

INSTRUCTION MANUAL

FUNCTION GENERATOR FG-281



Introduction

- ◇ Thank you for purchasing our instrument.
- ◇ Please read this manual before using the instrument, then keep the manual handy for future reference.
- ◇ This operation manual mainly describes notes on use, operation method, examples of use and performance, RS-232 and GP-IB remote control.

Safety Precautions

To ensure safe operation of this instrument and to prevent injury to the user or damage to property, read and carefully observe the  warnings and  cautions in the following section and associated symbols marked on the panel diagrams.

Definitions of  warnings and  cautions used in this manual

 WARNING	Incorrect operation or failure to observe the warning may result in death or serious injury.
 CAUTION	Incorrect operation or failure to observe the caution may result in injury or damage to instrument.

Precautions

- ◇ A company name and the brand name mentioned in this instruction manual are the trademark or the registered trademark of each company or group in each country and region.
- ◇ Parts of the contents of this manual may be modified without notice for improvements in performance and functions.
- ◇ Reproduction or reprinting of the contents of this manual without prior permission from us is prohibited.
- ◇ The display tube contains cold cathode fluorescent lamps.
Please follow local ordinances or regulations for its disposal.
- ◇ When export or ship the product to overseas, please confirm laws and regulations about the export.

Revision History

- ◇ March 2003 : 1st edition
- ◇ April 2003 : 2nd edition
- ◇ November 2006 : 3rd edition
- ◇ September 2010: 4th edition
- ◇ November 2012 : 5th edition
- ◇ October 2013 : 6th edition

Read this page to ensure proper safety. (Also read the following pages.)



WARNING

- **Do not use in an environment with explosive gases.**

This may result in explosion.

- **If you notice smoke, abnormal smell or abnormal sound, immediately turn off the power and unplug the power plug from the receptacle.**

Continued use under these circumstances may result in electric shock or fire. Turn off the power, disconnect the power plug from the receptacle and contact your dealer. Repairing the product yourself is very dangerous. Do not attempt to repair the product under any circumstances.

- **Make sure no water gets on or inside the product.**

Do not use the product if this happens. Failure to observe this precaution may result in electric shock or fire. If water gets on or inside the unit, immediately turn off the power, unplug the power plug from the receptacle and have the unit repaired. Contact your dealer.

- **Do not touch the plug of the power cable if your hands are wet.**

This may result in electric shock.

- **Do not put any foreign objects, such as metallic or flammable objects through the ventilation port.**

If any foreign object is put through the ventilation port, this may result in electric shock, fire, and/or malfunction.

If any foreign object enters the instrument, immediately turn OFF the power switch, unplug the plug from the receptacle, and contact your dealer.

- **Do not place this instrument on an unstable place such as a shaky stand or inclined place.**

Letting the instrument fall or topple down may result in electric shock, fire or injury. If this instrument falls or its cover is damaged, turn off the power switch, unplug the power plug from the receptacle and contact your dealer.

- **Do not remove the cover and panel.**

If any part inside the instrument is touched, this may result in electric shock. Contact your dealer for inspections, calibrations.

Read this page to ensure proper safety. (Also read the following pages.)

 **WARNING** (Continued)

- **Always connect the grounding line of the input connector of this instrument to the ground potential level (ground) of an object to be measured.**

If the grounding line of the input connector of this instrument is connected to a level other than the ground level of an object to be measured, this may result in electric shock (damage to object to be measured, this instrument, or other connected devices).

- **Do not measure the primary power supply.**

The input circuit of this instrument is a type of unbalanced method. If electrically floating two points, such as primary electric power supply, are connected, this may result in electric shock, fire, and/or malfunction. Start the measurement after checking that the grounding potential levels of an object to be measured are obtained correctly.

- **Do not attempt to modify the instrument.**

This may result in electric shock, fire or malfunction.

Requests to repair the unit may be refused if unauthorized modifications have been made.

- **Use the instrument at a specified supply voltage.**

Table 1 Power voltage range

Mid-voltage	LINE VOLTAGE
100V	90V - 110V
110V	100V - 120V
220V	198V - 242V
240V	216V - 264V

Using the instrument at a voltage other than that specified may result in electric shock, fire or malfunction. The mid-voltage is shown on the rear panel. Before connecting the power cord, always check the power voltage. The instrument can be operated in a voltage range shown in Table 1.

- **When handling power code:**

DO NOT ATTEMPT TO REPAIR CODES YOURSELF. This may result in fire or electric shock. If the power cord is damaged, have repairs conducted. Contact your dealer.

- Do not attempt to fabricate the power cord.
- Do not forcibly bend the power cord.
- Do not twist the power cord.
- Do not bind the power cords together.
- Do not pull power cord by the cord.
- Do not heat the power cord.
- Avoid getting the power cord wet.
- Do not place heavy objects on top of the power cord.

Read this page to ensure proper safety. (Also read the following pages.)



CAUTION

- **Always use a 3-core power cord applicable to the power voltage.**
When using a power cord not applicable to the power voltage, fire may result.
The power supply code of 100V is appended when it is not specified at purchase.
- **Turn off the power switch before connecting or disconnecting the power cord.**
Connecting or disconnecting the power cord while the power switch is ON may result in electric shock or malfunction.
- **When disconnect the power cord from the receptacle, hold the plug to pull it out.**
Pulling the power cord may result in electric shock or fire.
- **When any cables are connected to the instrument, do not pull such cables so that the instrument does not fall down. Always strictly observe this caution.**
If the instrument is fallen down, this may result in electric shock, personal injury and/or fire.
- **Do not use any damaged cable or adaptor.**
If any damaged cable or adaptor is used, this may result in electric shock and/or fire.
- **If the instrument will not be used for an extended period of time, unplug the power plug from the power receptacle for safety.**
- **If the generator is fallen down, the impact may result in personal injury or damage to other devices.**
When transporting this instrument, always disconnect the cables and hold the center of the grip firmly so that the instrument does not fall down.
- **When transporting this instrument, use the packing material provided at the time of purchase or packing material equivalent at least.**
Excessive vibration or shock applied to this instrument during transportation may cause it to malfunction, resulting in fire. If you do not have the proper packing materials needed to ship the unit, contact your dealer. When having the unit transported by a shipping company, write "Precision Instrument - Handle With Care" on each side of the packing box.

Read this page to ensure proper safety. (Also read the following pages.)



CAUTION (Continued)

- **Do not attempt to use this product if it becomes damaged.**
This may result in electric shock or fire.
If the unit fails to operate properly, have it repaired. Contact your dealer.
- **Do not apply a voltage beyond the specified level to the input terminal.**
If a voltage exceeding the specified level is applied, this may result in malfunction. The maximum input voltage is 0V to 5V peak of TRIG GATE IN.
- **Do not connect any deformed or damaged cable with the BNC connector to the input plug when inputting the signal.**
Doing so may result in damage to the OUTPUT, SYNC OUT, TRIG GATE IN and etc. connectors.

Memo

Operation Manual

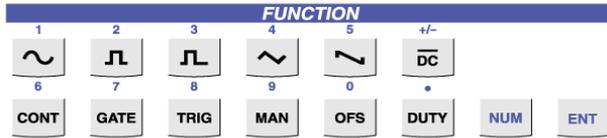
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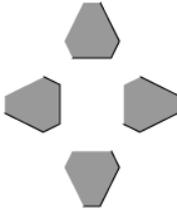
Symbols used in this manual

- [] indicates an operation key on the front panel.

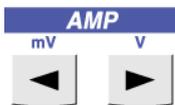


- The  [sin] key indicates sin.
- [NUM+] indicates an action while the [NUM] key is illuminated.
- The operation of each key is indicated in blue text.
- In the operation [NUM+sin], the [sin] key operates as a “1” input key.
- [NUM+sin] actually indicates pressing the [sin] key while the [NUM] key is illuminated.
- [↑], [↓], [←] and [→] symbolize [up], [down], [left] and [right].

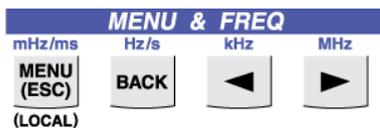
These keys are used for moving between setting items or changing a setting value in the fluorescent display.



- 100mV : Flashing of the letter m is indicated with an underbar.
- [AMP] area arrow keys are indicated as [Amp >] and [Amp <]. These keys are used for setting the amplitude.



- [MENU & FREQ] arrow keys are indicated as [FREQ >] and [FREQ <].
- These keys are used for setting various values including frequency.



- The unit of the voltage is Vp-p not Vrms.
- VFD stands for Vacuum Fluorescent Display.

Chapter 1 Overview

1.1 Features

This function generator uses DDS (Direct Digital Synthesis) for superior frequency stability.

- 10 mHz to 15 MHz wide oscillation range (sine wave, square wave)
- Vacuum Fluorescent Display that can simultaneously display voltage and frequency
- Frequency accuracy ± 50 ppm
- Frequency and amplitude can be input from a 10-key keypad (waveform does not become discontinuous even when frequency is changed)
- Variable maximum offset (when output terminal is open) +10 V, -10 V
- Equipped with linear/log sweep function (can be used over entire range of frequencies for which oscillation is possible)
- Duty 0 to 100% (pulse wave, ramp wave)
- Options
 - Pulse motor control function

Chapter 2 Introduction

2.1 Before Using

2.1.1 Safety Guidelines for Installation

- **Always operate this instrument within its specified operating range.**

Operating this instrument outside the specified range may result in damage to the instrument.

The following shows the operating temperature and humidity ranges.

For indoor use only

Temperature : 0°C to +40°C (no condensation)

Humidity : 85% RH (0°C to +40°C) or less

- **Do not place this instrument in an area where large amounts of moisture or dust exists.**

Operating this instrument in an area where large amounts of moisture or dust exists may result in electric shock and/or fire.

- **Do not place any objects on top of this instrument.**

Placing objects on top of this instrument may cause the cover to make contact with the internal circuitry, resulting in electric shock, fire, and/or damage to the instrument.

- **Do not place objects close to the cooling vent.**

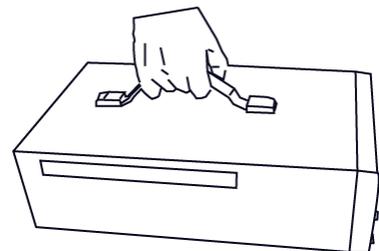
If an object is placed close to the cooling vent, the temperature inside the instrument will increase and may result in fire and/or damage to the instrument.

- **Maintain sufficient space behind and on both sides of this instrument.**

If this instrument is mounted in a rack or on top of another measuring unit, pay special attention so that the temperature does not rise. Failure to do so may result in malfunction or degraded performance. For further information, contact your dealer.

- **Dropping this instrument may result in bodily injury or damage to the unit itself.**

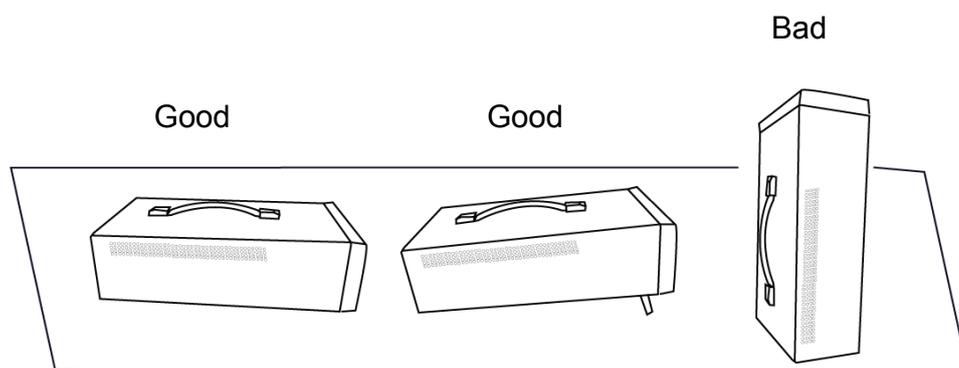
When transporting this instrument, always disconnect the cables and hold the center of the grip firmly, being careful not to drop the instrument.



● **Positioning of this instrument**

Always position the instrument horizontally or use the stand as shown in the figure below. When using the stand, pull the feet toward the front panel and lock them into place as shown in the figure.

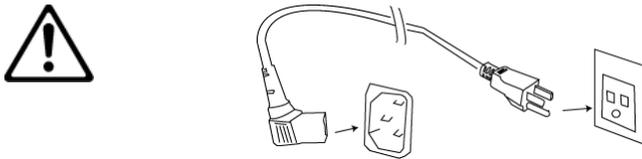
Do not operate with the rear panel facing down.



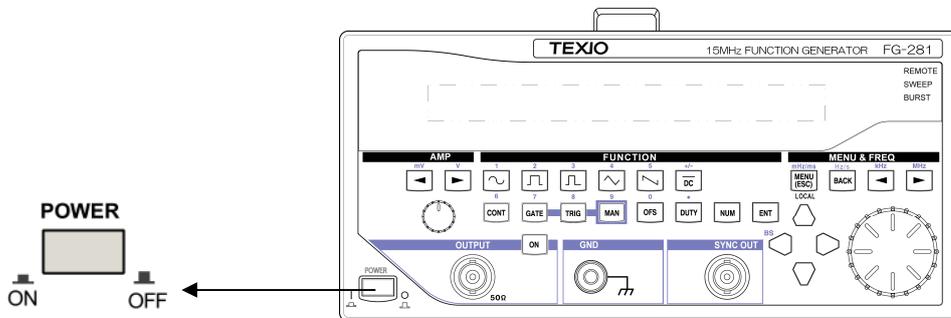
2.2 Let's Start Using the Instrument

(1) Connect the power supply

Turn OFF the power switch and then plug the power cord into an electrical outlet. Use the 3-prong power cord supplied with this instrument.



(2) Turn ON the POWER switch.

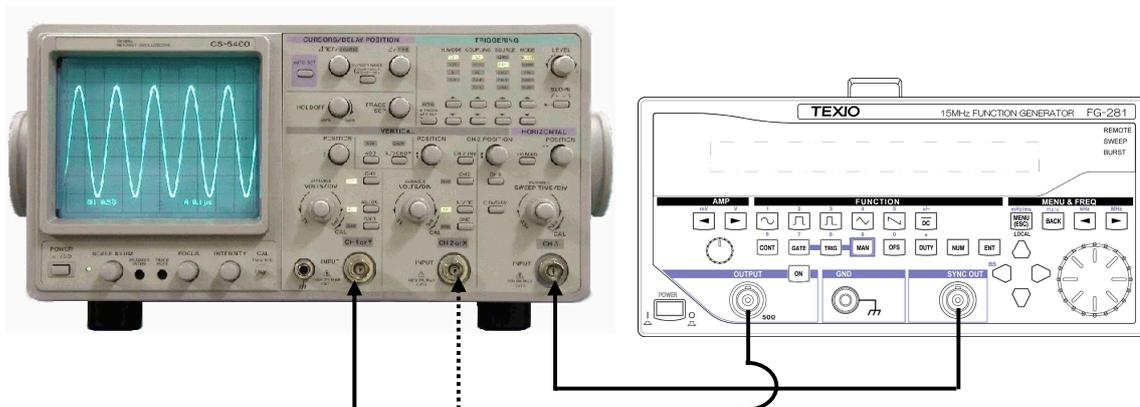


After the [FG-281 Vx. xx] message appears, the setting value of the currently selected waveform will be displayed on the screen.

Pressing the [ON] key causes it to illuminate, and the waveform to be output from this instrument.

For example, if the panel display is (VFD) 100 mV 1.0000 kHz and the [sin] FUNCTION key is illuminated, a sine wave of 100 mV, 1.00 kHz is being output from this instrument. (For details, refer to chapter 2.4, "Display Modes.")

The waveform can be verified by connecting a BNC cable to an oscilloscope.



Changing the waveform

Pressing the [square] key or [triangle] key changes the waveform to a square wave or triangular wave respectively. (For details, refer to chapter 3.1, “Output Waveform Selection.”)

