (ENTER), you can also switch by pressing the soft key [Osc→Seq]. To switch to normal oscillation, select “Osc” or press the soft key [Seq→Osc].

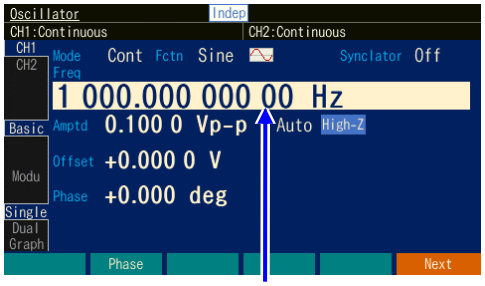
3. Confirmation dialog will appear.
Press [OK] soft key or select [OK] in the dialog and press the (ENTER) key to enter sequence oscillation mode and move the button position to “Seq”.

4. Press the (CANCEL) key or press [Close] soft key or select [Close] item with the up/down arrow keys or the modify knob and then press the (ENTER) key to close the top menu.

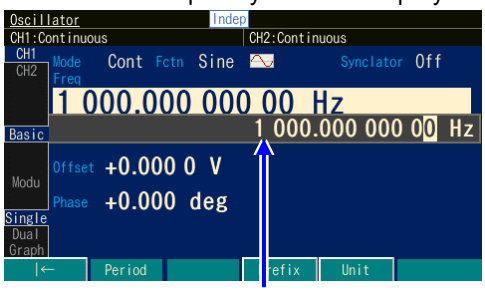


4.3.3 To change Values such as frequency and amplitude

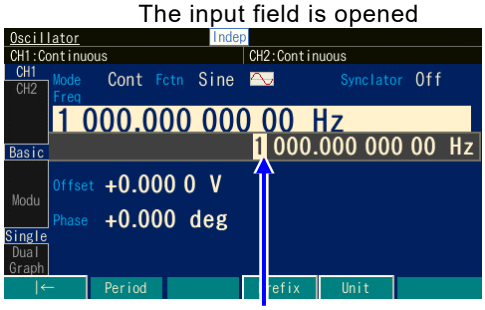
a) To change a value with the up/down arrow keys (or the modify knob)



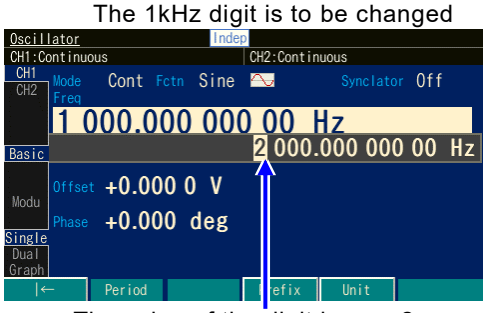
The frequency is selected
The current frequency value is displayed



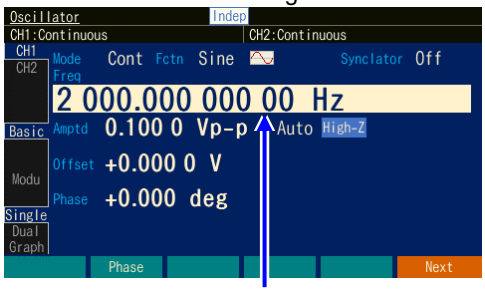
The input field is opened



The 1kHz digit is to be changed

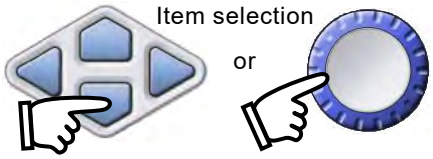


The value of the digit is now 2



The input field is closed

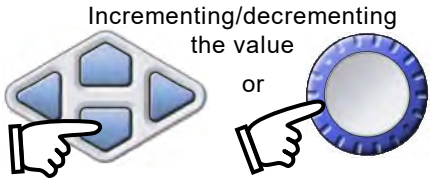
1. Select the desired item with the arrow keys or the modify knob. ☞ P.4-14 In the example on the left, the "Freq" field is selected.



2. Press the ENTER key to open the input field to change the current value. In this state, you can enter a value using the numeric keypad. ☞ P.4-17

3. Press the left/right keys to move the cursor to the digit to change the value. Use the sof tkey [|←] to move the cursor to the left end, the current most significant digit, or the right end. In the example on the left, the cursor is moved to the 1kHz digit.

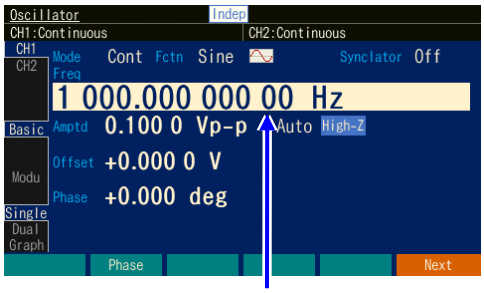
4. Increment or decrement the value of the digit using the up/down keys or modify knob. In the example on the left, the value is changed to 2kHz. The change is immediately reflected in the output.



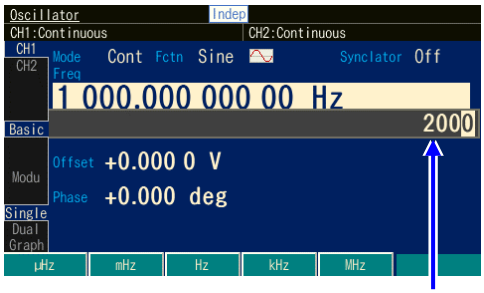
5. For some setting items, the unit or the prefix (k, m, etc.) can be changed. Use the left/right keys to move the cursor to those areas and use the modify knob or up/down keys to change the units or prefixe. You can move directly to the unit or prefix using the soft keys [Unit] and [Prefix]. ☞ P.4-22 Soft keys that change the input format (e.g. frequency ⇔period, amplitude/offset⇔high/low, etc.) may be available. ☞ P.4-35, 4-40

6. Press the ENTER key to close the input field. Instead, pressing the CANCEL key discards the changed value and reverts to the previous setting.

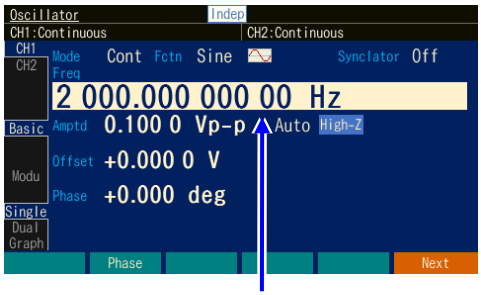
b) To change a value with the numeric keypad 0 ... 9



The frequency is selected
The current frequency value is displayed



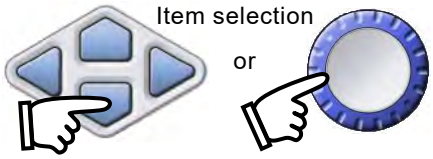
The input field is opened
and a value is input



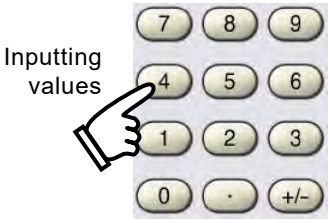
The setting is changed, and
the input field is closed.

1. Select the desired item with the arrow keys or the modify knob. ☞ P.4-14

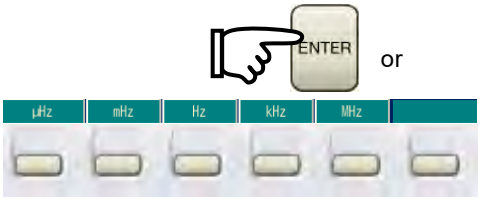
In the example on the left, the frequency “Freq” field is selected.



2. Press the numeric keypad to open the input field and enter the numeric value.
While inputting numeric values, the left arrow key serves as the delete key, and the right arrow key as the 0 key.



3. Press the ENTER key or the unit key (soft key) to set the input value and reflect it in the output.



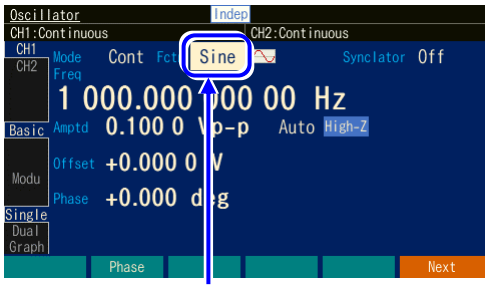
If you press the ENTER key, the value is set without prefixes such as k or m.

4. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

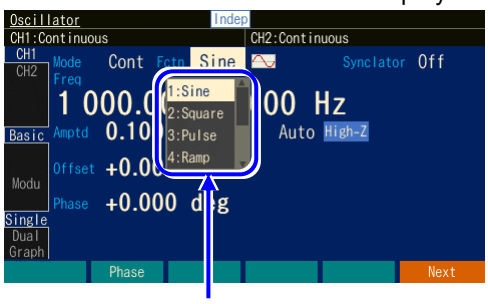
Check

If you press the numeric keypad during modification, the modification results up to that point will be ignored, a new input field will open, and the number will be entered.

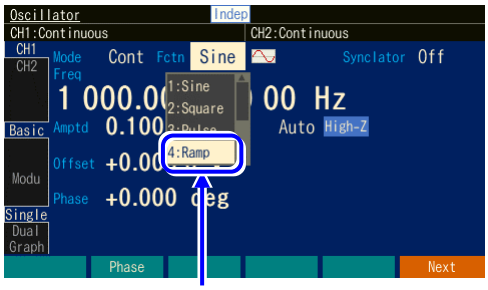
4.3.4 To change Options such as waveform and oscillation mode



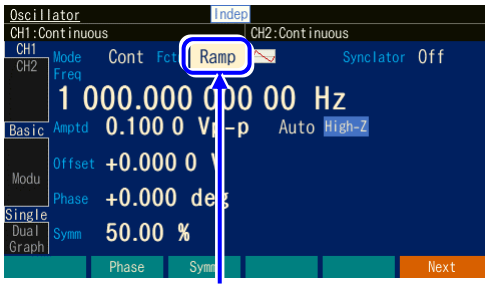
The waveform is selected
The current waveform value is displayed



The selection list is opened



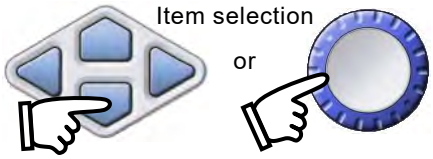
'Ramp' is selected



The waveform is set to 'Ramp'

1. Select the desired item. ☞ P.4-14

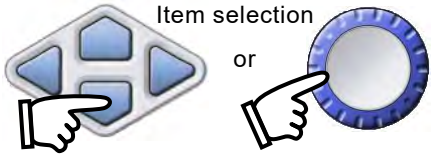
In the example on the left, the waveform "Fctn" field is selected.



2. Press the ENTER key to open the selection list. (In this example, options after "4:Ramp" are hidden.)

3. Use the up/down arrow keys or the modify knob to move within the selection list.

In this state or even before opening the selection list, you can specify an item by entering a number from the numeric keypad.



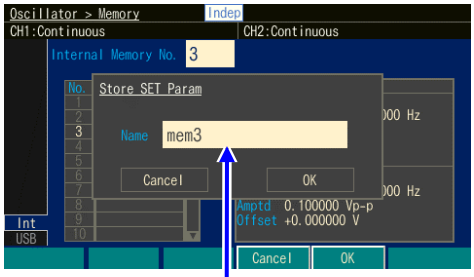
When inputting using the numeric keypad, the settings are set without the need for the ENTER key and are reflected in the output.

4. Press the ENTER key to set the selected item and reflect it in the output.

The selection list closes.

If you do not want to change the settings, press the CANCEL key to close the selection list without making any changes.

4.3.5 To change Text such as memory name and file name



The name of the settings memory has been selected
Current name is displayed

Entered [0] using the numeric keypad

1. Select the desired item. ☞ P.4-14
   In the example on the left, the “Name” field is selected.

2. Press the ENTER key to enter text editing mode. You can select a digit using the left/right keys and change the character of the target digit using the modify knob or up/down keys.
   Uppercase / lowercase letters, numbers, and symbols can be entered.
   You can enter numbers directly into the target digit using the numeric keypad.
   With this device, up to 20 characters can be used for the settings memory name and file name.

3. Use the soft key [Delete] to delete the character at the cursor position and shift the character string to the right of the cursor by one character to the left.
   Soft key [Insert] inserts a space at the cursor position.
   The character string to the right of the cursor position (not including the cursor position) is erased with the soft key [CLR⇒].
   Soft key [Clear] erases all characters.

4. Press the ENTER key or soft key [Apply] to confirm text editing and exit the editing state. With the CANCEL key, you can return to the state before the change and exit the text editing state.

Check

The following characters can be used in settings memory, file names, etc.

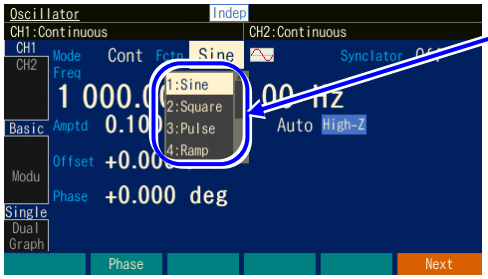
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q r s t u v w x y z
0 1 2 3 4 5 6 7 8 9
! # $ % & ' ( ) + , − . ; = @ [ ] ^ _ ` { } ~ and 「space」

However, if you use “,”, you need to be careful when separating parameters in programs that receive configuration memory names from remote commands.

4.3.6 Shortcut keys for changing basic parameters

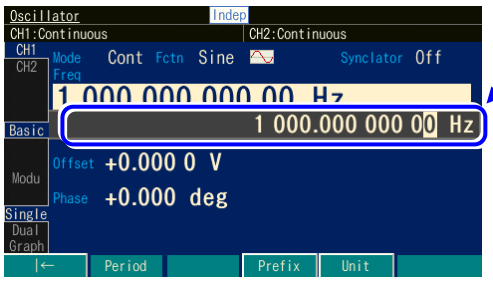
The selection list or input field for waveform, frequency, amplitude, DC offset, and oscillation mode can be immediately opened by using the corresponding basic parameter shortcut key.

■ **Waveform:** (FCTN) **key**



A waveform selection list opened
☞ P.4-33

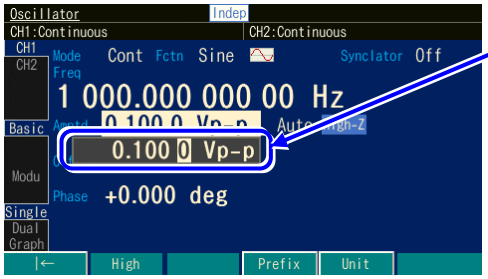
■ **Frequency:** (FREQ) **key**



The frequency input field is opened
☞ P.4-34

Press and hold the FREQ key to switch between “frequency” and “period” display and input. ☞ P.4-35

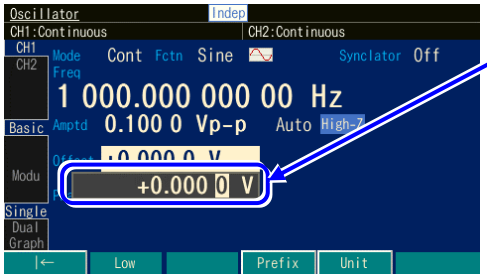
■ **Amplitude:** (AMPTD) **key**



The amplitude input field is opened
☞ P.4-38

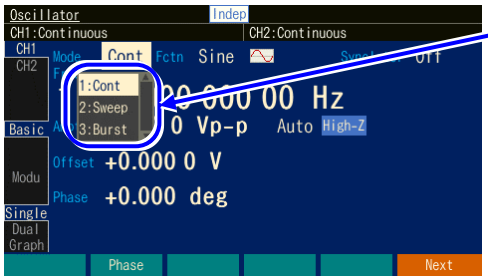
Press and hold the AMPTD / OFFSET key to switch between “amplitude/offset” and “high/low” display and input. ☞ P.4-40

■ **DC offset:** (OFFSET) **key**



The DC offset input field is opened
☞ P.4-39

■ **Oscillation mode:** (MODE) **key**



The Oscillation mode input field is opened
☞ P.4-32

4.3.7 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 a value input from the numeric keypad.
- Perform the function of the selected button or soft key displayed on the screen.

■ Functions of CANCEL key

The CANCEL key can be used to perform the following cancellations. However, setting changes cannot be undone with this key once made (to undo them, use the UNDO key in the next section).

- 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 can restore also a setting change that has been automatically made as a result of the last operation.

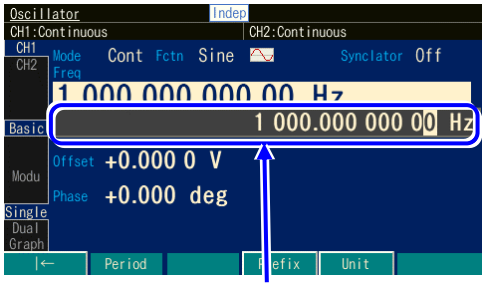
When you press the UNDO key again immediately after the undo operation, the setting before the undo operation is restored. Therefore, you can switch between two settings (for example, when reading out the setting memory, the current setting and the setting in the memory) with a single touch of a key.

Note that undo may not work for some operations. When undo is available, the LED is lit.
It can also be used to save screen images by pressing and holding for more than 1 second. ☞ P.4-13

4.3.8 To change the display Unit

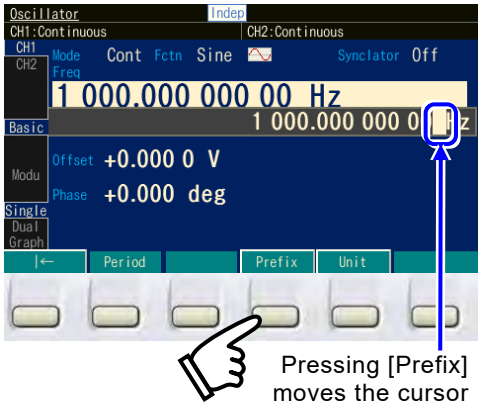
a) To change the unit prefix (k, m, M, etc.)

Frequency is used as an example here. The procedure is the same for amplitude, pulse width, etc.



The input field is opened

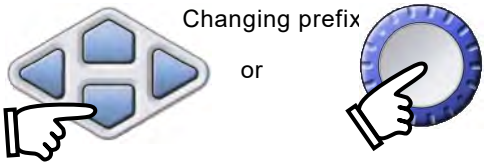
1. Select frequency field “Freq”(☞ P.4-14) and press the ENTER key to open the input field.

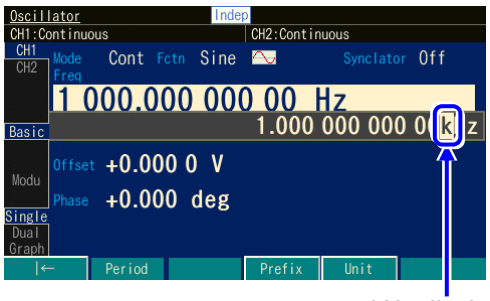


Pressing [Prefix] moves the cursor to before “Hz”

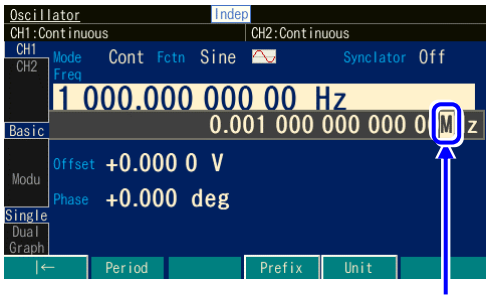
2. Press the [Prefix] soft key to move the cursor to before “Hz”.
   You can also press the right-arrow key to move the cursor to before “Hz”.

3. Units can be changed to MHz, kHz, Hz, mHz, µHz using the up/down keys, modify knob, or [Prefix] soft key. This just changes the display unit and decimal point position.
   The setting value itself does not change.





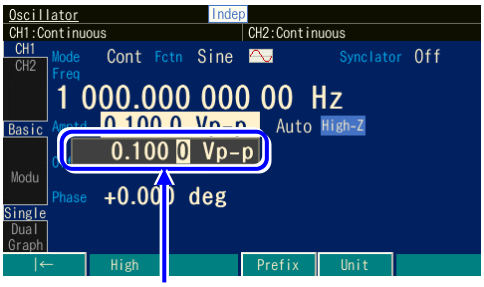
kHz display



MHz display

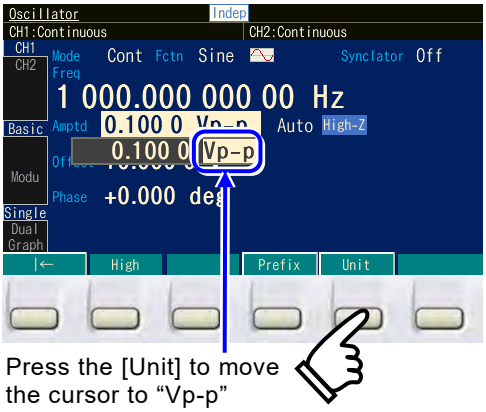
b) To change Vp-p, Vrms, user-defined unit, etc

Amplitude is used as an example here. The procedure is the same for frequency, pulse width, etc.



The input field is opened

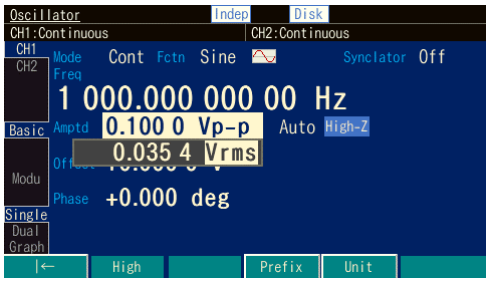
1. Select amplitude filed “Amptd” (☞ P.4-14) and press the ENTER key to open the input field.



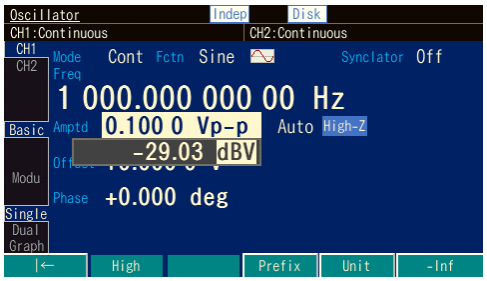
Press the [Unit] to move the cursor to “Vp-p”

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

3. Units can be changed to Vrms, dBV, user-defined unit using the up/down keys, modify knob, or [Unit] soft key. (in the case of sine wave and load impedance ‘High-Z’) This just changes the display unit and numeric value. The output value itself does not change.



Vrms display

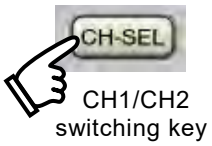


dBV display

Also refer to the following four items:

- Changing the frequency and period ☞ P.4-34, P.4-35
- Changing the amplitude unit (Vp-p, Vpk, Vrms, dBm, dBV) ☞ P.4-38
- Changing the pulse width time and duty of the pulse wave ☞ P.4-51, 4-51
- Setting user-defined units ☞ P.12-2
  Here you can change the conversion settings for the displayed/set values and the unit name.

4.3.9 CH1/CH2 Switching key and Active channel (WF1984/WF1982)



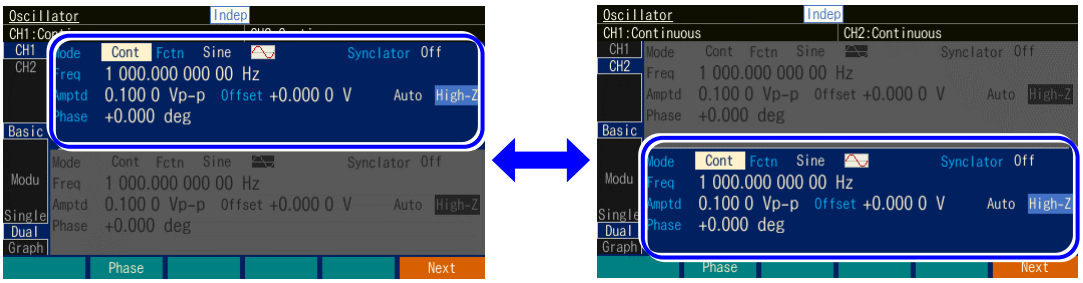
CH1/CH2 switching key

Each time the CH1/CH2 switching key [CH SEL] is pressed, the channel to be set is switched alternately.
This key is disabled on the setting screens that are not dependent on the channel.
The channel that is to be set is called the “active channel” in this product. In the burst and other modes, the [TRIG] key works on the “active channel”.
Note that if the channel equivalency setting function (CH LINK) described in the next section is set, it is valid for both channels. Active settings are saved even when moving to setting screens that are not dependent on the channel.

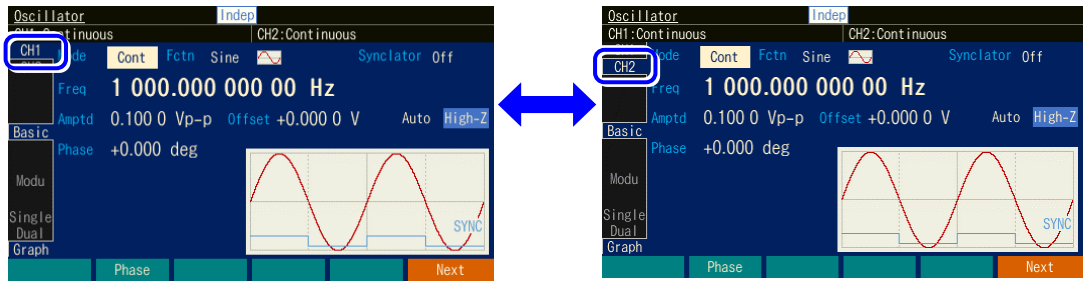
In addition, if you press and hold this key for 1 second or more, the parameters set from then on will be set to channel equivalent setting function (CH LINK) mode to be set simultaneously to CH1/CH2. In this mode, [CH1,2] are displayed in the status area ☞ P.4-7. Channel equivalency setting function (CH LINK) mode can be canceled by pressing and holding this key again. This function can also be set from the Utility screen ☞ P.8-5.

CH1 active
(CH1 is the setting target)

CH2 active
(CH2 is the setting target)



Display format: Dual

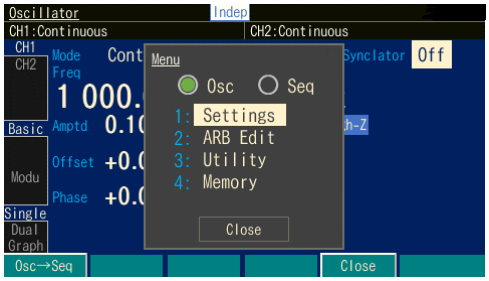


Display format: Graph

The channel that is currently active is displayed at the top of the tab area in the screen

4.3.10 Operations available on Utility Screen

a) Displaying the Utility screen



When the MENU key is pressed, the top menu opens. Select “Utility” and then press the ENTER key. The Utility screen opens. You can also use the numeric keypad 3 after the top menu is displayed.

b) Utility screen configuration

- Initialization: “Osc Reset” / “Seq Reset”
  Performs a reset of the setting values. ☞ P.4-27
  For a list of the initial settings, see ☞「16 List of Initial Settings」.

- External addition settings: “Osc Ext Add” / “Seq Ext Add”
  Sets the external addition gain. Available settings are off, ×0.4, ×2, and ×10. For the setting.
  Common in normal/sequence oscillation mode. procedure, ☞ P.4-47

- Upper and lower limit settings: “Limit”
  Sets the upper limit and lower limit of parameters. ☞ P.4-57
  For sequence oscillation, this setting is ignored and not displayed.

- Copy parameters between channels: “Parameter Copy” (WF1984/WF1982)
  Copies the settings between channels. (available only for normal oscillator) ☞ P.8-3

- Channel mode settings: “Multi CH” (WF1984/WF1982)
  Sets the type of 2-channel coordination operation:”Channel mode”, and channel equivalency setting function (CH LINK).
  For how to set the coordination operation, refer to ☞「8 Convenient Use of 2-channel Equipment」, ☞ P.8-2 (Various coordination operation).
  Coordination operation settings are invalid for sequence oscillation.
  For how to set channel equivalency setting function, ☞ P.8.3

- Settings at power-on: “Power-On State”
  Configures the output on/off settings and operation mode of sequence on/off settings for when the power is turned on. ☞ P.4-29

- External 10MHz frequency reference I/O settings: “Ref Clock IO”
  Enables/disables reference input and switches the output of reference output on/off.
  This also indicates whether a valid signal is being input to the reference input.
  For the setting procedure, ☞ P.10-4, 10-5

- Phase synchronization operation: “ΦSync”
  Handles the synchronization between multiple units when they are connected together and synchronization between channels on the WF1984/WF1982. ☞ P.8-6, P.9-4

- User-defined unit settings: “User Unit”
  Sets the user-defined units. ☞ P.12-2

- Remote settings: “Remote”
  Selects USB, LAN, or GPIB*. Set the the IP address and subnet mask when LAN is selected. Set the GPIB address when GPIB is selected. Also displays the USB ID. ☞ P.13-2

- System settings: “System”
  Sets the operation sound, base color, and graph color.
  Sets the display backlighting. For the setting procedure, ☞ P.13-3

- Self-diagnostics: “Self Check”
  Performs an internal status check. ☞ P. 13-3
  Execute this after initializing the settings.

- System Information: “Information”
  Displays the model name, firmware version, and last adjustment date. ☞ P. 13-4

c) To return to the Oscillator screen

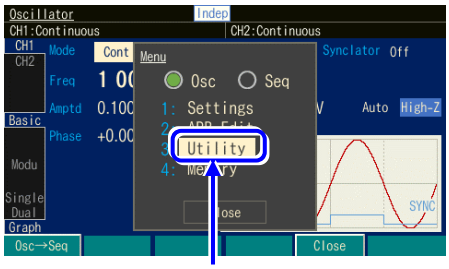
- When the (MENU) key is pressed, the top menu opens.
- Make sure the first line of the menu is on the “Osc” side. (For “Seq”, press the soft key [Seq → Osc] and the soft key [OK]) ☞ P.4-15
- Select “1: Settings” and then press the (ENTER) key. The Oscillator screen opens. You can also use the numeric keypad (1) after the top menu is displayed.

*) GPIB interface is not present on WF1982/WF1981

4.3.11 To restore Initial settings

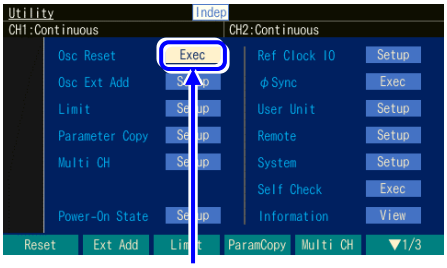
Restore the initial settings from the Utility screen. The items that are initialized differ depending on the current operating mode. For switching the operation mode, Please refer to ☞ P.4-15. For a list of the initial settings, see ☞ P.16-2, 16-4.

a) When the operation mode: normal oscillation



In the top menu, select “Utility” and then press the ENTER key

1. Press the (MENU) key to display the top menu. Select “3: Utility” and then press the (ENTER) key.
   The Utility menu opens. You can also use the numeric keypad (3) after the top menu is displayed.



In the Utility screen, select “Osc Reset” and press the ENTER key

2. Select “Osc Reset” and then press the (ENTER) key. This initializes the settings. You can also use [Reset] soft key. The screen on the left is an example for oscillator. For sequence oscillation, select the “Seq Reset” field.

3. Confirmation dialog will appear.
   Press [OK] soft key or select [OK] in the dialog and press the (ENTER) key to initializes the settings. If you wish to cancel initialization, press the (CANCEL) key to close the dialog.

The settings initialized by this operation are ☞ P.16-2.

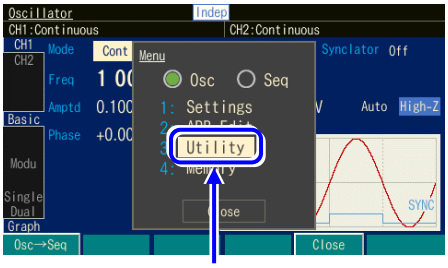
b) When the operation mode: sequence oscillation

On the Utility screen, the displayed item is “Seq Reset” instead of “Osc Reset”, and it is the same as in normal oscillation mode except that you select that item.

The settings initialized by this operation are ☞ P.16-4.

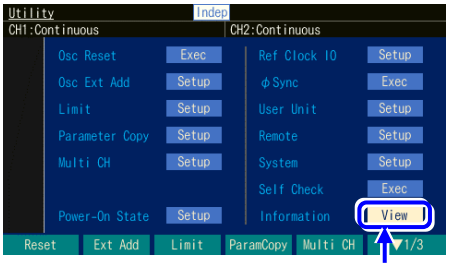
4.3.12 To restore Factory Default settings

Restore the factory default settings from the Utility screen. In addition to the both of initial settings in the previous section, ☞「16.3 Other factory default settings」 and various data saved internal memory by the user (setting/sequence memory, arbitrary waveform, etc) will also be initialized or deleted.



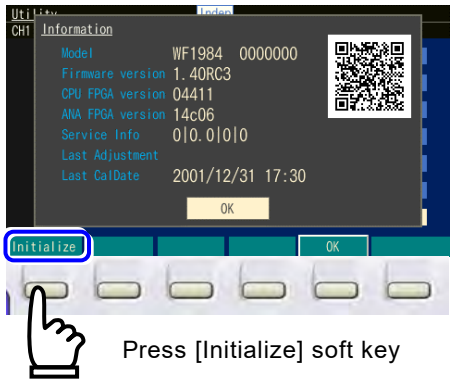
In the top menu, select “3: Utility” and then press the ENTER key

1. Press the MENU key to display the top menu. Select “3: Utility” and then press the ENTER key. The Utility menu opens.
You can also use the numeric keypad 3 after the top menu is displayed.



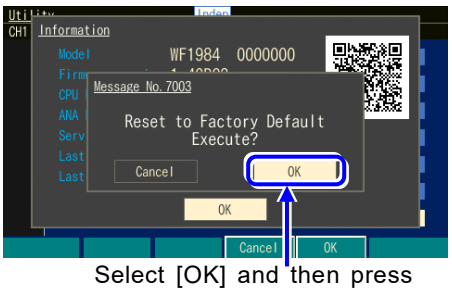
In the Utility screen, select “Information”, press the ENTER key

2. On the Utility screen, select the “Information” field using the arrow keys or modify knob, and press the ENTER key.
Soft key [Info] after pressing the rightmost soft key [▼n/3] several times until it becomes [▼3/3] works similarly.



Press [Initialize] soft key

3. A dialog displaying information about the instrument will appear.
Press [Initialize] soft key on the very left.



Select [OK] and then press the ENTER key

4. Confirmation dialog will appear.
Press [OK] soft key or select [OK] in the dialog and press the ENTER key to start processing.
The settings will become the factory default settings after a few minutes.
If you wish to cancel, select [Cancel] at the bottom of the dialog and press the ENTER key, or press the CANCEL key.

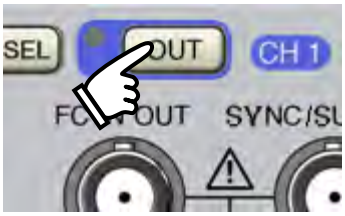
Check

Please note that if you perform this operation, the settings, arbitrary waveform data, and sequence data saved in the device's internal memory will be deleted.
It will take a few minutes for the process to finish.

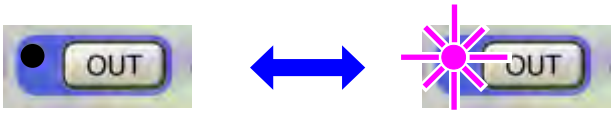
4.3.13 Output On/Off and Power-on settings

a) Key operation in the panel screen

The waveform output is switched on/off each time the waveform output OUT key is pressed. The lamp on the left side of the key is lit when output is on.



Output on/off key



The output terminal is released when the output is turned off.

The output impedance is 50Ω when this is turned on. Automatically turns off when overload is detected. For details, ☞「■ **Operation during overload**」.

The synchronization/sub output is always on regardless of the waveform output on/off setting.

Check

- A mechanical relay is used to turn on/off the waveform output. Therefore, chattering occurs when switching waveform output on/off. Use the trigger burst or gate mode when connecting to equipment which might malfunction due to chattering. ☞ P.4-108, P.4-112
- The relay inside the instrument for switching output on/off is a part with a limited life. Switching output on/off frequently may lead to a failure early and even within the warranty period of the product. The life expectancy of the relay is about 100 000 times. Also consider using the trigger burst and gate oscillation modes instead of on/off. ☞ P.4-108, P.4-112

b) Power-on state setting

Specify whether to turn waveform output on/off and operation mode when the power is turned on. There are three options.

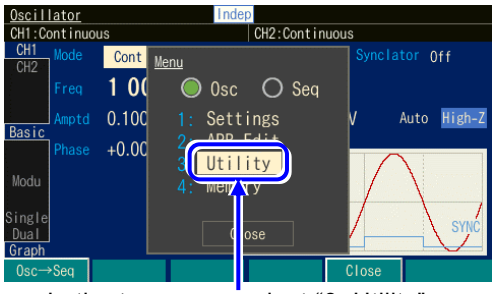
■ **Waveform output on/off**: "Output" (WF1984/WF1982: set for each channel)

- 'Off': Waveform output turns off.
- 'On': Waveform output turns on.
- 'Last State': Restoring last setting.
  This operation depends on how the power was previously shut off.
  If you press the power switch on the panel to turn off the power, the previous settings will be restored. ☞ P.4-3
  If the power supply is off due to interruption, the output will be off. ☞ P.4-4

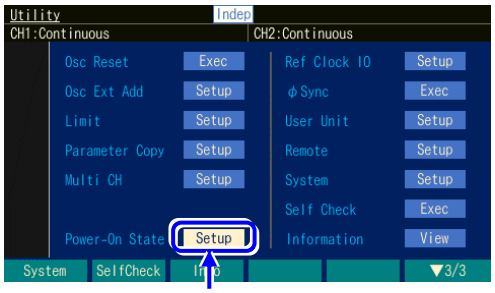
■ **Operating mode**: "Sequence" (About sequence oscillation mode, ☞ P.11-2.)

- 'Off': The operation mode will be normal Oscillator.
- 'On': The operation mode is Sequence oscillation.
  If the power supply is off due to interruption, the contents of sequence memory #1 will be used and compilation will start automatically.
- 'Last State': Restoring last settings.
  This operation depends on how the power was previously shut off. If you press the power switch on the panel to turn off the power, the previous settings will be restored.
  If the power supply is off due to interruption, Operation mode will be normal Oscillator.

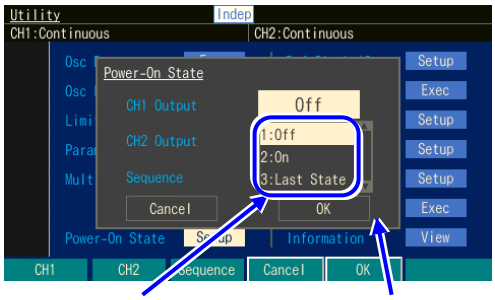
Select the setting on the Utility screen.



In the top menu, select “3: Utility” and then press the ENTER key

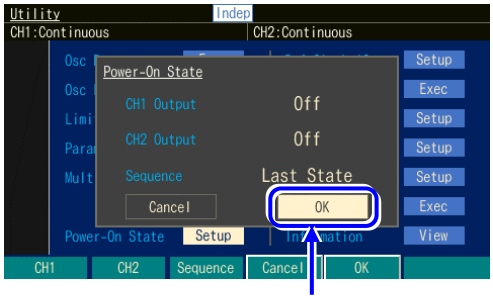


In the Utility screen, select “Power-On State” and then press the ENTER key



Set the output setting condition

The dialog for settings at power-on opens



Select [OK] and then press the ENTER key

1. Press the MENU key to display the top menu. Select “3: Utility” and then press the ENTER key. The Utility menu opens.
   You can also use the numeric keypad 3 after the top menu is displayed.

2. Select “Power-On State” and then press the ENTER key.
   Soft key [Power-ON] after pressing the rightmost soft key [▼n/3] several times until it becomes [▼2/3] works similarly.

3. When the Power-On State dialog opens, select the desired output setting and then press the ENTER key. You can also select using the soft key [Output] ([CH1], [CH2] for WF1984/WF1982). The selection list of the output setting conditions is opened.
   Select the desired condition and then press the ENTER key. You can also specify the number using the numeric keypad.

4. If necessary, also set the operation mode at power-on. You can also select using the soft key [Sequence].

5. When the power-on setting is completed, select [OK] at the bottom of the dialog, and then press the ENTER key. The change of the power-on setting is applied, and the dialog is closed.
   You can also use soft key [OK].
   If you wish to cancel, select [Cancel] at the bottom of the dialog and press the ENTER key, or press the CANCEL key.

4.3.14 To use USB flash drive

In the store / recall screen of setting, arbitrary waveform, and sequence settings, switch the operation target by tab selection to internal memory or USB flash drive. To select the operation target, switch the screen using the tabs.

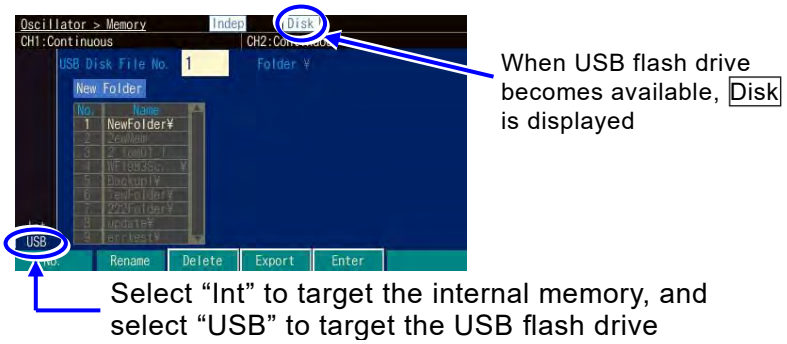
In addition, the current screen image can be saved as an image file on a USB flash drive.

a) To switch the storage and reading destination

When valid USB flash drive is inserted into the front panel, Disk will be displayed in the status area (☞ P.4-7).

First, go to the memory operation screen (Oscillator settings ☞ P.5-2, Arbitrary waveform ☞ P.7-10, Sequence settings ☞ P.11-22).

Select the “USB” tab and press the ENTER key in that state to change the operation target to USB flash drive.



b) To save screen image to USB flash drive

See, ☞ 「4.2.5 Saving a Screenshot」.

4.4 Setting for Main Items

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

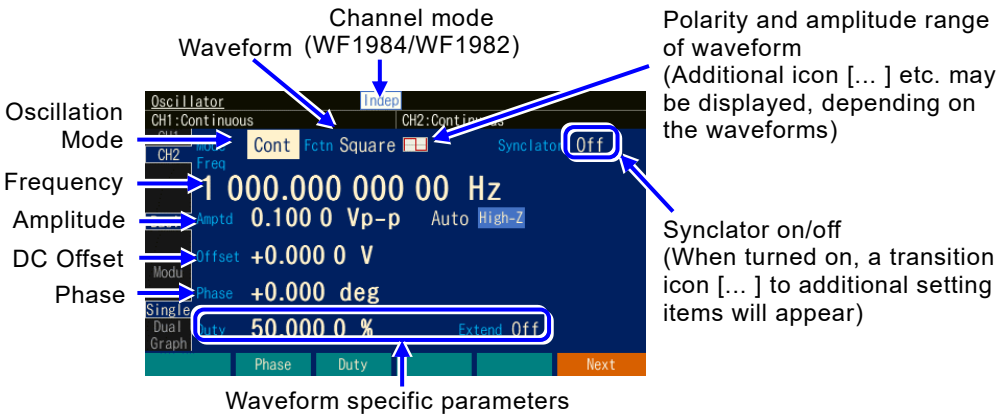
If another screen is displayed, do the following:

- When you press the [MENU] key, the Top menu is displayed.
- Make sure the first line of the menu is on the "Osc" side. (For "Seq", press the soft key [Seq → Osc] and the soft key [OK]) ☞ P.4-15
- Select "1: Settings" and then press the [ENTER] key. The Oscillator screen opens. You can also use the numeric keypad [1].

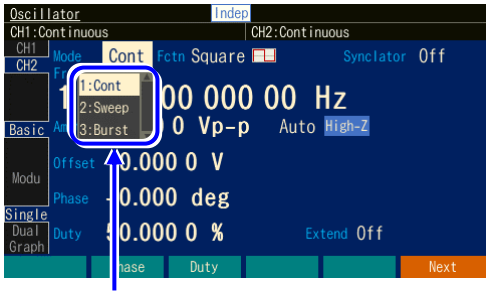
We explain by using the text display screen (1-channel display) in the continuous mode as an example. Graph display and 2-channel simultaneous display can be operated in the same way, only the display is different. (Display switching ☞ P.4-10)

4.4.1 Screen in Continuous mode at text display "Single"

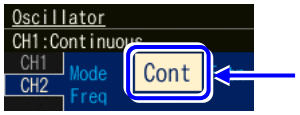
The screen to set the basic output waveforms.



4.4.2 To set Oscillation mode



The oscillation mode selection list is opened

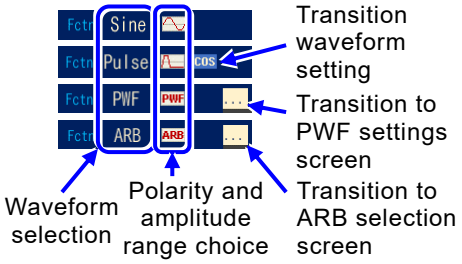


Current Oscillation Mode

1. Press the [MODE] key or select the "Mode" field (☞ P.4-14) and pressing the [ENTER] key will open the oscillation mode selection list.
2. Select the desired oscillation mode from the selection list and then press the [ENTER] key to reflect it in the output.
   You can also enter the number of the desired oscillation mode displayed in the selection list from the numeric keypad to reflect it in the output. ☞ P.4-18

Any of the three modes of continuous [1] 'CONT', sweep [2] 'Sweep' ☞ P.4-77, and burst [3] 'Burst' ☞ P.4-101 can be selected for the oscillation mode. If you want to perform modulation, see ☞ P.4-62.

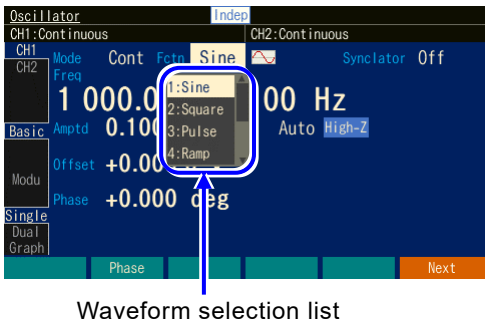
4.4.3 To set Waveforms



This device can easily generate a wide variety of waveforms such as the ones below.
In addition, you can specify the polarity and amplitude range for each waveform and PWF type ☞ P.4-41, allowing you to flip the waveform vertically and control the amplitude and offset flexibly.

- Standard waveform (followings are referred to as standard waveform)
  - ➢ Sine wave 'Sine'
  - ➢ Square wave (Variable duty) 'Square' ☞ P.4-49
  - ➢ Pulse wave (Variable LE/TE/Duty/Transition waveform) 'Pulse' ☞ P.4-51
    Transition waveform can be selected from cosine 'COS', liner 'LIN', parameter variable waveform 'PWF', and arbitrary waveform 'ARB' ☞ P.4-54
  - ➢ Ramp wave (Variable symmetry) 'Ramp' ☞ P.4-56
  - ➢ Parameter variable waveform 'PWF' ☞ P.6-2, 4-59
    26 types of waveforms (PWF types) and their respective parameters (up to 6 types each)
  - ➢ Noise waveform (Gaussian distribution, Variable equivalent bandwidth) 'Noise' ☞ P.4-56
  - ➢ Direct current component only 'DC' (No polarity and amplitude range specified)
- Arbitrary waveform (Control point format and array format) 'ARB' ☞ P.7-2, 4-60

Specify these waveforms as follows.



Waveform selection list

1. Press the FCTN shortcut key to open the waveform selection list.
   Or, select the "Fctn" field (☞ P.4-14) to open the selection list.

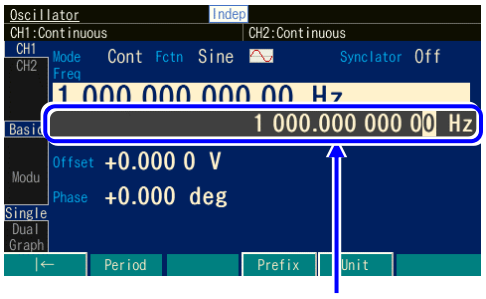
2. Select the desired waveform from the selection list. ☞ P.4-18
   "PWF": Parameter variable waveform (☞ P.6-2), "ARB": Arbitrary waveform (☞ P.7-2)

When selecting the parameter variable waveform, set the PWF type and parameters. ☞ P.4-59
When selecting the arbitrary waveform, choose the arbitrary waveform saved in the main unit. ☞ P.4-60

Check

With arbitrary waveforms and parameter variable waveforms, when you switch the waveform, the data in the waveform memory is rewritten, resulting in a transiently disturbed waveform being output.
Also, changing the waveform takes a maximum of about 0.5s for parameter variable waveforms and control point format arbitrary waveforms, and about 1s per 2Mi words for array format arbitrary waveforms.

4.4.4 To set Frequency/Sample rate



"Freq" input field

1. Press the FREQ shortcut key to open the frequency input field. Or, select the "Freq" field. ☞ P.4-14
   If "Period" is displayed for the "Freq" field because not the frequency but the period is displayed, press and hold down the FREQ key or press the [Freq] soft key.
   The display switches to the frequency display.

2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. The change is immediately reflected in the output. ☞ P.4-16
   Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key [μHz], [mHz], [Hz], [kHz], or [MHz]) to set the input value and reflect it in the output. When the ENTER key is used, Hz is set as the unit.

3. If the waveform is an arbitrary waveform in array format, you can also set it by sample rate. When the "Freq" field is open, use the soft key [SmplRate] to switch to sample rate display. Conversely, when the sample rate is displayed, you can switch to the frequency display using the soft key [Freq].
   The arrow keys, modify knob, and numeric keypad are used in the same way, and changes are reflected immediately.
   Press the ENTER key or the unit key (soft key [μS/s], [mS/s], [S/s], [kS/s] or [MS/s]) to set the input value and reflect it in the output. When the ENTER key is used, S/s is set as the unit.

4. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

Check

- The settable frequency range may be limited by the upper / lower limit settings.
  Please initialize (☞ P.4-27) or change the upper / lower limit setting values (☞ P.4-57).
  However, for compatibility, the lower limit is 0.01μHz during initialization.
  For array format arbitrary waveforms, you must also be aware of frequency limitations due to the upper limit of sample rate and waveform length. ☞ P.7-3
- For arbitrary waveforms and parameter variable waveforms, please note that if you change the frequency, oscillation may restart from the set phase, and the phase will become discontinuous at that time.

4.4.5 To set Period/Sample period

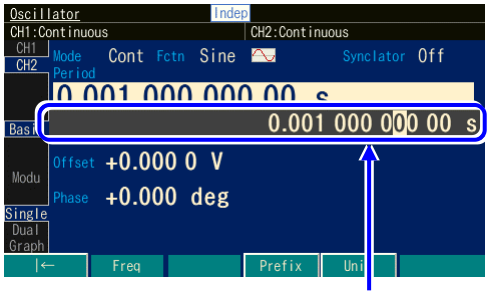
You can set the period, sample rate, or sample period instead of frequency.
There are two ways to change the frequency/period/sample rate/sample period display: (Sample rate/sample period settings are only available when the waveform is an arbitrary waveform in array format)

○ Changing to period / frequency using the [Period] / [Freq] soft key

When the “Freq” / “Period” / “SmplRt” / “SmplPd” input field opens and the current value is displayed, the soft keys [Period] / [Freq] will be displayed. When you press this key, the specified input field will open and the item display will change to “Period” / “Freq”. When the waveform is an arbitrary waveform in array format, sample rate “SmplRt” / sample period “SmplPd” can also be used with the soft keys [SmplRate] / [SmplPeriod].

○ Changing to period / frequency by pressing and holding down the FREQ key

Press and hold the shortcut key FREQ for more than 1 second to switch to period / frequency display. If the input fields are not open, press the FREQ key to open them. When the waveform is an arbitrary waveform in array format, the sample rate “SmplRt” / sample period “SmplPd” is also sequentially switched.



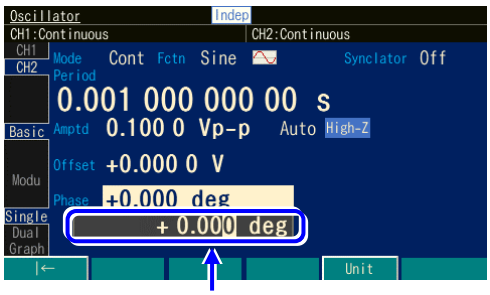
“Period” input field

1. When the “Period” input field opens, set it using the same procedure as for frequency. When you enter a value using the numeric keys, the unit key for period setting will be displayed on the soft keys. When changing to period, the display changes as follows.
   Item name : “Freq” → “Period”
   Unit display : “Hz” → “s”
   Soft key : [Period] → [Freq]
2. If the waveform is an arbitrary waveform in array format, you can also set it by sample rate. When the “Period” field is open, use the soft key [SmplPeriod] to switch to sample period display. Conversely, when the sample period is displayed, you can switch to the period display using the soft key [Period].
3. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. The change is immediately reflected in the output. ☞ P.4-16
   Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key [μs], [ms], [s], [ks], or [Ms]) to set the input value and reflect it in the output. When the ENTER key is used, s is set as the unit.
4. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

4.4.6 To set Phase

There is a virtual phase reference inside the main unit, and a waveform shifted by the value set in "Phase" with respect to that reference is output.

a) Setting procedure



1. Select the "Phase" field (☞ P.4-14) to open the phase input field. Or press the [Phase] soft key to open the input field.

2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value.
   The change is immediately reflected in the output. ☞ P.4-16

   Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key [deg]) to set the input value.

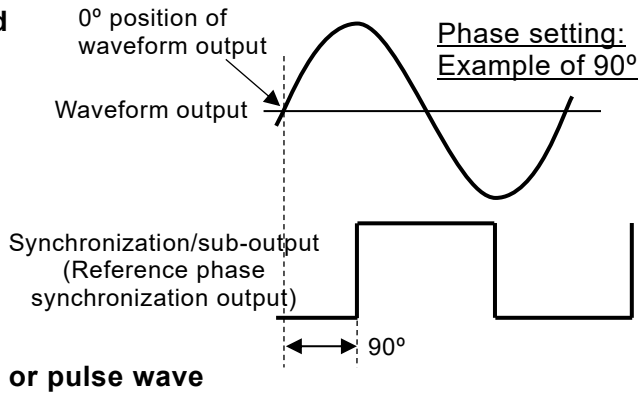
3. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

b) Items that can be changed in the phase setting

The following items can be changed in the phase setting.

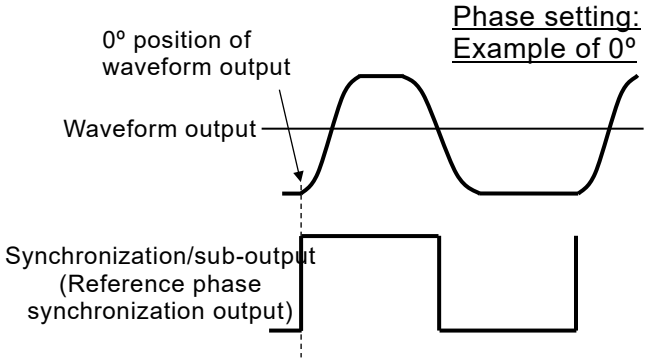
■ The phase difference between reference phase synchronized output and waveform output can be changed

The figure on the right shows an example of a phase setting of +90º. At this time, 0º position of waveform output precedes 90º from the rising position of the reference phase synchronous output.



■ Phase reference point of square or pulse wave

In the case of a square or pulse wave, the phase reference point is not the center of the transition part but the point where the transition begins.

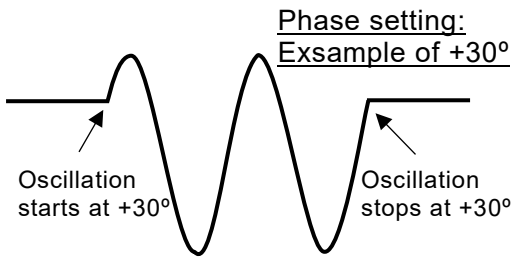


■ **The oscillation start/stop phase can be changed in burst mode and gated single sweep**

The figure on the right shows an example of the burst oscillation at the oscillation start/stop position of +30º. At this time, the oscillation starts at a +30º position, and also stops at a +30º position.

Burst mode ☞ P.4-101

Gated single sweep ☞ P.4-85

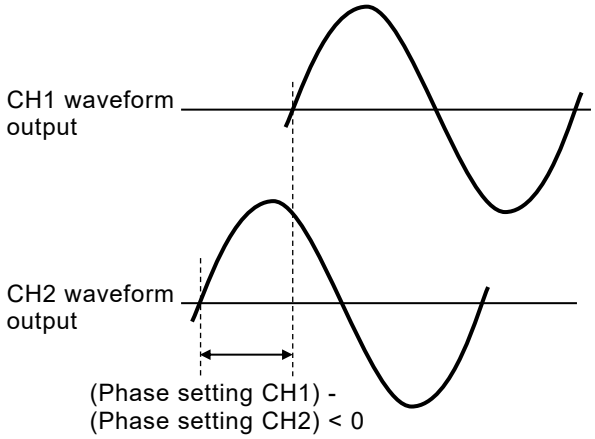


■ **The phase difference between channels can be changed in synchronous oscillation and 2 phase oscillation** (WF1984/WF1982)

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

When (Phase setting of CH1 minus Phase setting of CH2) is negative, the waveform of CH2 precedes the waveform of CH1 as shown in the following figure.

For synchronous oscillation and 2-phase oscillation see ☞ P.8-6, P.8-8



■ **Phase difference between waveform and sub output can be changed**
(modulation is off or when using external modulation)

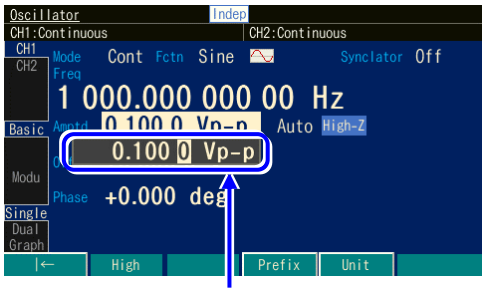
The difference in phase settings between the waveform output and sub waveform becomes the phase difference between the outputs. The mutual relationship is the same as explained in the previous section. For the sub waveform phase settings, ☞ P.4-124

Check

The settable phase range may be limited by the upper / lower limit settings.
Please initialize (☞ P.4-27) or change the upper / lower limit setting values (☞ P.4-57).
For arbitrary waveforms and parameter variable waveforms, please note that if you change the phase, oscillation may restart from the set phase, and the phase will become discontinuous at that time.
Also, when rewriting by changing the phase, it takes about 0.5s for parameter variable waveforms and arbitrary waveform in control point format, and about 1s per 2Mi words for arbitrary waveform in array format. Arbitrary waveforms in array format should normally be used at 0º

4.4.7 To set Amplitude

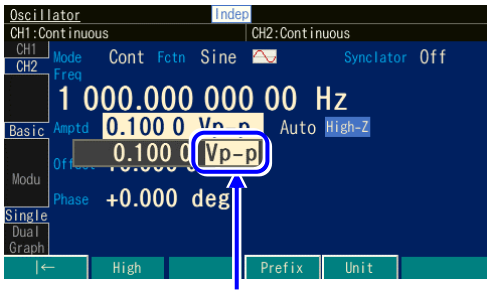
a) Setting procedure



"Amptd" input field

4. Press the AMPTD shortcut key to open the amplitude input field. Or select the "Amptd" field (☞ P.4-14) to open the input field.
   If "High" is displayed for "Amptd" field because not the amplitude but the high level is displayed, press and hold down the AMPTD key or press the [Amptd] soft key.
   The display switches to the amplitude display.
5. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value.
   The change is immediately reflected in the output. ☞ P.4-16
   Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key) to set the input value.
6. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

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



Move the cursor to the unit position

1. When the input field of the amplitude opens, press the [Unit] soft key to move the cursor to the unit position at the right end.
2. The unit can be changed by using the up/down arrow key or modify knob. (Unusable units are not displayed)
   Only the display unit is changed as the actual output value is not changed.

c) Available units differ 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 from amplitude settings).

Unit	Applied waveform
Vp-p	Standard waveforms or arbitrary waveforms with amplitude range of '±FS'
Vpk	Standard waveforms or arbitrary waveforms with amplitude range of '0/+FS', '-FS/0'
Vrms	'Sine' wave and 'Noise'
dBV	'Sine' wave and 'Noise'. 0dBV shall be 1Vrms.
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 50Ω, 0dBm=223.6mVrms/50Ω. This is not available when the load impedance is set as 'High-Z'.
User-defined unit	All waveforms. For user-defined units, ☞ P.12-2

d) Notes when the waveform is ARB or PWF

If the selected waveform is an arbitrary waveform or a parameter variable waveform, the specified amplitude may not be reached depending on the shape of the specified waveform.

For arbitrary waveforms, see ☞ P.7-4. For parameter variable waveforms, see ☞ P.6-3.

e) Restriction on AC + DC

The maximum total value of AC amplitude and DC offset is restricted to ±10.5V/open.

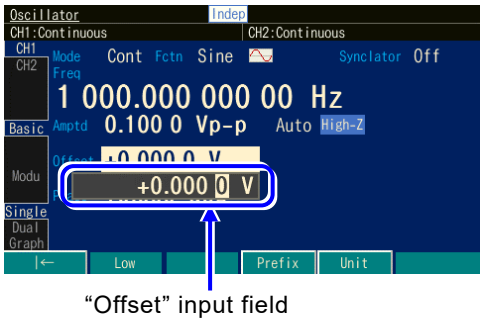
For example, when the AC amplitude is 5Vp-p/open, DC offset is restricted to the range from -8V/open to +8V/open.

The maximum value also differs depending on the range setting of output voltage or external addition setting. ☞ P.4-43, P.4-48

If the setting range restriction values of voltage are other than the defaults, observe those settings. ☞ P.4-57

4.4.8 To set DC Offset

a) Setting procedure



"Offset" input field

1. Press the OFFSET shortcut key to open the DC offset input field. Or select the "Offset" field (☞ P.4-14) to open the input field.
   If "Low" is displayed for "Offset" field because not the DC offset but the low level is displayed, press and hold down the OFFSET key or press the [Offset] soft key.
   The display switches to the DC offset display.
2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. The change is immediately reflected in the output. ☞ P.4-16
   Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key) to set the input value.
3. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

b) Restriction on AC + DC

The maximum total value of AC amplitude and DC offset is restricted to ±10.5V/open.

For example, when the AC amplitude is 5Vp-p/open, DC offset is restricted to the range from -8V/open to +8V/open.

The maximum value also differs depending on the range setting of output voltage or external addition setting. ☞ P.4-43, P.4-48

If the setting range restriction values of voltage are other than the defaults, observe those settings. ☞ P.4-57

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 two ways to change the amplitude/DC offset display to high/low display:

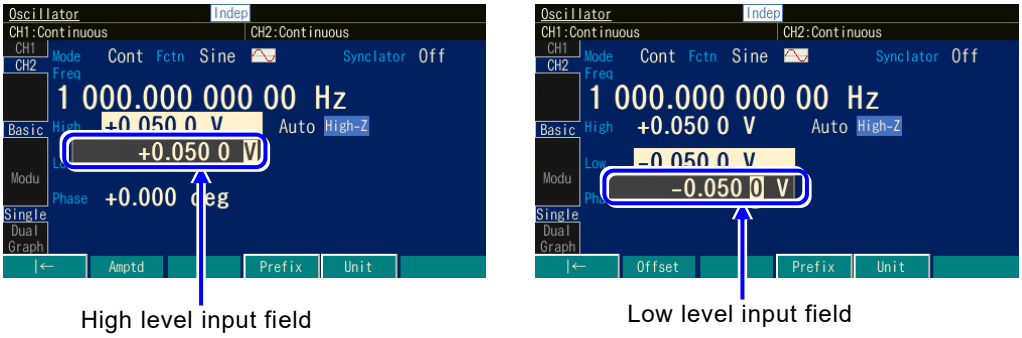
○ Changing to high / low using the [High] / [Low] soft key

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

When the [Amptd] or [Offset] soft key is pressed, the input field of amplitude or DC offset is opened.

○ Changing to high / low by pressing and holding down the AMPTD or OFFSET key

Press and hold down the AMPTD or OFFSET shortcut key, the display switches between amplitude/DC offset display and high/low display each time.



In the switched high/low display state, the AMPTD key opens the high level input field, and the OFFSET key opens the low level input field.

When the input field of high level or low level is open, the settings in the same way as 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 changing to the high level/low level display, the display is changed as follows:

Item Name : "Amptd" → "High", "Offset" → "Low"
Unit display : "Vp-p", "Vpk", "Vrms", "dBV", "dBm", "V" → "V"
Soft key : [High] → [Ampl], [Low] → [Offset]

b) Restriction on AC + DC

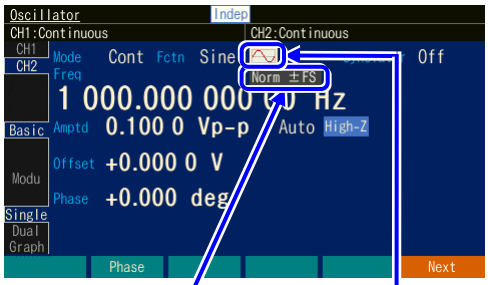
High level and low level are restricted to a range of −10.5V to +10.5V/open.

The maximum range also differs depending on the range setting of the output voltage or external addition setting. ☞ P.4-43, P.4-48

If the setting range restriction values of voltage are other than the defaults, observe those settings. ☞ P.4-57

4.4.10 To set waveform Polarity and Amplitude Range

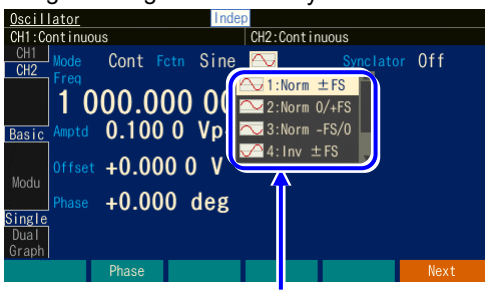
a) Setting procedure



Select the polarity/ amplitude range icon to display the current polarity and amplitude range settings

Select the polarity/amplitude range icon and press the ENTER key

1. Select the polarity/amplitude range icon (☞ P.4-14) on the right of the waveform name to open selection list.
   When selected for this item, the current polarity/amplitude range settings will be displayed below the icon before pressing the ENTER key.

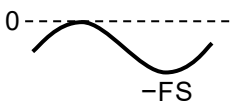
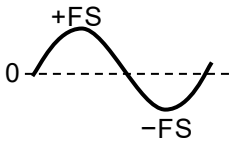
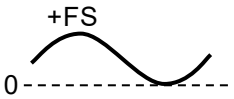
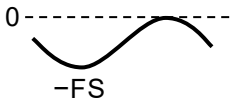
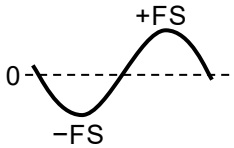
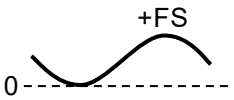


The selection list for the polarity/ amplitude range is opened

2. Select the desired polarity and amplitude range from the selection list. ☞ P.4-18

b) Polarity and amplitude range

You can invert the polarity or change the amplitude range to single polarity. The following figure shows the cases with sine waves:

Polarity	Amplitude range		
	'−FS/0'	'±FS'	'0/+FS'
Normal: 'Normal'			
Invert: 'Inv'			

Instead of setting the amplitude range, you can also do the same thing by toggling amplitude/offset ⇔ high/low ☞ P.4-40, but this also allows you to set the reference point for amplitude changes at the top or bottom of the waveform, even with amplitude modulation or amplitude sweep.

In the case of inversion, only the waveform is inverted, and the DC offset sign of the output remains unchanged.

Check

The polarity and amplitude range settings are independent for each waveform and PWF type.

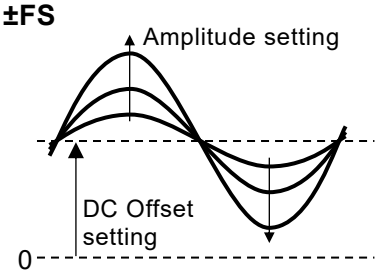
c) How to determine amplitude range

Take note of how waveforms change when the amplitude is changed, and then determine the amplitude range. By default, a waveform which oscillates to both polarities is set to '±FS', and a unipolar waveform is set to '0/+FS'.

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

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

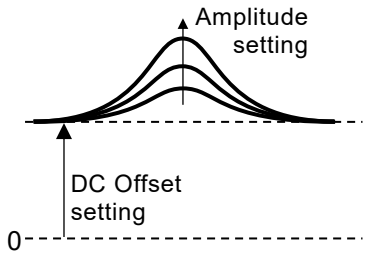
Normally, in the case of a waveform which oscillates between the two polarities with zero as the center, it is more convenient to set the amplitude range to '±FS'.



■ Example with a gaussian pulse and an amplitude range of 0/+FS

When the amplitude is changed, only the positive peak of the waveform will change in reference to the DC offset position. The amplitude will change in reference to the waveform's base.

Normally, in the case of a unipolar waveform, it is more convenient to set the amplitude range to '0/+FS' or '-FS/0'.



If the amplitude range is set to '-FS/0', the amplitude will change based on the top of the waveform.

(Gaussian pulse ☞ P.6-14 is a waveform included in parameter variable waveform ☞ P.6-2)

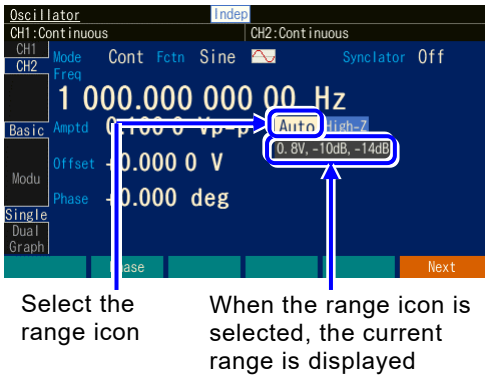
d) Restriction by amplitude range

- 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', this is equivalent to using only the upper or lower half of the waveform memory. Therefore, the amplitude resolution decreases by 1bit compared with '±FS'.
- The amplitude is set as Vp-p when the amplitude range is '±FS', and as Vpk when the amplitude range is '-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 optimum 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 accuracy and waveform fineness decrease as the amplitude is reduced with the range fixed.

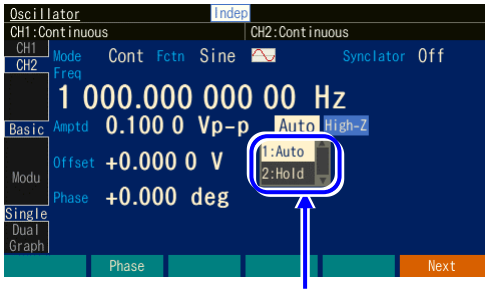
a) Setting procedure



Select the range icon

When the range icon is selected, the current range is displayed

1. Select the range icon (☞ P.4-14) on the right of the amplitude to open selection list.
When selected for this item, the current range will be displayed below the icon before pressing the [ENTER] key.
The current range displayed when the range icon is selected is a combination of “<OUT-RNG>,<AC-ATT>,<DC-ATT>”. ☞ P.4-44



The selection list for range processing is opened

2. When ‘Auto’ is selected, it is set to auto range. Selecting ‘Hold’ (☞ P.4-18) fixes the range at that time.

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

The instrument has the following range control elements: (block diagram ☞ P.1-4)

- Amplitude attenuator to control maximum AC amplitude: AC-ATT (0, -10, -20dB)
- DC offset attenuator to control maximum offset range: DC-ATT (0, -14dB)
- Output voltage range to control total output amplitude: OUT-RNG (20V, 4V, 0.8V)
  (The output voltage range interacts with the external addition function ☞ P.4-46)

When the range is fixed, the maximum value of amplitude and DC offset, and external addition gain are determined as shown in the table below.

Table 4-1 Range, external addition gain and output voltage range

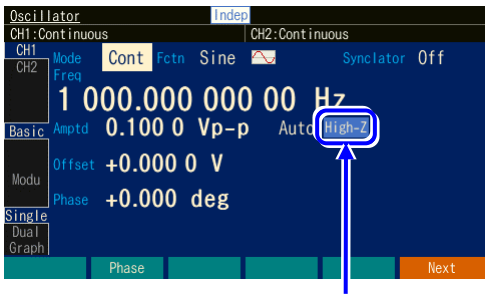
Range (maximum output voltage Vp-p, amplitude attenuator, DC offset attenuator)	Maximum values of amplitude (with no load)	Maximum values of DC offset (with no load)	Maximum values of AC+DC (with no load)	External Addition gain (rated ±1V, with no load)
20V, 0dB, 0dB	21Vp-p	±10.5V	±10.5V	×10 or Off
20V, 0dB, −14dB		±2.1V		
20V, −10dB, 0dB	6.641Vp-p	±10.5V		
20V, −10dB, −14dB		±2.1V		
20V, −20dB, 0dB	2.1Vp-p	±10.5V		
20V, −20dB, −14dB		±2.1V		
20V, −30dB, 0dB	0.6641Vp-p	±10.5V		
20V, −30dB, −14dB		±2.1V		
4V, 0dB, 0dB	4Vp-p	±2V	±2V	×2 or Off
4V, 0dB, −14dB		±0.4V		
4V, −10dB, 0dB	1.2650Vp-p	±2V		
4V, −10dB, −14dB		±0.4V		
4V, −20dB, 0dB	0.4Vp-p	±2V		
4V, −20dB, −14dB		±0.4V		
4V, −30dB, 0dB	0.1265Vp-p	±2V		
4V, −30dB, −14dB		±0.4V		
0.8V, 0dB, 0dB	0.8Vp-p	±0.4V	±0.4V	×0.4 or Off
0.8V, 0dB, −14dB		±0.08V		
0.8V, −10dB, 0dB	0.253Vp-p	±0.4V		
0.8V, −10dB, −14dB		±0.08V		
0.8V, −20dB, 0dB	0.08Vp-p	±0.4V		
0.8V, −20dB, −14dB		±0.08V		
0.8V, −30dB, 0dB	0.0253Vp-p	±0.4V		
0.8V, −30dB, −14dB		±0.08V		

4.4.12 To set Load Impedance

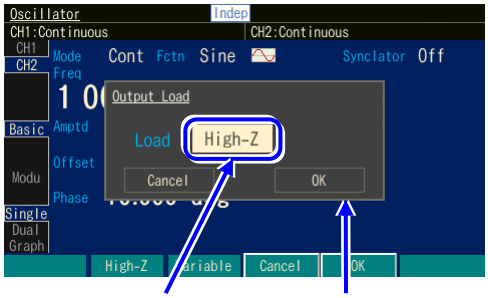
By matching the setting value of the load impedance to an actual loading condition, the amplitude and DC offset (including the setting according to high level and low level) can be set with the voltage that appears to the load end.

The value of the load impedance can be set to a range of 1Ω to 10kΩ or 'High-Z'. However, even if the setting value of load impedance is changed, only the displayed amplitude setting value and DC offset display value change. The output voltage when the load is opened does not change.

a) Setting procedure

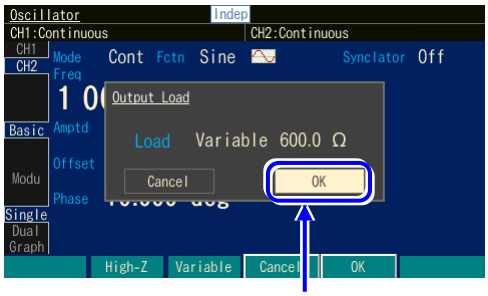


Select the load impedance icon and then press the ENTER key



Set the load impedance condition

The dialog for load impedance setting opens



Select [OK] key and then press the ENTER key

1. Select the load impedance icon on the right side of the range icon. ☞ P.4-14

2. When the load impedance setting dialog opens, press the ENTER key again.
   Opens 'Variable' or 'High-Z' load condition options.

3. Select the desired load impedance condition using the up/down keys or the modify knob. ☞ P.4-18

4. Select 'Variable' to set the load impedance value. Load impedance value can be specified numerically. ☞ P.4-16, 4-17

5. When the load impedance setting is completed, select [OK] at the bottom of the dialog and then press the ENTER key.
   The change in the load impedance setting is applied.
   When you do not want to apply the change of the load impedance setting, select [Cancel] at the bottom of the dialog and then press the ENTER key, or press the CANCEL key.

b) Conversion formula

The output voltage setting value when the load impedance is other than 'High-Z' is converted using the following formula:

Load impedance setting value: Rload[Ω]

Output voltage when load is opened: Vopen[V]

Output voltage setting value (load end voltage): Vload[V]

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

Check

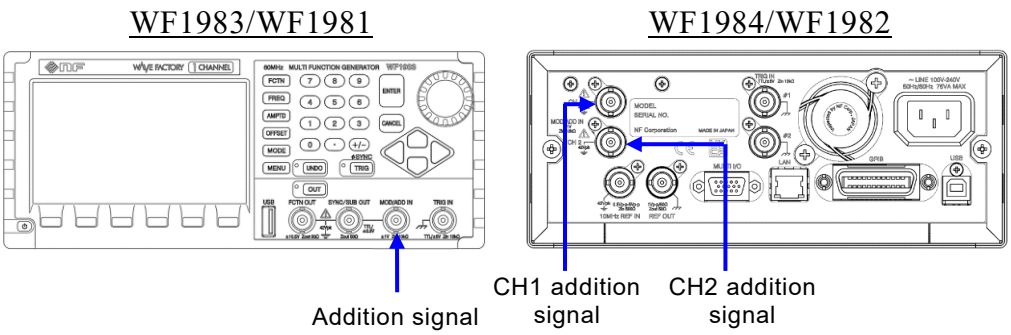
- The output impedance is a constant 50Ω.
- Neither the output impedance error nor the output voltage error are corrected. The accuracy specification of the output voltage is the value when there is no load.

4.4.13 To Add External Signal

Output can be performed by adding an external signal to the waveform output.

a) To Connect addition signal

Connect the addition signal to the external modulation / addition input (MOD/ADD IN) BNC terminal. It is located on the front panel in the case of the WF1983/WF1981, and the rear panel in the case of the WF1984/WF1982.



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

This BNC terminal is insulated from the enclosure, and has the same ground electrical potential as the waveform output of the same channel. For the floating ground connection, ☞ P.3-15.

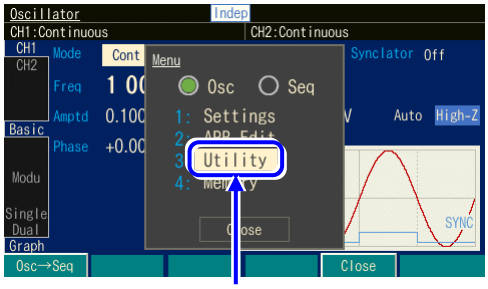
Check

Regardless of the settings, do not input a voltage that exceeds ±1V to the external modulation / addition input (MOD/ADD IN) BNC terminal. The input signal may be mixed into the output, causing overload or distortion of the output signal.