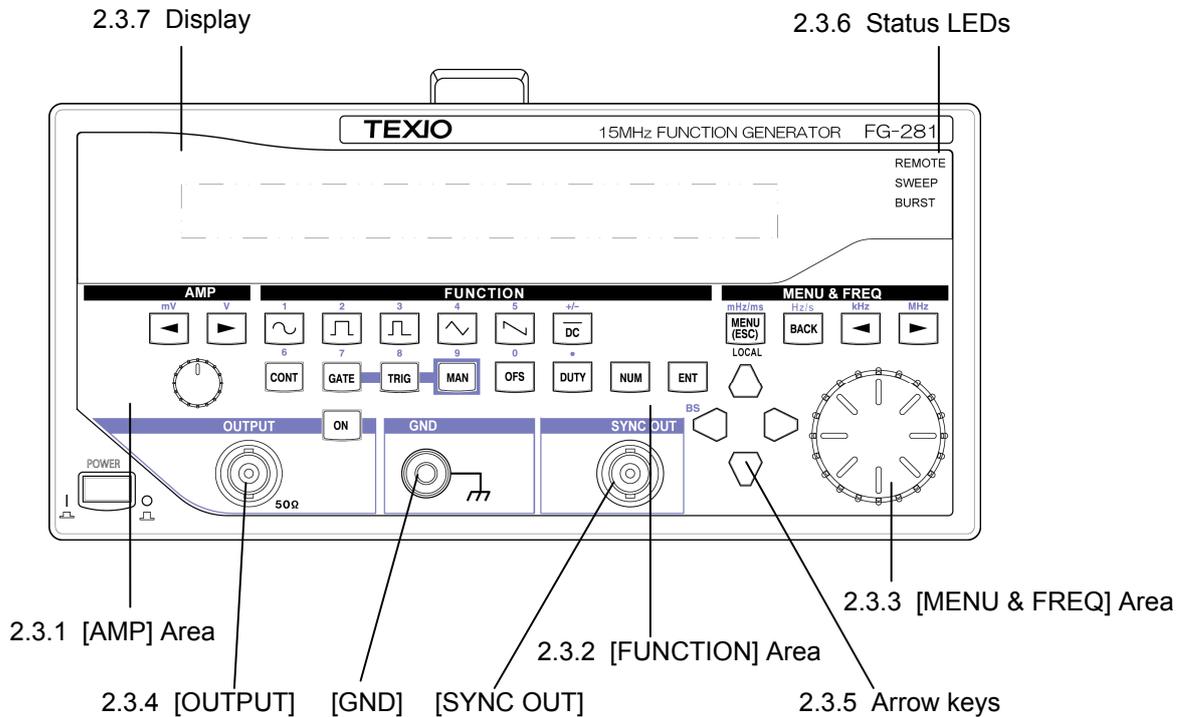
Changing the frequency

Rotating the frequency knob varies the frequency of the output waveform. (For details, refer to chapter 3.2, “Frequency Setting.”)

Changing the amplitude

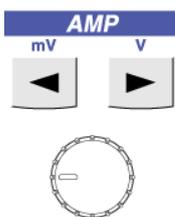
Rotating the AMP knob varies the amplitude of the output waveform. (For details, refer to chapter 3.3, “Amplitude and DC Voltage Settings.”)

2.3 Front Panel



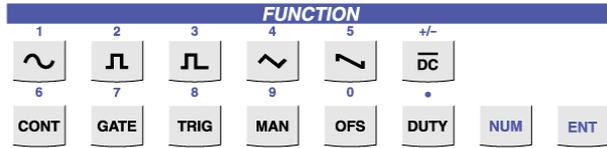
Each key except key, key, key, key, key and Arrow keys has built-in LED. When selected, these keys become illuminated. As for them, the toggle switch of ON/OFF operates.

2.3.1 [AMP] Area



- | | |
|--------------|---|
| [AMP] | Sets the amplitude of the output waveform. |
| [Amp <] | Moves the underbar of the digit for output amplitude setting to the left. |
| [NUM + AMP<] | Operates as a [mV] key. |
| [Amp >] | Moves the underbar of the digit for output amplitude setting to the right. |
| [NUM + AMP>] | Operates as a [V] key. |
| AMP knob | Rotating to the right increases the amplitude and rotating to the left decreases the amplitude. |

2.3.2 [Function] Area



* While the [NUM] key is illuminated, the keys operate as 10-keys with value indicated inside [[]].

- **Waveform selection keys**

Only the one key corresponding to the currently selected waveform is illuminated.

	[sin] key	[[1 key]]	([NUM + sin])
	[square] key	[[2 key]]	([NUM + square])
	[pulse] key	[[3 key]]	([NUM + pulse])
	[triangle] key	[[4 key]]	([NUM + triangle])
	[ramp] key	[[5 key]]	([NUM + ramp])
	[DC] key	[[+/-]]	([NUM + DC])

For waveform selection, refer to chapter 3.1, “Output Waveform Selection.”

- **Generation mode keys**

These keys are to select the oscillation mode of the waveform.

	[CONT] key	[[6 key]]	([NUM + CONT])
	[GATE] key	[[7 key]]	([NUM + GATE])
	[TRIG] key	[[8 key]]	([NUM + TRIG])
	[MANUAL] key	[[9 key]]	([NUM + MAN])

Refer to chapter 3.4.1, “About Generation Modes” and to chapter 3.11, “Generation Control by External Signal.”

- **Offset key**

Sets the offset of the output waveform. Refer to chapter 3.5, “Offset Setting.”

[OFS] key [[0 key]] ([NUM + OFS])

- **Duty key**

Sets the duty-factor of the output waveform. Refer to chapter 3.6, “Duty-Factor Setting.”

[DUTY] key [[. key]] ([NUM + DUTY])

- **Numeric keys**

[NUM] key

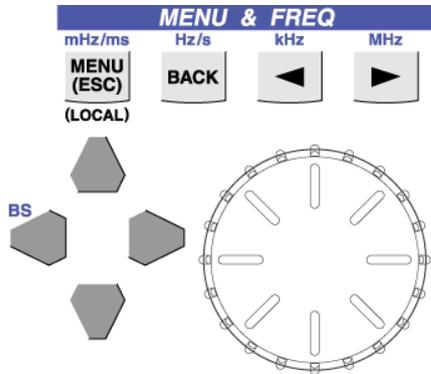
Enables use of the 10-key keypad.

The operation of each key when pressed, while the [NUM] key is illuminated, is shown in blue text.

[ENT] key

Validates and enters the setting value. Refer to chapter 2.5, “Numeric Input of Setting Values.”

2.3.3 [MENU & FREQ] Area



- **MENU keys**

[MENU (ESC)] key [[mHz/mS]] ([NUM + MENU (ESC)]), ([[LOCAL]])

Used for each menu setting. (Refer to chapter 2.4, “Display Modes,” section (3) “Menu Mode.”)
([[LOCAL]] is used to cancel the remote mode.)

[BACK] key [[Hz/s key]] ([NUM + BACK])

Used for setting numeric values and menu items. (Refer to chapter 2.5, “Numeric Input of Setting Values.”)

[FREQ <] key [[kHz key]] ([NUM + frequency<])

Moves the underbar of the numeric value or menu item digit setting to the left.

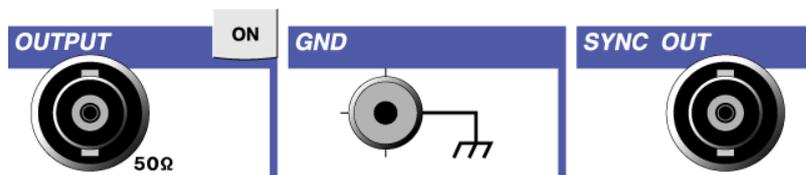
[FREQ >] key [[MHz key]] ([NUM + frequency>])

Moves the underbar of the numeric value or menu item digit setting to the right.

Frequency Knob

Used to increase/decrease or change numeric values and menu items. Rotating to the right increases the value and rotating to the left decreases the value.

2.3.4 [OUTPUT], [GND], [SYNC OUT]



[OUTPUT]

[ON] key Controls ON/OFF of the waveform output. (Refer to chapter 3.4, Waveform Output Method.)
When it is ON (the key is illuminated), the waveform is output.

[GND]

Ground terminal

[SYNC OUT]

Synchronous output. (Refer to 3.7 Initial Phase Setting and chapter 3.13.5, “Synchronous Output (SYNC OUT).”)

Can be switched ON/OFF by menu settings.

Phase is 0° that SYNC OUT changes to “H”, 180° to “L”.

2.3.5 Arrow Keys

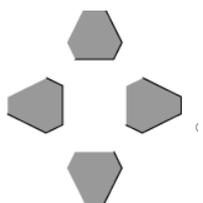
Used to move items and change settings in the menu mode.

[←] key

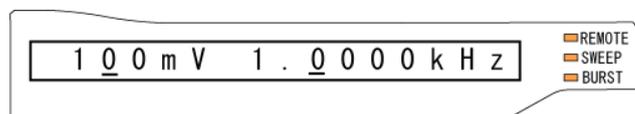
[→] key

[↑] key

[↓] key



2.3.6 Status LEDs



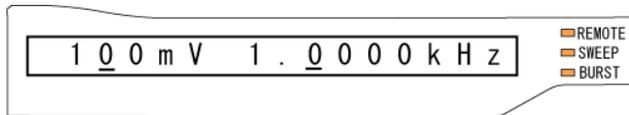
REMOTE When illuminated, this instrument is in the remote mode. (Refer to chapter 3.13.1, “Remote Control (GP-IB, RS-232).”)

SWEEP When illuminated, this instrument is in the sweep mode. (Refer to chapter 3.8, “Sweep Settings.”)

BURST When illuminated, this instrument is in the burst mode. (Refer to chapter 3.9, “Burst Settings.”)

2.3.7 Display

The 16-digit fluorescent display indicates the output waveform's setting values or the menu.

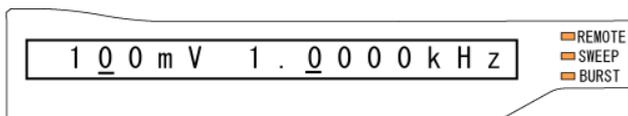


2.4 Display Modes

This instrument has the following 3 display modes.

(1) Normal Display Mode

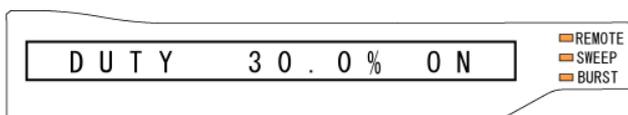
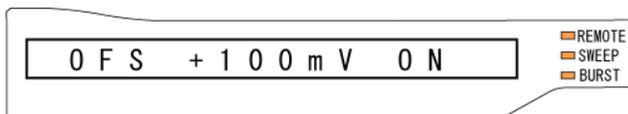
This display mode becomes active immediately after power is turned on. In the normal display mode, the display is as shown below.



Normally, this display mode is used. The frequency and amplitude of the output waveform can be set in this display mode. The current values of the amplitude and frequency of the output waveform are displayed.

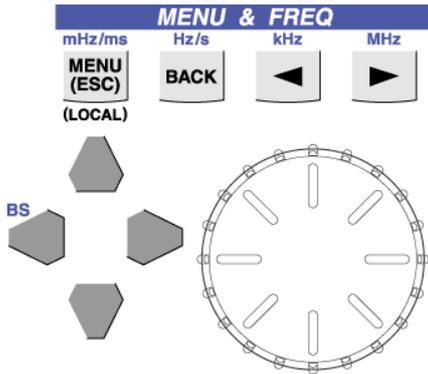
(2) Offset, Duty-Factor Setting Modes

When the [OFS] key or [DUTY] key is pressed, the offset or duty-factor setting mode is entered, enabling the respective offset or duty-factor of the output waveform to be set (duty-factor is only valid for square wave, pulse wave and ramp wave). Pressing any key while in these modes will initiate a return to the normal display mode. Refer to chapter 3.5, "Offset Setting" and chapter 3.6, "Duty-Factor Setting."

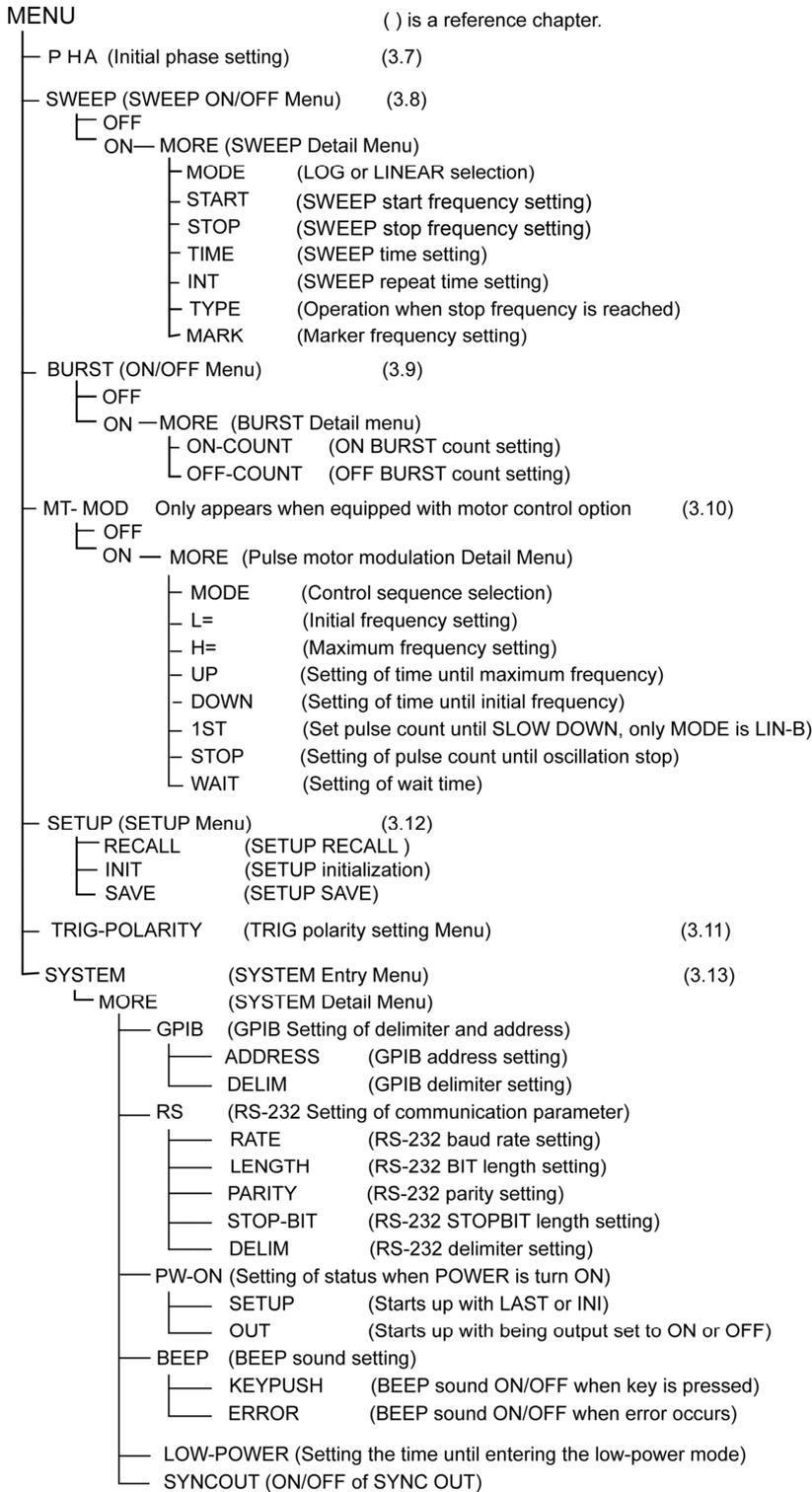


(3) Menu Mode

When the [MENU] key is pressed and becomes illuminated, the menu mode is entered and various settings can be made. Pressing the [MENU] key again turns this key off. Then the normal display mode appears. The menu tree and its setting items are shown on the next page. For details, refer to the specific chapters.



[[Menu tree]]



Use the arrow keys and frequency knob to move within the menu mode.

When such movement is possible, pressing the [→] key moves down one layer.

Pressing the [←] key or [BACK] key moves up one layer.

Pressing the [↑] and [↓] keys or rotating the frequency knob moves cyclically among items within the same layer.

- The following message might be displayed in a set change by the menu when time passes.

! S E T T I N G !

Note : Do not turn off the power during changing the menu.
When the power is turned off by any chance, FG-281 might be initialized.
After that, FG-281 starts up with the initialized setting.
Set **POWER-ON SETUP LAST**, FG-281 start up with the previous power shutdown.
See [3.13.2] POWER ON Settings.

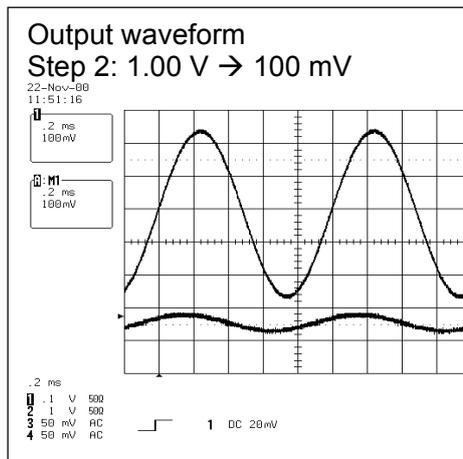
2.5 Numeric Input of Setting Values

Numeric setting

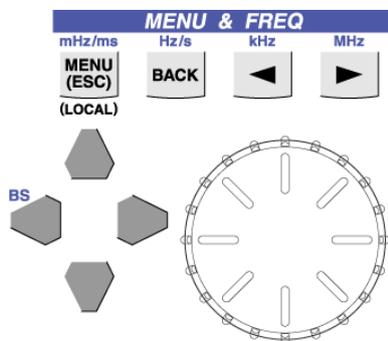
For the numeric setting of frequency, amplitude, and other various parameters, there are the “arrow key and rotary knob method” and the “direct input from the 10-key keypad method.”

2.5.1 Arrow Key and Rotary Knob Method

Setting the voltage

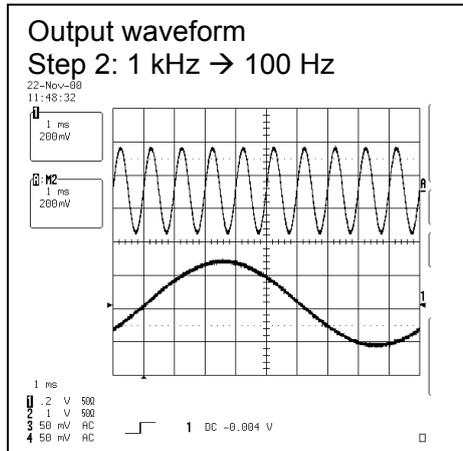


Setting Procedure		Display
1	Press the [Amp >] or [Amp <] key to cause the blinking underbar to move directly to the left of V.	100 <u>m</u> V
2	Rotate the AMP knob and set the units. Units can be changed 10× or 1/10×.	100mV 1.00 _ V 10.0 _ V
3	Press the [Amp >] or [Amp <] key to cause the underbar to blink at the desired digit for setting.	50 <u>0</u> mV
4	Rotate the AMP knob to the desired numeric value setting.	50 <u>2</u> mV
5	Repeat steps 3 and 4 for each digit to set the desired voltage value (peak value).	632mV (50Ω 0dBm)



Values exceeding the setting range cannot be set.

Setting the frequency



Setting Procedure		Display
1	Press the [FREQ >] or [FREQ <] key to cause the blinking underbar to move directly to the left of Hz.	10.000 <u>k</u> Hz
2	Rotate the frequency knob and set the units. Units can be changed 10× or 1/10×.	10mHz 100.00_ Hz . . . 100.00kHz 15.000MHz
3	Press the [FREQ >] or [FREQ <] key to cause the underbar to blink at the desired digit for setting.	1.000 <u>0</u> kHz
4	Rotate the frequency knob to the desired numeric value setting.	1.000 <u>3</u> kHz
5	Repeat steps 3 and 4 for each digit to set the desired frequency value.	12.300kHz

Values exceeding the setting range cannot be set.

Setting other parameters

Various settings such as offset, duty-factor, sweep time, etc.

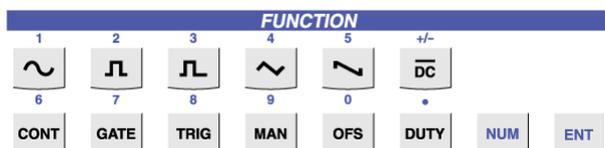
(Units vary depending on each parameter.)

Setting Procedure		Display
1	Press the [FREQ >] or [FREQ <] key to cause the underbar to blink.	100 <u>ms</u>
2	Rotate the frequency knob and set the units. Units can be changed 10× or 1/10×. Units can also be changed with the [↑] key or [↓] key.	100ms 1.00_s 10.0_s 100_s
3	Press the [FREQ >] or [FREQ <] key to cause the underbar to blink at the desired digit for setting.	10.0 <u>s</u>
4	Rotate the frequency knob to the desired numeric value setting. The value can also be incremented and decremented with the [↑] and [↓] keys.	10.3 <u>s</u>
5	Repeat steps 3 and 4 for each digit to set the desired frequency value.	1 <u>2</u> .3s

For all parameters, values exceeding the setting range cannot be set.

2.5.2 Direct Input from the 10-key Keypad Method

Press the [NUM] key to cause it to illuminate.



While the [NUM] key is illuminated, input the desired numeric value.

Next, press the units key to make the setting value effective. If there are no units, press the [ENT] key.

In cases where the setting of a negative value is possible, use the [+/-] key to set the polarity. Each press of the [+/-] key toggles the polarity.

Example 1) Setting the amplitude or DC voltage of the waveform being output to 10 mV

With the [NUM] key illuminated, press the [1] and [0] keys in sequence. (In other words, press [sin] and then [OFS].) Press the [mV] units key (the [Amp <] key). When the units key is pressed, the [NUM] key is unlit. When setting the amplitude of the waveform being output, if the [ENT] key is pressed instead of a units key, the warning message

! S E L E C T U N I T K E Y !

appears, prompting a valid units key to be pressed.

Select a valid units key of [mV] or [V].

Example 2) Setting the frequency of the waveform being output to 123.4 kHz

With the [NUM] key illuminated, press the [1], [2], [3], [.] and [4] keys in sequence. (In other words, press [sin], [square], [pulse], [DUTY], and then [triangle].)

Press the [kHz] units key (the [FREQ <] key). When the unit's key is pressed, the [NUM] key is unlit. When setting the frequency of the waveform being output, if the [ENT] key is pressed instead of a units key, the warning message

! S E L E C T U N I T K E Y !

appears, prompting a valid units key to be pressed.

Select a valid units key of [mHz], [Hz], [kHz] or [MHz].

Example 3) Setting the time to 10 ms

With the [NUM] key illuminated, press the [1] and [0] keys in sequence. (In other words, press [sin] and then [OFS].) Press the [ms] units key (the [MENU] key). When the unit's key or the [ENT] key is pressed, the [NUM] key is unlit.

When setting values other than the amplitude or frequency, the [ENT] key operates the same as selecting the unit suffix multiplier prior to entering the 10-key keypad input.

If a numeric setting is attempted that exceeds the upper or lower limits for a setting item, an error beep will sound, a warning message will be displayed, and the value will be set at the upper limit value or the lower limit value, whichever is closer.

Warning message:

! U P P E R L I M I T !

For signed values which are above upper limit

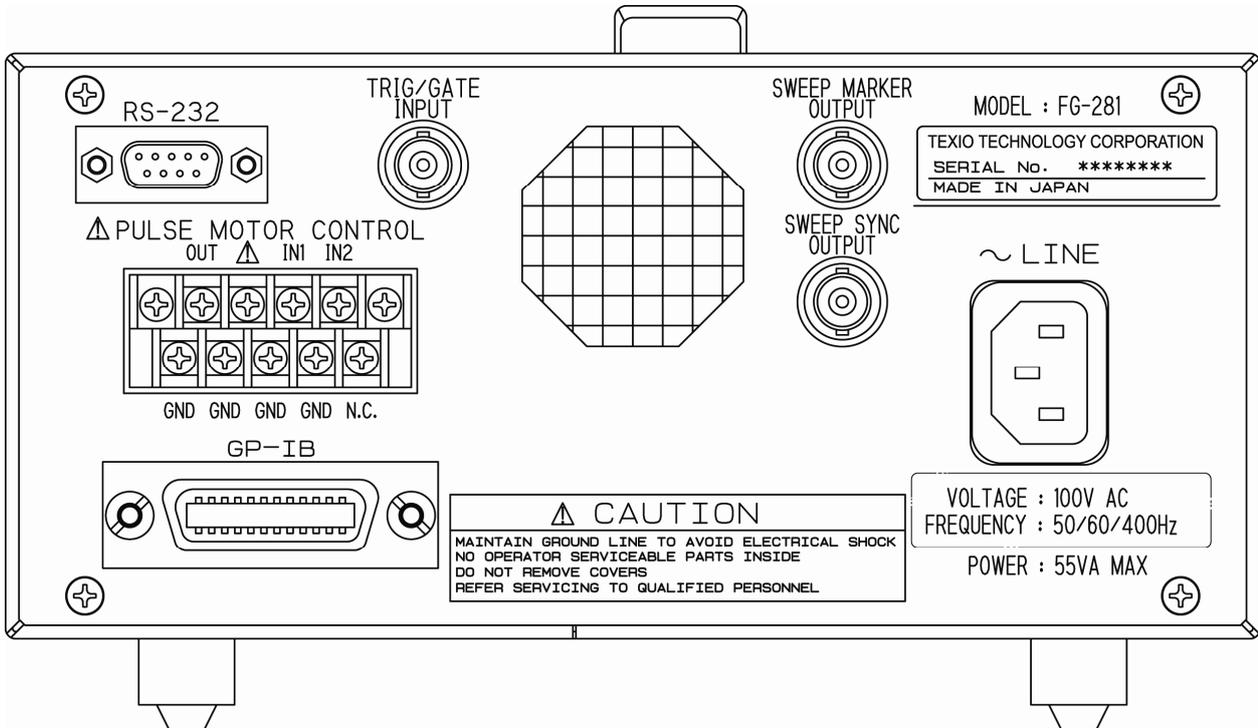
! L O W E R L I M I T !

For signed values which are under lower limit

- * The [+/-] key is only accepted when signed values are valid for the setting.
- * If an incorrect numeric value is input, use the [←] key (which operates as a backspace key) to delete the number and then re-input the correct number.
- * After the value has been input, it is set when the units key (or the [ENT] key) is pressed. Prior to pressing the units key or the [ENT] key, if the [NUM] key is pressed, this key is unlit, the numeric value that had been input becomes invalid and the display returns to its original state.

- * When you input numerical values of the number of digits more than the number of display digits, [←] mark is displayed in the leftmost digit.

2.6 Rear Panel



TRIG (GATE) input

Inputs the signal for oscillation control.

(TTL level, input impedance: 1 k Ω or more)

For details, refer to chapter 3.11, "Generation Control by External Signal."

While sweep is ON, the SWEEP SYNC signal and SWEEP MARKER signal are output.

- **SWEEP SYNC signal** : Outputs a "H" level TTL signal from the rear panel during the transition period from the sweep start frequency until the stop frequency. (Refer to the "Rear panel output" section of chapter 3.8, "Sweep Settings.")
- **SWEEP MARKER signal** : Outputs a "H" level TTL signal from the rear panel during the transition period from the sweep start frequency until the marker frequency. (Refer to the "Rear panel output" section of chapter 3.8, "Sweep Settings.")
- **RS-232 interface** : RS-232 connector for remote control
- **GP-IB interface** : GP-IB connector for remote control

If equipped with the pulse motor control option:

- OUT : The pulse signal for the driver of the pulse motor is output with an open collector.

- IN1 : Control signal for MT-MOD(pulse motor modulation). When the oscillation mode is the trigger, the trigger signal to start oscillation is input.
(H: 3.15V min, L: 1.35V max), input impedance: 5 k Ω or more)

- IN2 : Control signal for the MT-MOD(pulse motor modulation) that are the initiate slowdown and the control oscillation stopping. (Refer to chapter 3.10, "Pulse Motor Modulation Settings.")
(H: 3.15V min, L: 1.35V max), input impedance: 5 k Ω or more)

Chapter 3 Operating Procedures

3.1 Output Waveform Selection

The output waveform is changed using the [sin], [square], [pulse], [triangle], [ramp] and [DC] keys.



[sin] key

Outputs sine waves.



[square] key

Outputs square waves.



[pulse] key

Outputs pulse waves.



[triangle] key

Outputs triangular waves.



[ramp] key

Outputs ramp waves.



[DC] key

Outputs DC signals.

Press the desired output waveform key among the above keys. The selected key will illuminate and the waveform will change.

- **When sine wave or triangular wave is selected,**

the duty-factor setting is forcibly turned OFF. However, a value of the duty-factor setting parameters are saved including the ON/OFF status of the duty-factor and are applied the next time a waveform (square wave, pulse wave, or ramp wave) is selected for which duty-factor setting is valid.

- **When DC is selected,**

sweep, burst, offset and duty-factor settings are forcibly turned OFF. However, the values of setting parameters are saved including their ON/OFF status and are applied the next time a waveform is selected for which those settings are valid.

Note:

* About Waveform Parameters

For a newly selected waveform, invalid settings are ignored but the setting values are saved. Those settings are restored the next time a waveform is selected for which they are valid.

Example:

During output of a 60% duty ramp wave, the waveform is changed to sine wave.

↓

A sine wave is output.

(The duty 60% is ignored and the setting values are saved.)

↓

The waveform is changed back to a ramp wave.

The output waveform is a ramp wave with 60% duty.

* If the waveform's upper limit value is exceeded due to changing the waveforms:

If the upper limit frequency is exceeded due to the waveform selection, an error beep sounds and a warning message appears, and then the frequency is set to the upper limit of the selected waveform.

!	U	P	P	E	R	L	I	M	I	T	!
---	---	---	---	---	---	---	---	---	---	---	---

Upper limit warning message

Here, even if the waveform is changed back to a sine wave, the frequency does not change.

Example:

During output of a 1MHz sine wave, the waveform is changed to a triangular wave

↓

An upper limit value warning appears and the frequency becomes 100 kHz (upper limit frequency value with a triangular wave).

↓

The waveform is again changed back to a sine wave.

Even if the output waveform is changed back to a sine wave, the frequency remains at 100 kHz.

3.2 Frequency Setting

The setting of frequency is accomplished by the “arrow key and rotary knob method” or the “direct input from the 10-key keypad method.”

Setting range

Sine wave, square wave: 10 mHz to 15.000 MHz

When the oscillation mode is TRIG or GATE, or when BURST is ON, the performance is guaranteed over the frequency range of 10 mHz to 1.0000 MHz.

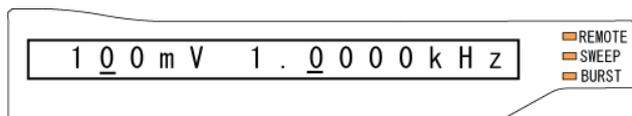
Pulse wave, triangular wave, and ramp wave: 10 mHz to 100.00 kHz

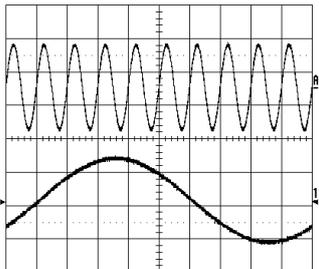
Valid number of digits: 5 digits

Minimum resolution: 10 mHz

(1) Arrow Key and Rotary Knob Method

With this setting method, the frequency changes in real-time.



Frequency Setting Procedure		Display
1	Press the [FREQ >] or [FREQ <] key to cause the blinking underbar to move directly to the left of Hz.	10.000 <u>k</u> Hz
2	 Rotate the frequency knob and set the units. Units can be changed 10(or 1/10(.	10mHz 100 mHz 1.00_Hz . . . 1.0000MHz 10.000 MHz
3	Press the [FREQ >] or [FREQ <] key to cause the underbar to blink at the desired digit for setting.	1.0000k <u>H</u> z
4	Rotate the frequency knob to the desired numeric value setting.	1.0003k <u>H</u> z
5	Repeat steps 3 and 4 for each digit to set the desired frequency.	12.300k <u>H</u> z

Note: Values exceeding the setting range cannot be set.

(2) Direct Input from the 10-key Keypad Method

Press the [NUM] key to cause it to illuminate.

While the [NUM] key is illuminated, enter the desired frequency setting with the 10-key keypad in the [FUNCTION] area.

Set the units with a units key in the [MENU & FREQ] area. When the units key is pressed, the frequency instantly changes to the frequency that was set. ([NUM] key is unlit.)

Valid units keys are [mHz], [Hz], [kHz] and [MHz].

Examples

Setting the frequency to 123.4 kHz

Press the [NUM] key to cause it to illuminate, and then press the [1], [2], [3], [.] and [4] keys in sequence. (In other words, press [sin], [square], [pulse], [DUTY] and then [triangle].)

Press the [kHz] units key (the [FREQ <] key).

When a numeric value that exceeds the setting range is set:

The warning message !UPPER LIMIT! appears if the frequency setting exceeds the upper limit, and the warning message !LOWER LIMIT! appears if the frequency setting exceeds the lower limit; then the frequency is set to the respective upper or lower limit value of the selected waveform.

- * If DC is selected as the waveform, the display will be similar to +50mV DC and the frequency cannot be set.
- * If SWEEP is set to ON, the frequency cannot be set. If an attempt is made to change the frequency using the direct input from the 10-key keypad method, an error beep is sounded and a warning message appears:

! S W E E P O N !

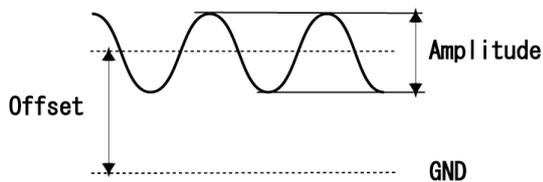
3.3 Amplitude and DC Voltage Settings

The setting of amplitude and DC voltage values is accomplished by the “arrow key and rotary knob method” or the “direct input from the 10-key keypad method.”

	For a Waveform	For DC Output
Setting Range	50 mV to 10 V (peak value) Note1)	-5.00 V to +5.00 V
Valid Number of Digits	3 digits	3 digits
Minimum Resolution	0.1 mV	1 mV

Note1) When the offset setting is ON, settings are possible within the range satisfied by $| \text{offset voltage} | + \text{amplitude}/2 \leq 5.025 \text{ V}$ (into a 50 Ω termination). For offset setting details, refer to chapter 3.5, “Offset Setting.”

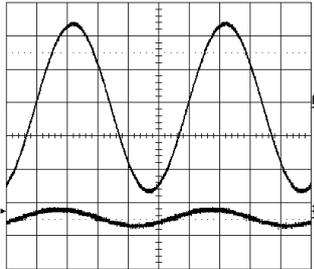
Note 2) The relation between the offset and the amplitude are shown in the figure below. The offset and the amplitude are the values at 50 Ω terminal. The voltage when 50 Ω terminal is opened increases to about twice that of a set value respectively.