Also, please note that even within the ±1V range, the output voltage of the addition result may be significantly distorted beyond the allowable range depending on the waveform, voltage, etc. settings.

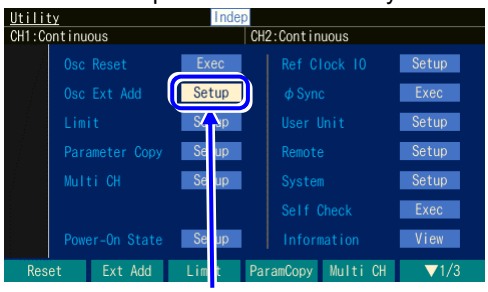
b) To enable the addition signal

Set the external addition on the Utility screen.



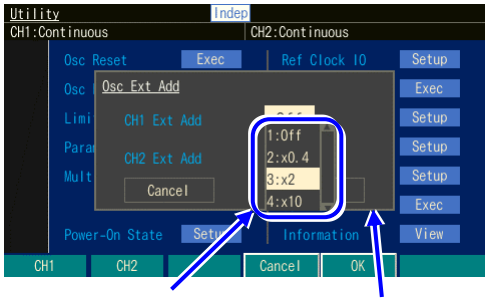
In the top menu, select “3: Utility” and then press the ENTER key

1. Press the MENU key to display the top menu window. Select “3: Utility” and then press the ENTER key. The Utility screen opens.
   You can also use the numeric keypad 3 after the top menu is displayed.



On the Utility screen, select the “Osc Ext Add” field and then press the ENTER key

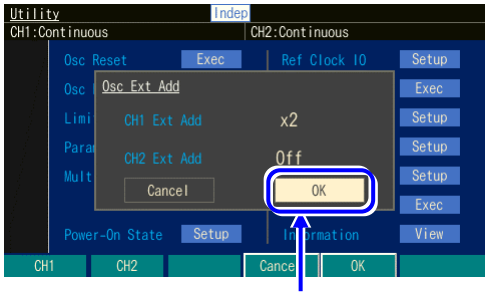
2. On the Utility screen, select the “Osc Ext Add” field and then press the ENTER key.
   In sequence oscillation mode, it is “Seq Ext Add”.
   You can also use [Ext Add] soft key.



Set the external addition setting

External addition setting dialog is opened

3. The external addition setting dialog will open, so select the setting item and press the ENTER key. [CH1], [CH2] ([Ext Add] for WF1983/WF1981) soft keys can also be used. When the selection list for the external addition condition opens, select the desired condition. ☞ P.4-18
   ‘x0.4’, ‘x2’, and ‘x10’ represent the addition gain. (Gain from MOD/ADD IN terminal to waveform output terminal with no load)



Select [OK] and then press the ENTER key

4. When the external addition setting is completed, select [OK] at the bottom of the dialog, and then press the ENTER key.
   You can also use [OK] soft key.
   The external addition setting change is applied.
   If you do not want to apply the external addition setting change, select [Cancel] at the bottom of the dialog and then press the ENTER key, or press the CANCEL key.

If you are unable to make the desired external addition, see the next section.

c) If the desired external addition condition cannot be selected

■ External addition cannot be ON (set as ‘x0.4’, ‘x2’, ‘x10’)

An external modulation is used.
To use the external addition, change the modulation source to Internal. ☞ P.4-65

The external addition input terminal is being shared 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 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

Since external addition is added to the final stage of waveform output, the addition gain and output voltage range are closely related. ☞ P.1-4
For the relationship between external addition gain and output voltage range, please refer to ☞ P.4-44.

To set the external addition gain to ‘x0.4’, first set the amplitude and DC offset to:
(Amplitude setting [Vp-p] / 2 + DC offset setting [V]) ≤ 0.4
Furthermore, if the previous setting was ‘x2’ or ‘x10’, please turn it ‘Off’ and then set it to ‘x0.4’.

To set the external addition gain to ‘x2’, first set the amplitude and DC offset to:
(Amplitude setting [Vp-p] / 2 + DC offset setting [V]) ≤ 2
Furthermore, if the previous setting was ‘x10’, please turn it ‘Off’ and then set it to ‘x2’.

When the external addition is used, the maximum output voltage of the range is fixed by the addition gain. In particular, note that the fineness of the amplitude accuracy and the waveform may decrease when the amplitude is reduced because it is fixed to 20V range when the addition gain is ‘x10’.

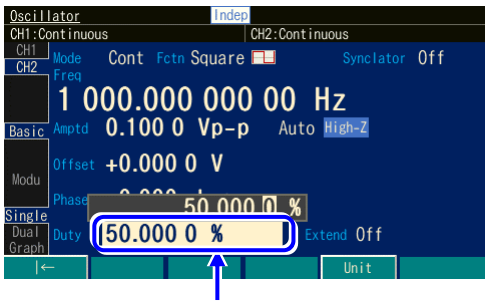
■ When compilation fails during sequence oscillation

If the maximum output level of the entire sequence exceeds the maximum output level determined by the output voltage range by external addition gain, an error will occur during compilation.
For the relationship between external addition gain, maximum amplitude, and DC offset, please refer to ☞ P.4-44.

4.4.14 To set Duty of Square wave

The waveform is assumed to be set as square wave “Square”. How to set the waveform, ☞ P.4-18.
The setting unit for duty is % only. It cannot be set or displayed with time. To set by time, Please use pulse waves for ☞ P.4-51

a) To set the duty



“Duty” input field is opened

1. Select the “Duty” field (☞ P.4-14) to open the duty input field.
   Or press the soft key [Duty] to open the duty input field.

2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value.
   The change is immediately reflected in the output. ☞ P.4-16
   Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key [%]) to set the input value.

3. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

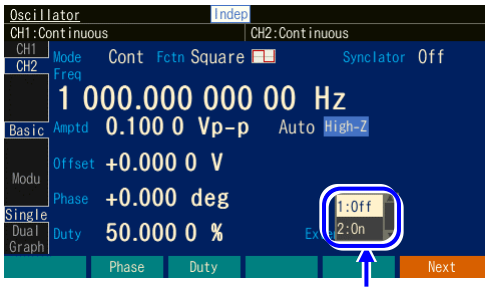
Check

The settable duty range is limited to ☞ P.4-50. In addition, there may be restrictions due to upper / lower limit settings.
Initialize (☞ P.4-27) or change the upper / lower limit setting values (☞ P.4-57).

To avoid glitches and keep the frequency unchanged when changing the duty, the duty is changed after waiting for the edge of the waveform. Therefore, when the frequency is low, changing the duty may not be reflected immediately.

b) To switch duty variable range

Normally, use the product with this set to Off (standard range).



Duty variable range extension selection list

1. Select the “Extend” field (☞ P.4-14) to open the extended duty variable range on/off selection list.

2. Select the desired option using the up/down keys or the modify knob. ☞ P.4-18

c) Difference between standard and extended duty variable range

Variable range	Features
Standard	Setting range: 0.0001% to 99.9999% (narrows depending on frequency) • Duty can be changed within the range where jitter is low and the pulse does not disappear. • The setting range of the duty narrows as the frequency rises. • For example, at 15MHz, the duty is limited to approximately 18% to 82%.
Extended	Setting range: 0.000 0% to 100.000 0% (independent of frequency) • There is jitter of 1.3ns rms or lower typ., and the duty can be always changed from 0% to 100%. • The pulse may sometimes disappear when the pulse width of the high level or the low level is narrower than that of 4.2ns. However, it becomes equal to the specified duty on average. • When 0% is set, the waveform is fixed to the low level, and when 100% is set, the waveform is fixed to the high level. The pulse is not output in either case. • When the oscillation frequency is an integer ratio relationship with 240MHz, the edge time will become indeterminate by approximately 4.6ns. Under other conditions, it will be the specified duty “on average”.

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:

$$\text{Frequency [Hz]} \times 115 / 96\,000\,000 \leq \text{Duty [\%]} \leq 100 - \text{Frequency [Hz]} \times 115 / 96\,000\,000$$

For example, the variable range at 10MHz is limited to approximately 12.0% to 88.0%.

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

Check

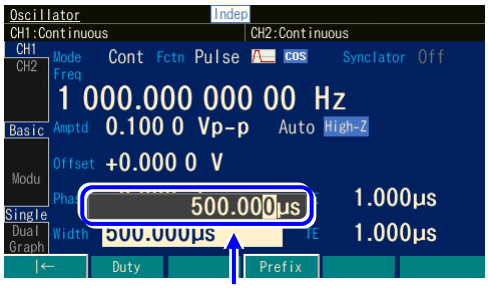
When extended duty variable range is on, pulses may sometimes disappear depending on the setting, so the apparent frequency may be lower than the setting.

With an application where the frequency needs to be kept constant, use this product with extended duty variable range set to off (i.e. standard range).

4.4.15 To set Width, Leading/Trailing edge times, and Transition waveform of the pulse wave

The waveform is assumed to be set as pulse wave “Pulse”. For how to set the waveform, ☞ P.4-33. Set the pulse width with time or duty. Set the leading and trailing edge times with time. Set the shape of rising and falling for the transition waveform.

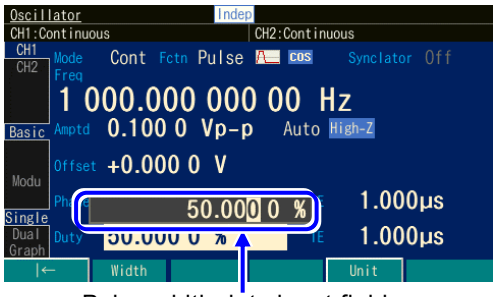
a) To set pulse Width time



Pulse width time input field

1. Select the “Width” field (☞ P.4-14) to open the input field for pulse width. [Duty] and [Width] soft keys can also be used.
   If “Duty” is displayed in the “Width” field and pulse duty is displayed, press the soft key [Width] while the input field is open. Switches to pulse width time display.
2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. ☞ P.4-16 Or use the numeric keypad to enter the value. ☞ P.4-17 Press the ENTER key or the unit key (soft key [µs], [ms], [s], [ks], or [Ms]) to set the input value.
   If you do not want to change the settings, press the CANCEL key.

b) To set pulse width Duty



Pulse width duty input field

1. Select the “Duty” field (☞ P.4-14) to open the input field for pulse width. [Duty] and [Width] soft keys can also be used.
   If “Width” is displayed in the “Duty” field and pulse width time is displayed, press the soft key [Duty] while the input field is open. Switches to pulse duty display.
2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. ☞ P.4-16 Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key [%]) to set the input value.
   If you do not want to change the settings, press the CANCEL key.

Check

The settable pulse width range is limited to ☞ P.4-53. In addition, there may be restrictions due to upper / lower limit settings.

Initialize (☞ P.4-27) or change the upper / lower limit setting values (☞ P.4-57).

To avoid glitches and keep the frequency unchanged when changing the duty, the duty is changed after waiting for the edge of the waveform. Therefore, when the frequency is low, changing the duty may not be reflected immediately.

c) To toggle pulse width time and pulse width duty

○ Pulse width time → Pulse width duty

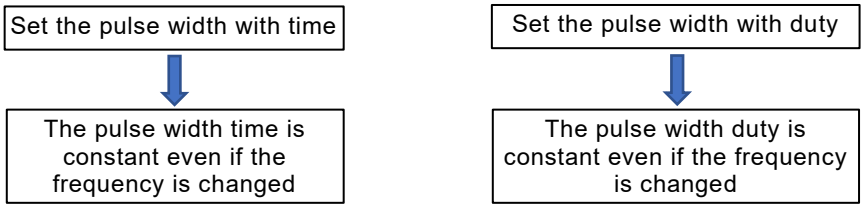
The input field of pulse width time opens. When the current pulse width time is displayed, the [Duty] soft key is displayed. Press the key to open the input field of pulse width duty, and change the display from “Width” to “Duty”. The [Duty] soft key changes to [Width].

○ Pulse width duty → Pulse width time

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

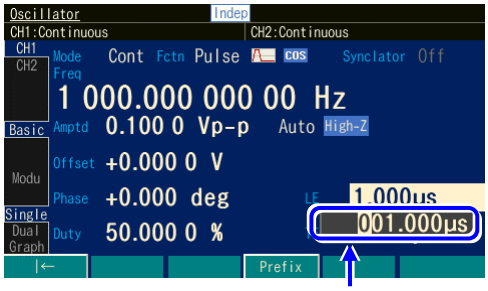
d) Difference between pulse width time setting and duty setting

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



e) To set the leading/trailing edge times

The leading edge “LE” and trailing edge “TE” times can be set with time only.

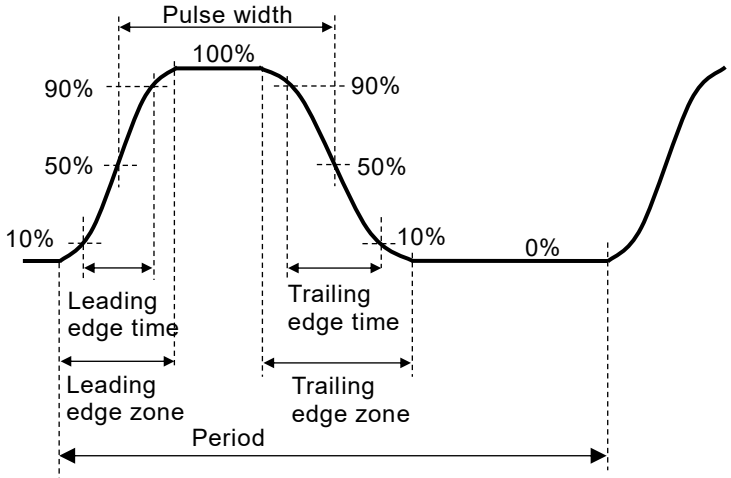


Leading-edge time input field

1. To set the leading-edge time, select the “LE” field (☞ P.4-14) to open the leading-edge input field.
   To set the trailing-edge time, select the [TE] field, to open the trailing-edge input field.
   [LE] and [TE] soft keys can also be used.
2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. The change is immediately reflected in the output. ☞ P.4-16
   Or use the numeric keypad to enter the value. ☞ P.4-17
   Press the ENTER key or the unit key (soft key [µs], [ms], [s], [ks], or [Ms]) to set the input value and reflect it in the output. When the ENTER key is used, s is set as the unit.
3. Before pressing the ENTER key or unit key (soft key), you can return to the state before the change using the CANCEL key.

f) Definitions and limitations of pulse width, leading/ trailing edge time, leading/ trailing edge zone

The definitions of pulse width, leading edge time, trailing edge time, leading edge zone, and trailing edge zone when 'COS' is selected as the transition waveform are shown in the following figure.



When a transition waveform other than 'COS' is selected, the leading-edge time and trailing-edge time are defined as the times of the leading edge zone and trailing edge zone. However, in this case, the transition start/end interval may look different due to analog bandwidth constraints.

■ Mutual restriction of setting parameters

The setting range is limited mutually as follows for pulse width, leading edge time, trailing edge time, and frequency.

If the following restriction is not satisfied by setting the frequency or the pulse width, the leading and trailing edge times are first adjusted, and then the pulse width is adjusted.

$$\left(\begin{matrix}Leading\ edge\ time + \\ trailing\ edge\ time\end{matrix}\right) \times k \leq Pulse\ width\ time \leq Period - \left(\begin{matrix}Leading\ edge\ time + \\ trailing\ edge\ time\end{matrix}\right) \times k$$

Transition waveform other than 'COS': $k = 1$, 'COS': $k = \frac{\pi}{4\,arcsin(0.8)} \approx 0.847$

For example, if the transition waveform is 'COS', the frequency is 1kHz and leading and trailing edge times are set 100ns, the pulse width time can be varied in the range of 169.32ns to 999.83µs.

■ Setting ranges of leading edge and trailing edge times

The setting values for the leading edge and trailing edge times are subjected to the following restrictions.

When transition waveform: 'COS'	7.69ns to 59.03Ms
When transition waveform: other than 'COS'	11.98ns to 99.99Ms
The setting resolution is 4 digits or 10ps.	

g) Transition waveform types and setting method

■ Transition waveform types

The following waveforms can be selected for the shapes of the leading-edge zone and trailing edge zone of the pulse waveform.

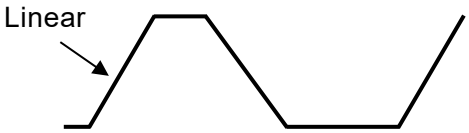
○ Cosine: 'COS'

This waveform is the same shape as the zone of -90º to 90º of a sine wave. The setting range of the leading and trailing edge times is 7.69ns to 59.03Ms. The setting values for the leading edge and trailing edge times are applied in any zone with an amplitude of 10% to 90%.

○ Liner: 'LIN'

This waveform changes linearly. The setting range of the leading and trailing edge times is 11.98ns to 99.99Ms.

The setting values for the leading edge and trailing edge times are applied in any zone with an amplitude of 0% to 100%.



○ Parameter variable waveform: 'PWF'

A parameter variable waveform is used for the leading edge, and a waveform which is that waveform inverted vertically is used for the trailing edge.

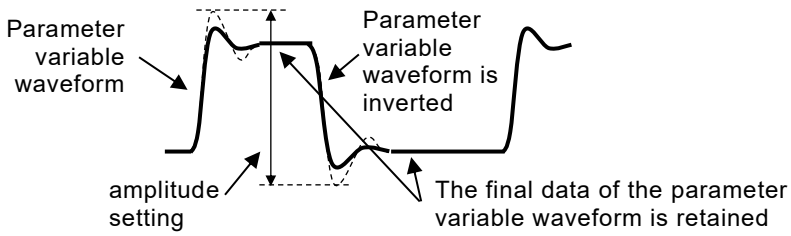
The example in the figure below is when a second order LPF step response waveform ☞ P.6-22 is selected. In this example, a pulse containing overshoot and ringing can be generated.

Automatically adjusted so that the Y value of the start point and the end point with reversed polarity match and fall within the full-scale range. Therefore, if there is a peak that exceeds the range between the start and end points of the waveform, the amplitude and offset may differ from the set values accordingly.

Please note that the specified amplitude will not be output unless the start and end of the waveform, including the amplitude range setting, is within ±FS.

If the leading/trailing edge is made too small, overshoot and ringing will increase.

PWF data is adjusted to 2 048 words and real-time interpolated data is used.

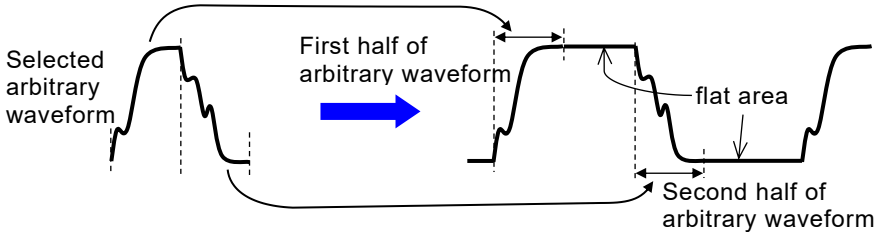


○ Arbitrary waveform: 'ARB'

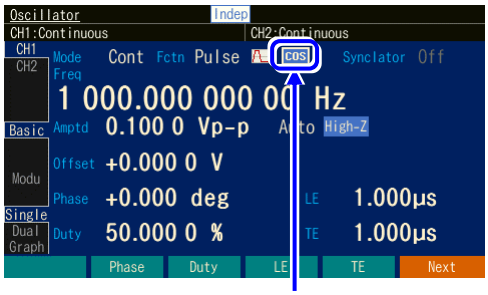
The first half of the arbitrary waveform is used as the leading edge, and the second half as the trailing edge. The items that can be selected are those in the edit memory and the main unit's arbitrary waveform memory.

Note: If the start/end of the waveform, including the amplitude range setting, is not -FS and the center is +FS (or vice versa), the specified amplitude will not appear in the flat part. leading/trailing edge time are applied to the width of each section of the ARB.

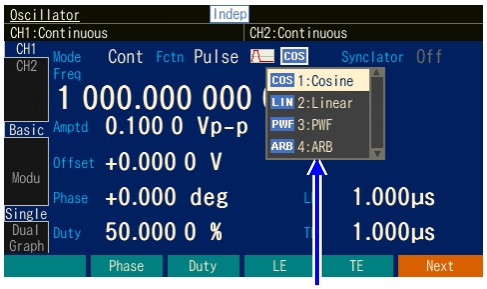
ARB data is adjusted to 2 048 words and real-time interpolated data is used.



■ Selecting the transition waveform



When the waveform is set to pulse, the edge selection icon appears



When the transition waveform selection list is opened

1. Select the edge selection icon(☞ P.4-14) to open the edge selection list.

2. Select the desired option using the up/down keys or the modify knob. ☞ P.4-18

3. If you select PWF or ARB as the transition waveform, a transition icon [...] to the respective setting screen will appear, so select it and configure. ☞ P.4-59, 4-60

When this item is selected, the name of the currently selected ARB name or PWF type will be displayed before pressing the ENTER key.

Check

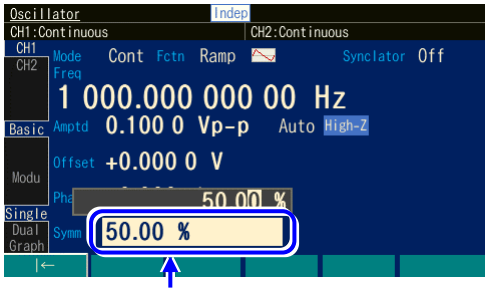
If a waveform has a peak that exceeds the ARB or PWF start point or stop point range, the voltage offset value or voltage peak value may differ from the set value in order to maintain waveform continuity.

If the transition waveform is an ARB, if the values before and after the center of the waveform, or between the beginning and the end, are significantly different, a whisker may appear at the end of the transition.

4.4.16 To set Symmetry of the ramp wave

The waveform is assumed to be set to ramp wave 'Ramp'. How to set the waveform, ☞ P.4-18
The unit of symmetry is %. It cannot be set or displayed with time.

a) To set symmetry



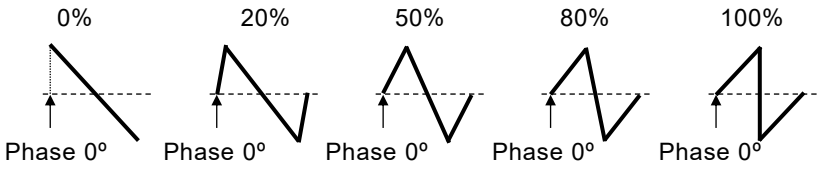
The symmetry input field is opened

1. Select the "Symm" field (☞ P.4-14) to open the symmetry input field.
   Soft key [Symm] is also available.
2. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. ☞ P.4-16

Or use the numeric keypad to enter the value. ☞ P.4-17
Press the ENTER key or the unit key (soft key [%]) to set the input value.
If you do not want to change the settings, press the CANCEL key.

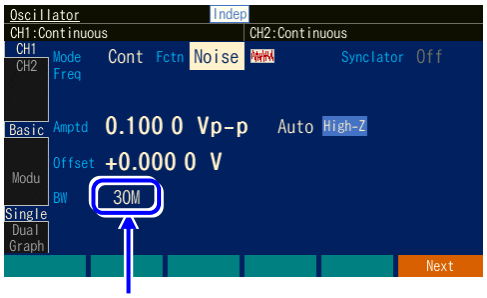
b) Relationship between symmetry and waveform

A waveform changes as follows depending on the symmetry setting. The symmetry is the total ratio of the rising portion from start to finish. The phase 0º is fixed to the position in the figure below.



4.4.17 To set the Equivalent Noise Bandwidth

When the 'Noise' waveform is selected, the "BW" item will appear to set the equivalent noise bandwidth. ☞ P.4-18



Set the equivalent bandwidth so that the bandwidth and amplitude density of the noise become optimal

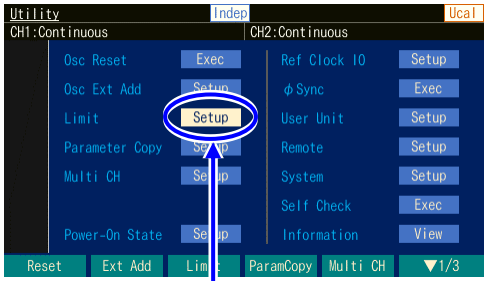
Even if you set the same output amplitude, the wider the equivalent bandwidth, the lower the noise amplitude density will be. Therefore, select the optimal equivalent bandwidth so that the noise voltage within the required band is sufficiently large.

The equivalent bandwidth refers to the value obtained when the noise power is the same as the ideal filter. The frequency characteristics of the cutoff area differ for each setting because this instrument uses a simple filter.

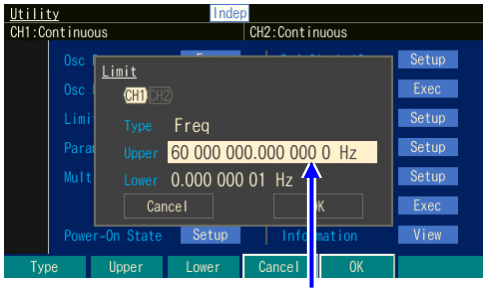
4.4.18 To set the setting range Limit Values

The setting range can be restricted for the setting value of the signal output from the waveform output in normal oscillation. The parameters that can be limited are frequency, voltage, phase, and duty. With respect to voltage, the setting range limit values apply to the positive and negative peak values of the waveform amplitude and DC offset combined.
These limit values are initialized by a reset. ☞ P.4-27 (initial value: ☞ P.16-2)

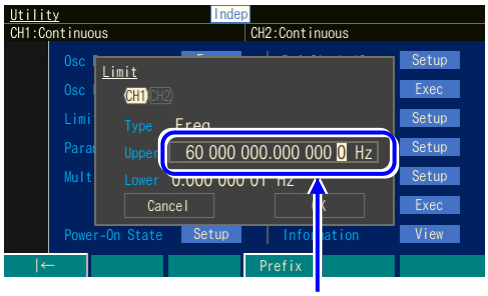
The settings of the setting range limits can be configured in the Utility screen. ☞ P.4-25



In the Utility screen, select “Limit” and press the ENTER key



In the Utility screen, select “Upper” and press the ENTER key



The upper limit setting input field is opened

1. In the Utility screen, select “Limit” (☞ P.4-14) to open limit value setting dialog.
   [Limit] soft keys can also be used.

2. The figure on the left is the case of the upper limit of frequency. Select Upper of Freq and then press the ENTER key to open the input field of the frequency upper limit value.
   [Upper] soft keys can also be used.

3. Select the digit to be changed with the right/left arrow key, and then use the up/down arrow key or the modify knob to increment or decrement the value. ☞ P.4-16
   Or use the numeric keypad to enter the value. ☞ P.4-17 Press the ENTER key or the unit key (soft key [μHz], [mHz], [Hz], [kHz], or [MHz]) to set the input value.

4. When the limits setting is completed, select [OK] at the bottom of the dialog and then press the ENTER key.
   If you wish to cancel, select [Cancel] at the bottom of the dialog and press the ENTER key, or press the CANCEL key.

Check

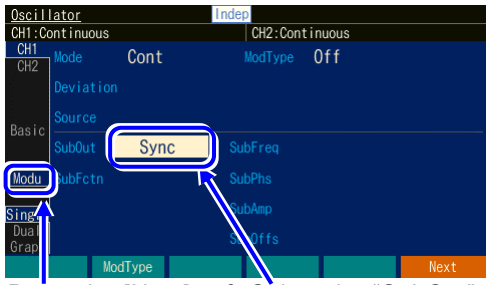
If you try to set a limit that would cause the currently set value to fall outside the range, you will receive a warning and the set limit value will be adjusted to include the current set value.

This setting is invalid for external addition input signals. Note that depending on the external addition signal, voltage or frequency exceeding the limit value may be output.

This limit value is invalid in sequence oscillation mode.

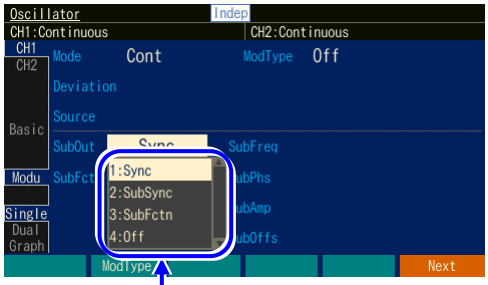
4.4.19 To select Sub Output

A signal output from the synchronization/sub output terminal is called sub output. It can be selected in the sub output field “SubOut” setting on page 4 “Modu” of the Oscillator setting screen.



Press the [Next] soft key until the “Modu” tab is selected

Select the “SubOut” field and press the ENTER key



Sub output selection list opens

1. Press the [Next] soft key until the “Modu” tab on the left side of the screen is selected. Or, select the tab “Modu” using the modify knob or arrow keys, and press the ENTER key.

2. Select the “SubOut” field (☞ P.4-14) to open the sub output selection list.

3. Select the desired output from the selection list ☞ P.4-18

Although the selection options differ depending on factors such as the oscillation mode, the following four selection are available for the continuous mode. For the selection options in other than the continuous mode, see each of the oscillation modes (sweep ☞ P.4-88, burst ☞ P.4-105).

■ Waveform reference phase synchronization: ‘Sync’

Outputs an internal timing signal (a 50% duty square wave that rises at 0° of the waveform reference phase) that is the reference for waveform generateion.

The waveform reference phase synchronization signal is not affected by the “Phase” setting. ☞ P.4-36

■ Sub-waveform reference phase synchronization: ‘SubSync’

Outputs an internal timing signal (a 50% duty square wave that rises at 0° of the sub-waveform reference phase) that is the reference for sub-waveform generation.

Independent of the reference phase of the waveform output. The sub-waveform reference phase synchronization signal is not affected by the “SubPhs” setting. ☞ P.4-124

■ Sub waveform: ‘SubFctn’

Outputs a waveform with a frequency (☞ P.4-124, amplitude (☞ P.4-124) and dc offset (☞ P.4-124) which differ from those of the waveform output. For general information about sub waveforms, see ☞ P.4-123.

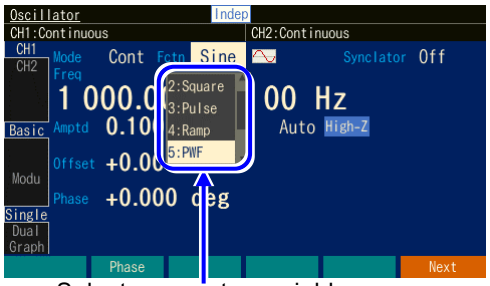
■ Off: ‘Off’

Output will be a direct current of about 0V. This helps to reduce interference from a ground common with externally connected devices or from a synchronization output signal.

4.5 Using Parameter variable Waveforms (PWF)

For details on parameter variable waveforms, ☞ P.6-2.

a) To output a parameter variable waveform



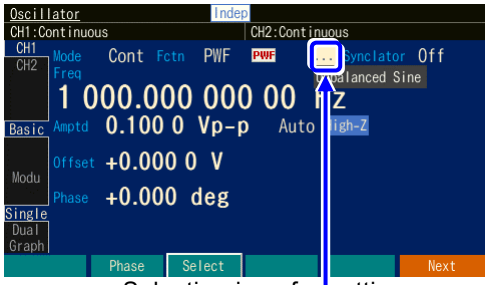
Select parameter variable waveform (PWF)

Press the FCTN shortcut key. Or, select the "Fctn" field (☞ P.4-14) to open the selection list.

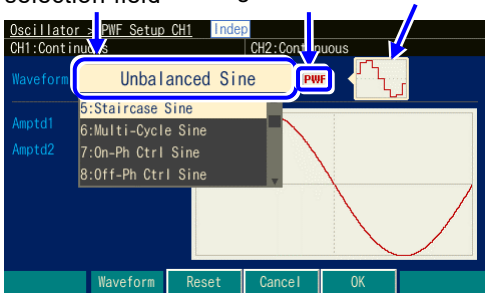
Press the 5 key corresponding to the PWF or select the 'PWF' from the selection list.

Similar to other waveforms, the waveform's polarity and amplitude range may also be changed with PWF icon. ☞ P.4-41

b) To change the waveform of a parameter variable waveform



Selection icon for setting a parameter variable waveform



1. The [...] button is displayed on the right of the polarity/amplitude range icon PWF when the waveform is set to PWF.
   Select the [...] icon (☞ P.4-14) to move to PWF setting screen. When this item is selected, the name of the currently selected PWF type will be displayed before pressing the ENTER key.
2. Configure the PWF type and individual parameter settings on the PWF setting screen. Set the desired PWF type in the "Waveform" field. Set the polarity and amplitude ranges with the PWF icon. The settings are independent for each PWF type. These settings can be changed even if you leave the setting screen.

   Each waveform has a maximum of 6 specific variable parameters to be set. ☞ P.4-16, 4-17 The shape of the set waveform is displayed on the graph.
3. Press the [OK] soft key to confirm the changes and exit the setting screen.
   Press the [Cancel] soft key to discard the changes and exit the setting screen.
   Press the shortcut key ☞ P.4-20 to confirm the changes and exit the setting screen.

Check

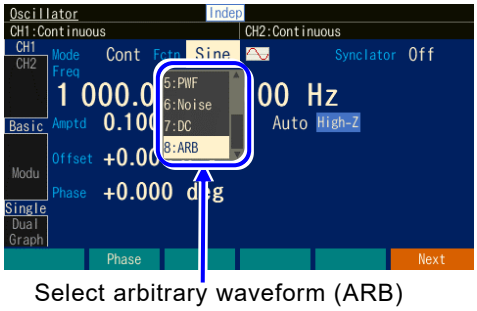
The AC component of the waveform may disappear depending on the parameter settings. Press the [Reset] soft key if it is unclear how to restore the settings. This returns each parameter to the default factory setting. The polarity and amplitude range are not changed.

4.6 Using Arbitrary Waveforms (ARB)

For how to create an arbitrary waveform, ☞ P.7-2.

To output an arbitrary waveform saved in USB flash drive, it must first be copied to the edit memory or internal memory. For the recall method, ☞ P.7-12.

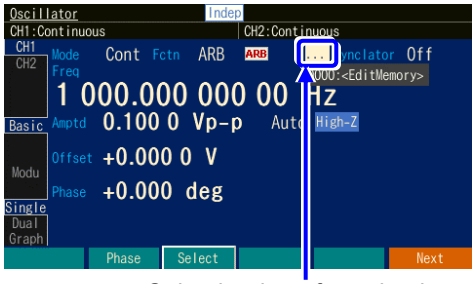
a) To output an arbitrary waveform



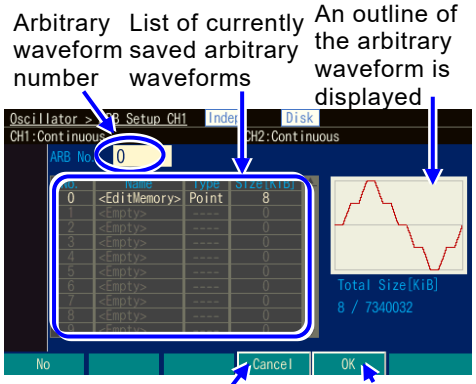
Select arbitrary waveform (ARB)

Press the FCTN shortcut key. Or, select the "Fctn" field (☞ P.4-14) to open the selection list. Press the 8 key corresponding to the ARB or select the 'ARB' from the selection list. Similar to other waveforms, the waveform's polarity and amplitude range may also be changed with ARB icon.

b) To select a waveform to use as an arbitrary waveform



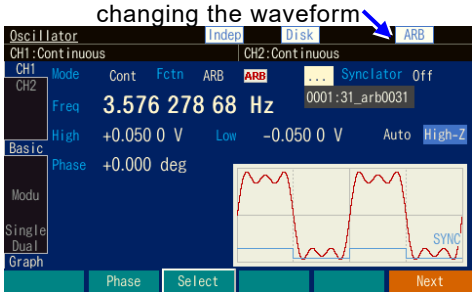
Selection icon for selecting an arbitrary waveform



Press the CANCEL key to discard the changes and exit the selection screen

Confirm the changes and exit the selection screen

ARB flashes while changing the waveform



1. The [...] button is displayed on the right of the polarity/amplitude range icon ARB when the waveform is set to 'ARB'. Select the [...] icon (☞ P.4-14) to move to ARB selection screen. When this item is selected, the name of the currently selected ARB name will be displayed before pressing the ENTER key.
2. The arbitrary waveform can be selected on the arbitrary waveform selection screen. Select the "ARB No." field using the [No.] soft key and set the waveform number, and an outline of the waveform is displayed on the graph screen. The list of ARBs will be scrolled to show the specified waveform number.
3. Press the [OK] soft key to confirm the changes and exit the selection screen.
   Press the [Cancel] soft key to discard the changes and exit the selection screen.
   Press the shortcut key ☞ P.4-20 to confirm the changes and exit the selection screen.
4. Changes will not be reflected in the output waveform until confirmed with the soft key [OK]. The ARB icon in the status area will flash while the waveform is switching.
   The waveform switching time is about 2Mi word/s in array format. For a 32Mi words waveform, it takes about 15s.

Arbitrary waveforms cannot be created on this screen. For details on creation of an arbitrary waveform or the data format and memory capacity, ☞ P.7-2, 7-18.

c) To use the arbitrary waveform data of our previous model

In the array format of previous models, the sample rate was constant, and depending on the set frequency, arbitrary waveform data was thinned out or duplicated so that the average frequency matched the set frequency.

In contrast, this product outputs all waveform data for each sampling frequency. Therefore, the maximum frequency [Hz] that can be output is limited to:

maximum sample rate [S/s] / waveform length [words]

When reusing data in the array format of previous models, process the waveform data to limit the number of data if necessary according to the output frequency of the arbitrary waveform due to this restriction.

d) Restrictions when using arbitrary waveform data

Changing the phase may rewrite the entire waveform data.

Note: If the waveform size is large, it will take some time (the ARB icon will blink during this time). For a 32Mi words waveform, it takes about 15s.

Phase sweep or phase modulation is not possible. However, by using the method described in the next section, it is possible to achieve approximate operation.

When using as a sub waveform, the sampling rate cannot be specified. Only the frequency can be set.

e) To approximate an arbitrary waveform and perform phase sweep/modulation

By specifying arbitrary waveform data as a pulse wave transition waveform, phase sweep and phase modulation are possible. However, since the arbitrary waveform is adjusted to 2 048 words and interpolated in real time, it may not be possible to reproduce it sufficiently if it contains high harmonics or thin pulses. The settings are as follows.

- Set the waveform to ‘Pulse’. ☞ P.4-33
- Set the transition waveform to ‘ARB’ and select the desired arbitrary waveform. ☞ P.4-54
- Set the duty to 50%. ☞ P.4-51
- Set TE and LE to half the period. ☞ P.4-52

For details on how to set each parameter of the pulse wave, ☞ P.4-51.

4.7 Modulation settings and operation

4.7.1 Modulation Function

Modulation is possible in continuous mode, as well as during burst mode and sweep mode, if the setting value does not conflict.
With this product, the oscillation mode is called a modulation function to make it clear that it means an independent function.
If modulation is used in combination when burst or gated sweep mode, modulation is usualy applied during the oscillation stop period as well. ☞ P.4-101

4.7.2 Modulation Types

By changing “ModType” (☞ P.4-63) from ‘Off’, the following eight types of modulations are available.

- Frequency Modulation: ‘FM’ ☞ P.4-69
- Frequency Shift Keying: ‘FSK’
  Binary Frequency Shift Keying. ☞ P.4-70
- Phase Modulation: ‘PM’ ☞ P.4-71
- Phase Shift Keying: ‘PSK’
  Binary Phase Shift Keying. ☞ P.4-72
- Amplitude Modulation: ‘AM’
  This is amplitude modulation with the carrier frequency component. ☞ P.4-73
- Amplitude Modulation (Double Side Band - Suppressed Carrier): ‘AM(SC)’
  AM without carrier frequency element. ☞ P.4-74
- DC Offset Modulation: ‘OFSM’
  That is, the modulating waveform is added to the modulated waveform. ☞ P.4-75
- Pulse Width Modulation: ‘PWM’ ☞ P.4-76

4.7.3 Screen for Setting and operation of modulation

The following explains the common screen configuration of the modulation function.

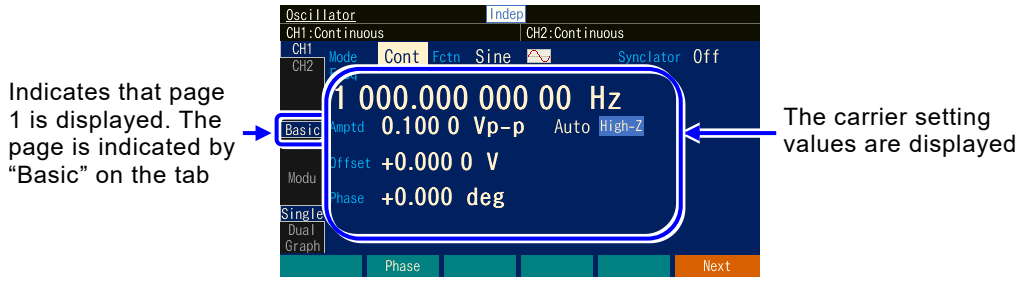
Perform configuration and operation in the Oscillator setting screen.

When another screen is displayed, ☞ P.4-26.

(Press MENU key, If the first line of the menu that appears is “Seq”, press the soft key [Seq→ Osc], the soft key [OK], and the 1 key in sequence.)

a) Page 1 “Basic”: for setting the carrier signal

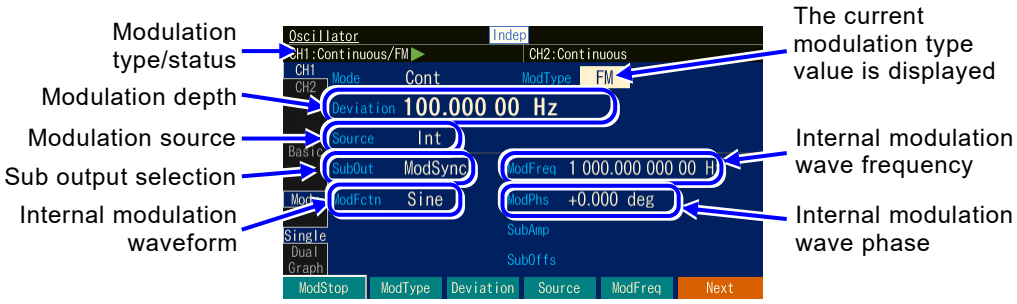
These are common items which are independent of the oscillation mode. This is the screen for setting the modulation carrier signal. For the setting procedure, see ☞「4.4 Setting for Main Items」.



b) Page 4 “Modu”: for setting the modulation function and synchronization/sub output

The page 4 “Modu” appears also in the sweep mode and burst mode.

The following figure is an example of selecting ‘FM’ as a modulation type.



1) Modulation type: “ModType”

These are the types of modulation. Select from ‘FM’, ‘FSK’, ‘PM’, ‘PSK’, ‘AM’, ‘AM(SC)’, DC offset modulation ‘OFSM’, ‘PWM’, or ‘Off’. ☞ P.4-65

‘FSK’ and ‘PSK’ cannot be selected in a burst mode other than auto burst and in sweep mode. (Because the trigger source and modulation source compete)

If you select ‘Off’ (modulation function is not used), a signal without modulation is output.

When it is not ‘Off’, the modulation type and status is displayed in the modulation status section of the target channel in the status display area ☞ P.4-7.

Modulation can also be paused ☞ P.4-67.

2) Modulation depth: “Deviation”, “Depth”, “HopFreq”

This is the modulation depth. ☞ P.4-65 The item name changes with the modulation type.

The modulation signal will have no effect on the waveform output when the modulation depth is set to 0 (Same frequency as carrier when using “HopFreq”).

3) Modulation source: “Source”

Select the modulation source from the following options:

Modulation type	WF1983/WF1981	WF1984/WF1982	External input terminal
‘FSK’/ ‘PSK’	Internal: ‘Int’ / External: ‘Ext’	Internal: ‘Int’ / External #1: ‘Ext1’ / External #2: ‘Ext2’	TRIG IN ☞ P.3-10
Others	Internal: ‘Int’ / External: ‘Ext’		MOD/ADD IN ☞ P.3-9

※ Internal detail ☞ P.4-66, External detail ☞ P.4-67

In WF1984/WF1982, the modulation source can be set independently for each channel, and the internal modulation source is also independent for each channel. (Identical settings and phase synchronization are also possible. ☞ P.8-6) When external modulation is selected for ‘FSK’/ ‘PSK’, the polarity/threshold of the external trigger input can be set by selecting [...] (☞ P.4-14) to the right. ☞ 「■ **Modulation type: ‘FSK’ or ‘PSK’**」

4) Internal modulation frequency/sub waveform frequency: “ModFreq”, “SubFreq”

When the modulation function is on and internal modulation is used, set the frequency of the internal modulation source(☞ P.4-66), and when not, set the frequency of sub waveform(☞ P.4-124) that can be output to the sub output. When the waveform is ‘Noise’, the frequency cannot be set. Alternatively, you can set the equivalent noise bandwidth: ModBW, SubBW.

See also ☞ P.4-56. The frequency characteristics of the cutoff area is different from those of the main output.

5) Internal modulation waveform/sub waveform: “ModFctn”, “SubFctn”

When the modulation function is on and internal modulation is used, set the waveform of the internal modulation source, and when not, set the sub waveform that can be output to the sub output. ☞ P.4-57 Select from ‘Sine’, ‘Square’, ‘Triangle’, rising ramp ‘UpRamp’, falling ramp ‘DnRamp’, ‘Noise’, arbitrary waveform ‘ARB’, and parameter variable waveform ‘PWF’. ☞ P.4-66, 4-123 Arbitrary waveforms and parameter variable waveforms are adjusted to 4 096 words and interpolated in real time.

6) Internal modulation phase/sub waveform phase: “ModPhs”, “SubPhs”

When the modulation function is on and internal modulation is used, set the phase of the internal modulation source, and when not, set the phase of sub waveform that can be output to the sub output. ☞ P.4-66, 4-124 When the waveform is ‘Noise’, the phase cannot be set.

7) Sub output selection: “SubOut”

Selects the output signal from the synchronization/sub output terminal. Choose from the selection list. ☞ P.4-68

8) Sub output amplitude: “SubAmp”

Sets the output amplitude for when the internal modulation waveform and sub waveform are output from the synchronization/sub output terminal. ☞ P.4-124

During internal modulation, this setting has no effect on the modulation result.

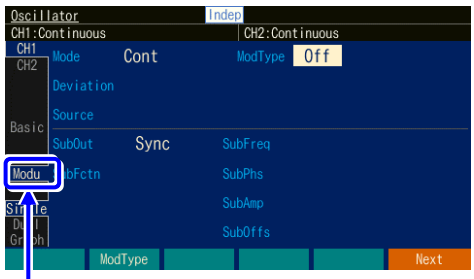
9) Sub output offset: “SubOfs”

Sets the output offset for when the internal modulation waveform and sub waveform are output from the synchronization/sub output terminal. ☞ P.4-124

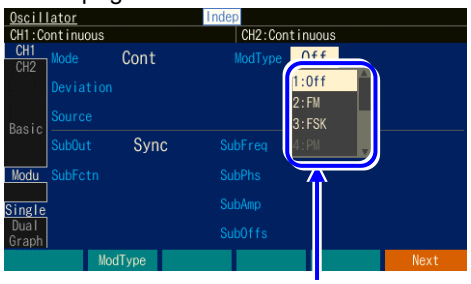
During internal modulation, this setting has no effect on the modulation result.

4.7.4 Common Settings and operation of modulation

The following explains the common settings and operation independent of the modulation type.



Switch to the state with the page 4 "Modu" selected



Select the desired modulation type

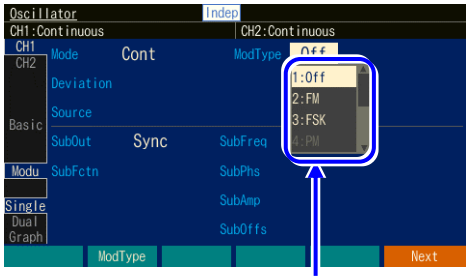
1. Press the [Next] soft key until the "Modu" tab on the left side of the screen is selected.
   Or, select the tab "Modu" using the modify knob or arrow keys, and press the ENTER key.

2. Select the "ModType" field (☞ P.4-14) to open the moduration selection list.
   Soft key [ModType] is also available.

3. Select a desired modulation type other than Off. ☞ P.4-18
   Selectable modulations are as follows.
   Modulation is now possible.

a) To select the type of modulation

Select from the following eight types or 'Off' in the modulation types "ModType" on page 4 of the setting screen "Modu". ☞ P.4-18 ('Off': Modulation function is not used)



Modulation type

- Frequency moduration: 'FM' ☞ P.4-69
- Frequency shift keying: 'FSK' ☞ P.4-70
- Phase moduration: 'PM' ☞ P.4-71
- Phase shift keying: 'PSK' ☞ P.4-72
- Amplitude moduration: 'AM' ☞ P.4-73
- AM(Suppressed carrier): 'AM(SC)' ☞ P.4-74
- DC offset moduration: 'OFSM' ☞ P.4-75
- Pulse width moduration: 'PWM' ☞ P.4-76

b) To set the carrier condition

Set each parameter of the carrier signals on page 1 of the setting screen "Basic". ☞ P.4-63 (frequency, phase, amplitude, DC offset, duty ☞ P.4-34, 4-36, 4-38, 4-39, 4-49)

c) To set the modulation depth

Set this in the modulation depth setting item on page 4 of the setting screen "Modu". ☞ P.4-16
The displayed item name will be any of "Deviation", "Depth", or "HopFreq" depending on the modulation type. For details, see the description of each type.

- Deviation 'FM': P.4-69, 'PM': P.4-71, 'PSK': P.4-72, 'OFSM': P.4-75, 'PWM': P.4-76
- Depth 'AM': P.4-73, 'AM(SC)': P.4-74
- HopFreq 'FSK': P.4-70

d) To modulate with internal signal source

Set the modulation source “Source” to internal ‘Int’ on page 4 “Modu”. ☞ P.4-18
See ☞ P.4-64 for details on source selection.

The internal modulation waveform “ModFctn”, internal modulation frequency “ModFreq”, and internal modulation phase “ModPhs” must be set. (In WF1984/WF1982, the internal modulation source are channel independent but can be synchronized ☞ P.8-6)
Internal modulation source settings are the same as sub waveform settings. See ☞ P.4-123 for details on settings.

Select the internal modulation waveform “ModFctn” from the following eight types:

- Sine wave: ‘Sine’
- Square wave (50% duty): ‘Square’
- Triangle wave (50% symmetry): ‘Triangle’
- Rising ramp wave: ‘UpRamp’
- Falling ramp wave: ‘DnRamp’
- Noise (Gaussian distribution, Variable bandwidth): ‘Noise’
- Arbitrary waveform: ‘ARB’
- Parameter variable waveform: ‘PWF’

If the internal modulation waveform is ‘Noise’, the internal modulation frequency cannot be set. Alternatively, you can set the equivalent bandwidth with “ModBW”.
When the modulation type is ‘FSK’ or ‘PSK’, the internal modulation waveform is fixed to a square wave with 50% duty, and the internal modulation waveform cannot be selected.

If you select an arbitrary waveform ‘ARB’ as the internal modulation waveform, the ARB whose Type column is displayed as “Raw” is in array format, and the ARB whose Type column is displayed as “Point” is in control point format.
In the case of these ARBs and parameter variable waveforms ‘PWF’, the entire waveform is adjusted to 4 096 points and interpolated in real time to preserve as much of the waveform characteristics as possible. Therefore, if you select a ‘PWF’ or ‘ARB’ that contains high harmonics or thin pulses, the waveform may not be reproduced satisfactorily. For details on arbitrary waveforms, ☞ P.7-2.

If you change the value of the internal modulation phase “ModPhs”, the phase of the modulation signal changes. In a 2-channel device, the phase reference of internal modulation source is also independent, but phase synchronization can be performed. ☞ P.8-6

e) To modulate with external signal source

Set the modulation source “Source” to external ‘Ext’, ‘Ext1’, or ‘Ext2’ on page 4 “Modu”. ☞ P.4-18 See also, ☞ P.4-64.

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

■ Modulation type: ‘FM’, ‘PM’, ‘AM’, ‘AM(SC)’, ‘OSFM’, or ‘PWM’ (analog)

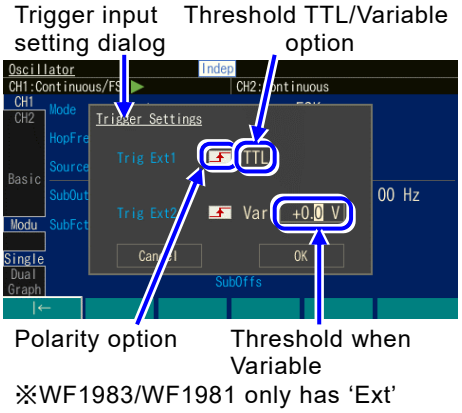
Input a modulation signal to the external modulation/addition (MOD/ADD IN) input terminal.

In WF1984/WF1982, each channel has a dedicated terminal. The setting of the modulation depth is the value for a signal level of ±1V. Note that if the input level is lower than ±1V, the modulation depth is lower than the specified value. When the MOD/ADD IN input terminal is used for the external addition input, the external modulation function cannot be used.

■ Modulation type: ‘FSK’ or ‘PSK’ (digital)

Input the modulation signal to the external trigger input terminal (TRIG IN). For WF1984/WF1982, you can select which of the two terminals to use for each channel. When selecting an external modulation source, select [...] (☞ P.4-14) to display the trigger input setting dialog. Polarity (positive/negative) and threshold value (TTL/Variable) can be selected. ☞ P.4-18

If you select ‘Variable’ for the threshold, you can specify the threshold voltage. ☞ P.4-16, 4-17



※WF1983/WF1981 only has ‘Ext’

f) To start modulation → Starts automatically. Resume with the [ModStart] soft key

When the modulation function is set to on, modulated oscillation starts automatically. However, the modulated oscillation will not start if the modulation setting is inappropriate (“Conflict” will be displayed blinking in the oscillation mode section of the target channel in the status area). When the [?] soft key displayed on the left end is pressed, a message about the inappropriate setting will be displayed. ☞ P.14-8

When the setting is changed to an appropriate setting, modulated oscillation starts.

If modulation is paused, press the [ModStart] soft key to resume modulation.

Modulation status (■ / ▶) is displayed in the modulation status section of the target channel in the status area (☞ P.4-7).

g) To stop modulation → [ModStop] soft key

Modulation can be paused. When the [ModStop] soft key is pressed during modulation, the modulation will stop and the carrier signal is output without being modulated. To resume modulation, press [ModStart] soft key.

h) To select the signal output from the synchronization/sub output → Select the "SubOut"

Set this in sub output selection "SubOut" on page 4 "Modu". This option change depending on the modulation function. ☞ P.4.7 If neither sweep mode (☞ P.4-88) nor burst mode (☞ P.4-105) is selected, select from the following options: ☞ P.4-58

Internal modulation	External modulation or moduration: 'Off'
Waveform reference phase synchronization: 'Sync'	
Internal modulation reference phase synchronization: 'ModSync'	Sub waveform reference phase synchronization: 'SubSync'
Internal modulation waveform: 'ModFctn'	Sub waveform: 'SubFctn'
Synchoronization/sub output off: 'Off'	

■ When 'Sync' is selected

A signal with TTL level which rises at the reference phase of the waveform is output from the synchronization/sub-output terminal.

When the waveform is a 'Noise' or 'DC', it is fixed to the low level.

■ When 'ModSync' is selected (at modulation is on and internal is used)

A signal with TTL level which is synchronized with the internal modulation waveform is output from the synchronization/sub-output terminal. A square wave with 50% duty 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 an oscilloscope or similar device, it can be used as a trigger signal of the oscilloscope.

■ When 'ModFctn' is selected (at modulation is on and internal is used)

The internal modulation waveform is output from the synchronization/sub-output BNC terminal. The amplitude can be set in sub output amplitude "SubAmp", and the DC offset in sub output offset "SubOfs". The signal level is a maximum of ±3.3V/open.

■ When 'SubSync' is selected (at modulation is off or external is used)

A signal with TTL level which is synchronized with the sub waveform is output from the synchronization/sub-output terminal. A square wave with 50% duty rising at the zero phase of the sub waveform. When the sub waveform is a 'Noise', it is fixed to the low level.

■ When 'SubFctn' is selected (at modulation is off or external is used)

The sub waveform is output. The waveform, amplitude, offset, and phase are settable independently from waveform output. For the setting procedure, ☞ P.4-123.

■ When 'Off' is selected

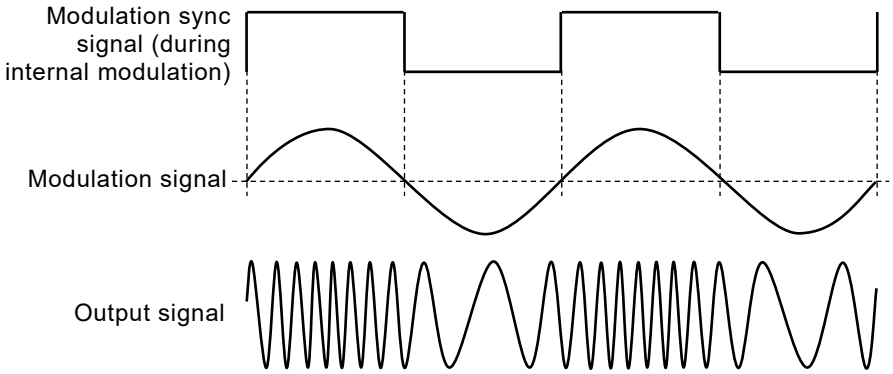
The output will be fixed at approximately 0V. Interference due to common GND with externally connected devices and leakage from synchronized output signals can be reduced.

4.7.5 FM settings

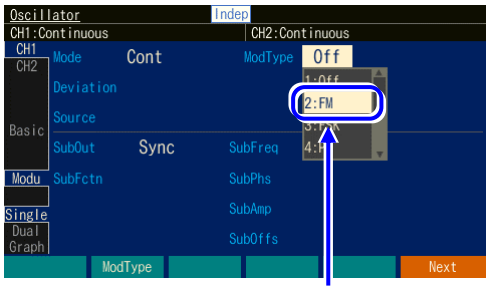
The output frequency varies according to the instantaneous value of the modulation signal.
For details on the modulation setting screen and common operation method, see P.4-63, P.4-65.

a) Example of FM

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



b) To select FM



Select 'FM' in the modulation type list

Select the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen.
Set the option that appears to 'FM'. ☞ P.4-18
You can also use the numeric keypad (2).

c) Waveform or mode where FM is unavailable

'FM' cannot be performed for 'Noise', 'Pulse', and 'DC'.
'FM' cannot be used when frequency sweep.

d) Setting items necessary for FM

Set the carrier frequency "Freq" on page 1 "Basic" of the setting screen.
Set the peak frequency deviation "Deviation" on page 4 "Modu" of the setting screen.
The output frequency varies within the range of carrier frequency ±peak frequency deviation.

When the modulation source "Source" is internal 'Int', set the modulation waveform "ModFctn", modulation frequency "ModFreq", and modulation phase "ModPhs".
When the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', input the modulating signal to the external modulation/addition input terminal. ☞ P.3-9
It reaches the specified peak frequency deviation at ±1V input.

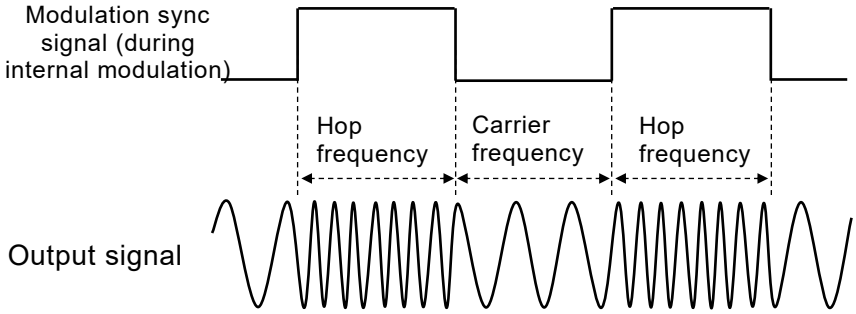
4.7.6 FSK settings

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

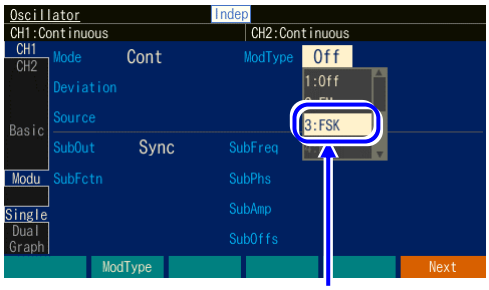
For details on the modulation setting screen and common operation method, see, P.4-63, P.4-65.

a) Example of FSK

The frequency changes abruptly, but the phase continuity of the output signal is maintained.



b) To select FSK



Select 'FSK' in the modulation type list

Select the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen.

Set the option that appears to 'FSK'. ☞ P.4-18

You can also use the numeric keypad (3).

c) Waveform or mode where FSK is unavailable

'FSK' cannot be performed for 'Noise', 'Pulse', and 'DC'.

In burst mode, 'FSK' cannot be performed when other than auto burst.

In sweep mode, 'FSK' cannot be performed.

d) Setting items necessary for FSK

Set the carrier frequency "Freq" on page 1 "Basic" of the setting screen.

Set the hop frequency "HopFreq" on page 4 "Modu" of the setting screen.

The output frequency is switched alternately between carrier frequency and hop frequency.

When the modulation source "Source" is internal 'Int', set the modulation frequency "ModFctn" and modulation phase "ModPhs".

Set the polarity of the trigger when the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', and then input a modulation signal to the external trigger input terminal. ☞ P.3-10

When the polarity is set as positive 'Positive', 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 'Negative', that is reversed.

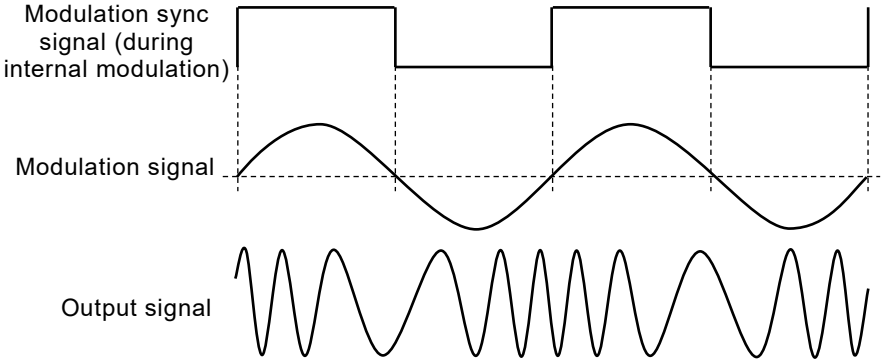
The external modulation source setting ☞「■ **Modulation type: 'FSK' or 'PSK'**」 is common to the burst internal trigger and sweep internal trigger settings.

4.7.7 PM settings

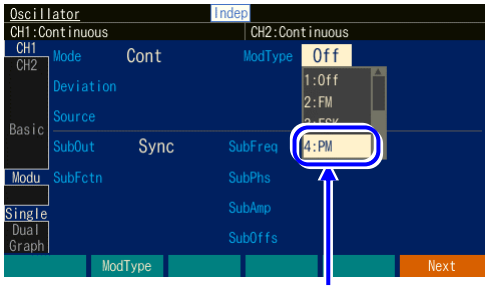
The output phase varies according to the instantaneous value of the modulation signal.
For details on the modulation setting screen and common operation method, see P.4-63, P.4-65.

a) Example of PM

When the modulating signal swings to the positive side, the phase shift of the output signal increases at the positive side. The instantaneous frequency also changes at the same time because the phase changes with time.



b) To select PM



Select 'PM' in the modulation type list

Select the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen.
Set the option that appears to 'PM'. ☞ P.4-18
You can also use the numeric keypad (4).

c) Waveform or mode where PM is unavailable

'PM' cannot be performed for an arbitrary waveform 'ARB', parameter variable waveform 'PWF', 'Noise', and 'DC'. For 'PM' with arbitrary waveforms See ☞ P.4-61.
'PM' cannot be performed when phase sweep.

d) Setting items necessary for PM

Set the peak phase deviation "Deviation" on page 4 "Modu" of the setting screen.
The output phase varies within the range of ±peak phase deviation.

When the modulation source "Source" is internal 'Int', set the modulation waveform "ModFctn", modulation frequency "ModFreq", and modulation phase "ModPhs".
When the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', input the modulating signal to the external modulation/addition input terminal. ☞ P.3-9
It reaches the specified peak phase deviation at ±1V input.

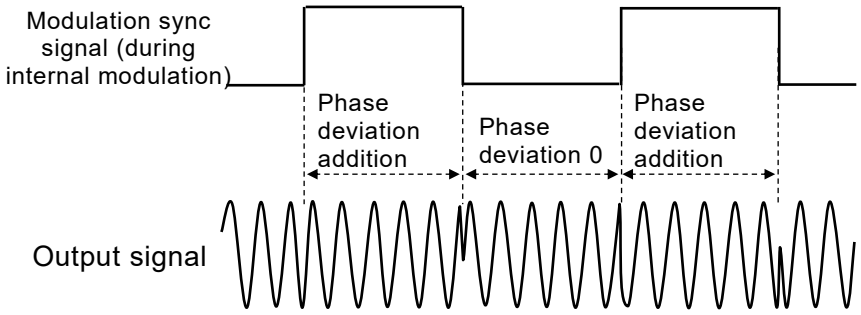
4.7.8 PSK settings

A binary frequency deviation modulation with which the output phase is offset according to the modulation signal.

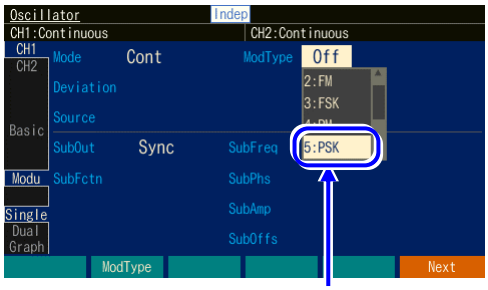
For details on the modulation setting screen and common operation method, see P.4-63, P.4-65.

a) Example of PSK

The output signal waveform is discontinuous because the phase changes abruptly.



b) To select PSK



Select 'PSK' in the modulation type list

Select the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen.
Set the option that appears to 'PSK'. ☞ P.4-18
You can also use the numeric keypad (5).

c) Waveform or mode where PSK is unavailable

'PSK' cannot be performed for an arbitrary waveform 'ARB', parameter variable waveform 'PWF', 'Noise', and 'DC'. For 'PSK' with 'ARB' See ☞ P.4-61. 'PSK' cannot be performed during burst mode other than auto burst, and during sweep mode.

d) Setting items necessary for PSK

Set the phase deviation "Deviation" on page 4 "Modu" of the setting screen.
The phase deviation zero state and specified phase deviation state alternate for 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", and modulation phase "ModPhs".
Set the polarity of the trigger when the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', and then input a modulation signal to the external trigger input terminal. ☞ P.3-10
When the polarity is set as positive 'Positive', 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 'Negative', that is reversed.

The external modulation source setting ☞ 「■ **Modulation type: 'FSK' or 'PSK'**」 is common to the burst internal trigger and sweep internal trigger settings.

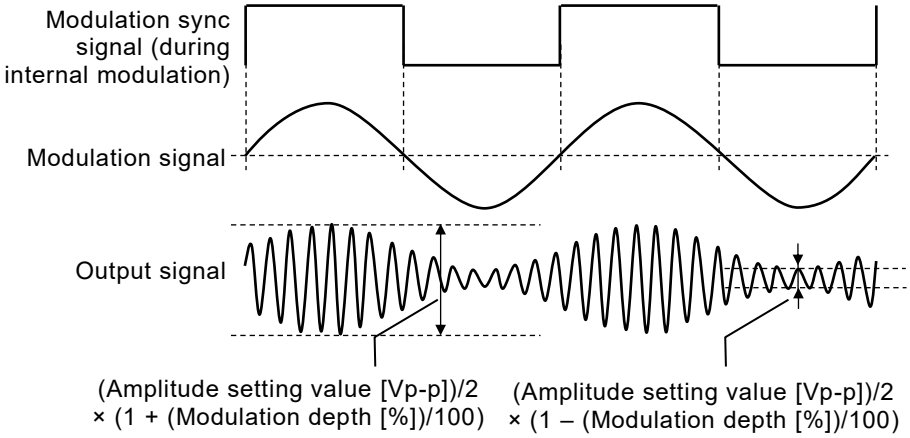
4.7.9 AM settings

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

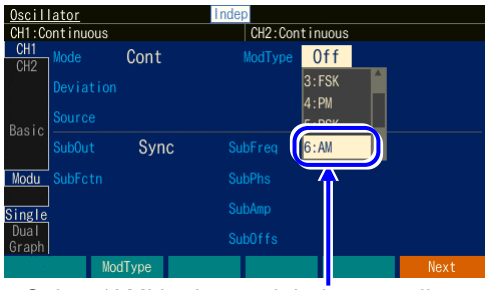
For details on the modulation setting screen and common operation method, see P.4-63, P.4-65.

a) Example of AM

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



b) To select AM



Select 'AM' in the modulation type list

Select the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen. Set the option that appears to 'AM'. ☞ P.4-18

You can also use the numeric keypad (6).

c) Waveform or mode where AM is unavailable

'AM' cannot be performed for 'DC'. 'AM' cannot be performed when amplitude sweep.

d) Setting items necessary for AM

Set the carrier amplitude "Amptd" on page 1 "Basic" of the setting screen.

Set the modulation depth "Depth" on page 4 "Modu" of the setting screen.

The output amplitude varies within the range:

(carrier amplitude setting value [Vp-p]) / 2 × (1 ± (modulation depth [%]) / 100)

For example, when the modulation depth is 0% or the modulation is stopped, the output amplitude is half of that in the continuous mode. When the modulation depth is 100%, the maximum value of the output amplitude is equal to the carrier amplitude setting value. When the modulation source "Source" is internal 'Int', set the modulation waveform "ModFctn", modulation frequency "ModFreq", and modulation phase "ModPhs".

When the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', input the modulating signal to the external modulation/addition input terminal. ☞ P.3-9

The specified modulation depth is achieved when inputting ±1V.

4.7.10 AM(DSB-SC) settings

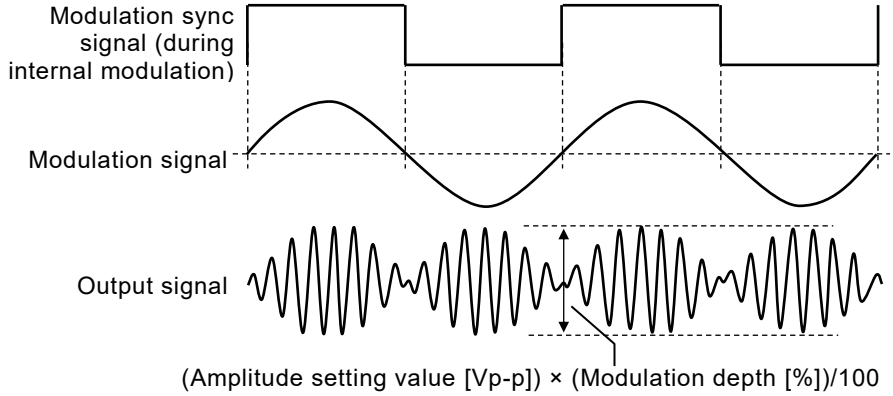
The output amplitude varies according to the instantaneous value of the modulation signal. This is AM without the carrier frequency component.

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

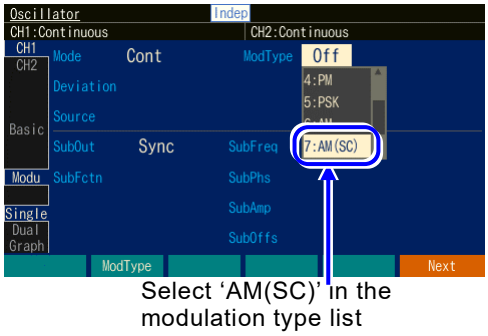
For details on the modulation setting screen and common operation method, see P.4-63, P.4-65.

a) Example of AM(DSB-SC)

The amplitude of the 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 the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen.

Set the option that appears to 'AM(SC)'. ☞ P.4-18

You can also use the numeric keypad 7.

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

'AM(SC)' cannot be performed when the waveform is 'DC' or amplitude sweep.

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

Set the carrier amplitude "Amptd" on page 1 "Basic" of the setting screen.

Set the modulation depth "Depth" on page 4 "Modu" of the setting screen.

The output amplitude varies within the range:

(carrier amplitude setting value [Vp-p]) × ((modulation depth [%]) / 100)

For example, when the modulation depth is 100%, the maximum value of the output amplitude is equal to the carrier amplitude setting value. When the modulation source "Source" is internal 'Int', set the modulation waveform "ModFctn", modulation frequency "ModFreq", and modulation phase "ModPhs". When the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', input the modulating signal to the external modulation/addition input terminal. ☞ P.3-9

The specified modulation depth is achieved when inputting ±1V.

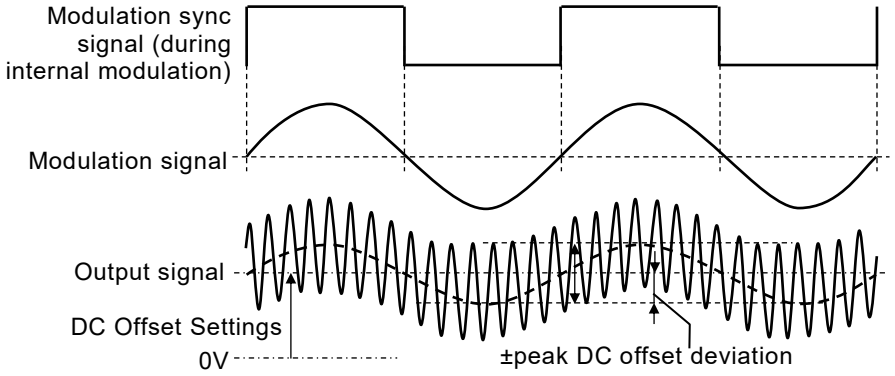
4.7.11 DC offset moduration settings

The DC offset varies according to the instantaneous value of the modulation signal. As a result, a waveform in which the modulation waveform is added to the carrier is output.

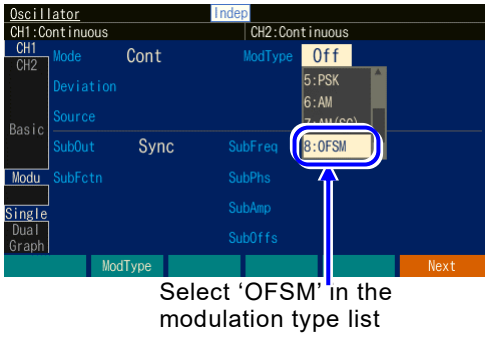
For details on the modulation setting screen and common operation method, see P.4-63, P.4-65.

a) Example of DC offset moduration

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



b) To select DC offset moduration



Select the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen.
Set the option that appears to 'OFSM'. ☞ P.4-18
You can also use the numeric keypad (8).

c) Waveform or mode where DC offset moduration is unavailable

There are no waveforms where DC offset modulation 'OFSM' is unavailable. All waveforms are included. DC offset modulation cannot be performed when DC offset sweep.

d) Setting items necessary for DC offset moduration

Set the DC offset "Offset" on page 1 "Basic" of the setting screen.

Set the peak DC offset deviation "Deviation" on page 4 "Modu" of the setting screen.

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

When the modulation source "Source" is internal 'Int', set the modulation waveform "ModFctn", modulation frequency "ModFreq", and modulation phase "ModPhs". When the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', input the modulating signal to the external modulation/addition input terminal. ☞ P.3-9

It reaches the specified peak DC offset deviation at ±1V input.

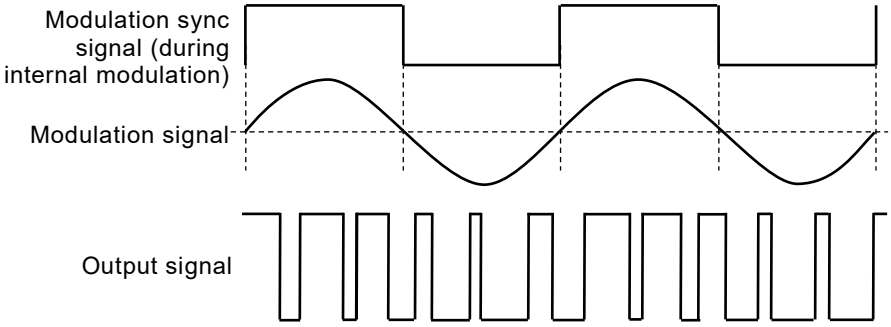
4.7.12 PWM settings

The duty of the square wave and pulse wave varies according to the instantaneous value of the modulation signal. However, the duty actually changes from the next cycle so that the cycle of the output signal does not become other than the set value.

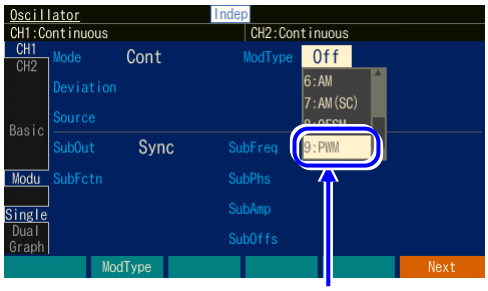
For details on the modulation setting screen and common operation method, see P.4-63, P.4-65.

a) Example of PWM

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



b) To select PWM



Select 'PWM' in the modulation type list

Select the modulation type "ModType" (☞ P.4-14) on page 4 "Modu" of the setting screen.
Set the option that appears to 'PWM'. ☞ P.4-18
You can also use the numeric keypad (9).

c) Waveform or mode where PWM is unavailable

'PWM' can be performed for only a square wave 'Square' and pulse wave 'Pulse'. 'PWM' cannot be performed for other waveforms. 'PWM' cannot be performed when duty sweep.

d) Setting items necessary for PWM

Set the carrier duty "Duty" on page 1 "Basic" of the setting screen.

Set the peak duty deviation "Deviation" on page 4 "Modu" of the setting screen.

The output duty is changed within the range of carrier duty ±peak duty deviation.

When the pulse wave is used, the pulse width of the carrier 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", modulation frequency "ModFreq", and modulation phase "ModPhs". When the modulation source "Source" is external 'Ext' / 'Ext1' / 'Ext2', input the modulating signal to the external modulation/addition input terminal. ☞ P.3-9

It reaches the specified peak duty deviation at ±1V input.