Offset : A center voltage of the amplitude waveform is shown like a left figure.

Amplitude : Peak to Peak voltage of the amplitude waveform is shown like a left figure.

(1) Arrow Key and Rotary Knob Method

	Setting Procedure	Display
1	Press the [Amp >] or [Amp <] key to cause the blinking underbar to move directly to the left of V.	100 <u>m</u> V
2	Rotate the AMP knob and set the units. Units can be changed 10× or 1/10×. 	100mV 1.00 <u>_</u> V 10.0 <u>_</u> V
3	Press the [Amp >] or [Amp <] key to cause the underbar to blink at the desired digit for setting.	500 <u>m</u> V
4	Rotate the AMP knob to the desired numeric value setting.	50 <u>2</u> mV
5	Repeat steps 3 and 4 for each digit to set the desired voltage value (peak value).	632mV (50 Ω 0dBm)

Values exceeding the setting range of the waveform cannot be set.

(2) Direct Input from the 10-key Keypad Method

Press the [NUM] key to cause it to illuminate.

While the [NUM] key is illuminated, enter the desired amplitude (peak value) or voltage value setting with the 10-key keypad in the [FUNCTION] area.

If setting a DC voltage, the polarity can be switched by the [+/-] key.

Set the units with a units key ([mV] or [V]) in the [AMP] area.

When the units key is pressed, the amplitude (or the voltage value in the case of DC) changes to the amplitude (or voltage value in the case of DC) that was set. ([NUM] key is unlit.)

Example

Setting the amplitude to 1.23 V

Press the [NUM] key to cause it to illuminate, and then press the [1], [.] , [2], [3] and [V] keys in sequence.

(In other words, press [sin], [DUTY], [square], [pulse] and then [Amp>].)

When a numeric value that exceeds the setting range is set:

The warning message !UPPER_LIMIT! appears if the voltage value setting exceeds the upper limit, and the warning message !LOWER_LIMIT! appears if the voltage value setting exceeds the lower limit; then the value is set to the respective upper or lower limit value of the selected waveform.

3.4 Waveform Output Method

Pressing the [ON] key illuminates this key. Then a waveform is output from this instrument.

If there is no waveform output even when the [ON] key is illuminated, carefully read the following “About Generation Modes.”

3.4.1 About Generation Modes

This instrument has the following 3 oscillation modes. Pressing any one of the oscillation mode keys so it illuminates causes the oscillation to switch to the corresponding oscillation mode. (Other oscillation mode keys un-illuminate.)

Generation Mode	Corresponding Key
Continuous Generation Mode 	[CONT] key
Gate Generation Mode  	[GATE] key
Triggered Generation Mode  	[TRIG] key

(1) Continuous Generation Mode ([CONT] key is illuminated)

This mode outputs a continuous waveform.

When the [ON] key is illuminated, a waveform is output from this instrument.

(2) Gate Generation Mode ([GATE] key is illuminated)

Controlled by external signal input or key operation, this mode oscillates the waveform only while the gate is open.

When the gate is open and the [ON] key is illuminated, a waveform is output from this instrument. (Refer to chapter 3.11, “Generation Control by External Signal.”)

(3) Triggered Generation Mode ([TRIG] key is illuminated)

Controlled by external signal input or key operation, this mode oscillates the waveform when a valid trigger is input.

If a valid trigger is captured while the [ON] key is illuminated, a waveform is output from this instrument. (Refer to chapter 3.11, “Generation Control by External Signal.”)

3.5 Offset Setting

Using the [OFS] key, an offset can be added to the waveform.

While the [OFS] key is illuminated, the offset setting is valid and the offset is added to the output waveform.

While the [OFS] key is turned off, the offset setting is invalid and an offset is not added to the output waveform.

- (1) Press the [OFS] key.

The display enters the offset/duty-factor setting display mode. (Refer to chapter 2.4, “Display Modes,” section (2), “Offset, Duty-factor Setting Modes.”)

(VFD) OFS +/-####V XXX

In the above screen, press the [→] key or [←] key to cause XXX to blink.

- (2) Operate the [↑] key, [↓] key, or frequency knob to set XXX to ON.

(VFD) OFS +/-####V ON (The “ON” characters are blinking.)

When set to ON, the offset setting becomes valid.

- (3) When the OFS setting is a value other than zero volts, the [OFS] key is illuminated and the offset is added to the waveform.

Press the [→] key to cause +/-#### to illuminate. (One digit within +/-####V will blink.)

(VFD) OFS +/-####V ON

- (4) Set the numeric value by moving the position of the blinking digit.

Press the [FREQ >] and [FREQ <] keys to move the blinking digit, and operate the [↑] key, [↓] key or frequency knob to set the desired value of each digit. (In this case, the offset changes in real-time.)

Setting range : Range of | offset voltage | + amplitude/2 \leq 5.025 V (when there is a 50 Ω termination)

Setting resolution : 3 digits (minimum 1 mV)

Direct input via the 10-key keypad is also possible. (Refer to chapter 2.5, “Numeric Input of Setting Values.”)

For example, in the case where it is desired to set an offset of 10 mV, press the [NUM] key to cause it to illuminate, and then press the [1], [0] and [mV] keys in sequence so that (VFD) OFS +10mV ON appears.

In the case where the setting value is 0 V, since there is no offset, the [OFS] key is unlit even if the right edge field of the display is ON.

(5) Press the [MENU] key to return to the normal display mode.

When (VFD) **OFS +/-###V OFF** appears, the setting value is ignored and operation is the same as when the offset is 0. (Even when it is OFF, the actual operation of setting the offset voltage can be performed.)

Caution

- When DC output has been selected for the waveform, it is not possible to enter the offset setting menu. Attempting to do so will cause an error beep to sound and the warning message

! I N V A L I D I N D C !

to be displayed.

To disable the offset

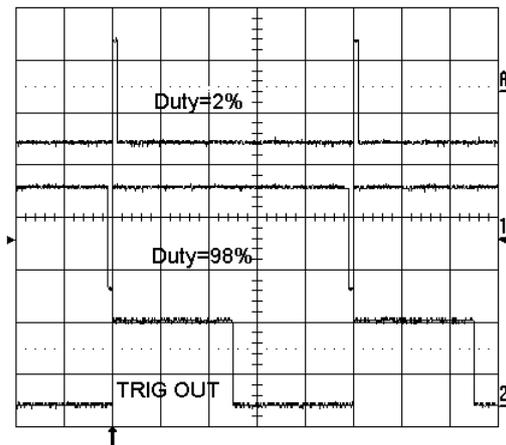
Follow steps (1) to (2). (VFD) **OFS +/-###V OFF** appears.

3.6 Duty-Factor Setting

Using the [DUTY] key, the duty-factor of the waveform can be set.

Illuminated [DUTY] key indicates that the duty-factor setting is ON.

(This key is illuminated when the setting for square waves and pulse waves is a value other than 50.0% or when the setting for ramp waves is a value other than 100.0%.)



[Example] Comparison of duty-factors

(1) Press the [DUTY] key.

The display enters the offset/duty-factor setting display mode. (Refer to chapter 2.4, “Display Modes,” section (2), “Offset, Duty-factor Setting Modes.”)

(VFD) DUTY ###% XXX

In the above screen, press the [→] key or [←] key to cause XXX to blink.

(2) Operate the [↑] key, [↓] key, or frequency knob to set XXX to ON.

(VFD) DUTY ###% ON (The “ON” characters are blinking.)

When set to ON, the duty setting becomes valid. When the duty setting of ### is a value other than 50.0% (other than 100.0% in the case of a ramp wave), the [DUTY] key is illuminated.

(3) Press the [→] key to cause ### to blink. (One digit within ##### will blink.)

(VFD) DUTY ###% ON

(4) Set the numeric value by moving the position of the blinking digit.

Press the [FREQ >] and [FREQ <] keys to move the blinking digit, and operate the [↑] key, [↓] key or frequency knob to set the desired value of each digit.

Setting ranges:	Square wave (over 5 MHz, 15 MHz and below)	40.0% to 60.0%
	Square wave (5 MHz and below)	20.0% to 80.0%
	(When the oscillation mode is TRIG or GATE, or when BURST is ON, performance is guaranteed over the range of 1 MHz and below.)	
	Pulse wave, ramp wave	0.0% to 100.0%
Setting resolution:		0.1%

Direct input via the 10-key keypad is also possible. With the duty-factor setting, the only valid units key is the [ENT] key. (Refer to chapter 2.5, "Numeric Input of Setting Values.")

For example, in the case where it is desired to set a 30% duty-factor, press the [NUM] key to cause it to illuminate, and then press the [3], [0] and [ENT] keys in sequence.

Then (VFD) DUTY 30.0% ON appears.

(5) Press the [MENU] key to return to the normal display mode.

When sine wave, triangular wave, or DC is selected, the duty-factor cannot be set.

When sine wave, triangular wave or DC is selected, pressing the [DUTY] key causes an error beep to sound and the corresponding error message below to be displayed.

Invalid the duty setting warning message (in the case of a sine wave)

! I N V A L I D I N S I N !

Invalid the duty setting warning message (in the case of a triangular wave)

! I N V A L I D I N T R I !

Invalid the duty setting warning message (in the case of DC)

! I N V A L I D I N D C !

When (VFD) DUTY ###% OFF appears, setting values are ignored. (Even when it is OFF, the actual operation of setting the duty-factor can be performed.)

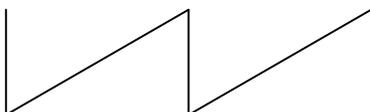
When the setting value is the same as the initial value, the [DUTY] key will not be illuminated even if the field at the right side of the display is ON.

Duty-factor initial values

Square wave, pulse wave 50%

Ramp wave 100%

A ramp wave with 100.0% duty factor has the following waveform.



Values of the duty-factor settings for square waves, pulse waves and ramp waves are saved individually. When a waveform is selected, individual setting values are applied.

Caution

While a pulse wave, triangular wave or ramp wave is being output in the gate or triggered oscillation modes, if the duty-factor changes during oscillation, the waveform output is terminated and then the trigger wait state is entered. When the next trigger is captured, a waveform is output with the duty-factor that has been set.

Also refer to chapter 3.11, “Generation Control by External Signal.”

Waveform output and offset/duty (enable = can be set, - - - = cannot be set)

	FUNCTION					
	1	2	3	4	5	+/-
						
	6	7	8	9	0	•
Duty	- - -	enable	enable	- - -	enable	- - -
Offset	enable	enable	enable	enable	enable	- - -

3.7 Initial Phase Setting (PHA Menu)

Setting of the initial phase is performed in the menu mode. (Refer to chapter 2.4, “Display Modes, section (3), “Menu Mode.”)

Setting of the initial phase can be performed in the PHA menu of the menu mode.

* The phase value set here is utilized for the oscillation start or stop phase during the trigger mode, gate mode, burst oscillation and sweep mode. (Not utilized for oscillation stop phase via the [ON] key.)

- (1) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then the display mode appears.

- (2) Enter the PHA mode.

Operate the [↑] key, [↓] key or frequency knob to display

(VFD) PHA XXX +/-#####°.

(The “PHA” characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) PHA XXX +/-#####°

- (3) Change the setting to ON.

Operate the [↑] key, [↓] key or frequency knob to display

(VFD) PHA ON +/-#####°.

(The “ON” characters are blinking.)

When (VFD) PHA OFF +/-#####° appears, the setting value is invalid and operation is the same as when the initial phase is 0°.

- (4) Press the [→] key to cause +/-### to blink. (One digit within +/-##### will blink.)

(VFD) PHA ON +/-#####°

- (5) Set the numeric value by moving the position of the blinking digit.

Press the [FREQ >] and [FREQ <] keys to move the blinking digit, and operate the [↑] key, [↓] key or frequency knob to set the desired value of each digit.

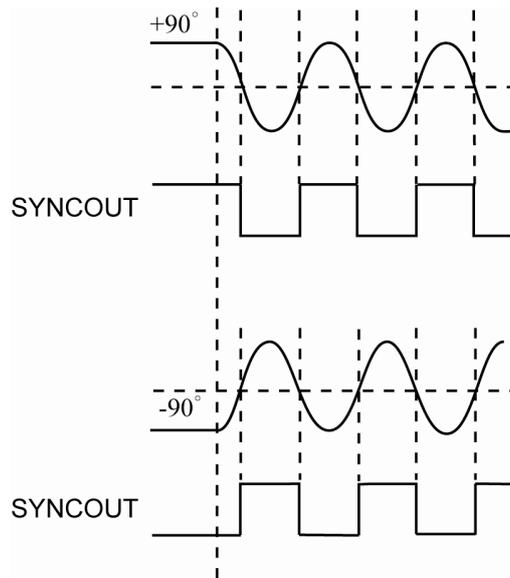
Setting range : -359.9° to 359.9°

Direct input via the 10-key keypad is also possible. (Refer to chapter 2.5, “Numeric Input of Setting Values.”)

For example, in the case where it is desired to set the initial phase 90° , press the [NUM] key to cause it to become illuminated, and then press the [9], [0] and [ENT] keys in sequence.

(VFD) PHA ON + 90.0° appears.

(6) Press the [MENU] key to return to the normal display mode.



Sine wave when initial phase is $\pm 90^\circ$

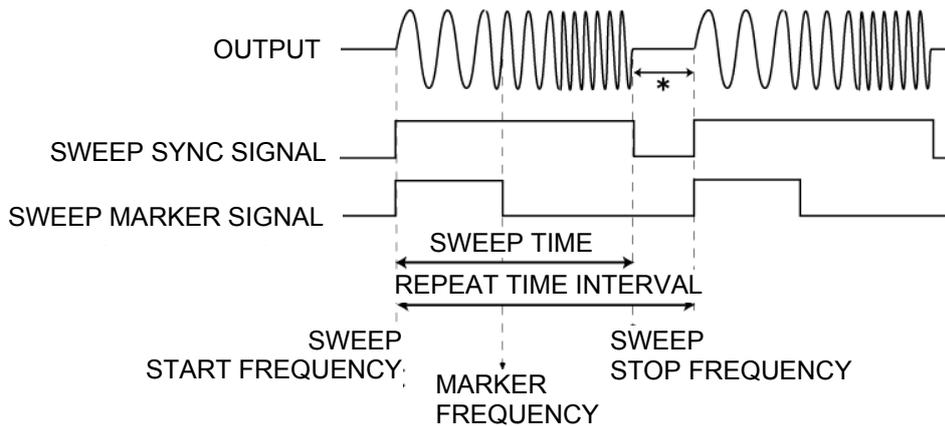
- * The initial phase setting becomes valid upon exiting the PHA menu.
- * While DC is selected as the waveform, even if the initial phase setting is set to ON, there is no effect while DC is selected.

3.8 Sweep Settings (SWEEP Menu)

This instrument can output while performing a frequency sweep.

About the generation modes and the sweep operation:

(1) When the oscillation mode is continuous oscillation mode ([CONT] key is illuminated)



- Pressing the [MENU] key and exiting the SWEEP menu will automatically start the oscillation. Each item in the above figure is set in the SWEEP menu.

Sweep setting items	Menu	Factory default settings
Sweep time	TIME	100 ms
Repeat time interval	INT	200 ms
Sweep start frequency	START	1.0000 kHz
Sweep stop frequency	STOP	10.000 kHz
Marker frequency	MARK	5.0000 kHz

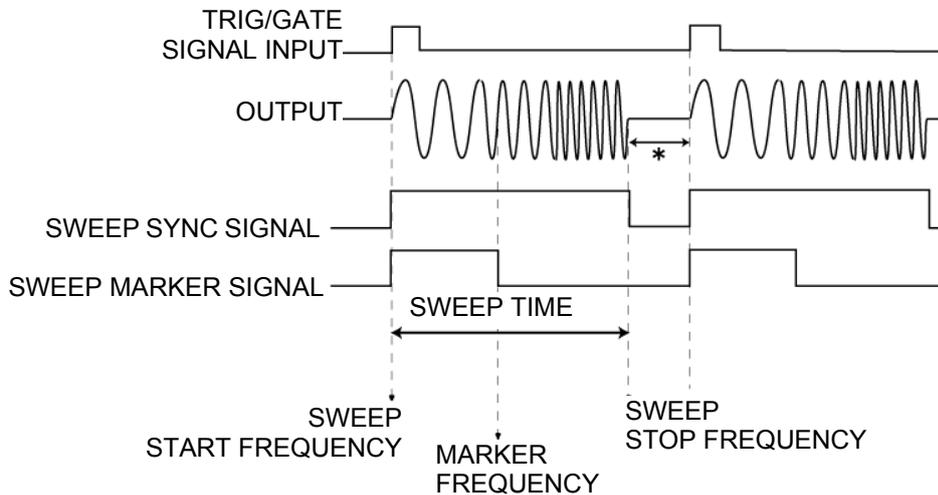
Sweep stop interval and TYPE

Operation of the * part in the above figure will differ depending upon the oscillation TYPE setting after sweep has stopped.

CONTINUE	* part continues oscillation at SWEEP STOP FREQUENCY.
STOP	* part stops oscillation. (Stops at the phase, which was set.)