4.8 Sweep settings and operation

4.8.1 Sweep type (Sweep type)

By setting “SwpType” ☞ P.4-81, you can execute the following five types of sweep:

- Frequency sweep: ‘Freq’ ☞ P.4-91
- Phase sweep: ‘Phase’ ☞ P.4-93
- Amplitude sweep: ‘Amptd’ ☞ P.4-95
- DC offset sweep: ‘Offset’ ☞ P.4-97
- Duty sweep: ‘Duty’ ☞ P.4-99

4.8.2 Screen for Setting and operation of sweep

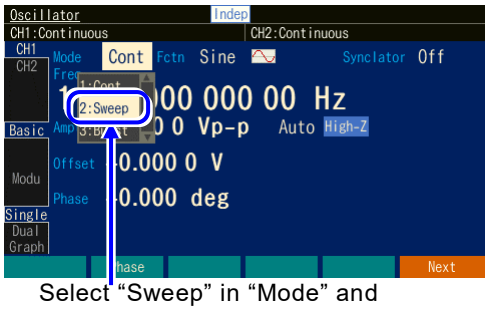
This section describes the common screen configuration in the sweep mode.

Perform configuration and operation in the Oscillator setting screen.

When another screen is displayed, ☞ P.4-26.

(Press [MENU] key, If the first line of the menu that appears is “Seq”, press the soft key [Seq→ Osc], the soft key [OK], and the [1] key in sequence.)

a) To set the oscillation mode to sweep



Select “Sweep” in “Mode” and then press the ENTER key

Press the [MODE] key to open the oscillation mode selection list. Select sweep mode: ‘Sweep’ ☞ P.4-32

You can also use the numeric keypad [2]. This switches to the sweep mode.

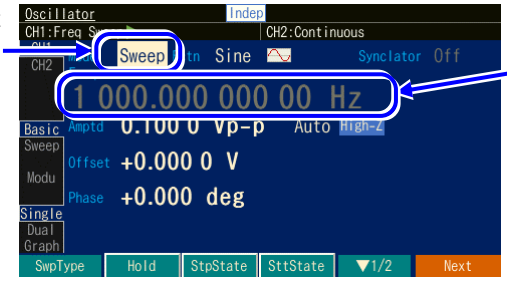
To display the parameters specific to the sweep mode, switch the page 2 “Sweep” with the [Next] soft key.

When the sweep mode is activated, the sweep type and operation status are displayed in the operation status section of the target channel in the status area (☞ P.4-7).

b) Page 1 “Basic”: Basic parameter setting screen

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

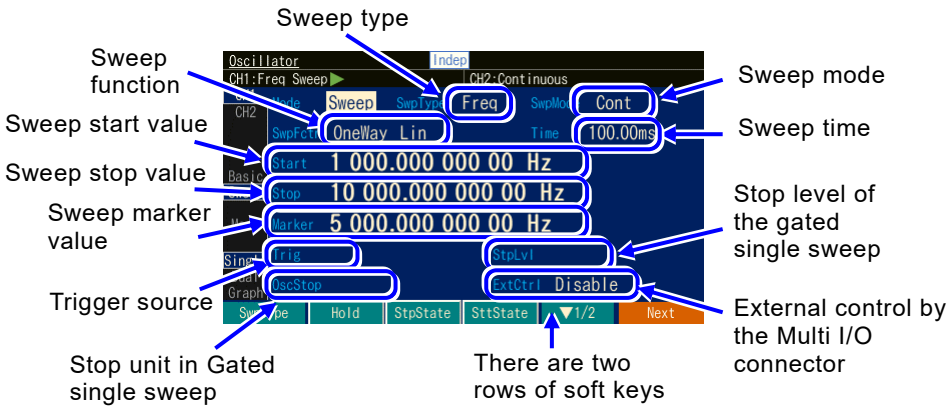
This indicates that the oscillation mode is sweep



The parameter selected in “SweepType” cannot be changed

c) Page 2 “Sweep”: Sweep parameter setting screen

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



○ Sweep type: “SwpType”

This is the item to sweep. Select from frequency ‘Freq’, phase ‘Phase’, amplitude ‘Amptd’, DC offset ‘Offset’, and duty ‘Duty’. ☞ P.4-81

○ Sweep function: “SwpFctn”

This is the sweep form. Select from ‘OneWay’ and ‘Shuttle’. Linear ‘Lin’ and ‘Log’ are available only when the sweep type is frequency. ☞ P.4-82, 4-82

○ Sweep start value: “Start”

This is the start value of sweep. ☞ P.4-81

○ Sweep stop value: “Stop”

This is the stop value of sweep. ☞ P.4-81

○ Sweep marker value: “Marker”

This is the marker value of sweep. If you set the sub output selection to ‘SwpSync+Mkr’, you can know when the sweep target crosses this value during sweep execution. ☞ P.4-88

○ Trigger source: “Trig”

This is the trigger condition of single sweep and gated single sweep. Select internal or external as the trigger source. ☞ P.4-86

○ Oscillation stop unit in gated single sweep: “OscStop”

This is the oscillation stop unit in gated single sweep. Select from 1 cycle unit ‘Cycle’ or half cycle unit ‘HalfCycle’. Usually, set this to 1 cycle unit. ☞ P.4-85

○ Sweep Mode: “SwpMode”

This is the oscillation style of sweep. Select from continuous sweep, single sweep, and gate single sweep. ☞ P.4-83, 4-84, 4-85

○ Sweep time: “Time”

This is the transition time to sweep from the start value to stop value. ☞ P.4-81

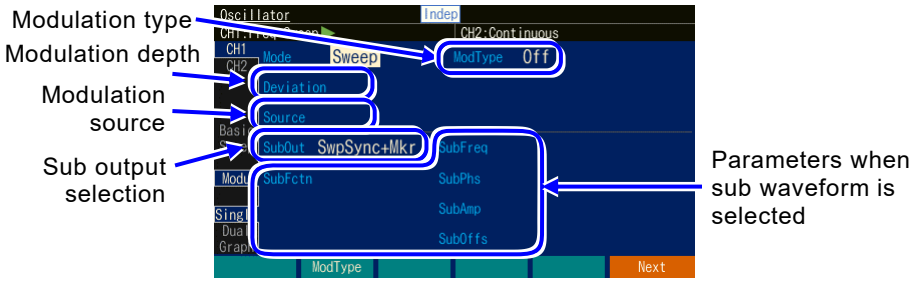
○ Stop level: “StpLvl”

This is the signal level when gated single sweep is stopped. Set the level by specifying ‘Off’ or ‘On’. Normally, set this to ‘Off’. ☞ P 4-85

○ External control via Multi I/O connector: “ExtCtrl”

‘Enable’ or ‘Disable’ external control by the Multi I/O connector. ☞ P.4-90

d) Page 4 “Modu”: Modulation function and synchronization/sub output setting screen



○ Modulation type: “ModType”

These are the types of modulation. ☞ P.4-65

Select from ‘FM’, ‘PM’, ‘AM’, ‘AM(SC)’, ‘OFSM’, ‘PWM’, or ‘Off’.

In sweep mode, ‘FSK’, ‘PSK’, and sweep target parameters cannot be selected.

○ Modulation depth: “Deviation”, “Depth”, “HopFreq”

This is the modulation depth. ☞ P.4-65 The item name changes with the modulation type.

If you specify the modulation depth as 0, the modulation signal has no effect on the waveform output.

○ Modulation source: “Source”

Select the modulation source from internal: ‘Int’ / external: ‘Ext’ (WF1983/WF1981), internal #1,2: ‘Int1’, ‘Int2’ / external #1,2: ‘Ext1’, ‘Ext2’ (WF1984/WF1982).

Internal detail ☞ P.4-66, External detail ☞ P.4-67

○ Internal modulation waveform / sub waveform: “ModFctn” / ”SubFctn”

When the modulation function is on and internal modulation is used, set the waveform of the internal modulation source (☞ P.4-66), and when not, set the sub waveform (☞ P.4-123) that can be output to the sub output.

Select from ‘Sine’, ‘Square’, ‘Triangle’, rising ramp ‘UpRamp’, falling ramp ‘DnRamp’, ‘Noise’, arbitrary waveform ‘ARB’, and parameter variable waveform ‘PWF’.

○ Internal modulation frequency / sub waveform frequency: “ModFreq” / “SubFreq”

When the modulation function is on and internal modulation is used, set the frequency of the internal modulation source(☞ P.4-66), and when not, set the frequency of sub waveform(☞ P.4-124) that can be output to the sub output.

○ Internal modulation phase / sub waveform phase: “ModPhs” / “SubPhs”

When the modulation function is on and internal modulation is used, set the phase of the internal modulation source, and when not, set the phase of sub waveform that can be output to the sub output. ☞ P.4-66, 4-124

○ Sub output selection: “SubOut”

Select the output signal from the synchronization/sub output terminal. Choose from the selection list. ☞ P.4-58

The options for sweep mode are ☞ P.4-88.

Select “ModFctn” to output the internal modulation waveform, and select “SubFctn” to output the sub waveform.

○ Sub output amplitude: “SubAmp”

Sets the output amplitude for when the internal modulation waveform and sub waveform are output from the synchronization/sub output terminal. ☞ P.4-124

During internal modulation, this setting has no effect on the modulation result.

○ Sub output DC offset: “SubOfs”

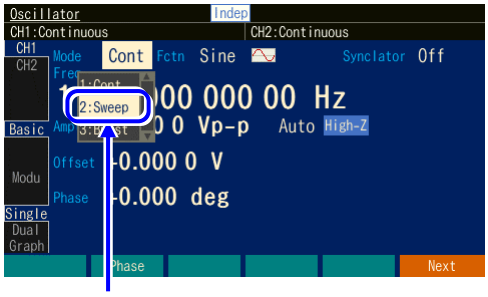
Sets the output offset for when the internal modulation waveform and sub waveform are output from the synchronization/sub output terminal. ☞ P.4-124

During internal modulation, this setting has no effect on the modulation result.

4.8.3 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 mode



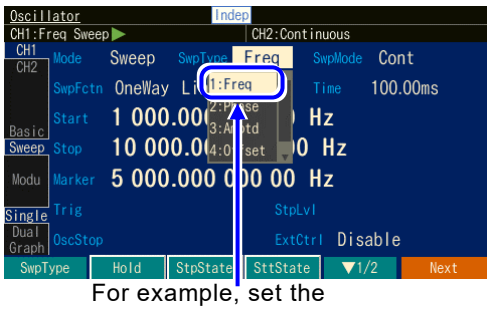
Select ‘Sweep’ in “Mode” and then press the ENTER key.

Press the MODE key to open the oscillation mode selection list. Select sweep mode: ‘Sweep’ ☞ P.4-32

You can also use the numeric keypad 2. This switches to the sweep mode.

To display the parameter screen specific to the sweep mode, use the [Next] soft key to switch to the setting screen page 2 “Sweep”.

b) To select sweep object



For example, set the sweep type to ‘Freq’

Select the object to sweep in sweep types “SwpType” on page 2 “Sweep” of the setting screen from the following five items.

- Frequency Sweep: ‘Freq’ ☞ P.4-91
- Phase sweep: ‘Phase’ ☞ P.4-93
- Amplitude sweep: ‘Amptd’ ☞ P.4-95
- DC offset sweep: ‘Offset’ ☞ P.4-97
- Duty sweep: ‘Duty’ ☞ P.4-99

Check

If the sweep type is amplitude and/or DC offset, and the start/stop values of amplitude and/or DC offset are changed during sweep, the range may change. If the range changes as a result, restart the sweep from the beginning.

If necessary, fix the range setting. ☞ P.4-43

c) To set the range and time to sweep

Set the following items.

- Start value: “Start”
- Stop value: “Stop”
- Sweep time: “Time”

  Time to change from the start value to stop value.

  The setting method is the same as ☞ P.4-35, but setting by frequency is not possible.

For details, see the description of each sweep type

d) To set the sweep range with center and span

When the input field of the start/stop value is opened and the current value is displayed, the [Center] or [Span] soft key 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” or “Stop” to “Center” or “Span” respectively.

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

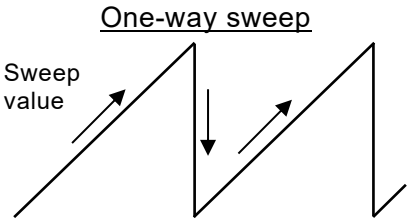
The center value is the average of the start value and stop value. The span value is the absolute value of difference of the start value and stop value. If the log sweep of the frequency is selected, the center value is an arithmetic average of the start and the stop value.

If it is changed to the center value or span value, the magnitude relationship of the start value and stop value is maintained.

e) To sweep as sawtooth wave → Use one way sweep

Select the sweep function “SwpFctn” (☞ P.4-14) on page 2 “Sweep” of the setting screen. And set to one-way ‘OneWay’. ☞ P.4-18

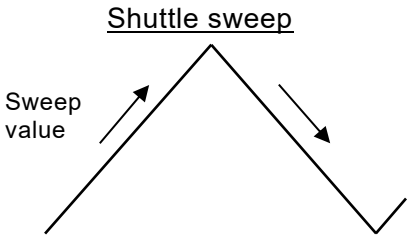
For frequency sweep, linear ‘Lin’ or log ‘Log’ is available for the slope.



f) To sweep as triangular waveform → Use shuttle sweep

Select the sweep function “SwpFctn” (☞ P.4-14) on page 2 “Sweep” of the setting screen. And set to shuttle ‘Shuttle’. ☞ P.4-18

For frequency sweep, linear ‘Lin’ or log ‘Log’ is available for the slope.



g) To change upward/downward direction of sweep → Swap start/stop value

When sweep is performed with a sawtooth waveform (one-way sweep), the sweep is performed from the start value toward the stop value. The value increases when the start value < stop value during the sweep. Conversely, the value decreases when the start value > stop value during the sweep.

When the [Stt⇔Stp] soft key of the soft key set (displayed as [▼2/2] on the right end soft key) on the second row of page 2 of the setting screen is pressed, the start value and stop value are swapped.

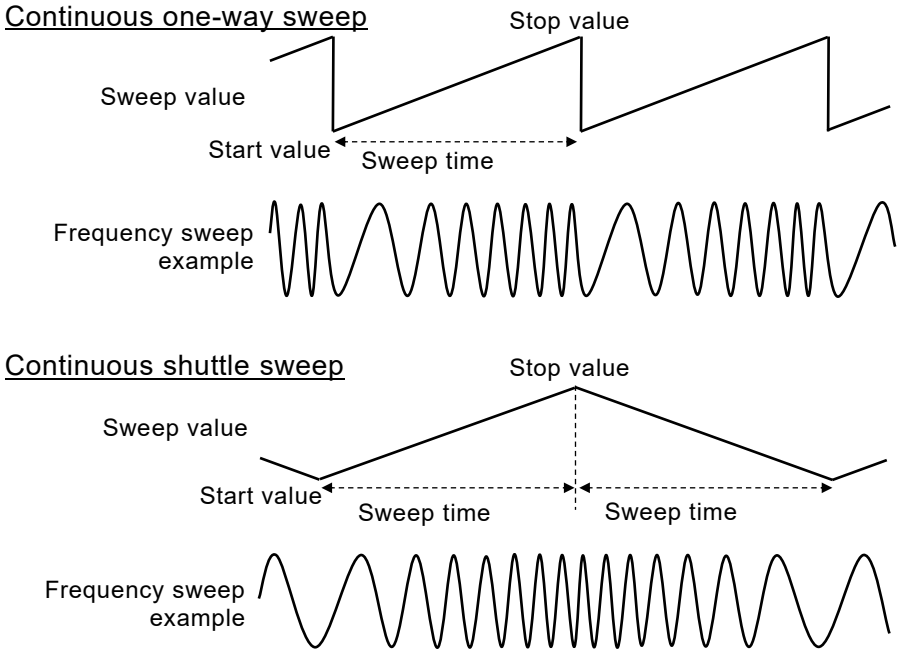
h) To repeat sweep continuously → Use continuous mode

Select the sweep function “SwpFctn” (☞ P.4-14) on page 2 “Sweep” of the setting screen. And set to continuous ‘Cont’. ☞ P.4-18

A trigger signal is not necessary.

Set the time to change from the start value to stop value in sweep time “Time” on the same page 2 “Sweep”. ☞ P.4-16, 4-17

Since the sweep time is the time to change from the start value to stop value, the repeating period is twice the sweep time setting as shown in following figure when the sweep function is ‘Shuttle’.



i) To start sweep with trigger → Use single sweep

Select the sweep mode “SwpMode” (☞ P.4-14) on page 2 “Sweep” of the setting screen. And set to single ‘Single’. ☞ P.4-18

Since a trigger signal is necessary, Select a trigger source in trigger “Trig” (☞ P.4-14) on the same page 2 “Sweep”. For the trigger setting, ☞ P.4-86.

Set the time to change from the start value to stop value in sweep time “Time” on the same page 2 “Sweep”.

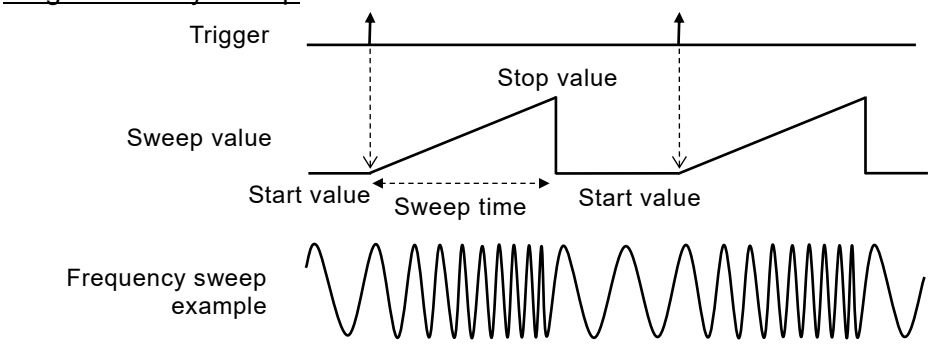
The sweep is performed once in single sweep every time a trigger is accepted. If a trigger is received during a sweep, the sweep will resume from the start value.

The appearance of the change is different as shown in the following figure depending on whether the sweep function is ‘OneWay’ or ‘Shuttle’ sweep.

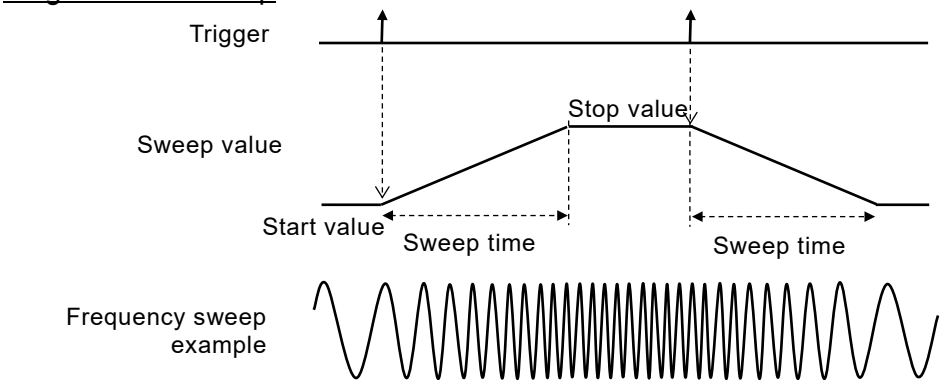
In case of ‘OneWay’ sweep, the start value is immediately returned to after the sweep ends.

In case of ‘Shuttle’ sweep, processing switches to standby in the sweep terminated state after the sweep ends.

Single one-way sweep



Single shuttle sweep



j) To output waveform only when sweep running → Use geted single sweep

Select the sweep mode “SwpMode” (☞ P.4-14) on page 2 “Sweep” of the setting screen. And set to gated single ‘Gated’. ☞ P.4-18

This is an operation that combines gate oscillation with sweep. Sweeps start with a trigger. Since a trigger signal is necessary, select a trigger source in trigger “Trig” (☞ P.4-14) on the same page 2 “Sweep”. For the trigger setting. ☞ P.4-86

■ Oscillation start/stop phase

Set the oscillation start/stop phase in phase “Phase” on page 1 “Basic” of the setting screen. ☞ P.4-36

■ Stop level (usualy set as Off)

When you want to determine the level while oscillation is stopped separately from the phase, Select the stop level “StpLvl” (☞ P.4-14) on page 2 “Sweep” of the setting screen to on ‘On’, ☞ P.4-18 and then set the level as a % value based on the amplitude full scale. ☞ P.4-16, 4-17

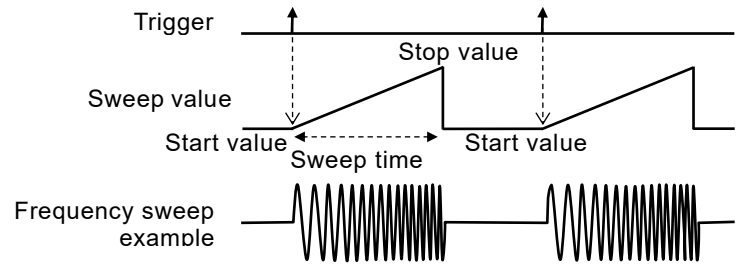
When ‘Off’ is selected, the signal level while oscillation is stopped is determined depending on the phase set in “Phase” on page 1 “Basic” of the setting screen. For details on the stop level function. ☞ P.4-101

■ Oscillation stop unit (usually set as 1 cycle ‘Cycle’)

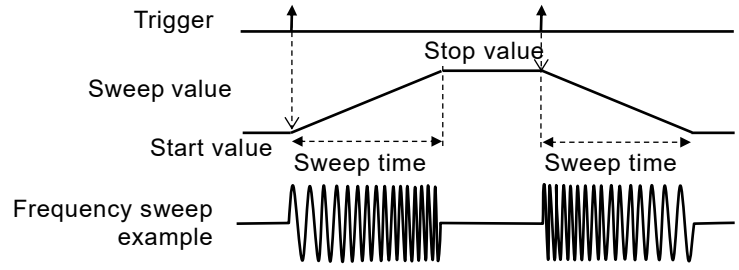
When you want to stop the oscillation every half cycle, set the oscillation stop unit “OscStop” to half cycle ‘HalfCycle’ on page 2 “Sweep” of the setting screen. Usually, set this to 1 cycle ‘Cycle’. When this is set as 1 cycle ’Cycle’, the oscillation is with an integer cycle.

Since the oscillation ends without fail every one cycle or half cycle, the oscillation time is usually longer than the time set in the sweep time setting.

Gated single one-way sweep



Gated single shuttle sweep



Check

In phase sweep, the start phase setting becomes the oscillation start phase, and the stop phase setting becomes the oscillation stop phase.

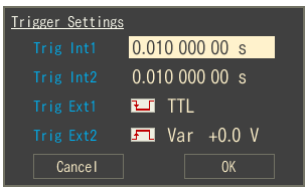
k) To set the trigger condition of single sweep and gated single sweep

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

When a trigger is received, the Triggered lamp on the TRIG key lights up.
A trigger condition is set in the trigger "Trig" on page 2 "Sweep" of the setting screen.

■ Trigger source setting

A trigger source can be selected from internal 'Int'/ 'Int1'/ 'Int2' or external 'Ext'/ 'Ext1'/ 'Ext2'. ('Int'/ 'Ext' for WF1983/WF1981, 'Int1'/ 'Int2'/ 'Ext1'/ 'Ext2' for WF1984/WF1982)



Select [...] (☞ P.4-14) to the right of trigger source selector to display the trigger setting dialog. In this dialog, you can set the trigger cycle time of the internal trigger (☞ P.4-16, 4-17) and select the polarity (positive/negative/off) and threshold value (TTL/Variable) of the external trigger. ☞ P.4-18 If you select Variable for the threshold, you can specify the threshold voltage. ☞ P.4-16, 4-17

If the trigger source is external: 'Ext'/ 'Ext1'/ 'Ext2', input the trigger signal to the external trigger input terminal (TRIG IN, or the selected terminal for WF1984/WF1982 ☞ P.3-10).

The trigger source is shared with the burst trigger (☞ P.4-103) and synclator synchronization source (☞ P.4-122).

Operations to start and stop a sweep can be performed independently of the trigger source setting with a logic signal input to the Multi I/O connector. ☞ P.4-90

■ How to use manual and remote triggers

Manual trigger operation and remote trigger operation is effective, regardless of the trigger source setting. The [Start] soft key and TRIG key can be used for manual trigger operation. (The trigger will be generated when pressed regardless of the trigger polarity specification.) However, in the case of WF1984/WF1982, the TRIG key only works on the active channel. About active channel, see ☞ P.4-24.

When only manual trigger operation and remote trigger operation are used for a trigger, we recommend setting the trigger source to external 'Ext'/ 'Ext1'/ 'Ext2' and polarity to 'Off'.

l) To start a sweep → Use soft key [Start] or trigger

The sweep status is displayed in the operating status section of the target channel in the status area (☞ P.4-7). (: waiting for trigger, ▶: sweep in progress, ❚❚: paused)

■ In continuous sweep

The sweep starts automatically when the mode becomes sweep mode. However, if the sweep setting is inappropriate, sweep will not start.

When the setting is changed to an appropriate setting, sweep starts.

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

■ **In case of single sweep or gated single sweep**

When a trigger is accepted, the sweep is started. However, if the sweep setting is inappropriate, a trigger cannot be accepted. When it is changed to an appropriate setting, a trigger can be accepted.

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

In either case, if it is inappropriate, "Conflict" will flash in the oscillation mode section of the target channel in the status area (☞ P.4-7).

When the [?] soft key displayed on the left end is pressed, a message about the inappropriate setting will be displayed. ☞ P. 14-8

m) To stop sweep → Use soft key [SttState]

When the [SttState] soft key is pressed while sweep is running, the sweep stops.

For single sweeps or gated single sweeps, if a new trigger is received afterwards, the sweep will start again.

n) To pause sweep temporarily → Use soft key [Hold]

When the [Hold] soft key is pressed while a sweep is running, the sweep is paused. When the [Resume] soft key is pressed afterwards, the sweep is resumed at the point where it was paused.

If the [Hold] or [Resume] soft key is not displayed, press the [▼2/2] soft key to toggle the soft key set.

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

The [Hold] and [Resume] soft keys are located in the same position, with [Hold] displayed during a sweep, and [Resume] during a hold.

o) To output the sweep start value → Use soft key [SttState]

When the [SttState] soft key is pressed, the state becomes the sweep start value output state.

You can check the state of the equipment under test from the sweep start value.

The [SttState] soft key is displayed in the output state for the sweep start value or stop value.

If the [SttState] soft key is not displayed, press the [▼2/2] soft key to toggle the soft key set.

p) To output the sweep stop value → Use soft key [StpState]

When the [StpState] soft key is pressed, the state becomes the sweep stop value output state.

You can check the state of the equipment under test from the sweep stop value.

The [StpState] soft key is displayed when the output state is other than for the sweep stop value.

If the [StpState] soft key is not displayed, press the [▼2/2] soft key to toggle the soft key set.

q) To output a sweep synchronization and sweep marker signal → Select the sub output

This option change depending on the modulation function. ☞ P.4.7

Set this in synchronization/sub output “SubOut” on page 4 “Modu” of the setting screen. Select from the following options (in sweep mode): ☞ P.4-58

Internal modulation	External modulation or moduration: ‘Off’
Waveform reference phase synchronization: ‘Sync’	
Internal modulation reference phase synchronization: ‘ModSync’	Sub waveform reference phase synchronization: ‘SubSync’
Sweep synchronization: ‘SwpSync’	
Combination of marker signal and sweep synchronization: ‘SwpSync+Mkr’	
Internal modulation waveform: ‘ModFctn’	Sub waveform: ‘SubFctn’
Synchoronization/sub output off: ‘Off’	

For ‘ModSync’/ ‘SubSync’/ ‘ModFctn’/ ‘SubFctn’/ ‘Off’, see ☞ P.4-68.

■ When ‘Sync’ is selected

A signal with TTL level which rises at the reference phase of the waveform is output from the synchronization/sub-output terminal.

When the waveform is a ‘Noise’ or ‘DC’, it is fixed to the low level.

■ When ‘SwpSync’ is selected

A signal with TTL level which is synchronized with the sweep is output from the synchronization/sub-output terminal. It changes from high to low when the sweep starts.

When one-way sweep, it changes to high when it passes half the start value and stop value, and when shuttle sweep, it changes to high when it reaches the stop value.

When observing a signal during sweep execution with an oscilloscope or similar device, you can use the signal as a trigger signal of the oscilloscope.

■ When ‘SwpSync+Mkr’ is selected

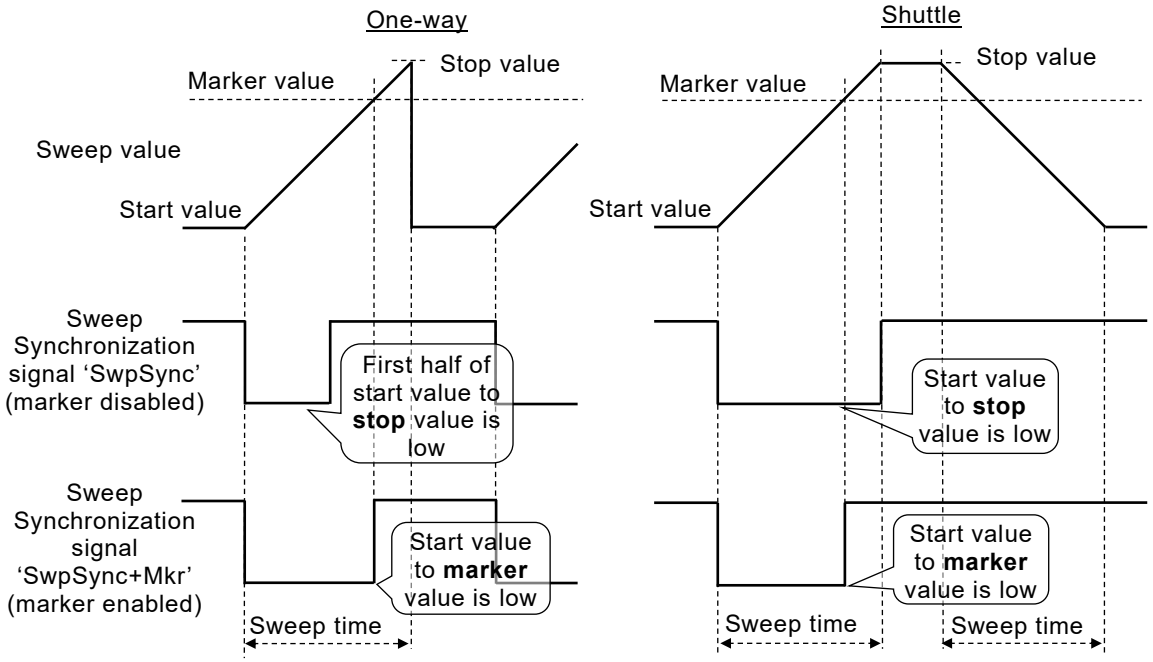
The rising of sweep synchronous output is a marker signal. The sweep synchronous output is low until it reaches the marker value from the sweep start value. The sweep synchronization output does not change on the return path of a shuttle sweep.

The timing at which the signal under sweep passes the marker value can be known.

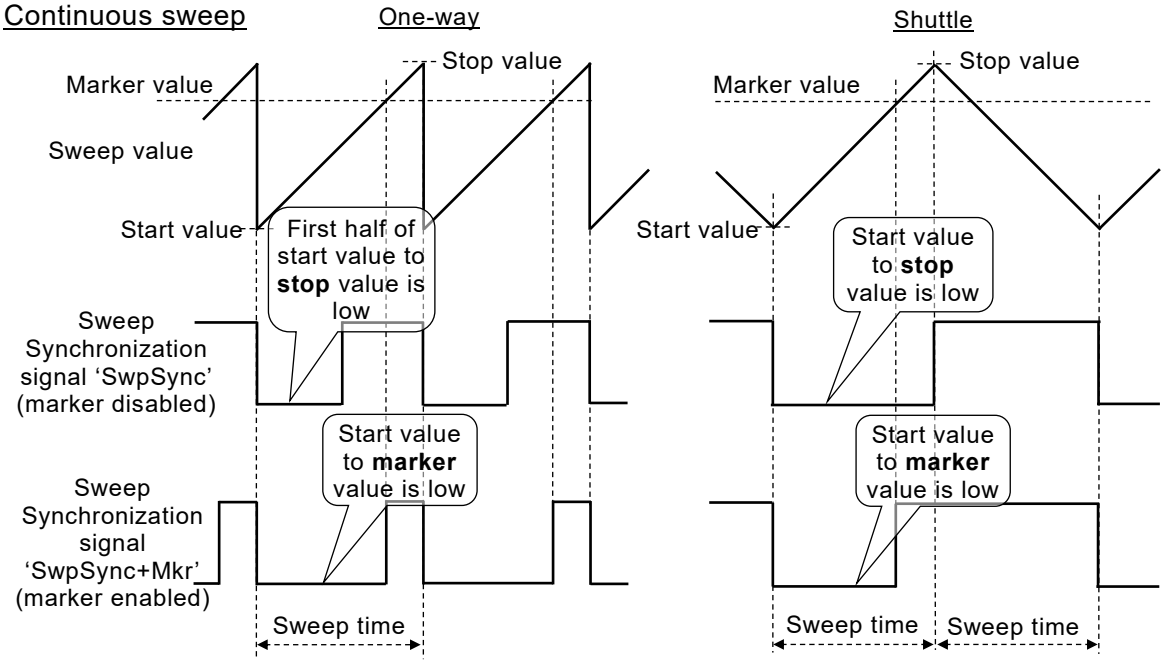
However, there are the following restrictions for the time zone when a synchronous sweep output is at a low level.

- The time zone is limited to about 0.05% to 99.95% of the sweep time. Therefore, the time zone does not change even if the marker value is changed when the marker value is close to the start value or the stop value.
- The resolution of the time zone is limited to 1/32 768 of the sweep time or 2.38ns, whichever is the larger. Therefore, the time zone does not necessarily change even if the marker value is changed finely.

Single sweep and gated single sweep



Continuous sweep



r) To substitute center and marker values for each other

When the [Ctr⇒Mkr] soft key is pressed on page 2 “Sweep”, a center value is substituted with a marker value. When the [Mkr⇒Ctr] soft key is pressed, conversely a marker value is substituted with a center value.

If these soft keys on page 2 “Sweep” of the setting screen are not displayed, press the [▼1/2] soft key to toggle the soft key set.

s) To control the sweep start, stop, and pause with an external logic signal

Set the external control “ExtCtrl” to enable ‘Enable’ on page 2 “Sweep” of the setting screen to conduct sweep operations with a TTL level logic input to the Multi I/O connector on the rear panel. This is shared by CH1 and CH2 (WF1984/WF1982).

It is recommended that this be set to disable ‘Disable’ when not using an external control signal in order to avoid malfunctions caused by external noise. For pin number assignment, ☞ P.3-14.

The following operations can be performed. See also trigger condition settings ☞ P.4-86.

■ Sweep start (pin 14)

Falling input to pin 14 starts the sweep. The sweep will restart from the beginning even if it is already running.

In the case of a single sweep or a gated single sweep, the sweep will start from the beginning when a trigger is received. The operation is a logical sum with the trigger source that is set.

■ Sweep stop (pin 13)

Falling input to pin 13 stops the sweep, and the output returns to the sweep start value. However, in the case of a single sweep or a gated single sweep, the sweep will start from the beginning when a new trigger is received.

■ Sweep hold/resume (pin 12)

Falling input to pin 12 holds the sweep if it is running. If the sweep is paused, it will restart from the hold position.

However, if a new trigger is received while a single sweep or gated single sweep is paused, the sweep (out-going or return for shuttle) will start from the beginning.

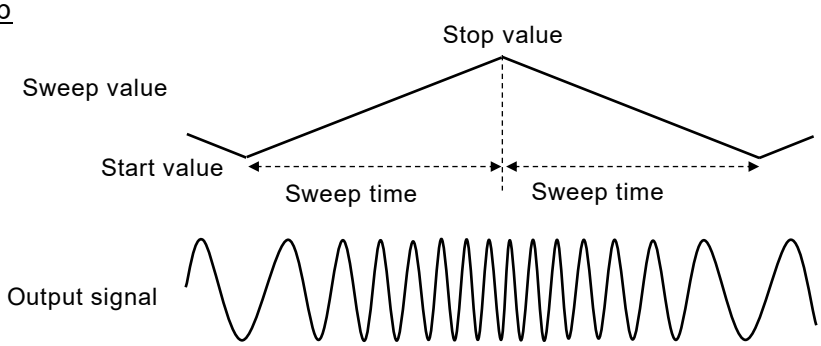
4.8.4 Frequency Sweep settings

For details on the sweep setting screen and common operation method, see P.4-77, P.4-81.

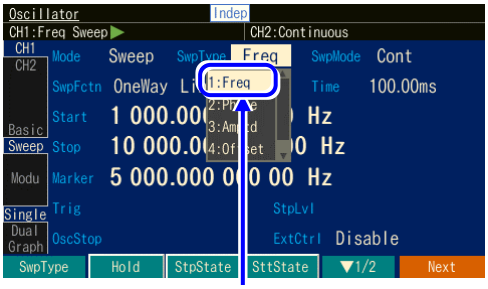
a) Frequency sweep example

Examples of a continuous sweep and linear shuttle.

Shuttle sweep



b) To select frequency sweep



In the sweep type setting menu, select 'Freq'

When the oscillation mode "Mode" is set to sweep mode 'Sweep', select the sweep type "SwpType" (☞ P.4-14) on page 2 "Sweep" of the setting screen to display the selection list. Select frequency 'Freq' (☞ P.4-18) to set frequency sweep.

You can also use the numeric keypad [1].

c) Waveform or mode where frequency sweep is unavailable

Frequency sweep cannot be performed for 'Noise', 'Pulse', and 'DC'.

'FSK', 'FM' and 'PSK' modulation are canceled (modulation function is turned off) when frequency sweep is selected.

d) Items necessary for frequency sweep

Set the following items on page 2 “Sweep” of the setting screen. The frequency setting on page 1 “Basic” of the setting screen becomes invalid and the current oscillation frequency is displayed.

- Starting frequency: “Start” / Stop frequency: “Stop”
  This is the frequency at which the sweep starts/ends. The frequency range depends on the waveform.
  The setting method is the same as ☞ P.4-34, but the period/sample rate/sample period cannot be set.
- Sweep time: “Time”
  Time to change from the start frequency to stop frequency. ☞ P.4-81
- Sweep Mode: “SwpMode”
  Select from continuous, single, and gated single. ☞ P.4-83, 4-84, 4-85
- Sweep function: “SwpFctn”
  Select from one-way/shuttle and linear/log. ☞ P.4-82, 4-82

This can be set with center frequency “Center” and span frequency “Span”, instead of start frequency and stop frequency. ☞ P.4-82
The setting method is the same as ☞ P.4-34, but the period/sample rate/sample period cannot be set.
When the sweep mode is single or gated single, it is necessary to set the trigger condition “Trig”. ☞ P.4-86

Set the following items as needed:

- Marker frequency: “Marker” page 2 of the setting screen “Sweep”
  The setting method is the same as the start frequency.
- Stop level: “StpLvl” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Oscillation stop unit: “OscStop” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Synchronization/sub output selection: “SubOut”
  page 3 of the setting screen “Modu” ☞ P.4-58

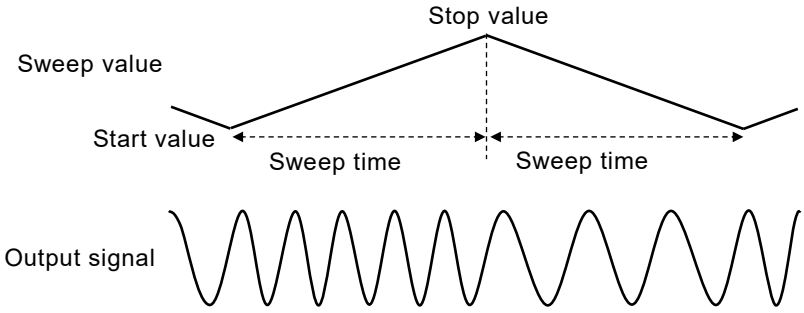
4.8.5 Phase Sweep settings

For details on the sweep setting screen and common operation method, see P.4-77, P.4-81.

a) Phase sweep example

Examples of a continuous sweep and linear shuttle.

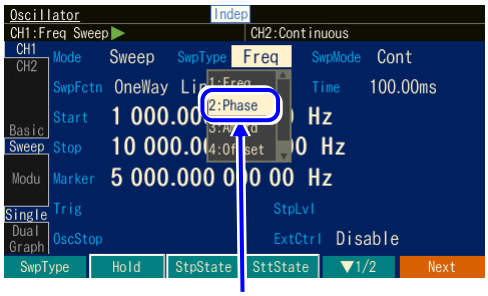
Shuttle sweep



When the phase increases, the frequency rises by just the amount of the following value. When the phase decreases, the frequency falls by just the amount of the following value.

$$\frac{|(\text{Stop phase[deg]}) - (\text{Start phase[deg]})|}{360} \times \frac{1}{\text{Sweep time[s]}}$$

b) To select phase sweep



In the sweep type setting menu, select 'Phase'

When the oscillation mode "Mode" is set to sweep mode 'Sweep', select the sweep type "SwpType" (☞ P.4-14) on page 2 "Sweep" of the setting screen to display the selection list. Select phase 'Phase' (☞ P.4-18) to set phase sweep.

You can also use the numeric keypad [2].

c) Waveform or mode where phase sweep is unavailable

Phase sweep cannot be performed for an arbitrary waveform 'ARB', parameter variable waveform 'PWF', 'Noise', and 'DC'. For arbitrary waveform for phase sweep, see ☞ P.4-61.

'FSK', 'PSK' and 'PM' modulation are canceled (modulation function turned off) when phase sweep is selected.

d) Items necessary for phase sweep

Set the following items on page 2 “Sweep” of the setting screen. The phase setting on page 1 “Basic” of the setting screen becomes invalid and the current phase is displayed.

- Start phase: “Start” / Stop phase: “Stop”
  This is the phase at which the sweep starts/ends. The setting method is the same as ☞ P.4-36.
- Sweep time: “Time”
  Time to change from the start phase to stop phase. ☞ P.4-81
- Sweep Mode: “SwpMode”
  Select from continuous, single, and gated single. ☞ P.4-83, 4-84, 4-85
- Sweep function: “SwpFctn”
  Select from one-way/shuttle. ☞ P.4-82, 4-82

This can be set with center phase “Center” and span phase “Span”, instead of start phase and stop phase. ☞ P.4-82
The setting method is the same as ☞ P.4-36.
When the sweep mode is single or gated single, it is necessary to set the trigger condition “Trig”. ☞ P.4-86

Set the following items as needed:

- Marker phase: “Marker” page 2 of the setting screen “Sweep”
  The setting method is the same as P.4-36.
- Stop level: “StpLvl” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Oscillation stop unit: “OscStop” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Synchronization/sub output selection: “SubOut”
  page 3 of the setting screen “Modu” ☞ P.4-58

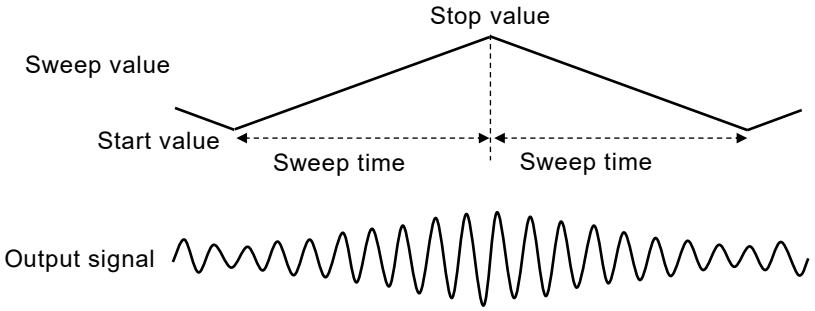
4.8.6 Amplitude Sweep settings

For details on the sweep setting screen and common operation method, see P.4-77, P.4-81.

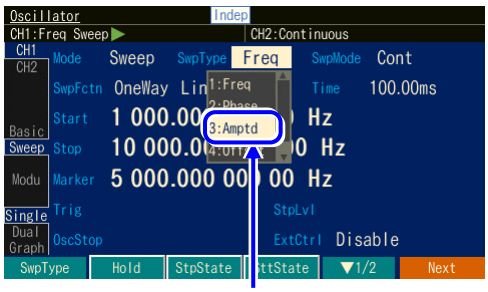
a) Amplitude sweep example

Examples of a continuous sweep and linear shuttle.

Shuttle sweep



b) To select amplitude sweep



In the sweep type setting menu, select 'Amptd'

When the oscillation mode "Mode" is set to sweep mode 'Sweep', select the sweep type "SwpType" (☞ P.4-14) on page 2 "Sweep" of the setting screen to display the selection list. Select amplitude 'Amptd' (☞ P.4-18) to set amplitude sweep.

You can also use the numeric keypad [3].

c) Waveform or mode where amplitude sweep is unavailable

Amplitude sweep cannot be performed for 'DC'.

'AM' and 'AM(SC)' modulation are canceled (modulation function turned off) when amplitude sweep is specified.

d) Items necessary for amplitude sweep

Set the following items on page 2 “Sweep” of the setting screen. The amplitude setting on page 1 “Basic” of the setting screen becomes invalid and the current amplitude is displayed.

- Start amplitude: “Start” / Stop amplitude: “Stop”
  This is the amplitude at which the sweep starts/ends.
  The setting method is the same as ☞ P.4-38, but high/low settings are not possible.
- Sweep time: “Time”
  Time to change from the start amplitude to stop amplitude. ☞ P.4-81
- Sweep Mode: “SwpMode”
  Select from continuous, single, and gated single. ☞ P.4-83, 4-84, 4-85
- Sweep function: “SwpFctn”
  Select from one-way/shuttle. ☞ P.4-82, 4-82

This can be set with center amplitude “Center” and span amplitude “Span”, instead of start amplitude and stop amplitude. ☞ P.4-82
The setting method is the same as ☞ P.4-38, but high/low settings are not possible.
When the sweep mode is single or gated single, it is necessary to set the trigger condition “Trig”. ☞ P.4-86

Set the following items as needed:

- Marker amplitude: “Marker” page 2 of the setting screen “Sweep”
  The setting method is the same as the start amplitude.
- Stop level: “StpLvl” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Oscillation stop unit: “OscStop” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Synchronization/sub output selection: “SubOut”
  page 3 of the setting screen “Modu” ☞ P.4-58

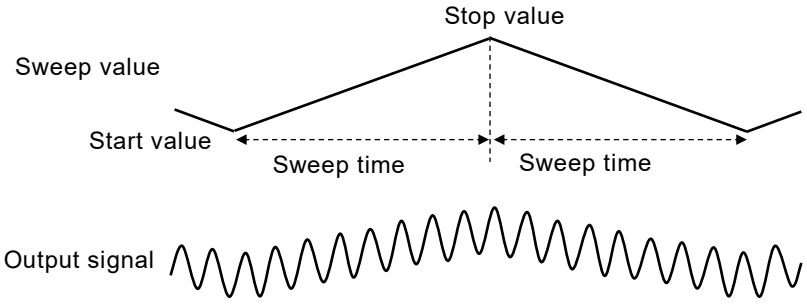
4.8.7 DC offset Sweep settings

For details on the sweep setting screen and common operation method, see P.4-77, P.4-81.

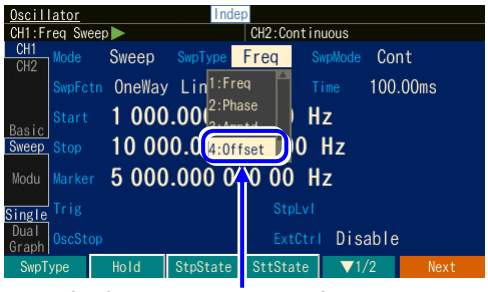
a) DC offset sweep example

Examples of a continuous sweep and linear shuttle.

Shuttle sweep



b) To select DC offset sweep



In the sweep type setting menu, select 'Offset'

When the oscillation mode "Mode" is set to sweep mode 'Sweep', select the sweep type "SwpType" (☞ P.4-14) on page 2 "Sweep" of the setting screen to display the selection list. Select DC offset 'Offset' (☞ P.4-18) to set DC offset sweep.

You can also use the numeric keypad 4.

c) Waveform or mode where phase sweep is unavailable

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

DC offset modulation 'OFSM' is canceled (modulation function turned off) when DC offset sweep is specified.

d) Items necessary for DC offset sweep

Set the following items on page 2 “Sweep” of the setting screen. The DC offset setting on page 1 “Basic” of the setting screen becomes invalid and the current DC offset is displayed.

- Start DC offset: “Start” / Stop DC offset: “Stop”
  This is the DC offset at which the sweep starts/ends. The setting method is the same as ☞ P.4-39, but high/low settings are not possible.
- Sweep time: “Time”
  Time to change from the start DC offset to stop DC offset. ☞ P.4-81
- Sweep Mode: “SwpMode”
  Select from continuous, single, and gated single. ☞ P.4-83, 4-84, 4-85
- Sweep function: “SwpFctn”
  Select from one-way/shuttle. ☞ P.4-82, 4-82

This can be set with center DC offset “Center” and span DC offset “Span”, instead of start DC offset and stop DC offset. ☞ P.4-82
The setting method is the same as ☞ P.4-39, but high/low settings are not possible.
When the sweep mode is single or gated single, it is necessary to set the trigger condition “Trig”. ☞ P.4-86

Set the following items as needed:

- Marker DC offset: “Marker” page 2 of the setting screen “Sweep”
  The setting method is the same as the start DC offset.
- Stop level: “StpLvl” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Oscillation stop unit: “OscStop” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Synchronization/sub output selection: “SubOut”
  page 3 of the setting screen “Modu” ☞ P.4-58

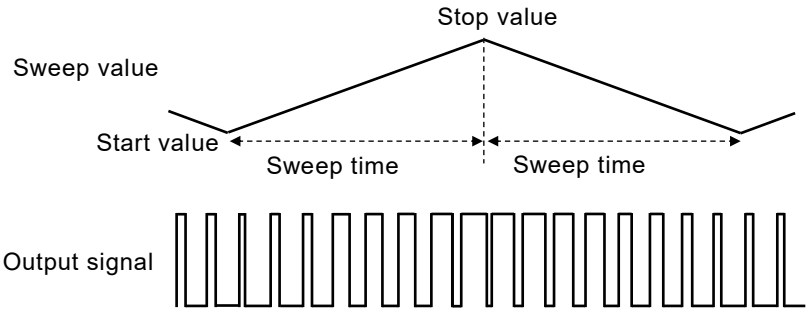
4.8.8 Duty Sweep settings

For details on the sweep setting screen and common operation method, see P.4-77, P.4-81.

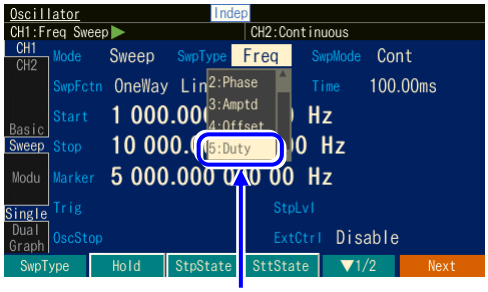
a) Duty sweep example

Examples of a continuous sweep and linear shuttle.

Shuttle sweep



b) To select duty sweep



In the sweep type setting menu, select 'Duty'

When the oscillation mode "Mode" is set to sweep mode 'Sweep', select the sweep type "SwpType" (☞ P.4-14) on page 2 "Sweep" of the setting screen to display the selection list. Select duty "Duty" (☞ P.4-18) to set duty sweep.

You can also use the numeric keypad [5].

c) Waveform or mode where duty sweep is unavailable

Only square wave 'Square' and pulse wave 'Pulse' are available.

'PWM' modulation is canceled (modulation function turned off) when duty sweep is specified.

d) Items necessary for duty sweep

Set the following items on page 2 “Sweep” of the setting screen. The duty setting on page 1 “Basic” of the setting screen becomes invalid and the current duty is displayed.

- Start duty: “Start” / Stop duty: “Stop”
  This is the duty at which the sweep starts/ends. The range of duty depends on the frequency. In the case of pulse wave, it also depends on the leading and trailing edge times.
  The setting method is the same as ☞ P.4-49, 4-51.
- Sweep time: “Time”
  Time to change from the start duty to stop duty. ☞ P.4-81
- Sweep Mode: “SwpMode”
  Select from continuous, single, and gated single. ☞ P.4-83, 4-84, 4-85
- Sweep function: “SwpFctn”
  Select from one-way/shuttle. ☞ P.4-82, 4-82

This can be set with center duty “Center” and span duty “Span”, instead of start duty and stop duty. ☞ P.4-82
The setting method is the same as ☞ P.4-49, 4-51.
When the sweep mode is single or gated single, it is necessary to set the trigger condition “Trig”. ☞ P.4-86

Set the following items as needed:

- Marker duty: “Marker” page 2 of the setting screen “Sweep”
  The setting method is the same as ☞ P.4-49, 4-51.
- Stop level: “StpLvl” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Oscillation stop unit: “OscStop” page 2 of the setting screen “Sweep” ☞ P.4-85
  The setting used for gated single sweep only.
- Synchronization/sub output selection: “SubOut”
  page 3 of the setting screen “Modu” ☞ P.4-58

4.9 Burst setting and operation

Burst mode is an intermittent oscillation that allows you to set the oscillation wave number, stop wave number, start/stop phase, etc. With this device, it is also possible to perform modulation at the same time as burst oscillation, although there are restrictions. ☞ P.4-62

4.9.1 Burst mode and stop levle

a) Burst mode: “BrstMode”

The following four types of burst oscillation can be performed by setting the “BrstMode”:

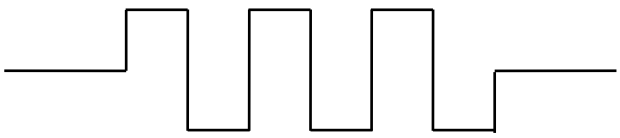
- Auto burst: ‘AutoBurst’
  Repeats oscillating and stopping automatically with each specified wave number. A trigger signal is not necessary. ☞ P.4-106
- Trigger burst: ‘Trigger’
  Performs oscillation with the specified wave number (half cycle as unit) every time a trigger is accepted. ☞ P.4-108
- Gate oscillation: ‘Gate’
  Performs oscillation in an integer cycle or half-cycle unit while the gate is on. ☞ P.4-112
- Triggered Gate Oscillation: ‘TrigGate’
  Gate oscillation that turns the gate on/off every time a trigger is accepted. ☞ P.4-116

b) Stop level fumction: “StpLvl”

This function controls the signal level while oscillation is stopped in each burst mode. The settings for burst are, ☞ P.4-103. Can also be used with gated single sweep. ☞ P.4-85

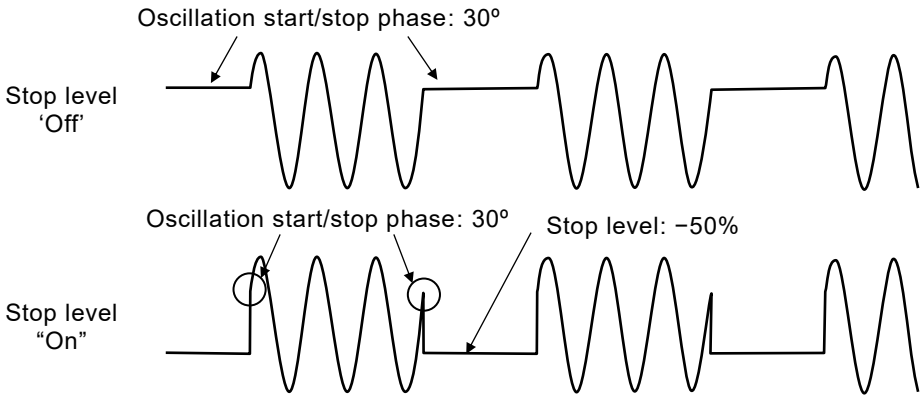
- Stop level: ‘Off’
  The signal level during burst stop is the instantaneous value at the oscillation start/stop phase. During modulation, the signal level may change because the oscillation start and stop phase changes due to modulation even when oscillation is stopped. Normally set to off.
- Stop level: ‘On’
  Set the signal level during burst stop as a ratio [%] of amplitude to full scale.
  Even during modulation except DC offset modulation ‘OFSM’, the signal level can be kept constant while oscillation is stopped. (During DC offset modulation, the modulation offset is added to the specified stop level and output.)

By applying a stop level to a square wave, you can output a 3-value square wave as shown in the following figure.



The example shown is when the oscillation start/stop phase is 0º, the modulation type is ‘Off’, and the stop level is on and 0%. (Both standard and extended duty variable ranges can be used.) If a stop level is not applied, the level while the square wave oscillation is stopped will always be either low level or high level, regardless of the oscillation start/stop phase.

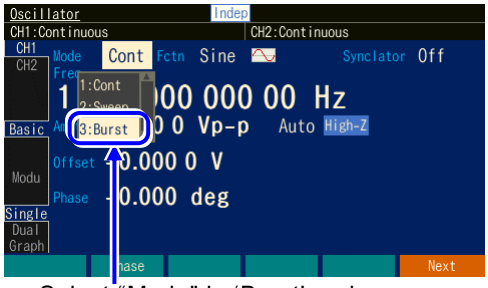
The example in the figure below is for mark wave number: 3 waves, oscillation start/stop phase: 30º, modulation type: 'Off', and stop level: -50% for off and on. Note that the oscillation start/stop phase is still valid.



4.9.2 Screen for Setting and operation of bursts

This section describes the common screen configuration in the burst mode. Perform configuration and operation in the Oscillator setting screen. When another screen is displayed, ☞ P.4-26. (Press MENU key, If the first line of the menu that appears is "Seq", press the soft key [Seq→ Osc], the soft key [OK], and the 1 key in sequence.)

a) To set the oscillation mode to burst



Select "Mode" in 'Burst' and then press the ENTER key

Press the MODE key to open the oscillation mode selection list. Select burst mode: 'Burst' ☞ P.4-32

You can also use the numeric keypad 3. This switches to the burst mode.

To display the parameters specific to the burst mode, switch the page 3 "Burst" with the [Next] soft key.

If the settings are inappropriate for burst, "Conflict" will blink in the oscillation mode section of the target channel in the status area (☞ P.4-7). When the [?] soft key displayed on the left end is pressed, a message about the inappropriate setting will be displayed. ☞ P.14-8

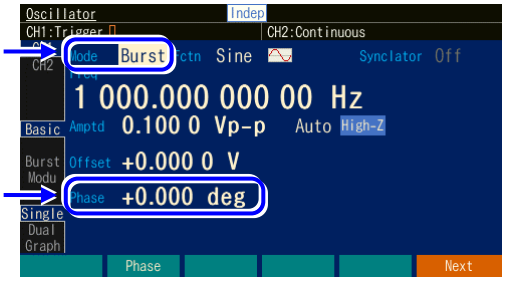
If appropriate, the burst mode is displayed in the oscillation mode section and the operation state is displayed in the operation state section.

b) Page 1 "Basic": Basic parameter setting screen

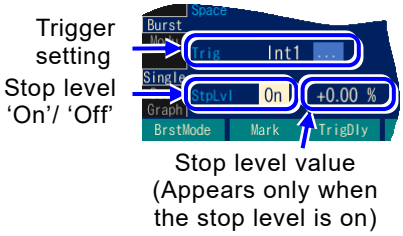
These are common items which are independent of the oscillation mode.

This indicates that the oscillation mode is burst

Oscillation start/stop phase



c) Page 3 “Burst”: Burst parameter setteing screen



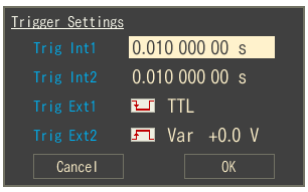
○ Stop level: “StpLvl”

The signal level during burst stop is normally set by the oscillation start/stop phase, but it can also be set to a fixed value independently of this. For details, see ☞ P.4-101.

To set the stop level, select “StpLvl” (☞ P.4-14) and select ‘On’ or ‘Off’ from the options. ☞ P.4-18

When set to on, sets the level as a percentage of amplitude full scale. ☞ P.4-16, 4-17

○ Trigger setting: “Trig” (valid except for auto burst)



A trigger source can be selected from internal ‘Int’/ ‘Int1’/ ‘Int2’ or external ‘Ext’/ ‘Ext1’/ ‘Ext2’. (‘Int’/’Ext’ for WF1983/ WF1981, ‘Int1’/ ‘Int2’/ ‘Ext1’/ ‘Ext2’ for WF1984/WF1982) Select [...] (☞ P.4-14) to the right of trigger source selector to display the trigger setting dialog.

In this dialog, you can set the trigger cycle time of the internal trigger (☞ P.4-16, 4-17) and select the polarity (positive/negative/off) and threshold value (TTL/Variable) of the external trigger. ☞ P.4-18 If you select ‘Variable’ for the threshold, you can specify the threshold voltage. ☞ P.4-16, 4-17

If the trigger source is internal ‘Int’/ ‘Int1’/ ‘Int2’, the gate signal for gate oscillation will be a square wave with a duty of 50%. If the trigger source is external: ‘Ext’/ ‘Ext1’/ ‘Ext2’, input the trigger signal to the external trigger input terminal (TRIG IN, or the selected terminal for WF1984/WF1982 ☞ P.3-10).

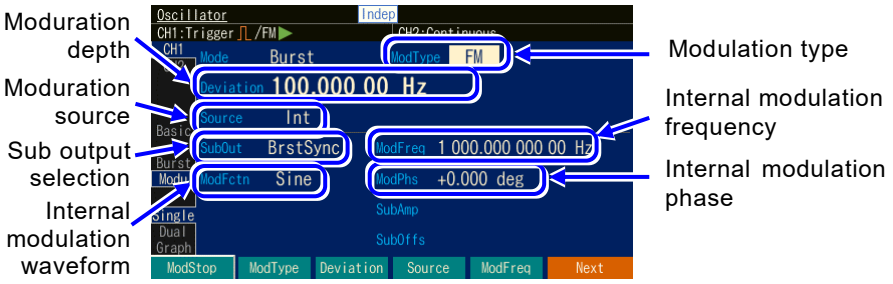
The trigger source is shared with the sweep trigger (☞ P.4-86) and synclator synchronization source (☞ P.4-122).

○ Other items (BrstMode/ Mark/ Space/ TrigDly/ OscStop)

Depends on burst mode “BrstMode”. Explained in individual burst modes. (Auto burst, Trigger burst, Gate oscillation, Triggered gate oscillation ☞ P.4-106, 4-109, 4-112, 4-116)

d) Page 4 “Modu”: Modulation function and synchronization/sub output setting screen

The following figure shows an example with ‘FM’ selected as the modulation type.



○ Modulation type: “ModType”

These are the types of modulation. ☞ P.4-65

Select from ‘FM’, ‘FSK’, ‘PM’, ‘PSK’, ‘AM’, ‘AM(SC)’, DC offset modulation ‘OFSM’, ‘PWM’, or ‘Off’.

However, ‘FSK’ and ‘PSK’ can only be selected when ‘AutoBurst’ is selected.

Modulation is always active during burst oscillation and when oscillation is stopped.

If you want to keep the output level constant while oscillation is stopped during ‘PM’/’PSK’/’AM’/’AM(SC)’ modulation, turn on the stop level. ☞ P.4-103

○ Modulation depth: “Deviation”, “Depth”, “HopFreq”

This is the modulation depth. ☞ P.4-65 The item name changes with the modulation type.

If you specify the modulation depth as 0 (At “HopFreq”, the same value as the carrier), the modulation signal has no effect on the waveform output.

○ Modulation source: “Source”

Select the modulation source from internal: ‘Int’ / external: ‘Ext’ (WF1983/WF1981), internal #1,2: ‘Int1’, ‘Int2’ / external #1,2: ‘Ext1’, ‘Ext2’ (WF1984/WF1982).

For internal modulation, see ☞ P.4-66. For external modulation, see ☞ P.4-67.

○ Internal modulation waveform / sub waveform: “ModFctn” / “SubFctn”

When the modulation function is on and internal modulation is used, set the waveform of the internal modulation source (☞ P.4-66), and when not, set the sub waveform (☞ P.4-123) that can be output to the sub output.

Select from ‘Sine’, ‘Square’, ‘Triangle’, rising ramp ‘UpRamp’, falling ramp ‘DnRamp’, ‘Noise’, arbitrary waveform ‘ARB’, and parameter variable waveform ‘PWF’.

○ Internal modulation frequency / sub waveform frequency: “ModFreq” / “SubFreq”

When the modulation function is on and internal modulation is used, set the frequency of the internal modulation source(☞ P4-66), and when not, set the frequency of sub waveform(☞ P.4-124) that can be output to the sub output.

○ Internal modulation phase / sub waveform phase: “ModPhs” / “SubPhs”

When the modulation function is on and internal modulation is used, set the phase of the internal modulation source, and when not, set the phase of sub waveform that can be output to the sub output. ☞ P.4-66, 4-124

○ Sub output selection: “SubOut”

This option change depending on the modulation function. ☞ P.4.7

Set the signal to be output to synchronization/sub output using “SubOut”.

Select from the following options (in burst mode): ☞ P.4-58

Internal modulation	External modulation or moduration: ‘Off’
Waveform reference phase synchronization: ‘Sync’	
Internal modulation reference phase synchronization: ‘ModSync’	Sub waveform reference phase synchronization: ‘SubSync’
Burst synchronization: ‘BrstSync’	
Internal modulation waveform: ‘ModFctn’	Sub waveform: ‘SubFctn’
Synchoronization/sub output off: ‘Off’	

When selecting “ModFctn” outputs the internal modulation waveform, and “SubFctn” outputs the sub waveform. When selecting ‘Sync’/ ‘BrstSync’, refer to the explanation for each burst mode. ☞ P.4-107, 4-111, 4-114, 4-118

For ‘ModSync’/ ‘SubSync’/ ‘ModFctn’/ ‘SubFctn’/ ‘Off’, see ☞ P.4-68.

○ Sub output amplitude: “SubAmp”

Sets the output amplitude for when the internal modulation waveform and sub waveform are output from the synchronization/sub output terminal. ☞ P.4-124

During internal modulation, this setting has no effect on the modulation result.

○ Sub output DC offset: “SubOfs”

Sets the output offset for when the internal modulation waveform and sub waveform are output from the synchronization/sub output terminal. ☞ P.4-124

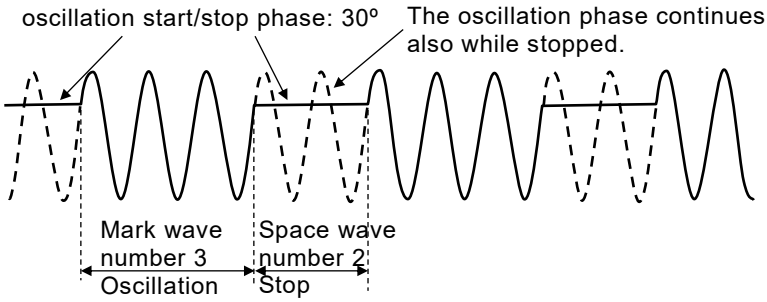
During internal modulation, this setting has no effect on the modulation result.

4.9.3 Auto burst

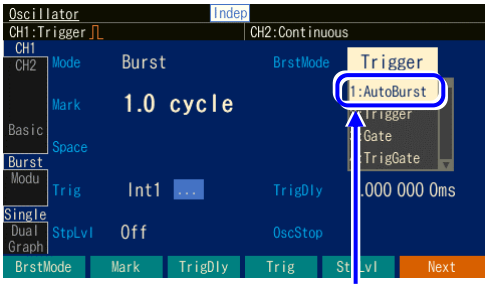
In this mode, oscillation and stop are automatically repeated at each specified wave number. Does not require a trigger signal.

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°, stop level: In case of 'Off'.



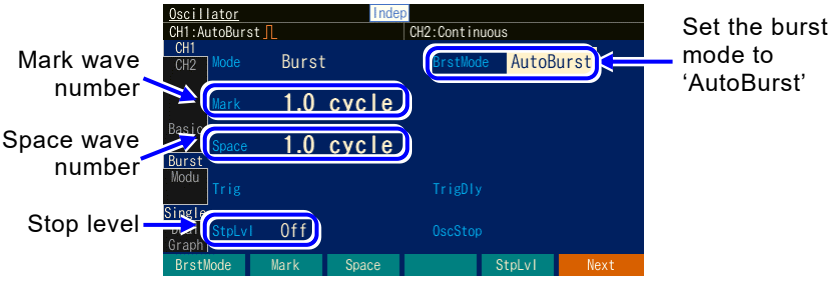
b) To set burst mode to auto burst



Select 'AutoBurst' in "BrstMode" and then press the ENTER key

Select burst mode "BrstMode" (☞ P.4-14) on page 3 "Burst" of the setting screen to display the burst mode selection list.
Select auto burst 'AutoBurst' (☞ P.4-18) to set the auto burst mode.
You can also use the numeric keypad (1).

c) Screen for auto burst setting



○ Burst mode: "BrstMode"

Set the burst mode. Set the mode here to auto burst 'AutoBirst'.

○ Mark wave number: "Mark" / Space wave number: "Space"

Mark wave number is the wave number to oscillate, space wave number is the wave number to stop oscillation. Each can be set in 0.5 cycle units from 0.5 to 999 999.5. Usually, set this to 1 cycle unit. ☞ P.4-16, 4-17

○ Stop level: "StpLvl" ☞ P.4-101

d) Waveform where auto burst is unavailable

Auto burst cannot be performed for 'Noise' and 'DC'.

e) Setting items necessary for auto burst

Set the oscillation start/stop phase “Phase” on page 1 “Basic” of the setting screen. ☞ P.4-36

Set mark and space wave number “Mark”, “Space” on page 3 “Burst” of the setting screen. Each wave number can be set in units of 0.5 waves, but is usually set to an integer value. ☞ P.4-106

The stop level “StpLvl” on page 3 “Burst” of the setting screen is usually set to off ‘Off’. ☞ P.4-101

f) To start auto burst → Started automatically

In auto burst mode, burst starts automatically when the mode switches to burst mode.

However, if the burst setting is inappropriate, the burst oscillation will not start. “Conflict” will flash in the oscillation mode section of the target channel in the status area (☞ P.4-7). When the [?] soft key displayed on the left end is pressed, a message about the inappropriate setting is displayed. ☞ P.14-8

When the setting is changed to an appropriate setting, burst oscillation starts.

g) To stop auto burst → Cannot

Oscillation cannot be stopped while in auto burst mode.

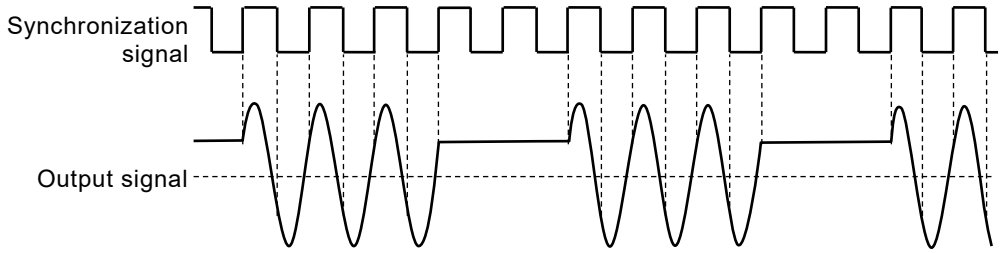
To stop oscillation, set the burst mode “BrstMode” to a setting other than auto burst “Auto” on page 3 “Burst” of the setting screen to prevent a trigger or gate signal from arriving. To set as continues oscillation, change the oscillation mode to ‘Cont’.

h) To output a burst synchronization signal → Select the sub output (AutoBurst)

Set this in synchronization output “SubOut” on page 4 “Modu” of the setting screen. ☞ P.4-105

■ When ‘Sync’ is selected

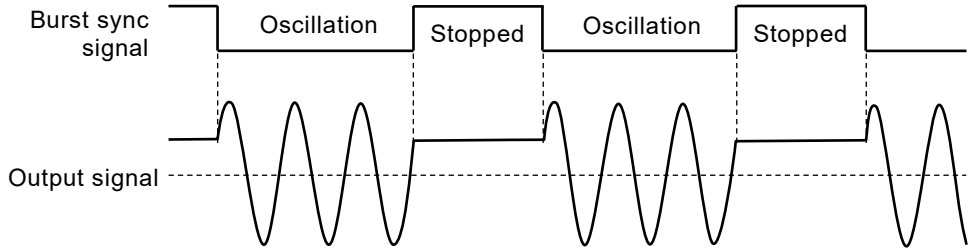
A signal with TTL level which rises at the reference phase of the waveform is output from the synchronization/sub-output terminal. Auto burst does not stop the synchronization signal.



■ When ‘BrstSync’ is selected

A signal with TTL level which is synchronized with the burst oscillation is output from the synchronization/sub-output 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 an oscilloscope or similar device, it can be used as a trigger signal of the oscilloscope.



i) How to use stop level

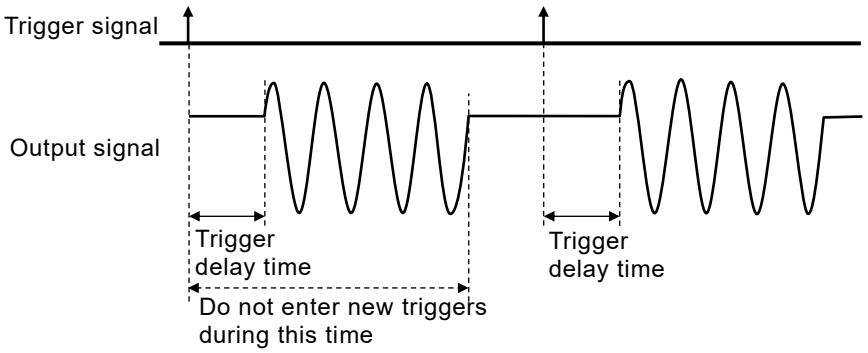
The level while oscillation is stopped is usually set by oscillation start/stop phase. It is also possible to set it by the ratio to the full scale of the amplitude independently. ☞ P.4-101

4.9.4 Trigger burst

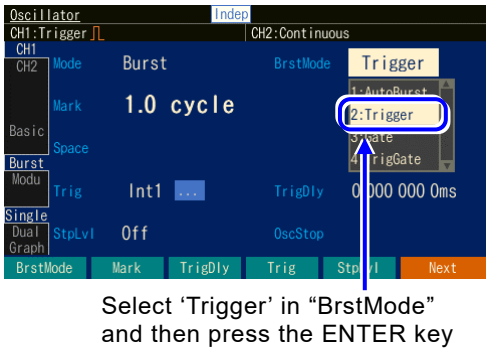
This performs oscillation with the specified wave number every time a trigger is accepted.
The burst status is displayed in the operation status section of the target channel in the status area (☞ P.4-7). ⎍: waiting for trigger, ■: waiting for trigger delay, ▶: oscillating.

a) Trigger burst example

Mark wave number (oscillation wave number): 4 waves, oscillation start/stop phase: 30°, stop level: In case of 'Off'.

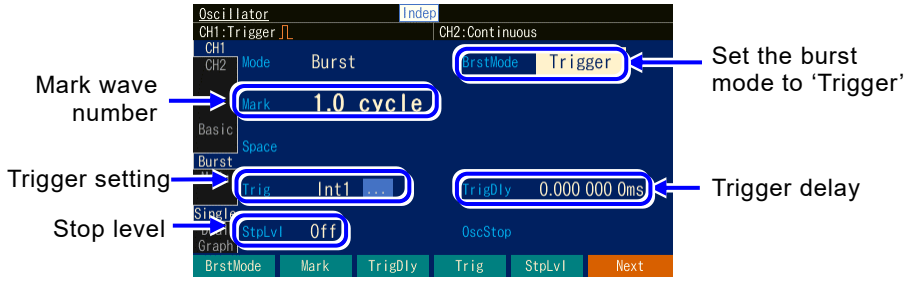


b) To set burst mode to trigger burst



Select burst mode "BrstMode" (☞ P.4-14) on page 3 "Burst" of the setting screen to display the burst mode selection list.
Select auto burst 'Trigger' (☞ P.4-18) to set the trigger burst mode.
You can also use the numeric keypad (2).

c) Screen for trigger burst setting



○ Burst mode: "BrstMode"

Set the burst mode. Set the mode here to trigger 'Trigger'.

○ Mark wave number: "Mark"

This is the wave number for oscillation every time a trigger is accepted.

This can be set from 0.5 to 999 999.9 in 0.5-cycle units or to 'Inf' (infinite number of times).

☞ P.4-16, 4-17

To set 'Inf', place the cursor over the leftmost digit and then press the up-arrow key or turn the modify knob right. You can also use soft key [Inf].

○ Trigger delay: "TrigDly"

This is the trigger delay time. Start oscillation when the specified time elapses after accepting a trigger. ☞ P.4-110

○ Trigger: "Trig"

This is the trigger condition. Select a trigger source from internal and external. ☞ P.4-110

○ Stop level: "StpLvl" ☞ P.4-101

d) Waveform where trigger is unavailable

Trigger burst cannot be performed for 'Noise' and 'DC'.

e) Setting items necessary for trigger burst

Set the oscillation start/stop phase "Phase" on page 1 "Basic" of the setting screen. ☞ P.4-36

Set mark wave number "Mark" on page 3 "Burst" of the setting screen. Wave number can be set in units of 0.5 waves, but is usually set to an integer value. ☞ P.4-106

The stop level "StpLvl" on page 3 "Burst" of the setting screen is usually set to off 'Off'. ☞ P.4-101

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 received, the Triggered lamp on the left of the TRIG key lights up.

■ Trigger source setting

Set the trigger source in trigger "Trig" on page 3 "Burst" of the setting screen. ☞ P.4-103

■ 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.

(The trigger will be generated when pressed regardless of the trigger polarity specification.)

However, in the case of WF1984/WF1982, the TRIG key only works on the active channel. About active channel, see ☞ P.4-24.

When only manual trigger operation and remote trigger operation are used for a trigger, we recommend setting the trigger source to external 'Ext'/ 'Ext1'/ 'Ext2' and polarity to 'Off'.

■ Trigger delay setting

Set the trigger delay time in the trigger "TrigDly" on page 3 "Burst" of the setting screen.

Start oscillation when the specified time elapses after accepting a trigger. The setting of the 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, but there is a delay in the waveform actually output. ☞ P.17-17

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

g) To start trigger burst → Trigger

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

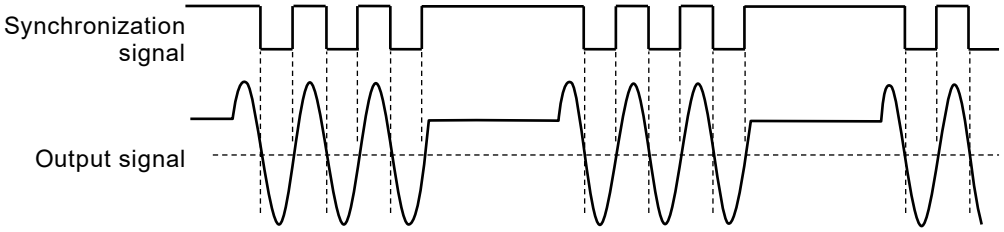
Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger. The internal trigger oscillator setting is common to the sweep internal trigger oscillator and 'FSK'/ 'PSK' internal trigger settings.

h) To output a burst synchronous signal → Select the sub output (Trigger)

Set this in synchronization output "SubOut" on page 4 "Modu" of the setting screen. ☞ P.4-105

■ When 'Sync' is selected

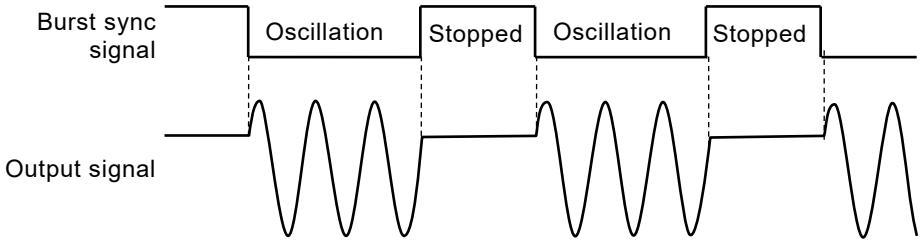
A signal with TTL level which rises at the reference phase of the waveform is output from the synchronization/sub-output terminal.



■ When 'BrstSync' is selected

A signal with TTL level which is synchronized with the burst oscillation is output from the synchronization/sub-output 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 an oscilloscope or similar device, it can be used as a trigger signal of the oscilloscope.



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 it by the ratio to the full scale of the amplitude independently. ☞ P.4-101

j) To perform burst an infinite number of times

If 'Inf' is set for the mark wave number, oscillation will continue infinitely once a trigger is input. To set 'Inf', place the cursor over the leftmost digit and then press the up-arrow key or turn the modify knob right. You can also use soft key [Inf].

There are the following two way to stop oscillation.

○ Using the stop [BrstStop] soft key

Press the [BrstStop] soft key. If the mark wave number is an integer, it will be the oscillation start/stop phase, otherwise it will wait for that phase or +180° and then stop.

○ Set the burst mode to "Trigger" again

Oscillation will stop immediately.

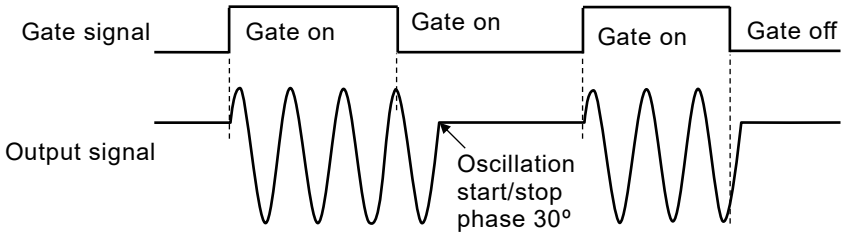
4.9.5 Gate Oscillation

This performs oscillation in an integer cycle or half-cycle unit while the gate is on.

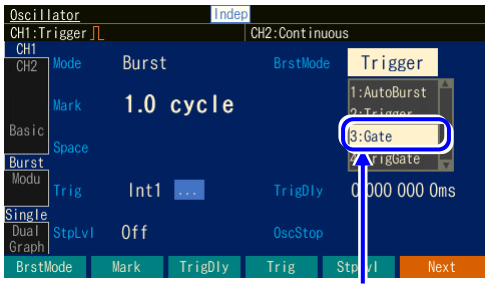
The burst status is displayed in the operation status section of the target channel in the status area (☞ P.4-7). ⎍: waiting for gate signal, ▶: oscillating.

a) Gate oscillation example

Oscillation start/stop phase: 30º, Oscillation stop unit: 1 cycle, Stop level: In case of 'Off'. The oscillation is stopped when the oscillation start/stop phase is reached after the gate signal turns off.



b) To set burst mode to gate oscillation

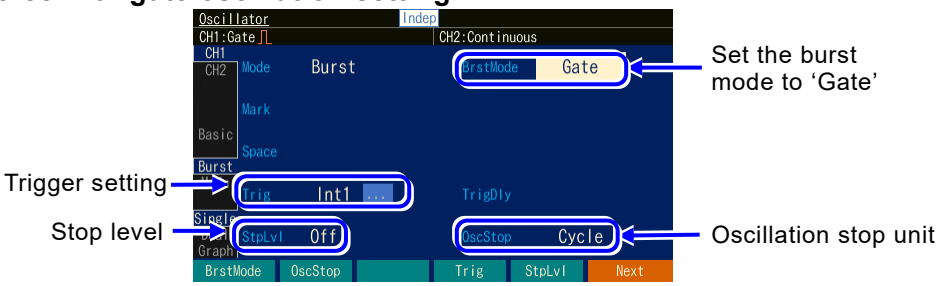


Select burst mode "BrstMode" (☞ P.4-14) on page 3 "Burst" of the setting screen to display the burst mode selection list.

Select gate oscillation 'Gate' (☞ P.4-18) to set the gate oscillation mode.

You can also use the numeric keypad 3.

c) Screen for gate oscillation setting



○ Burst mode: "BrstMode"

Set the burst mode. Set the mode here to gate oscillation 'Gate'.

○ Oscillation Stop Unit: "OscStop"

This is the oscillation stop unit. Select from 1 cycle 'Cycle' or half cycle 'HalfCycle'. Usually, set this to 1 cycle. ☞ P.4-115

○ Trigger: "Trig"

This is the trigger condition (gate condition). Select a trigger source from internal and external. ☞ P.4-113

When the trigger source is set to internal, the operation is the same as a triggered gate.

○ Stop level: "StpLvl" ☞ P.4-101

d) Waveform where gate oscillation is unavailable

Gate oscillation cannot be performed for 'DC'. Gate oscillation can be performed for 'Noise', but the action differs from other waveforms. ☞ P.4-115

e) Setting items necessary for gate oscillation

Set the oscillation start/stop phase "Phase" on page 1 "Basic" of the setting screen. ☞ P.4-36

The stop level "StpLvl" on page 3 "Burst" of the setting screen is usually set to off 'Off'. ☞ P.4-101

The Oscillation Stop Unit "OscStop" on page 3 "Burst" of the setting screen is usually set to set to 1 cycle 'Cycle'. ☞ P.4-115

A trigger (gate) is necessary for gate oscillation. See the next section.

f) Trigger (gate) setting for gate oscillation

Internal trigger oscillator, external signal, and manual trigger operation can be used as a trigger (gate). While the gate signal is on, the Triggered lamp on the left of the TRIG key is lit.

The trigger delay is fixed to the minimum. ☞ P.17-17

■ Trigger source setting

Set the trigger source in trigger "Trig" on page 3 "Burst" of the setting screen. ☞ P.4-103

■ Manual trigger

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 pressing the TRIG key (regardless of trigger polarity specification), the gate signal is turned on. However, in the case of WF1984/WF1982, the TRIG key only works on the active channel. About active channel, see ☞ P.4-24.

When only manual trigger operation is used for a trigger, we recommend setting the trigger source to external 'Ext'/ 'Ext1'/ 'Ext2' and polarity to 'Off'.

■ How to perform gate oscillation with a remote trigger

Gate oscillation cannot be performed directly from external control. This is because the gate signal will conflict with the manual trigger, trigger input, etc. However, operation equivalent to gate oscillation can be performed by using a trigger burst.

In this case, first set the burst mode "BurstMode" to 'Trigger', number of mark waves to 'Inf', and trigger delay time to 0s.

To turn on the gate signal, issue a trigger command. To turn off the gate signal, issue the "burst oscillation mode selection" command or "burst mode selection" command. The difference between them is the phase that is stopped. "Burst oscillation mode selection" will stop oscillation immediately. "Burst mode selection" continues oscillation up until the number of cycle units specified in "OscStop".

Remote trigger operation is always effective, regardless of the trigger source setting.

When only manual trigger operation is used for a trigger, we recommend setting the trigger source to external 'Ext'/ 'Ext1'/ 'Ext2' and polarity to 'Off'.

g) To start gate oscillation → Trigger (gate signal)

When gate signal on is accepted, oscillation starts.

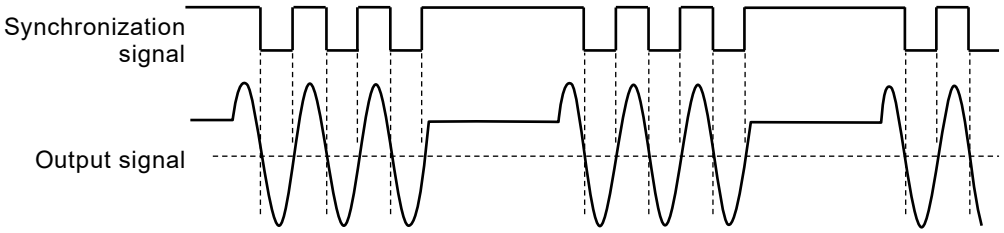
Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger.

h) To output a burst synchronous signal → Select the sub output (Gate)

Set this in synchronization output “SubOut” on page 4 “Modu” of the setting screen. ☞ P.4-105

■ When ‘Sync’ is selected

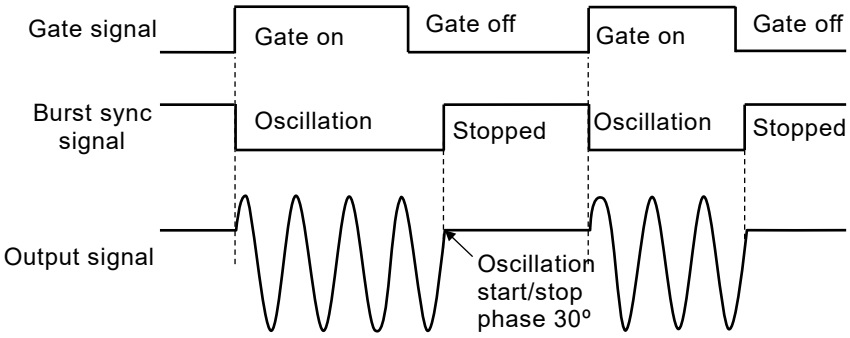
A signal with TTL level which rises at the reference phase of the waveform is output from the synchronization/sub-output terminal.



■ When ‘BrstSync’ is selected

A signal with TTL level which is synchronized with the gate oscillation is output from the synchronization/sub-output 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 an oscilloscope or similar device, it can be used as a trigger signal of the oscilloscope.



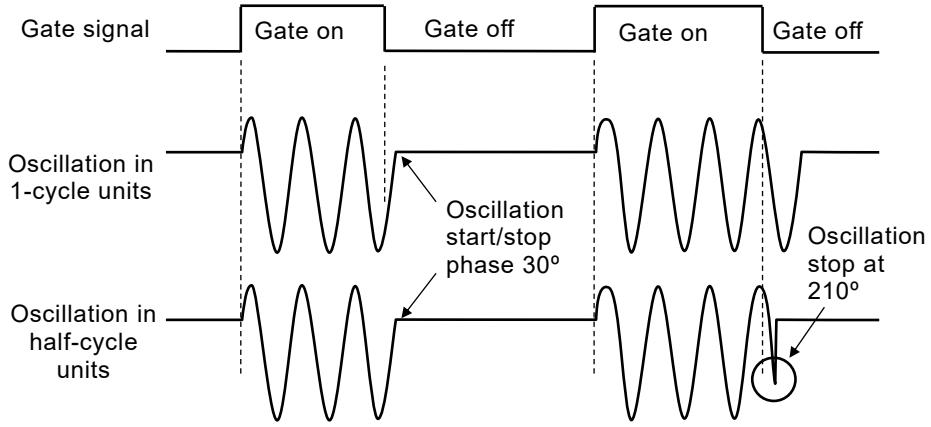
i) To oscillate in half cycle → Oscillation stop unit as half cycle

When you want to stop oscillation every half cycle, set the oscillation stop unit "OscStop" to half cycle 'HalfCycle' on page 3 "Burst" of the setting screen. Usually, set this to 1 cycle 'Cycle'. When it is set to 1 cycle 'Cycle', the oscillation has an integer cycle.

The following figure shows the comparison for the cases of one cycle and half cycle when oscillation start/stop phase: 30º, stop level 'Off'.

In the case of 1 cycle unit, the oscillation is stopped when the oscillation start/stop phase is reached after the gate turns off.

In the case of a half cycle unit, the oscillation is stopped when the oscillation start/stop phase or the oscillation start/stop phase +180º (or −180º) is reached after the gate turns off, and then it transitions to the oscillation start/stop phase.



Since the 'Noise' waveform has no period, the oscillation stop unit: "OscStop" cannot be set in that case.

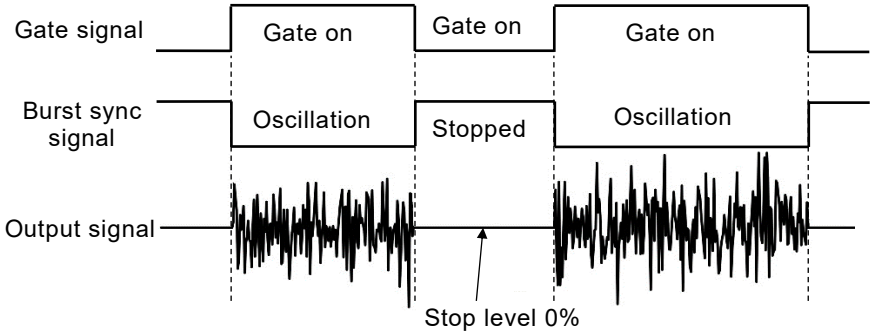
j) How to use stop level

The level while oscillation is stopped is usually set by oscillation start/stop phase. It is also possible to set it by the ratio to the full scale of the amplitude independently. ☞ P.4-101

k) Gate oscillation of Noise

Since 'Noise' has no cycle, the gate on zone becomes the oscillation zone directly, and the gate off zone becomes the oscillation stop zone directly. In addition, since 'Noise' has no phase, a stop level setting (☞ P.4-101) is always effective.

The following figure shows an example of 'Noise' gate oscillation. This is a case with the stop level of 0%.



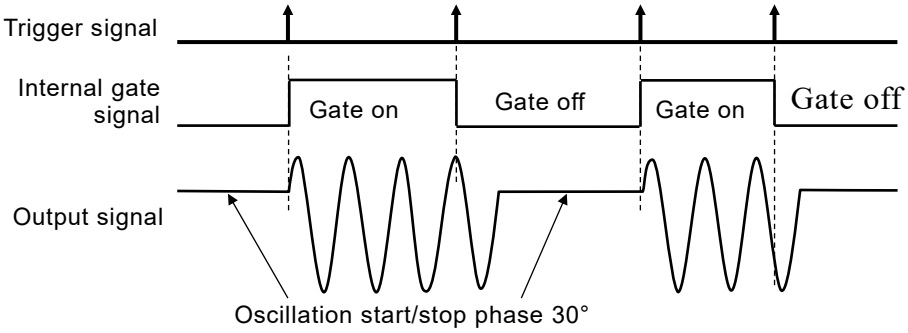
4.9.6 Triggered Gate Oscillation

Gate oscillation that turns the gate on/off every time a trigger is accepted.

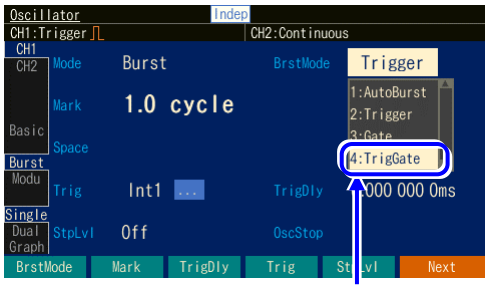
The burst status is displayed in the operation status section of the target channel in the status area (☞ P.4-7). : oscillation stop / waiting for trigger, ▶: oscillating / waiting for trigger.

a) Triggered gate oscillation example

Oscillation start/stop phase: 30º, Oscillation stop unit: 1 cycle, Stop level: In case of 'Off'. The oscillation is stopped when the oscillation start/stop phase is reached after the gate signal turns off.



b) To set burst mode to triggered gate oscillation

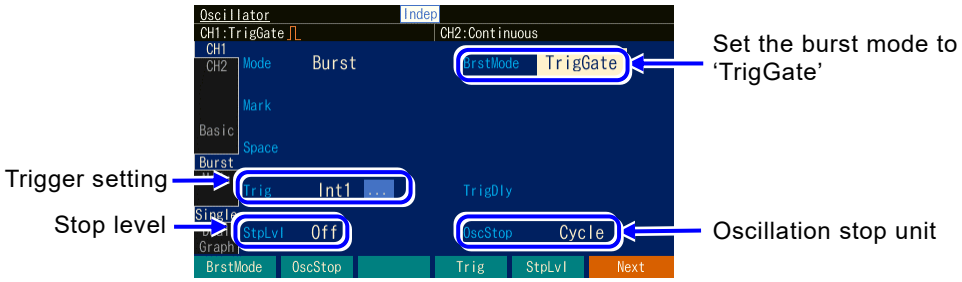


Select 'TrigGate' in "BrstMode" and then press the ENTER key

Select burst mode "BrstMode" (☞ P.4-14) on page 3 "Burst" of the setting screen to display the burst mode selection list.

Select auto burst 'TrigGate' (☞ P.4-18) to set the triggered gate oscillation mode.

You can also use the numeric keypad 4.



c) Screen for triggered gate oscillation setting

○ Burst mode: "BrstMode"

Set the burst mode. This sets the triggered gate oscillation 'TrigGate'.

○ Oscillation Stop Unit: "OscStop"

This is the oscillation stop unit. Select from 1 cycle 'Cycle' or half cycle 'HalfCycle'. Usually, set this to 1 cycle. ☞ P.4-118

○ Trigger: "Trig"

This is the trigger condition. Select a trigger source from internal and external. ☞ P. 4-117

○ Stop level: "StpLvl" ☞ P.4-101

d) Waveform where trigger gate oscillation is unavailable

Triggered gate oscillation cannot be performed for 'DC'.

Triggered gate oscillation can be performed for 'Noise', but the action differs from other waveforms. ☞ P.4-118

e) Setting items necessary for triggered gate oscillation

Set the oscillation start/stop phase "Phase" on page 1 "Basic" of the setting screen. ☞ P.4-36

The stop level "StpLvl" on page 3 "Burst" of the setting screen is usually set to off 'Off'. ☞ P.4-101

The Oscillation Stop Unit "OscStop" on page 3 "Burst" of the setting screen is usually set to set to 1 cycle 'Cycle'. ☞ P.4-115

A trigger is necessary for triggered gate oscillation. See the next section.

f) Trigger setting for 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 received, the Triggered lamp on the left of the TRIG key lights up.

The trigger delay is fixed to the minimum. ☞ P.17-17

■ Trigger source setting

Set the trigger source in trigger "Trig" on page 3 "Burst" of the setting screen. ☞ P.4-103

■ 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.

(The trigger will be generated when pressed regardless of the trigger polarity specification.)

However, in the case of WF1984/WF1982, the TRIG key only works on the active channel. About active channel, see ☞ P.4-24.

When only manual trigger operation and remote trigger operation are used for a trigger, we recommend setting the trigger source to external 'Ext'/ 'Ext1'/ 'Ext2' and polarity to 'Off'.

g) To start triggered gate oscillation → Trigger

When the trigger is accepted and the internal gate signal is On, oscillation starts.

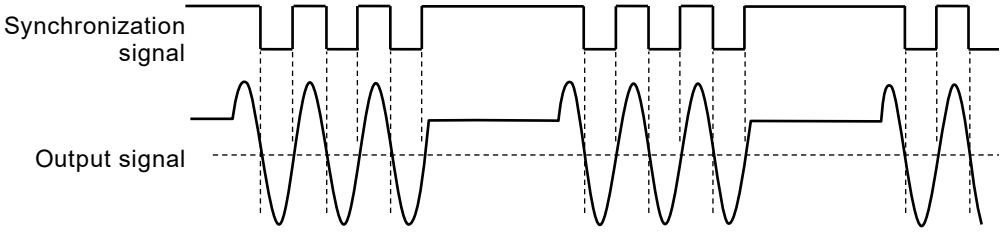
Internal trigger oscillator, external signal, manual trigger operation, and remote trigger can be used as a trigger.

h) To output a burst synchronous signal → Select the sub output (TrigGate)

Set this in synchronization output “SubOut” on page 4 “Modu” of the setting screen. ☞ P.4-105

■ When ‘Sync’ is selected

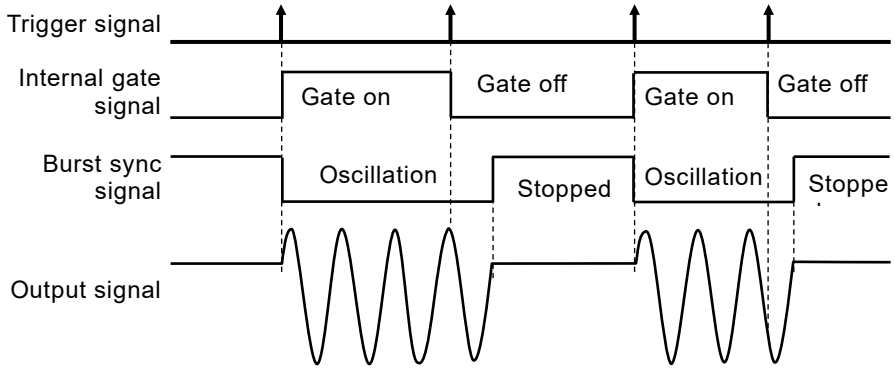
A signal with TTL level which rises at the reference phase of the waveform is output from the synchronization/sub-output terminal.



■ When ‘BrstSync’ is selected

A signal with TTL level which is synchronized with the burst oscillation is output from the synchronization/sub-output 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 an oscilloscope or similar device, it can be used as a trigger signal of the oscilloscope.



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” to half cycle ‘HalfCycle’ on page 3 “Burst” of the setting screen. Usually, set this to 1 cycle ‘Cycle’. When it is set to 1 cycle ‘Cycle’, the oscillation has an integer cycle.

Please refer to the figure of gate oscillation (read gate signal as internal gate signal) ☞ P.4-115

Since the ‘Noise’ waveform has no period, the oscillation stop unit: “OscStop” cannot be set in that case.

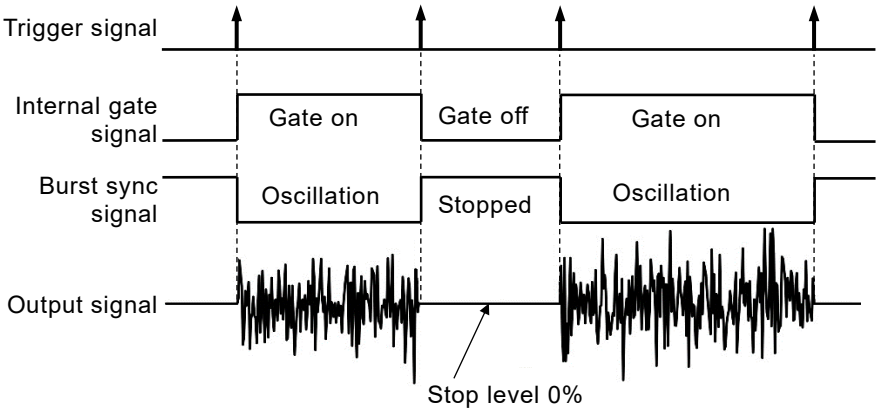
j) How to use stop level

The level while oscillation is stopped is usually set by oscillation start/stop phase. It is also possible to set it by the ratio to the full scale of the amplitude independently. ☞ P.4-101

k) Triggered gate oscillation of Noise

Since ‘Noise’ has no cycle, the gate on zone becomes the oscillation zone directly, and the gate off zone becomes the oscillation stop zone directly. In addition, since ‘Noise’ has no phase, a stop level setting (☞ P.4-101) is always effective.

The following figure shows an example of ‘Noise’ triggerd gate oscillation. This is a case with the stop level of 0%.



4.10 To Use the Synclator Function

4.10.1 About Synclator

The function that outputs a waveform synchronized with the frequency of an externally input signal is called the syncrator function. It is capable of conversion, smoothing, and phase shift of waveforms and frequency division and multiplication ratio of the input frequency.
In addition, it can be combined with the modulation function and auto burst.

4.10.2 Operation of Synclator

○ Lock operation

The frequency of the signal input to the external trigger input terminal (TRIG IN) (after division: M, multiplication: N) and the waveform output are forcibly matched. If the input of the phase comparator shifts by 90º or more, the frequency is matched again.
The phase is changed discontinuously at this time.

○ Phase difference between input and output

Due to internal processing, the input and output phases will not be completely the same even in the locked state. In addition, the phase difference varies depending on the frequency. To make the phases the same, match them in the “Phase” settings.

○ Display of “Freq” field

If the synclator function is turned on and the input signal is locked, the current oscillator frequency is displayed in the “Freq” field. The frequency cannot be changed manually.
If it is not locked, “Unlock” is displayed in the “Freq” field.

4.10.3 Conditions under which Synclator Is Available

○ Inputtable frequency range

The frequency rage is 30Hz × M to 5MHz / N.
M is the division ratio, and N the multiplication ratio.

○ Outputtable frequency range

The frequency range is 30Hz to 5MHz regardless of the settings for the division ratio M and multiplication ratio N. However, if the setting range limit value of the frequency (☞ P.4-57) is set to within 30Hz to 5MHz, oscillation exceeding that range is not possible.
In addition, if waveform is an array format arbitrary waveform, the upper limit frequency is limited to the lower of (Maximum sample rate [S/s]) / (Waveform length) or 5MHz. For example, for a 1 000 words arbitrary waveform, the upper frequency limit is 240kHz. (Half of that for WF1981/WF1982)

○ Rate of change of frequency of input signal

Locking is not possible for an input signal with which the rate of change of frequency will exceed about 5kHz/s or (Oscillation frequency [Hz] / 2)[Hz/s].

○ Oscillation modes in which can be used

The synclator can be used when modulation except 'FM'/ 'FSK'/ external 'PSK' and when auto burst or continuous mode.

○ Limitations due to channel mode

Use is not possible when the channel mode is constant frequency difference or constant frequency ratio.

○ Waveforms

Use is possible when 'Sine', 'Square', 'Ramp', parameter variable waveform 'PWF', and arbitrary waveform 'ARB'. Use is not possible with 'DC', 'Noise', and pulse wave 'Pulse'.
When using parameter variable waveforms or arbitrary waveforms (control point format ☞ P.7-2), a waveform is generated internally to generate the upper limit of possible frequencies. Therefore, if the upper frequency limit at that time is too high, the quality of the generated waveform will deteriorate.
We recommend that you set the upper limit of the frequency setting range limit value (☞ P.4-57) to the minimum value that includes the frequency range to be used, plus a slight margin.

○ Other limitations

- When the waveform is an arbitrary waveform or parameter variable waveform, rewriting the waveform may cause it to unlock. (It may also be rewritten when changing the phase)
- The phase between the input external signal and the signal output to the waveform output is not perfectly aligned. Also, it varies slightly with frequency. (This can be freely set in the phase setting)
- When the number of waveform points is odd in an array format arbitrary waveform, the following phase shift (⊿ph) is added. The minimum odd number of waveform length: n is 17 words, so that is the maximum.

  $\angle ph[^{o}]=180 / n \qquad \therefore 10.588^{o}@n=17$

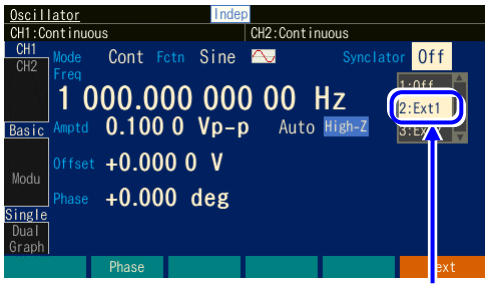
- The frequency setting range limit value must have some margin for the frequency to be locked. With the synclator, it is not possible to lock to the same frequency as the upper and lower limits of the frequency range limit.
  Regarding frequency setting range limit values, ☞ P.4-57.

Check

Even if the phase is set to 0º, the phase difference between the applied external signal and the output signal will not be 0º.
Except for the above ⊿ph, there will be a deviation of approximately ±(1º +20ns).

4.10.4 Setting procedure

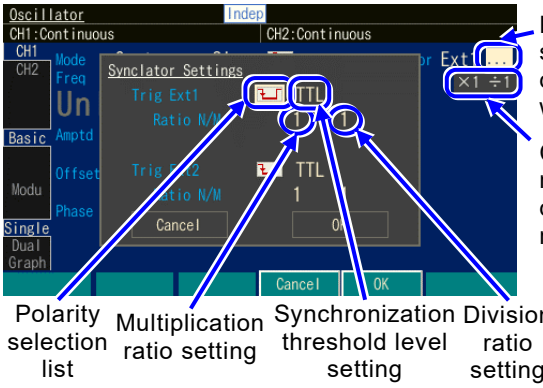
a) To turn the synclator on



Select 'Ext'/ 'Ext1'/ 'Ext2' and then press the ENTER key
For WF1984/WF1982 use TRIG IN #1/ #2 terminal for 'Ext1'/ 'Ext2'

Select "Synclator" field on the top right of the "Basic" screen to set the synchronization source for the synclator. ☞ P.4-14 Setting this source to other than 'Off' will turn the syncrator on. For WF1983/WF1981, it is fixed to 'Ext'. For WF1984/WF1982, 'Ext1' or 'Ext2' can be selected for each channel independently. Also use the key (2) or (3). Synchronization source is shared with the sweep trigger (☞ P.4-86) and the burst trigger (☞ P.4-103)

b) Synchronization source parameter setting dialog



When a syncrator is enabled, [...] appears to the right of the "Synclator" field. Select this (☞ P.4-14) to open the synchronization source parameter setting dialog. When this item is selected, the current multiplier and divider will be displayed before pressing the ENTER key.

○ Polarity selection

Select the edge polarity of the synchronization source. ☞ P.4-18 Select from off, leading edge, and trailing edge. This is the same as the external trigger polarity for burst and sweep.

○ Synchronization threshold level

Set the threshold level of the synchronization source. Select from 'TTL' or 'Variable'. When 'Variable' is selected, voltage setting becomes possible (☞ P.4-16, 4-17), and the range of ±5V can be set with a 0.1V resolution. This is the same as the external trigger threshold for burst and sweep. If the threshold level is changed, takes approximately 800ms to stabilize.

○ Division ratio setting: M

Divides the frequency of the synchronization source. Set this within the range of 1 to 64. ☞ P.4-16, 4-17 If (frequency of synchronization source) / M falls below 30Hz or lower limit of frequency limit value, the status becomes unlocked.

○ Multiplication ratio setting: N

Set the multiplication ratio for the (frequency of synchronization source) / M. Set this within the range of 1 to 64. ☞ P.4-16, 4-17

If (frequency of synchronization source) / M × N exceeds upper limit frequency (☞ P.4-120) or upper limit of frequency limit value, the status becomes unlocked.

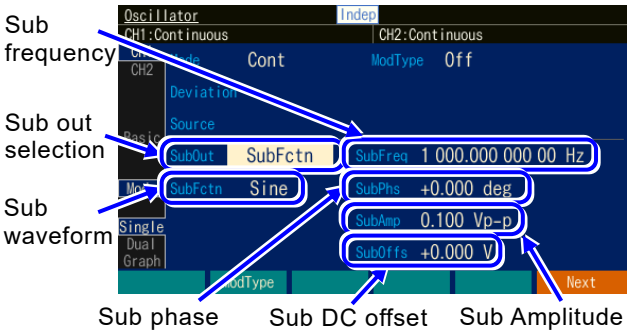
4.11 Using Sub Waveforms

A waveform that differs from the waveform output that is output from the synchronization/sub-output BNC terminal is called a sub-waveform. Compared to waveform output, there are some limitations such as a frequency range of 0 to 5 MHz and an output voltage range of -3.3V to +3.3V/open, but the WF1983/WF1981 can be used as a 2 frequency or 2 phase oscillator, and the WF1984/WF1982 can be used as a maximum 4 frequency or 4 phase oscillator.

The following settings are common to the internal signal source when modulating the main signal with the internal modulation source. ☞ P.4-66

4.11.1 Conditions under which Sub waveforms are Available

A sub-waveform can be used when the modulation function is turned off or when external modulation.



4.11.2 To set Sub waveforms

This can be set when Sub Output selection "SubOut" (☞ P.4-58) on page 4 "Modu" of the Oscillator setting screen is "SubFctn" or "ModFctn".

a) Selectable waveforms

This can be set in sub-waveform "SubFctn" or "ModFctn" on page 4 "Modu" of the Oscillator setting screen. Select from the following 8 options: ☞ P.4-14

- Sine wave: 'Sine'
- Square wave (50% duty): 'Square'
- Triangle wave (50% symmetry): 'Triangle'
- Rising ramp wave: 'UpRamp'
- Falling ramp wave: 'DnRamp'
- Noise (Gaussian distribution, Variable bandwidth): 'Noise'
- Arbitrary waveform: 'ARB'
- Parameter variable waveform: 'PWF'

b) Operation when Noise is selected

When 'Noise' is selected, an item to select the noise bandwidth "SubBW" or "ModBW" will appear instead of Sub phase "SubPhs" or "ModPhs". Select your desired bandwidth. ☞ P.4-18

c) Operation when an arbitrary waveform 'ARB' is selected

When an 'ARB' is selected, the [...] icon appears to the right of it. This icon will open a screen to select an arbitrary waveform. ☞ P.4-60 When this item is selected, the name of the currently selected 'ARB' name will be displayed before pressing the ENTER key. The arbitrary waveform data is adjusted to 4 096 points and interpolated in real time.

When using an arbitrary waveform as a sub-waveform, the sample rate cannot be specified. For details of arbitrary waveform, ☞ P.7-2.

d) Operation when parameter variable waveform 'PWF' is selected

When a 'PWF' is selected, the [...] icon appears to the right of it. This icon will open a screen to change parameter for PWF. ☞ P.4-59 When this item is selected, the name of the currently selected PWF type will be displayed before pressing the ENTER key. The PWF data is adjusted to 4 096 points and interpolated in real time. For details of PWF, ☞ P.6-2.

4.11.3 To set Frequency of the Sub waveform

This can be set when sub output selection “SubOut” (☞ P.4-58) on page 4 “Modu” of the Oscillator setting screen is “SubFctn”, “ModFctn”, “SubSync” or “ModSync”. Set with “SubFreq” or “ModFreq” field. (Same as ☞ P.4-34, but period time cannot be set, and even when using arbitrary waveforms, sample rate cannot be specified)

When the sub waveform is ‘Noise’, you can set the equivalent noise bandwidth instead. ☞ P.4-18

See also ☞ P.4-56. The frequency characteristics of the cutoff area is different from those of the main output.

4.11.4 To set Phase of the Sub waveform

Set the phase to add to the reference phase of the sub waveform.

This can be set when sub output selection “SubOut” (☞ P.4-58) on page 4 “Modu” of the Oscillator setting screen is “SubFctn”, “ModFctn”, “SubSync” or “ModSync”.

Set with “SubPhs” or “ModPhs” filed. (Same as ☞ P.4-36)

When the frequency of the sub waveform is set in an integer ratio relationship with the main output, the reference phases of the main and sub waveforms can be aligned using the phase synchronization operation. ☞ P.8-6

From then on, the main and sub phase relationships will be synchronized until either frequency is changed. (The delay time difference mainly caused by the analog circuit remains about ±20ns)

When the sub waveform is ‘Noise’, the phase cannot be set.

4.11.5 To set Amplitude of the Sub waveform

This can be set when sub output selection “SubOut” (☞ P.4-58) on page 4 “Modu” of the Oscillator setting screen is “SubFctn” or “ModFctn”.

Set with “SubAmp” filed. (Same as ☞ P.4-38, but high/low settings are not possible)

The maximum total value of AC amplitude and DC offset is restricted to ±3.3V/open.

For example, when the AC amplitude is 1Vp-p/open, DC offset is restricted to the range from -2.8V/open to +2.8V/open.

4.11.6 To set DC Offset of the Sub waveform

This can be set when sub output selection “SubOut” (☞ P.4-58) on page 4 “Modu” of the Oscillator setting screen is “SubFctn” or “ModFctn”.

Set with “SubOfs” filed. (Same as ☞ P.4-39, but high/low settings are not possible)

There are limits to the setting range as well as the amplitude. See previous section.

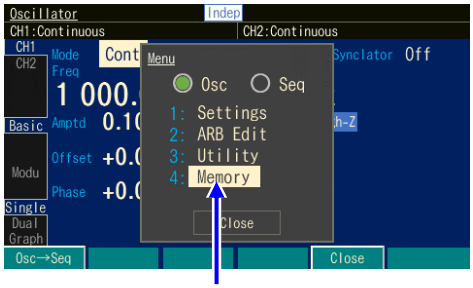
5. Saving and Recalling settings

You can save the current setting condition in the setting memory, and call it to use later. Settings are saved and recalled on the Memory screen. When the power is resumed after a power failure, WF198x will load the setting or sequence memory #1. ☞ P.4-4 Factory defaults are saved in all the setting and sequence memories at factory shipment.

5.1 To Save settings

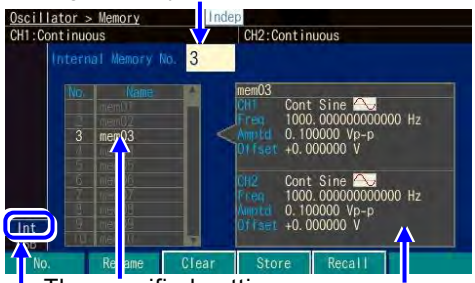
You can select internal memory or USB flash drive as the save destination. The following assumes that the current operating mode is normal oscillation. For switching the mode, see ☞ P.4-15.

5.1.1 To save to the unit's Internal memory



In the top menu, select "4: Memory"

When you select "Internal Memory No.", an input field for the save destination setting memory number will open



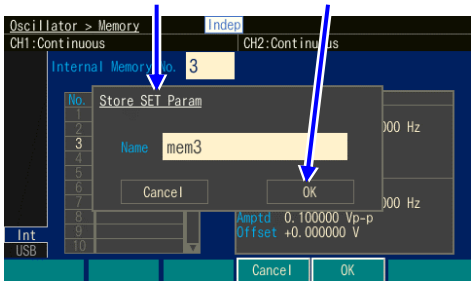
The specified setting memory number and setting name will be highlighted

To save to internal memory, select the "Int" tab and Press ENTER

Specified settings displays an overview of the contents of memory

When [Store] soft key, the dialog to confirm the save operation is opened

Select [OK], and then press the ENTER key to save the settings



1. Press the [MENU] key to display the top menu window. Select "4: Memory" and then press the [ENTER] key. The Memory screen opens. You can also use the numeric keypad [4] after the top menu is displayed.

2. If "Int" at the bottom left of the screen is selected, the settings will be save to the internal memory. If "USB" is selected, select "Int" and press the [ENTER] key.

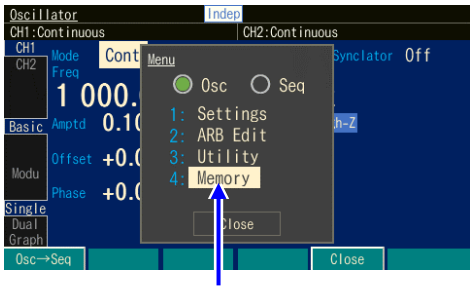
3. Select the "Internal Memory No." field (☞ P.4-14) at the top left of the screen to open the input field of the setting memory number to which to save. You can also use [No.] soft key. Set the save destination memory number in this field. ☞ P.4-16, 4-17
   The specified setting memory number and its setting name will be highlighted on the left side of the screen. On the right side of the screen, a summary of the settings saved in the specified settings memory is displayed.

4. Press the [Store] soft key opens a dialog to confirm the save operation. Select "Name" field (☞ P.4-14) to open the name input field. Change the name if necessary. ☞ P.4-19

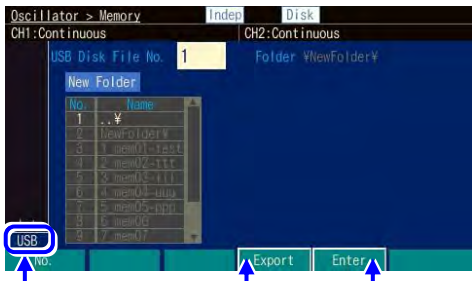
5. To save the settings, select [OK] and then press the [ENTER] key. Saving is performed and the settings previously saved to the setting memory are overwritten by the new settings. You can also use [OK] soft key. You can cancel saving by pressing the soft key [Cancel].

5.1.2 To save to USB flash drive

You can copy the current settings and contents saved in internal memory to USB flash drive.
For operations using USB flash drive, See also, ☞ P.5-7.



In the top menu, select "4: Memory"



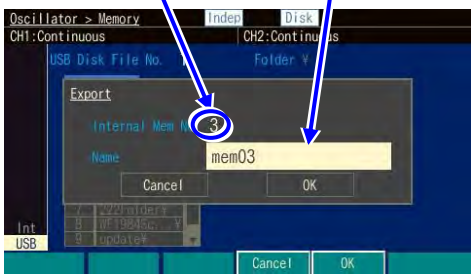
When [Export] soft key, the dialog for saving is displayed

Select a folder and press the [Enter] soft key to go to that folder

To save to USB flash drive, select the "USB" tab and Press ENTER

Specify the internal memory number of the save source

Specify the name of the file to be saved



1. Press the (MENU) key to display the top menu window. Select "4: Memory" and then press the (ENTER) key. The Memory screen opens. You can also use the numeric keypad (4) after the top menu is displayed.
2. To save to USB flash drive, connect the USB flash drive to the unit (☞ P.3-2) and then select the "USB" tab on the bottom left of the screen and press the (ENTER) key.
3. Navigate to the destination folder if necessary. Select the "USB Disk File No." field (☞ P.4-14) to open the input field of the setting target file number. You can also use [No.] soft key. In this field, select a folder. Select a folder (name with "¥" at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7
4. Press soft key [Export] to display the settings save dialog. Specify the internal memory number of the save source in the "Internal Mem No." field. ☞ P.4-16, 4-17 ("0" indicates the current setting)
   In the "Name" field, specify the file name when saving to the USB flash drive. ☞ P.4-19
5. To save the settings, select [OK] and then press the (ENTER) key. You can also use [OK] soft key. Saving is performed and the settings previously saved to the target file is overwritten by the new settings.

You can cancel saving by pressing the soft key [Cancel].

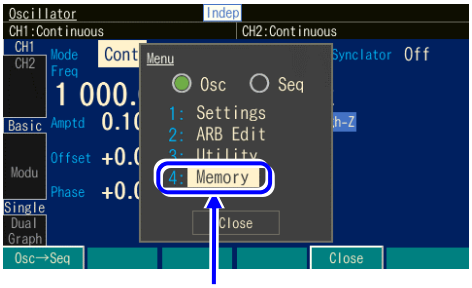
> Check
> Folder and file names are not case sensitive. If a file "aaa" exists, and you create "Aaa", the original "aaa" will be lost.

a) File time stamps

See ☞ P.5-8 for timestamps of files created with this device.

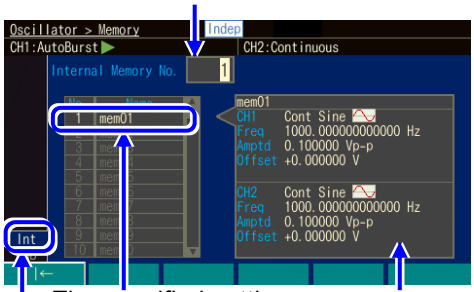
5.2 To Recall settings

5.2.1 To recall from the unit's Internal memory



In the top menu, select "4: Memory"

When you select "Internal Memory No.", an input field for the recall source setting memory number will open



The specified setting memory number and setting name will be highlighted

To recall from internal memory, select the "Int" tab and Press ENTER

Specified settings displays an overview of the contents of memory

1. Press the [MENU] key to display the top menu window. Select "4: Memory" and then press the [ENTER] key. The Memory screen opens. You can also use the numeric keypad [4] after the top menu is displayed.

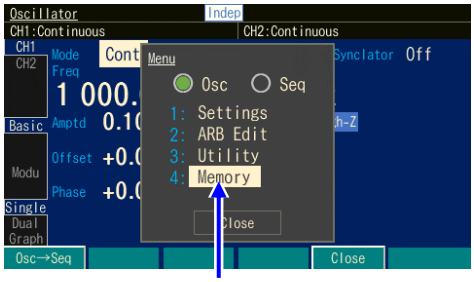
2. If "Int" at the bottom left of the screen is selected, the settings will be recall from the internal memory. If "USB" is selected, select "Int" and press the [ENTER] key.

3. Select the "Internal Memory No." field (☞ P.4-14) at the top left of the screen to open the input field of the setting memory number to which to recall. You can also use [No.] soft key. Set the recall source memory number in this field. ☞ P.4-16, 4-17
   The specified setting memory number and its setting name will be highlighted on the left side of the screen. On the right side of the screen, a summary of the settings saved in the specified settings memory is displayed.

4. Press the [Recall] soft key opens a dialog to confirm the recall operation. To recall the settings, select [OK] and then press the [ENTER] key. You can also use [OK] soft key. Perform recalling and change the current settings.
   You can cancel recalling by pressing the soft key [Cancel].

5.2.2 To recall from USB flash drive

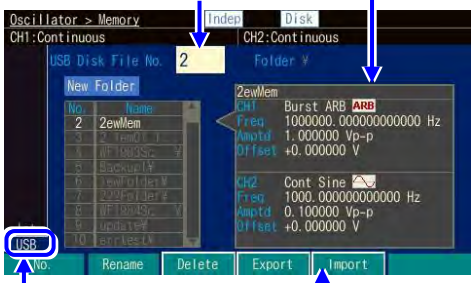
You can copy the contents from the USB flash drive to the current settings or internal settings memory. For operations using USB flash drive, See also, ☞ P.5-7.



In the top menu, select "4: Memory"

A summary of the selected files will be displayed

Select the source file to recall

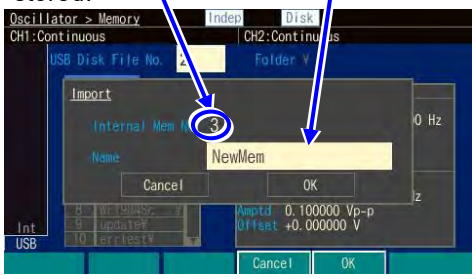


To recall from USB flash drive, select the "USB" tab and Press ENTER

Press the soft key [Import] to open a dialog to select the import destination

Specify the memory number where the recall settings are stored.

Can change the setting name



1. Press the (MENU) key to display the top menu window. Select "4: Memory" and then press the (ENTER) key. The Memory screen opens. You can also use the numeric keypad (4) after the top menu is displayed.

2. To recall from USB flash drive, connect the USB flash drive to the unit (☞ P.3-2) and then select the "USB" tab on the bottom left of the screen and press the (ENTER) key.
Select the "USB Disk File No." field (☞ P.4-14) to open the input field of the setting target file number. You can also use [No.] soft key.
Select the source settings file and destination folder number in that field. ☞ P.4-16, 4-17

3. Navigate to the folder where you want to read the settings file if necessary. Select a folder (name with "¥" at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7

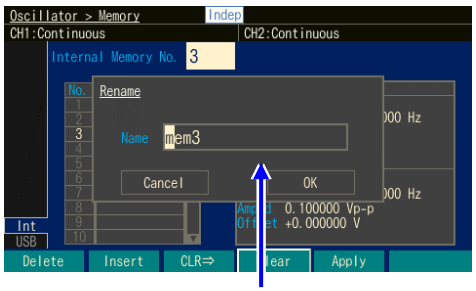
4. If you press the soft key [Import] with the target file selected, a dialog will open to confirm the import operation.
Specify the internal setteing memory number of the save destination in the "Internal Mem No." field. ☞ P.4-16, 4-17
You can also change the setting name in the "Name" field. ☞ P.4-19

5. To recall the settings, select [OK], and then press the (ENTER) key. You can also use [OK] soft key. The settings are recalled and the current settings are changed.
You can cancel memory recall using soft key [Cancel].

Check

Settings saved between WF198x models with different parameter limits will result in an error if the settings exceed the limits of the model being read. In addition to the setting value itself, you must also be careful about the setting range limit value. Regarding the setting range limit value, ☞ P.4-57.

5.3 To Rename setting memory



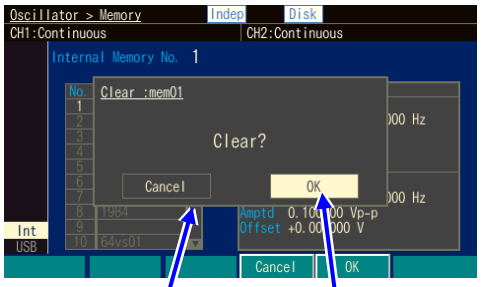
When the [Rename] soft key is pressed, the input field of the setting memory name is opened

1. As with the save operation, press the [Rename] soft key after setting the setting memory number. ☞ P.4-16, 4-17
   The setting memory name change dialog will appear.
2. The old name is displayed in the “Name” field, so change it to the new name. ☞ P.4-19
3. Select [OK] and then press the ENTER key to confirm the changed name and close the dialog. You can also use [OK] soft key.

Now, press the CANCEL key to close the dialog and keep the name as before.

To change the name of the setting file in the USB flash drive, see ☞ P.5-8.

5.4 Restoring saved contents to default settings



Press the [Clear] soft key to open the dialog to confirm the initialization operation

Select [OK] and then press the ENTER key to restore the initial settings

1. As with the save operation, press the [Clear] soft key after setting the setting memory number. ☞ P.4-16, 4-17
   A dialog opens to confirm the initialization operation.
2. Select [OK] and then press the ENTER key to confirm the initialization and close the dialog. You can also use [OK] soft key.
   The settings previously saved in that setting memory will be overwritten with the default settings.

Now, press the CANCEL key to close the dialog and keep contents as before.

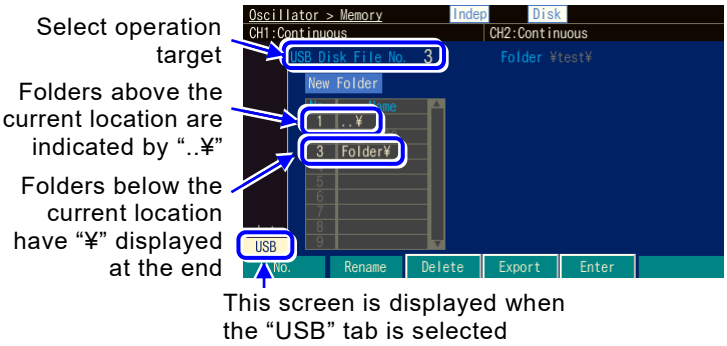
To delete the setting file in the USB flash drive, see ☞ P.5-8.

5.5 USB flash drive operations

This section explains the operations specific to working with USB flash drive.
The connector for connecting the USB flash drive of this device is ☞ P.3-2.

5.5.1 File list

When USB flash drive is the operation target in the operation screen for storing/recalling the settings, arbitrary waveform, or sequence, a list of files in the current folder appears. Any folders directly above the current location are indicated by "..¥" and any folders below the current location are listed. In addition, unrelated files (When the setting operation screen, files other than the setting file of this instrument) are not displayed.



To select a file or folder for operation, select the "USB Disk File No." field (☞ P.4-14) at the top left of the screen, and the file number input field will open. You can also use [No.] soft key. Select the target file or folder number in that field. ☞ P. 4-16, 4-17

> **Check**
> This device cannot display files or folder names that contain characters outside the ASCII range. Also, if the number of files and folders in one folder exceeds several hundred, some file and folder names will not be displayed.
> Folder and file names are not case sensitive. If a file "aaa" exists, and you create "Aaa", the original "aaa" will be lost.

5.5.2 To change the Current folder

When working with USB flash drive, the saving or recall of settings applies to the files in the current folder.

a) To move to the folder directly above

Select "..¥" in the file list and press the [Enter] soft key.

b) To move to a folder directly below

Select the name of the folder you wish to move to from the file list and press the [Enter] soft key.

5.5.3 To Create a folder

A [NewFolder] button will appear on the Memory screen for USB flash drive.
Select this button (☞ P.4-14) and press the ENTER key to display a dialog for entering the name of the folder to be created.
Note, folder and file names on the USB flash drive are not case sensitive.
Enter the name (☞ P.4-19) and press [OK] soft key to create the new folder below the current folder and display it in the file list. You can also cancel the folder creation by pressing the [Cancel] soft key or the CANCEL key.
You can also create a folder for USB flash drive on the arbitrary waveform file screen (☞ P.7-17) and on the sequence memory operation screen (☞ P.11-28).

5.5.4 To Delete a file or folder

On the Memory screen for the USB flash drive, select the file or folder you want to delete in the "USB Disk File No." field (☞ P.5-7) and press the [Delete] soft key.
A confirmation dialog will appear. Press the [OK] soft key to delete the file or folder. You can also cancel the deletion by pressing the [Cancel] soft key or the CANCEL key.
Note that if a folder is the target, all of the contents of that folder and all of its subfolders and files will also be deleted.
You can also delete folders for USB flash drive on the Memory screen of ARB Edit ☞ P.7-15 and on the sequence memory operation screen ☞ P.11-26.

5.5.5 To Rename a file or folder

On the Memory screen for the USB flash drive, select the file or folder you want to rename in the "USB Disk File No." field (☞ P.5-7) and press the [Rename] soft key.
The rename dialog will appear. The previous name will be displayed in the "Name" field, so change it to the new name. ☞ P.4-19
Note, folder and file names on the USB flash drive are not case sensitive.
Press the [OK] soft key to rename the file or folder. You can also cancel the name change by pressing the [Cancel] soft key or the CANCEL key.
You can also change the folder name of the USB flash drive on the Memory screen of ARB Edit ☞ P.7-16 and on the sequence memory operation screen ☞ P.11-27.

5.5.6 File Time Stamps

This device does not have a built-in battery to facilitate disposal.
Therefore, the time stamp will be delayed compared to the actual date and time by the amount of time the power is off.
The timestamp of the file created by this device will be delayed by the amount mentioned above.
The date and time for the time stamp cannot be changed.

6. Parameter variable waveforms (PWF)

6.1 Overview of parameter variable waveform (PWF)

With respect to complicated waveforms such as those that cannot be created unless they are arbitrary waveforms, any waveform with variables (parameters) that can be changed easily is called a parameter variable waveform.

On the parameter variable waveform selection screen (☞ P.4-59), you can select the name of each waveform (PWF type) and set each parameter (up to 6 types).
With the exception of some names, each of the waveform and parameter names are defined uniquely in this product.

For convenience, the total 26 types are divided into 6 groups as shown below.

■ **Steady Sine Group** ☞ P.6-4 (6 types)
Waveform created based on a sine wave. Intended for repeated output.

■ **Transient Sine Group** ☞ P.6-10 (4 types)
Waveform created based on a sine wave. Intended for use as one cycle of the start or end of a continuous sine wave in a sequence oscillation.

■ **Pulse Group** ☞ P.6-14 (6 types)
Pulse shaped waveforms.

■ **Transient Response Group** ☞ P.6-20 (4 types)
Waveform which simulates a system's transient response.

■ **Surge Group** ☞ P.6-24 (2 types)
Waveform which simulates a surge signal.

■ **Others Group** ☞ P.6-26 (4 types)
Waveforms which do not belong to the groups above.

Check
If the frequency or phase is changed, oscillation may be resumed from the set phase.
Note that the phase will become discontinuous.
Changing parameters may cause unexpected output while changing the waveform.

6.2 Meaning of Each Parameter and Waveform Examples

The following provides an overview, explains the meaning of each parameter, and gives examples for each waveform (PWF type).

The waveform examples display one cycle of the waveform drawn in the waveform memory. The polarity setting in each example is Normal. The amplitude range (☞ P.4-41) settings in each example vary depending on the waveform, and are set to the amplitude range that is generally considered to be the most common when using that waveform (initial setting value).
The vertical axis ±1 corresponds to the waveform memory's full-scale amplitude ±FS.
The horizontal axis is the time axis and represents the time for one cycle with a 1. The horizontal axis also represents the phase axis from 0 to 360°. The time for one period is called the “basic period” and the inverse is the “fundamental frequency”. Each of these is also the respective oscillation cycle and the oscillation frequency of the entire waveform.

■ PWF and amplitude settings

Depending on the PWF type and parameters, the generated positive and negative peaks may not reach the full-scale level (see individual waveform examples below).
Note that the set amplitude value is output when the generated waveform reaches ±FS.
Otherwise, the amplitude of the output signal will not reach the set amplitude [Vp-p].

Check

The AC component of the waveform may disappear depending on the parameter settings.

Press the [Reset] soft key in the center if it is unclear how to restore the settings. This returns each parameter to the default factory setting.

The polarity and amplitude range are not changed.

6.2.1 Steady Sine Group

a) Unbalanced sine wave: 'Unbalanced Sine'

■ Overview

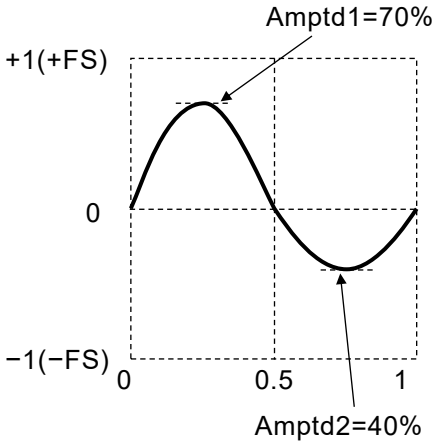
Waveform for which the amplitudes of the first half and second half of the sine wave can be changed independently.

■ Application examples

- Simulation of an output waveform where the gain of the plus side differs from the minus side
- Simulation of full-wave rectification and half-wave rectification waveforms

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.



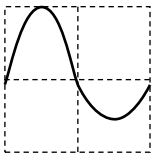
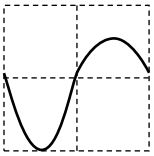
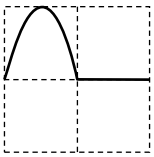
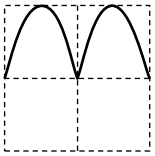
- First half amplitude (Amptd1)
  The amplitude of the first half cycle.
  When it is 100%, the amplitude is the same as the original sine wave.
  Variable range: −100.00% to +100.00%
- Second half amplitude (Amptd2)
  The amplitude of the second half cycle.
  When it is 100%, the amplitude is the same as the original sine wave.
  Variable range: −100.00% to +100.00%

Note that when changing each of the amplitudes, the upper and lower peak values for the waveform will change.

Also, when the amplitudes of the first and second halves differ, the average value for one cycle will not be zero. Please note that this will generate a DC portion.

■ Waveform examples

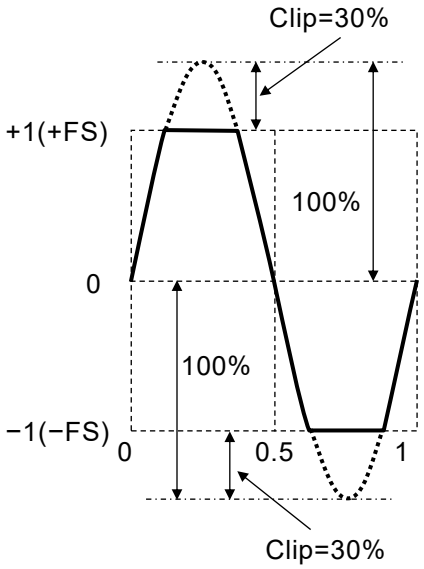
The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
Amptd1=100 Amptd2=50	Amptd1=−50 Amptd2=−100	Amptd1=100 Amptd2=0	Amptd1=100 Amptd2=−100

b) Clipped sine wave: 'Clipped Sine'

■ Overview

Waveform acquired by clipping the top and bottom of the amplitude of a sine wave



■ Application examples

- Simulates a waveform clipped by an input clamp circuit
- Simulates an amp output waveform saturated by the power supply voltage

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

- Clip ratio (Clip)

  The ratio by which the top and bottom of the original sine wave is clipped.

  The peak value of the original sine wave is 100%.

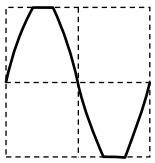
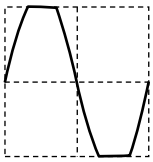
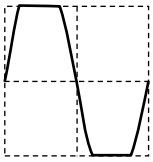
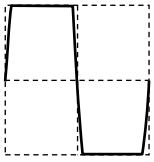
  The original sine wave corresponds to the 0% value.

  Variable range: 0.00% to 99.99%

Peak value is fixed to ±FS.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
Clip=10	Clip=20	Clip=40	Clip=80

c) CF controlled sine wave: 'CF Ctrl Sine'

■ Overview

Waveform acquired by extracting only the neighborhood of 90° and 270° of a sine wave and expanding the amplitude.

■ Application examples

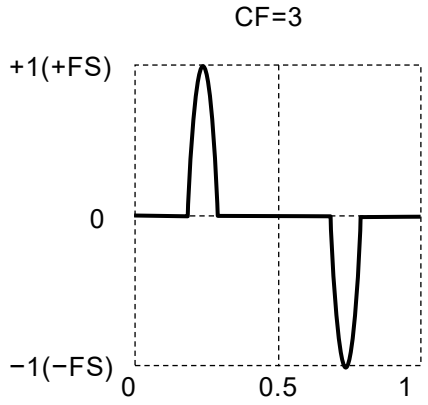
- Simulates the current waveform of a condenser input rectifier circuit

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

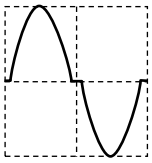
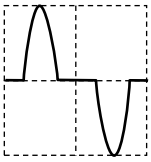
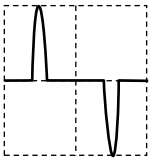
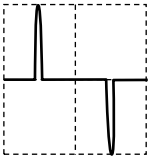
- Crest factor (Crest Factor)
  The crest factor expresses the ratio of the peak value to the effective value. At a value of 1.41, it is almost equal to the original sine wave.
  Variable range: 1.41 to 10.00

Peak value is fixed to ±FS.



■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
CF=1.5	CF=2	CF=3	CF=5

d) Angle controlled sine wave: 'Angle Ctrl Sine'

■ Overview

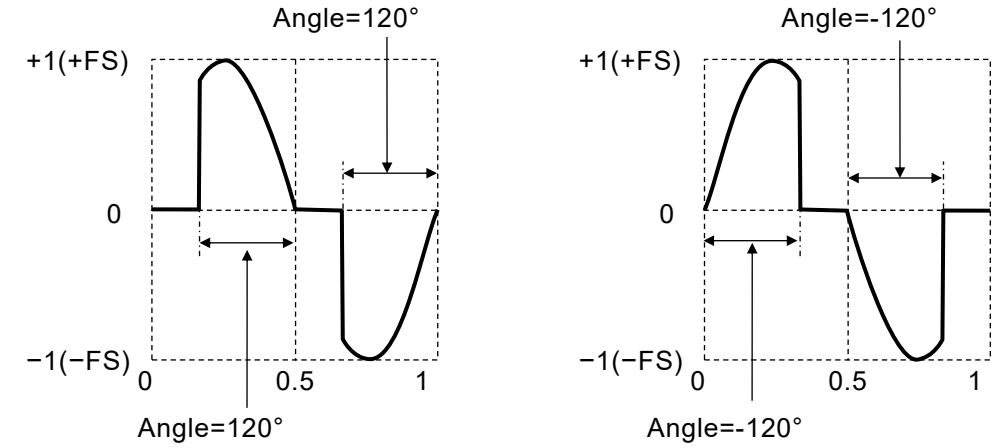
Waveform acquired by extracting only the front or back portion of each half cycle of a sine wave.

■ Application examples

- Simulates a thyristor-controlled waveform

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.



- Conduction angle (Angle)

  When the conduction angle is positive, the waveform is a sine wave with the conduction angle portion extracted from the back portion of the half cycle.

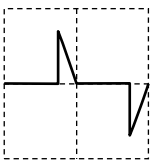
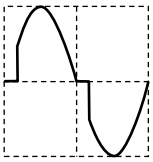
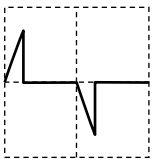
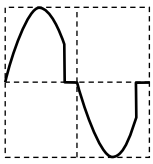
  When the conduction angle is negative, the waveform is a sine wave with the absolute value portion of the conduction angle extracted from the front portion of the half cycle.

  Variable range: −180.00° to +180.00°

The amplitude of the original sine wave is fixed to ±FS. Please note that the amplitude may be less than ±FS depending on the value of the conduction angle.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
Angle=45	Angle=150	Angle=−45	Angle=−150

e) Staircase sine wave: 'Staircase Sine'

■ Overview

This is a staircase shaped sine wave. The horizontal axis and vertical axis are divided at an equal interval.

■ Application examples

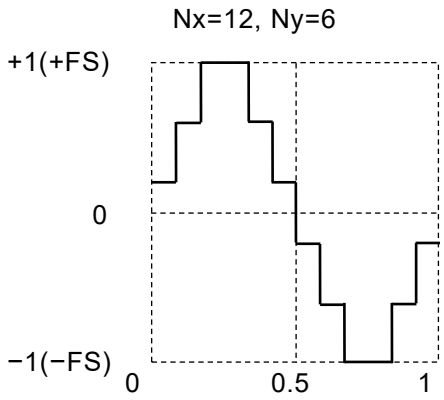
- Simulates the pseudo sine wave output waveform of an uninterruptible power supply (UPS), etc.
- Simulates a sine wave converted from analog to digital with a rough voltage and time resolution.

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

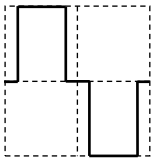
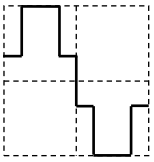
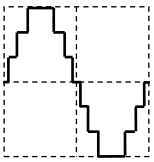
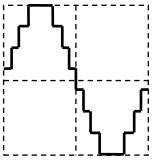
- X steps (Nx)
  The number of steps. The example on the right is a pseudo sine wave with 12 steps.
  Variable range: 2 to 1 024, or infinite 'Inf'
- Y steps (Ny)
  The number of steps. The example on the right is a pseudo sine wave with 6 steps.
  Variable range: 2 to 256, or infinite 'Inf'

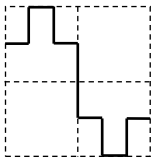
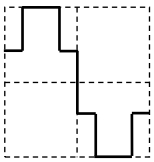
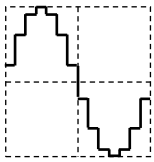
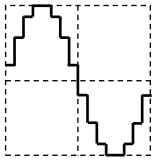
Peak value is fixed to ±FS.



■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
Nx=Inf, Ny=3	Nx=Inf, Ny=4	Nx=Inf, Ny=7	Nx=Inf, Ny=8

			
Nx=6, Ny=Inf	Nx=8, Ny=Inf	Nx=14, Ny=Inf	Nx=16, Ny=Inf

f) Multi-cycle sine wave: 'Multi-Cycle Sine'

■ Overview

Waveform acquired by continuing the sine wave for multiple cycles.

■ Application examples

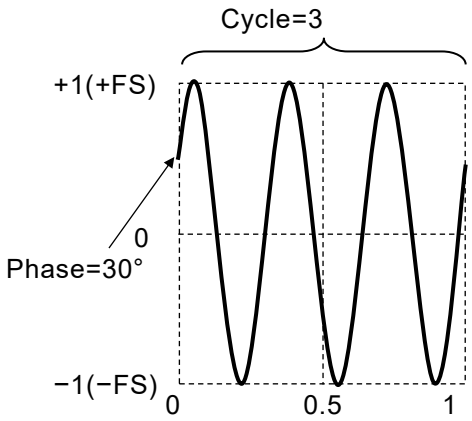
- Burst wave substitution

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

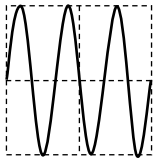
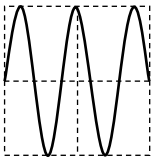
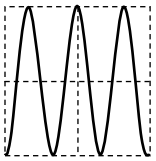
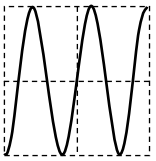
- Cycles
  The number of cycles included in one basic period.
  Variable range: 0.01 to 50.00
- Start Phase (Phase)
  The phase of the start point.
  The phase in the frequency of the above cycle multiple of the fundamental frequency.
  Variable range: −360.00° to +360.00°

Peak value is fixed to ±FS.



■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
Cycle=3 Phase=0	Cycle=2.5 Phase=0	Cycle=3 Phase=−90	Cycle=2.5 Phase=−90

6.2.2 Transient Sine Group

a) On-phase controlled sine wave: 'On-Ph Ctrl Sine'

■ Overview

Sine wave with a slope into the on state.

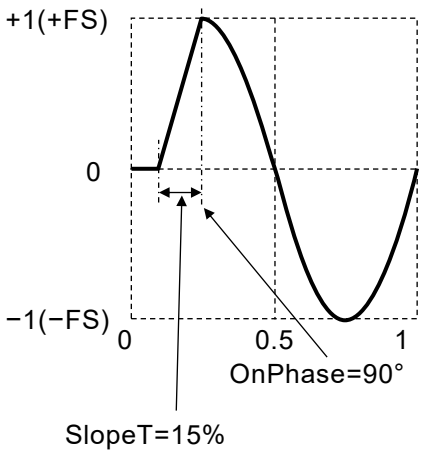
■ Application examples

- Simulates the output waveform of an AC power supply with a restricted rising and falling time

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

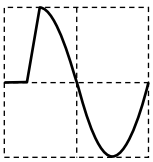
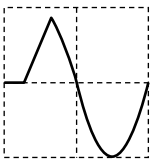
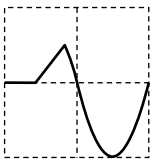
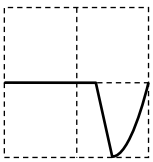
- Phase at start completion (OnPhase)
  The original sine wave starts from this phase.
  Variable range: 0.00° to 360.00°
- Starting slope time (SlopeTime)
  The linear change in time of the amplitude from the zero to the amplitude at the start completion phase.
  Variable range: 0.00% to 50.00% of basic period



The amplitude of the original sine wave is fixed to ±FS.
Please note that the amplitude may be less than ±FS depending on the value of the start completion phase.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
OnPhase=90 SlopeT=10	OnPhase=120 SlopeT=20	OnPhase=150 SlopeT=20	OnPhase=270 SlopeT=10

b) Off-phase controlled sine wave: 'Off-Ph Ctrl Sine'

■ Overview

Sine wave with a slope into the off state.

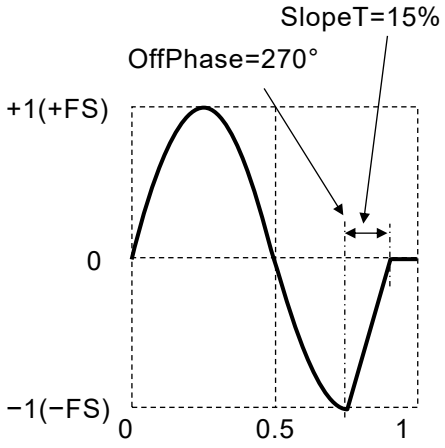
■ Application examples

- Simulates the output waveform of an AC power supply with a restricted rising and falling time

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

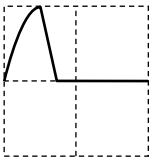
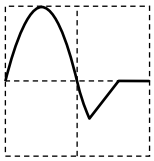
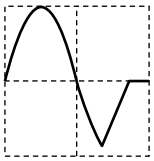
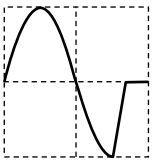
- Shut off start phase (OffPhase)
  The original sine wave ends at this phase.
  Variable range: 0.00° to 360.00°
- Shut off slope time (SlopeTime)
  The linear change in time of the amplitude from the amplitude of the shutdown start phase to the zero.
  Variable range: 0.00% to 50.00% of basic period



The amplitude of the original sine wave is fixed to ±FS.
Please note that the amplitude may be less than ±FS depending on the value of the shutdown start phase.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
OffPhase=90 SlopeT=10	OffPhase=210 SlopT=20	OffPhase=240 SlopT=20	OffPhase=270 SlopT=10

c) Chattering-on sine wave: ‘Chattering-On Sine’

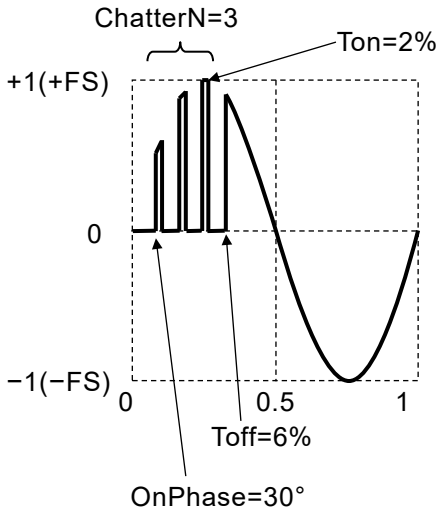
■ Overview

Sine wave with chattering into the on state.

■ Application examples

- Simulates an AC power supply output waveform which follows the chattering pattern of a switch or relay during the start of output.

■ Meaning of each parameter



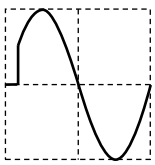
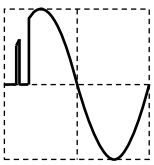
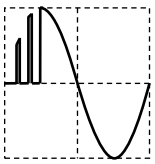
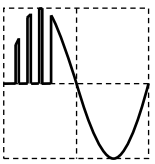
The example shows the case where the amplitude range is ‘±FS’.

- On start phase (OnPhase)
  The sine wave starts from this phase.
  It is fixed to zero before that.
  Variable range: 0.00° to 360.00°
- Number of chattering (ChatterN)
  The number of times it repeatedly turns on and off. This is on at first. The repeated on and off portions have the same time duration.
  Variable range: 0 to 20
- Time On (Ton)
  The amount of time one chatter is turned on.
  Variable range: 0.00% to 20.00% of basic period
- Time Off (Time off)
  The amount of time one chatter is turned off.
  Variable range: 0.00% to 20.00% of basic period

The amplitude of the original sine wave is fixed to ±FS. Please note that the amplitude may be less than ±FS depending on each parameter setting.

■ Waveform examples

The polarity and amplitude ranges are all ‘Normal’ and ‘±FS’.

			
OnPhase=30 ChatterN=0 Ton=2 Toff=6	OnPhase=30 ChatterN=1 Ton=2 Toff=6	OnPhase=30 ChatterN=2 Ton=2 Toff=6	OnPhase=30 ChatterN=3 Ton=2 Toff=6

d) Chattering-off sine wave: 'Chattering-Off Sine'

■ Overview

Sine wave with chattering into the off state.

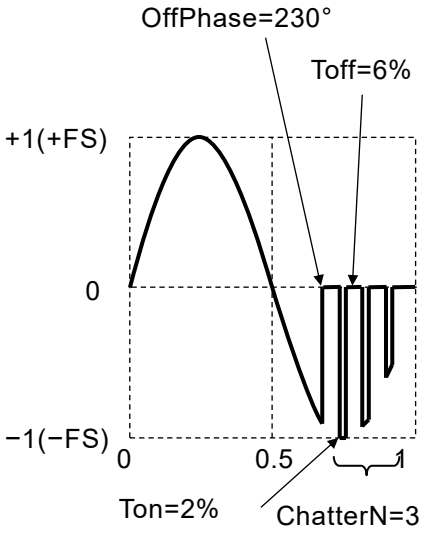
■ Application examples

- Simulates an AC power supply output waveform which follows the chattering pattern of a switch or relay during output shut off.

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

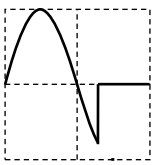
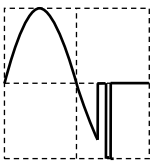
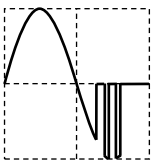
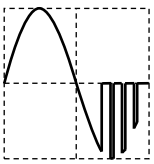
- Shut off start phase (OffPhase)
  The original sine wave begins to follow a chattering pattern from this phase as it shuts off.
  Variable range: 0.00° to 360.00°
- Number of chattering (ChatterN)
  The number of times it repeatedly turns off and on.
  This is off at first.
  The repeated on and off portions have the same time duration.
  Variable range: 0 to 20
- Time On (Time on)
  The amount of time one chatter is turned on.
  Variable range: 0.00% to 20.00% of basic period
- Time Off (Time off)
  The amount of time one chatter is turned off.
  Variable range: 0.00% to 20.00% of basic period



The amplitude of the original sine wave is fixed to ±FS. Please note that the amplitude may be less than ±FS depending on each parameter setting.

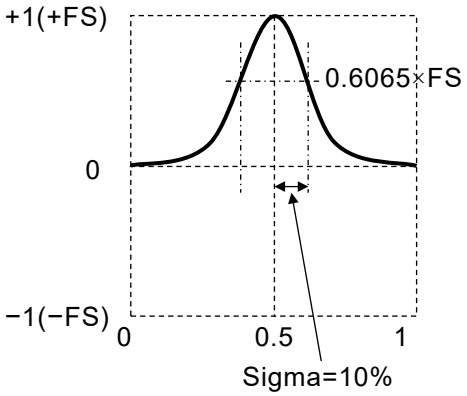
■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
OffPhase=230 ChatterN=0 Ton=2 Toff=6	OffPhase=230 ChatterN=1 Ton=2 Toff=6	OffPhase=230 ChatterN=2 Ton=2 Toff=6	OffPhase=230 ChatterN=3 Ton=2 Toff=6

6.2.3 Pulse Group

a) Gaussian Pulse: 'Gaussian Pulse'



■ Overview

Waveform with a Gaussian distribution.

■ Meaning of each parameter

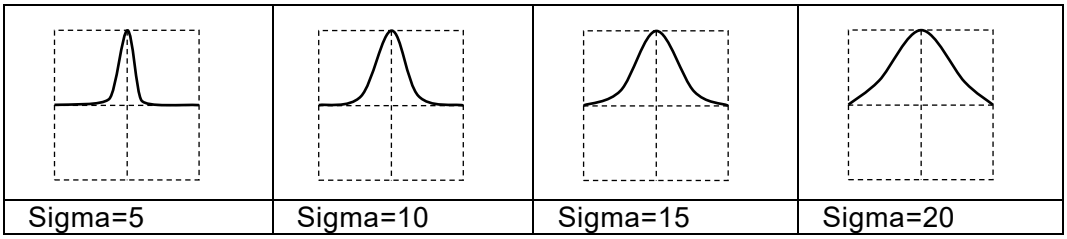
The example shows the case where the amplitude range is '0/+FS'.

- Standard deviation (Sigma)
  This is σ of the Gaussian function.
  Variable range: 0.01% to 100.00% of basic period

Peak value is fixed to +FS at the center of the horizontal axis.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.



Sigma=5	Sigma=10	Sigma=15	Sigma=20

■ Remarks

The half value width is, $2 \cdot Sigma\sqrt{2 \cdot ln(2)} \approx 2.35 \cdot Sigma$[%].

The following formula expresses x as the horizontal axis and y as the vertical axis (when the amplitude range is '0/+FS').