(2) When the oscillation mode is triggered oscillation mode ([TRIG] key is illuminated)

<In the below figure, TRIG POLARITY is set to +>



- Sweep starts when a trigger signal is input to the TRIG/GATE input on the rear panel. However, the trigger signals input during a sweep are ignored.
- Sweep will also start manually when the [MAN] key on the front panel is pressed.

Each item in the above figure is set in the SWEEP menu.

Sweep setting items	Menu	Factory default settings
Sweep time	TIME	100 ms
Repeat time interval	INT	200 ms
Sweep start frequency	START	1.0000 kHz
Sweep stop frequency	STOP	10.000 kHz
Marker frequency	MARK	5.0000 kHz

Sweep stop interval and TYPE

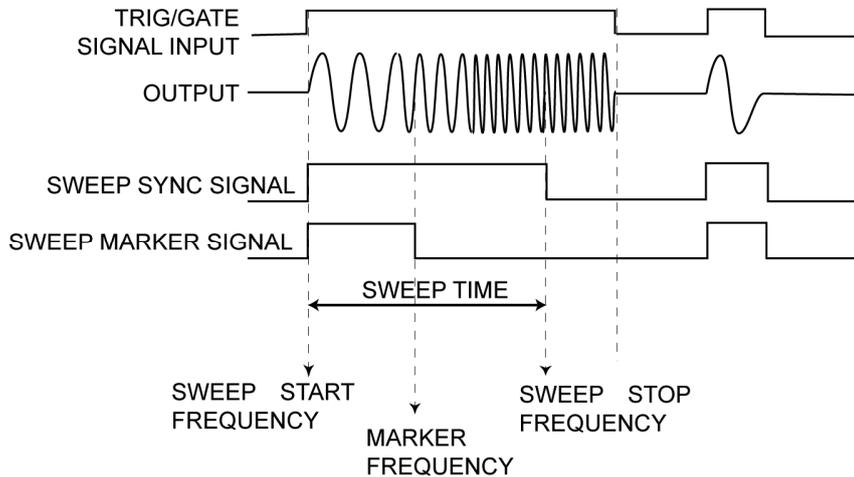
Operation of the * parts in the above figure will differ depending upon the oscillation TYPE setting after sweep has stopped.

CONTINUE	* part continues oscillation at SWEEP STOP FREQUENCY.
STOP	* part stops oscillation. (Stops at the phase, which was set.)

The menu for sweep parameter INT is ignored.

(3) When the oscillation mode is gate mode ([GATE] key is illuminated)

<In the below figure, TRIG POLARITY is set to +>



- Sweep starts when a gate signal is input to the TRIG/GATE input on the rear panel.
- Even if the stop frequency for sweeping is reached while a gate signal is input, oscillation will be maintained at the stop frequency for sweeping. Generation stops (at the phase that was set) when the gate signal is discontinued.
- When the sweep mode is “log”, if the gate signal is discontinued during the SWEEP TIME, the sweep is terminated. The next time a gate signal is input, sweep starts from the beginning.
- When the sweep mode is “linear”, if the gate signal is discontinued during the SWEEP TIME, the sweep is terminated. However, the next time a gate signal is input, the sweep may start from a midway point.

Each item in the above figure is set in the SWEEP menu.

Sweep setting items	Menu
Sweep time	TIME
Repeat time interval	INT
Sweep start frequency	START
Sweep stop frequency	STOP
Marker frequency	MARK

The menus for sweep parameters TYPE and INT are ignored.

Sweep settings are performed in the menu mode. (Refer to chapter 2.4, “Display Modes,” section (3), “Menu Mode.”)

The sweep can be set in the SWEEP menu of the menu mode.

The display is the normal display mode; the amplitude is shown on the left side, and the frequency is shown on the right side. When the sweep is ON, the frequency display is as follows.

- When the sweep time is less than 1s, the start frequency for sweeping and stop frequency for sweeping are displayed alternately.
- When the sweep time is 1 s or more, the current frequency is monitored and, at the same time, displayed.

(1) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then the display mode appears.

(2) Enter the SWEEP menu.

Operate the [↑] key, [↓] key or frequency knob to display (VFD) SWEEP XXX ???.

(The “SWEEP” characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) SWEEP XXX ???

Display of ???

When XXX is OFF: Nothing appears.

When XXX is ON: MORE→ appears.

(3) Change the setting to ON.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) SWEEP ON MORE→.

(The “ON” characters are blinking.)

(4) Enter the sweep detail menu and set each sweep item.

Press the [→] key to enter the sweep detail menu. (VFD) MODE XXX appears.

(The “MODE” characters are blinking.)

(a) Sweep mode setting

Selects linear sweep or log sweep.

Selection values: LINEAR or LOG (linear sweep or log sweep)

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) MODE XXX. (The “MODE” characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) MODE XXX (The “XXX” characters are blinking.)

Operate the [↑] key, [↓] key or the frequency knob to select the desired sweep mode (LINEAR or LOG). Press the [←] key to cause the MODE characters to blink.

(b) Sweep start frequency setting

Sets the frequency that starts the sweep.

Setting range: sine wave, square wave 10 mHz to 15.0000 MHz
 pulse wave, ramp wave, triangular wave 10 mHz to 100.000 kHz

Valid number of digits: 5 digits (minimum resolution 10 mHz)

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) START #####XHz.

(The “START” characters are blinking.)

Press the [→] key to cause #####X to blink. (One digit within #####X will blink.)

Set the numeric value by moving the position of the blinking digit.

Press the [FREQ >] and [FREQ <] keys to move the blinking digit, and operate the [↑] key, [↓] key or frequency knob to set the desired value of each digit. Values that exceed the setting range cannot be set.

Direct input via the 10-key keypad is also possible. (Refer to chapter 2.5, “Numeric Input of Setting Values.”)

Through direct input via the 10-key keypad, if a setting is made which exceeds the setting range, that setting becomes the value of either the upper limit value or lower limit value, whichever is closer.

Press the [←] key to cause START to blink.

(c) Sweep stop frequency setting

Sets the frequency that stops the sweep. The setting range is the same as the range of the start frequency for sweeping.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) STOP #####XHz.

(The “STOP” characters are blinking.)

Press the [→] key to cause #####X to blink. (One digit within #####X will blink.)

Set the numeric value by moving the position of the blinking digit.

The setting method is the same as (b), “Sweep start frequency setting.”

Press the [←] key to cause STOP to blink.

- * Whether the sweep is an UP or DOWN sweep is determined according to the relative sizes of the start frequency for sweeping and stop frequency for sweeping. If the start frequency for sweeping = stop frequency for sweeping, there is no tangible sweep.

(d) Sweep time setting

Sets the time from the sweep start until the sweep stop.

Setting range : 1 ms to 500 s

When three conditions of the following become complete, the sweep time and the stop frequency for sweeping are restricted by the next expression.

sweep time ≥ 2 / stop frequency for sweeping

1) sweep mode is linear. 2) sweep time is less than 1s. 3) DOWN sweep is set.

Valid number of digits : 3 digits (minimum resolution 1 ms)

Operate the [\uparrow] key, [\downarrow] key or the frequency knob to display (VFD) TIME ####Xs.

(The "TIME" characters are blinking.)

Press the [\rightarrow] key to cause ####Xs to blink. (1 digit with ####X will blink.)

Set the numeric value by moving the position of the blinking digit.

The setting method is the same as (b), "Sweep start frequency setting," only the units are different.

Press the [\leftarrow] key to cause TIME to blink.

(e) Repeat time interval setting

Sets the repeat time interval for the sweep.

Setting range : 1 ms to 500 s

If the sweep time and repeat time are set to the same time, the repeat time may in some cases be twice as long.

Valid number of digits : 3 digits (minimum resolution 1 ms)

Operate the [\uparrow] key, [\downarrow] key or the frequency knob to display (VFD) INT #####s.

(The "INT" characters are blinking.)

The setting method is the same as (d), "Sweep time setting."

Press the [\leftarrow] key to cause INT to blink.

(f) Selection of oscillation type after sweep completion

Sets whether oscillation will continue or stop after completion of the sweep (after arriving at the stop frequency for sweeping).

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) TYPE #####.

(The “TYPE” characters are blinking.)

Press the [→] key to cause ##### to blink, and then select CONTINUE (continue oscillation) or STOP (stop oscillation).

If the [↑] key, [↓] key or the frequency knob is operated to select (VFD) TYPE CONTINUE, oscillation will continue even after the sweep is completed.

If the [↑] key, [↓] key or the frequency knob is operated to select (VFD) TYPE STOP, oscillation will stop after the sweep is completed.

Press the [←] key to cause TYPE to blink.

(g) Marker frequency setting

Sets a marker frequency for the sweep. Also refer to “2.6 Rear panel output”.

Setting range:

sweep start frequency \leq marker frequency \leq sweep stop frequency, or

sweep start frequency \geq marker frequency \geq sweep stop frequency

If outside the setting range, the marker setting will take the value of either the start frequency for sweeping or stop frequency for sweeping, whichever is closer.

Valid number of digits : 5 digits (minimum resolution 10m Hz)

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) MARK #####Hz.

(The “MARK” characters are blinking.)

Press the [→] key to cause #####Hz to blink. (One digit within #####X will blink.)

Set the numeric value by moving the position of the blinking digit.

The setting method is the same as (b), “sweep start frequency setting.”

Press the [←] key to cause MARK to blink.

Pressing the [MENU] key un-illuminates this key. Then (VFD) !SETTING! and “the normal display mode” appears.

Pressing the [BACK] key while in the sweep detail menu, or pressing the [←] key while items on the left side of the sweep detail menu are blinking, causes a return to the SWEEP menu.

- Sweep settings are valid upon exiting the SWEEP menu.

At the same time, the sweep status LED will become illuminated.

-
- While BURST or MT-MOD(pulse motor modulation) is “ON”, SWEEP cannot be set to “ON.”

If SWEEP is set to “ON” while the BURST or MT-MOD(pulse motor modulation) setting is “ON”, a warning message (shown below) appears for 1 second and then BURST or MT-MOD(pulse motor modulation) is forcibly set to “OFF.”

If the SWEEP setting is returned to “OFF” after the warning message appears, the BURST or MT-MOD(pulse motor modulation) setting will remain “ON.”

Case where SWEEP is set to “ON” while BURST is “ON”:

! B U R S T O N → O F F !

Case where SWEEP is set to “ON” while MT-MOD(pulse motor modulation) is “ON”:

! M T O N → O F F !

- * SWEEP cannot be set to “ON” while the waveform is selected as DC. If an attempt is made to set SWEEP to “ON” while the waveform is DC, an error beep is sounded and the warning message

! S W E E P D I S A B L E !

appears.

Rear panel output

While SWEEP is ON, the following signals can be obtained from the rear panel.

- SWEEP SYNC signal : Output of a “H” level TTL signal during the transition interval from the (SWEEP SYNC) start frequency until the stop frequency for sweeping.
- SWEEP MARKER signal : Output of a “H” level TTL signal during the transition interval from the (SWEEP MARKER) start frequency until the marker frequency.

Generation mode limitations

All oscillation modes, the continuous oscillation mode, gate oscillation mode and triggered oscillation mode, are possible. (Refer to chapter 3.4.1, “About Generation Modes.”)

In the triggered oscillation mode, sweep starts each time there is a trigger input.

However, trigger signals input while a sweep is in progress are ignored. (Refer to chapter 3.11, “Generation Control by External Signal.”)

In the gate oscillation mode, sweep starts while a gate signal is being input.

If the gate signal input ceases during the sweep, the sweep is terminated.

When sweep is operated under the following types of conditions, amplitude distortion may occur immediately after starting a sweep or immediately prior to completion of a sweep, however this is not a malfunction.

1. UP sweep

Generation type (TYPE) after completion of the sweep is "STOP."

Sweep stop frequency (STOP) is between 1 and 15 MHz.

With the above types of conditions, amplitude distortion may occur in the last cycle immediately prior to completion of the sweep.

2. Generation type (TYPE) after completion of the sweep is "CONTINUE."

Either the start frequency for sweeping (START) or the stop frequency for sweeping (STOP) is in the range of 1 to 15 MHz.

With the above types of conditions, amplitude distortion may occur immediately after sweep restarts.

Even when the oscillation type (TYPE) after completion of the sweep is "STOP", similar phenomenon may be observed if due to the triggered oscillation mode or gate oscillation mode, the sweep stop timing and next sweep start timing are close to one another.

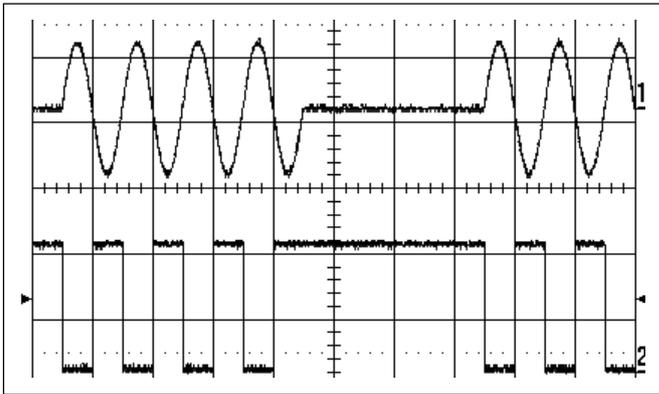
3. The sweep time might not become accurate in the following conditions.

In that case, please shorten the sweep time.

$$\frac{|start\ frequency(Hz) - stop\ frequency(Hz)|}{2} \times sweep\ time(s)$$

3.9 Burst Settings (BURST Menu)

This instrument can output a waveform as a burst oscillation. Generation starts and stops at the phase set as the initial phase setting. (Refer to chapter 3.7, Initial Phase Setting.)



Sine wave burst waveform

Burst settings are performed in the menu mode. (Refer to chapter 2.4, “Display Modes,” section (3), “Menu Mode.”)

The burst can be set in the BURST menu of the menu mode.

- (1) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then the display mode appears.

- (2) Enter the BURST menu.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) BURST XXX.
(The “BURST” characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) BURST XXX

- (3) Change the setting to ON.

Operate the [↑] key, [↓] key or the frequency knob to display

(VFD) BURST ON MORE→.

(The “ON” characters are blinking.)

- (4) Enter the burst detail menu and set each burst item.

Press the [→] key to enter the burst detail menu. (VFD) ON-COUNT ##### appears.

(The “ON-COUNT” characters are blinking.)

(a) Set the burst ON-COUNT

Set the burst oscillation interval with a wave count (integer value).

Setting range: 1 to 65536 (setting resolution: 1)

- Press the [→] key to cause #####X to blink. (One digit within #####X will blink.)
- Set the numeric value by moving the position of the blinking digit.
- Press the [FREQ >] and [FREQ <] keys to move the blinking digit, and operate the [↑] key, [↓] key or frequency knob to set each digit to the desired numeric value.

Direct input via the 10-key keypad is also possible. (Refer to chapter 2.5, “Numeric Input of Setting Values.”)

- Press the [←] key to cause ON-COUNT to blink.

(b) Set the burst OFF-COUNT

Set the burst off interval with a wave count (integer value).

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) OFF-COUNT #####.

(The “OFF-COUNT” characters are blinking.)

Setting range: 1 to 65536 (setting resolution: 1)

- Press the [→] key to cause ##### to blink. (One digit within ##### will blink.)
- Set the numeric value by moving the position of the blinking digit.
- The setting method is the same as that for the burst ON-COUNT.

(5) Pressing the [MENU] key un-illuminates this key. Then (VFD) ! SETTING ! and “ the normal display mode” appears.

Pressing the [BACK] key while in the burst detail menu, or pressing the [←] key while items on the left side of the burst detail menu are blinking, causes a return to the BURST menu.

- Burst settings are valid upon exiting the BURST menu.

At the same time, the BURST status LED will become illuminated.

- While SWEEP or MT-MOD(pulse motor modulation) is “ON”, BURST cannot be set to “ON.”

If BURST is set to “ON” while the SWEEP or MT-MOD(pulse motor modulation) setting is “ON”, a warning message (shown below) appears for 1 second and then SWEEP or MT-MOD(pulse motor modulation) is forcibly set to “OFF.”

If the BURST setting is returned to “OFF” after the warning message appears, the SWEEP or MT-MOD(pulse motor modulation) setting will remain “ON.”

Case where BURST is set to “ON” while SWEEP is “ON”:

! S W E E P O N → O F F !

Case where BURST is set to "ON" while MT-MOD(pulse motor modulation) is "ON":

! M T O N → O F F !

* BURST cannot be set to "ON" while the waveform is selected as DC. If an attempt is made to set BURST to "ON" while the waveform is DC, an error beep is sounded and a warning message appears.

! B U R S T D I S A B L E !

BURST cannot be set to "ON" while the oscillation mode is the gate oscillation mode. If an attempt is made to set BURST to "ON", an error beep is sounded and a warning message appears.

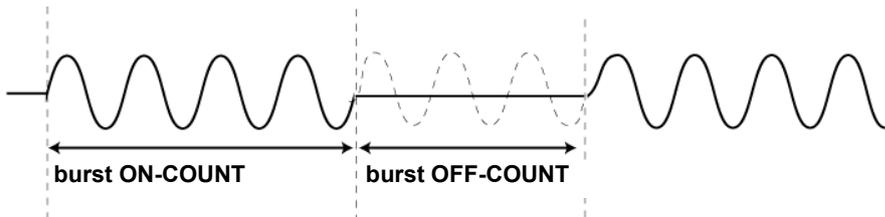
! B U R S T D I S A B L E !