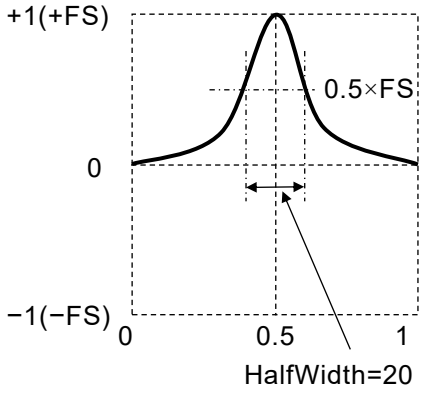
$$y = FS \cdot exp(-\frac{1}{2}\left(\frac{100}{Sigma}(x - 0.5)\right)^2)$$

At the start (x=0) and end (x=1), the y value does not decrease all the way down to zero.
Please note that the greater the standard deviation, the higher the start and end will rise above the zero level.
When sigma is16.47% or lower, the start and end will be 0.01×FS or lower.

b) Lorentz Pulse: 'Lorentz Pulse'

■ Overview

Lorentz waveform.



■ Meaning of each parameter

The example shows the case where the amplitude range is '0/+FS'.

・ HalfWidth

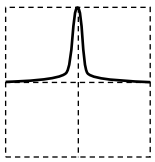
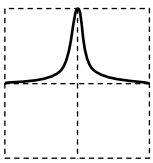
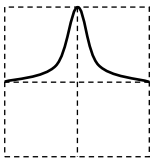
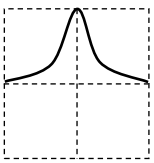
The half value width of the Lorentz function.

Variable range: 0.01% to 100.00% of basic period

Peak value is fixed to +FS at the center of the horizontal axis.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
HalfWidth=5	HalfWidth=10	HalfWidth=15	HalfWidth=20

■ Remarks

The following formula expresses x as the horizontal axis and y as the vertical axis (when the amplitude range is '0/+FS').

$$y = FS\frac{1}{1+\left(\frac{200}{HalfWidth}(x-0.5)\right)^2}$$

At the start (x=0) and end (x=1), the y value does not decrease all the way down to zero. Please note that the greater the half value width, the higher the start and end will rise above the zero level. When the half value width is 10.05% or lower, the start will be 0.01×FS or lower.

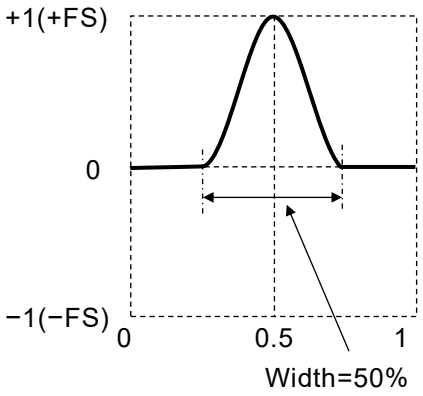
c) Haversine: 'Haversine'

■ Overview

Sin^2 pulse. This is similar to a waveform of a sine wave from the -90° to 270° range.

■ Application examples

・ Simulates an impact test device waveform



■ Meaning of each parameter

The example shows the case where the amplitude range is '0/+FS'.

・ Width

The width of one cycle of the sin^2 pulse.

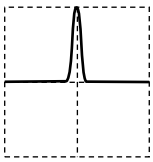
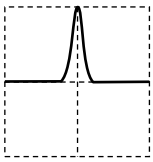
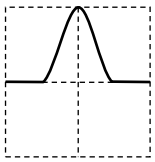
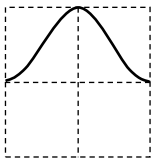
Other ranges are fixed to the zero level.

Variable range: 0.01% to 100.00% of basic period

Peak value is fixed to +FS at the center of the horizontal axis.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
Width=10	Width=20	Width=50	Width=100

■ Remarks

The half value width is Width/2 [%].

The following formula expresses x as the horizontal axis and y as the vertical axis (when the amplitude range is '0/+FS').

In the range where x is, $0.5 \pm \frac{Width}{200}$

$$y = \frac{FS}{2}\left(1 + cos\left(2\pi\frac{100}{Width}(x - 0.5)\right)\right)$$

d) Half-Sine Pulse: 'Half-Sine Pulse'

■ Overview

Sine wave half cycle pulse. A half cycle waveform of a sine wave from the 0° to 180° range.

■ Meaning of each parameter

The example shows the case where the amplitude range is '0/+FS'.

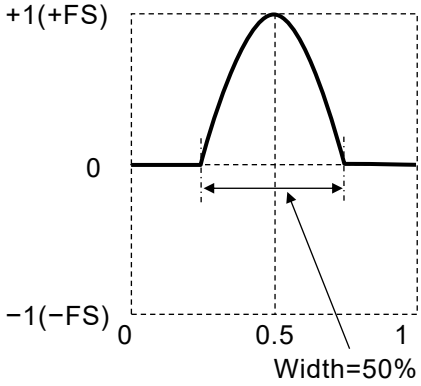
- Width

  The width of a sine wave from the 0° to 180° range.

  Other ranges are fixed to the zero level.

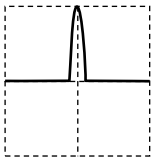
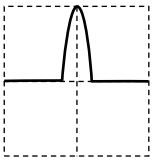
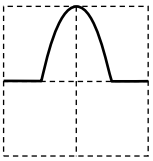
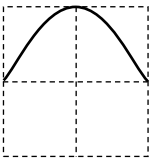
  Variable range: 0.01% to 100.00% of basic period

Peak value is fixed to +FS at the center of the horizontal axis.



■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
Width=10	Width=20	Width=50	Width=100

■ Remarks

The half value width is, 2×Width / 3 [%].

The following formula expresses x as the horizontal axis and y as the vertical axis (when the amplitude range is '0/+FS').

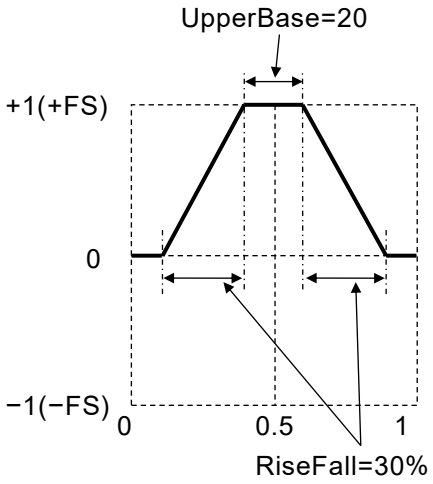
In the range where x is, $0.5 \pm \frac{Width}{200}$

$$y = FS \cdot cos\left(\pi \frac{100}{Width}(x - 0.5)\right)$$

e) Trapezoid Pulse: 'Trapezoid Pulse'

■ Overview

Trapezoid waveform pulse.



■ Meaning of each parameter

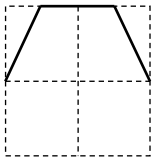
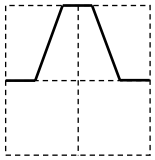
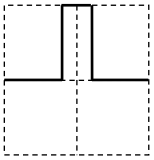
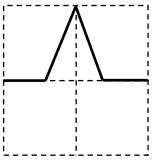
The example shows the case where the amplitude range is '0/+FS'.

- Slope width (RiseFall)
  The width of each oblique side.
  Variable range: 0.00% to 50.00% of basic period
- Upper base width (UpperBase)
  The width of the upper base.
  Variable range: 0.00% to 100.00% of basic period

The peak value is fixed to +FS at the upper base.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
RiseFall=25 UpperBase=50	RiseFall=20 UpperBase=20	RiseFall=0 UpperBase=20	RiseFall=20 UpperBase=0

■ Remarks

Please note that the start (x=0) and end (x=1) will be greater than zero when the sum of double the slope width and the upper base width exceeds 100%.

f) Sin(x)/x: 'Sin(x)/x'

■ Overview

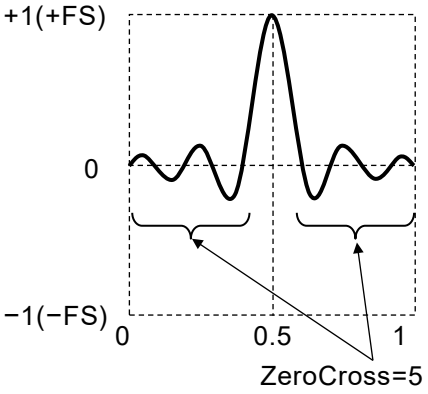
Sin(x)/x waveform. This is called the sinc function.

■ Meaning of each parameter

The example shows the case where the amplitude range is '±FS'.

- Number of zero crossings (ZeroCross)
  The number of zero crossings on one side.
  Variable range: 1 to 50

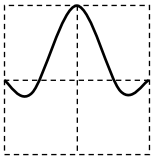
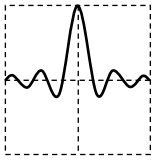
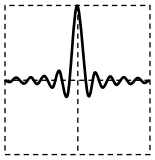
Peak value is fixed to +FS at the center of the horizontal axis.



Has a frequency band that is roughly fundamental frequency times number of zero crossings.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
ZeroCross=2	ZeroCross=5	ZeroCross=10	ZeroCross=20

■ Remarks

The following formula expresses x as the horizontal axis and y as the vertical axis (when the amplitude range is '±FS').

$$y = FS \cdot \frac{sin(\,2\pi \cdot ZeroCross \cdot (x - 0.5))}{2\pi \cdot ZeroCross \cdot (x - 0.5)}$$

6.2.4 Transient Response Group

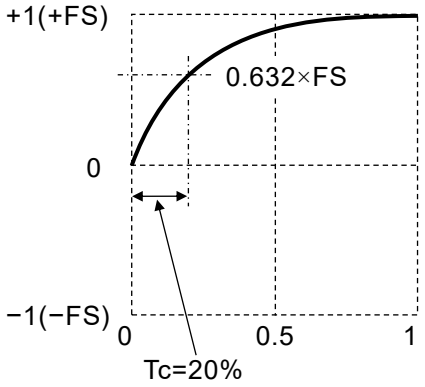
a) Exponential Rise: 'Exponential Rise'

■ Overview

First order LPF step response waveform.

■ Application examples

- Simulates a first order lag system's step output waveform



■ Meaning of each parameter

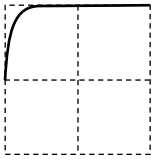
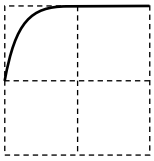
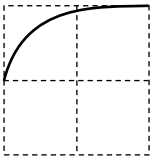
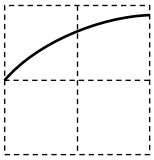
The example shows the case where the amplitude range is '0/+FS'.

- Time constant (TimeConstant)
  Time constant of the exponential function.
  Variable range: 0.01% to 100.00% of basic period

The amplitude at infinite time is +FS.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
TC=5	TC=10	TC=20	TC=50

■ Remarks

The following formula expresses x as the horizontal axis and y as the vertical axis (when the amplitude range is '0/+FS').

$$y = FS \cdot \left(1 - exp\left(-\frac{100}{TC}x\right)\right)$$

The end (x=1) does not rise up to +FS. Please note that the larger the time constant, the smaller the end value. When the time constant is 21.71% or lower, the end will be 0.99×FS or more.

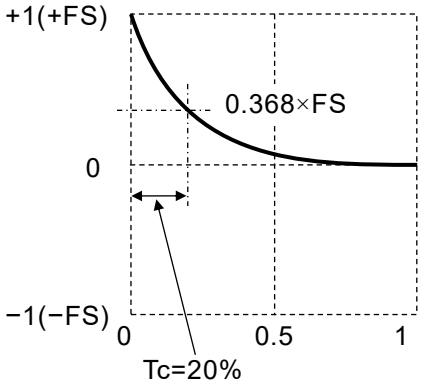
b) Exponential Fall: ‘Exponential Fall’

■ Overview

First order HPF step response waveform.

■ Application examples

- Simulates a first order lead system's step output waveform



■ Meaning of each parameter

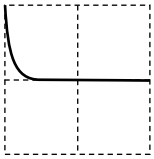
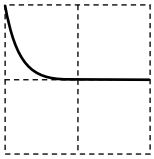
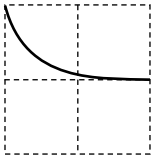
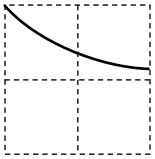
The example shows the case where the amplitude range is ‘0/+FS’.

- Time constant (TimeConstant)
  Time constant of the exponential function.
  Variable range: 0.01% to 100.00% of basic period

The start begins from +FS.

■ Waveform examples

The polarity and amplitude ranges are all ‘Normal’ and ‘0/+FS’.

			
TC=5	TC=10	TC=20	TC=50

■ Remarks

The following formula expresses x as the horizontal axis and y as the vertical axis (when the amplitude range is ‘0/+FS’).

$$y = FS \cdot exp\left(-\frac{100}{TC}x\right)$$

The end (x=1) does not decrease all the way down to zero. Please note that the larger the time constant, the larger the end offset. When the time constant is 21.71% or lower, the end will be 0.01×FS or lower.

c) Second order LPF step response: '2nd Ord LPF Step'

■ Overview

Second order LPF step response waveform.

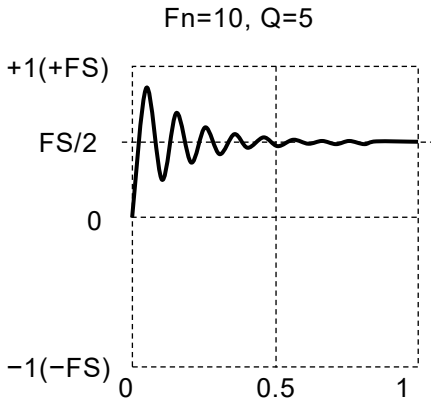
■ Application examples

- Simulates the step output waveform of a transmission system accompanied by ringing and over shooting

■ Meaning of each parameter

The example shows the case where the amplitude range is '0/+FS'.

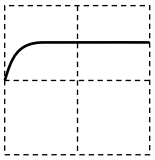
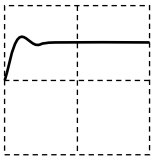
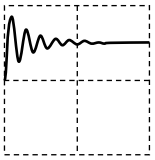
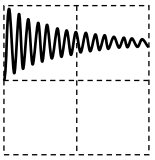
- Natural frequency of the LPF (Frequency natural)
  The frequency of the oscillation component is lower than Fn.
  Variable range: 1.00 to 50.00 times fundamental frequency
- LPF Q (Quality factor)
  The oscillation component will disappear when the Q is 0.5.
  Variable range: 0.50 to 50.00



The amplitude at infinite time is FS/2. The peak value is less than +FS.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
Fn=5 Q=0.5	Fn=5 Q=1	Fn=10 Q=5	Fn=15 Q=20

■ Remarks

The oscillation frequency is expressed in the following formula (fundamental frequency standard).

$$Fn \cdot \sqrt{1 - \frac{1}{4 \cdot Q^2}}$$

d) Damped Oscillation: ‘Damped Oscillation’

■ Overview

Oscillation waveform with an amplitude that dampens exponentially. An oscillation waveform with an amplitude that increases exponentially can also be created.

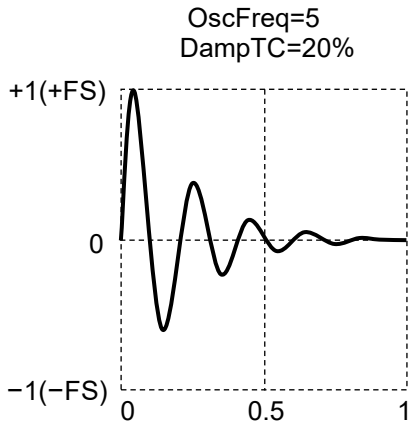
■ Application examples

- Simulates a pulse response waveform with oscillation

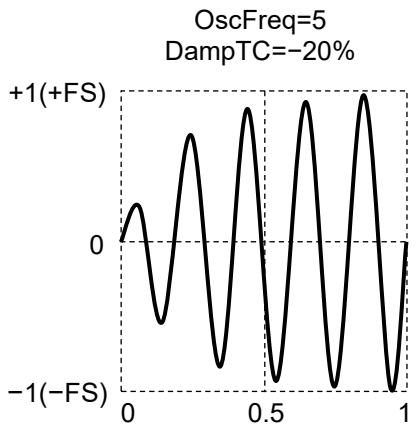
■ Meaning of each parameter

The example shows the case where the amplitude range is ‘±FS’.

DampTC is positive



DampTC is negative

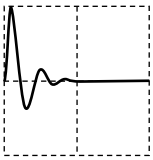
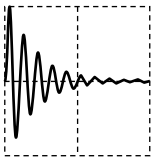
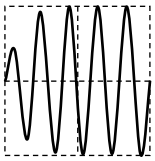
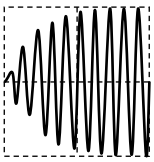


- Oscillation frequency (OscFreq)
  Variable range: 0.01 to 50.00 times fundamental frequency
- Damped oscillation time constant (Damp TimeConstant)
  The oscillation exponentially dampens with this time constant when positive.
  The oscillation exponentially increases with this time constant when negative.
  Variable range: −100.00% to +100.00% of basic period

The peak value is fixed to +FS when the damped oscillation time constant is positive.
The oscillation is ± FS over an infinite time when the damped oscillation time constant is negative.

■ Waveform examples

The polarity and amplitude ranges are all ‘Normal’ and ‘±FS’.

			
OscFreq=5 DampTC=10	OscFreq=10 DampTC=20	OscFreq=5 DampTC=−10	OscFreq=10 DampTC=−20

6.2.5 Surge Group

a) Oscillation Surge: 'Oscillation Surge'

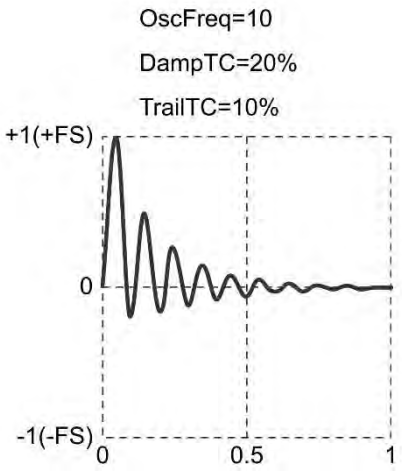
■ Overview

Simulates a surge waveform with damped oscillation.

The step response waveform of a cascade connection circuit with a first order HPF and a second order LPF.

■ Application examples

- Simulates a surge waveform superimposed on a power supply
- Simulates the rush current waveform of a power supply



■ Meaning of each parameter

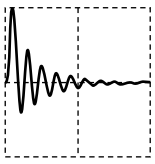
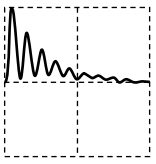
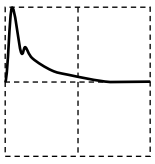
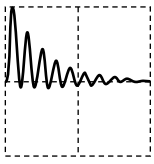
The example shows the case where the amplitude range is '±FS'.

- Oscillation frequency (OscFreq)
  Variable range: 0.01 to 50.00 times fundamental frequency
- Damped oscillation time constant (Damp TimeConstant)
  The amplitude of the oscillation component exponentially attenuates with this time constant.
  Variable range: 0.01% to 100.00% of basic period
- Trailing time constant (Trail TimeConstant)
  Damping time constant of the waveform without the oscillation component (first order HPF time constant).
  Variable range: 0.01% to 100.00% of basic period

Peak value is fixed to +FS. Please note that the amplitude also oscillates in the negative direction.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '±FS'.

			
OscFreq=10 DampTC=20 TrailTC=5	OscFreq=10 DampTC=20 TrailTC=30	OscFreq=10 DampTC=5 TrailTC=20	OscFreq=10 DampTC=30 TrailTC=20

b) Pulse Surge: 'Pulse Surge'

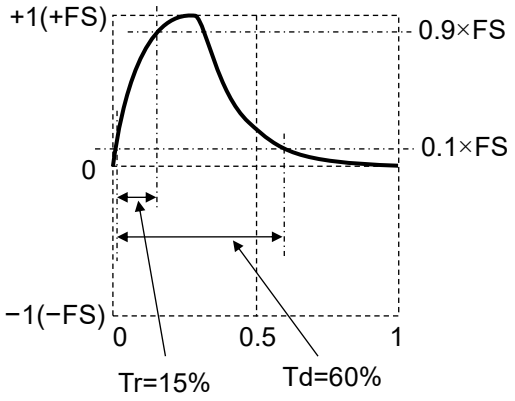
■ Overview

Simulates a surge waveform. Does not have an oscillation component.

■ Application examples

・ Simulates the transient voltage waveform of a car battery

■ Meaning of each parameter



The example shows the case where the amplitude range is '0/+FS'.

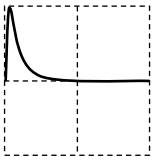
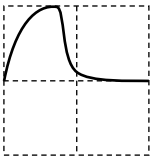
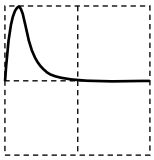
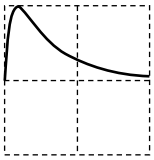
・ Rising time (Time raise)
  Time for the amplitude to change from 10% to 90% of the peak value.
  Variable range: 0.01% to 100.00% of basic period

・ Time duration (Time duration)
  Pulse width with an amplitude 10% or greater of the peak value.
  Variable range: 0.01% to 100.00% of basic period

Peak value is fixed to +FS.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
Tr=1 Td=20	Tr=20 Td=50	Tr=5 Td=30	Tr=5 Td=80

■ Remarks

The prescribed waveform will not be created unless the condition that approx. 1.839 ＜ Td / Tr is satisfied.

The end does not decrease all the way down to zero. Please note that the greater the time duration, the higher the end will rise above the zero level.

6.2.6 Other Waveform Group

a) Trapezoid wave with Offset: 'Trapezoid with Offset'

■ Overview

Trapezoid wave with an offset in the amplitude direction.

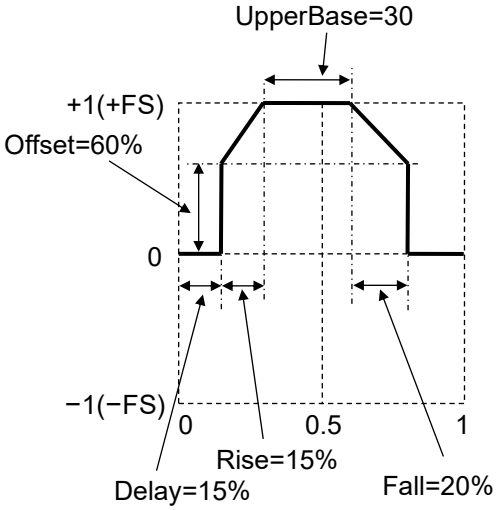
■ Application examples

- Simulates the various voltages and current waveforms of a switching power supply circuit

■ Meaning of each parameter

The example shows the case where the amplitude range is '0/+FS'.

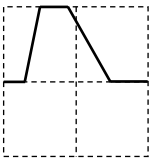
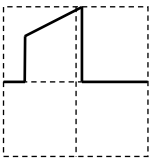
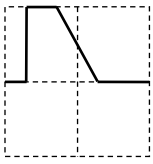
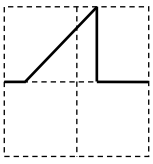
- Leading delay (Delay)
  The rising start position of the trapezoid wave.
  Variable range: 0.00% to 100.00% of basic period
- Rising slope width (Rise)
  The width of the rising portion.
  Variable range: 0.00% to 100.00% of basic period
- Upper base width (UpperBase)
  The width of the upper base.
  Variable range: 0.00% to 100.00% of basic period
- Falling slope width (Fall)
  The width of the falling portion.
  Variable range: 0.00% to 100.00% of basic period
- Offset
  The amplitude direction offset of the entire trapezoid.
  Variable range: 0.00% to 100.00% of basic period



The peak value is fixed to +FS at the upper base.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
Delay=15 Rise=10 UpperBase=20 Fall=30 Offset=0	Delay=15 Rise=40 UpperBase=0 Fall=0 Offset=60	Delay=15 Rise=0 UpperBase=20 Fall=30 Offset=0	Delay=20 Rise=40 UpperBase=0 Fall=0 Offset=0

b) Half-Sine Edge Pulse: ‘Half-Sine Edge Pulse’

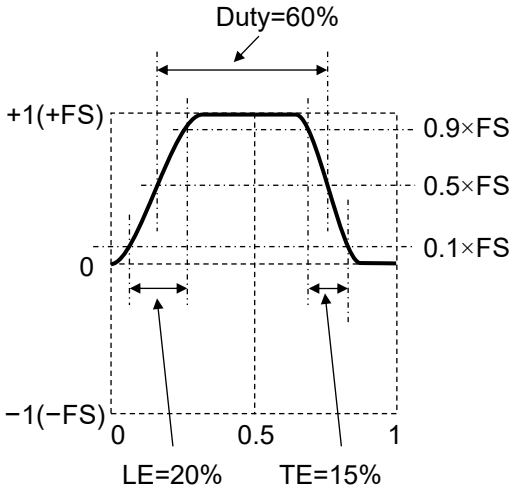
■ Overview

Pulse wave with variable rising time, falling time, and pulse width duty.

The rising and falling shapes are half-sine wave shapes (half cycle of a sine wave), similar to when ‘COS’ is selected as the transition waveform with the standard waveform pulse wave.

■ Application examples

- To replace pulse waves in sequence oscillation (load into arbitrary waves and use)



■ Meaning of each parameter

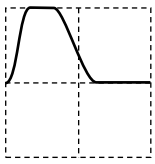
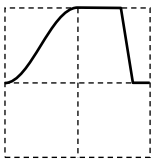
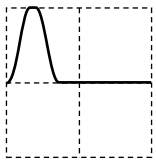
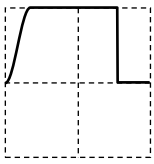
The example shows the case where the amplitude range is ‘0/+FS’.

- Rising time (LeadingEdge time)
  Time for the amplitude to change from 10% to 90% of the peak value.
  Variable range: 0.00% to 100.00% of basic period
- Trailing time (TrailingEdge time)
  Time for the amplitude to change from 90% to 10% of the peak value.
  Variable range: 0.00% to 100.00% of basic period
- Duty
  Pulse width duty with an amplitude 50% or greater of the peak value.
  Variable range: 0.00% to 100.00% of basic period

Peak value is fixed to＋FS.

■ Waveform examples

The polarity and amplitude ranges are all ‘Normal’ and ‘0/+FS’.

			
LE=10 TE=20 Duty=40	LE=30 TE=5 Duty=60	LE=10 TE=10 Duty=20	LE=10 TE=0 Duty=70

■ Remarks

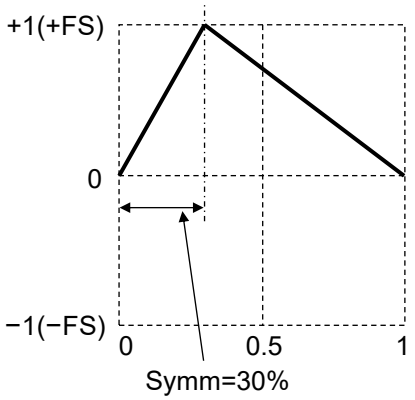
The prescribed waveform will not be created unless the following formula is satisfied.

$0.85\times(LE + TE) \leq Duty \leq 100 - 0.85\times(LE + TE)$

c) Bottom Referenced Ramp: 'Bottom Referenced Ramp'

■ Overview

Ramp wave with bottom level as reference



■ Meaning of each parameter

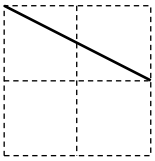
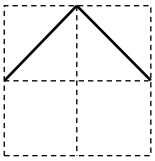
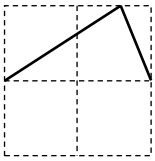
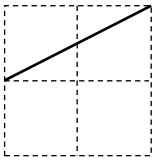
The example shows the case where the amplitude range is '0/+FS'.

- Symmetry (Symmetry)
  The ratio of the rising portion.
  Variable range: 0.00% to 100.00% of basic period

Peak value is fixed to＋FS.

■ Waveform examples

The polarity and amplitude ranges are all 'Normal' and '0/+FS'.

			
Symm=0	Symm=50	Symm=80	Symm=100

■ Remarks

The phase 0º point is fixed to the bottom level except when the symmetry is 0%.

In a standard ramp wave, the phase 0º point is fixed to the amplitude's center zero point. ☞ P.4-56

d) Double pulse: ‘Double pulse’

■ Overview

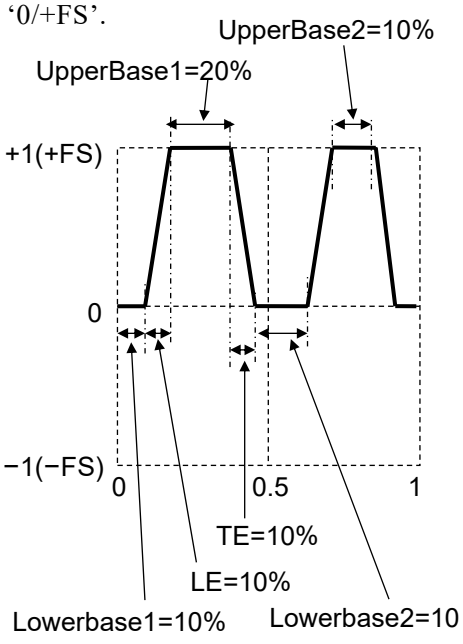
This is a pulse of 2 waves. Rising and falling are both linear.

■ Application examples

- Measure the switching characteristics of MOSFET

■ Meaning of each parameter

The example shows the case where the amplitude range is ‘0/+FS’.

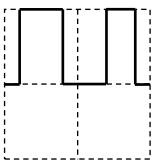
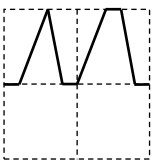
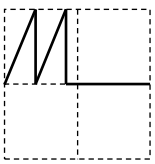
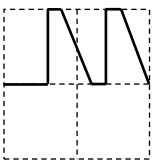


- Rising slope time (LeadingEdge time)
  This is the leading edge time.
  Variable range: 0.00% to 100.00% of basic period
- Falling slope time (TrailingEdge time)
  This is the trailing edge time.
  Variable range: 0.00% to 100.00% of basic period
- Lower Base 1 (LowerBase1)
  This is the width of the lower base of the first wave.
  Variable range: 0.00% to 100.00% of basic period
- Upper Base 1 (UpperBase1)
  This is the width of the upper base of the first wave.
  Variable range: 0.00% to 100.00% of basic period
- Lower Base 2 (LowerBase2)
  This is the width of the lower base of the second wave.
  Variable range: 0.00% to 100.00% of basic period
- Upper Base 2 (UpperBase2)
  This is the width of the upper base of the second wave.
  Variable range: 0.00% to 100.00% of basic period

The peak value is fixed to +FS at the upper base. Please note that the end will be greater than zero if ((LE+TE) × 2 + other parameters) exceeds 100%.

■ Waveform examples

The polarity and amplitude ranges are all ‘Normal’ and ‘0/+FS’.

			
LE=0 TE=0 LowerBase1=10 UpperBase1=30 LowerBase1=30 UpperBase2=20	LE=20 TE=10 LowerBase1=10 UpperBase1=30 LowerBase1=10 UpperBase2=10	LE=20 TE=0 LowerBase1=0 UpperBase1=0 LowerBase1=0 UpperBase2=0	LE=0 TE=20 LowerBase1=10 UpperBase1=10 LowerBase1=10 UpperBase2=10

7. Creating Arbitrary (ARB) Waveforms

7.1 Basics of arbitrary waveform (ARB)

There are mainly the following two methods to create arbitrary waveforms:

- Enter waveform data from the panel
- Use the arbitrary waveform editing software to create arbitrary waveforms on a personal computer

This section describes the method to create arbitrary waveforms by performing operations on the panel of the main unit.

Before doing so, you need to understand some points about the arbitrary waveforms of this product.

For information on using arbitrary waveforms, please refer to ☞ P.4-60.

■ Two types of data formats

There are the following two types of data formats for the arbitrary waveform data of this product:

- Array format: “Raw”

  The data sequence corresponding to the address of a waveform memory.

  This is the data format for using a waveform acquired with an oscilloscope as an arbitrary waveform.

  Waveform data in text format imported by the oscilloscope can be transferred to this product using the arbitrary waveform editing software.

  Array format data cannot be created or edited on the panel. Also, it cannot be copied to edit memory.

  Waveform length of the array format is 16 words to maximum waveform length.

  Can be specified in 1 word units. (For maximum waveform length, See ☞ P.17-2)

  Maximum frequency is limited by waveform length and maximum sample rate. ☞ P.7-3

  When high frequency is required or to reduce the time to switch waveforms, reduce waveform length as much as possible.

- Control point format: “Point”

  A waveform is created by linearly interpolating between specified points (control points).

  A waveform can be created or edited manually from the panel.

  The data value for each memory address cannot be specified directly.

  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 cycle and its amplitude direction is fixed to ±1 (equivalent to ±FS of waveform memory).

  According to the set frequency (sweep range/modulation range/ upper limit of setting range when using synclator), output waveform data is automatically generated taking into account the maximum sample rate.

  Therefore, high time resolution can be obtained with lightweight data, and the upper frequency limit is not limited by the waveform length.

  In addition, if there are isolated steps in the data, the waveform is output after adjustment to obtain a much higher time resolution than the sample rate of the instrument.

■ Relationship between waveform length, frequency, and sampling frequency

The period of the waveform is an inverse number of the frequency of the waveform. The sample period is an inverse number of the sample frequency. In array format, setting by the waveform frequency, waveform period, sample frequency, and sample period are possible.

・ Array format: 'Raw'

The highest frequency at which all data points are played is (maximum sample rate) / (waveform length). Higher frequencies cannot be set. (For maximum sample rate, See ☞ P.17-2) In addition, due to system limitetions, when the sample rate is 109MS/s or higher or less than 15mS/s, the jitter will gradually increase.

The approximate relationship between sample rate and jitter is shown in the table below.

Table 7-1 ARB sample rate and jitter in array format (calculated value)

Sample rate [MS/s]	≤ 109	≤ 120	≤ 200	≤ 220	≤ 240
Jitter [ps rms]	10	50	60	110	200

・ Control point format: 'Point'

There is no restriction on the frequency setting based on data, but generates waveform data to be output according to the set frequency (sweep range/ modulation range/ upper limit of setting range when using synclator) and takes into account the maximum sample rate.

Therefore, the higher the set frequency, the lower the quality of the waveform. The sampling frequency is set automatically inside the unit.

■ Save location of arbitrary waveforms

There are the following three save locations for ARB data (separate from the output waveform memory for each channel). Each memory below is shared by 2 channels in WF1984/WF1982.

・ Internal storage memory

This is non-volatile memory to save arbitrary waveforms. Identified by a number from 1 to 4096. Up to 4 096 waves, a total of approximately 4Gi words of arbitrary waveforms can be stored. The arbitrary waveform data can be saved in either array format or control point format. The waveforms saved here can be used as the main/sub output waveforms, transition waveforms when pulse waveform is selected as the main output, and waveforms used in each step of sequence oscillation mode. For the memory capacity required for saving, ☞ P.7-18.

・ Edit memory

This is volatile memory to create an arbitrary waveform in the control point format. When identifying this memory by number, use 0. You can change the number of control points between 2 and 10 000 points. When creating/editing an arbitrary waveform on the panel, you are operating the data in this edit memory. Only one waveform can be handled in the edit memory. It is not possible to copy waveforms in array format to the edit memory.

・ External USB flash drive

Arbitrary waveform data can be copied back and forth between this memory and the internal storage memory and edit memory. Arbitrary waveforms stored in USB flash drive cannot be directly output or directly edited in the unit. In order to edit or output the waveforms, first copy them to the edit memory or internal memory.

■ Selection of arbitrary waveforms to be output

When setting a waveform as an arbitrary waveform in the Oscillator setting screen, you can select a waveform in internal memory or the edit memory. ☞ P.4-60

The selected waveform is written to the output waveform memory.

If you select an output waveform in the edit memory, the waveform you are creating/editing appears as is in the output.

When used as a sub waveform (☞ P.4-123), it is adjusted to 4 096 points, and when used as a pulse transition waveform (☞ P.4-55) it is adjusted to 2 048 points and interpolated in real time.

■ ARB and amplitude settings

When an arbitrary waveform is selected, the set amplitude value is output if the waveform data of the selected arbitrary waveform contains a value that reaches ±FS.

Note that if this is not the case, the amplitude of the output signal will not reach the set amplitude [Vp-p]. Also, note that if the frequency is high and the peak waveform that reaches ±FS is sharp, the amplitude may be reduced depending on the output bandwidth.

■ Output frequency bandwidth

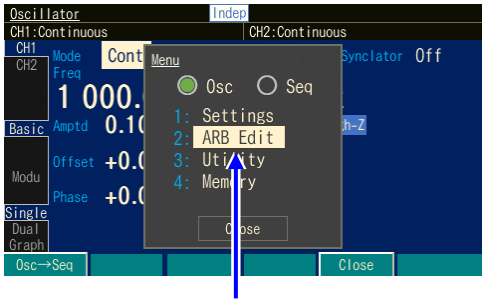
The main output bandwidth when selecting arbitrary waveform is approximately 40MHz.

Therefore, the set waveform will be output limited to that bandwidth.

Therefore, when the sample rate is high, the stepped parts in the original data in the “array format” waveform will be smoothly connected due to the band limit. On the other hand, when the sample rate is low, the staircase part will be noticeable.

7.2 Overview of Screen for Creating/Editing arbitrary waveforms

An arbitrary waveform is created or edited in the ARB Edit screen. Only arbitrary waveforms in control point format are applicable.



Select “2: ARB Edit”

1. Press the MENU key to open the top menu. Select “2: ARB Edit” (☞ P.4-14), the ARB Edit screen will be displayed. You can also use the numeric keypad 2.

2. The ARB Edit screen has 2 types of display formats. They are a list display, which displays values side by side, and a graph display. You can switch between displays using the tabs on the far left of the screen.

“Index” field shows the control point numbers, beginning with 0. The start point is fixed to “X” = 0.000 000 000. Also, the end point is fixed to “X” = 1.000 000 000, and the pair of “Y” values for both the start and end points will be the same value (same point).

If an output waveform is set to the arbitrary waveform in the edit memory, the waveform being created appears as is in the output. If the output is set to another waveform, when you select the [Apply] button (For WF1984/WF1982, use the [CH1] and [CH2] buttons to reflect on the corresponding channel) and press the ENTER key, the setting of output waveform is changed to the arbitrary waveform in the edit memory, and the waveform being created appears in the output. Once [Apply] executed, the editing results will be reflected immediately.

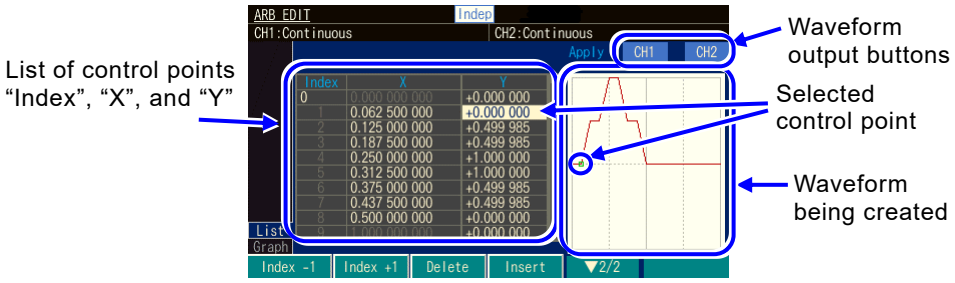
■ List display

List display shows the waveform being created and a list of control points.

Select the “X” value and “Y” value of the control point in the “Index” field or list using the modify knob and arrow keys (☞ P.4-14) to open the input field. You can specify numerical values in those fields. ☞ P.4-16, 4-17

If you change the value in the “Index” column, 10 points from that point will be listed.

The shape of the waveform is created by setting “X” and “Y” values for each control point.

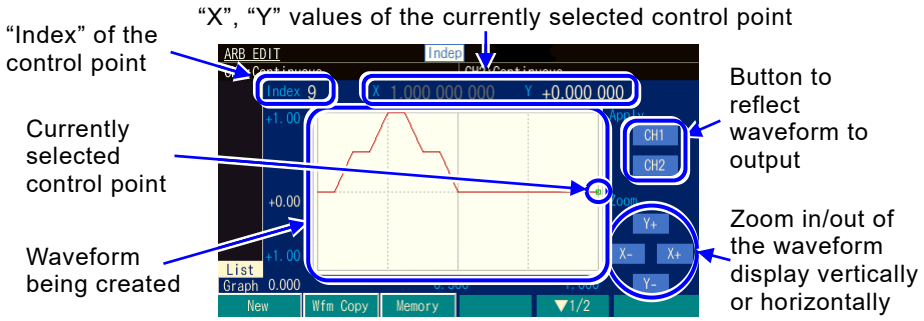


■ Graph display

Graph display shows the waveform being created in an enlarged state. The “X” and “Y” values of the one selected control point are displayed.

As with the list display, the shape of the waveform is created by setting the “X” and “Y” values for each control point.

The waveform display can be expanded/reduced around the current control point. To do so, select the [Y+], [X-], [X+], [Y-] button (☞ P.4-14) on the screen.



■ Soft keys

First row ([▼1/2] is displayed to the right side)

[New]: Clears the edit memory and initializes its state.
In the confirmation dialog, you can specify the number of control points after initialization.

[Wfm Copy]: Copies a standard waveform in to the edit memory.
A dialog opens to select the standard waveform to copy.

[Memory]: Transitions to the screen where you can save the waveform in the edit memory or recall the ARB waveform to the edit memory. ☞ P.7-10, 7-12

Second row ([▼2/2] is displayed to the right side)

[Index −1]: Decrements the value of “Index” by one. (Selects the next control point)

[Index +1]: Increments the value of “Index” by one. (Selects previous control point)

[Delete]: Deletes the selected control point.

[Insert]: Inserts a new control point between the selected control point and the control point just before the selected point.

■ Necessity of storing edit memory data

Arbitrary waveform data on edit memory that is being created or edited will be lost if the power supply is cut off while the power is on. Please save it if necessary. ☞ P.7-10

7.3 Creating New arbitrary waveform

There are the following three methods to create new arbitrary waveforms:

・Completely from the beginning

First, press the [New] soft key to clear the edit memory. Then, enter the control points. The next section ☞ P.7-8 describes an example of creation.

・Based on the standard waveform by making modifications

First, press the [Wfm Copy] soft key to copy a standard waveform to the edit memory. (PWF is also available) Then, modify the control points.

How to operate control points is the same as the case of creating a new arbitrary waveform completely from the beginning.

However, the 'Noise' and 'DC' of the standard waveform cannot be copied. In addition, 'Square' wave is copied as ideal square waves that keep their duty.

In WF1984/WF1982, the current value of the active channel (☞ P.4-24) is used for parameters other than the specified waveform (such as duty).

・Based on a saved arbitrary waveform by making modifications

First, press the soft key [Memory] to move to the screen for saving/reading arbitrary waveforms. (For recalling saved waveforms, see ☞ P.7.7)

Select the source waveform there and press the soft key [Recall] to copy the saved arbitrary waveform to the edit memory. (Only available in control point format ☞ P.7-2)

Then, modify the control points.

How to operate control points is the same as the case of creating a new arbitrary waveform completely from the beginning.

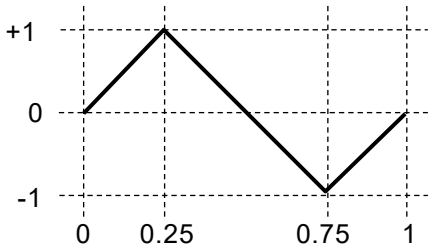
Note that if the power supply is cut off while the power is on, the contents of the edit memory will be lost. ☞「■ **Necessity of storing edit memory data**」

7.4 Example of Creating Simple arbitrary waveform

In this section, we will actually create a simple arbitrary waveform. The procedure is explained using list format display.

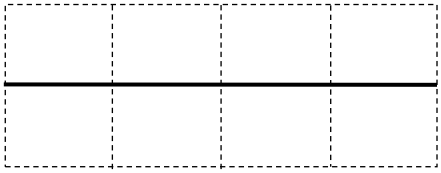
The arbitrary waveform to be created is a triangular wave as shown below.

The number of control points in this waveform is 3, but we will start with 2 and increase to 3 by adding more points along the way.



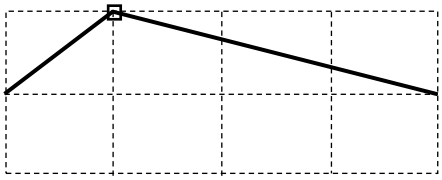
1. Press the [New] soft key and set the number of control points to 2. The settings will be as follows.

Index	X	Y
0	0.000 000 000	+0.000 000
1	0.500 000 000	+0.000 000
2	1.000 000 000	+0.000 000



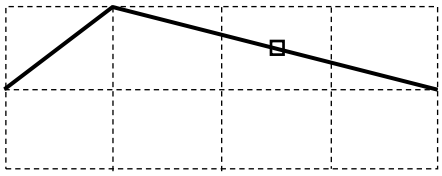
2. Change the settings of Index=1 to X=0.25 and Y=+1.

Index	X	Y
0	0.000 000 000	+0.000 000
1	**0.250 000 000**	**+1.000 000**
2	1.000 000 000	+0.000 000



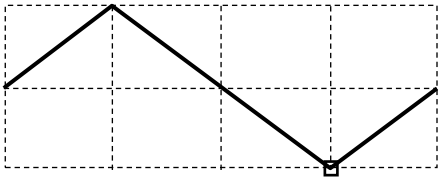
3. Select the Y value field in the last row (Index=2, X=1) and press the soft key [Insert] The control point of X=0.625 000 000 and Y=+0.499 985 is newly created. The values rounded to 16-bit resolution are displayed as the Y values, assuming ±32 767 to be ±1.

Index	X	Y
0	0.000 000 000	+0.000 000
1	0.250 000 000	+1.000 000
2	**0.625 000 000**	**+0.499 985**
3	1.000 000 000	+0.000 000



4. Change the settings of Index=2 to X=0.75 and Y=−1. This completes the procedure.

Index	X	Y
0	0.000 000 000	+0.000 000
1	0.250 000 000	+1.000 000
2	**0.750 000 000**	**−1.000 000**
3	1.000 000 000	+0.000 000

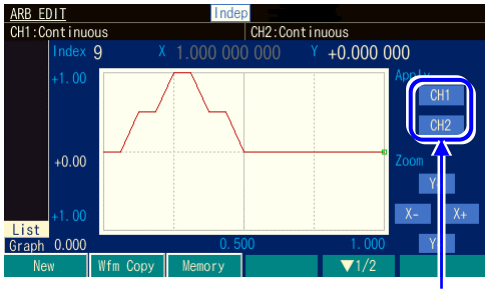


Note that if the power supply is cut off while the power is on, the contents of the edit memory will be lost. ☞ 「■ **Necessity of storing edit memory data**」

Check

- The 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.
- The Y value is rounded to 16-bit resolution.
- To change the Y value to the form of a step, set the variation width between adjacent X values to the minimum value of 0.000 000 001.

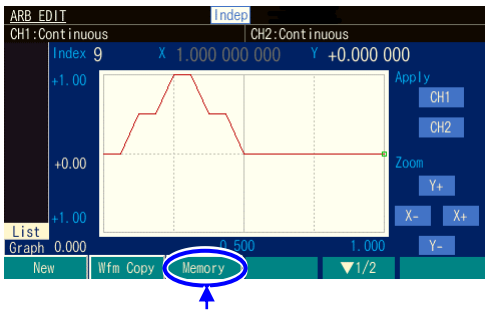
7.5 Outputting Created arbitrary waveform



Select [CH1] or [CH2] and press ENTER to output the waveform. For WF1983/WF1981, press [Apply]

If the ARB Edit screen is not displayed, press the (MENU) key and numeric keypad (2) to display the ARB Edit screen.
Select the channel to be assigned to the output using the [CH1]/[CH2] buttons ([Apply] in WF1983/1981) at the top right of the screen and press the (ENTER) key to output the waveform being created.

7.6 Saving Created arbitrary waveform



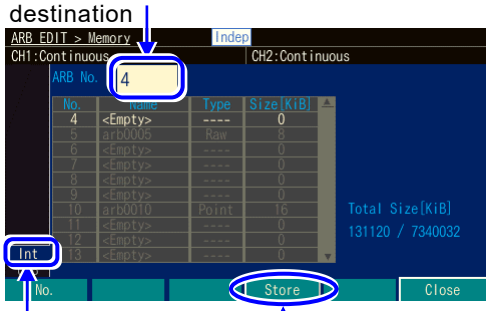
Press the [Memory] soft key to save

Press the MENU key and numeric keypad 2 to display the ARB Edit screen.
Pressing the [Memory] soft key switches to a screen for reading, saving, and file operations.
On this screen, you can select the unit's internal memory or USB flash drive as the save destination.

7.6.1 Saving to Internal Memory

You can save the contents of the edit memory to the internal memory. You can also delete and rename arbitrary waveform data in the internal memory.

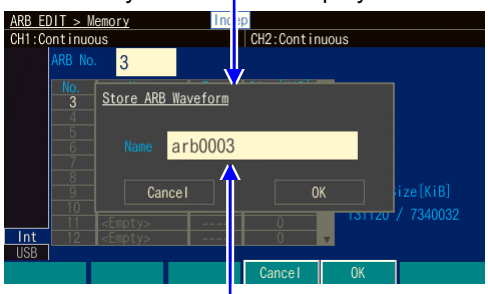
Select the memory number of the save destination



Select "Int" and press the ENTER key

Press the [Store] soft key

The dialog to enter the name of the arbitrary waveform is displayed



Enter a name for the arbitrary waveform, select the [OK] soft key, and press the ENTER key, the waveform data is saved

1. When "Int" at the bottom left of the screen is selected, the data will be saved to the internal memory. If "USB" is selected, select "Int" and press the ENTER key.

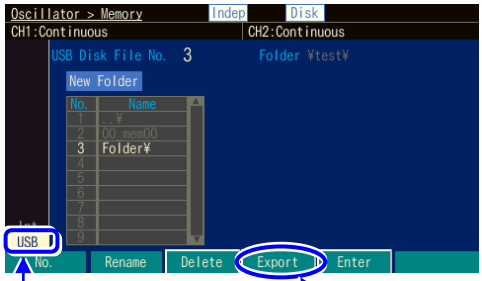
2. Select "ARB No." field. ☞ P.4-14 You can also use [No.] soft key. Enter the save destination waveform memory number between 1 and 4 096. ☞ P.4-16, 4-17
[Store] soft key to display the dialog for entering a name.
Delete an existing waveform memory with the [Delete] soft key, and rename it with the [Rename] soft key.

3. Select "Name" field (☞ P.4-14) in the dialog, an iput field for arbitrary waveform name will open. Set the arbitrary waveform name in this field. ☞ P.4-19

4. To save, select [OK] on the dialog and press the ENTER key. You can also use [OK] soft key. The arbitrary waveform will be saved and the previously saved waveform in that memory number will be overwritten.

7.6.2 Saving to USB flash drive

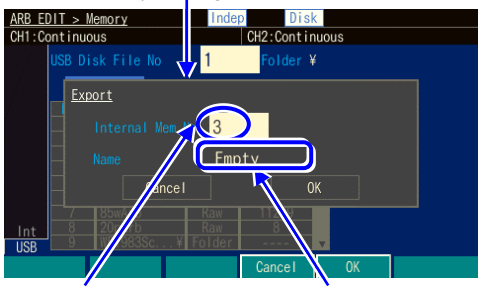
You can copy the waveform in edit memory or wavforms saved in internal wave memory to USB flash drive. For operations using USB flash drive, See also, ☞ P.5-7.



Select “USB” and press the ENTER key

Press [Export] soft key

A export (to USB flash drive) dialog opens



Waveform number of the save source

Enter the file name in the “Name” field

1. When “USB” at the bottom left of the screen is selected, the data will be saved to the USB flash drive. If “Int” is selected, select “USB” and press the ENTER key. Connect the USB flash drive to the unit. ☞ P.3-2

2. Navigate to the destination folder if necessary.
   Select the “USB Disk File No.” field (☞ P.4-14) to open the input field of the setting target file number. You can also use [No.] soft key.
   In this field, select a folder. Select a folder (name with “¥” at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7

3. Press soft key [Export] to display the waveform export dialog.
   Specify the internal memory number of the export source in the “Internal Mem No.” field. ☞ P.4-16, 4-17
   Specify 0 to use the edit memory as the export source. A number other than 0 indicates the internal memory number.

4. Specify the file name to save in the “Name” field of the dialog. The arbitrary waveform name of the save source is set as the initial value. Rename the file if necessary. ☞ P.4-19

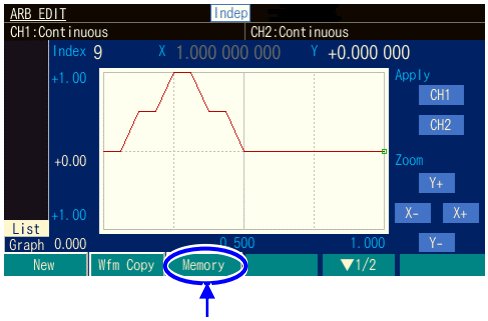
5. To export, select [OK] on the dialog and press the ENTER key. You can also use [OK] soft key. If a file with the specified file name already exists, the contents of that file will be overwritten.
   You can cancel the export by pressing the soft key [Cancel].

> Check
> Folder and file names are not case sensitive. If a file "aaa" exists, and you create "Aaa", the original "aaa" will be lost.

a) File time stamps

See ☞ P.5-8 for timestamps of files created with this device.

7.7 To Retrieve the Saved arbitrary waveform

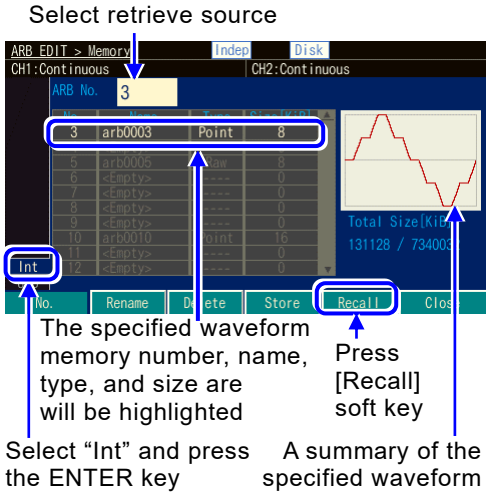


Press the [Memory] soft key to save

Press the (MENU) key and numeric keypad (2) to display the ARB Edit screen.
Pressing the [Memory] soft key switches to a screen for reading, saving, and file operations.
On this screen, you can select the unit's internal memory or USB flash drive as the read source.

7.7.1 To retrieve from Internal Memory

You can retrieve the contents of the main unit's internal memory to the edit memory.
Arbitrary waveforms in array format (Type column indicates “Raw”) cannot be read into edit memory. See ☞ P.7-2. Therefore, when selecting an arbitrary waveform whose Type is “Raw”, the [Recall] soft key does not appear.



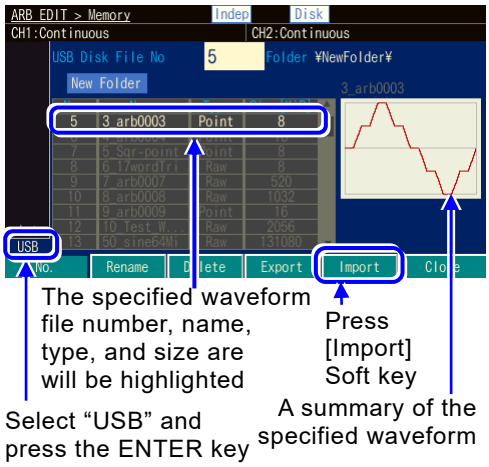
1. If “Int” at the bottom left of the screen is selected, the waveform will be read from the internal memory. If “USB” is selected, select “Int” and press the (ENTER) key.
2. Select “ARB No.” field. ☞ P.4-14 You can also use [No.] soft key. Enter the retrieve source waveform memory number between 1 and 4 096. ☞ P.4-16, 4-17
3. Press the [Recall] soft key opens a dialog to confirm the recall operation. To recall the settings, select [OK] and then press the (ENTER) key. You can also use [OK] soft key.

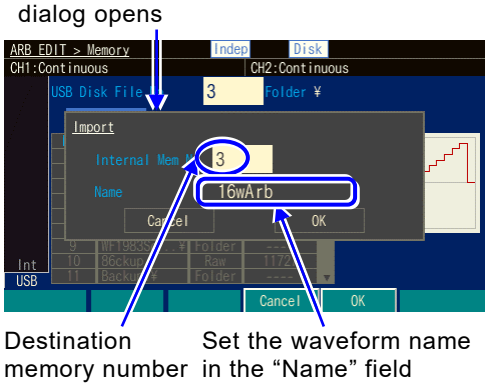
The contents of the specified internal memory will be read to the edit memory, and the waveform in the edit memory will be overwritten.
You can cancel recalling by pressing the soft key [Cancel].

In this screen, you can delete an existing waveform memory with the [Delete] soft key, and rename it with the [Rename] soft key. Delete: ☞ P.7-15, Rename: ☞ P.7-16

7.7.2 To retrieve from USB flash drive

You can retreieve arbitrary waveform data from USB flash drive to edit memory or built-in memory. Arbitrary waveforms in array format (Type column indicates “Raw”) cannot be read into edit memory. For operations using USB flash drive, See also, ☞ P.5-7.





1. When “USB” at the bottom left of the screen is selected, the data will be retrieved from the USB flash drive. If “Int” is selected, select “USB” and press the ENTER key. Connect the USB flash drive to the unit. ☞ P.3-2

2. Select the “USB Disk File No.” field (☞ P.4-14) to open the input field of the setting target file number. You can also use [No.] soft key. Select the target file and destination folder number in that field. ☞ P.4-16, 4-17

3. Navigate to the folder where you want to read the settings file if necessary. Select a folder (name with “¥” at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7

4. If you press the soft key [Import] with the target file selected, a dialog will open to confirm the import operation.
Specify the internal waveform memory number of the save destination in the “Internal Mem No.” field. ☞ P.4-16, 4-17
Select number “0” to read into edit memory.

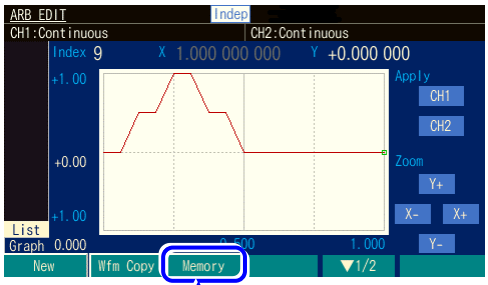
5. The file name on the USB flash drive is set as the initial value in the “Name” field of the dialog. Set the waveform name as necessary. ☞ P.4-19

6. To retreieve arbitrary waveform, select [OK], and then press the ENTER key. You can also use [OK] soft key. The arbitrary waveform previously saved in that memory number will be overwritten.
You can cancel memory import using soft key [Cancel].

7.8 File Operations

Perform the operations of deleting and renaming the arbitrary waveform data in internal memory and also deleting and renaming the arbitrary waveform data and creating, deleting, and renaming folders in USB flash drive on the Memory screen of ARB Edit.

For operations using USB flash drive, See also, ☞ P.5-7.



To perform file operations, press the [Memory] soft key

Press the MENU key and numeric keypad 2 to display the ARB Edit screen.

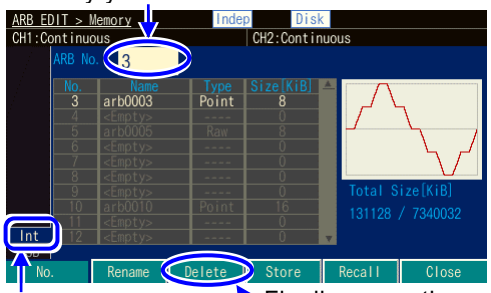
Pressing the [Memory] soft key switches to a screen for reading, saving, and file operations.

7.8.1 To Delete Saved arbitrary waveform

To delete arbitrary waveform data in internal memory or delete arbitrary waveform data or a folder in USB flash drive, use the [Delete] soft key.

The arbitrary waveform memory number currently being used for waveform output cannot be deleted.

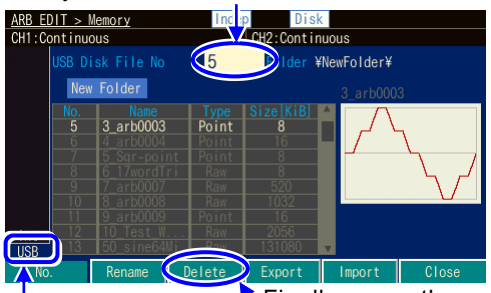
Specify the number of the internal memory you want to delete.



Select the Internal tab

Finally, press the [Delete] soft key

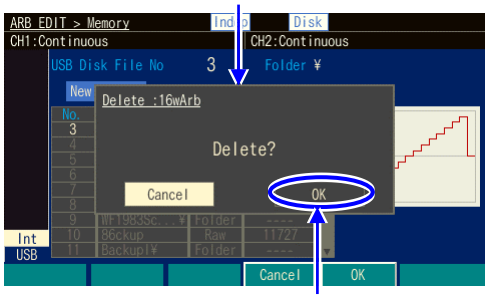
Specify the number of the file you want to delete.



Select the USB tab

Finally, press the [Delete] soft key

The dialog for deleting a file or folder is displayed



Press the [OK] soft key to delete

■ If target is a internal memory

1. Select “ARB No.” field. ☞ P.4-14 You can also use [No.] soft key. Specify the deletion target by that number. ☞ P.4-16, 4-17
2. Press the [Delete] soft key to display a dialog for deletion.
3. To delete, select [OK] and then press the ENTER key. You can also use [OK] soft key.

■ If target is a USB flash drive (☞ P.5-7)

When the target is a file or folder on a USB flash drive, the screen shown on the left will appear. Folders have a “¥” at the end of their name. “..¥” indicates the folder one level above. ☞ P.5-7

If you press the [Enter] soft key while a folder is selected, that folder becomes the current folder.

1. Select the “USB Disk File No.” field (☞ P.4-14) to open the input field of the target file number. You can also use [No.] soft key. Specify the number of the file or folder to delete with that number ☞ P.4-16, 4-17
2. Press the [Delete] soft key. A confirmation dialog will be displayed.
3. To delete, select [OK] on the dialog and press the ENTER key. You can also use [OK] soft key.

Note that if a folder is the target, all of the contents of that folder and all of its subfolders and files will also be deleted.

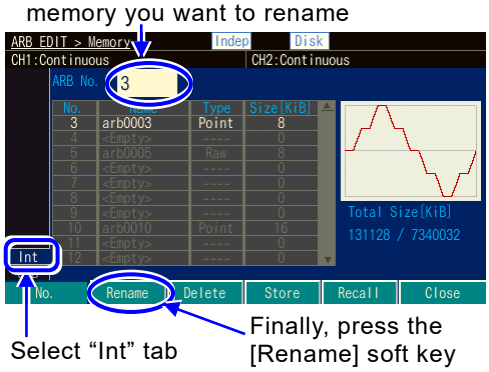
In either case, you can alternatively cancel the deletion with the [Cancel] soft key.

7.8.2 To Rename

To rename arbitrary waveform data in internal memory or rename arbitrary waveform data or a folder in USB flash drive, use the [Rename] soft key.

■ If target is a internal memory

Specify the number of the internal memory you want to rename

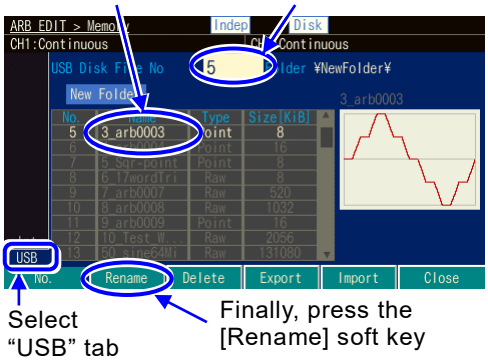


1. Select "ARB No." field. ☞ P.4-14
   You can also use [No.] soft key.
   Specify the target to be renamed here. ☞ P.4-16, 4-17
   Press the [Rename] soft key to display a dialog for renaming.
2. The old name is displayed in the "Name" field, so change it to the new name. ☞ P.4-19
3. To rename, select [OK] and then press the ENTER key. You can also use [OK] soft key.

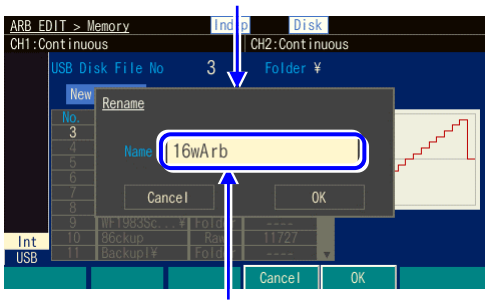
■ If target is a USB flash drive (☞ P.5-7)

Displays the name of the selected file or folder

By changing this, you can select files and folders



A dialog will appear to rename the file or folder



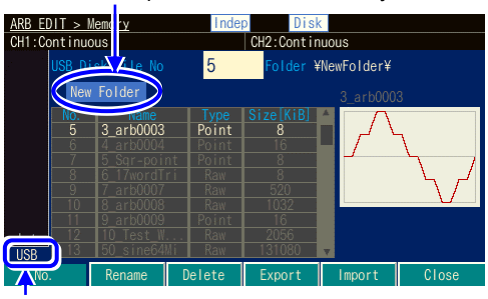
1. Select the "USB Disk File No." field (☞ P.4-14) to open the input field of the target file number. You can also use [No.] soft key.
   Specify the number of the file or folder to rename with that number ☞ P.4-16, 4-17
2. Folders have a "¥" at the end of their name. If you press the [Enter] soft key while a folder is selected, that folder becomes the current folder. "..¥" indicates the folder one level above. ☞ P.5-7
3. Press the [Rename] soft key to display the file or folder renaming dialog. Select the "Name" field (☞ P.4-14) and change the name. ☞ P.4-19
   Note, folder and file names on the USB flash drive are not case sensitive.
4. To rename, select [OK] on the dialog and press the ENTER key. You can also use [OK] soft key.

In both cases, you can also cancel the renaming using the [Cancel] soft key.

7.8.3 To Create a Folder in USB flash drive

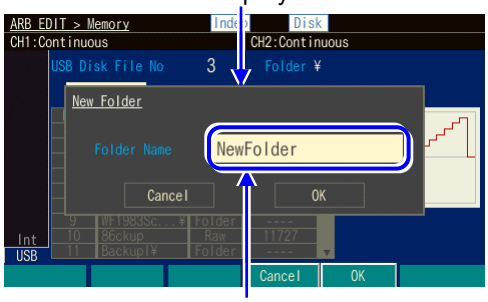
Folders have "¥" at the end of the name. When a folder is selected, pressing the [Enter] soft key makes that folder the current folder. "..¥" indicates the folder one level up.
For operations using USB flash drive, See also, ☞ P.5-7.

Select the [New Folder] button and then press the ENTER key



Since folders can only be created on USB flash drive, [New Folder] does not appear on the "Int" tab

The dialog for creating a folder is displayed



Select the "Folder Name" field and press the [OK] soft key to change the name

1. If necessary, navigate to the parent folder where you want to create the folder.
   Select a folder (name with "¥" at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7
2. Select the [New Folder] button at the top right of the screen (☞ P.4-14) to open a dialog for entering the name of the folder to be created.
3. "NewFolder" is set as the initial value in the Folder Name field. Rename the folder with the ENTER key if necessary. ☞ P.4-19
   Note, folder and file names on the USB flash drive are not case sensitive.
4. To create folder, select [OK], and then press the ENTER key.
   You can also use [OK] soft key.
   You can cancel create folder using soft key [Cancel].

You can also create folders for USB flash drive on the setting memory operation screen ☞ P.5-8 and on the sequence memory operation screen ☞ P.11-28.

7.9 Memory Capacity required to save arbitrary waveforms

A maximum of approximately 7Gi bytes can be saved to the unit's internal non-volatile memory. The memory capacity (Ki-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×(waveform length [word]) + 8 258) / 1 024 （round up to integer）

Control point format: (8×(number of control points) + 8 258) / 1 024 （round up to integer）

Memory capacity required to save arbitrary waveforms for each format:

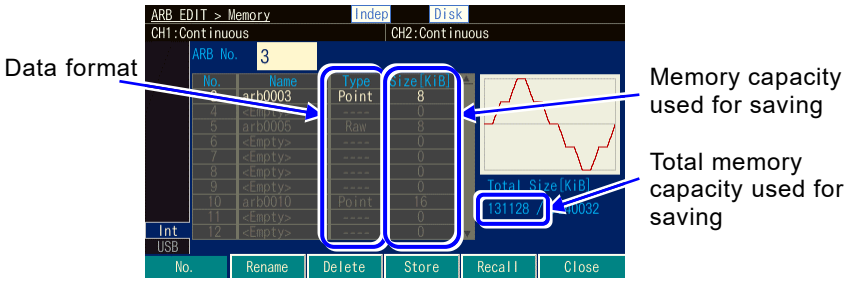
Table 7-2 Memory capacity required to save arbitrary waveforms

Array format	Waveform length	1KiW	10KiW	100KiW	1MiW	10MiW	32MiW	64MiW	-
	Memory capacity required for saving	11KiB	29KiB	209KiB	2MiB	20MiB	64MiB	128MiB	-
Control point format	Number of control points	2	10	100	300	1 000	2 000	5 000	10 000
	Memory capacity required for saving	9KiB	9KiB	9KiB	11KiB	16KiB	24KiB	48KiB	87KiB

1Ki=1 024, 1Mi=1 024×1 024, W: words, B: bytes

In the selection screen of the arbitrary waveform (common to both recalling and saving), 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 of No.0 is displayed as “Point” because it is in control point format.
- Save memory capacity: “Size” (Ki byte unit)
  For arbitrary waveforms between No.1 and 4 096, the memory capacity used for saving is displayed in Ki-bytes. For the edit memory of No.0, the memory capacity required if it is saved is displayed in Ki-bytes.
- Total save memory capacity: “Total Size” (Ki byte unit)
  Total memory capacity currently used for saving arbitrary waveforms between No.1 and 4 096 is displayed in Ki-bytes. The size of edit memory of No.0 is excluded from the total capacity.



8. Convenient Use of 2-channel Equipment (WF1984/WF1982)

8.1 Overview of 2-channel operation

You can use 2-channel equipment like the WF1984/WF1982 as not only two oscillators with each channel independent but also with the settings and operations coordinated between the two channels. Functions specific to 2-channel equipment are as follows:

- Parameter copy function
  The settings of one channel can be copied to the other channel.
  In addition, the settings of each channel can be swapped. ☞ P.8-3

- 2-channel equivalence setting function (CH LINK)
  Values such as the amplitude and DC offset can be set to the same values for both channels.
  Operations such as turning output on/off can be performed simultaneously for both channels.
  ☞ P.8-5

- Phase synchronization function (ΦSync)
  Align the reference phase of each channel (including sub waveform). ☞ P.8-6
  Oscillation of the waveform output stops temporarily and restarts from the set phase.

- 2-channel coordination operation: 2-phase function “2Phase”
  The synchronization relationship with the same frequency can be kept. This function performs control to keep the synchronization relationship with the same frequency also during the frequency modulation or frequency sweep. ☞ P.8.5

- 2-channel coordination operation: function with constant frequency difference “2Tone”
  The frequency can be changed while keeping the difference constant. This function performs control to keep the frequency difference constant also during the frequency modulation or frequency sweep. ☞ P.8-10

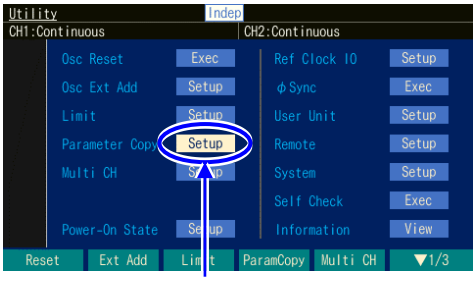
- 2-channel coordination operation: function with constant frequency ratio “Ratio”
  The frequency can be changed with both the frequency ratio and synchronization relationship kept constant. This function performs control to keep the frequency ratio constant also during the frequency modulation or frequency sweep. ☞ P.8-12

- 2-channel coordination operation: differential output function “Diff”
  The reverse phase waveform can be output with the same frequency, amplitude, and DC offset. This function performs control to keep the reverse phase waveform also during the frequency modulation or frequency sweep. ☞ P.8-14

- 2-channel coordination operation: differential 2 function “Diff2”
  The reverse phase waveform can be output with the same frequency and amplitude. In this mode, the polarity of DC offset is also reversed, which is different from the differential output function. Therefore, when connect the signal GND sides of CH1 and CH2 and output the CH1 hot side with the CH2 hot side as the reference, you will get twice the output voltage including DC. ☞ P.8-15

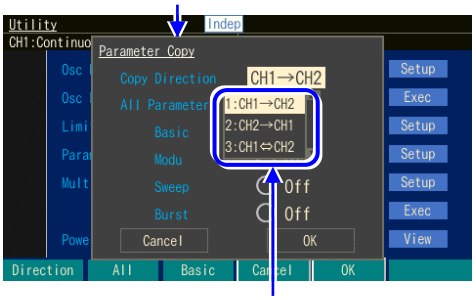
8.2 Copying Settings between channels

The settings can be copied between channels in the Utility screen. ☞ P.4-25



In the Utility screen, select “Parameter Copy” and then press the ENTER key

The Parameter copy dialog is opened



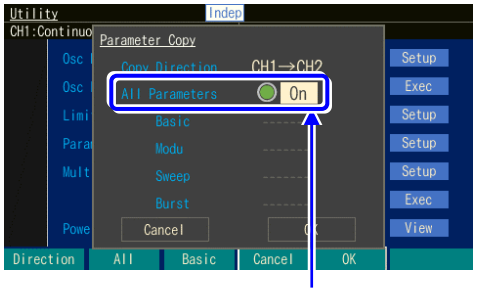
Select a copy direction

1. In the Utility screen, select “Parameter Copy” field. ☞ P.4-14
You can also use [ParamCopy] soft key.

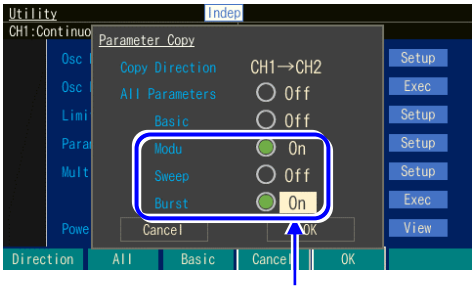
2. After the Parameter copy dialog opens, select the [Copy Direction] field. ☞ P.4-14
You can also use [Direction] soft key.
A list to select the copy direction opens. You can select a copy direction from the following three types: ‘CH1→CH2’ (CH1 to CH2), ‘CH2→CH1’ (CH2 to CH1), and ‘CH1⇔CH2’ (swap CH1 and CH2).
Select the desired direction. ☞ P.4-18

3. Next, select a parameter type to copy.
For the parameter type to copy, set “All Parameters” for all parameters or select from the parameters of individual oscillation modes.

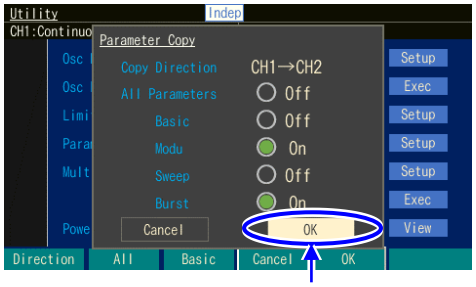
There are four parameter types for individual oscillation modes: “Basic” (basic parameters), “Modu” (for the modulation function), “Sweep” (for the sweep mode), and “Burst” (for the burst mode). Selecting the desired parameter type and pressing the ENTER key sets it as the copy target and displays “On”.
Pressing the ENTER key again excludes it from the copy target and displays “Off”.
You can also select all or select basic parameters using the [All] or [Basic] soft keys.



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 dialog, and then press the ENTER key. The copy operation is performed. You can also use [OK] soft key.
If you do not want to copy, select [Cancel] at the dialog and press the ENTER key, or press the CANCEL key.

■ **Remarks**

Copying all of “Basic”, “Modu”, “Sweep”, and “Burst” is not equivalent to copying “All Parameters”.

The following items are copied only when copying “All Parameters”:

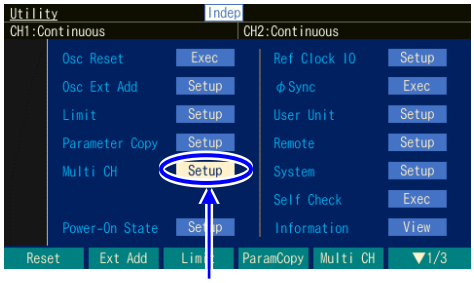
- Output on/off state ☞ P.4-29
- Oscillation mode ☞ P.4-32
- External addition setting ☞ P.4-47
- User-defined units ☞ P.12-2
- Power-on output on/off setting ☞ P.4-29
- Basic parameter settings for waveforms that are not currently in use (When copying using “Basic”, the waveform parameter settings are copied only for the waveform that is currently in use at the copy source)
- Amplitude/DC offset setting or high level/low level setting
- Setting range limit value ☞ P.4-57

For copying other than “All Parameters”, any setting value exceeding the setting range limit value of the copy destination is not copied.

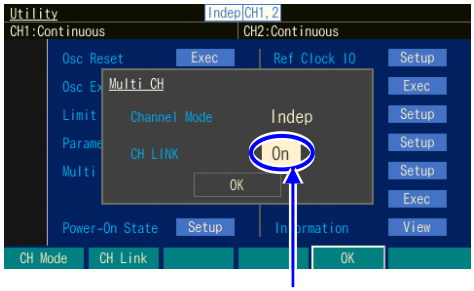
8.3 Unifying Settings of 2 channels

To unify the settings of 2 channels, set the 2-channel equivalence setting function (CH LINK) to on in the Utility screen. ☞ P.4-25

This function is enabled until the 2-channel equivalence setting function is reset to off. You can also turn this function on/off by pressing the key CH SEL for more than 1 second. ☞ P.4-24



Select “Multi CH” and then press the ENTER key



Set “CH LINK” to “On” and then press [OK]

1. In the Utility screen, select “Multi CH” field. ☞ P.4-14
   You can also use [Multi CH] soft key.
2. Select the channel equivalency setting function “CH LINK” on the Utility screen. ☞ P.4-14
3. Select the desired function. ☞ P.4-18
   You can also select by pressing 1: ‘Off’, 2: ‘On’ on the numeric keypad.
4. Select [OK] at the dialog, and then press the ENTER key. You can also use [OK] soft key.
5. Next, set items to which you want to set the same settings. When you set the settings for one channel, the same settings are set for the same items of the other channel.

This function is a function that sequentially sets the same value to both channels. Even if the frequency and phase are set to the same value, the phase relationship between the output waveforms of the two channels will change each time depending on the relationship between frequency and timing. Synchronization operation is required to align the reference phases. ☞ P.8-6

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.8-8, P.8-12

For synchronization of multiple units, ☞ P.9.

■ Remarks

The 2-channel equivalence setting function (CH LINK) is valid for the following setting items:

- Frequency ☞ P.4-34
- Phase ☞ P.4-36
- Amplitude ☞ P.4-38
- DC Offset ☞ P.4-39
- Oscillation mode ☞ P.4-32
- Waveform ☞ P.4-33
- Output on/off ☞ P.4-29
- Burst trigger ☞ P.4-103
- Sweep start/stop operation ☞ P.4-86, 4-87

8.4 Synchronizing Phase between channels

The following operations can synchronize the reference phase between two channels and the sub waveform (internal modulation source).

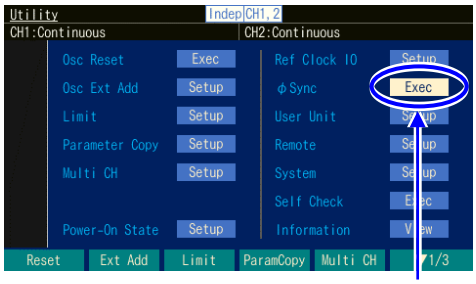
If you want to always keep the same frequency or frequency ratio and need a phase synchronization state, use the 2-channel coordination function. ☞ P.8-8, P.8-12

For synchronization of multiple units, ☞ P.9.

■ Performing synchronization

Synchronization between two channels and the sub waveform (internal modulation source) can be performed in the following two ways.

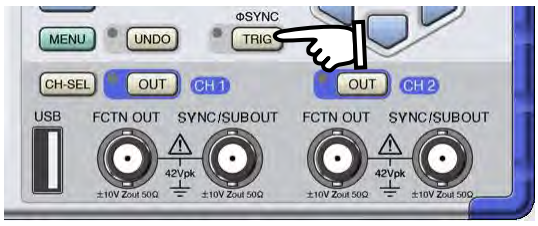
○ Performing synchronous operation from a button in the Utility screen. ☞ P.4-25



In the Utility screen, select “ΦSync” and then press the ENTER key to execute the phase synchronization

The synchronous operation is performed in the Utility screen.
Select “ΦSync” (☞ P.4-14) in the Utility screen, and then press the ENTER key.
Press the rightmost soft key [▼n/3] several times until it becomes [▼2/3], then do the same with the [ΦSync] soft key.

○ Perform synchronization operation by long pressing the TRIG key



Press and hold the TRIG key on the front panel for at least 1 second. (However, this method cannot be used in burst modes other than ‘AutoBurst’ or sweep modes other than ‘Cont’)

The reference phase will be initialized and a synchronization operation execution message will be displayed. At this time, both channels temporarily stop oscillation, so the phase becomes temporarily discontinuous.

■ Phase relationship after synchronous operation

The synchronization operation initializes the reference phase of each channel.

The phase difference of the output waveform is the difference between the phase settings of each channel.

At the same time, the reference phase of each channel's sub waveform (internal modulation source) is also initialized.

Even if a synchronization operation is performed in 2-channel independent operation (channel mode setting is independent “Indep”), if the frequency is subsequently changed, the synchronization relationship will be lost. Perform synchronous operation again.

■ Operational restrictions

There are the restrictions shown in the following table for synchronous operation. Even if the synchronous operation is invalid, performing synchronous operation causes both channels to stop the oscillation once.

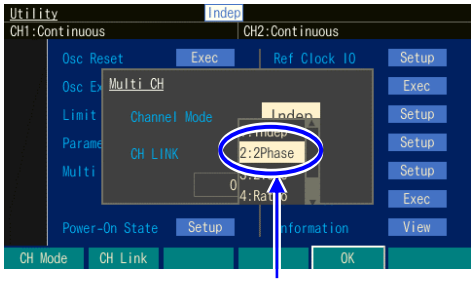
Item	Restriction
Waveform	Invalid for ‘Noise’ and ‘DC’.
Sweep mode	Invalid for frequency sweep. Invalid for gated single sweep.
Burst mode	Invalid
Internal sweep and burst trigger sources can be selected for each channel ‘Int1’ and ‘Int2’, and they are shared between channels, so if you select the same source for each channel, synchronization is not required.	

The delay time varies depending on the output range. Therefore, when the range is different between the channels, the apparent phase difference becomes larger.

8.5 To keep the frequency the Same between channels ‘2Phase’

If the channel mode is ‘2Phase’, you can change the frequency with the frequencies for both channels kept to the same value while the synchronization relationship is kept. In coordination with the change of the frequency of channel 1, the frequency of channel 2 is automatically changed. Channel 2 coordinates with channel 1 also during the frequency modulation or frequency sweep. This function is disabled for the burst mode and gated single sweep.

■ Selecting 2-channel coordination ‘2Phase’



Set “Channel Mode” to ‘2Phase’

1. In the Utility screen (☞ P.4-25), select “Multi CH” field. ☞ P.4-14
   You can also use [Multi CH] soft key.

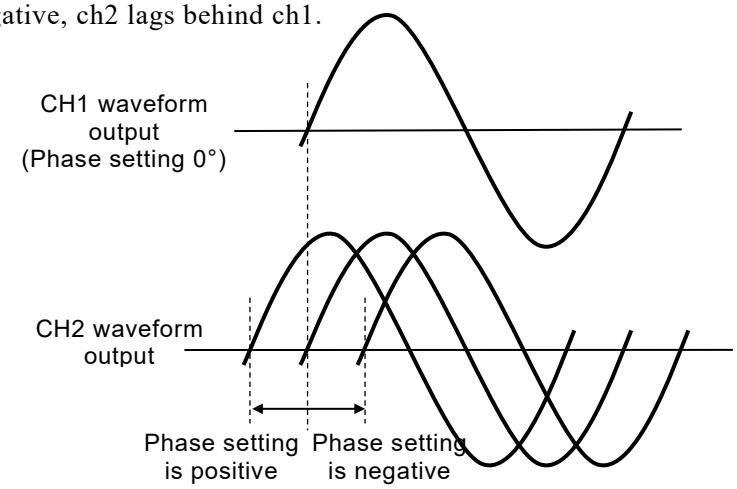
2. After the Multi CH dialog opens, select the “Channel Mode” field. ☞ P.4-14
   Select ‘2Phase’ (‘Indep’ is normally set) from the options opened here. ☞ P.4-18
   You can also use the numeric keypad 2.

3. Select [OK] at the dialog, and then press the ENTER key. You can also use [OK] soft key.

This will result in two-phase oscillation. Both channels have the same frequency and are automatically phase synchronized. Synchronization is maintained even if the frequency is changed. It is controlled so that the same frequency and synchronous relationship are maintained even during frequency modulation or frequency sweep.
For 2-phase oscillation, settings related to the frequency can be set only for channel 1.

■ Changing phase difference between channels

You can set a phase (☞ P.4-36) for each channel in the Oscillator setting screen (☞ P.4-26). The phase between channels appears as the difference for each phase setting.
Normally, set the phase of the phase reference channel (for example, ch1) to 0° and change only the phase setting of ch2. At this time, the phase setting of ch2 is a phase of ch2 based on the ch1. As shown in the figure below, if the phase setting of ch2 is positive, ch2 precedes ch1, and if it is negative, ch2 lags behind ch1.



■ Operational restrictions

There are the restrictions shown in the following table to keep the synchronization relationship with the same frequency:

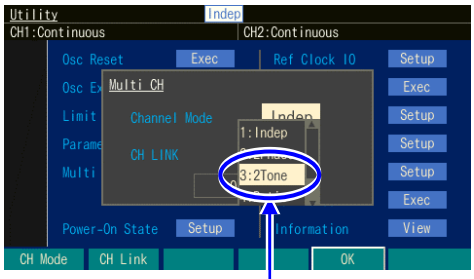
Item		Restriction
Mode and target / waveform		Disabled for ‘Noise’ and ‘DC’.
Modulation function	‘FM’	Both CHs are ‘FM’. Peak deviation is common. Modulation source is internal only. Internal modulation waveform and internal modulation frequency are common.
	‘FSK’	Both CHs are ‘FSK’. Hop frequency is common. 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’, ‘AM(SC)’	Both CHs are ‘AM’ or ‘AM(SC)’. Modulation setting is independent for each CH.
	DC offset modulation ‘OFSM’	Both CHs are ‘OFSM’. Modulation setting is independent for each CH.
	‘PWM’	Both CHs are ‘PWM’. Modulation setting is independent for each CH.
Sweep mode	Frequency sweep	Both CHs are frequency sweep. Sweep function, sweep range, sweep time, and sweep mode are common. Gated single sweep is not used. Single 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 mode		Cannot be used.

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 depth or sweep width of the channel to 0.

8.6 To keep the frequency Difference between channels ‘2Tone’

If the channel mode is constant frequency difference ‘2Tone’, you can change the frequency with the frequency difference between both channels kept constant. In coordination with the change of the frequency of channel 1, the frequency of channel 2 is automatically changed. Channel 2 coordinates with channel 1 also during the frequency modulation or frequency sweep. This function is disabled for the burst mode and gated single sweep.

■ Selecting 2-channel coordination ‘2Tone’

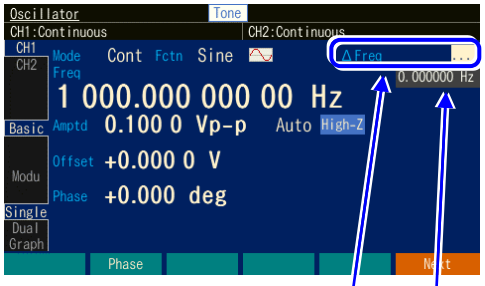


Set “Channel Mode” to ‘2Tone’

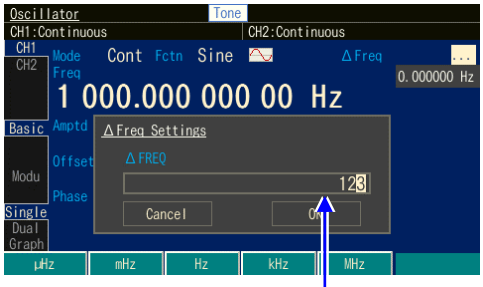
1. In the Utility screen (☞ P.4-25), select “Multi CH” field. ☞ P.4-14
   You can also use [Multi CH] soft key.
2. After the Multi CH dialog opens, select the “Channel Mode” field. ☞ P.4-14
   Select ‘2Tone’ (‘Indep’ is normally set) from the options opened here. ☞ P.4-18
   You can also use the numeric keypad 3.
3. Select [OK] at the dialog, and then press the ENTER key. You can also use [OK] soft key.

This results in constant frequency difference oscillation, and the frequency difference between both channels is kept constant. This frequency difference is set in the “ΔFreq” field of either channel. The frequency of channel 2 is the frequency of channel 1 plus this frequency difference. For the oscillation with the constant frequency difference, you cannot set the frequency of channel 2 directly.

■ To set the frequency difference



Set ΔFreq of CH2-CH1
Current frequency difference: ΔFreq



Set delta frequency in the “ΔFREQ” field

1. Select [...] of the “ΔFreq” field (☞ P.4-14) to display a dialog for setting the frequency difference. When selected, this item will display the current frequency difference before pressing the ENTER key.
2. When the dialog is displayed, select the “ΔFreq” (☞ P.4-14) to open the input field.
3. Specifies the positive difference in the frequency of channel 2 relative to the frequency of channel 1. ☞ P.4-34
4. Before pressing the ENTER key or unit key (soft key), you can cancel with the CANCEL key.

Note that you can only set the frequency of channel 1 ≤ the frequency of channel 2.

■ Operational restrictions

There are the restrictions shown in the following table to keep the frequency difference:

Item		Restriction
Mode and target / waveform		Disabled for 'Noise' and 'DC'.
Modulation function	'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. 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', 'AM(SC)'	Both CHs are 'AM' or 'AM(SC)'. Modulation setting is independent for each CH.
	DC offset modulation 'OFSM'	Both CHs are 'OFSM'. Modulation setting is independent for each CH.
	'PWM'	Both CHs are 'PWM'. Modulation setting is independent for each CH.
Sweep 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 sweep is not used. Single 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 mode		Cannot be used.

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 depth or sweep width of the channel to 0.

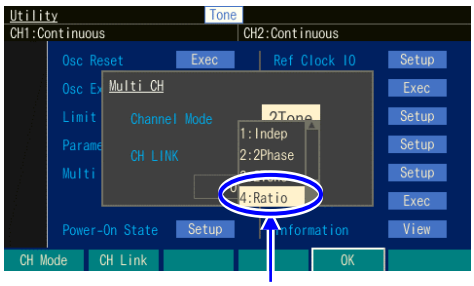
The frequency difference of the hop frequency in 'FSK' is restricted to the setting resolution of the hop frequency.

If you select the logarithmic sweep as the frequency sweep, channel 1 performs the logarithmic sweep, but channel 2 does not perform the logarithmic sweep because channel 2 follows with the constant frequency difference.

8.7 To keep the frequency Ratio between channels 'Ratio'

If the channel mode is constant frequency ratio 'Ratio', you can change the frequency with the frequency ratio between both channels kept constant. In coordination with the change of the frequency of channel 1, the frequency of channel 2 is automatically changed.
Channel 2 coordinates with channel 1 also during the frequency modulation or frequency sweep. This function is disabled for the burst mode and gated single sweep.

■ Selecting 2-channel coordination (Ratio)

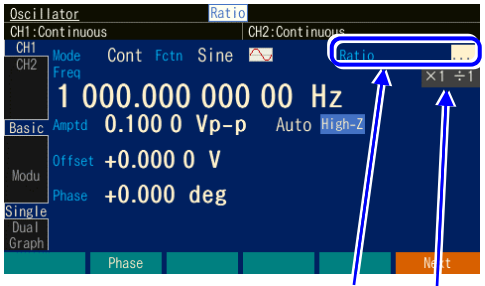


Set "Channel Mode" to 'Ratio'

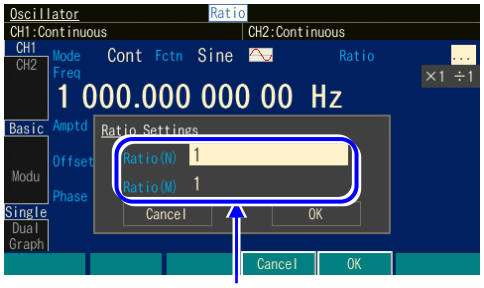
1. In the Utility screen (☞ P.4-25), select "Multi CH" field. ☞ P.4-14
   You can also use [Multi CH] soft key.
2. After the Multi CH dialog opens, select the "Channel Mode" field. ☞ P.4-14
   Select 'Ratio' ('Indep' is normally set) from the options opened here. ☞ P.4-18
   You can also use the numeric keypad (4).
3. Select [OK] at the dialog, and then press the ENTER key. You can also use [OK] soft key.

This results in constant frequency ratio oscillation. The frequency ratio of both channels remains constant. This frequency ratio is set in the "Ratio" field of either channel.
Channel 2 frequency: Channel 1 frequency becomes N: M.
It is controlled so that the frequency ratio and synchronous relationship are maintained even during frequency modulation or frequency sweep.
In constant frequency ratio oscillation, the frequency of channel 2 cannot be set directly.

■ To set the frequency ratio



Set Ratio(N), Ratio(M)
Current frequency ratio: × N ÷ M



Set the ratio in the input fields of "Ratio(N)" and "Ratio(M)"

1. Select [...] of the "Ratio" field (☞ P.4-14) to display a dialog for setting the frequency ratio. When selected, this item will display the current frequency ratio before pressing the ENTER key.
2. When the dialog appears, select each "Ratio(N)", "Ratio(M)" field (☞ P.4-14) and open the input field.
3. In each input field, specify the N by which the frequency of channel 1 is multiplied and the M which it is divided. ☞ P.4-16, 4-17
4. Before pressing the ENTER key or unit key (soft key), you can cancel with the CANCEL key.

■ Operational restrictions

There are restrictions shown in the following table to keep the frequency ratio:

Item		Restriction
Mode and target / waveform		Disabled for 'Noise' and 'DC'.
Modulation function	'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. 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', 'AM(SC)'	Both CHs are 'AM' or 'AM(SC)'. Modulation setting is independent for each CH.
	DC offset modulation 'OFSM'	Both CHs are 'OFSM'. Modulation setting is independent for each CH.
	'PWM'	Both CHs are 'PWM'. Modulation setting is independent for each CH.
Sweep 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 sweep is not used. Single 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 mode		Cannot be used.

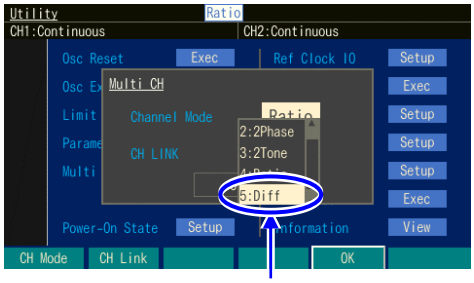
Both channels have the same type of modulation or sweep during the modulation or sweep. If another channel does not need the modulation (other than 'FM' and 'FSK') or sweep (other than the frequency sweep), set the modulation depth or sweep width of the channel to 0.

The peak deviation in 'FM' and the frequency ratio of the hop frequency in 'FSK' are restricted to individual frequency setting resolution and the frequency setting range or setting range limit value, respectively.

8.8 To obtain Differential output 'Diff'

If the channel mode is 'Diff', you can change the setting with the differential output of both channels kept. In this 2-channels coordination mode, the DC offset setting is the same for channel 1 and channel 2. In coordination with the change of the setting of channel 1, the setting of channel 2 is automatically changed. Coordination is performed also during modulations or sweeps. If you connect the signal GNDs of CH1 and 2 and make the hot sides output, the output voltage will be doubled, excluding the DC component. (However, the differential output impedance will be 100Ω)

■ Selecting 2-channel coordination (Diff)



Set "Channel Mode" to 'Diff'

1. In the Utility screen (☞ P.4-25), select "Multi CH" field. ☞ P.4-14
You can also use [Multi CH] soft key.

2. After the Multi CH dialog opens, select the "Channel Mode" field. ☞ P.4-14
Select 'Diff' ('Indep' is normally set) from the options opened here. ☞ P.4-18
You can also use the numeric keypad (5).

3. Select [OK] at the dialog, and then press the (ENTER) key. You can also use [OK] soft key.

This will result in differential output oscillation (DC has the same polarity). The frequency, phase, amplitude, and DC offset settings of both channels are the same, outputting out-of-phase waveforms. Even if the settings are changed, the differential output relationship will be maintained. The differential output relationship is maintained even during modulation and sweep.

For differential output oscillation, only channel 1 can be set (behaves as a 1-channel oscillator).

■ Operational restrictions

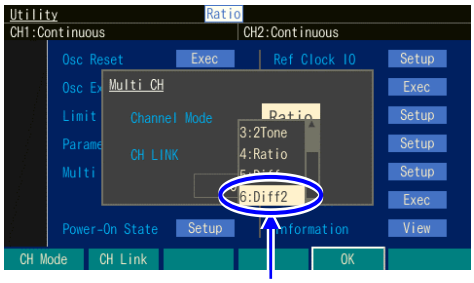
There are the restrictions shown in the following table to keep the differential output:

Moduration and Oscillation Mode	Restriction
Modulation function	Modulation source can be set to internal for 'FM', 'PM', 'AM', 'AM(SC)', 'OFSM', and 'PWM'. Modulation source can be set to internal or external for 'FSK' or 'PSK'.
Sweep mode	Gated single sweep not available. External trigger source is valid only for CH1.
Burst mode	Cannot be used.
External addition	Cannot be used.

8.9 To obtain Double output voltage 'Diff2'

With respect to the AC signal component, this is the same as 'Diff' (differential) in the previous section. The DC offset setting is reversed polarity with channel 1 and channel 2.
If you connect the signal GND of CH1 and 2 and make the hot sides output, you can get twice the output voltage including DC (however, the output impedance will be 100Ω).

■ Selecting 2-channel coordination (Diff2)



Set "Channel Mode" to 'Diff2'

1. In the Utility screen (☞ P.4-25), select "Multi CH" field. ☞ P.4-14
   You can also use [Multi CH] soft key.
2. After the Multi CH dialog opens, select the "Channel Mode" field. ☞ P.4-14
   Select 'Diff2' ('Indep' is normally set) from the options opened here. ☞ P.4-18
   You can also use the numeric keypad 6.
3. Select [OK] at the dialog, and then press the ENTER key. You can also use [OK] soft key.

This will result in differential output oscillation (DC also has opposite polarity). The frequency, phase, and amplitude settings of both channels will be the same, and an out-of-phase waveform will be output. DC offset also has reverse polarity.
Even if the settings are changed, the differential output relationship will be maintained. The differential output relationship is maintained even during modulation and sweep.
For differential2 output oscillation, only channel 1 can be set (behaves as a 1-channel oscillator).

■ Operational restrictions

The restrictions are the same as when the channel mode is "Diff":

Moduration and Oscillation Mode	Restriction
Modulation function	Modulation source can be set to internal for 'FM', 'PM', 'AM', 'AM(SC)', 'OFSM', and 'PWM'. Modulation source can be set to internal or external for 'FSK' or 'PSK'.
Sweep mode	Gated single sweep not available. External trigger source is valid only for CH1.
Burst mode	Cannot be used.
External addition	Cannot be used.

9. Synchronizing Multiple Units

Synchronous operation of multiple units with the series product WF198x is possible. A maximum of 12-phase oscillators (when 6 WF1982/WF1984 units are used) can be configured. Each phase can change phase and amplitude independently.
Furthermore, if you use the sub waveform output, up to 18 phases are possible under the above conditions.
Set the frequency to a common to all devices and all channels (and set the frequency of sub-waveform if you use them).

9.1 Connection Procedure

Here, the WF198x that will be the synchronization reference is called the primary unit. The other WF198x are called secondary units.

■ Connectors to use

Use the external 10MHz frequency reference input (10MHz REF IN) ☞ P.10-2 and frequency reference output (REF OUT) ☞ P.10-3 on the rear panel.

■ Cables to use for connection

Cable type: Characteristic impedance 50Ω series coaxial cable with BNC connector (RG-58A/U etc.).

Restriction to cable length: 1m or less between units, total cable length is 3m or less

■ Connection method

There are two connection methods (connection method 1 and connection method 2).
If there are many units, using connection method 1 can reduce the time difference between secondary units. However, in addition to the coaxial cable, a BNC Tee adapter and 50Ω terminating resistor are required.
Connecting with connection method 2 is easy because connection using only a coaxial cable is possible. However, the time difference between the secondary units is larger than that of connection method 1. The maximum number of units that can be connected is fewer than that of connection method 1.
In either case, the external 10MHz frequency reference input terminal (10MHz REF IN) ☞ P.10-2 and the frequency reference output terminal (REF OUT) ☞ P.10-3 are used.
Any of the built-in crystal oscillator or external 10MHz clock can be used as the frequency reference for the primary unit. If you use the external 10MHz as the reference, the frequency of the secondary unit will also be the same accuracy as the external reference.

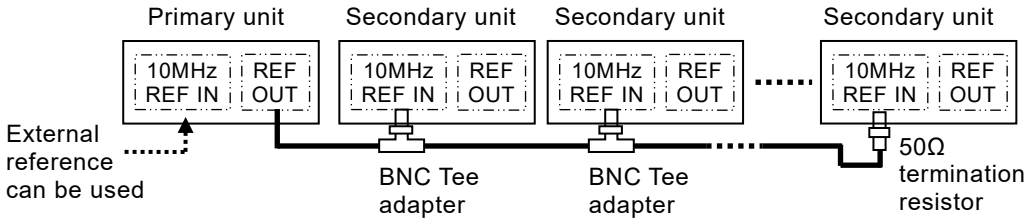
・Connection method 1

Connect the reference output for the primary unit to the reference inputs of the secondary units in parallel using BNC Tee adapter.

Use the 50Ω terminating resistor for the reference input for the terminal secondary unit.

The time difference between the secondary units varies depending on the connection cable length (approximately 5ns/m).

A maximum of 6 units can be connected, including the primary and secondary units.

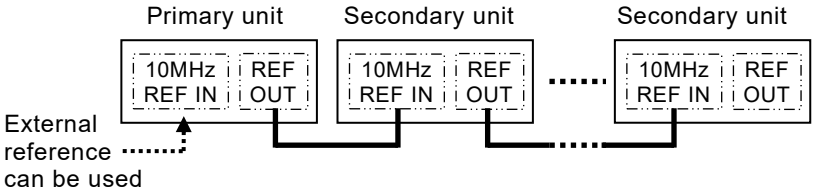


・Connection method 2

Connect the reference output for the primary unit or secondary unit to the reference input for the next secondary unit.

The time difference between secondary units varies depending on the delay within units (approximately 5ns) and connection cable length (approximately 5ns/m).

A maximum of 4 units can be connected, including primary and secondary units.



■ Settings of Primary / Secondary unit

When using either connection method, the following settings are required for the primary unit and each secondary unit.

・When using the 10MHz REF IN terminal

Enable external frequency reference input. ☞ P.10-4

・When using the REF OUT terminal

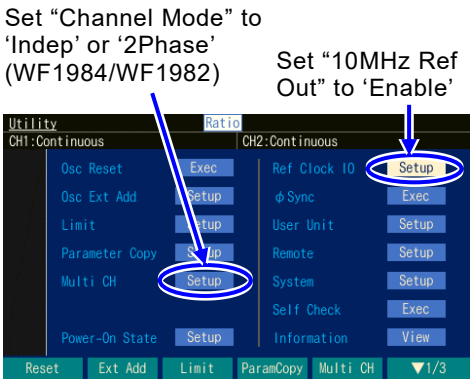
Turn on frequency reference output. ☞ P.10-5

9.2 Performing Synchronization

■ Before synchronization

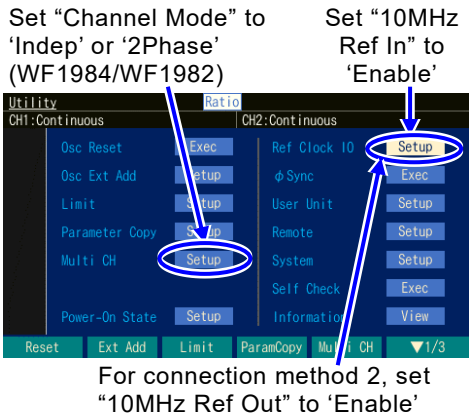
After connecting the primary unit and secondary unit, set on the Utility screen ☞ P.4-25 as shown below.

○ Primary unit



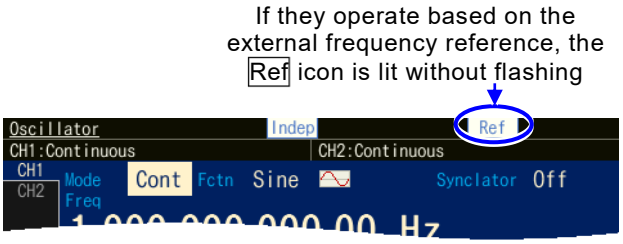
- Select 2-channel independent operation or 2-phase operation (in the Utility screen, set the channel mode setting to ‘Indep’ or ‘2Phase’ ☞ P.8-8) (WF1984/WF1982).
- Enable the frequency reference output (in the Utility screen, set “10MHz Ref Out”: ‘Enable’) ☞ P.10-5
- Set the frequency of each channel (sub-waveform frequency if necessary) used for synchronized operation of multiple units.
- If you want to use an external frequency reference, enable the external frequency reference (“10MHz Ref In”: ‘Enable’ on the Utility screen). ☞ P.10-4

○ Secondary unit



- Select 2-channel independent operation or 2-phase operation (WF1984/WF1982).
- Enable the external frequency reference (“10MHz Ref In”: ‘Enable’ on the Utility screen). ☞ P.10-4
- Set the frequency of each channel (sub-waveform frequency if necessary) used for synchronized operation of multiple units.
- For connection method 2, enable the frequency reference output (in the Utility screen, set “10MHz Ref Out”: ‘Enable’). ☞ P.10-5

Check that all secondary units operate based on the external frequency reference. If the Ref icon is lit without flashing on the status display area at the top of the screen, they operate based on the external frequency reference. See ☞ 「External frequency reference status」.



■ Performing multi unit synchronization

Operate the primary unit to perform synchronous operation.

When this device detects a “synchronization command” in the 10MHz reference signal received at the 10MHz REF IN terminal, it performs its own synchronization operation.

If the following synchronization operation is performed, or if there is a “synchronization command” received at the 10MHz REF IN terminal, the “synchronization command” (while maintaining the frequency) will be superimposed on the 10MHz reference signal output from the REF OUT terminal.

The following two methods are available to perform synchronous operation:

For details ☞「■ **Performing synchronization**」

- ○ Performing ΦSync operation on the Utility screen
- ○ Performing synchronization by long-pressing the TRIG key (conditions apply)

■ 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. At the same time, the reference phase of each channel's sub waveform (internal modulation source) is also initialized.

Even if synchronous operation is performed, the synchronization relationship will be lost if the frequency is changed later. Even if the synchronization relationship is lost, no message is displayed. Perform synchronous operation again.

The synchronization relationship is lost when the connection cable between the primary unit and a secondary unit or between secondary units is disconnected. If you change the setting for the channel mode or external frequency reference, the synchronization relationship is lost.

■ Operational restrictions

There are the restrictions shown in the following table for synchronous operation. Even if the synchronous operation is invalid, performing the synchronous operation causes all channels to stop the oscillation once.

Item	Restriction
Waveform	Invalid for ‘Noise’ and ‘DC’
Modulation	Invalid for ‘FM’ and ‘FSK’.
Sweep mode	Invalid for frequency sweep. Invalid for gated single sweep. The synchronization operation may not be performed correctly during sweep. Perform it during hold.
Burst mode	Invalid
Synclator Function	Invalid during synclator operation.

10. Using External Frequency Reference

10.1 Purpose of Using External Frequency Reference

This product uses a built-in crystal oscillator as the frequency reference, but you can also use an external 10MHz clock as the frequency reference. In addition, you can also output the 10MHz frequency reference clock of this unit to other devices.

Generally, an external frequency reference is used for the following purposes:

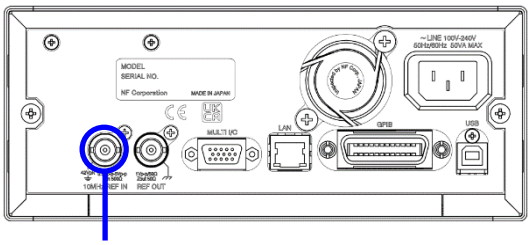
- To use a frequency reference with a higher accuracy than that of the frequency reference built into this product to improve the accuracy and stability of the frequency.
- To use a frequency reference that is common to other units when wish the frequency accuracy to be common.
- To synchronize with other WF198x. For this synchronous operation of multiple units, ☞ P.9-2.

10.2 Connecting an external frequency reference

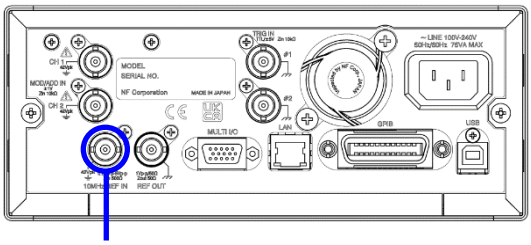
10.2.1 To connect an external 10MHz signal

Connect the external 10MHz signal to the external 10MHz frequency reference input (10MHz REF IN) BNC terminal on the rear panel. Settings are required to use a connected external standard. ☞ P.10-4

WF1983/WF1982



WF1984/WF1982



Input characteristics are as follows:

Input voltage	0.5Vp-p to 5Vp-p
Maximum allowable input	10Vp-p
Input impedance	300Ω, unbalanced, AC coupled
Input frequency	10MHz±50kHz
Input waveform	Sine or square wave (50±5% duty)
Signal GND	Insulated from the enclosure and each channel waveform output terminal (maximum 42Vpk)

If reflection is a problem, use the terminating resistor since the input impedance is not 50Ω.

The signal ground of the external 10MHz 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 WF198x.

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

For cautions on the floating ground connection, ☞ P.3-15.

⚠ WARNING

To prevent electric shocks, do not apply a voltage exceeding 42Vpk (DC + AC peak) between the ground of the BNC connectors insulated from the enclosure and the enclosure.
Also, do not apply a voltage exceeding 42Vpk (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 voltage that is too high may cause the product to burnout.

⚠ 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

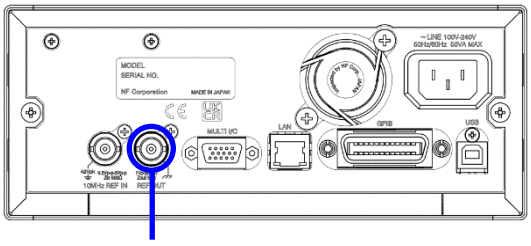
If a difference in potential exists between the grounds of BNC connectors, do not short circuit these BNC connector grounds. This may damage the product.

10.2.2 To use frequency reference output

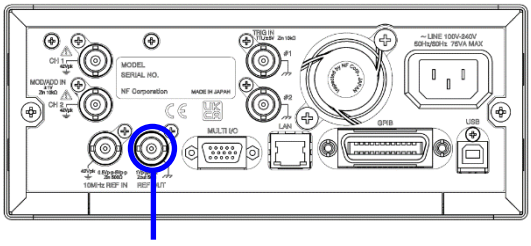
Connect the frequency reference output (REF OUT) BNC terminal on the rear panel to the 10MHz reference input terminal of the external device.

Use when you want to align the frequency and phase of multiple WF198x units. ☞ P.9-1

WF1983/WF1981



WF1984/WF1982



Output characteristics are follwos:

Output voltage	1Vp-p / 50Ω
Output impedance	50Ω, AC cuppled
Output frequency	10MHz
Output waveform	Square wave (Synchronous command superimposed)
Signal GND	Same potential as the enclosure

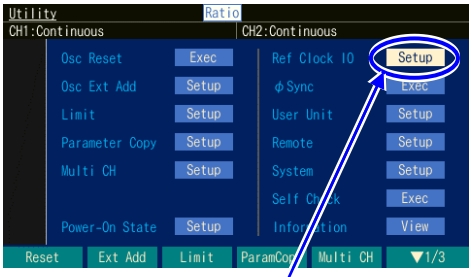
The frequency reference output of this instrument can be turned on/off by setting. ☞ P.10-5
To reduce unnecessary radiation and noise, please turn off when not in use.

Since a synchronization command is superimposed on the frequency reference output (☞ P.9-5), we do not recommend connecting any equipment other than our specified equipment (WF198x series, etc.) to the frequency reference output.

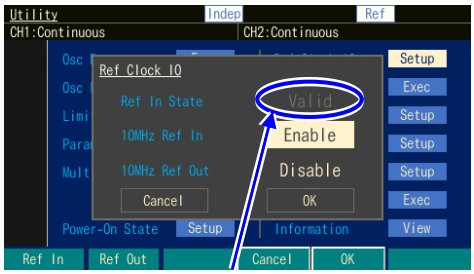
10.3 To use an external frequency reference input/output

10.3.1 Enabling external frequency reference input

You can enable/disable the external frequency reference input in the Utility screen. ☞ P.4-25
You can enable external frequency reference input by following the steps below.



Select “Ref Clock IO” and then press the ENTER key



When an available frequency reference is applied, “Valid” will be displayed in the “Ref In State” field
If not, “Invalid” will be displayed

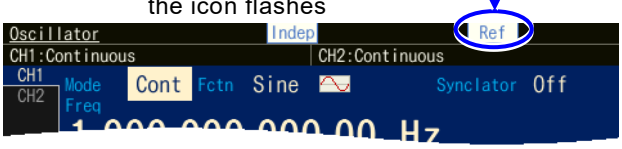
1. In the Utility screen (☞ P.4-25), select “Ref Clock IO” field. ☞ P.4-14
   Press the rightmost soft key [▼n/3] several times until it becomes [▼2/3], then do the same with the [Ref Clock] soft key.

2. The external frequency reference operation dialog will be displayed, so select the “10MHz Ref In” field to be set. ☞ P.4-14
   External frequency reference input options will be displayed, select ‘Enable’ ☞ P.4-18

3. Select [OK] at the dialog, and then press the ENTER key. You can also use [OK] soft key.
   If you select [Cancel] and press the ENTER key or press the CANCEL key, the settings will not be changed.

If the “10MHz Ref In” setting of Ref Clock IO dialog is ‘Enable’ and the status of “Ref In State” is “Valid”, then this product operates using the signal input to the external 10MHz frequency reference terminal as the frequency reference.
However, if the external frequency reference signal is interrupted, the frequency reference is automatically switched to the built-in frequency reference. After that, if the external frequency reference signal is restored, this product will resume operation using it as the frequency reference.
What is used as the frequency reference is always displayed on the status display area at the top of the screen. If the Ref icon is lit without flashing on the status display area at the top of the screen, they operate based on the external frequency reference. See ☞ 「External frequency reference status」 .

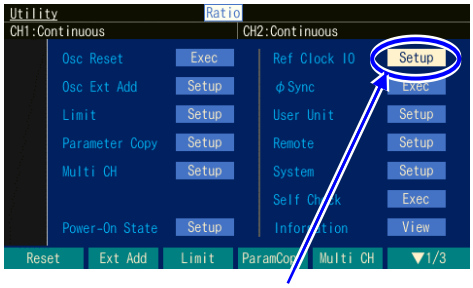
If the current frequency reference is external, the Ref icon is displayed
If the status of reference input is Invalid, the icon flashes



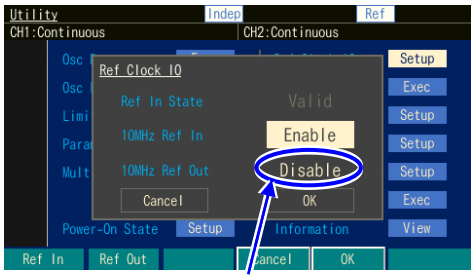
10.3.2 To turn on the frequency reference output

Frequency reference output can be turned on/off on the Utility screen. ☞ P.4-25

You can turn on the frequency reference output by following the steps below.



Select “Ref Clock IO” and then press the ENTER key



Frequency reference output is turned on when this is ‘Enable’ and turned off when it is ‘Disable’

1. In the Utility screen (☞ P.4-25), select “Ref Clock IO” field. ☞ P.4-14
Press the rightmost soft key [▼n/3] several times until it becomes [▼2/3], then do the same with the [Ref Clock] soft key.

2. The external frequency reference operation dialog will be displayed, so select the “10MHz Ref Out” field to be set. ☞ P.4-14
External frequency reference output options will be displayed, select ‘Enable’ ☞ P.4-18

3. Select [OK] at the dialog, and then press the ENTER key. You can also use [OK] soft key.
If you select [Cancel] and press the ENTER key or press the CANCEL key, the settings will not be changed.

To reduce unnecessary radiation and noise, please turn off when not in use.

11. Using Sequence Oscillation

11.1 About Sequence Oscillation

Sequence oscillation is the operation to output while automatically changing the amplitude, frequency, and other parameters according to a predetermined procedure.

For example, you can output a 2kHz, 2Vp-p triangular wave for 2s immediately after outputting a 1kHz, 1Vp-p sine wave for 1s. In addition, repeating a specified number of times and branching according to the inputs of external signals are also possible.

In WF1984/WF1982, the step transitions of the two channels are common.

For details, ☞ P.11-4.

11.2 Sequence Oscillation Example

As a simple example of sequence oscillation, this section describes how to build a sequence to change DC voltage in three stages as shown in the following figure. The setting details are shown in Table 11-1. The operation is described in step transition order on the next page. (First, restore the initial setting in the Utility screen. ☞ P.4-27)

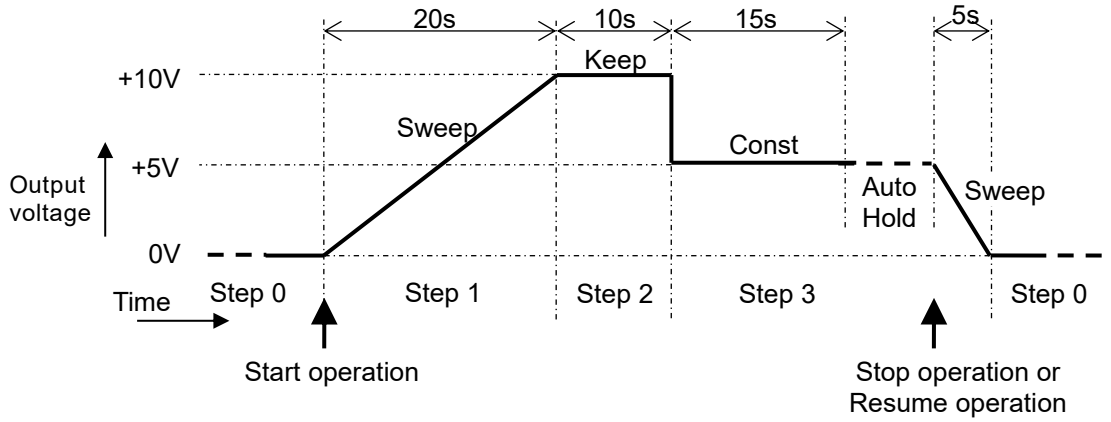


Table 11-1 Sequence setting details

Step number	Step control parameters AutoHold, JumpTo, Count, etc.				Intra-step channel parameters Fctn, Freq, Amptd, etc.
0	Time: 5s	StopPhs: Off		Code: Any	Fctn: DC Offset:0V Action: Sweep
1	Time: 20s	AutoHold: Off StopPhs: Off StateB: Off EventB: Off	JumpTo: Off StepTerm: Continue Code: Any		Fctn: DC Offset: +10V Action: Sweep
2	Time: 10s	AutoHold: Off StopPhs: Off StateB: Off EventB: Off	JumpTo: Off StepTerm: Continue Code: Any		Fctn: DC Offset: ---- Action: Keep
3	Time: 15s	AutoHold: On StopPhs: Off StateB: Off EventB: Off	JumpTo: Off StepTerm: End Code: Any		Fctn: DC Offset: +5V Action: Const

・Step 0

These are the special output settings for transitioning before the sequence begins and when the sequence ends.
In this example, the system waits for the sequence to start in the state of 0V DC.

"Time" and "Action" of Step 0 are enabled only when the sequence ends, and have no meaning here. They will be explained later. See for detail of Step 0. ☞ P.11-9

・Step 1

When the sequence starts, the sequence goes to Step 1.
Since "Time" is set to 20s, "Offset" is set to +10V, and "Action" of "Offset" is set to 'Sweep', the output voltage rises linearly from 0V to +10V over 20s.
Once the output voltage has reached +10V after 20s, since "StepTerm" is set to 'Continue', the sequence moves on to the next step, Step 2.

・Step 2

Since "Time" is set to 10s and "Action" of "Offset" is set to 'Keep', the last value of the previous step, Step 1, which is +10V, is held for 10s.
After the lapse of 10s, since "StepTerm" is set to 'Continue', the sequence moves on to the next step, Step 3.

・Step 3

Since "Time" is set to 15s, "Offset" is set to +5V, and "Action" of "Offset" is set to 'Const', a constant value, which is +5V, is held for 15s. When the sequence moves on from Step 2 to Step 3, the output voltage abruptly changes from +10V to +5V.
After the lapse of 15s, since "AutoHold" is set to 'On', the sequence goes into standby in that state. After that, when the stop operation is performed, the sequence moves to Step 0.

Since "StepTerm" is set to 'End', the sequence moves to Step 0 even if the resume operation is performed.
Note that if "StepTerm" is set to 'Continue', the sequence moves to Step 4 when the resume operation is performed.

・Step 0

Since "Time" is set to 20s, "Offset" is set to 0V, and "Action" of "Offset" is set to 'Sweep', the output voltage rises linearly from + 5V to 0V over 20s.
Once the output voltage has reached 0V after 5s, the sequence goes into standby in that state. When the start operation is performed at this point, the same sequence is repeated.

11.3 Basics of sequence oscillation

This section explains what you need to know when using sequence oscillation.

a) Difference between Sequence oscillation and normal oscillation

This instrument has two operating modes, one of which is normal oscillator, which is used to generate various test signals mainly manually. (Switching the operating mode, see ☞ P.4-15.)
On the other hand, sequence oscillation is an operation in which the waveform generation FPGA's built-in processor outputs signal while controlling various parameters instead of manual operation. Sweeping multiple parameters and switching waveforms can be done automatically. In this mode, you can generate a program that operates the processor by inputting steps in advance and compiling them. However, with WF1984/WF1982, it is not possible to set only one channel to sequence oscillation mode.
You can also automatically switch to sequence oscillation mode when the power is turned on. ☞ P.4-29

b) Common settings, step control parameters and intra-step channel parameters

Sequence oscillation has the following 3 main types of parameters.

- Common settings

  Sequence oscillation consists of multiple steps linked to each other. Setting items that are common within this sequence regardless of the step are common settings.
  Select this item [...] in the figure below (☞ P.4-14) to open the settings dialog.
  For details, ☞「Common settings for sequence」.

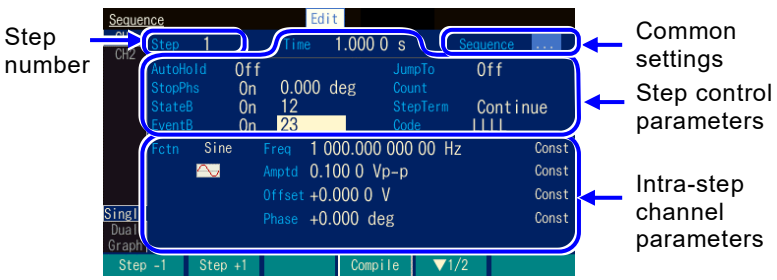
- Step control parameters

  The step flow is controlled by the step control parameters. These parameters determine the step duration time and the next step. For convenience, the step synchronization code output setting is also included in the step control parameters.
  For details, ☞「Individual explanation of step control parameters」.

- Intra-step channel parameters

  This is a parameter that determines the output state within each step for each channel. Defines the waveform, along with basic parameters such as frequency and amplitude, and how they change within a step. For details, ☞「Individual description of channel parameters」.

When the display format is text display



Examples of other display formats are, ☞ P.11-21. To switch the display format, ☞ P.4-11.

c) Intra-step parameter change pattern

Some of the intra-step channel parameters can be changed automatically within the step. There are the following three ways of doing this. These are called action settings. In the case of waveform parameters, there is no action setting. Instead, the setting is always done in that step.

- Constant: 'Const'

  The value is fixed to that setting specified in the step.

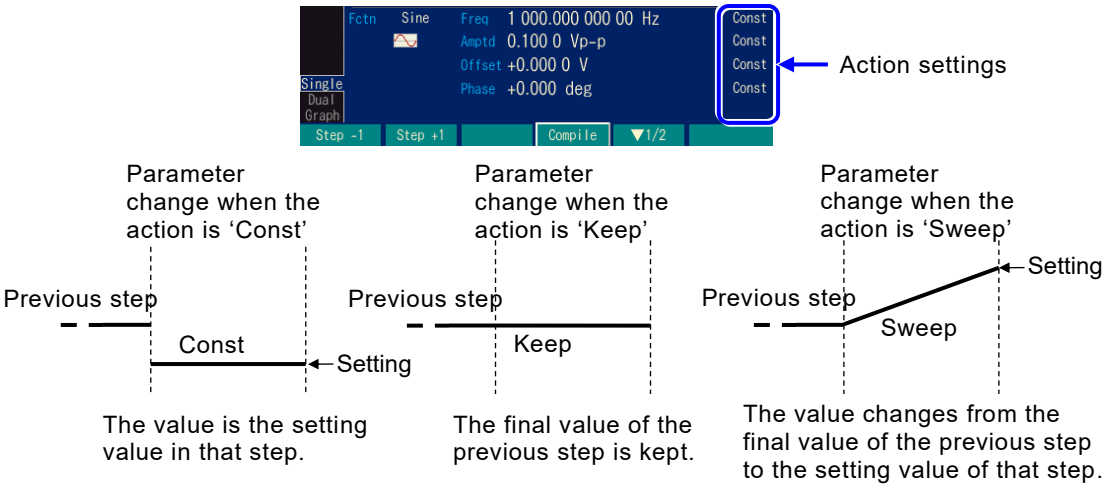
- Keep: 'Keep'

  The value immediately before the move to that step is maintained. This means, the value changes according to the status of the previous step.

  When the action setting is set to 'Keep', you will not be able to set the parameter value. In Step 0, 'Keep' cannot be selected.

- Sweep: 'Sweep'

  The value changes linearly over the step time from the value immediately before to the value set in that step. This means that the set value is reached when the step time of that step has elapsed. The starting value changes according to the status of the previous step.



The parameters that can be set for "Action" are as follows:

- Frequency: "Freq"

  When the waveform is 'Noise'/ 'DC', "Action" cannot be set including the frequency itself.

- Amplitude: "Amptd" / DC offset: "Offset"

  When the waveform is 'DC', the amplitude "Action" cannot be set including itself.

- Phase: "Phase"

  When the waveform is 'Noise'/ 'DC', you cannot set the phase itself, and when it is an arbitrary wave, "Action" cannot be set.

- Duty: "Duty"

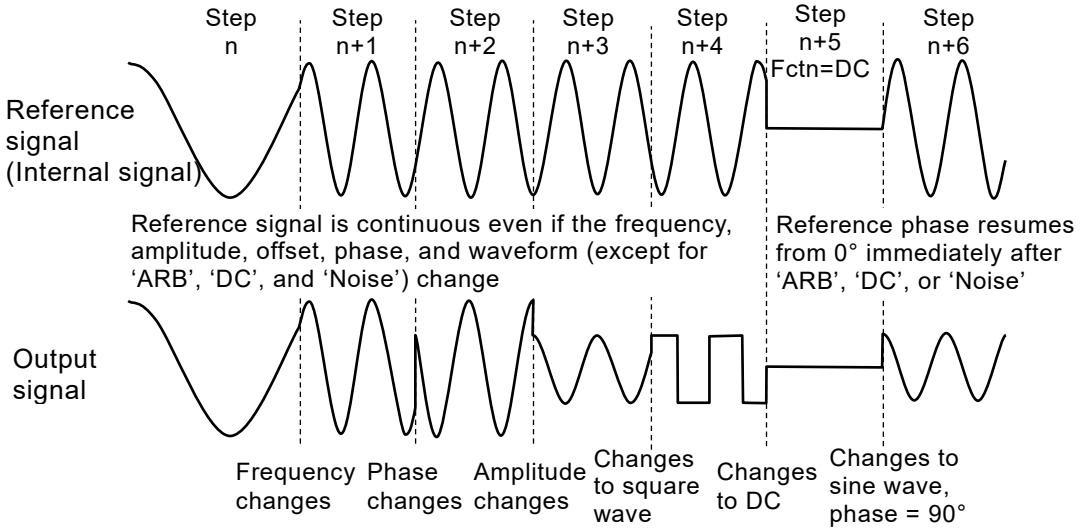
  Only when the waveform is a square wave, "Action" can be set including the duty itself.

Parameters that cannot be set as "Actions" will behave equivalent to 'Keep'.

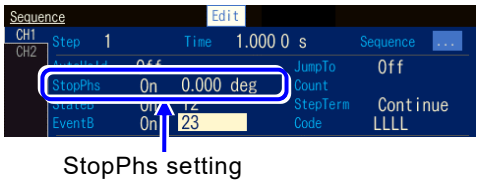
d) Phase during sequence oscillation

With sequence oscillation, the reference phase is generated inside the unit and then the reference phase with the value set in “Phase” added to it is output. The reference phase changes continuously even if the frequency / amplitude / offset / phase changes. With the exception of an arbitrary waveform ‘ARB’, ‘DC’, or ‘Noise’, it changes continuously even if the waveform changes.

The reference phase resumes from 0° immediately after ‘ARB’, ‘DC’, or ‘Noise’ has been output.



e) Phase at step end: “StopPhs”

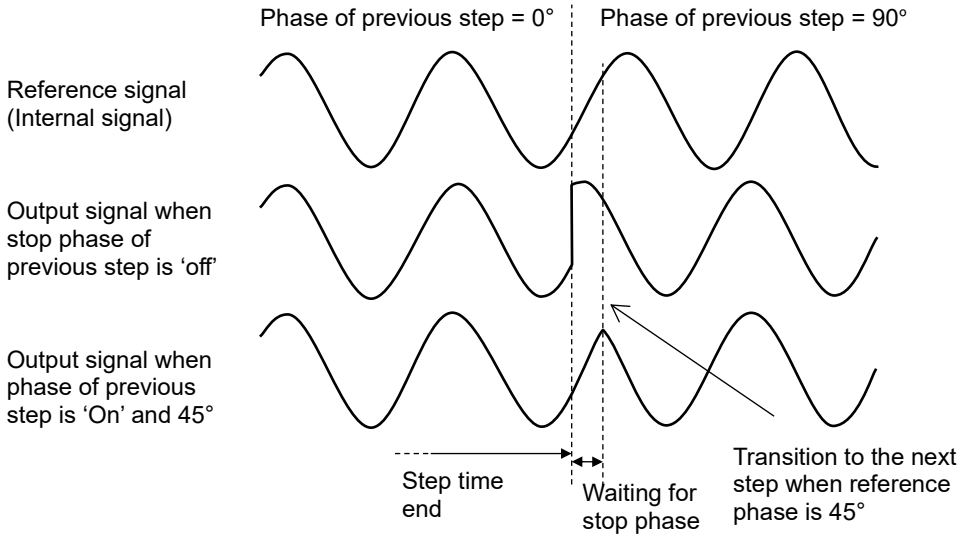


Normally, when the prescribed step time has elapsed, the sequence moves to the next step regardless of the reference phase. But, if you wish to set a sequence that moves to the next step when the waveform reaches a certain phase, it is possible to specify the stop phase.

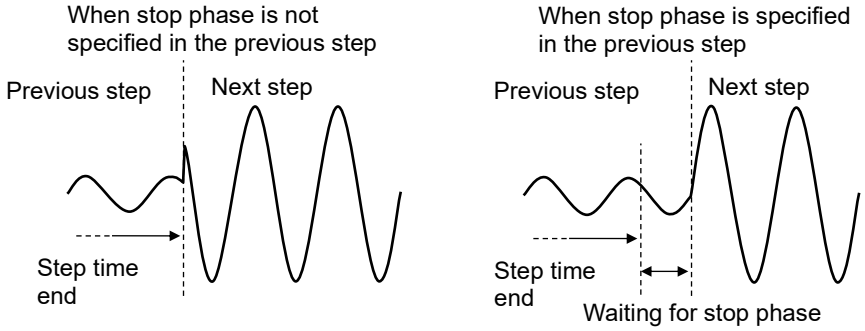
However, with WF1984/WF1982, operation is with respect to the phase of channel 1. The stop phase cannot be set for channel 2. In addition, when the waveform is a ‘Square’, ‘Noise’, ‘DC’ or ‘Ramp’ wave with symmetry other than 50%, it is not possible to specify the stop phase. With an arbitrary waveform, it can only be with the phase set in “Phase” regardless of the setting of “StopPhs”.

When the stop phase is specified, after the lapse of the prescribed step time, the sequence moves to the next step when the specified reference phase has been reached, with the output setting maintained as is (sweep is not performed during this interval). As a result, the actual step time is longer than the specified step time. The sequence moves on to the next step with a continuous phase regardless of the stop phase setting.

The following figure shows examples in which the stop phase is specified and in which it is not specified when the phase between steps is changed quickly. These are examples when the phase setting value and stop phase setting value are both set to 0° in the previous step and 90° in the next step, and the stop phase is set to 45°. In both cases, the reference phase is continuous at the transition of the steps. When “StopPhs” is ‘On’, the sequence proceeds to the next step when the reference phase is equal to the set value.



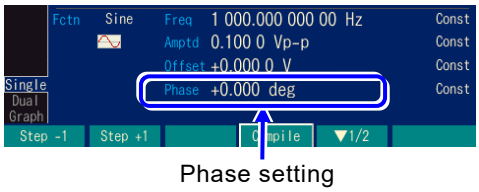
Similarly, the following figure shows examples in which the stop phase is specified and in which it is not specified when the amplitude is changed quickly. These are examples when the phase setting value and stop phase setting value are both 0°. In both cases, the phase is continuous at the transition of the steps.



Check

- The stop phase setting cannot be set for a ‘Square’, ‘Noise’, and ‘DC’.
- When the stop phase is on in an ‘ARB’, the actual “StopPhs” is fixed at the oscillation start phase (“Phase” value) regardless of the ‘StopPhs’ specification.
- The sequence changes to the next step after approximately 650ns (equivalent to 0.234° at 1kHz) has elapsed from the specified stop phase.

f) Phase at step start

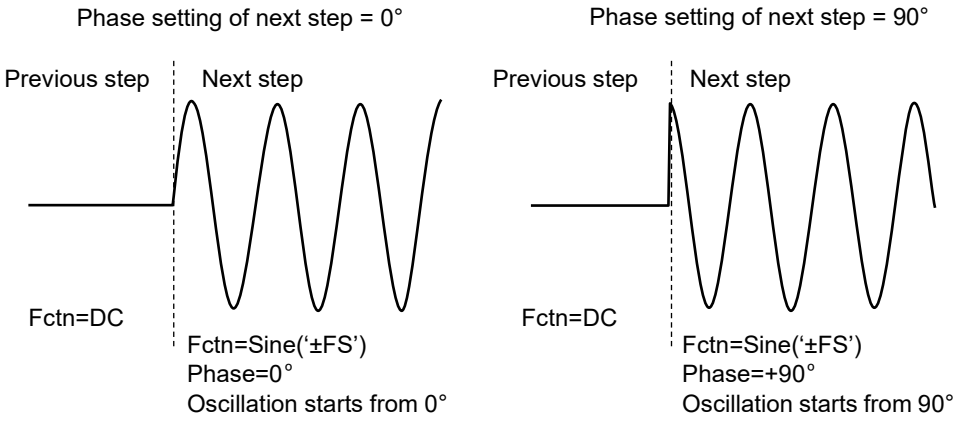


If the waveform of the previous step was an 'ARB', 'DC', or 'Noise', oscillation in the next step starts from reference phase 0°.

Phase setting is the value added to the reference phase. The starting phase that appears in the actual output is the reference phase at that time + the phase setting value for that step.

If the phase setting is set to 0º, oscillation will start from the reference phase at that time.

The following figures show examples of when the phase is set to 0° and when the phase is set to 90°, where the step after DC is sine wave.



Check

When you wish to specify the start phase, set the previous step to 'ARB'/ 'DC'/ 'Noise'.

g) Frequency during DC or Noise waveform output

If the action of frequency is set to Sweep in the next step of 'DC' or 'Noise', the sweep begins from 1kHz in the next step.

h) Two types of branches

The control flow can be changed by the panel operation or by the external signals. This is called branching. For example, branching can be used to set the sequence to move to a different step in response to a status change of the equipment under test.

There are two types of branches as follows:

- State branch: StateB

  The operation branches to the specified step according to a signal from a multi-I/O connector (pin 14). ☞ P.11-11

  However, the signal from the multi-I/O connector is checked only after the step time of that step has elapsed (excluding the time that held). ☞ P.11-13

- Event branch: EventB

  The operation branches immediately to the specified step according to the soft key operation or the signal from a multi-I/O connector (pin 11). Even if the stop phase has been set, it is ignored.

  Internal processing occurs every time an event branch is entered. If you input a signal that includes chattering, multiple processes will be executed and it will take extra time to branch, so please input a signal that does not have chattering.

  This function can be used for evacuation processing when an abnormality is detected.

i) Step 0 before the start and at the end

The step in a standby state before the start of sequence is called Step 0. Step 0 is also the state at the end of the sequence. When the mode changes from the normal oscillation (Oscillator) to sequence oscillation, the status changes to the Step 0. Only the following three items can be set for the step control parameters. Since Step 0 is special, the meanings that can be set in the step control parameters are different from other steps, as shown below.

- Step time: “Time”

  Time to execute Step 0 at the end of the sequence. When a sequence starts, it immediately moves to the next step (usually Step 1) regardless of this time. If ‘Sweep’ is set in the “Action” setting of the step channel parameter of Step 0, the sweep will be performed over this time at the end of the sequence. ☞ P.11-5

- Stop phase: “StopPhs”

  At the start of the sequence, the sequence waits for the reference phase specified here and then moves to the next step (normally Step 1). This setting is disabled for a square wave, ‘Noise’, and ‘DC’.

- Step synchronization code output: “Code”

  This is the step synchronization code output of Step 0.

The action setting of intra-step channel parameters consists of ‘Const’ (constant) and ‘Sweep’ (sweep) only. It does not include ‘Keep’ (keep). This means, the same output setting is always applied to the start and the end.

j) Limitation of available waveform

The waveforms that can be used for sequence oscillation are limited to ‘Sine’, ‘Square’ (both standard and extended duty variable range), ‘Ramp’, ‘Noise’, ‘DC’, and arbitrary waveform ‘ARB’. When you wish to use a parameter variable waveform, copy the desired waveform to the ARB and save it as an ARB in advance in the ARB Edit screen. During sequence oscillation, it is not possible to specify the parameters of the parameter variable waveform. When you wish to use a pulse waveform, save the half sine edge pulse of the parameter variable waveform as an ARB.

k) Waveform size

In sequence oscillation, all waveforms to be used automatically are saved in waveform memory in advance when preparing for execution. ☞ P.11-16

Therefore, when many types of waveforms are used, the memory size allocated to one waveform becomes smaller. However, the waveform memory is not used for DC, sine wave, square wave (regardless of whether the duty variable range is standard or extended) and ramp wave. In addition, the required memory size does not change when the same waveform is used repeatedly.

Beware of the following points:

- When the memory size that can be allocated becomes smaller, an arbitrary waveform 'ARB' in control point format with many abrupt changes may lose its characteristics.
- When a large ARB in array format is used, the memory size that can be allocated to other waveforms becomes smaller.
- For ARBs, memory may be reserved for each phase setting even for the same waveform. For example, if there are 5 different phase settings, up to 5 times more memory is required.

The following table shows the memory size that can be allocated to each waveform:

Waveform	Size	Resizability
'DC' or 'Square'/ 'Sine'/ 'Ramp' wave	0	Fixed
'Noise'	65 728 words	Fixed
'ARB' (control point format)	Automatically converted to 16Ki words to 1Mi words	Variable
'ARB' (array format)	Extended to multiple of 32 words	Fixed

When a parameter variable waveform, square waveform, pulse waveform, or ramp waveform is copied to an ARB, it becomes an ARB in control point format.

'Noise' is always used in a memory size of 65 728 words. The size is fixed. However, this does not mean that the same pattern is repeated during output.

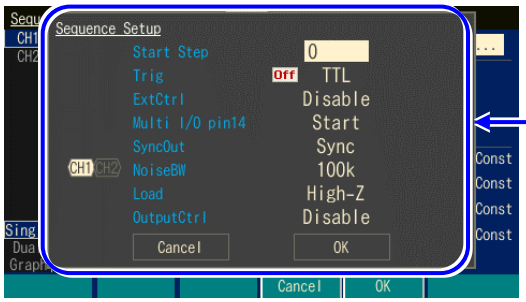
For an ARB in array format, the waveform size transferred from the USB flash drive or external control is extended to a multiple of 32 words. For an ARB in control point format, the size is allocated within the range of 16Ki words to 1Mi words according to the frequency for each step. The waveforms of steps with the same waveform length are used commonly.

If 16Ki words cannot be secured, an insufficient memory error occurs. The ARB s in the control point format are not simply thinned but expanded to the memory in such a way that the characteristics of the waveforms are maintained as much as possible.

l) Channel coordination (WF1984/WF1982)

The step control parameters are common to both channels. The sequence makes the same step transition for both channels. However, since the stop phase can be controlled only by the channel 1 side, the stop phase of channel 2 does not necessarily match the desired value.
On the other hand, the intra-step channel parameters can be set independently for each channel.

m) Common settings for sequence



Select [...] the right of the “Sequence” field and press the ENTER key to open common settings dialog

The following items are common settings within one sequence.
For WF1984/WF1982, noise bandwidth/load impedance/output control is set for each channel. These settings apply to the active channel. ☞ P.4-24

- Start step: “Start Step”
  The number of the next step, to which the sequence moves to after Step 0, can be specified (1 to 1023). Usually, this is set to 1. ☞ P.4-16
  You can start from the middle by specifying a value other than 1.

- External trigger polarity: “Trig”
  When using the external trigger input (TRIG IN) BNC terminal as the sequence start trigger, its polarity (Positive/Negative/Off) and threshold (TTL/Variable) can be specified. ☞ P.4-18
  When it is not used, set this item to ‘Off’. If you select ‘Variable’ for the threshold, you can specify the threshold voltage. ☞ P.4-16 For external trigger input terminal, ☞ P.3-10.
  With WF1984/WF1982, only the trigger input terminal on the channel 1 side is enabled.

- External control: “ExtCtrl”
  ‘Enable’/ ‘Disable’ this item to control the start, stop, hold/resume, and branch of the sequence by using the signal from the multi-I/O connector. ☞ P.4-18
  If not used, set to ‘Disable’ ☞ P.11-18 For multi-I/O connector, ☞ P.3-13.

- Allocation of pin 14 of multi-I/O connector: “Multi I/O pin14”
  Pin 14 of the multi-I/O connector can be allocated either to the sequence start (set to ‘Start’) or to the state branch (set to ‘State Branch’).

- Synchronization output: “SyncOut”
  This selects (☞ P.4-18) whether to output the waveform synchronization signal (set to ‘Sync’) or LSB (set to ‘StepCode (LSB)’) of the step synchronization code (☞ P.11-20) to the synchronization/sub-output terminal. If LSB of the appropriate step synchronization code is set to ‘H’ and output, it can be used as the trigger source to enable a simplified check of the sequence to be executed with an oscilloscope.
  For synchronization/sub-output terminal, ☞ P.3-8.

- Noise bandwidth: “NoiseBW”
  When a ‘Noise’ waveform is selected for a step in the sequence, set its noise bandwidth. This bandwidth is common for all steps. ☞ P.4-56
- Load resistance: “Load”
  Set the load resistance value in the sequence oscillation mode. You can select no-load/variable (☞ P.4-18) and set the load impedance (☞ P.4-16) when variable.
  For load resistance, please refer to the explanation in normal oscillation mode. ☞ P.4-45
- Output control: OutputCtrl
  Set waveform output (FCNT OUT) in the sequence oscillation mode to on/off.
  When this setting is ‘Enable’, on/off of waveform output (FCNT OUT) changes under the following conditions.
  - When transitioned to the Run state, waveform output (FCNT OUT) turns on.
  - When transitioned to the Rdy state, waveform output (FCNT OUT) turns off.

  Output control by normal (OUT) key operation is always enabled regardless of this setting.

n) External addition on/off setting

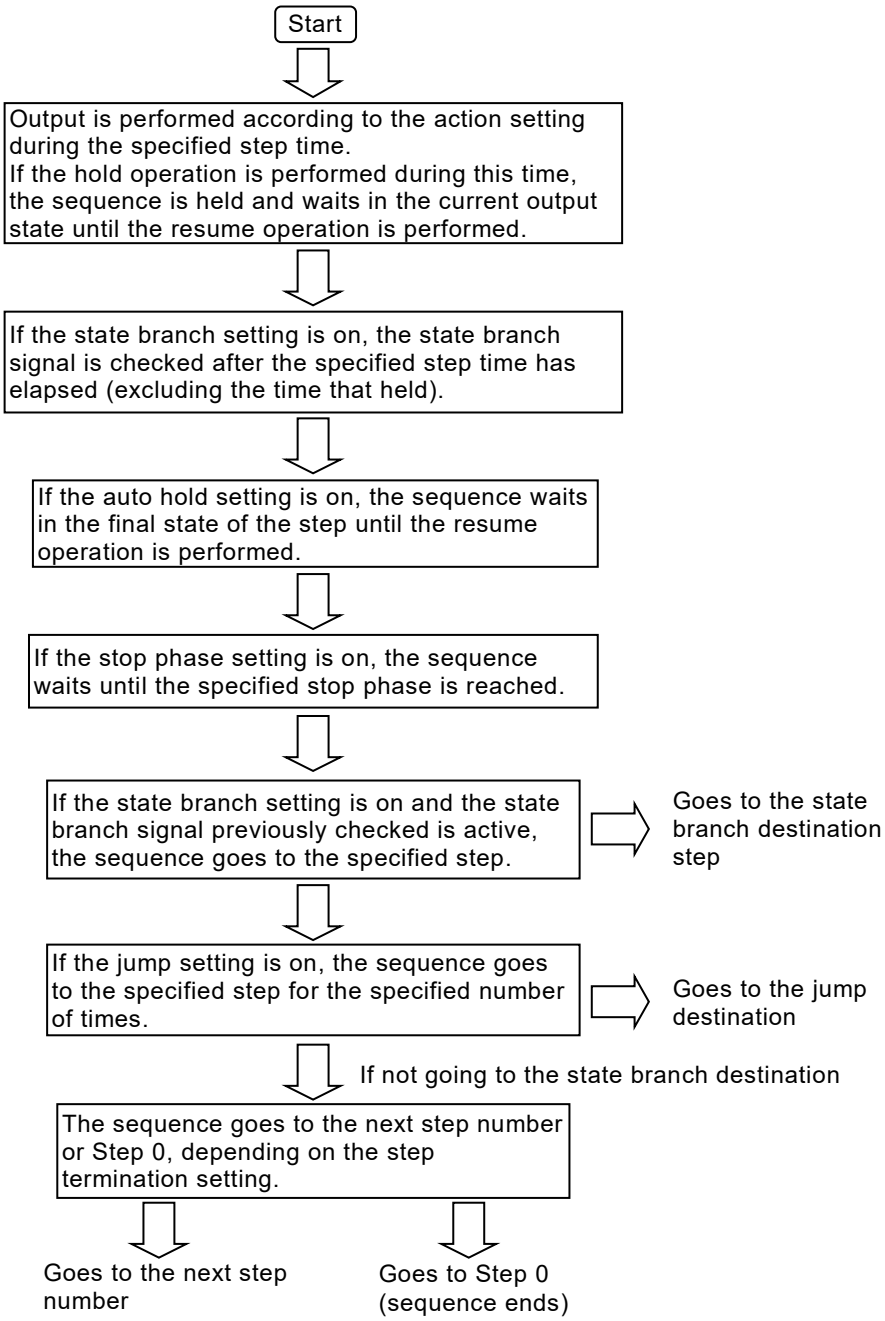
Set external addition on/off during sequence execution.
It is off during sequence editing regardless of the settings. It turns on when compilation is complete and remains on until you return to editing.
If the amplitude range determined by the maximum output level of the entire sequence does not match the amplitude range determined by the multiplication factor of this setting, an error will occur during compilation.
The setting procedures and restrictions are the same as for Oscillator. The details are the same as the normal oscillator settings. ☞「4.4.13 To Add External Signal」

o) Other limitations

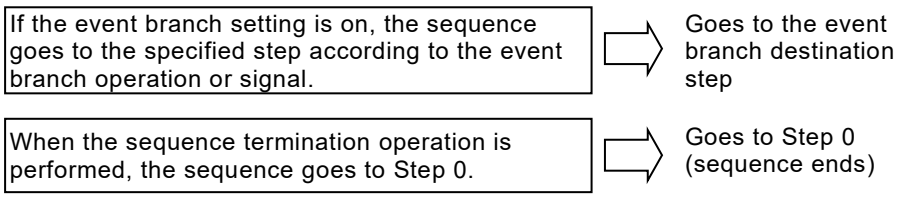
- With WF1984/WF1982, it is not possible to set only one channel to sequence oscillation mode.
- The amplitude range is automatically determined according to the maximum output level of the overall sequence. During sequence execution, range switching does not occur. ☞ P.4-44
- The value set on the Utilty screen is used as the condition for external addition. ☞ P.4-47
- Stop phase cannot be turned on for ‘Square’/ ‘DC’/ ‘Noise’. For arbitrary waveforms, the phase set in “StopPhs” is ignored and is considered equivalent to the “Phase” setting. ☞ P.11-6
- “Action” of arbitrary waveform phase cannot be set (equivalent to ‘Keep’ fixed) ☞ P.11-5

11.4 In-Step Processing Flow

The following figure shows the flow of processing within one step.



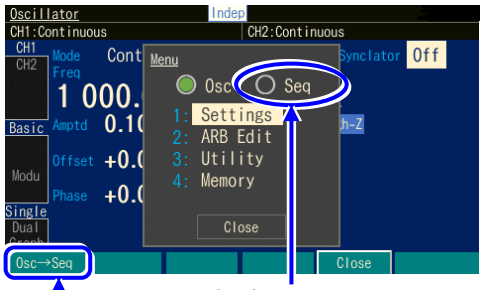
The following transitions occur as a result of event branching or termination operation, regardless of the flow in the step.



11.5 Setting and Operation Procedure

Create and edit a sequence in sequence oscillation mode.

a) To switch to Sequence oscillation mode



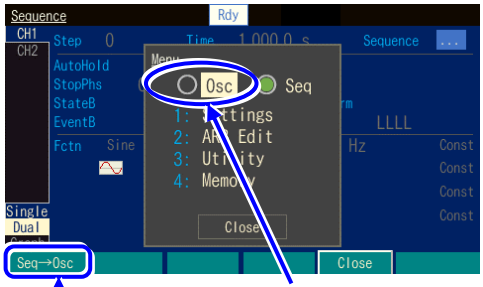
[Osc→Seq] soft key also available

In the top menu, select “Seq” and then press the ENTER key

1. Press the (MENU) key to display the top menu window. Select “Seq” and then press the (ENTER) key. You can also use [Osc→Seq] soft key.
2. A dialog will appear to confirm the transition to sequence oscillation mode, so select [OK] on the dialog and press the (ENTER) key. Now move to sequence oscillation mode.
   The sequence creation/edit screen will be displayed, and the status of Step 0 will be output.

To automatically switch to sequence oscillation mode when power is turned on ☞ P.4-29

b) To return to normal Oscillator mode



[Seq→Osc] soft key also available

In the top menu, select “Osc” and then press the ENTER key

1. Press the (MENU) key to display the top menu window. Select “Osc” and then press the (ENTER) key. You can also use [Seq→Osc] soft key.
2. A dialog will appear to confirm the transition to normal oscillation mode, so select [OK] on the dialog and press the (ENTER) key. Now move to normal oscillation mode.

■ Necessity of storing sequence data

The created/edited sequence data will be volatile when the power supply is cut off while the power is on, so please save it if necessary. ☞ P.11-22

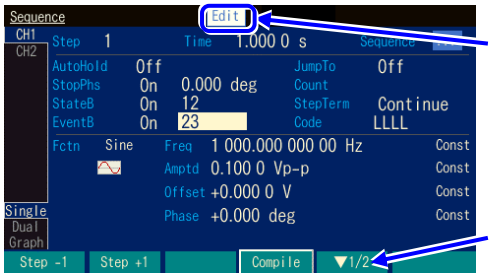
Press the (MENU) key and select “4: Memory” from the top menu, then press the soft key [Store] to open the save settings dialog. Saving can be done before or after performing the [Compile] operation (but only in the Edit state).

c) To create/edit a sequence

There are 3 types of sequence screens. ☞ P.4-10, 11-21 Here, we will explain using the text display “Single” screen. Screen switching can be done on, ☞ P.4-11.

When creating a new sequence, configure the settings one step at a time.

The [Copy] soft key and [Paste] soft key (soft key 2nd row) allow you to reuse existing settings. Targets that can be copied and pasted are step control parameters and intra-step channel parameters.



In the creating/editing screen, Edit is displayed

The soft keys are two rows, can switch using this soft key

During editing, the waveform of the selected step is output to the waveform output.

In the sequence creating/editing screen, Edit is displayed in the status display area of the screen.

The soft key items in the sequence creating/editing screen are as follows:

■ Soft keys in Edit state

○ First row (“Single” and “Dual” screens)

Indicates the first row

Go to the previous or next step number with [Step +1] or [Step −1].

Make the sequence executable with [Compile]. ☞ P.11-16

○ First row (“Graph” screen)

Go to the previous or next step number with [Step +1] or [Step −1].

Adjust the vertical-axis scale of graph display so that the scale does not become saturated with [AutoScale].

Make the sequence executable with [Compile]. ☞ P.11-16

○ Second row (“Single”, “Dual”, and “Graph” screens)

Indicates the second row

Step parameters (both step control parameters and intra-step channel parameters) corresponding to the step number currently displayed can be copied and pasted, or the step itself can be cut and inserted.

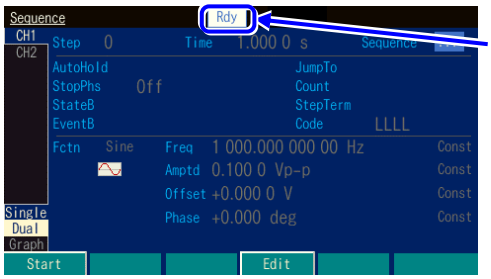
Intra-step channel parameters of the currently displayed step number can be deleted, copied, and pasted with [Cut], [Copy], and [Paste]. With WF1984/WF1982, these soft keys function on the active channel (☞ P.4-24).

Even when a step is cut and inserted, the step numbers referenced in each step (jump destination and branch destination) are not changed.

Note that these sequence data will be lost when the power supply is cut off while the power is on. ☞ 「■ **Necessity of storing sequence data**」

d) To prepare for sequence execution

Just recalling or creating/editing a sequence does not make the sequence executable.
When the [Compile] (compilation) soft key is pressed in the Edit state, the settings are checked to determine whether they are appropriate, the waveform data is allocated, and the optimum output range settings are configured to make the sequence executable (Ready).



When complication ends successfully, Rdy is displayed.

If any setting that is inappropriate for execution is found as a result of compilation, an error message is displayed.
When compilation ends successfully and the sequence becomes executable, Rdy is displayed in the status area (☞ P.4-7).

The soft key items in this state are as follows:

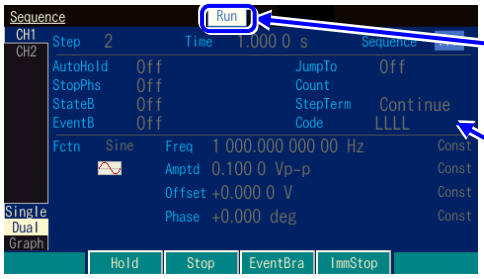
■ Soft keys in Rdy state

Start sequence execution with [Start]. ☞ P.11-16
Return to the creating/editing sequence screen with [Edit]. ☞ P.11-17

Note that these sequence data will be lost when the power supply is cut off while the power is on. ☞ 「■ **Necessity of storing sequence data**」

e) To execute the sequence

Press the [Start] soft key in the Rdy screen to start sequence execution.
When the sequence begins, Run is displayed in the status display area of the screen.



When the sequence begins, Run is displayed

Displays the steps being executed

The screen displays the step being executed (horizontally scrolls when displaying a Graph).

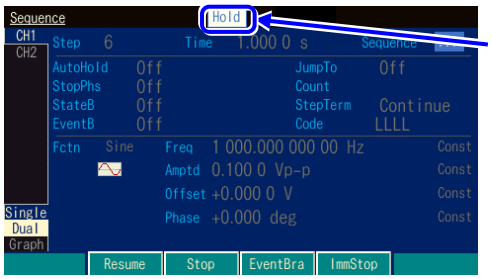
Due to execution performance, display updates for short steps will be thinned out to some extent.

Execution can also be started using signals from the multi-I/O connector or external trigger terminal. ☞ P.11-18
The soft key items in this state are as follows:

■ Soft keys in Run state

Pauses the sequence with [Hold]. ☞ P.11-17
Stop after the time set in Step 0 has elapsed with [Stop] ☞ P.11-17
When you press [EventBra] key, an event branch occurs. ☞ P.11-17
Stop immediate and enter the Step 0 state with [ImmStop]. ☞ P.11-17

f) To pause sequence execution



In the hold state, Hold is displayed

Press the [Hold] soft key in the Run state to pause the sequence. The sequence goes into standby while keeping the output condition as is.
To resume the sequence, press the [Resume] soft key in the Hold state.
Operation by external input ☞ P.11-18
In the hold state, Hold is displayed.