For further information regarding the gate oscillation mode, refer to chapter 3.4.1, "About Generation Modes" and chapter 3.11.2, "Gate Controlled Generation."

Generation modes and burst operation:

(1) When the oscillation mode is continuous oscillation mode ([CONT] is illuminated):

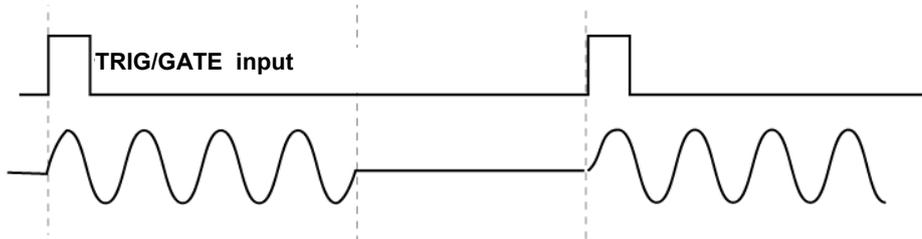
Example: burst ON-COUNT=4 burst OFF-COUNT=3



As can be seen in the figure, the waveform oscillates for the number of cycles set with the burst ON-COUNT and then oscillation stops for the number set with the burst OFF-COUNT.

(2) When the oscillation mode is triggered oscillation mode ([TRIG] is illuminated):

Example: burst ON-COUNT=4



As can be seen in the figure, each time a trigger signal is input to the TRIG/GATE input on the rear panel, the waveform oscillates for the number of cycles set with the burst ON-COUNT.

A trigger signal input during burst oscillation will be ignored.

Burst oscillation can also be implemented manually by pressing the [MAN] key on the front panel.

The burst OFF-COUNT setting will be ignored.

When the waveform is selected as sine wave or square wave and BURST is ON, performance is guaranteed over the frequency range of 10 mHz to 1 MHz.

3.10 Pulse Motor Modulation Settings (MT-MOD Menu)

This function is optional. The MT-MOD menu only appears when the motor control option has been installed.

With this function, a MT-MOD(pulse motor modulation) waveform can be output.

Setting of the MT-MOD(pulse motor modulation) is performed in the menu mode. (Refer to chapter 2.4, “Display Modes,” section (3), “Menu Mode.”)

Pulse motor modulation can be set in the MT-MOD menu of the menu mode.

- (1) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then “the display mode” appears.

- (2) Enter the MT-MOD menu.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) MT-MOD XXX.

(The “MT-MOD” characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) MT-MOD XXX

- (3) Change the setting to ON.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) MT-MOD ON MORE→.

(The “ON” characters are blinking.)

- (4) Enter the MT-MOD detail menu and set each MT-MOD(pulse motor modulation) related item.

Press the [→] key to enter the MT-MOD detail menu. (VFD) MT MODE XXX appears. (The “MODE” characters are blinking.)

- (a) Setting the MT-MOD(pulse motor modulation) mode

Press the [→] key to cause XXX to blink.

(VFD) MT MODE XXX

Operate the [↑] key, [↓] key or the frequency knob and select the desired MT-MOD(pulse motor modulation) mode (LIN-A or LIN-B).

LIN-A : Trapezoidal control of speed, slowdown according to sensor input

LIN-B : Trapezoidal control of speed, slowdown according to pulse count

Press the [←] key to cause MODE to blink.

(b) Setting the initial frequency

This sets the initial frequency.

Setting range : 10 mHz to 100.00 kHz (where the range satisfies the condition “initial frequency \leq maximum frequency”)

Valid number of digits : 5 digits

Operate the [\uparrow] key, [\downarrow] key or the frequency knob to display

(VFD) MT L= #####XHz.

(The “L=” characters are blinking.)

Press the [\rightarrow] key to cause #####X to blink.

Set the numeric value by moving the position of the blinking digit.

Press the [FREQ >] and [FREQ <] keys to move the blinking digit and operate the [\uparrow] and [\downarrow] keys or frequency knob to set each digit to the desired numeric value.

Direct input via the 10-key keypad is also possible. (Refer to chapter 2.5, “Numeric Input of Setting Values.”)

Press the [\leftarrow] key to cause L= to blink.

(c) Setting the maximum frequency

This sets the maximum frequency.

Setting range : 10 mHz to 100.00 kHz (where the range satisfies the condition “initial frequency \leq maximum frequency”)

Valid number of digits : 5 digits

Operate the [\uparrow] key, [\downarrow] key or the frequency knob to display (VFD) MT H= #####XHz.

(The “H=” characters are blinking.)

Press the [\rightarrow] key to cause #####XHz to blink.

Set the numeric value by moving the position of the blinking digit.

The method of setting is the same as (b), “Setting the initial frequency.”

Press the [\leftarrow] key to cause H= to blink.

(d) Setting the time until maximum frequency

This sets the time until the maximum frequency.

Setting range : 1 ms to 45 s

Valid number of digits : 3 digits

Operate the [\uparrow] key, [\downarrow] key or the frequency knob to display (VFD) MT UP #####s.

(The “UP” characters are blinking.)

Press the [\rightarrow] key to cause #####s to blink.

Set the numeric value by moving the position of the blinking digit.

The method of setting is the same as (b), "Setting the initial frequency", only the units are different.

Press the [←] key to cause UP to blink.

(e) Setting the time until initial frequency

This sets the time until the initial frequency.

Setting range : 1 ms to 45 s

Valid number of digits : 3 digits

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) MT DOWN #####s.

(The "DOWN" characters are blinking.)

Press the [→] key to cause #####s to blink.

Set the numeric value by moving the position of the blinking digit.

The method of setting is the same as (d), "Setting the time until maximum frequency."

Press the [←] key to cause DOWN to blink.

(f) Setting the pulse count until slowdown

(This menu appears only when the mode is set to "LIN-B.")

This sets the number of pulses until slowdown as a wave count (integer value).

Setting range : 1 to 16777216 (integer) (See note.)

Valid number of digits : 8 digits (Resolution: 1)

Display (VFD) MT 1ST #####. (The "1ST" characters are blinking.)

Press the [→] key to cause ##### to blink. (One digit within ##### will blink.)

Set the numeric value by moving the position of the blinking digit.

The method of setting is the same as (b), "Setting the initial frequency."

Press the [←] key to cause 1ST to blink.

(Note) The following conditions must be satisfied.

"L=" is set to the value of F1,

"H=" is set to the value of F2, and where "UP" is the time until maximum frequency,

When $UP \leq 60\text{ms}$ 1ST count > $UP \times (F1+F2)/2 + 6\text{ms} \times F2$

When $UP > 60\text{ms}$ 1ST count > $UP \times (F1+F2)/2 + UP \times F2 \times 0.1$

(g) Setting the pulse count until oscillation stop

This sets the number of pulses until oscillation stops as an integer value.

Setting range : 1 to 16777216 (integer) (See note.)

Valid number of digits : 8 digits (Resolution: 1)

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) MT STP #####.

(The “STP” characters are blinking.)

Press the [→] key to cause ##### to blink. (One digit within ##### will blink.)

Set the numeric value by moving the position of the blinking digit.

The method of setting is the same as (b), “Setting the initial frequency.”

Press the [←] key to cause STP to blink.

(Note) The following conditions must be satisfied.

During LIN-A mode

“L=” is set to the value of F1,

“H=” is set to the value of F2, and where “UP” is the time until maximum frequency,

When $UP \leq 60\text{ms}$ $STOP \text{ count} > UP \times (F1+F2)/2 + 6\text{ms} \times F2$

When $UP > 60\text{ms}$ $STOP \text{ count} > UP \times (F1+F2)/2 + UP \times F2 \times 0.1$

During LIN-B mode

“L=” is set to the value of F1,

“H=” is set to the value of F2, and where “DOWN” is the time until initial frequency,

When $DOWN \leq 60\text{ms}$ $STOP \text{ count} > DOWN \times (F1+F2)/2 + 6\text{ms} \times F1$

When $DOWN > 60\text{ms}$ $STOP \text{ count} > DOWN \times (F1+F2)/2 + DOWN \times F1 \times 0.1$

(h) Setting the wait time

This sets the wait time.

Setting range : 10 ms to 100 s

Valid number of digits : 3 digits

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) MT WAIT #####s.

(The “WAIT” characters are blinking.)

Press the [→] key to cause #####s to blink.

Set the numeric value by moving the position of the blinking digit.

The method of setting is the same as (b), “Setting the initial frequency.”

Press the [←] key to cause WAIT to blink.

- While SWEEP or BURST is “ON”, MT-MOD(pulse motor modulation) cannot be set to ON. If the MT-MOD(pulse motor modulation) is set to “ON” while the SWEEP or BURST setting is “ON”, a warning message (shown below) appears for 1 second and then SWEEP or BURST is forcibly set to “OFF.”

If the MT-MOD(pulse motor modulation) setting is returned to “OFF” after the warning message appears, the SWEEP or BURST setting will remain “ON.”

Case where MT-MOD(pulse motor modulation) is set to “ON” while SWEEP is “ON”:

! S W E E P O N → O F F !

Case where MT-MOD(pulse motor modulation) is set to “ON” while BURST is “ON”:

! B U R S T O N → O F F !

Pressing the [MENU] key un-illuminates this key. Then (VFD) ! SETTING ! and “the normal display mode” appears.

Pressing the [BACK] key while in the MT-MOD detail menu, or pressing the [←] key while items on the left side of the MT-MOD detail menu are blinking, causes a return to the MT-MOD menu.

- * Pulse motor modulation settings are valid upon exiting the MT-MOD menu.

At the same time, the setting status of this instrument will become as follows.

Selected waveform : Pulse wave ([pulse] key is illuminated)

Generation mode : Continuous oscillation mode ([CONT] key is illuminated), or triggered oscillation mode ([TRIG] key is illuminated)

(In the case of gate oscillation, the mode switches to the continuous oscillation mode.)

(Refer to chapter 3.4.1, “About Generation Modes.”)

Display : Normal display mode

The display is similar to the following.

5 0 . 0 m V M T - M O D U

Implementing either of the following operations while MT-MOD(pulse motor modulation) is set to “ON” will cause an error beep to sound, (VFD) !MT CANCELED! to be displayed, and MT-MOD(pulse motor modulation) to be forcibly set to “OFF.”

- Pressing a waveform selection key other than pulse wave
- Pressing the [GATE] key

- During operation with MT-MOD(pulse motor modulation), the waveform, having the same frequency and duty as the output from the OUT pin of the rear panel, is output as a pulse wave from the OUTPUT pin of the front panel.
- The OUT pin of the rear panel is an open collector output. The signal output from the OUTPUT pin of the front panel is a normal pulse wave output with the variable amplitude and offset.
- While a oscillation stops, the rear OUT terminal is OFF and the front OUTPUT is being output L level. Reversed OUTPUT is available to set the initial phase settings as below table.

Oscillation Stop	Front OUTPUT	Recommend Initial Phase Settings
OFF	“L”	-1°
ON	“H”	+179°

- The OUTPUT ON key located on the front panel simultaneously turns ON/OFF the output of both the front panel OUTPUT pin and the rear panel OUT pin.

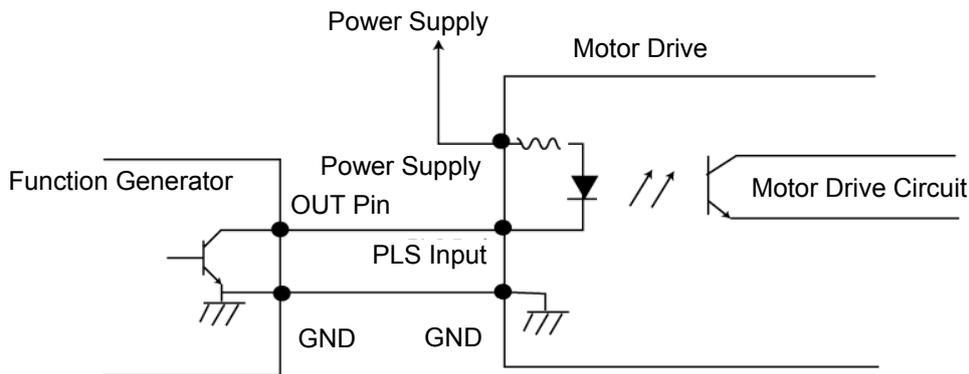
Operation of pulse motor modulation

(1) Input pin on rear panel

OUT pin

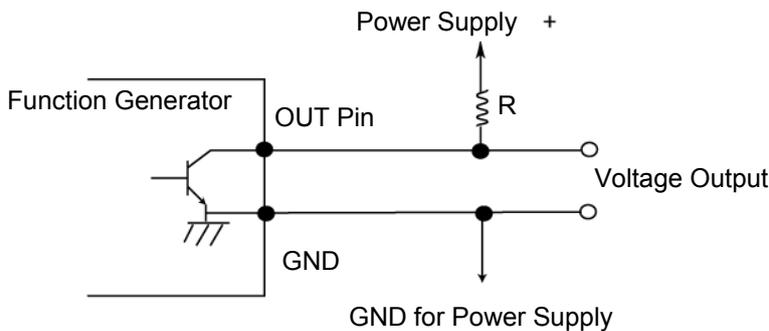
The OUT pin is used being connected to the pulse motor driver.

Because pulse motor drivers often have a photo-coupled input, this instrument has an open collector output that can withstand up to +50 V.



When a simple voltage output is required, connect the output signal from the OUT pin through a resistor to the power supply.

The OUT pin can withstand voltages up to +50V and has a maximum current of 100 mA, select the power supply and resistor values carefully.



IN1 pin

When the oscillation mode is set to triggered oscillation, the IN1 pin is used as a trigger input to start oscillation. Since this input is wired in a logical OR configuration with the BNC TRIG/GATE input of the rear panel, use just one of these inputs.

Use "H:3.75Vmin, L:1.75Vmax" levels to control this pin. The polarity conforms to the TRIG POLARITY setting.

IN2 pin

In accordance with the MT-MOD(pulse motor modulation) mode, the IN2 pin is used to initiate slowdown or control oscillation stopping.

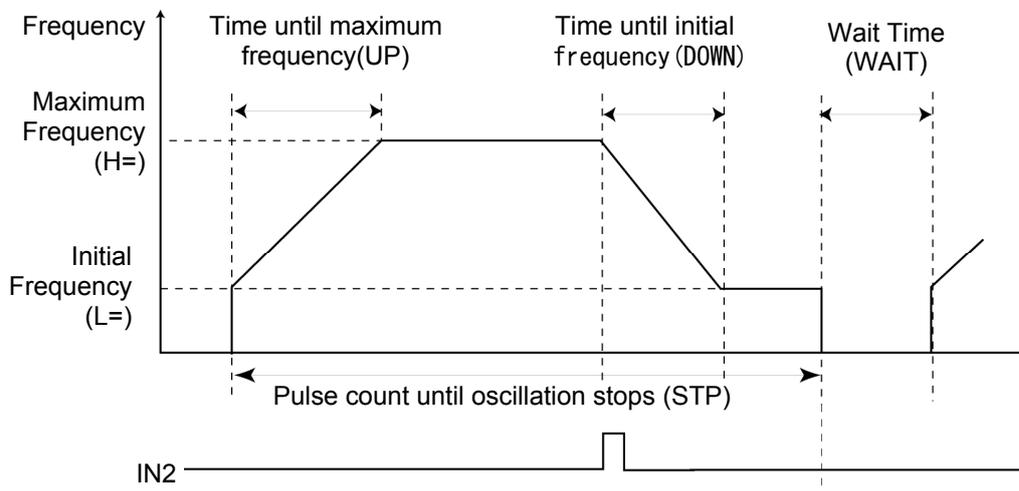
Use "H:3.75Vmin, L:1.75Vmax" levels to control this pin. The polarity conforms to the TRIG POLARITY setting.

(2) Operation of LIN-A mode

- As shown in the figure, control the number of pulse motor revolutions with trapezoidal control.
- Set the initial frequency to a frequency lower than the self-starting frequency of the pulse motor to be used.
- When oscillation in the LIN-A mode is started, the frequency rises in accordance with the setting of the time from initial frequency until maximum frequency.
- When the frequency reaches the maximum frequency, oscillation is maintained at the maximum frequency.

When a signal is input to the IN2 pin:

- The frequency drops in accordance with the setting of the time until initial frequency. (Slowdown)
- When the frequency reaches the initial frequency, oscillation is maintained at the initial frequency.
- When the "pulse count until oscillation stop" is reached, oscillation stops.



- After the start of oscillation, IN2 input is ignored until the maximum frequency is reached.
- If no signal is input to the IN2 pin, oscillation continues at the maximum frequency and when the "pulse count until oscillation stop" is reached, oscillation stops.