The soft key items in this state are as follows:

■ Soft keys in Hold state

Resume the sequence with [Resume].
Stop after the time set in Step 0 has elapsed with [Stop]. ☞ P.11-17
When you press [EventBra] key, an event branch occurs. ☞ P.11-17
Stop immediate and enter the Step 0 state with [ImmStop]. ☞ P.11-17

g) To execute an event branch

Press the [EventBra] soft key in the Run or Hold state to execute an event branch. If the event branch is set to on in the step which is being executed at that moment, the sequence moves to the specified step.

h) To terminate the sequence

If you press the soft key [Stop] in the Run or Hold state, the sequence will move to Step 0, and the sequence will end after the time set in Step 0 has elapsed.
Rdy is displayed in the status display area of the screen. The sequence can be restarted at any time.

> **Check**
> Note, even if you end the sequence with the soft key [Stop] or [ImmStop], the sequence will be restarted immediately if there is a falling edge of the multi-I/O terminal set for start control or a valid edge of the external trigger terminal.

i) To forcibly terminate the sequence without waiting for the stop phase or sweep

Press the [ImmedStop] soft key in the Run or Hold state to immediately terminate the sequence without waiting for the stop phase or sweep execution. The setting switches to Step 0.

j) To edit the sequence again

Press the [Stop] soft key in the Run or Hold state to terminate the sequence. When it has terminated, press the [Edit] soft key in the Rdy state to enable creating and editing the sequence again. To execute the sequence, press the [Compile] soft key in the Edit state again.

k) To control the start, stop, and pause of a sequence using an external logic signal

When the external control "ExtCtrl" in the common settings is set to 'Enable', the sequence operation can be performed by TTL level logic input to the multi-I/O connector on the rear panel. It is recommended that this be set to 'Disable' when not using an external control signal in order to avoid malfunctions caused by exogenous noise. ☞ P.11-11
For the multi-I/O connectors and their pin allocation, ☞ P.3-14.
During external trigger input (TRIG IN) BNC terminal (☞ P.3-10), only the sequence start operation can be performed. ☞ P.11-11

The following operations can be performed:

■ Starting a sequence

When in the Rdy state, the sequence starts at the falling edge of the multi-I/O pin set for start control or the valid edge of the TRIG IN terminal. There are disabled in the Run / Hold state.

■ Stopping a sequence

When in the Run or Hold state, the falling input of the multi-I/O stop pin ends the sequence and moves to Step 0.

■ Holding/resuming sequence

When in the Run state, the sequence will be paused on falling input of the multi-I/O hold/resume pin. A rising input while paused, that is, in the Hold state, will restart the sequence from the point where it was paused.

■ Event branch of the sequence

If you turn on event branch and execute a step in the Run or Hold state, an event branch will occur at the falling input of the multi-I/O event branch pin. The sequence changes to the specified event branch destination step.

■ State branch of the sequence

In the Run or Hold state, when executing a step with state branch on, a state branch will occur at the low-level input of the multi-I/O pin set to state branch. The sequence changes to the specified state branch destination step. For the timing to check that input, ☞ P.11-13.
It is not possible to control both the sequence start and the state branch via the multi-I/O connector (☞ P.11-11). When using the multi-I/O connector for the state branch, use the TRIG IN terminal for the sequence start operation.

Check

- Start, stop and hold/resume operations from the multi-I/O connector will cause a delay and variation of approximately 5µs to 20µs
- Event branch operations from multi-I/O connectors will have a delay and variation of approximately 50µs to 100µs.
- When starting from an external trigger input, there will be a delay and variation of approximately 5µs to 20µs.

11.6 Individual Descriptions of Step Control Parameters

a) Individual explanation of step control parameters

■ Step time: “Time”

This parameter sets the step duration. ☞ P.4-16 This setting is interpreted as the time to run at the end of the sequence, in Step 0. Step time is common between channels in WF1984/WF1982.

■ Auto hold: “AutoHold”

Normally, set this to off.

Set this parameter to on when you wish the sequence to go into standby without moving on to the next step after the lapse of the specified step time. (‘Off’ / ‘On’ ☞ P.4-18)

This is useful when you want to move through the sequence while checking the status of the equipment under test step by step. In Step 0, “AutoHold” cannot be selected.

When the resume operation or resume signal is received, the processing resumes. ☞ P.11-17

■ Stop phase: “StopPhs”

When this parameter is set to on, the reference phase at the end of that step can be specified.

After the lapse of the specified step time, channel 1 reaches the specified reference phase and ends this step. ☞ P.11-6 (‘Off’ / ‘On’ ☞ P.4-18, Reference phase at end ☞ P.4-16)

Cannot be turned on when the waveform of that step is ‘Square’/ ‘Noise’/ ‘DC’. For arbitrary waveforms, the phase specification of “StopPhs” is ignored and is regarded as the value of “Phase”. ☞ P.11-12

■ Jump destination: “JumpTo”

When this parameter is set to on, the next step which the sequence moves to after the end of the current step can be specified. (‘Off’ / ‘On’ ☞ P.4-18, Specified step ☞ P.4-16)

By specifying the number of jumps “Count”, you can configure a loop that repeats the same step. In Step 0, “JumpTo” cannot be selected.

■ Jump count: “Count”

When this is set to on, you can specify the number of jumps to the step specified with “JumpTo” (jump destination). When this is set to ‘Inf’, the jump is repeated for an infinite number of times. (‘Inf’ / ‘On’ ☞ P.4-18, Number of jumps ☞ P.4-16) Note that the number of times that the same step is repeated is (jump count + 1). In Step 0, “Count” cannot be selected.

■ State branch: “StateB”

When this is set to on, the state branch signal of multi-I/O connector (pin 14) is checked and if the signal is active, the sequence moves to the specified step. (‘Off’ / ‘On’ ☞ P.4-18, Specified step ☞ P.4-16) However, the state branch signal can be checked only after the lapse of the specified step time of that step (excluding the time that held). ☞ P.11-8, P.11-13

In Step 0, “StateB” cannot be selected.

■ Event branch: “EventB”

When this is set to on, the soft keys or event branch signal of multi-I/O connector (pin 11) is checked and if the signal is active, the sequence moves to the specified step. ☞ P.11-8, P.11-13 (‘Off’ / ‘On’ ☞ P.4-18, Specified step ☞ P.4-16) In Step 0, “EventB” cannot be selected.

■ **Step termination: “StepTerm”**

This parameter specifies whether to jump to the next number step (‘Continue’) or to go to Step 0 and end the sequence (‘End’) upon termination of the step. ☞ P.4-18

In Step 0, “StepTerm” cannot be selected.

■ **Step synchronization code output: “Code”**

This parameter sets the 4-bit logic signal that is output to the multi-I/O connector during that step. The left-most bit is D3 (MSB), and the right-most bit is D0 (LSB). (Select ‘LLLL’ to ‘HHHH’ ☞ P.4-18) For multi-I/O connector, ☞ P.3-13.

D0 (LSB) can be output to the synchronization/sub-output terminal. ☞ P.11-11

b) Individual description of channel parameters

For WF1984/WF1982, set for each channel. Settings are for active channels, and channel equivalency setting function (CH LINK) mode is also available. ☞ P.4-24

■ **Waveform: “Fctn”**

Select the waveform for that step ‘Sine’, ‘Square’, ‘Ramp’, ‘Noise’, ‘DC’, ‘ARB’. ☞ P.4-33

Setting the polarity and amplitude range is possible in the same way as ☞ P.4-41.

Waveform constraints in sequence oscillation are ☞ P.11-9.

When using an arbitrary waveform, select the target waveform with [...]. ☞ P.4-60

In that case, you need to be careful about the size. ☞ P.11-10

If the waveform is ‘Square’, you can set the duty variable range “Extend” as in ☞ P.4-49.

If the waveform is ‘Noise’, it will be the equivalent bandwidth set on ☞ P.11-12.

■ **Frequency: “Freq”**

Set the frequency of that step. ☞ P.4-34 “Action” can be specified. ☞ P.11-5

Frequency cannot be set when the waveform is ‘Noise’/ ‘DC’.

It is not possible to switch to period or set period/sample rate/sample period.

Sequence oscillation has a different frequency range from normal oscillation. ☞ P.17-3

■ **Amplitude: “Amptd” / DC offset: “Offset”**

Set the amplitude and DC offset of that step. ☞ P.4-38, 4-39 “Action” can be specified. ☞ P.11-5 When the waveform is DC, the amplitude cannot be set. Affected by load impedance setting of sequence common settings (☞ P.11-12) and external addition setting (☞ P.11-12).

■ **Phase: “Phase”**

Set the amount of phase shift from the reference phase (☞ P.11-6) of that step. ☞ P.4-36

“Action” can be specified other than arbitrary waveforms. ☞ P.11-5 When the waveform is ‘Noise’/ ‘DC’, phase cannot be set.

■ **Duty: “Duty”**

Set the duty of that step. ☞ P.4-49 “Action” can be specified. ☞ P.11-5

Can only be set when the waveform is ‘Square’.

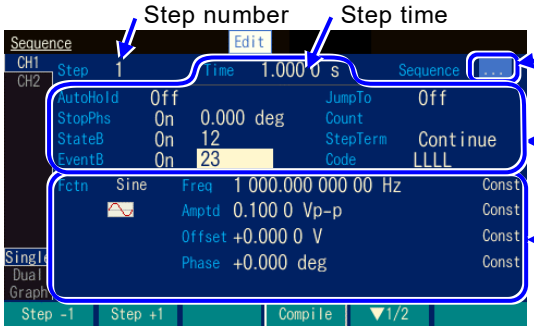
■ **Symmetry: “Symm”**

Set the symmetry of that step. ☞ P.4-56 Can only be set when the waveform is ‘Ramp’.

11.7 Screen overview for sequence oscillation

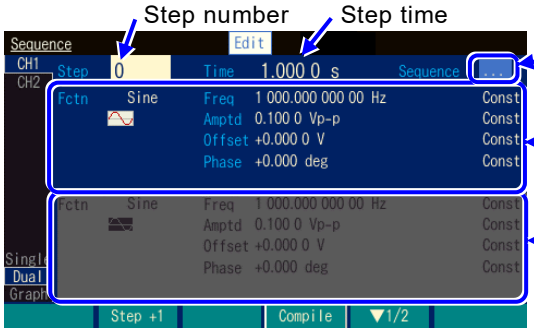
For switching display formats, see ☞ P.4-11.

■ Text display: “Single”



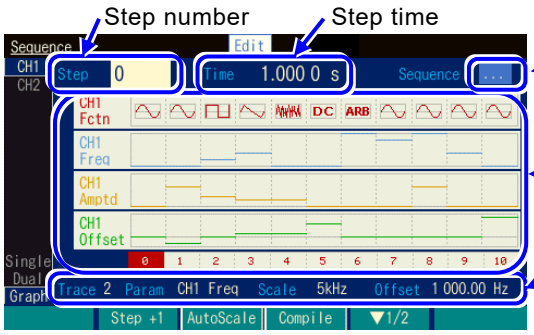
The step control parameters of one step and the intra-step channel parameters of one channel are displayed simultaneously.
The channel of the intra-step channel parameter is the active channel. ☞ P.4-24

■ 2-channel simultaneous display: “Dual” (WF1984/WF1982)



The intra-step channel parameters of one step are displayed for two channels simultaneously. For the step control parameters, only the step time is displayed.
You can set intra-step channel parameters for the active channel. ☞ P.4-24

■ Graph display: “Graph”



Displays the trend as the step progresses for the four intra-step channel parameters.
But, this is the trend when the steps progress in numerical order starting from number 0.

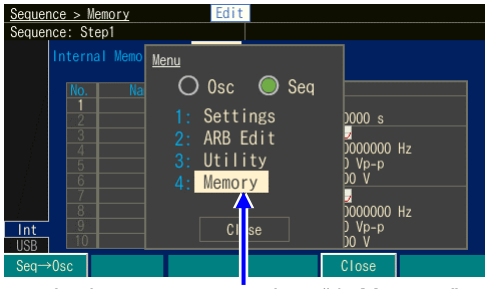
Situations where the sequence does not proceed in numerical order due to jumps or branches will not be reproduced.
You can change which parameters are displayed in which traces in the trace settings.
The trace setting is the trace number to be set in “Trace”, and “Param” is the item to be displayed there.
“Scale” is the vertical width of the trace frame, “Offset” is the value at the bottom of the trace frame for frequency, amplitude, and duty, and the value at the center of the trace frame for offset and phase. (When the display item is a waveform, “Scale” / “Offset” are not displayed.)

The soft key [AutoScale] adjusts the vertical axis scale of the graph display so that it does not become saturated, including unused steps.

11.8 Saving created sequence

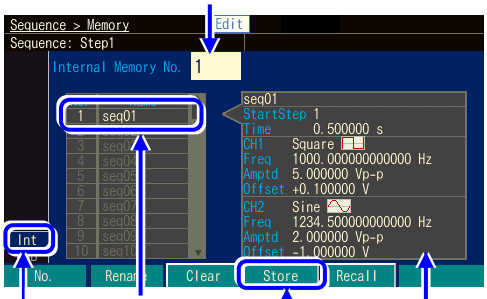
The following assumes that the current operating mode is sequence oscillation. For switching the operation mode, refer to ☞ P.11-14.

11.8.1 Saving to internal memory



In the top menu, select “4: Memory”

Sequence memory number of the save destination



The specified sequence memory number and setting name will be highlighted

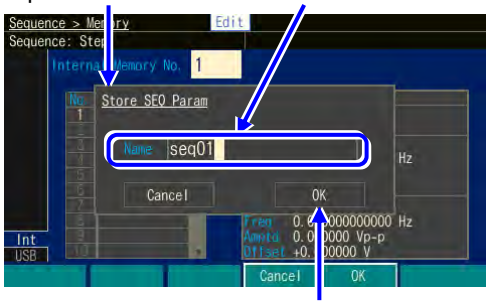
Press [Store] soft key

Summary of the first step in the specified sequence memory

To save to internal memory, select the “Int” tab and Press ENTER

Save operation confirmation dialog opens

You can change the name here



Select [OK], and then press the ENTER key to save the sequence

1. Press the [MENU] key to display the top menu window. Select “4: Memory” and then press the [ENTER] key. The Memory screen opens. You can also use the numeric keypad [4] after the top menu is displayed.

2. If “Int” at the bottom left of the screen is selected, the sequence will be save to the internal memory. If “USB” is selected, select “Int” and press the [ENTER] key.

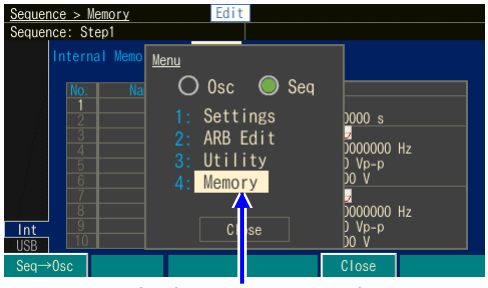
3. Select the “Internal Memory No.” field (☞ P.4-14) at the top left of the screen to open the input field of the sequence memory number to which to save. You can also use [No.] soft key. Set the save destination memory number in this field. ☞ P.4-16, 4-17
The specified setting memory number and its sequence name will be highlighted on the left side of the screen. On the right side of the screen, a summary of the sequence saved in the specified sequence memory is displayed.

4. Press the [Store] soft key opens a dialog to confirm the save operation. Select “Name” field (☞ P.4-14) to open the name input field. Change the name if necessary. ☞ P.4-19

5. To save the sequence, select [OK] and then press the [ENTER] key. Saving is performed and the sequence previously saved to the sequence memory are overwritten by the new sequence. You can also use [OK] soft key. You can cancel saving by pressing the soft key [Cancel].

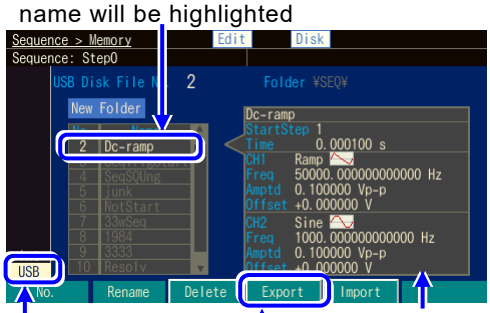
11.8.2 Saving to USB flash drive

You can copy the current sequence and contents saved in internal memory to USB flash drive.
For operations using USB flash drive, See also, ☞ P.5-7.



In the top menu, select "4: Memory"

Specified sequence file number and name will be highlighted



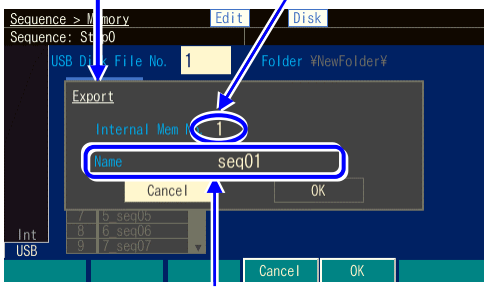
To save to USB flash drive, select the "USB" tab and Press ENTER

Press [Export] soft key

Summary of the first step in the specified sequence file

Save operation confirmation dialog opens

Select sequence data source to save



You can change the file name

1. Press the [MENU] key to display the top menu window. Select "4: Memory" and then press the [ENTER] key. The Memory screen opens. You can also use the numeric keypad [4] after the top menu is displayed.

2. To save to USB flash drive, connect the USB flash drive to the unit and then select the "USB" tab on the bottom left of the screen and press the [ENTER] key. Connect the USB flash drive to the unit. ☞ P.3-2

3. Navigate to the destination folder if necessary. Select the "USB Disk File No." field (☞ P.4-14) to open the input field of the setting target file number. You can also use [No.] soft key. In this field, select a folder. Select a folder (name with "¥" at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7

4. Press soft key [Export] to display the sequence export dialog. Specify the internal memory number of the save source in the "Internal Mem No." field. ☞ P.4-16, 4-17 ("0" indicates the current sequence) In the "Name" field, specify the file name when saving to the USB flash drive. ☞ P.4-19

5. To save the sequence, select [OK] and then press the [ENTER] key. You can also use [OK] soft key. Saving is performed and the sequence previously saved to the target file is overwritten by the new sequence. You can cancel saving by pressing the soft key [Cancel].

Check

Folder and file names are not case sensitive. If a file "aaa" exists, and you create "Aaa", the original "aaa" will be lost.

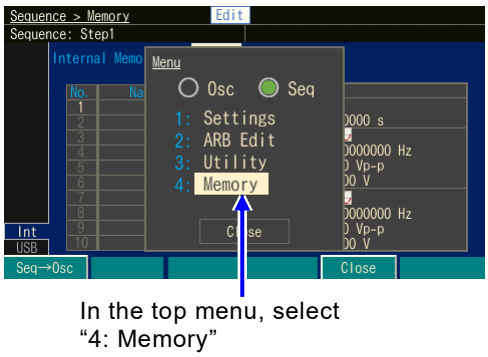
a) File time stamps

See ☞ P.5-8 for timestamps of files created with this device.

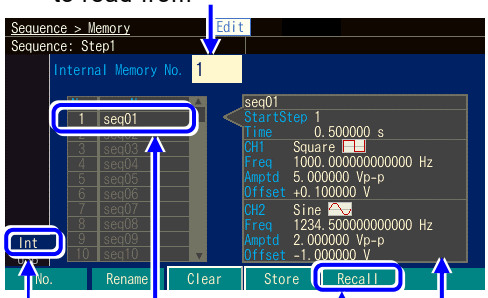
11.9 Using the saved sequence

The following assumes that the current operating mode is sequence oscillation. For switching the operation mode, refer to ☞ P.11-14.

11.9.1 To retrieve from Internal Memory



In the top menu, select "4: Memory"



Sequence memory number to read from

Specified sequence memory number and name will be highlighted

Press [Recall] soft key

Select "Int" tab

Summary of the first step in the specified sequence memory

1. Press the (MENU) key to display the top menu window. Select "4: Memory" and then press the (ENTER) key. The Memory screen opens. You can also use the numeric keypad (4) after the top menu is displayed.

2. If "Int" at the bottom left of the screen is selected, the sequence will be read from the internal memory. If "USB" is selected, select "Int" and press the (ENTER) key.

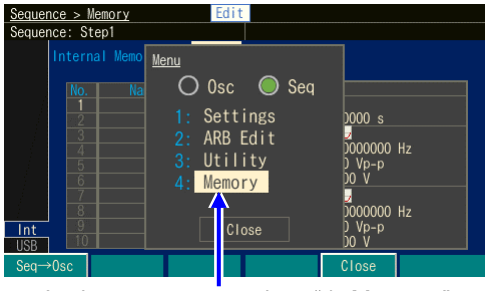
3. Select the "Internal Memory No." field (☞ P.4-14) at the top left of the screen to open the input field of the sequence memory number to which to recall. You can also use [No.] soft key. Set the recall source memory number in this field. ☞ P.4-16, 4-17
The specified sequence memory number and its setting name will be highlighted on the left side of the screen. On the right side of the screen, a summary of the sequence saved in the specified sequence memory is displayed.

4. Press the [Recall] soft key opens a dialog to confirm the recall operation. To recall the sequence, select [OK] and then press the (ENTER) key. You can also use [OK] soft key. Perform recalling and change the current sequence.
You can cancel recalling by pressing the soft key [Cancel].

11.9.2 To retrieve from USB flash drive

You can copy from USB flash drive to the current sequence or the built-in sequence memory.

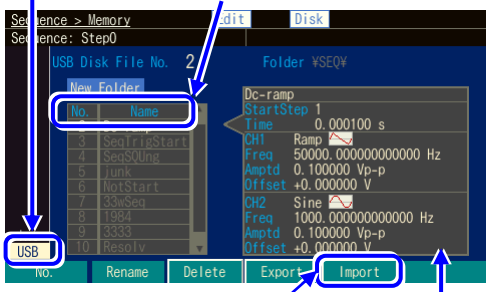
For operations using USB flash drive, See also, ☞ P.5-7.



In the top menu, select “4: Memory”

Select “USB” tab

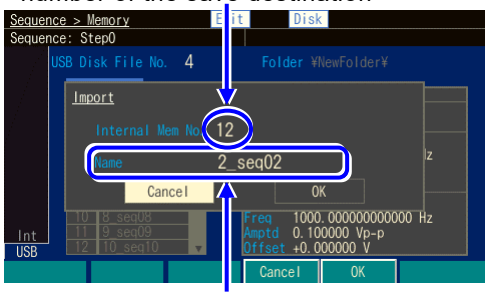
Specified sequence file number and name will be highlighted



Press [Import] soft key

Summary of the first step in the specified sequence file

Specify the internal memory number of the save destination



You can change the sequence name

1. Press the [MENU] key to display the top menu window. Select “4: Memory” and then press the [ENTER] key. The Memory screen opens. You can also use the numeric keypad [4] after the top menu is displayed.

2. When “USB” at the bottom left of the screen is selected, the data will be retrieved from the USB flash drive. If “Int” is selected, select “USB” and press the [ENTER] key. Connect the USB flash drive to the unit. ☞ P.3-2

3. Select the “USB Disk File No.” field (☞ P.4-14) to open the input field of the setting target file number. You can also use [No.] soft key. Select the target file and destination folder number in that field. ☞ P.4-16, 4-17

4. Navigate to the folder where you want to read the sequence file if necessary. Select a folder (name with “¥” at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7

5. If you press the soft key [Import] with the target file selected, a dialog will open to confirm the import operation.
Specify the internal sequence memory number of the save destination in the “Internal Mem No.” field. ☞ P.4-16, 4-17
Select number “0” to read into current sequence.

6. The file name on the USB flash drive is set as the initial value in the “Name” field of the dialog. Set the sequence name as necessary. ☞ P.4-19

7. To retreieve the sequence, select [OK], and then press the [ENTER] key. You can also use [OK] soft key. The sequence data previously saved in that memory number will be overwritten. You can cancel import using soft key [Cancel].

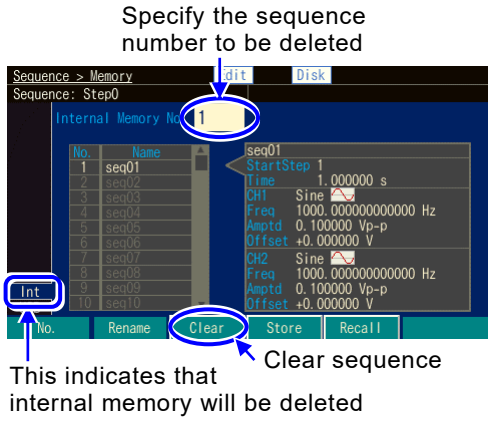
Check

Settings saved between WF198x models with different parameter limits will result in an error if the settings exceed the limits of the model being read.

11.10 File operation

Perform the operations of deleting and renaming the sequence data in internal memory and also deleting and renaming the sequence data and creating, deleting, and renaming folders in USB flash drive on the Memory screen. (To go to Memory screen, Press MENU and 4 keys in sequence.)

11.10.1 To delete sequence data saved on the main unit

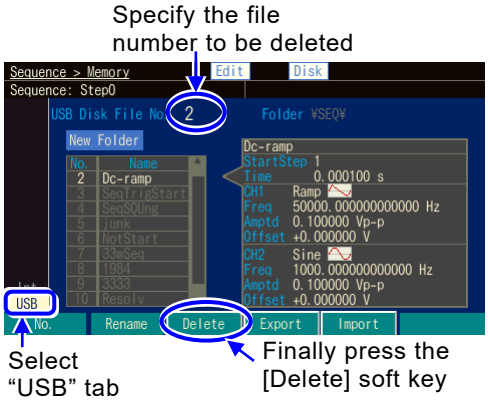


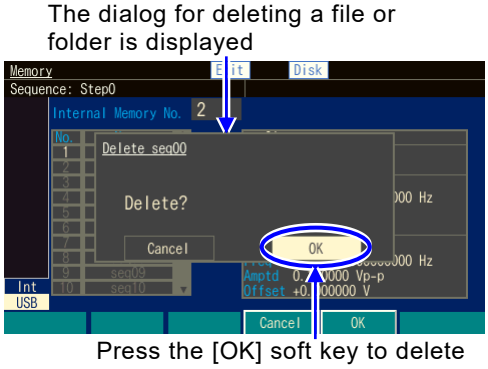
1. Select the “Internal Memory No.” field (☞ P.4-14) at the top left of the screen to open the memory number input field. You can also use [No.] soft key. Set the sequence memory number to clear in this field. ☞ P.4-16, 4-17
   Press the [Clear] soft key opens a dialog to confirm the clear operation.
2. To clear the sequence, select [OK] and then press the ENTER key. You can also use [OK] soft key.

The sequence data contents previously saved in that memory number will be overwritten with the initial setting contents. You can cancel clear by [Cancel] soft key.

11.10.2 To delete sequence data or folder on USB flash drive

For operations using USB flash drive, See also, ☞ P.5-7.



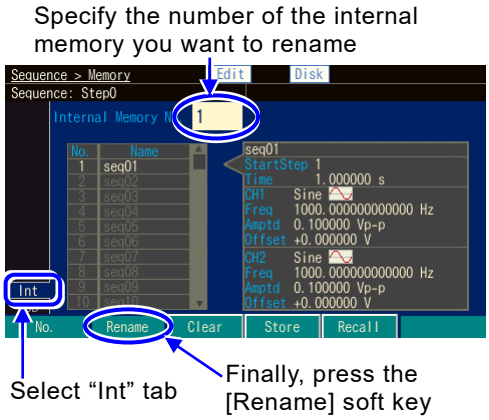


1. Select the “USB Disk File No.” field (☞ P.4-14) to open the input field of the setting target file number. You can also use [No.] soft key. In that field, specify the number of the file or folder you want to delete. ☞ P.4-16, 4-17
2. Navigate to the folder where you want to delete the file or folder if necessary. Select a folder (name with “¥” at the end) and press soft key [Enter] to move to that folder. ☞ P.5-7
3. If you press the soft key [Delete] with the target file or folder selected, a dialog will open to confirm the delete operation.
4. To delete the file, select [OK], and then press the ENTER key. You can also use [OK] soft key. The soft key [Cancel] allows you to cancel the deletetion of the file.
   Note that if a folder is the target, all of the contents of that folder and all of its subfolders and files will also be deleted.

11.10.3 To Rename

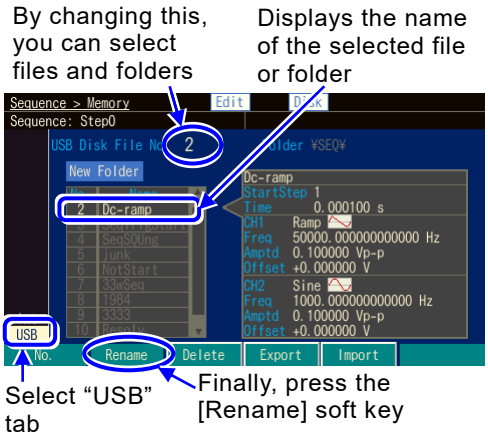
To rename sequence data in internal memory or rename sequence data or a folder in USB flash drive, use the [Rename] soft key on the Memory screen. (To go to Memory screen, Press MENU and 4 keys in sequence.)

■ If target is a internal memory



1. Select “Internal Memory No.” field. ☞ P.4-14
   You can also use [No.] soft key. Specify the target to be renamed here. ☞ P.4-16, 4-17
   Press the [Rename] soft key to display a dialog for renaming.
2. The old name is displayed in the “Name” field, so change it to the new name. ☞ P.4-19
3. To rename, select [OK] and then press the ENTER key. You can also use [OK] soft key.

■ If target is a USB flash drive (☞ P.5-7)



1. Select the “USB Disk File No.” field (☞ P.4-14) to open the input field of the target file number. You can also use [No.] soft key. Specify the number of the file or folder to rename with that number ☞ P.4-16, 4-17
2. Folders have a “¥” at the end of their name. If you press the [Enter] soft key while a folder is selected, that folder becomes the current folder. “..¥” indicates the folder one level above. ☞ P.5-7
3. Press the [Rename] soft key to display the file or folder renaming dialog. Select the “Name” field (☞ P.4-14) and change the name. ☞ P.4-19
   Note, folder and file names on the USB flash drive are not case sensitive.
4. To rename, select [OK] on the dialog and press the ENTER key. You can also use [OK] soft key.

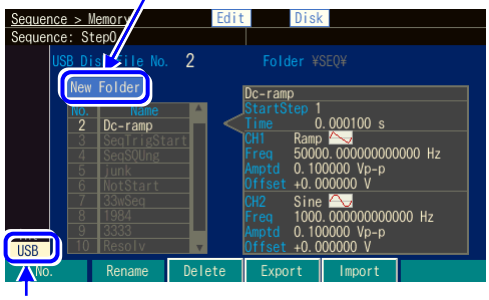
In both cases, you can also cancel the renaming using the [Cancel] soft key.

11.10.4 To Create a Folder in USB flash drive

Folders have "¥" at the end of the name. When a folder is selected, pressing the [Enter] soft key makes that folder the current folder. "..¥" indicates the folder one level up.

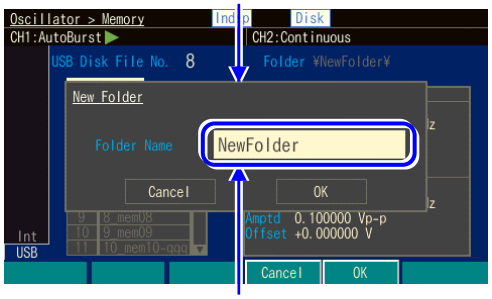
For operations using USB flash drive, See also, ☞ P.5-7.

Select the [New Folder] button and then press the ENTER key



Since folders can only be created on USB flash drive, [New Folder] does not appear on the "Int" tab

The dialog for creating a folder is displayed



Select the "Folder Name" field and press the [OK] soft key to change the name

1. If necessary, navigate to the parent folder where you want to create the folder.
Select a folder (name with "¥" at the end) and press soft key [Enter] to move to that folder.
☞ P.5-7

2. Select the [New Folder] button at the top right of the screen (☞ P.4-14) to open a dialog for entering the name of the folder to be created.

3. "NewFolder" is set as the initial value in the "Folder Name" field. Rename the folder with the ENTER key if necessary. ☞ P.4-19
Note, folder and file names on the USB flash drive are not case sensitive.

4. To create folder, select [OK], and then press the ENTER key.
You can also use [OK] soft key.
You can cancel create folder using soft key [Cancel].

You can also create folders for USB flash drive on the setting memory operation screen ☞ P.5-8 and on the arbitrary waveform file operation screen ☞ P.7-17.

12. Using User-defined units

12.1 About User-defined units

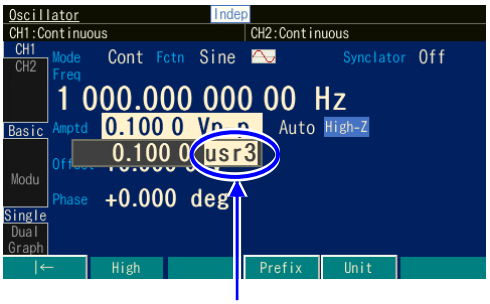
You can set, for example, the frequency in units of rpm (number of rotations per minute) instead of Hz. You can also set a value converted to the mechanical deviation quantity or a value converted to the output voltage after the power amplifier output instead of voltage.

Defining these mutual conversion formulas enables you to use them like the usual units. In this product, these units are called “user-defined units”.

The user-defined units can be used for the following six parameters:

Frequency, period, amplitude, DC offset, phase, and duty

12.2 Display and Setting in User-defined units



Select the user-defined unit

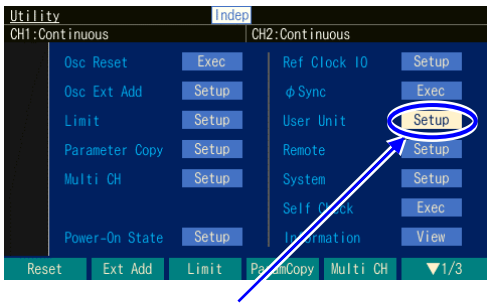
When an input field for each parameter opens, can change the unit by placing the cursor over the unit at the right end and using the up/down arrow key or the modify knob. If set this as the top/right end, it will become a user-defined unit.

The unit name displayed here can be set arbitrarily. Even if change the unit, just the display unit is changed without changing the actual output value.

12.3 Defining User-defined units

■ Setting screen

The setting is done on the Utility screen. (To go to Utility screen, press MENU and 3 keys in sequence.)

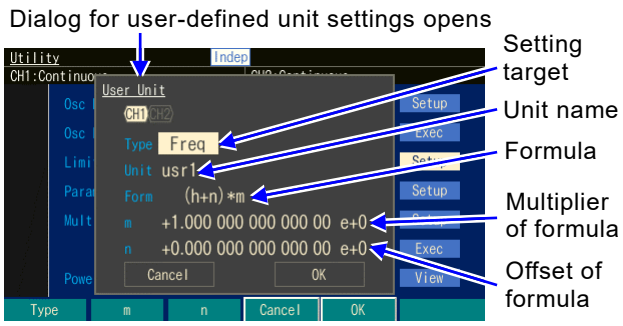


In the Utility screen, select the “User Unit” field and press the ENTER key

1. On the Utility screen, select the “User Unit” field using the arrow keys or modify knob, and press the ENTER key.
   Soft key [User Unit] after pressing the rightmost soft key [▼n/3] several times until it becomes [▼2/3] works similarly.

2. The user-defined unit setting dialog opens. Select the respective item and then press the ENTER key and configure the setting. 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 ☞ P.4-14
Frequency, Period, Amplitude, DC offset, Phase, or Duty

Unit name “Unit”: Text input ☞ P.4-19
Sets the unit name with up to 4 characters.

Formula “Form”: Select ☞ P.4-14
‘(h+n)*m’ or ‘(log(h)+n)*m’

In the unit conversion formula, “h” is the original value to be set. The value converted by this formula is displayed on the screen when the user-defined unit is actually used. And this setting value operated by the user.

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	s
Amplitude	If amplitude range is ‘±FS’, then Vp-p If amplitude range is ‘0/+FS’ and ‘-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	%

The log is a common logarithm whose base is 10. You need to be careful when using a log formula for a value that can be negative such as the DC offset and phase. If the value before changing to the user-defined unit is 0, “-Inf” is displayed when changing to the user-defined unit using the log. Similarly, if the 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” and “n”

Select the multiplier “m” and offset “n” in the selected formula.

The input field is divided into a mantissa part and an exponent part.

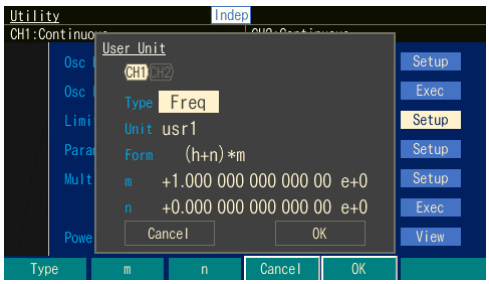
After setting each parameter, select [OK] at the bottom of the dialog and press the ENTER key.

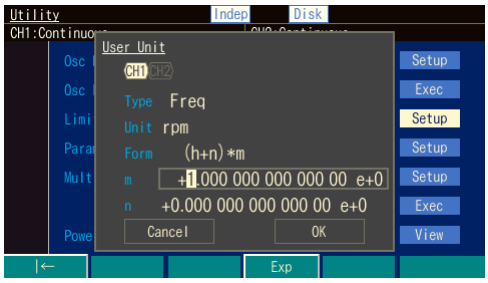
You can cancel the changes by pressing the soft key [Cancel].

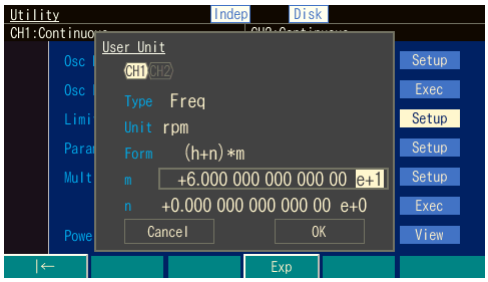
> **Check**
> When you use a user-defined unit, the setting resolution may be rough depending on the setting of the multiplier or offset.

■ To set the frequency in rpm

To display and set, for example, the frequency 1Hz as 60rpm, set the following.



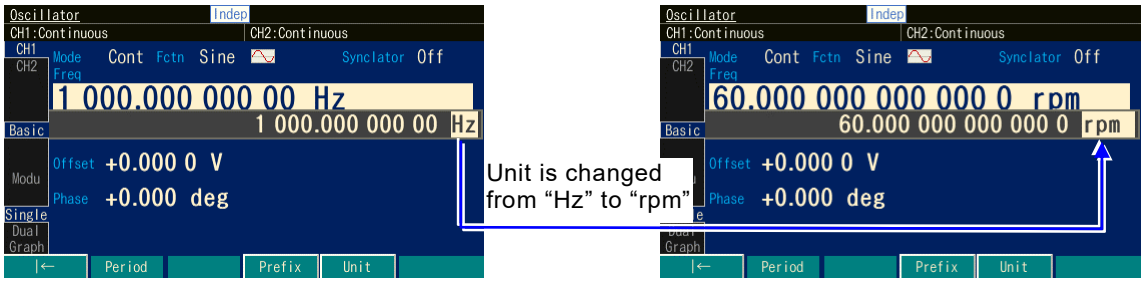




1. Select the “Type” field. ☞ P.4-14 You can also use [Type] soft key. Set it to ‘Freq’ to the frequency unit. ☞ P.4-18
   Select the “Form” field ☞ P.4-14 and set it to ‘(h+n)*m’. ☞ P.4-18
2. Select the “Unit” (☞ P.4-14) to edit the unit text. Set uint text to “rpm”. ☞ P.4-19
3. Select the “m” field. ☞ P.4-14 You can also use [m] soft key. Multiplier can now be entered. Set it to “60” to Hz→rpm.
   When setting by modifying, you can move the cursor directly to the mantissa part using the [|←] soft key, and to the exponent part using the [Exp] soft key. ☞ P.4-16
   When entering the numeric keypad, you can also add the exponent part using the soft keys ([e-6], [e-3], [e+0], [e+3], [e+6]). ☞ P.4-17
4. Select [OK] on the dialog and press the key or press the [OK] soft key to close the dialog.

Now you are ready to convert units.

Next, in the Oscillator screen, open the input field for the frequency (Press FREQ key), and then change the unit from “Hz” to “rpm”. (Press the [Unit] soft key several times.) ☞ P.4-23



Frequency can now be set and displayed as “rpm” value.

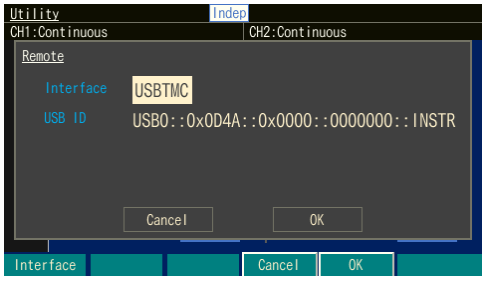
13. Other Utility Settings

For Utility screen functions other than those introduced here, please refer to ☞「4.3.10 Operations available on Utility Screen」

13.1 Selecting Remote Interface: “Remote”

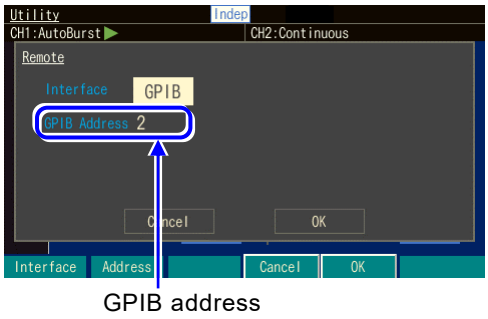
Set on the Utility screen. (Press MENU and 3 keys in sequence.)
On the Utility screen, select the “Remote” field using the arrow keys or modify knob, and press the MENU key. Soft key [Remote] after pressing the rightmost soft key [▼n/3] several times until it becomes [▼2/3] works similarly.
The remote setting dialg opens. Select the “Interface” field (☞ P.4-14) and select the external control interface from ‘USBTMC’, ‘LAN’, or ‘GPIB’ (WF1983/WF1984 only). ☞ P.4-18

■ USBTMC setting screen



When you select ‘USBTMC’, the “USB ID” is displayed. There is no specific setting with USBTMC.

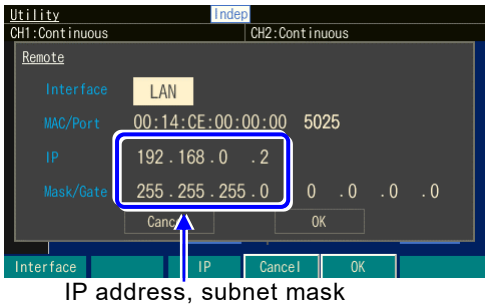
■ GPIB setting screen



GPIB address

If you select ‘GPIB’, select the “GPIB address” field (☞ P.4-14) and set in the range of 0 to 30.
☞ P.4-16, 4-17
WF1982/WF1981 is not equipped with a GPIB interface, so this screen is not available.

■ LAN setting screen



IP address, subnet mask

When you select ‘LAN’, the MAC address and port address “MAC/Port” are displayed. Set “IP” address and subnet mask (left of “Mask/Gate”). The default gateway (right of “Mask/Gate”) can also be set if necessary. Select each target item (☞ P.4-14) and enter the setting value. ☞ P.4-16, 4-17

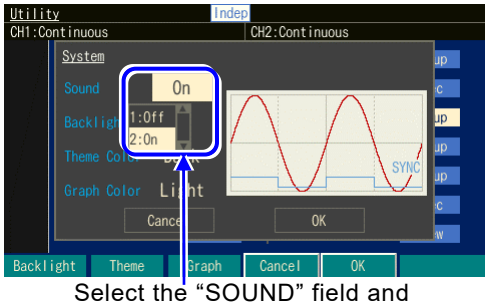
13.1.1 Remote/local state

When operated from the configured interface, it enters the remote state.
At this time, an icon USB, LAN, GPIB will be displayed in the status display area depending on the interface used. [Local] will be displayed in the soft key area, and panel operations other than the power switch, TRIG key, [Local] soft key, and long press of the UNDO key (☞ P.4-13) will be ignored. To operate the panel, press the soft key [Local] to enter the local state.

13.2 Display and Operation Sound Settings: “System”

Set on the Utility screen. (Press MENU and 3 keys in sequence.)
On the Utility screen, select the “System” field using the arrow keys or modify knob, and press the MENU key. Soft key [System] after pressing the rightmost soft key [▼n/3] several times until it becomes [▼3/3] works similarly. System settings dialog will appear.

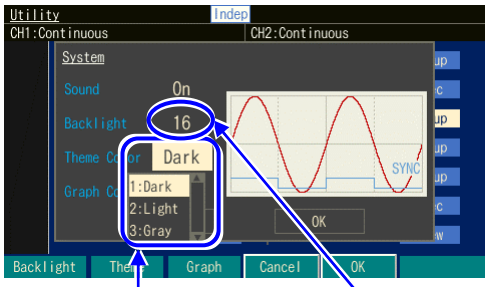
■ Operation Sound Setting



Select the “SOUND” field and then press the ENTER key

The operation sound can be set in the System screen.
Select the “Sound” field (☞ P.4-14) to open a list of operation sound options.
Choose from options ☞ P.4-18

■ Display Setting

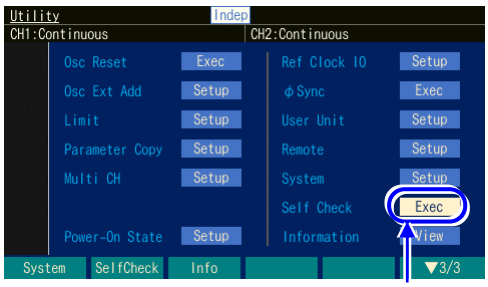


Theme color Brightness of backlight

Set the brightness of backlight and theme color.
Select the “Backlight” field. ☞ P.4-14 You also use [Backlight] soft key. Enter the brightness (1 to 31)☞ P.4-16, 4-17
Select the “Theme Color” field (☞ P.4-14) and switch the theme color from dark background with color ‘Dark’, light background with color ‘Light’ and gray scale ‘Gray’ ☞ P.4-18

13.3 Self-Diagnosis: “Self Check”

Set on the Utility screen. (Press MENU and 3 keys in sequence.)
On the Utility screen, select the “Self Check” field using the arrow keys or modify knob, and press the MENU key. Soft key [Self Check] after pressing the rightmost soft key [▼n/3] several times until it becomes [▼3/3] works similarly.



Self-Diagnosis

Perform a self-diagnosis. Initialize the settings (☞ P.4-27) and disconnect all cables other than the power before proceeding. Confirmation dialog to start will appear. Press the [OK] soft key or select [OK] on the dialog, and press the ENTER key to start checking. Once the check is complete, the results will be displayed. Select [OK] and press the ENTER key to automatically power off.

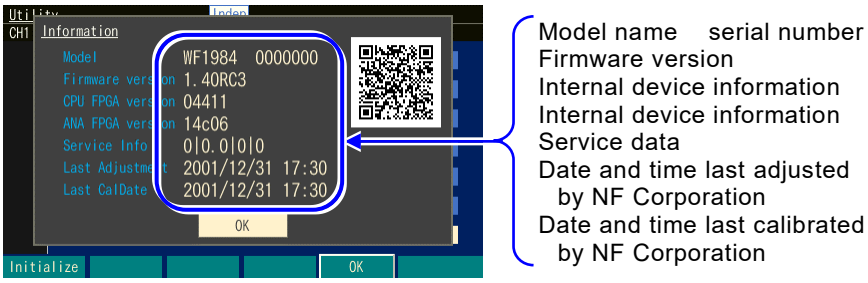
In rare cases, an error may occur due to the effect of noise. If you encounter an error repeatedly, please contact NF Corporation or one of our representatives.

13.4 Product Information Display: “Information”

Set on the Utility screen. (Press MENU and 3 keys in sequence.)

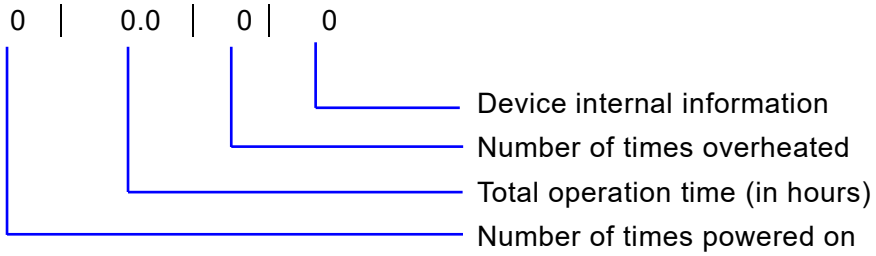
On the Utility screen, select the “Information” field using the arrow keys or modify knob, and press the MENU key. Soft key [Info] after pressing the rightmost soft key [▼n/3] several times until it becomes [▼3/3] works similarly.

The model name, firmware version, and other information about this product are displayed. There are no items to be set.



■ Service data details

The service data has five areas separated by “|” that contain the following information, respectively.



■ Details of 2D barcode

The information in the 2D barcode consists of our company name, model name, manufacturing number, device information, firmware version, and date last calibrated by NF Corporation

14. Troubleshooting

14.1 Error messages at Power-on

Self-diagnosis is performed when the power is turned on, and a message is displayed if there is anything to report.

If you encounter any failure, please contact NF Corporation or one of our representatives.

Message	Explanation
Check sum error	There is a malfunction. Please contact us or our agent. Depending on the nature of the failure, you may be able to temporarily start up by pressing and holding the rightmost soft key. Please save the data inside the main unit as necessary.
Settings load error. Calibration Data lost.	
Settings load error. Initialize and start up.	
Settings load error. Memory contents lost.	
File system Fail	
OSC-block Fail	
ROM/RAM Fail	
This device shutdown due to overheating.	Last time, it shut down due to overheating inside. Please check the ambient temperature environment of this product again. If this message appears in a good ambient temperature environment, this indicates a malfunction of the instrument.
Last shutdown caused by a power failure.	The previous power off was due to line power loss. In this case, the instrument reads the contents stored in setting memory #1 or sequence memory #1.

14.2 Error Messages while Running

Error messages are displayed while the product is running mainly when a setting exceeds the allowable output range. For example, when a ramp 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 for a ramp wave.

Error messages are also displayed for internal overheating and output overload.

This section describes the errors displayed in the dialog in ascending order of the error numbers.

Number	Message	Explanation
1000	Last shutdown caused power failure	Displayed when the power was turned off due to the last power outage. It starts with the contents of setting memory #1 or sequence memory #1. The arbitrary waveform's <Edit Memory> will be initialized.
1500	Settings load error. Initialize and start up.	Since the data read from resume memory and the checksum do not match, it will start with the initial value.
1501	Output overload detected; Output turned off.	An attempt was made to turn on the output according to the output settings at power-on, but the output could not be turned on because an overload of the synchronous/sub output was detected. Please release the overload condition.
1502	This device shutdown due to overheating.	The internal temperature has reached the limit and the power to the instrument will be automatically turned off soon. Check the operating environment and the condition of the instrument.
2000	Data beyond lower limit; Value clipped to lower limit.	An attempt was made to set a value below the lower limit, so the lower limit was set.
2001	Data beyond upper limit; Value clipped to upper limit.	An attempt was made to set a value that exceeds the upper limit, so the upper limit was set.
2500	Data out of range.	The setting value is outside the setting range. Please set a value within the setting range.
2501	Settings conflict.	Cannot be set due to parameter restrictions. Please reset to the correct value.
2502	Not allowed character.	A character that is not allowed is used. The characters that can be used are ☞ P.4-19
2503	String length error.	Exceeds the number of characters that can be entered.
2504	Execution error.	Could not execute due to parameter constraints. Please set it to the correct value.
2505	Syntax error.	There is an error in the input content.
2506	Not acceptable due to another CH limitation.	In the same value setting, the other channel is restricted and cannot be set.
2507	Zero data not allowed.	0 was set for parameters that cannot be set to 0.
2508	Some are out of range.	When importing settings from USB flash drive, some of the settings were outside the setting range. When migrating the settings of WF1983/WF1984 to WF1981/WF1982, change the frequency, sample rate, and frequency setting range limit values to within the setting range of WF1981/WF1982.

Number	Message	Explanation
3000	Function changed to Sine by changing Channel Mode	Since 2-channel linked mode was selected when the waveform was 'Noise' or 'DC', the waveform of the corresponding channel was switched to a sine wave.
3001	Mode changed to Continuous by changing Channel Mode	Since 2-channel linked mode was selected in burst mode, the mode switched to continuous mode. Burst mode cannot be used in 2-channel linked mode.
3002	Modulation type changed to off by changing Channel Mode	The modulation type has been switched to OFF due to restrictions in 2-channel linked mode. When 2-channel linked mode is selected, the modulation source is set internally regardless of the modulation type.
3003	Synclator turned off by changing Channel Mode	The synclator has been turned OFF due to restrictions in 2-channel linked mode.
3004	External addition turned off by changing Channel Mode	When using external addition, you selected differential as the channel mode, so external addition was turned off. External addition cannot be used in differential mode.
3005	SwpMode changed to Single by changing Channel Mode	When the sweep mode was gated single-shot, the channel mode was selected as 2-phase, constant frequency difference, constant frequency ratio, or differential, so it switched to single-shot sweep. Gated single sweep cannot be used in 2-channel linked mode.
3006	Modulation type changed to off by changing Oscillation Mode	The modulation type has been switched to OFF due to oscillation mode restrictions.
3007	Synclator turned off by changing Oscillation Mode	The synclator has been turned OFF due to oscillation mode restrictions.
3008	Synclator turned off by changing Modulation type	The synclator has been switched OFF due to modulation type restrictions.
3009	SyncOut selection changed to Sync by selection of external modulation	Since internal modulation was switched to external modulation, reference phase synchronization 'Sync' was assigned to the sync/sub output.
3010	Edge time changed due to Duty	Since the specified pulse width duty cannot be achieved with the current edge times (LE, TE), the edge times have been reduced. Pulse width duty has higher priority than edge time.
3011	Edge time and/or Duty changed due to Frequency	Since the specified frequency cannot be achieved with the current edge times (LE, TE) and pulse width times, the edge times and pulse width times have been changed. Frequency has higher priority than edge time and pulse width time.

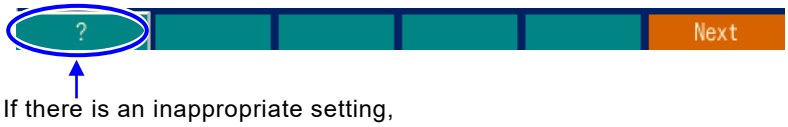
Number	Message	Explanation
3012	Too narrow or too wide Duty specified Amplitude may decrease or pulse may be lost	If the duty is set too low or too high, the amplitude may become small or the pulse may disappear. This phenomenon occurs when the pulse width on the high side or low side becomes narrower than approximately 8.4ns in a square wave with an extended duty variable range.
3013	Frequency reduced due to Function	The frequency has been changed to a lower value to match the waveform.
3014	Frequency and/or DeltaFreq changed due to Function	When the channel mode was set to constant frequency difference, the frequency and frequency difference were changed according to the upper limit frequency of the waveform.
3015	Amplitude and/or Offset changed due to Frequency	The amplitude and offset were changed by changing the frequency.
3016	Frequency changed due to Amplitude or Offset	The frequency was changed by changing the amplitude or offset.
3017	Duty changed due to Extend-Off	Since the square wave duty variable range has been changed to standard, the duty has been changed to a value limited by frequency.
3018	Duty changed due to Frequency	Since the square wave duty variable range is standard, the duty has been changed to a value limited by frequency.
3019	High level changed due to Low level	Due to the available output range, the high level was also changed when the low level was changed.
3020	Low level changed due to High level	Due to the available output range, the low level was also changed when the high level was changed.
3021	MOD/ADD IN connector used by external addition now	The external modulation/summing input connector is currently used for external addition.
3022	MOD/ADD IN connector used by external modulation now	The external modulation/summing input connector is currently used for external modulation.
3024	Frequency display format Changed.	The frequency display format has been changed using key shortcuts. (This is not an error)
3025	Amptd / Offset display format Changed.	The key shortcut has been changed to amplitude/display format. (This is not an error)
3026	Synclator turned off by changing Fctn.	The synclator has been switched OFF because the waveform has changed.
3027	Ratio N/M changed due to tracking	The ratio of the synclator has been changed for the purpose of tracking the resonance point.
3028	Amplitude and/or Offset changed due to Auto Range	The amplitude and offset were changed by changing the auto range.
3029	Amplitude and/or Offset changed due to Output Impedance	The amplitude and offset were changed by changing the output impedance.
3030	Edge time changed due to Range	The current edge time (LE, TE) cannot be achieved in the specified range, so the edge time has been extended.

Number	Message	Explanation
3500	Start-locked occurred due to setting conflict.	Oscillation could not be started in modulation, sweep, or burst mode due to inappropriate operation settings.
3501	Modulation Type not compatible with current Function	Modulation type does not match current waveform.
3502	Modulated peak or bottom value out of range	For 'FM', 'PM', 'OFSM', and 'PWM', (carrier value + deviation) or (carrier value - deviation) exceeds the output range.
3503	HopFreq beyond upper limit for current Function	In 'FSK', the hop frequency exceeds the output range of the current waveform.
3504	Modulated peak or bottom phase out of range	In 'PSK', (carrier value + deviation) or (carrier value - deviation) exceeds the output range.
3505	MOD/ADD IN connector used by external addition now	The external modulation/summing input connector is currently used for external summing and cannot be used for external modulation.
3506	Sweep Type not compatible with current Function	Sweep type does not match current waveform.
3507	Frequency beyond upper limit for Gated sweep	The frequency exceeds the gated sweep upper frequency limit.
3508	Start value out of range	The start value exceeds the output range.
3509	Stop value out of range	The stop value exceeds the output range.
3510	Gated sweep not available for DC	Gated sweep is not possible with 'DC' waveforms.
3511	BrstMode not compatible with current Function	The burst mode does not match the current waveform.
3512	Frequency beyond upper limit for current Function	The frequency exceeds the upper frequency limit of the current waveform.
5500	Invalid insert operation.	Insertion failed because the number of control points exceeds 10000.
5501	Invalid delete operation.	Control point deletion failed because the number of control points is less than 2.
6012	Selected ARB is missing Edit Memory ARB assigned.	Since the specified arbitrary wave does not exist, the arbitrary wave in the edit memory was allocated instead. This happens when a previously used arbitrary wave is deleted while not in use. Note that arbitrary waves are identified only by numbers.

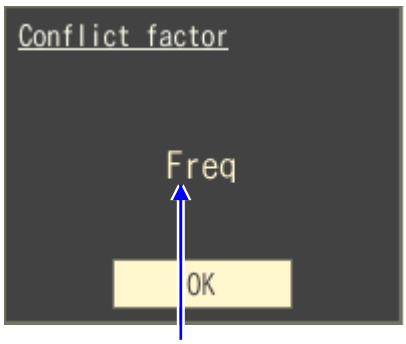
Number	Message	Explanation
6500	Can't access USB storage.	Unable to access USB flash drive.
6501	There is already a file of the same name.	The file cannot be renamed because it has the same name.
6502	USB storage overflow.	The file cannot be saved because there is not enough space on the USB flash drive.
6503	Failed to save.	Saving failed.
6504	Failed to load.	Loading failed.
6505	Failed to delete.	Deletion failed.
6506	Data for unsupported models.	This data is for a model that is not supported by this device.
6507	Not able to delete this ARB This ARB is in current use.	Arbitrary waves that are currently being output or in use cannot be deleted. Arbitrary waves used as internal modulation waveforms or pulse transition waveforms cannot be deleted either.
6508	Unable to recall Array format not allowed for Edit Memory.	Arbitrary wave data saved on USB flash drive could not be copied to internal memory.
6509	File-system error.	The device is malfunctioning.
6510	Invalid length in array format ARB.	The waveform length of ARB in array format is invalid. The waveform length should be between 16 words and the maximum waveform length.
6511	Invalid number of points in control point format ARB.	The number of control points in ARB in control point format is invalid. The number of control points should be in the range 2 to 10 000.
6512	Unable to copy There is not enough free memory.	Arbitrary waveform memory is full and could not be copied from USB flash drive.
7500	Output overload detected (Ch:<N>-FCTN OUT) Output turned off	An overload was detected at the FCTN OUT terminal of CH<N>, so the CH<N> output was turned off.
7501	Output overload detected (Ch:<N>-SUB OUT)	An overload was detected on the SYNC/SUB OUT terminal of CH<N>.
7502	Self Check failed Auto-shutdown will occur	Self-check failed. The device may be malfunctioning.
7503	Oscillation section no response	Internal error. The device may be malfunctioning.
7504	Internal error.	An error occurred in internal processing.
7505	Unsupported model.	The update file is for a different model.
7506	Unsupported version.	This version is not eligible for updates.
7507	Invalid update data.	The update data is corrupted.
8000	Interface setting in progress	An attempt was made to change to a different interface during interface configuration.

14.3 Conflict Messages

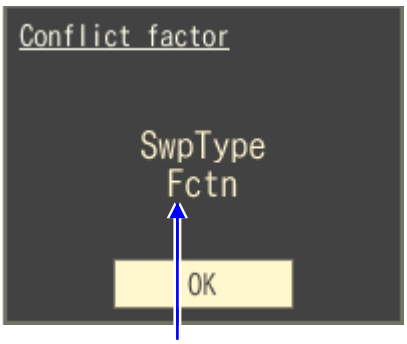
These messages are displayed when the [?] soft key is pressed when the specified modulation, sweep, or burst oscillation cannot be executed due to an inappropriate setting (conflict state).
If you press this soft key [?], inappropriate setting items will be displayed, so set the setting items to the correct values. There may be one factor or multiple factors.
They explain about the inappropriate setting.



If there is an inappropriate setting,
[?] will be displayed



Displayed when only the frequency is inappropriate, such as when switching to 'FM' with the upper limit frequency set



This appears when the combination of sweep type and waveform is inappropriate, such as when setting a frequency sweep when the waveform is 'Noise'

Message	Explanation
Mode	The oscillation mode is inappropriate. Check the oscillation mode and waveform.
SwpType	Invalid sweep type. Check the sweep type and waveform.
SwpMode	Sweep mode is inappropriate. Check the sweep type and waveform.
BrstMode	Burst mode is inappropriate. Check the burst mode, waveform, frequency, etc.
Fctn	The waveform is inappropriate. Please check whether the waveform can be output.
Freq	Incorrect frequency. Check the difference in frequency range depending on the waveform and the setting range limit value.
Phase	Incorrect phase. Check the phase range, etc.
Duty	Duty is inappropriate. Please check the duty setting value, frequency, etc.

14.4 Sequence Compiler Message

These messages are displayed when a setting with which execution is not possible was found as a result of sequence compilation.

Number	Message	Explanation
4500	Amptd-Offset conflict CH:<N> Step:<M> Amptd (Step <K>) - Offset (Step <L>)	In step M of channel N, amplitude and offset do not satisfy mutual constraints. Amplitude is set in step K and offset in step L. Please reduce the amplitude or offset.
4501	Fctn-Freq conflict CH:<N> Step:<L>-<M>	Between steps L and M on channel N, the frequency exceeds the upper limit of the waveform. Please lower the frequency.
4502	Fctn-Freq-Duty conflict CH:<N> Step:<M> Freq (Step <K>) - Duty (Step <L>)	In step M of channel N, the frequency and duty of the square wave do not satisfy the mutual constraint. The frequency is set in step K and the duty is set in step L. Lower the frequency or bring the duty closer to 50%.
4503	Selected ARB is missing CH:<N> Step:<M>	The arbitrary wave specified in step M of channel N does not exist. Please specify another arbitrary wave.
4504	Selected ARB loading failed CH:<N> Step:<M>	Arbitrary wave could not be read in step M of channel N. This device is malfunctioning.
4505	Too complex to check.	It was too complex to perform a check. Please simplify the sequence structure.
4506	Too many or too large Functions used.	The total amount of waveforms used exceeds maximum waveform length. Please reduce the number of waveforms. Alternatively, reduce the number of arbitrary wave length in array format. ☞ P.11-10
4507	Freq-Range conflict CH:<N> Step:<M>	In step M of channel N, frequency and range do not satisfy mutual constraints.
4508	ExtAdd-Range conflict CH:<N>	Range and external addition do not satisfy mutual constraints on channel N

14.5 When Suspect a Failure

When an abnormality is suspected, perform the corresponding action below. If this fails to resolve the problem, please contact NF Corporation or one of its representatives.

Problem	Possible cause	Action	Reference page ☞
The power does not turn on	A power supply out of the rated range is being used.	Use a power supply within the rated range.	「2.3 Grounding and Power Supply Connection」 P.2-4
	A malfunction is occurring due to external noise, etc.	Install the instrument in a location with suitable conditions.	「2.2 Installation」 P.2-3
Panel operation is not possible	In the remote state	Change to the local state.	「13.1.1 Remote/local state」 P.13-2
	Keys and/or modify knob are deteriorated.	Contact NF Corporation and request repair.	—
Setting is not possible	The setting range limit values are set to a narrow values.	Change the setting range limit values or perform initialization.	「4.4.18 To set the setting range Limit Values」 P.4-57
Output level is abnormal	The ambient temperature/humidity range is out of the guaranteed operating range.	Use in the environment within the specified range.	「2.2 Installation」 P.2-3
	Warm up is insufficient.	Allow to warm up for more than 30 minutes after the power turns on.	—
	DC offset has been added.	Set the DC offset to 0V.	「4.4.8 To set DC Offset」 P.4-39
	A user-defined unit is being used.	Select the standard unit.	「4.4.7 To set Amplitude」 P.4-38
	The load impedance function is being used.	Change the setting to ‘High-Z’.	「4.4.12 To set Load Impedance」 P.4-45
Setting by remote control is not possible	A different interface is set.	Make sure it matches the interface you use	「13.1 Selecting Remote Interface: “Remote」 P.13-2
	The USB ID, LAN parameter or GPIB address are different from that in the program.	Make sure the USB ID, LAN parameters, and GPIB address match the program.	
	The GPIB address is the same as another device.	Use a GPIB address that does not overlap with other devices.	
Self-diagnosis identified an error	Malfunctioning due to external noise.	Remove all cables other than the power cable from the device and perform the self-diagnosis again.	「13.3 Self-Diagnosis: “Self Check」 P.13-3
	Initialization has not been performed.	The explanations presume that initialization has been performed. Perform initialization.	「4.3.11 To restore Initial settings」 P.4-27
Incorrect behavior	Internal memory has deteriorated.	Turn on the power while pressing the soft key immediately to the right of the power switch. An internal memory check is performed at startup. If an error is found as a result of the check, the device is malfunctioning, so please contact our agent or our company.	—

15. Maintenance

15.1 Introduction

This chapter describes the following:

- Routine maintenance
- Precautions and storage method when not used for a long period of time
- Precautions for repacking and transportation when transported
- Performance tests necessary when, for example, performing preventive maintenance and verifying performance during operation inspection and after repair

This instruction manual describes the operation inspection and the performance testing methods that can be easily performed.

For more accurate inspections, adjustments, calibrations, or repairs, contact NF Corporation or one of our representatives.

⚠ WARNING

This product contains high-voltage components. Do not remove its cover.
Inspection of the inside of the instrument must not be performed by anyone except trained service technicians with extensive experience in hazard prevention.

15.2 Routine Maintenance

Install and use this unit in a location that satisfies the installation conditions. Details on installation conditions ☞ P.2-3

The front panel of this unit is made of plastic. Take care not to damage it with a sharp or hot object. 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 any organic solvents like thinner or benzene or chemical cleaning cloths as they may cause the surface finish to deteriorate or peel off.

When the surface of the LCD becomes dirty, wipe it with absorbent cotton or a soft cloth. Avoid using detergents, organic solvents, etc., as they may cause deterioration or tarnishing.

15.3 Storage When Not Used for a Long Period of Time

- Disconnect the power cord from the outlet and the unit.
- Store the unit in a location free from falling objects and dust, such as a shelf or rack. If dust may be present, cover the unit with a cloth or polyethylene cover.
- The environmental conditions for storage are −10°C to +50°C and 5% to 95% RH. However, avoid a location where the temperature fluctuates significantly or where the unit will be exposed to direct sunlight, and store the unit in an environment as close to room temperature as possible.

15.4 Repacking and transportation

When repacking the unit to transport or send it for repairs, pay attention to the following points:

- Store away the tilt legs located on the unit lower base.
- Wrap the unit in a polyethylene bag or sheet.
- Prepare a carton box that can sufficiently withstand the weight of the unit and is of a large enough size to accommodate it.
- Fill the carton box with cushioning material so that the top, bottom, and six sides of the main unit can be protected.
- When making a request for transportation, inform the transport operator that the product is a precision instrument.

15.5 Operation Inspections

■ Equipment

To check the output waveform, an oscilloscope (e.g. Tektronix MDO3032) with an analog bandwidth of 300MHz or higher, 2GS/s, and an input impedance of 50Ω is required.

■ Checks before operation inspections

Check the following before the operation inspections:

- The power supply voltage is within the rated range
- The ambient temperature is within the range of 0 to +40°C
- The ambient relative humidity is within the range of 5 to 85%RH (furthermore, the absolute humidity is within the range of 1 to 25g/m^3)
- Non-condensing

■ Function check

- Checks at power-on

  Make sure that no error message appears when the power is turned on.

  When an error message appears, see ☞ P.14-2.

  If an error message is displayed at the power-on, turn the power off, wait for at least 5s, and turn the power-on again.

- Self-diagnosis

  Run “Self Check” on the Utility screen. ☞ P.13-3

- Checks of important functions

  To avoid miss-setting, perform initialization first. ☞ P.4-27

  (Press [Reset] soft key in the Utility screen.)

  Then, connect the FCTN OUT to the oscilloscope using characteristic impedance 50Ω series coaxial cable and observe the output.

  Change the following settings several times and check that the instrument works properly.

  For items that set numeric values like the frequency, more reliable checks can be performed by operating both the numeric keypad and modify knobs.

  - Waveform (shortcut key: FCTN)
  - Frequency (shortcut key: FREQ)
  - Amplitude (shortcut key: AMPTD)
  - DC offset (shortcut key: OFFSET)
  - Output on/off (OUT key)

- Check of USB, LAN, and GPIB

  Make some of the setting changes described in the “Checks of important functions” section from USB, LAN, and GPIB. Verify that the output changes are the same. (GPIB interface is not present on WF1982/WF1981)

  In this case USB, LAN, or GPIB will be displayed in the status area at the top of the screen. Check also that pressing the [Local] soft key while USB, LAN, or GPIB is displayed in the status display area clears the previous status display and returns to the local state (except when local lockout).

15.6 Performance tests

■ Equipment

The following measuring instruments are required:

	Requirement	Sample Model	Intended Purpose
Digital multi-meter	AC voltage (TrueRMS) Accuracy: ±0.1% (1kHz to 100kHz) DC voltage Accuracy: ±0.1%	Keysight 3458A	Measurement of AC voltage of 100kHz or lower, and DC voltage.
Power meter and power sensor	100kHz to 60MHz 5μW to 250mW (-23dBm to +24dBm) Accuracy: 0.02dB Resolution: 0.01dB	Rohde&Schwarz NRP6A and NRP-ZKU/03	Measurement of AC voltage of 100kHz or greater
Universal counter	Accuracy: 0.1ppm	Keysight 53220A Opt010 (highly-stabilized TB)	Measurement of frequency, duty, time difference between channels
Oscilloscope	300MHz or greater 2GS/s, 50Ω input	Tektronix MDO3032	Measurement of leading edge and trailing edge times
Audio analyzer	0.01% or lower, THD measurement	Panasonic VP-7722A	Harmonic distortion measurement
Spectrum analyzer	10kHz to 1GHz Resolution: 100Hz	Keysight N9322C	Measurement of non-harmonic spurious
BNC cable	Characteristics impedance: 50Ω Length: 1m, 30cm	—	—
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) banana adapter	Characteristics impedance: 50Ω	—	To connect a BNC cable to a power sensor

■ Performance tests

The performance tests are carried out as a part of the preventive maintenance to prevent product performance from deteriorating.

Carry out the performance tests in the event of the need to perform an acceptance inspection, periodic inspection, or performance checks after repair.

If the results of the performance tests indicate that the product does not meet the specifications, repair is required. Contact NF Corporation or one of our representatives.

■ Checks before performance tests

Check the following before the performance tests.

- The power supply voltage is within the rated range
- The ambient temperature is within the range of +20 to +30°C
- The ambient relative humidity is within the range of 20 to 70%RH
- Non-condensing
- The product was allowed to warm up for at least 30 minutes

■ Preparations before performance tests

- As the signal cable, use a coaxial cable with a characteristic impedance of 50Ω, thickness of RG-58A/U or more, and length of 1m or less, and BNC connectors on both ends.
- For the items that 50Ω termination is specified, set the input impedance to 50Ω for the measuring instrument to be connected.
- For a measuring instrument that cannot be set to 50Ω input, install a 50Ω terminator (feed through terminator) at the input of the instrument.
- Measure a signal up to approx. 24dBm (when the amplitude setting is 20Vp-p/open). Use a coaxial attenuator separately if needed so as not to exceed the allowable input of the instrument. Note that a power meter (power sensor) and spectrum analyzer in particular are damaged easily.
- The setting information for each test item includes descriptions on items requiring additional changes after performing setting initialization (performing [Reset] in the Utility screen) and turning the output on.

15.6.1 Frequency Accuracy Test

Connection: FCTN OUT → Universal counter input (50Ω termination)
Use a coaxial cable.

Setting: Set the frequency to 1MHz and the amplitude to 10Vp-p/open after setting initialization.

Measurement: Set the universal counter to the frequency measurement mode and measure the frequency.

Judgment: Normal if the value falls within the following range.
However, the instrument may vary ±1 ppm annually due to deterioration with age. For example, if one year has passed since the instrument was shipped, the extent of deterioration may be within ±2 ppm (999.998kHz to 1.000 002MHz).

Rating range
0.999 999MHz to 1.000 001MHz

15.6.2 Sine wave Amplitude Accuracy test

Connection: FCTN OUT → Digital multi-meter (AC voltage TrueRMS measurement)
Use a coaxial cable.
Setting: The following table shows the amplitude after setting initialization.
(Frequency is set to 1kHz).
Measurement: Measure the output voltage for each waveform as the effective value.
Judgment: Normal if the values fall within the ranges in the following table.

Amplitude setting @open	Rating range
20 Vp-p (7.071 Vrms)	7.000 Vrms ～ 7.142 Vrms
5 Vp-p (1.768 Vrms)	1.749 Vrms ～ 1.786 Vrms
3 Vp-p (1.061 Vrms)	1.049 Vrms ～ 1.072 Vrms
1 Vp-p (353.6 mVrms)	349.3 mVrms ～ 357.8 mVrms
0.3 Vp-p (106.1 mVrms)	104.3 mVrms ～ 107.8 mVrms
0.1 Vp-p (35.36 mVrms)	34.29 mVrms ～ 36.42 mVrms
0.02 Vp-p (7.071 mVrms)	6.293 mVrms ～ 7.849 mVrms

15.6.3 DC Offset Accuracy test

■ DC only

Connection: FCTN OUT → Digital multi-meter (DC voltage measurement)
Setting: Set the waveform to DC after setting initialization. The following table shows the DC offset settings.
Measurement: Measure the output voltage as DC.
Judgment: Normal if the values fall within the ranges in the following table.

DC offset setting @open	Rating range
±10 V	±9.895 V ～ ±10.105 V
±3 V	±2.965 V ～ ±3.035 V
±1 V	±0.9850 V ～ ±1.0150 V
±0.3 V	±0.292 V ～ ±0.308 V
±0 V	-5.000 mV ～ +5.000 mV

■ **AC+DC**

Connection: FCTN OUT → Digital multi-meter (DC voltage measurement)
Setting: Set the oscillation mode to 'Burst', burst mode to 'Gate', trigger to external (oscillation of sine wave is stopped at 0º) after setting initialization.
Measurement: The following table shows the amplitude. DC offset setting is left at 0V.
Judgment: Measure the output voltage as DC.

Amplitude setting @open	Ratein range
6.4 Vp-p	-37.00 mV ～ +37.00 mV
3.5 Vp-p	-22.50 mV ～ +22.50 mV
0.7 Vp-p	-8.50 mV ～ +8.50 mV

15.6.4 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 setting initialization.
Measurement: Measure the output voltage for each frequency as the effective value.
Judgment: For each amplitude setting, normal if the measurement error for each frequency based on the measurement values at 1kHz falls within the range in the following table. (The right-most column of the table is used in the next section.)

Amplitude Setting @50Ω	Measured value at 1kHz	Error at 50kHz	Error at 100kHz	Error of each amplitude at 100kHz is as follows.
10Vp-p	Reference value	±0.1dB	±0.1dB	X1(dB)
2.5Vp-p	Reference value	±0.1dB	±0.1dB	X2(dB)
2.0Vp-p	Reference value	±0.1dB	±0.1dB	X3(dB)
0.5Vp-p	Reference value	±0.1dB	±0.1dB	X4(dB)
0.15Vp-p	Reference value	±0.1dB	±0.1dB	X5(dB)
0.05Vp-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 so as not to exceed the allowable input of the power sensor.

Setting: The following table shows the amplitude and frequency after setting initialization.

Measurement: Measure the output voltage or the power at each frequency.

Judgment: For each amplitude setting, normal if the measurement error for each frequency based on the measurement values at 100kHz falls within the range in the following table.
Add the error Xn (n=1 to 6), previously measured at 100kHz by the digital multi-meter, to the judgment range.
For example, when X1 is −0.05dB, the judgment range at 10Vp-p and 5MHz is −0.1dB to +0.2dB.

Amplitude Setting @50Ω	Measured value at 100kHz	Error at 5MHz	Error at 20MHz	Error at 30MHz	Error at 60MHz
10Vp-p	Reference value	-X1±0.15dB	-X1±0.2dB	-X1±0.5dB	-X1±0.7dB
2.5Vp-p	Reference value	-X2±0.15dB	-X2±0.2dB	-X2±0.5dB	-X2±0.7dB
2.0Vp-p	Reference value	-X3±0.15dB	-X3±0.2dB	-X3±0.5dB	-X3±0.7dB
0.5Vp-p	Reference value	-X4±0.15dB	-X4±0.2dB	-X4±0.5dB	-X4±0.7dB
0.15Vp-p	Reference value	-X5±0.15dB	-X5±0.2dB	-X5±0.5dB	-X5±0.7dB
0.05Vp-p	Reference value	-X6±0.15dB	-X6±0.2dB	-X6±0.5dB	-X6±0.7dB

15.6.5 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 terminator, install a 50Ω terminator (feed through terminator) at the input of the instrument.

Setting: Set frequency to 20kHz after setting initialization. The following table shows the amplitude.

Measurement: Measure the harmonic distortion up to the 7th order THD_7[%]. (Not THD+N)
When THD_7 cannot be measured directly, measure the harmonic distortion from the 2nd order to the 7th order (HD_2 to HD_7)[%] and obtain THD_7[%] through calculation.

$$THD_7 = \sqrt{{HD_2}^2 + {HD_3}^2 + {HD_4}^2 + {HD_5}^2 + {HD_6}^2 + {HD_7}^2}$$

Judgment: Normal if the value falls within the range in following table.

Amplitude Setting @50Ω	Total harmonic distortion (THD_7)
2Vp-p	0.03% or less

15.6.6 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 so as not to exceed the allowable input of the spectrum analyzer.

Setting: The following table shows the amplitude and frequency after setting initialization.

Measurement: Measure the harmonic spurious up to the 5th order and obtain the total value of harmonic spurious through calculation.
Make the attenuator of the spectrum analyzer high until the relative level of the fundamental wave stabilizes. In addition, average the measurement values because they vary due to noise.
Using X2 to X5[dBc] as the relative values of the harmonic spurious up to the 5th order based on the fundamental wave, the total harmonic spurious can be obtained with the following formula.

$$\text{Harmonic spurious} = 10 \times log_{10}\sqrt{10^{\frac{X2}{10}} + 10^{\frac{X3}{10}} + 10^{\frac{X4}{10}} + 10^{\frac{X5}{10}}}$$

Judgment: Normal if the values fall within the ranges in the following table.

	Total value of the maximum harmonic spurious level up to the 5th order			
Amplitude Setting @50Ω	Frequency setting 1MHz	Frequency setting 5MHz	Frequency setting 30MHz	Frequency setting 60MHz
2Vp-p	−65dBc or less	−60dBc or less	−46dBc or less	−40dBc or less

15.6.7 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 so as not to exceed the allowable input of the spectrum analyzer.

Setting: The following table shows the amplitude and frequency after setting initialization.

Measurement: Measure the non-harmonic spurious maximum value. Average the measurement values because they vary due to noise.

Judgment: Normal if the value falls within the range in the following table.

	Maximum non-harmonic spurious level		
Amplitude Setting @50Ω	Frequency setting 8MHz	Frequency setting 30MHz	Frequency setting 60MHz
2Vp-p	−70dBc or less	−65dBc or less	−65dBc or less

15.6.8 Square wave Duty Accuracy test

Connection: FCTN OUT → Universal counter (50Ω termination)
Use a coaxial cable.

Setting: Set the waveform to square wave and the amplitude to 20Vp-p/open after setting initialization. The following table shows the duty variable range setting, frequency setting, and duty setting.

Measurement: Set the universal counter to duty measurement mode. Set the trigger level of the universal counter to 0V. Average the measured values because they vary due to jitter (especially when extended duty variable range).

Judgment: Normal if the values fall within the ranges following tables.

■ Standard and Extended duty variable range

Frequency	Duty		
300kHz	When 1% is set 0.9% to 1.1%	When 50% is set 49.9% to 50.1%	When 99% is set 98.9% to 99.1%
3MHz	When 5% is set 4% to 6%	When 50% is set 49% to 51%	When 95% is set 94% to 96%
10MHz	When 40% is set 37% to 43%	When 50% is set 47% to 53%	When 60% is set 57% to 63%

15.6.9 Square wave Leading/Trailing time test

Connection: FCTN OUT → Oscilloscope (50Ω termination)
Use a coaxial cable.

Setting: Set the waveform to square wave, the frequency to 5MHz, and the amplitude to 4Vp-p/open after setting initialization.
The following table shows the duty variable range.

Measurement: Observe the waveform and measure the leading and trailing time.

Judgment: Normal if the value falls within the range in the following table.

Duty variable range	Leading edge and trailing edge time
Standard	8.2ns or less
Extended	8.2ns or less

15.6.10 Time Difference between channels for 2-Phase (WF1984/WF1982)

Connection: CH1 FCTN OUT → Universal counter input 1 (50Ω termination)
CH2 FCTN OUT → Universal counter input 2 (50Ω termination)
Use coaxial cables of the same length and type.

Setting: Set the channel mode to '2Phase', amplitude to 20Vp-p/open, phase of CH2 to 180º, and frequency to 10MHz after setting initialization. The following table shows the waveform.
Perform the measurement by setting the phase difference to 180º. This is because the normal counter cannot measure a negative time difference. With this setting, a fixed offset time can be provided.

Measurement: Measure the interval between CH1 and CH2 by setting the universal counter to the time interval mode of input 1 → input 2. Set the trigger level of the universal counter to 0V and the trigger polarity to rising for CH1 and CH2.
Average the measurement values because they vary.

Judgment: Normal if the values fall within the ranges in the following table.

Waveform	Rating range
Sine wave	50ns ±20ns
Square wave (standard duty variable range)	50ns ±20ns
Square wave (extended duty variable range)	50ns ±20ns

16. List of Initial Settings

The settings can be initialized in the Utility screen. ☞ P.4-27

The soft key [Reset] on the Utility screen initializes the contents of ☞「16.1 Settings related to normal Oscillator mode」 when the operation mode is normal oscillation, and the contents of ☞「16.2 Settings related to Sequence oscillation mode」 when sequence oscillation is selected. These items are also stored in the setting memory.

However, arbitrary wave memories, setting memories, sequence memories saved by user, ☞「16.3 Other factory default settings」 (definition of user-defined units, output and operation mode settings at power-on, panel operation settings, remote settings) are not initialized. Initialization including these can be performed on ☞ P.4-28.

16.1 Settings related to normal Oscillator mode

■ Waveform output settings

Oscillation mode	Continuous mode
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°
Output	Off
Noise bandwidth	Full (30MHz for WF1981/WF1982)

■ Waveforms

Square wave duty	Standard range, 50%
Pulse wave duty	50%
Pulse wave leading/trailing time	1μs
Lamp wave symmetry	50%

■ Sub output settings

Synchronization/sub output	Reference phase synchronization
Sub-waveform	Sine wave
Sub-waveform frequency	1kHz
Sub-waveform phase	0°
Band when sub-waveform is Noise	Full (30MHz for WF1981/WF1982)
Sub-waveform amplitude	0.1Vp-p
Sub-waveform DC offset	0V

■ Modulation

Modulation type	FM
FM peak deviation	100Hz
FSK hop frequency	1.1kHz
PM peak deviation	90°
PSK deviation	90°
AM modulation depth	50%
DC offset modulation peak deviation	0.1V
PWM peak deviation	10%
Modulation source	Internal, sine wave, 1 000Hz
FSK/PSK external modulation input polarity	Positive
Synchronization/sub-output	Internal modulation synchronization

■ Sweep

Sweep type	Frequency
Frequency sweep range	1kHz to 10kHz
Phase sweep range	−90° to +90°
Amplitude sweep range	0.1Vp-p to 0.2Vp-p
DC offset sweep range	−0.1V to +0.1V
Duty sweep range	40% to 60%
Sweep time	100ms
Sweep mode	Continuous
Trigger source	Internal, 1sec
External trigger input polarity	Negative
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	Cycle
Synchronization/sub-output	Sweep synchronization, marker on

■ Burst

Burst mode	Trigger burst
Mark wave number	1.0
Space wave number	1.0
Trigger source	Internal, 10ms
External trigger input polarity	Negative
Trigger delay	0s
Stop level	Off, 0%
Oscillation stop unit when gate	Cycle
Synchronization/sub-output	Burst synchronization

■ Synclator

Synclator	Off
External trigger input polarity	Negative
External trigger threshold	TTL
Dividing ratio M, multiplication ratio N	1, 1

■ 2 Channel Coordination (WF1984/WF1982)

Channel mode	Independent
Frequency difference	0Hz
Frequency ratio	1:1
Same value setting	Off

■ Setting range limits

Frequency upper limit	60MHz (30MHz for WF1981/WF1982)
Frequency lower limit	0.01μHz
High level	+10.5V
Low level	−10.5V
Phase upper limit	+1800°
Phase lower limit	−1800°
Duty upper limit	100%
Duty lower limit	0%

■ Others

Use of user-defined unit	Not used
External 10MHz frequency reference input	Disabled
External 10MHz frequency reference output	Disabled
External addition	Off

16.2 Settings related to Sequence oscillation mode

■ Step control parameters

Start step	1
Trigger polarity	Off
Noise bandwidth	Full (30MHz for WF1981/WF1982)
External control input	Disabled
External control start/state branch	Start
Synchronization/sub-output	Step synchronization
Step time	1s
Auto hold	Off
Jump destination	Off
Jump count	Infinite
Stop phase	Off
State branch	Off
Event branch	Off
Control at step terminate	Moving to the next step
Step synchronization code	LLLL
Intra-step operation	Constant

■ Intra-step channel parameters

Channel parameters	Equal to initial values of Oscillator mode

16.3 Other factory default settings

The following settings are factory default settings for items not changed when setting initialization is performed.

■ Definition of user-defined unit

Unit name	“usr1” to “usr6”
Formula	(h+n)*m
m	1
n	0

■ Output setting at power-on, panel operation settings

Output at power-on	Off
Operation mode at power-on	Oscillator
Display	Dark color
Operation sound	On

■ Remote settings

Interfaces	USBTMC
IP address / Subnet mask	192.168.0.2 / 255.255.255.0
GPIB address	2

17. Specifications

Unless otherwise specified, the conditions are as follows: waveform output (FCTN OUT) is the target, oscillation is continuous, load is 50Ω, amplitude setting is 10Vp-p/50Ω, DC offset setting is 0V, auto range for output voltage, amplitude range of waveform is ±FS, external addition is off, and AC voltage is effective value measurement.

Numeric values marked as *1 are guaranteed values. The other numeric values are not guaranteed values but nominal values or typical values (marked as typ.).

17.1 Oscillation Mode

Oscillation mode	Continuous, burst, sweep, sequence
Modulation function	In each of the continuous, burst, and sweep modes, modulations are possible simultaneously. However, in the sweep mode, modulations with the same parameters as the sweep type are not allowed. In other than auto burst mode, external FSK and PSK are not allowed.

17.2 Waveform

17.2.1 Standard waveform

Types	Sine wave, square wave, pulse wave, ramp wave, parameter variable waveforms, Noise (gaussian distribution), DC
Polarity	Normal, inverted (switchable) Except for DC
Amplitude range	−FS/0, ±FS, 0/+FS (switchable) Except for DC.

17.2.2 Arbitrary waveform

Waveform length	16 words to 64Mi words (WF1983/WF1984) 16 words to 32Mi words (WF1981/WF1982) or 2 to 10 000 control points (linear interpolation is performed between control points)
Total amount of waveforms that can be saved	Approx. 4Gi words (common for all channels) Saving of maximum of 4 096 waveforms (when average waveform length 900Ki words, 32Mi words length allows 112 waveforms to be saved) Stored in non-volatile memory Can also be saved on USB flash drive
Resolution of waveform data amplitude	Approx. 16bit
Sampling rate	0 to 240MS/s (WF1983/WF1984) 0 to 120MS/s (WF1981/WF1982)
Resolution	16 digits or 100nS/s
Polarity	Normal, inverted (switchable)
Amplitude range	−FS/0, ±FS, 0/+FS (switchable)
Output bandwidth	40MHz (−3dB) when 240MS/s (WF1983/WF1984) 25MHz (−3dB) when 120MS/s (WF1981/WF1982)

17.3 Frequency and Phase

Frequency setting range

Limited to the smaller of the ranges determined by the waveforms and oscillation mode.

When the synclator function is enabled, the available frequency range of oscillation is limited to 30Hz to 5MHz.

Model	WF1983/WF1984			WF1981/WF1982		
Oscillation mode / Waveform	Continuous, modulated, sweep (continuous and single)	Sweep (gated single), Burst	Sequence oscillation	Continuous, modulated, sweep (continuous and single)	Sweep (gated single), Burst	Sequence oscillation
Sine wave	0 to 60MHz	0 to 20MHz	0 to 20MHz	0 to 30MHz	0 to 10MHz	0 to 10MHz
Square wave	0 to 30MHz			0 to 15MHz		
Pulse wave			Not available			Not available
Ramp wave	0 to 10MHz			0 to 5MHz		
Parameter variable waveform	0 to 5MHz *2					
Noise	Equivalent bandwidth: select from 100kHz / 300kHz / 1MHz / 3MHz / 10MHz / 30MHz / FULL *3			Equivalent bandwidth: select from 100kHz / 300kHz / 1MHz / 3MHz / 10MHz / 30MHz		
DC	Frequency setting is invalid					
Arbitrary waveform	0 to 15MHz (The following restrictions are added for array format: ≤ 240M / waveform length)			0 to 5MHz (The following restrictions are added for array format: ≤ 120M / waveform length)		

*2 : Convert to arbitrary waveform and use in sequence

*3 : FULL specification is approximately 70MHz

Frequency setting resolution	0.01μHz (< 50MHz), 0.1μHz (50MHz ≤)
Frequency setting with period	Setting with frequency that is inverse number of set period Less than 0.01μHz is rounded off
Frequency accuracy at shipment *1	± (1 ppm of setting + 4pHz)
Frequency aging rate *1	±1 ppm/year
Setting range of phase	−1 800.000° to +1 800.000° (resolution 0.001°)

17.4 Output Characteristics

17.4.1 Amplitude

Setting range	0Vp-p to 21Vp-p/open, 0Vp-p to 10.5Vp-p/50Ω A peak value combining waveform amplitude and DC offset is limited to ±10.5V/open or less.
Setting resolution	0.1mVp-p (2.999 9Vp-p or less)/open 1mVp-p (3.000Vp-p or more)/open
Accuracy *1	± (1% of amplitude setting [Vp-p] + 2mVp-p)/open
Conditions:	Continuous oscillation, 1kHz sine wave, amplitude setting 20mVp-p to 20Vp-p/open, DC offset setting 0V, auto range, external addition off, and effective value measurement

Setting unit	Vp-p, Vpk, Vrms, dBV, dBm Vp-p is applied to the standard waveforms and arbitrary waveform with amplitude range of ±FS. Vpk is applied to the standard waveforms and arbitrary waveforms with amplitude range of −FS/0 or 0/+FS. Vrms, dBV, and dBm are applied to sine wave and Noise only. (0dBV will be 1Vrms) Regarding dBm, voltage that is 1mW at the specified load impedance (excluding High-Z) will be 0dBm.
Range	Auto, Hold (switchable) Maximum output voltage range: 20Vp-p, 4Vp-p, 0.8Vp-p Amplitude attenuator range: 0dB, −10dB, −20dB, −30dB
Resolution of waveform amplitude	Approx. 16bit
Conditions:	Amplitude setting 8mVp-p/open or more, DC offset setting 0V, auto range, external addition off, and standard waveform with amplitude range of ±FS.

17.4.2 DC offset

Setting range	±10.5V/open, ±5.25V/50Ω A peak value combining waveform amplitude and DC offset is limited to ±10.5V/open or less.
Setting resolution	0.1mV (−2.999 9V to +2.999 9V)/open 1mV (−3.000V or less and +3.000V or more)/open
Accuracy*1	± (|1% of DC offset setting [V]|+ 5mV +0.5% of amplitude setting [Vp-p])/open
Conditions:	When sine wave output of 10MHz or less, load open, auto range, external addition off, and 20°C to 30°C. When 1mV/°C typ and 2Vp-p will be exceeded with an amplitude setting of 2Vp-p outside of the temperature range of 20°C to 30°C, add 2mV/°C typ.
Range	0dB, −14dB

17.4.3 Load Impedance Setting

Function	Set and display the amplitude and DC offset at the output terminal voltage under the specified load condition.
Setting range	1Ω to 10kΩ (resolution 4 digits or 0.1Ω), High-Z (load open)

17.4.4 Waveform Output

Output on/off control	On, off (switchable) Output terminal is in an open condition when off
Output impedance	50Ω, unbalanced
Short-circuit protection	Protection against short circuit with signal GND
Output connector	Front panel, BNC receptacle

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

Output signals	Reference phase synchronization, burst synchronization, sweep synchronization, sequence step synchronization, sub-waveform, internal modulation synchronization, and off (switchable)
Reference phase synchronization	Square wave with duty 50% rising at 0° of reference phase of the waveform output.
Sub-waveform	Analog waveform output independent from the main-output Frequency, phase, amplitude, and offset are also adjustable.
Available waveform	Sine wave, square wave (50% duty), triangle wave (50% symmetry), rising ramp, falling ramp wave, Noise, arbitrary wave, parameter variable waveform
Setting frequency range	0 to 5MHz (resolution 0.01μHz)
Internal modulation waveform	Modulation waveform at the time of internal modulation oscillation. Amplitude and offset are also adjustable independent from the modulation depth.
Output voltage	Each type of synchronized signal: TTL level (low ≤ 0.4V, high 2.7V ≤ /open) Sub-waveform/Internal modulation waveform: −3.3V to +3.3V/open
Phase setting range	−180.000° to +180.000° (resolution 0.001°) When sub-waveform and internal modulation waveform are selected. Phase represents the phase of waveform output with respect to reference phase synchronization.
Output impedance	50Ω, unbalanced
Load impedance	50Ω or more
Output connector	Front panel, BNC receptacle

17.5 Main Signal Characteristics

17.5.1 Sine wave

Amplitude frequency characteristics *1

100kHz or less	±0.1dB
100kHz< to 5MHz	±0.15dB
5MHz< to 20MHz	±0.3dB
20MHz< to 30MHz	±0.5dB
30MHz< to 60MHz	±0.7dB (WF1983/WF1984 only)
Conditions:	Continuous oscillation, 50Ω load, DC offset setting 0V, amplitude setting 50mVp-p to 10Vp-p/50Ω, auto range, external addition off, effective value measurement, frequency 1kHz reference

Total harmonic distortion

10Hz to 20kHz	0.03% or less typ
Conditions:	Continuous oscillation, 50Ω load, DC offset setting 0V, amplitude setting 2Vp-p/50Ω, auto range, external addition off, synchronization/sub-output off, sum up to 7th harmonic, noise is not included

Harmonic spurious

1MHz or less	−65dBc or less typ
1MHz< to 10MHz	−60dBc or less typ
10MHz< to 60MHz	−60dBc+20dB/dec or less typ (Up to 30MHz for WF1981/WF1982)
Conditions:	Continuous oscillation, 50Ω load, amplitude setting 2Vp-p/50Ω, DC offset setting 0V, auto range, external addition off, synchronization/sub-output off

Non-harmonic spurious

10MHz or less	−70dBc or less typ
10MHz< to 60MHz	−65dBc or less typ (Up to 30MHz for WF1981/WF1982)
Conditions:	Continuous oscillation, 50Ω load, DC offset setting 0V, amplitude setting 2Vp-p/50Ω, synchronization/sub-output off

17.5.2 Square wave

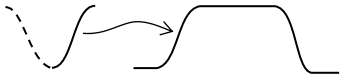
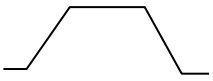
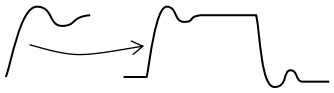
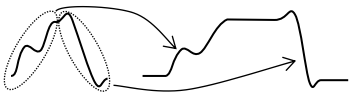
Duty

Variable range	Standard, extended (switchable)
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 setting range with 15MHz Approx. 18% to 82%

Extended range	There is jitter of 1.3ns rms or less typ., and the duty can be always changed at the maximum range. When the pulse width is narrower than 4.2ns, pulses may disappear. When the frequency is not 1/(integer) of 240MHz, it becomes equal to the specified duty on average.
Setting range	
Standard range	0.000 0% to 99.999 9% (resolution 0.000 1%) Upper limit [%]: 100–Frequency [Hz] × 115 / 96 000 000 Lower limit [%]: Frequency [Hz] × 115 / 96 000 000
Extended range	0.000 0% to 100.000 0% (resolution 0.000 1%)
Duty accuracy *1	
100kHz or less	±0.1% of period (duty setting is 1% to 99%)
100kHz< to 1MHz	±1% of period (duty setting is 5% to 95%)
1MHz< to 3MHz	±3% of period (duty setting is 40% to 60%)
Leading/trailing edge time	8.0ns or less typ, but when continuous oscillation mode
Overshoot	2% or less typ.
Jitter	40ps rms or less typ. (standard range, 100Hz or more) 1.3ns rms or less typ. (extended range)

17.5.3 Pulse wave

Available edge waveform: Transition part of the pulse is selectable from cosine, linear, parameter variable waveform, and arbitrary waveform. For details, refer to the table below

Edge waveform	Description	Output waveform
Cosine	Rising: 180° to 360° of cosine waveform Falling: Waveform with rising inverted	
Linear	Rising and falling are both linear	
Parameter variable waveform	Rising: Selected parameter variable waveform Falling: Waveform with rising inverted	
Arbitrary waveform	Rising: First half of selected arbitrary waveform Falling: Second half of selected arbitrary waveform	

Pulse width *4	
Duty setting range	0.000 1% to 99.999 9% (resolution 0.000 1%)
Time setting range	12ns to 99.999 9Ms (resolution < 0.000 1% of period or 0.01ns)
Leading edge time, trailing edge time *4	
Setting range	7.7ns to 59.03Ms (resolution 4 digits or 0.01ns) Independent setting of leading and trailing edge times
Minimum setting value	0.000 1% of period or 7.7ns, whichever is larger

Limitations on pulse width time, leading edge time, and trailing edge time *4

The pulse width time, leading edge time, trailing edge time, and period are mutually limited according to the following expression.

The duty is calculated by pulse width time / period.

Pulse width time ≥ (leading edge time + trailing edge time) × 0.85

Pulse width time ≤ period – (leading edge time + trailing edge time) × 0.85

Overshoot *4 2% or less typ.

Jitter *4 40ps rms or less typ. (100Hz or more)

1.3ns rms or less typ. (less than 100Hz)

Condition: Leading edge time setting: 7.7ns

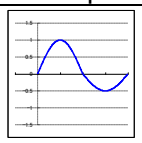
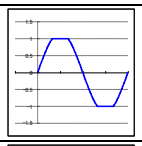
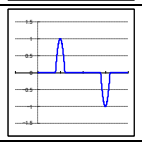
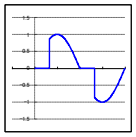
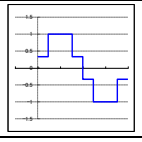
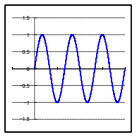
*4: When the edge waveform is cosine

17.5.4 Ramp wave

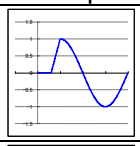
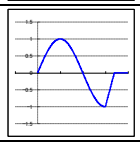
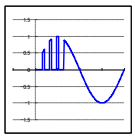
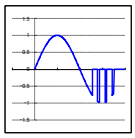
Setting range of symmetry 0.00% to 100.00% (resolution 0.01%)

17.5.5 Parameter variable waveform

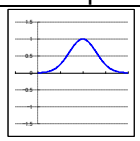
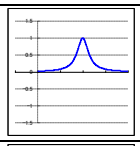
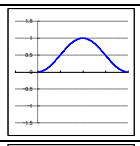
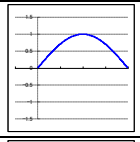
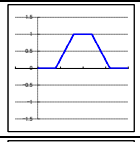
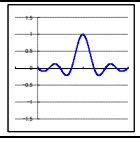
a) Steady sine group

Waveform name	Waveform example	Overview and variable parameters
Unbalance sine		Waveform for which the amplitudes of the first half cycle and second half cycle of a sine wave can be changed independently
		First half amplitude (−100.00% to +100.00%) Second half amplitude (−100.00% to +100.00%)
Clipped sine wave		Waveform acquired by clipping the top and bottom of the amplitude of a sine wave
		Clip ratio (0.00% to 99.99%)
CF controlled sine wave		Waveform acquired by extracting only the neighborhood of 90° and 270° of a sine wave and expanding the amplitude
		Crest factor (1.41 to 10.00)
Angle controlled sine wave		Waveform acquired by extracting only the front or back portion of each half cycle of a sine wave
		Conduction angle (−180.00° to +180.00°) Remark: A back conduction angle if the conduction angle is positive, and a front conduction angle if it is negative.
Staircase sine wave		Staircase shaped sine wave
		Number of horizontal axis steps (2 to 1 024 or infinite) Number of vertical axis steps (2 to 256 or infinite)
Multiple-cycle sine wave		Waveform acquired by continuing the sine wave for multiple cycles
		No. of cycles (0.01 to 50.00) Start phase (−360.00° to +360.00°)

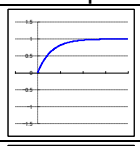
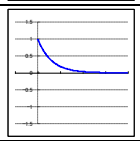
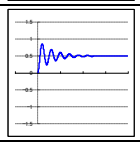
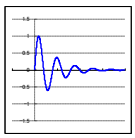
b) Transient sine group

Waveform name	Waveform example	Overview and variable parameters
On-phase controlled sine wave		Sine wave with a slope into the on state On completion phase (0.00° to 360.00°) On slope time (0.00% to 50.00% of basic period)
Off-phase controlled sine wave		Sine wave with a slope into the off state Off start phase (0.00° to 360.00°) Off slope time (0.00% to 50.00% of basic period)
Chattering-on sine wave		Sine wave with chattering into the on state On start phase (0.00° to 360.00°) Number of chattering (0 to 20) On time (0.00% to 20.00% of basic period) Off time (0.00% to 20.00% of basic period)
Chattering-off sine wave		Sine wave with chattering into the off state Off start phase (0.00° to 360.00°) Number of chattering (0 to 20) On time (0.00% to 20.00% of basic period) Off time (0.00% to 20.00% of basic period)

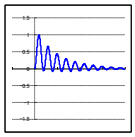
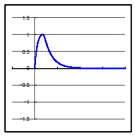
c) Pulse group

Waveform name	Waveform example	Overview and variable parameters
Gaussian pulse		Waveform with a Gaussian distribution Standard deviation (0.01% to 100.00% of basic period)
Lorentz pulse		Lorentz waveform Half value width (0.01% to 100.00% of basic period)
Haversine		Sin^2 pulse Width (0.01% to 100.00% of basic period)
Half-sine pulse		Sine wave half cycle pulse Width (0.01% to 100.00% of basic period)
Trapezoid pulse		Trapezoid waveform pulse Slope width (0.00% to 50.00% of basic period) Upper base width (0.00% to 100.00% of basic period)
Sin(x)/x		Sin(x)/x waveform Number of zero crossings (1 to 50)

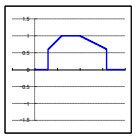
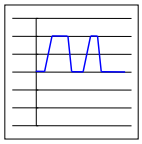
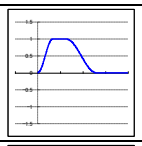
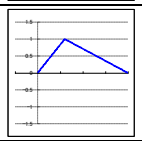
d) Transient response group

Waveform name	Waveform example	Overview and variable parameters
Exponential rise		First order LPF step response waveform Time constant (0.01% to 100.00% of basic period)
Exponential fall		First order HPF step response waveform Time constant (0.01% to 100.00% of basic period)
Second order LPF step response		Second order LPF step response waveform Natural frequency of LPF (fundamental frequency ×1.00 to ×50.00) LPF Q (0.50 to 50.00)
Damped oscillation		Oscillation waveform with an amplitude that dampens exponentially Oscillation frequency (fundamental frequency ×1.00 to ×50.00) Damped oscillation time constant (−100.00% to +100.00% of basic period) Remark: If the damped oscillation time constant is negative, an oscillation waveform with an amplitude that increases exponentially.

e) Surge group

Waveform name	Waveform example	Overview and variable parameters
Oscillation surge		Surge waveform with damped oscillation Oscillation frequency (fundamental frequency ×1.00 to ×50.00) Damped oscillation time constant (0.01% to 100.00% of basic period) Trailing edge time constant (0.01% to 100.00% of basic period)
Pulse surge		Pulse surge waveform Leading edge time (0.01% to 100.00% of basic period) Time duration (0.01% to 100.00% of basic period) The leading edge time is the time that the amplitude rises from the 10% to the 90%, and time duration is the pulse width with an amplitude of 10% or greater.

f) Other group

Waveform name	Waveform example	Overview and variable parameters
Trapezoid wave with offset		Trapezoid wave with offset in the amplitude direction
		Leading edge delay (0.00% to 100.00% of basic period) Rising slope width (0.00% to 100.00% of basic period) Upper base width (0.00% to 100.00% of basic period) Falling slope width (0.00% to 100.00% of basic period) Offset (0.00% to 100.00%)
Double pulse		Double wave pulse for which rising and falling of the pulse are the same
		Leading edge time (0.00% to 100.00% of basic period) Trailing edge time (0.00% to 100.00% of basic period) Lower base time 1 (0.00% to 100.00% of basic period) Upper base time 1 (0.00% to 100.00% of basic period) Lower base time 2 (0.00% to 100.00% of basic period) Upper base time 2 (0.00% to 100.00% of basic period)
Half-sine edge pulse		Pulse whose rise and fall are half-sine waveform
		Leading edge time (0.00% to 100.00% of basic period) Trailing edge time (0.00% to 100.00% of basic period) Duty (0.00% to 100.00%)
Bottom referenced ramp		Ramp waveform with bottom level as reference
		Symmetry (0.00% to 100.00%)

17.6 Modulation Function

17.6.1 General

Modulation type	FM, FSK, PM, PSK, AM, DC offset modulation, and PWM PM and PSK are not available for parameter variable waveform and arbitrary waveform
Modulation operation	Start and stop
Modulation source	Internal, external (switchable). External modulation of FSK and PSK uses an external trigger input terminal
Internal modulation waveform	
Except for FSK, PSK	Sine wave, square wave (50% duty), triangle wave (50% symmetry), rising / falling ramp wave, Noise, arbitrary waveform
FSK, PSK	Square wave (50% duty)
Noise equivalent bandwidth	Select from 100kHz / 300kHz / 1MHz / 3MHz / 10MHz / 30MHz / Full (Full: WF1983/WF1984 only)
Internal modulation frequency	0 to 5MHz (Resolution 0.01μHz)
Internal modulation synchronization output	
Output waveform	A square wave with duty 50% rising at 0º 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 (SYNC/SUB OUT)

Internal modulation waveform output	
Output voltage	-3.3V to +3.3V/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 to 50kHz (−3dB)
Input connector	Front (WF1983/WF1981) / rear (WF1984/WF1982) panel, BNC receptacle. Shared with external addition input. Simultaneous use with the addition operation is not possible. WF1984/WF1982 has 2 inputs, each channel is dedicated
External modulation input (FSK and PSK)	
Polarity	Positive, negative (switchable)
Input frequency	DC to 5MHz
Input connector	Use external trigger input terminal. Input voltage and input impedance depend on external trigger input specification
Simultaneous use with burst and sweep	Some modulation is possible in the burst and sweep modes. For details, refer to ☞「17.7 Sweep mode」,「17.8 Burst mode」

17.6.2 Modulation Conditions

■ FM

Carrier waveform	Sine wave, square wave, ramp wave, parameter variable waveforms, and arbitrary waveforms
Peak deviation setting range	0.00μHz to less than 30MHz (less than 15MHz for WF1981/WF1982, resolution 8 digits or 0.01μHz) Carrier frequency ± peak deviation is limited within the allowable range of frequency for each carrier waveform

■ FSK

Carrier waveform	Sine wave, square wave, ramp wave, parameter variable waveforms, and arbitrary waveforms
Hop frequency setting range	Within the allowable range of frequency for each carrier waveform (resolution 8 digits or 0.01μHz).

■ PM

Carrier waveform	Sine wave, square wave, pulse wave, and ramp wave
Peak deviation setting range	0.000° to 180.000° (resolution 0.001°)

■ PSK

Carrier waveform	Sine wave, square wave, pulse wave, and ramp wave
Setting range of deviation	−1 800.000° to +1 800.000° (resolution 0.001°)
Remark	Amplitude frequency characteristic of sine wave during PSK is limited to 25MHz (−3dB)

■ AM (non DSB-SC)

Carrier waveform	Arbitrary waveforms and standard waveforms except for DC
Modulation depth setting range	0.00% to 100.00% (resolution 0.01%)
Remark	When the modulation depth is 0%, amplitude becomes equal to 1/2 of setting

■ AM(DSB-SC) (Double Side Band - Suppressed Carrier)

Carrier waveform	Arbitrary waveforms and standard waveforms except for DC
Modulation depth setting range	0.00% to 100.00% (resolution 0.01%)
Remark	When the modulation depth is 100%, maximum amplitude becomes equal to setting. The component of the carrier frequency is 0 during DSB-SC

■ DC offset moduration

Carrier waveform	Arbitrary waveforms and standard waveforms
Peak deviation setting range	0V to 10.5V/open Resolution: 5 digits or 0.1mV (< 3V), 4 digits or 1mV (3V ≤) Carrier DC offset ± peak deviation is limited within the allowed setting range of DC offset for each carrier waveform

■PWM

Carrier waveform	Square wave and pulse wave
Peak deviation setting range	
Square wave	
Duty variable range standard	0.000 0% to 49.999 9% (resolution 0.000 1%)
Duty variable range extended	0.000 0% to 50.000 0% (resolution 0.000 1%)
Pulse Wave	0.000 0% to 49.999 9% (resolution 0.000 1%) Carrier duty ± peak deviation is limited within the allowable range of duty for each carrier waveform

17.7 Sweep mode

17.7.1 General

Sweep type	
Waveforms except arbitrary waveforms and parameter variable waveform	
	Frequency, phase, amplitude, and DC offset
Arbitrary waveforms, parameter variable waveforms	
	Frequency, amplitude, DC offset
Square wave and pulse wave	Duty
Sweep function	One way (ramp wave shape), shuttle (triangular wave shape) (switchable)
	Linear, logarithmic (switchable)
	Common regardless of sweep type.
	However, logarithmic can use only frequency sweep
Sweep range setting	Specify start value and stop value, or center value and span value
	However, the center value is also a simple average of the start value and stop value during frequency logarithmic sweep
Sweep time setting range	0.1ms to 10 000s (resolution 5 digits or 10μs)
	Common regardless of sweep type
Limitations of modulation function	Modulation except sweep type is available
Sweep mode	Continuous, single, gated single (switchable)
	Common regardless of sweep type. For gated single, it oscillates only while sweep is running. However, when the waveform is DC, gated single is not available
Operation	Start, stop, hold, resume, start value output and stop value output
Trigger source (used for single sweep and gated single sweep)	
	Internal, external (switchable)
	Common regardless of sweep type. Trigger delay setting is disabled. Manual trigger available
Internal trigger oscillator for sweep (used for single sweep and gated single sweep)	
Period setting range	0.1μs to 10 000s (resolution 7 digits or 2.5ns)
Stop level setting (used for gated single sweep)	
Function	Specifies the signal level when gated single-sweep is stopped
Setting range	−100.00% to +100.00% (amplitude full-scale reference, resolution 0.01%) or off
	When stop level is set to off, stops by set oscillation start/stop phase. Common regardless of sweep type
Oscillation stop unit when gated single	Cycle, Half Cycle (switchable)

Sweep synchronization/marker output

Marker off at one-way	Low level is used from sweep start value to half of sweep time. Otherwise, high level
Marker off at shuffle	Low level is used from sweep staring value to sweep stop value. Otherwise, high level
Marker on	Low level is used from sweep start value to marker value. High level, otherwise
Output connector	Shared with synchronization/sub-out connector

Sweep external control input

Input connector	Use 3-bit of multi-I/O connector
Control items	Start, stop, hold/resume With WF1984/WF1982, this is shared by two channels, and enable and disable can be set separately for each channel

Sweep external trigger input (used for single sweep and gated single sweep)

Polarity	Positive, negative, disable (switchable)
Input connector	Use external trigger input terminal. Input voltage and input impedance depend on external trigger input specification

17.7.2 Sweep Conditions

■ Frequency Sweep

Waveform	Sine wave, square wave, ramp wave, parameter variable waveforms, and arbitrary waveforms
Setting range of start / stop frequency	0 to 60MHz (Up to 30MHz for WF1981/WF1982)
Resolution:	0.01μHz (<50MHz), 0.1μHz (50MHz≤)
	Limited within the allowable setting range of frequency for each waveform

■ Phase Sweep

Waveform	Sine wave, square wave, pulse wave, and ramp wave
Setting range: start and stop phase	−1 800.000° to +1 800.000° (resolution 0.001°)

■ Amplitude Sweep

Waveform	Arbitrary waveforms and standard waveforms except for DC
Setting range of start and stop amplitude	0Vp-p to 21Vp-p/open.
Resolution:	5 digits or 0.1mVp-p (< 3Vp-p), 4 digits or 1mVp-p (3Vp-p ≤)

■ DC Offset Sweep

Waveform	Arbitrary waveforms and standard waveforms
Setting range of start and stop DC offset	−10.5V to +10.5V/open.
Resolution:	5 digits or 0.1mV (< ±3V), 4 digits or 1mV (±3V ≤)

■ **Duty Sweep**

Waveform	Square wave and pulse wave
Setting range of start and stop duty	
Square wave	
Duty variable range standard	0.000 1% to 99.999 9% (resolution 0.000 1%)
Duty variable range extended	0.000 0% to 100.000 0% (resolution 0.000 1%)
Pulse wave	0.000 1% to 99.999 9% (resolution 0.000 1%)
	Limited within the allowable setting range of duty for each waveform

17.8 Burst mode

Burst mode	
Auto burst	Repeats oscillation for the number of mark waves and oscillation stop for the number of space waves. Trigger is disabled
Trigger burst	Oscillates the number of mark waves in synchronization with a trigger
Gate	Oscillates integer multiples in cycles or half-cycles, in synchronization with the gate signal. However, when the waveform is Noise, it turns oscillation on/off by gate signal
Triggered gate	Gate oscillation, that toggles the gate on and off for each trigger
Target waveform	
Auto, trigger burst	Arbitrary waveforms and standard waveforms except for Noise and DC
Gate, triggered burst	Arbitrary waveforms and standard waveforms except for DC
Mark wave number setting range	0.5 to 999 999.5 cycles, in 0.5-cycle units or infinit
Space wave number setting range	0.5 to 999 999.5 cycles, in 0.5-cycle units
Oscillation stop unit at gate	1-cycle units, 0.5-cycle units (switchable)
Setting range of start/stop oscillation phase	
	−1 800.000° to +1 800.000° (resolution 0.001°) Remark: The same setting value as the phase setting in Section 17.3
Stop level setting range	
Function	Specifies the signal level when oscillation is stopped
Setting range	−100.00% to +100.00% (amplitude full-scale reference, resolution 0.01%) or off. When stop level is set to off, stops by set oscillation start/stop phases
Trigger source (used for other than auto burst)	
	Internal, external (switchable). Manual trigger available

Internal trigger oscillator for burst (used except for auto burst)	
Period setting range	0.1µs to 10 000s (resolution 7 digits or 2.5ns)
Burst external trigger input (used except for auto burst)	
Polarity	Positive, negative, disable (switchable)
Input connector	Use external trigger input terminal. Input voltage and input impedance depend on external trigger input specification
Trigger delay setting range	0.00µs to 1 000s (resolution 8 digits or 100ps) Latent delay approx. 0.48µs Enabled only for trigger burst (disabled for gate and triggered gate) and enabled for internal, external, and manual triggers.
Trigger jitter	300ps rms or less typ. (setting frequency ≥ 100Hz)
Burst synchronization output	
Polarity	Low level during oscillation. High level, otherwise
Output connector	Shared with synchronization/sub-out connector
Limitations of modulation function	FSK/PSK are available only in auto burst mode

17.9 Synclator Function

Synclator function	Function to make the frequencies of the signal input from the synchronization source and the signal output to the main output automatically become the same or to the multiplication ratio n / frequency division ratio m. The frequency of the output signal is displayed on the screen. Modulation except frequency and auto burst are also possible
Input frequency range	30Hz × m to 5MHz / n (m, n: ratio of division, multiplication)
Output frequency range	30Hz to 5MHz
Setting ranges of frequency division ratio: m and multiplication ratio: n	
	1 to 64 (for each of m and n)
Input connector	External trigger input terminal Trigger delay setting is disabled. Others depend on external trigger input specification
Phase difference	The phase between the input external signal and the signal that is output to the waveform output can be set freely in the phase setting (however, due to internal processing, it will not become the same phase even with the 0° setting, and if the frequency is high, the phase shift will become large)

Limitations

- Not available when sweep, frequency modulation, and burst except auto and when the waveform is Noise, DC, and pulse
- Not available together with the sequence function (section 17.11)
- Not available when channel coordination operation (section 17.13) is constant frequency difference and constant frequency ratio

17.10 Triggers

External trigger input	
Usage	For single sweep, gated single sweep, trigger burst, gate, trigger gate, sequence, FSK/PSK external moduration, and synclator function
Input voltage	TTL level (low ≤ 0.8V, high 2.6V ≤) or variable (threshold variable range −5.0V to＋5.0V, and resolution 0.1V)
Maximum allowable input	−7V to +7V
Polarity	Positive, negative, or off (switchable, off is not available for FSK/PSK and synclator) Each setting is independent for FSK/PSK, sweep, sequence, and synclator.
Minimum pulse width	50ns
Input impedance	10kΩ, unbalanced (pull up to approx. +3V when TTL level, and pull down to GND when variable level)
Input connector	Front panel, BNC receptacle (WF1983/WF1981) Rear panel, BNC receptacle, 2 inputs available, can be shared (WF1984/WF1982)
Manual trigger	Panel key operation
Usage	For single sweep, gated single sweep, trigger burst, gate, and trigger gate
Internal trigger oscillator	Common for sweep and burst See the internal trigger oscillation in each section (Not available for synclator)

17.11 Sequence oscillation

Number of sequences saved	99 sets (saved to non-volatile memory) Saving to USB flash drive is possible
Maximum number of steps	1 023 steps at a maximum per sequence (the steps before start are excluded)
Interoperability between channels	Sequence oscillation mode is applied both channels in the sequence oscillation. Step control is shared
Step control parameters	Step time, hold operation, jump destination, jump count, step end phase, branch operation, step termination control, step synchronization code output
Intra-step channel channel parameter	Waveform, frequency, phase, amplitude, DC offset, square wave duty, and ramp wave symmetry
Intra-step operation	Constant, keep, linear interpolation (excluding waveform switching, symmetry, or arbitrary waveforms phase)
Sweep time setting range	0.1ms to 1 000s (resolution 5 digits or 0.01ms)
Jump count setting range	1 to 9 999 or infinite

Step end phase setting range	0.000° to 360.000° (CH1 reference phase. resolution 0.001°) or disabled Sine wave and ramp wave (only when symmetry is 50%) can be set, fixed phase setting for arbitrary waveform
Branch operation	
State branch	Check the state branch input via the multi-I/O connector at step end. Branches to the specified step when the branch is detected
Event branch	Immediately branches to the specified step by event branch operation or input
Control at step end	Stop or move to the next step
Step synchronization code output	4-bit code specified for each step is output to the multi-I/O connector In addition, LSB can be output to the synchronization/sub output connector (SYNCOUT/SUB OUT)
Available waveforms	Sine wave, square wave, ramp wave, Noise, and arbitrary waveform. Parameter variable waveforms can be used by saving them as arbitrary waveforms
Maximum number of waveforms	1 023 (each channel)
Phase at step start	The reference phase at the start of a step is 0° for the next step of an arbitrary waveform, DC, or Noise, otherwise continuous from the previous step
Sequence operation	Start, stop (immediate or in steps), hold/resume, and event branch
Sequence external control	
Input connector	Use 4-bit of multi-I/O connector
Control items	Start or state branch, stop, hold/resume, event branch
Sequence external trigger input (start trigger)	
Polarity	Positive, negative or off (switchable)
Input connector	Use external trigger input terminal of CH1 side Input voltage and input impedance depend on external trigger input specification
External addition	Combined use is possible
Limitations	Use with synclator function is not available

17.12 Other I/Os

External 10MHz frequency reference input

Frequency reference selection	External reference enable, disable (switchable)
Input voltage	0.5Vp-p to 5Vp-p
Maximum allowable input	10Vp-p
Input impedance	300Ω, unbalanced, AC coupled
Input frequency	10MHz ± 50kHz
Input waveform	Sine or square wave (50 ± 5% duty)
Input connector	Rear panel, BNC receptacle

Frequency reference output

Function	For synchronization of multiple units
Output voltage	1Vp-p/50Ω square wave
Output impedance	50Ω, AC coupled
Output frequency	10MHz (Synchronization signal is also superimposed)
Output connector	Rear panel, BNC receptacle

External addition input

Addition gain	×0.4, ×2, ×10, or off (switchable) The maximum output range is fixed to 0.8Vp-p for ×0.4, 4Vp-p for ×2, and 20Vp-p for ×10 Input voltage −1V to +1V
Maximum allowable input	±2V
Input frequency	DC to 10MHz (−3dB)
Input impedance	10kΩ, unbalanced
Input connector	Front panel, BNC receptacle (WF1983/WF1981) Rear panel, BNC receptacle (WF1984/WF1982) Shared with external modulation input, and not available when external modulation

Multi-I/O

Usage	For sweep control, sequence control, each 4-bit general-purpose IO port (access is possible only from an external remote interface)
Input voltage	TTL level (low ≤ 0.8V, high 2.6V ≤ , 10kΩ, pull up to +5V)
Maximum allowable input	−0.5V to +5.5V
Output voltage	TTL level (low ≤ 0.4V, high 2.7V ≤ /open)
Connector	Rear panel, Mini-Dsub 15-pin multi connector

17.12.1 BNC Connector Placement

The placement locations differ for BNC connectors depending on the model. Also refer to the outline drawing.

BNC connector placement:

Name	Placement location
FCTN OUT	Front panel
SYNC/SUB OUT	Front panel
TRIG IN	WF1983/WF1981: Front panel WF1984/WF1982: Rear Panel
MOD/ADD IN	WF1983/WF1981: Front panel WF1984/WF1982: Rear Panel
10MHz REF IN	Rear Panel
REF OUT	Rear Panel

17.13 2 Channel Coordination Operation (WF1984/WF1982)

Channel mode:

Channel mode	Operation
Independent	Independent settings for each channel
2 phases	Oscillation in the same frequency. Limited to be the same for the oscillation mode, modulation type, and sweep type. Noise and DC cannot be selected. External FM and external FSK are not allowed. Burst and gated single sweep are not allowed.
Constant frequency difference	Oscillation with the frequency difference constant. Limited to be the same for the oscillation mode, modulation type, and sweep type. Noise and DC are not allowed. External FM and external FSK are not allowed. Burst and gated single sweep are not allowed.
Constant frequency ratio	Oscillation with the frequency ratio constant. Limited to be the same for the oscillation mode, modulation type, and sweep type. Noise and DC are not allowed. External FM and external FSK are not allowed. Burst and gated single sweep are not allowed.
Differential output	Oscillates with a waveform of the same frequency, amplitude, and reversed polarity. DC offset changes to the same polarity. Limited to be the same for the oscillation mode, modulation type, and sweep type. Noise and DC are not allowed. External modulation and external addition are not allowed. Gated single sweep are not allowed.
Differential output 2	Same as differential output but DC offset is reversed polarity. When connect the signal GND of CH1 and 2 and make the hot sides of CH1 and 2 are used as the output, including DC, it is possible to obtain the double amount of output voltage (however, the output impedance is 100Ω).

Same value, same operation　　Yes

Frequency difference setting range　　0.00μHz to less than 60MHz (WF1983/WF1984)
0.00μHz to less than 30MHz (WF1981/WF1982)
Resolution:0.01μHz (<50MHz), 0.1μHz (50MHz≤)
CH2 frequency - CH1 frequency

Frequency ratio N:M setting range　　1 to 9 999 999 (for both N and M)
N:M = CH2 frequency:CH1 frequency

Phase synchronization operation　　Auto executed when the channel mode is changed

Time difference between channels for 2-phase [*1]
±20ns or less (±10ns or less typ.)

Conditions:　　Continuous oscillation, same waveform (sine wave or square wave), 50Ω load, DC offset setting 0V, amplitude setting 10Vp-p/50Ω

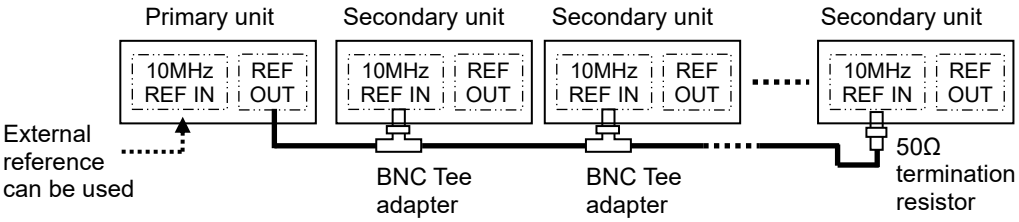
17.14 Synchronization of Multiple Units

Connection

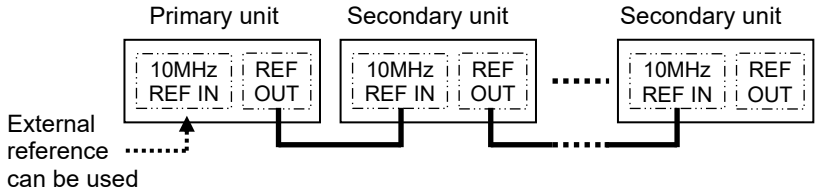
Connect the frequency reference output of the primary unit to the frequency reference input of the secondary unit

Connect the frequency reference output of the primary unit or secondary unit to the frequency reference input of the next secondary unit

Connection method 1



Connection method 2



Connection cables

Cable type: Characteristic impedance 50Ω series coaxial cable with BNC connector (RG-58A/U etc.)

Limitation on cable length: 1m or less between units, total cable length of 3m or less

Maximum number of units for connection

Connection method 1: 6 units including primary unit

Connection method 2: 4 units including primary unit

Phase synchronization operation: Manual operation on the primary unit

Time difference between waveform output units

Delay of each channel of Nth secondary unit with respect to each channel of primary unit ($1 \leq N$)

Connection method 1: 25ns + (N − 1) × 6ns ±25ns or less typ.

Connection method 2: 25ns + (N − 1) × 25ns ±25ns or less typ.

Conditions: Same frequency, same phase, same waveform (sine wave or square wave), and length of connection cable between frequency reference output and external frequency reference input = 1m (RG-58A/U)

17.15 User-defined Units

Function	Set and display settings in any unit based on a specified conversion expression
Setting items	Frequency [Hz], period [sec], amplitude [Vp-p, Vpk], DC offset [V], phase [deg] and duty [%]
Conversion expression	((setting target value)+n)×m or ($\log_{10}$(setting target value)+n)×m Specify a conversion expression and values of n and m
Unit string	Maximum 4 characters

17.16 Setting Value Upper and Lower Limit Function

Function	Limit the upper and lower limits of setting values. However, this is not applied to external addition
Setting target	Frequency, negative and positive values of output voltage (amplitude setting [Vp-p] / 2 + DC offset setting [V]), phase, duty
Setting range and resolution	In accordance with the setting range of each target

17.17 Other Functions

Setting saving memory	10 sets (saved to non-volatile memory) Saving to USB flash drive is possible

17.18 External Storage

Media	USB flash drive
Connector	Front panel, USB-A connector, USB 2.0 Hi-speed
File format	FAT
Stored data	Setting conditions, arbitrary waveform data, sequence data, and screen images
Screen image save function	
File format	Microsoft Windows bitmap file (extension: .BMP, image size: 480×272)
File size	Approx. 256Ki bytes
File name	“ScreenShot<X>.bmp” (<X> is numbers, auto increment)
File save location	“¥<M>ScreenShot” folder (<M> is, for example, WF1984)

17.19 Remote Interfaces

●USB

Standard	USB 1.1 Full Speed
Connector	Rear panel, USB-B connector
Device class	TMC (Test and Measurement Class)

●GPIB (WF1983/WF1984 only)

Standard	IEEE-488.1, IEEE-488.2
Connector	Rear panel, GPIB connector
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0

●LAN

Standard	10/100Base-T
Connector	Rear panel, RJ-45 connector
Protocol	TCP/IP (socket communication)

17.20 Options

PA-001-1318	Multi-I/O Cable Cable with connector on one end, for connection to multi-I/O connector on rear panel. 2m length. Cut off at one end
PA-001-3838	Rack Mount Kit (EIA, for 1 unit)
PA-001-3839	Rack Mount Kit (EIA, for 2 units)
PA-001-3840	Rack Mount Kit (JIS, for 1 unit)
PA-001-3841	Rack Mount Kit (JIS, for 2 units)

17.21 General Characteristics

Display 4.3-inch TFT color LCD

I/O ground

Signal grounds for waveform output (FCTN OUT), synchronization/sub-output (SYNC/SUB OUT), external modulation/addition input (MOD/ADD IN) are insulated from the enclosure.

These signal grounds are shared within the same channel.

The signal ground for the external 10MHz frequency reference input (10MHz REF IN) is insulated from the enclosure.

Each of the signal grounds of CH1, CH2, and 10MHz reference input are independent.

The maximum withstand voltage is 42Vpk (DC+AC peak) between insulated signal grounds and enclosures.

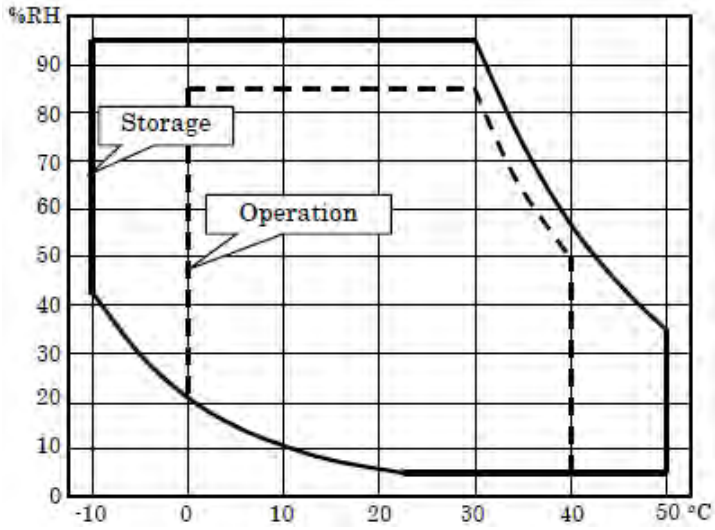
Other signal grounds are connected to enclosures.

Power supply

Power voltage range	100V to 240V AC
Power frequency range	50Hz/60Hz ±2Hz
Power consumption	WF1983/WF1981: 50VA or less
	WF1984/WF1982: 75VA or less
Overvoltage category	II

Ambient temperature/humidity range conditions

Guaranteed operation range	0℃ to +40℃, 5%RH to 85%RH (Where absolute humidity is 1g/m^3 to 25g/m^3, non-condensing) The temperature range is limited for some specifications Altitude: 2 000m or lower
Storage requirements	−10℃ to +50℃, 5%RH to 95%RH (Where absolute humidity is 1g/m^3 to 29g/m^3, non-condensing)



Pollution degree	2
Installation location	Indoor use
Warm-up time	30 minutes or more
Outline dimension	215 (W) × 88 (H) × 306 (D) mm (excluding protrusions)
Weight	Approx. 1.8kg (main body excluding accessories)
Safety, EMC, and RoHS	
Safety	EN 61010-1
EMC	EN 61326-1 (Group 1, Class A) Applicable only to products with CE marking on the rear panel
RoHS	Directive 2011/65/EU

■ Outline dimensional drawing (WF1983/WF1981)

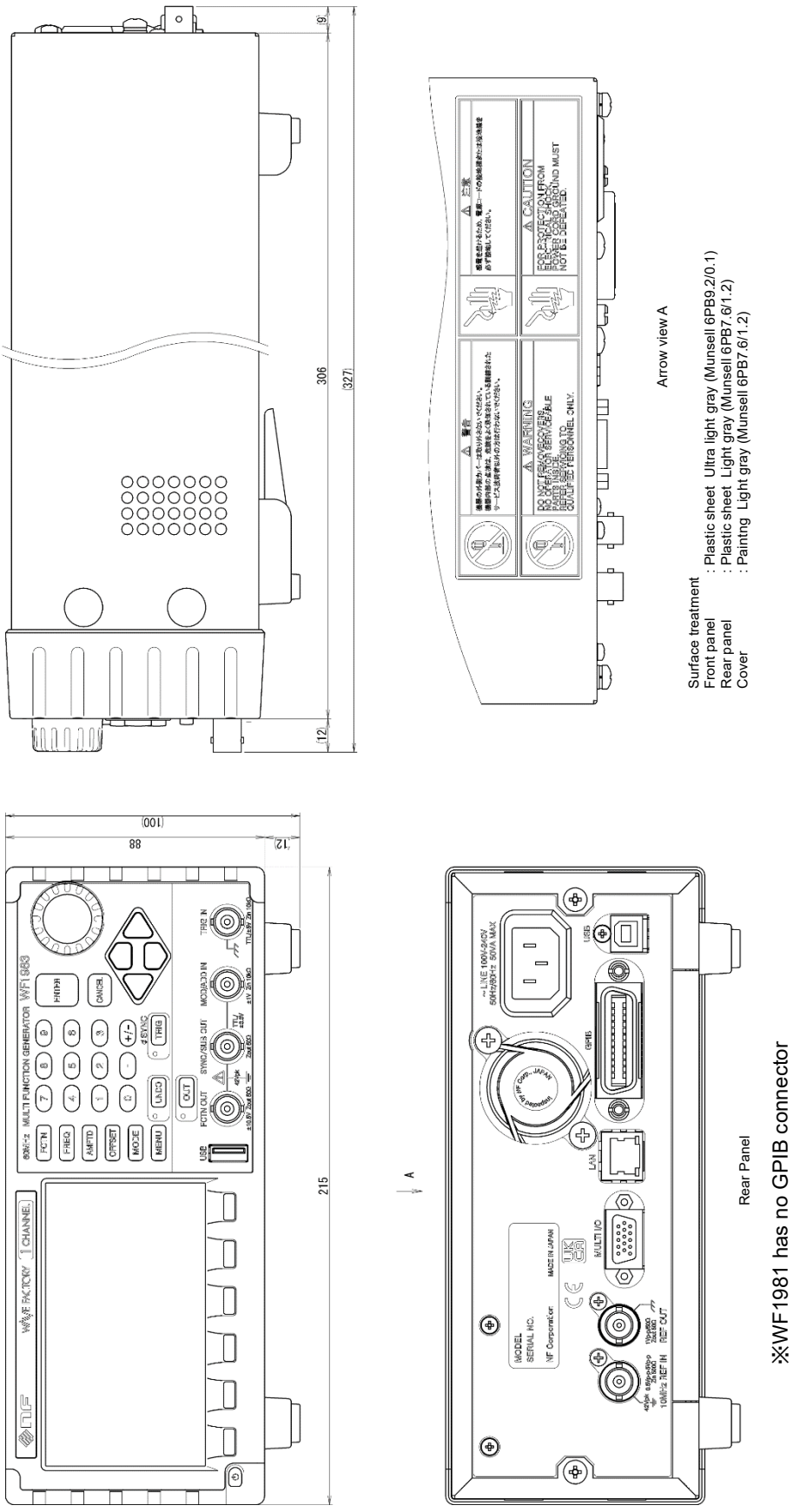


Figure 17-1 Outline dimensional drawing (WF1983/WF1981)

■ Outline dimensional drawing (WF1984/WF1982)

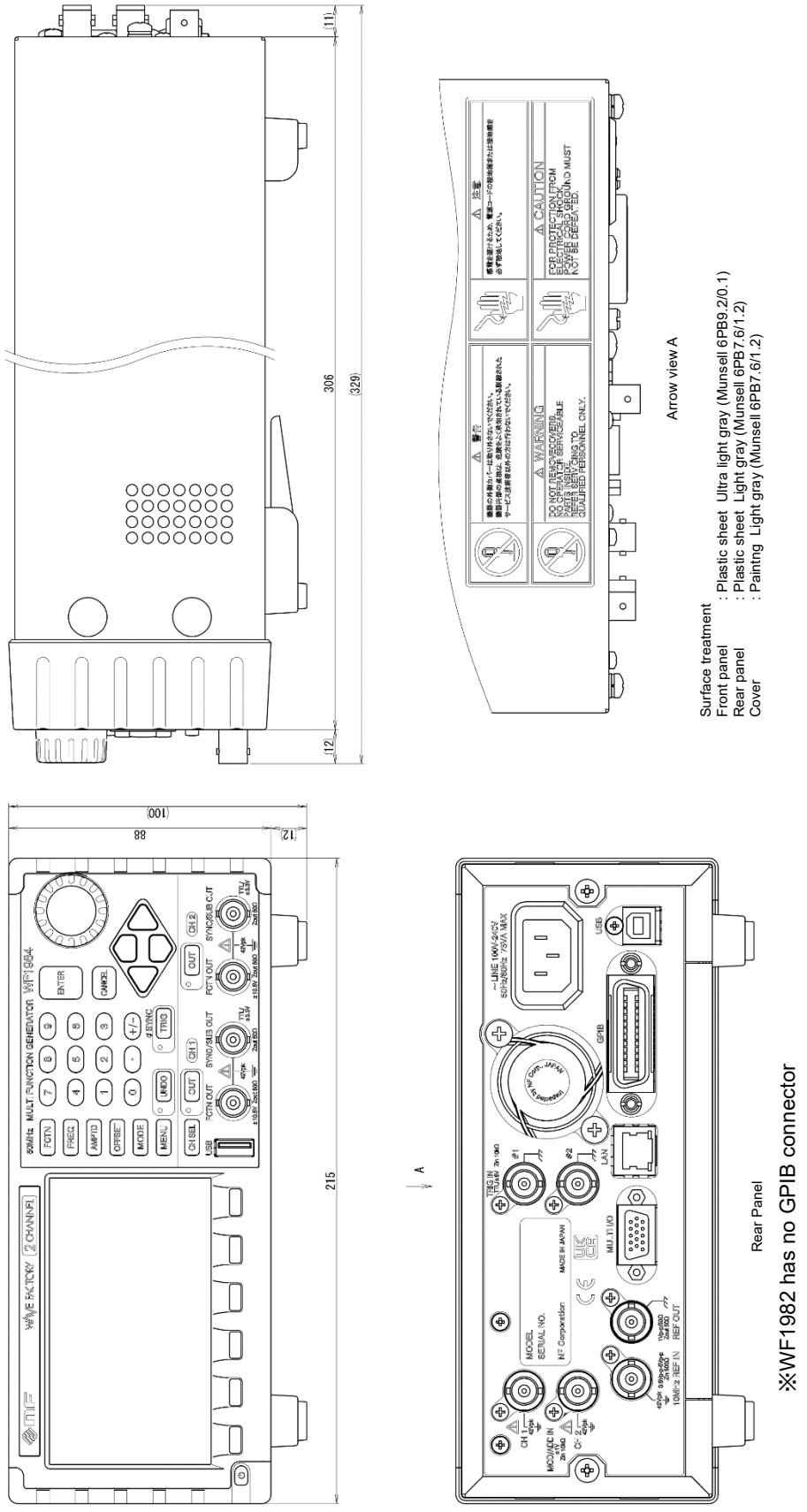


Figure 17-2 Outline dimensional drawing (WF1984/WF1982)

■ Rack mount dimensional drawing (EIA, for 1 unit)

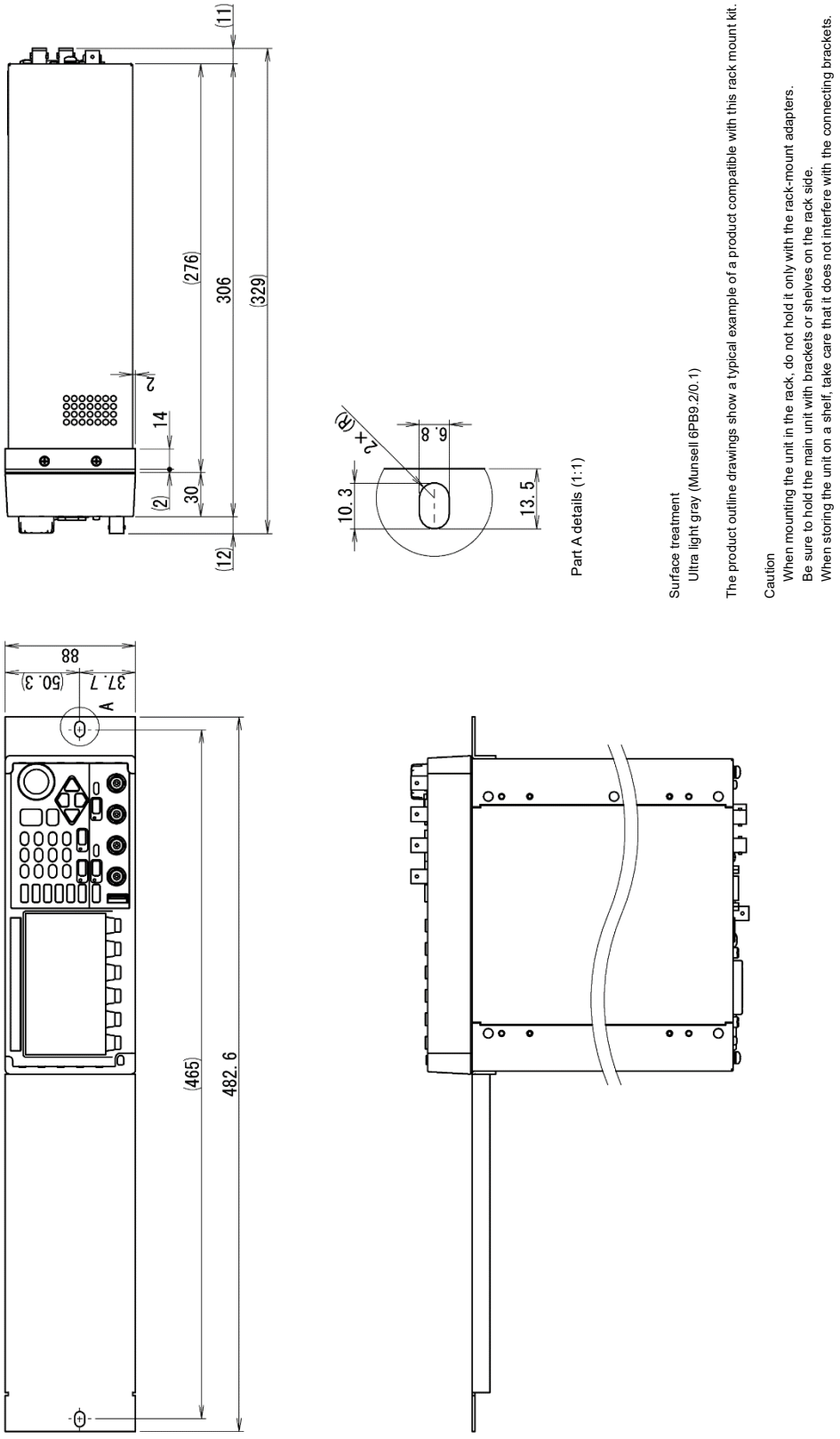


Figure 17-3 Rack mount dimensional drawing (EIA, for 1 unit)

■ Rack mount dimensional drawing (EIA, for 2 units)

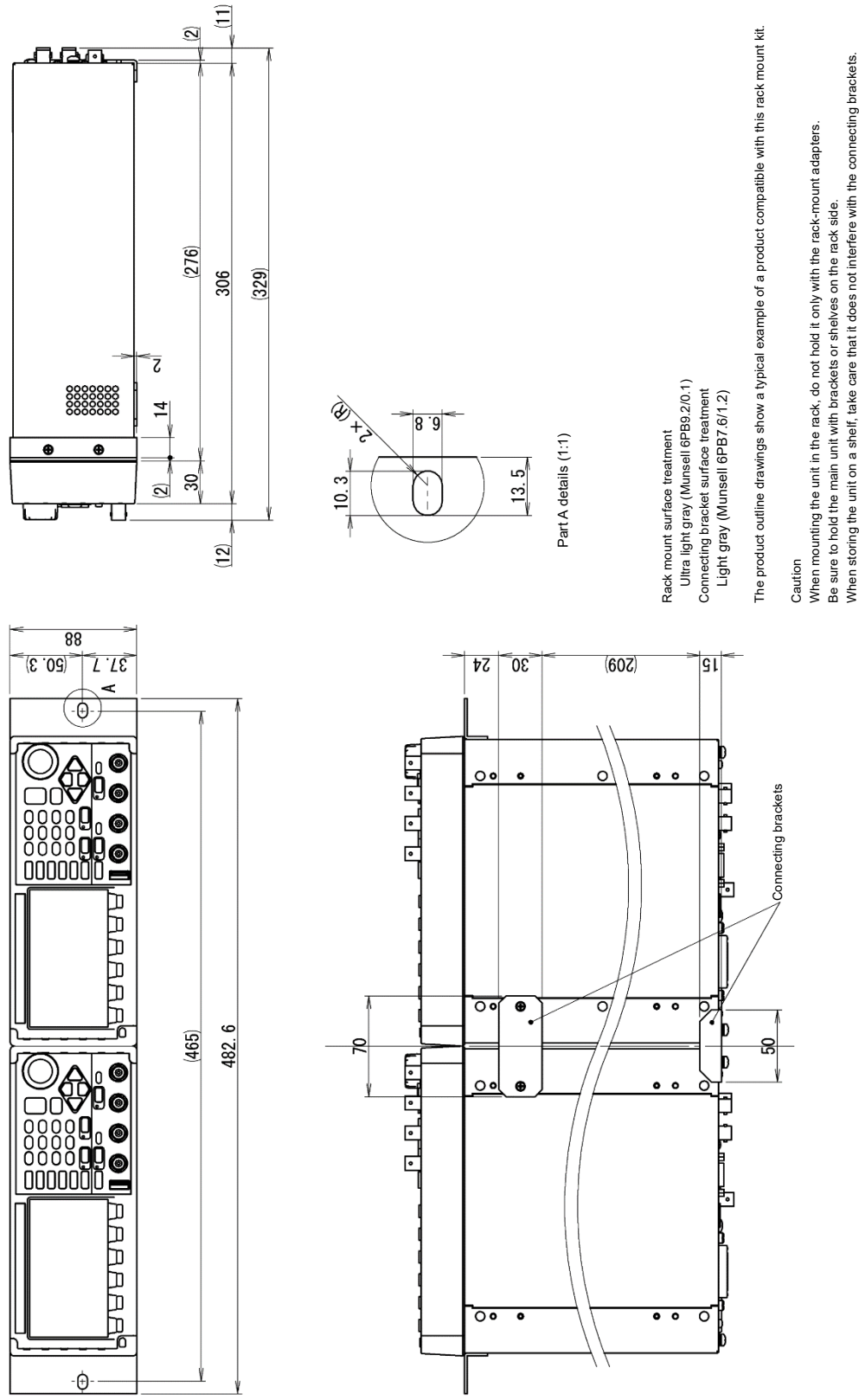


Figure 17-4 Rack mount dimensional drawing (EIA, for 2 units)

■ Rack mount dimensional drawing (JIS, for 1 unit)

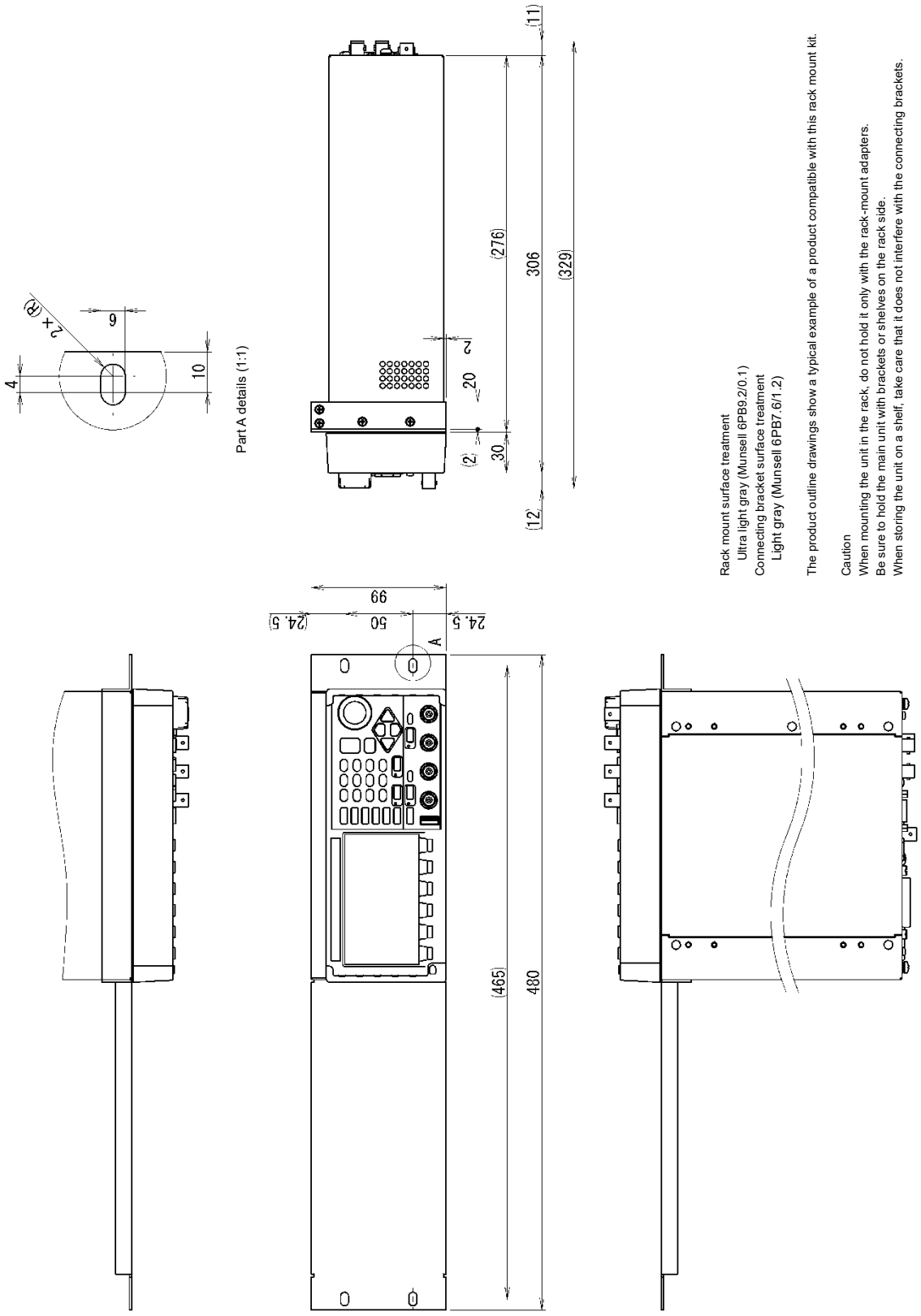


Figure 17-5 Rack mount dimensional drawing (JIS, for 1 unit)

■ Rack mount dimensional drawing (JIS, for 2 units)

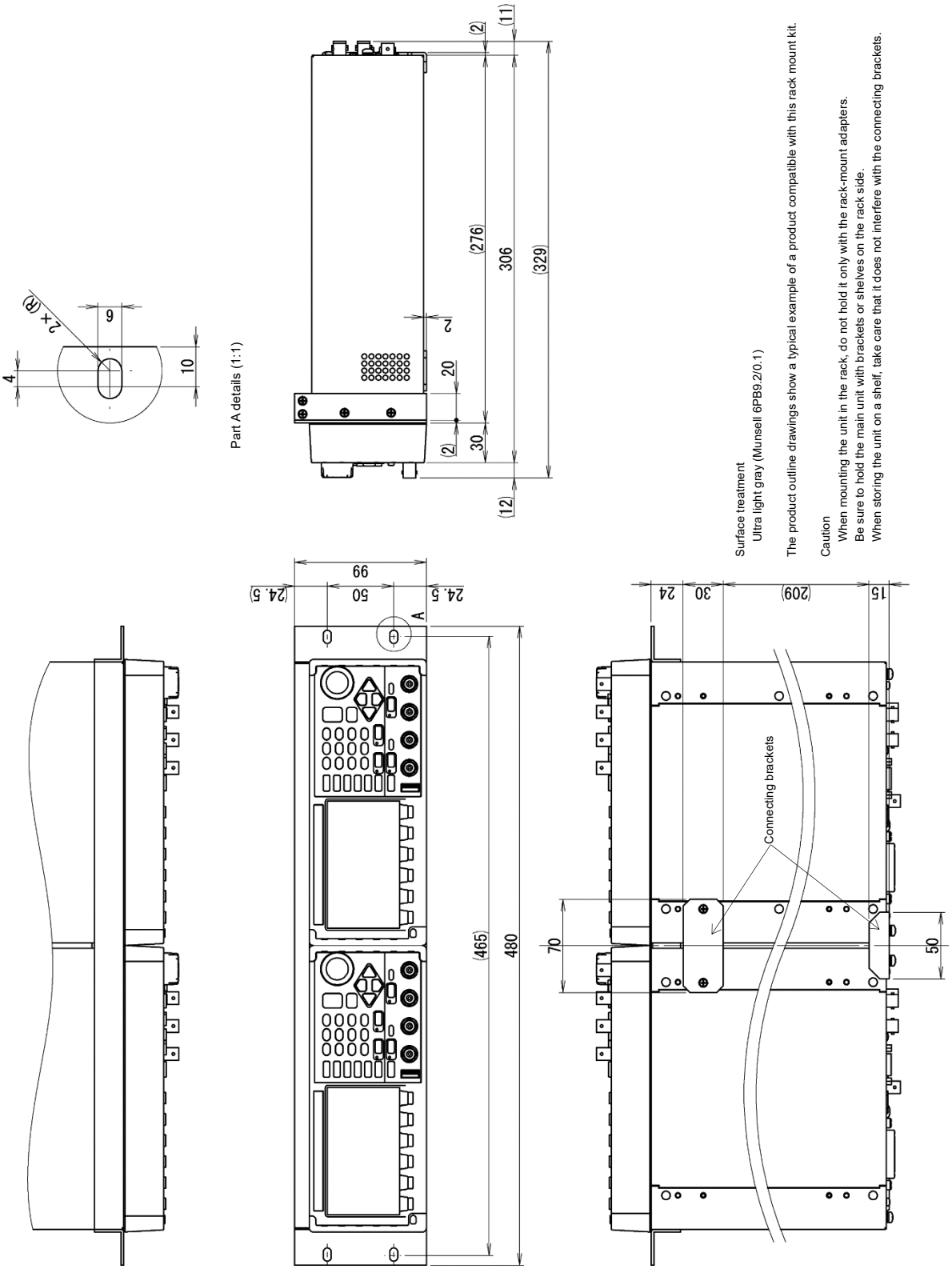


Figure 17-6 Rack mount dimensional drawing (JIS, for 2 units)

——— 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 three years from the date of shipment. During the warranty period, NF will repair the defective product without any charge for the parts and labor, or either repair or replace products which prove to be defective. For repair service under warranty, the product must be returned to either NF or an agent designated by NF. Purchaser shall prepay all shipping cost, duties, and taxes for the product to NF from another country, and NF shall pay shipping charge to return the product to purchaser.

This warranty shall not apply to any defect, failure or damage caused by improper use, improper or inadequate maintenance and care or modified by purchaser or personnel other than NF corporation.

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.

If you find any suspicious points, errors, or omissions, please contact NF Corporation or one of our representatives.

WF198x series Instruction Manual (Operation)

NF Corporation
6-3-20 Tsunashima Higashi, Kohoku-ku, Yokohama 〒223-8508, JAPAN
Phone: +81-45-545-8128 Fax: +81-45-545-8187
https://www.nfcorp.co.jp/english