When the oscillation mode is continuous oscillation mode:

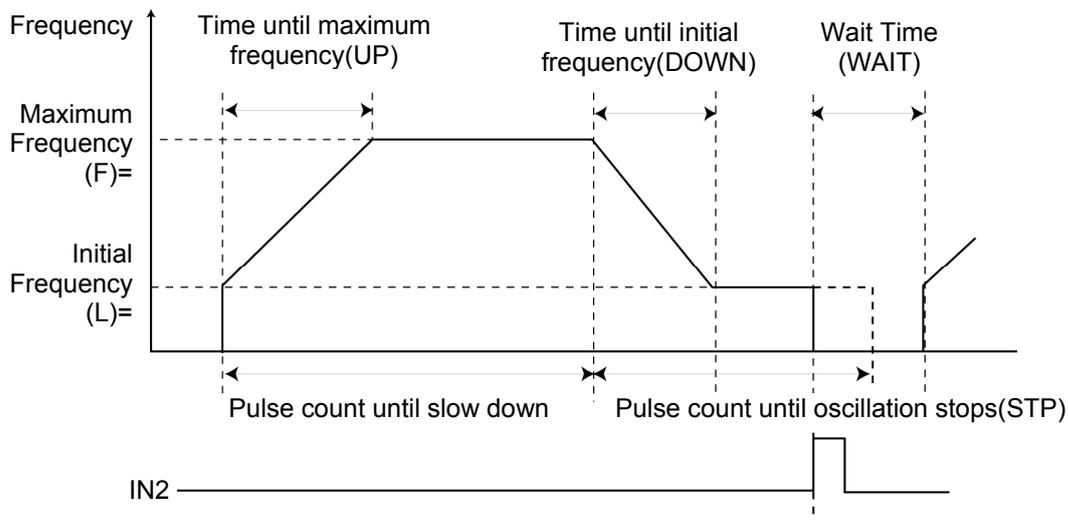
- Generation starts automatically after setting is complete. After oscillation is stopped according to the “pulse count until oscillation stop” setting, and after the wait time has elapsed, oscillation starts automatically.

When the oscillation mode is triggered oscillation mode:

- Generation starts by the IN input or the trigger input to the rear panel BNC TRIG/GATE.
- Press [MAN] key to start a oscillation.
- If the input to IN2 is a signal such as from a photosensor, slowdown can be implemented after a prescribed rotation.
- The WAIT time set by the menu is ignored.

(3) Operation of LIN-B mode

- As shown in the figure, control the number of pulse motor revolutions with trapezoidal control.
- Set the initial frequency to a frequency lower than the self-starting frequency of the pulse motor to be used.
- When oscillation in the LIN-B mode is started, the frequency rises in accordance with the setting of the time from initial frequency until maximum frequency.
- When the frequency reaches the maximum frequency, oscillation is maintained at the maximum frequency.
- After oscillation for the duration of the pulse count set in “pulse count until slowdown”, the frequency drops in accordance with the setting of the time until initial frequency. (Slowdown)
- When the frequency reaches the initial frequency, oscillation is maintained at the initial frequency.
- If a signal is input to the IN2 pin, oscillation stops.
- If no signal is input to the IN2 pin, oscillation stops when the “pulse count until oscillation stop” is reached.
- After the start of oscillation, IN2 input is ignored until the maximum frequency is reached.



When the oscillation mode is continuous oscillation mode:

- Oscillation starts automatically after setting is complete. After oscillation is stopped according to the IN2 input or “pulse count until oscillation stop” setting, and after the wait time has elapsed, oscillation starts automatically.

When the oscillation mode is triggered oscillation mode:

- Oscillation starts by the IN1 input or the trigger input to the rear panel BNC TRIG/GATE.
- Press [MAN] key to start a oscillation.
- Inputting a signal such as from a photo sensor to IN2, rotation can be stopped at a prescribed position.
- The WAIT time set by the menu is ignored.

3.11 Generation Control by External Signal

With this instrument, starting and stopping of the output can be controlled by external signal input or manual operation. There are two types of generation control as follows:

Trigger controlled generation

Outputs the waveform each time a trigger is input.

Gate controlled generation

Outputs the waveform while the gate signal is open.

3.11.1 Trigger Controlled Generation

Outputs the waveform each time a valid trigger input is captured.

The trigger is connected to the TRIG input pin of the rear panel and the polarity is selected with the TRIG menu.

TRIG input:TTL level

The [MAN] key (manual key) internally generates a valid trigger signal. When the [MAN] key is pressed, operation starts as if there was a valid trigger input at the TRIG input pin of the rear panel.

Caution : Depending on the status of the signal input to the rear panel TRIG input pin, the [MAN] key might be disabled in some cases.

Example: When TRIG POLARITY is “+”, the [MAN] key is disabled while a high level (H) signal is input to the rear panel TRIG input pin.

(1) Press the [TRIG] key of the front panel to set the oscillation mode to the triggered oscillation mode.

(2) Set the trigger polarity.

(a) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then “the menu display mode” appears.

(b) Enter the TRIG menu.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) TRIG-POLARITY X.

(The “TRIG-POLARITY” characters are blinking.)

Press the [→] key to cause X to blink.

(VFD) TRIG-POLARITY X

(c) Select the polarity.

Operate the [↑] key, [↓] key or frequency knob to select “+” or “-.”

When (VFD) TRIG-POLARITY + is set, this instrument starts oscillation at the rising edge.

When (VFD) TRIG-POLARITY - is set, this instrument starts oscillation at the falling edge.

When both SWEEP and BURST are “OFF”, only 1 cycle of the waveform is output each time a trigger is captured in the triggered oscillation mode.

When SWEEP is “ON”, the sweep starts each time a trigger is input in the triggered oscillation mode.

However, trigger inputs are ignored during the sweep time.

When BURST is “ON”, each time a trigger is input, output of the waveform lasts for the number of cycles set with the burst ON-COUNT, and then stops. However, trigger inputs are ignored during the oscillation.

Caution : In the case of a sine wave or square wave, the waveform and flatness of the amplitude are not guaranteed for frequencies exceeding 1 MHz.

3.11.2 Gate Controlled Generation

This method controls output of the waveform during the interval while the gate is open. Gate polarity (whether “H” or “L” is open) is set with the TRIG menu. The gate signal is input to the rear panel TRIG input pin.

TRIG input:TTL level

In the gate oscillation mode, the [MAN] key (manual key) operates to open the gate. While the key is pressed, the gate is open.

(1) Press the [GATE] key of the front panel and set the oscillation mode to gate controlled oscillation.

(2) Set the gate polarity.

The operation of setting the polarity is the same as that of chapter 3.11.1, (2) “Set the Trigger Polarity.”

When SWEEP is “ON”, in the gate oscillation mode, the sweep starts each time the gate signal becomes “H.”

If the gate signal becomes “L” during the sweep, the sweep is terminated.

With MT-MOD(pulse motor modulation), oscillation by gate control is not possible.

If MT-MOD(pulse motor modulation) is set to “ON”, the oscillation mode is forcibly changed from gate oscillation mode to continuous oscillation mode.

With the burst oscillation, oscillation by gate control is not possible.

When the BURST setting is “ON”, if the [GATE] key is pressed to select gate oscillation as the oscillation mode, the BURST setting is forcibly set to “OFF.” However, the values of setting parameters are saved, including there ON/OFF status, and are reapplied when another oscillation mode is selected.

Caution : In the case of a sine wave or square wave, the waveform and flatness of the amplitude are not guaranteed for frequencies exceeding 1 MHz.

3.12 Save and Recall of Panel Settings (SETUP Menu)

This instrument is equipped with memory to save various panel settings. A maximum of 9 user settings may be saved. When necessary, the saved settings can be recalled and applied to this instrument's panel settings.

The save and recall of panel settings is performed in the menu mode. (Refer to chapter 2.4, "Display Modes, section (3), "Menu Mode.")

Save and recall of this instrument's panel settings can be set in the SETUP menu of the menu mode. This instrument can also be initialized to the factory default settings.

3.12.1 Save of Panel Settings

- (1) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then "the menu display mode" appears.

- (2) Enter the SETUP menu.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) SETUP XXX YYY.

(The "SETUP" characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) SETUP XXX YYY

- (3) Enter the SETUP SAVE menu.

With XXX in the (VFD) SETUP XXX YYY display blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) SETUP SAVE ##→. (The "SAVE" characters are blinking.)

Press the [→] key to cause ## to blink.

(VFD) SETUP SAVE ##→

- (4) Operate the [↑] key, [↓] key or frequency knob and specify the memory number for saving the setting.

(Setting range: 1 to 9)

Pressing the [→] key causes (VFD) SAVE OK? Y→, N← to be displayed.

- (5) Pressing the [→] key causes the save to be executed. After (VFD) SAVE COMPLETE appears, the display returns to the normal display mode.

This instrument's panel settings are now saved in the specified memory.

With (VFD) SAVE OK? Y→, N← displayed, pressing the [←] key causes a return to the SETUP menu without executing a save.

(6) Press the [MENU] key to return to the normal display mode.

3.12.2 Recall of Panel Settings

(1) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then “the menu display mode” appears.

(2) Enter the SETUP menu.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) SETUP XXX YYY.

(The “SETUP” characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) SETUP XXX YYY

(3) Enter the SETUP RECALL menu.

With XXX in the (VFD) SETUP XXX YYY display blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) SETUP RECALL ##→. (The “RECALL” characters are blinking.)

Press the [→] key to cause ## to blink.

(VFD) SETUP RECALL ##→

(4) Operate the [↑] key, [↓] key or frequency knob and specify the memory number of the desired setting to recall.

(Setting range: 1 to 9)

Pressing the [→] key causes (VFD) RECALL OK? Y→, N← to be displayed.

(5) Pressing the [→] key causes the recall to be executed. After (VFD) RECALL COMPLETE appears, the display returns to the normal display mode.

The recalled panel settings are applied to this instrument.

With (VFD) RECALL OK? Y→, N← displayed, pressing the [←] key causes a return to the SETUP menu without executing a recall.

(6) Press the [MENU] key to return to the normal display mode.

Note : Do not turn off the power during doing the RECALL.
When the power is turned off by any chance, FG-281 might be initialized.
After that, FG-281 starts up with the initialized setting.
Set POWER-ON SETUP LAST, FG-281 start up with the previous power shutdown.
See [3.13.2] POWER ON Settings.

3.12.3 Initialization of Panel Settings

- (1) Enter the menu mode.

Pressing the [MENU] key illuminates this key. Then the menu display mode appears.

- (2) Enter the SETUP menu.

Operate the [↑] key, [↓] key or the frequency knob to display (VFD) SETUP XXX YYY.

(The "SETUP" characters are blinking.)

Press the [→] key to cause XXX to blink.

(VFD) SETUP XXX YYY

- (3) With XXX in the (VFD) SETUP XXX YYY display blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) SETUP INIT →. (The "INIT" characters are blinking.)

Pressing the [→] key causes (VFD) INIT OK? Y→, N← to be displayed.

- (4) Pressing the [→] key causes initialization to be executed. After (VFD) INIT COMPLETE appears, the display returns to the normal display mode.

This instrument is initialized to the panel settings.

With (VFD) INIT OK? Y→, N← displayed, pressing the [←] key causes a return to the SETUP menu without executing initialization.

These are the settings of this instrument prior to entering the SETUP menu.

- (5) Press the [MENU] key to return to the normal display mode.

Caution : If panel settings are restored to the initialized settings, the settings will unconditionally return to the initialized state when power is turned ON. To recall the state immediately prior to the last time power was shut OFF, set the "panel settings immediately after POWER ON" in the system menu to "LAST." (Refer to chapter 3.13.2, "POWER ON Settings.")

The initialized settings are listed below.

For information regarding the menu tree, refer to chapter 2.4, "Display Modes," section (3), "Menu Mode."

Front Panel

- Display : Normal display mode
(VFD) 1.00 V 1.0000KHZ
- Output waveform : Sine wave ([sin] key is illuminated)
(1.0000 KHz, peak value: 1.00 V)
- Generation mode : Continuous oscillation mode ([CONT] key is illuminated)

Offset setting

O F S + 0 m V O F F

Duty-factor setting

- Square wave, pulse wave

D U T Y 5 0 . 0 % O F F

- Ramp wave

D U T Y 1 0 0 . 0 % O F F

Initial phase (PHA menu)

P H A O F F + 0 . 0 °

Sweep (SWEEP menu)

S W E E P O F F

(Sweep detail menu)

M	O	D	E			L	I	N	E	A	R				
S	T	A	R	T		1	.	0	0	0	0	k	H	z	
S	T	O	P			1	0	.	0	0	0	k	H	z	
T	I	M	E			1	0	0	m	s					
I	N	T				2	0	0	m	s					
T	Y	P	E			C	O	N	T	I	N	U	E		
M	A	R	K			5	.	0	0	0	0	k	H	z	

Burst (BURST menu)

B	U	R	S	T	O	F	F												
---	---	---	---	---	---	---	---	--	--	--	--	--	--	--	--	--	--	--	--

Burst detail menu

O	N	-	C	O	U	N	T												1	
O	F	F	-	C	O	U	N	T												1

Pulse motor modulation (MT-MOD menu)

M	T	-	M	O	D	O	F	F											
---	---	---	---	---	---	---	---	---	--	--	--	--	--	--	--	--	--	--	--

(Pulse motor modulation detail menu)

M	T	M	O	D	E	L	I	N	-	A									
M	T	L	=	1	.	0	0	0	0	k	H	z							
M	T	H	=	5	.	0	0	0	0	k	H	z							
M	T	U	P					1	0	0	m	s							
M	T	D	O	W	N			1	0	0	m	s							
M	T	1	S	T						1	0	0	0						
M	T	S	T	P						1	0	0	0						
M	T	W	A	I	T			2	.	0	0	s							

Save and recall of panel settings (SETUP menu)

S	E	T	U	P	R	E	C	A	L	L	#	1	→
S	E	T	U	P	I	N	I	T					→
S	E	T	U	P	S	A	V	E			#	1	→

Polarity of external signal input for control (TRIG menu)

T	R	I	G	-	P	O	L	A	R	I	T	Y	+
---	---	---	---	---	---	---	---	---	---	---	---	---	---

System settings (System detail menu)

G	P	I	B	A	D	D	R	E	S	S		4			
G	P	I	B	D	E	L	I	M	C	R	+	L	F		
R	S		R	A	T	E		9	6	0	0	B	P	S	
R	S		L	E	N	G	T	H				8	B	I	T
R	S		P	A	R	I	T	Y				N	O	N	E
R	S		S	T	O	P	-	B	I	T		1	B	I	T
R	S		D	E	L	I	M			C	R	+	L	F	
P	W	-	O	N	S	E	T	U	P		I	N	I		
P	W	-	O	N	O	U	T				L	A	S	T	
B	E	E	P	K	E	Y	P	U	S	H		O	N		
B	E	E	P	E	R	R	O	R				O	N		
L	O	W	-	P	O	W	E	R			6	0	m	i	n
S	Y	N	C	O	U	T	O	N							

3.13 System Settings (SYSTEM Menu)

3.13.1 Remote Control (GP-IB, RS-232)

Remote control of this instrument is possible via the GP-IB or RS-232 interfaces. The various communication-related settings are implemented in the RS menu and GP-IB menu of the SYSTEM menu. For information regarding commands, refer to the “Remote Control” volume.

About the remote mode

When a command is received, this instrument immediately enters the remote mode.

Whichever of the GP-IB or RS-232 interface that is first to be sent a remote command will be enabled. If the remote mode is entered by a remote command via the GP-IB interface, remote commands from the RS-232 interface will not be accepted. On the other hand, if the remote mode is entered by a remote command via the RS-232 interface, remote commands from the GP-IB interface will not be accepted.

To release the remote mode, press the [MENU] key (which operates as the [LOCAL] key).

During the remote mode, key input other than by the [MENU] key, and input by rotation of the AMP knob or frequency knob, are not accepted. (These operations only work to release display-off when the low-power mode is set to ON. For details of the low-power mode, refer to chapter 3.13.4, “Low-power Mode.”)

3.13.1.1 GP-IB Settings

- (1) Press the [MENU] key illuminates this key, and then operate the [↑] key, [↓] key or frequency knob to display (VFD) `SYSTEM MORE→_____`. (The “SYSTEM” characters are blinking.)
- (2) Press the [→] key to enter the SYSTEM detail menu.
(VFD) `GPIB ADDRESS ##` appears. (The “GPIB” characters are blinking.)

Setting the address

- (3) Press the [→] key twice to cause ## to blink, and then operate the [↑] key, [↓] key or frequency knob to set the address.
(Setting range:0 to 30)

For example, to set the address to 6, implement settings such that (VFD) `GPIB ADDRESS 6` appears. After the address has been set, press the [←] key to cause ADDRESS to blink.

Setting the delimiter

- (4) With the “ADDRESS” characters blinking, press the [↓] key or operate the frequency knob to display (VFD) `GPIB DELIM YY`.
Press the [→] key to cause YY to blink. While blinking, operate the [↑] key, [↓] key or frequency knob to set the delimiter.

(Setting range:CR+LF or LF)

(5) Press the [MENU] key to return to the normal display mode.

* Settings become effective as soon as the parameter is changed.

3.13.1.2 RS-232 Settings

(1) Press the [MENU] key illuminates this key, and then operate the [↑] key, [↓] key or frequency knob to display (VFD) SYSTEM MORE→___. (The “SYSTEM” characters are blinking.)

(2) Press the [→] key to enter the SYSTEM detail menu.

(VFD) GPIB ADDRESS ## appears. (The “GPIB” characters are blinking.)

Setting the baud rate

(3) With the “GP-IB” characters blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) RS RATE ####.

Press the [→] key twice to cause #### to blink, and then operate the [↑] key, [↓] key or frequency knob to set the baud rate.

(Setting range:300, 600, 1200, 2400, 4800, 9600, 19200)

For example, to set the baud rate to 9600, implement settings such that (VFD) RS RATE 9600BPS appears.

After the baud rate has been set, press the [←] key to cause RATE to blink.

Setting the data length

(4) With the “RATE” characters blinking, operate the [↓] key or frequency knob to display (VFD) RS LENGTH #BIT. (The “LENGTH” characters are blinking.)

Press the [→] key twice to cause #BIT to blink, and then operate the [↑] key, [↓] key or frequency knob to set the data length.

(Setting range:8 bits , 7 bits)

After the data length has been set, press the [←] key to cause the “LENGTH” characters to blink.

Setting the parity

(5) With the “LENGTH” characters blinking, operate the [↓] key or frequency knob to display (VFD) RS PARITY ###. (The “PARITY” characters are blinking.)

Press the [→] key to cause ##### to blink, and then operate the [↑] key, [↓] key or frequency knob to set the parity.

(Setting range:NONE, ODD, EVEN)

For example, to set the parity to “NONE”, implement settings such that (VFD) RS PARITY NONE appears.

After the parity has been set, press the [←] key to cause PARITY to blink.

Setting the stop bit

(6) With the PARITY characters blinking, operate the [↓] key or frequency knob to display

(VFD) RS STOP-BIT #BIT. (The “STOP-BIT” characters are blinking.)

Press the [→] key to cause #BIT to blink, and then operate the [↑] key, [↓] key or frequency knob to set the stop bit.

(Setting range:1 bit, 2 bits)

After the stop bit has been set, press the [←] key to cause the “STOP-BIT” characters to blink.

(7) Press the [MENU] key to return to the normal display mode.

* Settings become effective as soon as the parameter is changed.

3.13.2 POWER ON Settings

The status of the panel settings and output of this instrument immediately after POWER ON can be set in the PW-ON menu.

(1) Press the [MENU] key illuminates this key, and then operate the [↑] key, [↓] key or frequency knob to display (VFD) SYSTEM MORE→. (The “SYSTEM” characters are blinking.)

(2) Press the [→] key to enter the SYSTEM detail menu.

(VFD) GPIB ADDRESS ## appears. (The “GPIB” characters are blinking.)

Panel settings immediately after POWER ON

(3) With the “GP-IB” characters blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) PW-ON SETUP ###.

Press the [→] key twice to cause ### to blink, and then operate the [↑] key, [↓] key or frequency knob to select the panel settings immediately after POWER ON.

(Setting range:LAST, INI)

If (VFD) **PW-ON SETUP LAST** is set, the next time power is turned on this instrument will start up with the settings that were effective at the time of the previous power shutdown.

If (VFD) **PW-ON SETUP INI** is set, immediately after power is turned on this instrument will startup with the initialized settings.

After the setting is complete, press the [←] key to cause SETUP to blink.

Setting of output immediately after POWER ON

- (4) With the “SETUP” characters blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) **PW-ON OUT ###**.

Press the [→] key to cause **###** to blink, and then operate the [↑] key, [↓] key or frequency knob to set the waveform output state immediate after POWER ON.

(Setting range:LAST, OFF)

If (VFD) **PW-ON OUT LAST** is set, the next time power is turned on the ON/OFF status of the waveform output will be the same as the status immediately prior to the previous power shutdown.

If (VFD) **PW-ON OUT OFF** is set, immediately after power is turned on the ON/OFF status of the waveform output will always be OFF.

- (5) Press the [MENU] key to return to the normal display mode.

3.13.3 Beep Sounds

The key-push sound when a key is pressed and the error beep sound when an error occurs can be set to ON or OFF in the BEEP menu.

- (1) Press the [MENU] key illuminates this key, and then operate the [↑] key, [↓] key or frequency knob to display (VFD) **SYSTEM MORE→**. (The “SYSTEM” characters are blinking.)

- (2) Press the [→] key to enter the SYSTEM detail menu.

(VFD) **GPIB ADDRESS ##** appears. (The “GPIB” characters are blinking.)

Setting the key-push sound

- (3) With the “GP-IB” characters blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) **BEEP KEYPUSH ##**.

Press the [→] key twice to cause **##** to blink, and then operate the [↑] key, [↓] key or frequency knob to set the key-push sound to ON or OFF.

If set to ON, the key-push beep will sound when a key is pressed. If set to OFF, no beep will sound when keys are pressed.

After the setting is complete, press the [←] key to cause KEYPUSH to blink.

Setting the error beep sound

- (4) With the “KEYPUSH” characters blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) BEEP ERROR ##.

Press the [→] key twice to cause ## to blink, and then operate the [↑] key, [↓] key or frequency knob to set the error beep sound to ON or OFF.

If set to ON, an error beep is sounded and a warning message appears when an error occurs. If set to OFF, only the warning message appears; no beep is sounded.

3.13.4 Low-power Mode

This instrument’s low-power mode can be set in the LOW-POWER menu. Here, if there is no key input for a specific time interval, the display turns completely off to conserve power.

- (1) Press the [MENU] key illuminates this key, and then operate the [↑] key, [↓] key or frequency knob to display (VFD) SYSTEM MORE→. (The “SYSTEM” characters are blinking.)

- (2) Press the [→] key to enter the SYSTEM detail menu.

(VFD) GPIB ADDRESS ## appears. (The “GPIB” characters are blinking.)

Setting the time until entering the low-power mode

- (3) With the “GP-IB” characters blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) LOW-POWER ###.

Press the [→] key to cause ## to blink, and then operate the [↑] key, [↓] key or frequency knob to set the time interval.

(Setting range: OFF, 10 min, 20 min, 30 min, 40 min, 50 min, 60 min)

For example, when (VFD) LOW-POWER 30min is set, if there is no key input or knob operation for a time interval of 30 minutes, the display turns completely off and the low-power mode is entered. Pressing any key or rotating the knob will restore the display.

- * Even if in the remote mode, operating a key or the knob will restore the display. However, since the system will remain in the remote mode, the action corresponding to that key operation is not performed.

3.13.5 Synchronous Output (SYNC OUT)

- (1) Press the [MENU] key illuminates this key, and then operate the [↑] key, [↓] key or frequency knob to display (VFD) SYSTEM MORE→. (The “SYSTEM” characters are blinking.)

(2) Press the [→] key to enter the SYSTEM detail menu.

(VFD) GPIB_ADDRESS ## appears. (The “GPIB” characters are blinking.)

Setting of synchronous output

(3) With the “GP-IB” characters blinking, operate the [↑] key, [↓] key or frequency knob to display (VFD) SYNCOUT ##.

Press the [→] key to cause ## to blink, and then operate the [↑] key, [↓] key or frequency knob to set the sync output to ON or OFF.

ON : Signal is output from SYNC OUT of front panel.

OFF: There is no output from SYNC OUT of front panel.

Chapter 4 Specifications

If there is no explanation, the output signals are terminated through 50 Ω and the offset and the duty are set to OFF.

Output waveform

Sine wave, square wave, triangular wave, ramp wave, pulse wave, DC output

Oscillator Frequency

Sine wave, square wave: 10 mHz to 15 MHz

Triangular wave, ramp wave, pulse wave: 10 mHz to 100 kHz

Accuracy: ±50 ppm (See Note)

Note) If the accuracy of frequency in low oscillator frequency is measured, you may not measure the frequency accurately for the reason that the jitters increase due to the principles of the measurement.

Resolution: 10 mHz or 5 digits

Output

No. of channels: 1 channel

Amplitude: when open 100 mVp-p to 20 Vp-p

into 50 Ω termination 50 mVp-p to 10 Vp-p

Setting resolution: Except for DC waveform output: 0.1 mV or 3 digits (50.0 mV to 10.0 V)

For DC waveform output: 1 mV or 3 digits (1 mV to 5.00 V)

DAC resolution: 12 bits

Amplitude accuracy*: (into 50 Ω termination, 1 kHz, offset OFF)

Sine wave ±1%

Pulse wave, triangular wave ±2% (in the case of a pulse wave, pulse duration of H level or L level is 1 μs or more)

Square wave ±3%

Amplitude flatness: (Amplitude of a 1 kHz sine wave is taken as the reference)

Frequency	Sine wave	Square wave	Triangular wave, pulse wave
10 mHz to 100 kHz	±1%	±3%	±3%
100 kHz to 1 MHz	±2%	±5%	---
1 MHz to 15 MHz	±3%	±5%	---

Up to 1 MHz in the trigger, gate and burst modes

For a pulse wave, pulse duration of H level or L level is 1 μs or more

Offset:

Setting range when open $\pm 10\text{ V}$ (where $AC+DC \leq \pm 10.05\text{V}$)
 into $50\ \Omega$ termination $\pm 5\text{ V}$ (where $AC+DC \leq \pm 5.025\text{V}$)
 Setting resolution 3 digits or 1mV
 Setting accuracy (*for DC) $\pm 1\%$ of setting value $\pm 5\text{ mV}$ (into $50\ \Omega$ termination)

* When the output is opened, the setting accuracy increases by 5%.

Output impedance:

$50\ \Omega$ fixed (when OUTPUT ON)

Sine wave spectral purity:

Harmonic distortion (into $50\ \Omega$ termination, the offset set to OFF, this characteristic is a typical value excluding 10Vp-p.)

$F_{out} = 100\text{ kHz}$	-50 dBc or less
$100\text{ kHz} < F_{out} \leq 1\text{ MHz}$	-45 dBc or less
$1\text{ MHz} < F_{out} \leq 15\text{ MHz}$	-35 dBc or less

Spurious (non-harmonic) (into $50\ \Omega$ termination, the offset set to OFF, this characteristic is a typical value excluding 10Vp-p.)

	1 Vp-p and above	Below 1 Vp-p
$100\text{ kHz} < F_{out} \leq 1\text{ MHz}$	-60 dBc or less	-45 dBc or less
$1\text{ MHz} < F_{out} \leq 10\text{ MHz}$	-50 dBc or less	-40 dBc or less
$10\text{ MHz} < F_{out} \leq 15\text{ MHz}$	-40 dBc or less	-40 dBc or less

Total harmonic distortion (DC to 100 kHz)

1 Vp-p and above	0.1% or less
Below 1 Vp-p	0.3% or less

Square wave characteristics :

Square wave (The oscillator frequency is 1MHz or less. into $50\ \Omega$ termination)

RISE/FALL TIME	20 ns or less
Overshoot, ringing, sag	$\pm 2.0\%$

Pulse wave (The pulse duration is $1\ \mu\text{s}$ or more. into $50\ \Omega$ termination)

RISE/FALL TIME	300 ns or less
Overshoot, ringing, sag	$\pm 2.0\%$

Oscillation modes

CONT, TRIG, GATE

- When CH's OUTPUT is set to ON, oscillation is performed as indicated below for each oscillation mode.
- When CH's OUTPUT is set to OFF, oscillation stops immediately.

	SWEEP	*BURST
CONT	○	○
TRIG	○	○
GATE	○	×

*Enabled when SWEEP is OFF; ○ = valid setting, × = invalid setting

	BURST, SWEEP	Action
Continuous (CONT)	OFF	Continuous oscillation
	BURST (Note 1)	Repeated oscillations for the number of cycles set with Burst-on wavenumber as well as stops for the number of cycles set with burst OFF-COUNT
	SWEEP	Repeated sweep according to INT and TIME settings
Triggered (TRIG) (Note 1)	OFF	Trig activated oscillation for only 1 cycle (Initial phase can be set.)
	BURST	Trig activated oscillation for the number of cycles set with burst ON-COUNT
	SWEEP	Trig activated one-time sweep
Gate (GATE) (Note 1)	OFF	Generation for TRIG (GATE) input time
	BURST	Invalid setting
	SWEEP	One-time sweep during TRIG (GATE) input

(Note 1) In the case of a sine wave or square wave, the waveform and amplitude flatness cannot be guaranteed for frequencies above 1 MHz.

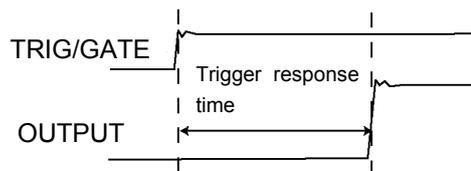
Trig response time

Square wave:

5% of period +350ns or less

Pulse wave:

800 ns + period/16384 or less



TRIG/GATE Input

Input level:

TTL level

Minimum width:

100 ns

Input impedance:

1 kΩ or more

Duty

Resolution:

Square wave 5-15 MHz 40 to 60% (0.1% resolution)

5 MHz or less 20 to 80% (0.1% resolution)

Ramp wave, pulse wave 0% to 100% (0.1% resolution)

Accuracy:

Square wave (pulse duration)	$\pm 1\% \pm 5 \text{ ns}$
Pulse wave (pulse duration)	$\pm 1\%$ (where the pulse duration is $1 \mu\text{s}$ or more)

Phase

Function:

The oscillation start phase and stop phase are set in following modes:

During the trigger, gate modes

When SWEEP is ON and operation after the stop frequency for sweeping is set to oscillation stop

When BURST is ON

Setting range: $\pm 359.9^\circ$

Resolution: 0.1°

Sweep

Function:

- Valid when BURST and MT-MOD(pulse motor modulation) are set OFF except DC.

Type	Linear or log
Sweep direction	UP or DOWN (start frequency, stop frequency setting)
Operation after stop frequency	Maintain stop frequency or stop the oscillation
- The phase which begins and stops oscillation is a phase set by an initial phase.

Rear panel signal outputs:

SWEEP SYNC signal	Outputs a "H" level TTL signal during the transition from the start frequency until the stop frequency.
SWEEP MARKER signal	Outputs a "H" level TTL signal during the transition from the start frequency until the marker frequency.

Modes:

CONT, TRIG, GATE

CONT Repeat time can be set from 1 ms to 500 s (where the setting is at least sweep time + 1 ms).

TRIG Sweep starts at each trigger input. (However, the trigger signals input during the sweep time are ignored.)

GATE Sweep is repeated each time the GATE (TRIG) input goes to a "effective level". (However, if the GATE input goes to a "ineffective level" during the sweep time, the sweep is terminated.)

Sweep range:

Sine wave, square wave	10 mHz to 15 MHz
Triangular wave, ramp wave, pulse wave	10 mHz to 100 kHz

Sweep time:

Setting range: 1 ms to 500 s (See note.)

(Note) If the operation is set to STOP after SWEEP stop frequency, oscillation stops in the immediate vicinity of the initial phase after reaching the stop frequency. The sweep time is below 1 s and linear sweep in the down direction is performed according to the following the expression.

sweep time $\geq 2 /$ stop frequency for sweeping

Burst

Function:

- Valid when the oscillation mode is CONT or TRIG and when SWEEP and MT-MOD(pulse motor modulation) is OFF except DC.

CONT	Generates for the number of cycles set with the burst ON-COUNT, stops for the number of cycles set with the burst OFF-COUNT, and then repeats.
TRIG	Each time there is an input to TRIG, oscillates for the number of cycles set with the burst ON-COUNT, and then stops. (the trigger signals input during oscillation are ignored.)

- Generation starts and stops at the phase set as the initial phase setting.

Burst count settings:

burst ON-COUNT	1 to 65536 cycles
burst OFF-COUNT	1 to 65536 cycles

Setup Memory

Count of the setting: 9 (battery backup)

Data retention time: Approx. 10 years (note 1)

(note 1): Although the life of a battery is ten years about, it is changed according to use environment. Since it is possible that the battery is exhausted when a panel setup is not saved and recalled, please contact your dealer or our distributor.

Sync out

Output level:	L : 0.3 V or less, H : 1.0 V or more (into 50 Ω termination) When the phase of the waveform is 0° , SYNC OUT outputs H level .
ON/OFF:	Switched ON/OFF with system menu

Remote Control

RS-232:	Full remote functions (For details, refer to the Remote Control volume.)
GP-IB:	Full remote functions (For details, refer to the Remote Control volume.)

Power Supply

AC Voltage:	AC100 /220/240V \pm 10%
Power supply frequency:	50/60/400Hz
Power consumption:	Maximum 55 VA
Overvoltage category	II

Dimensions

Approx. 210W \times 99H \times 353L mm (Dimensions view shown on page 84)

Weight

Approx. 4 kg

Environment Conditions

Warm up time:	30 minutes or more
Operating temperature and humidity:	0°C to 40°C, 85% R.H or less (no condensation)
Storage temperature and humidity:	-20°C to 60°C, 90% R.H or less (no condensation)
Pollution degree	2

Accessories Included

Power cord (1), Operation Manual (1)

Forecast deterioration

Fluorescent character display tube	Brightness of the display tube may be reduced by half in about 30,000 hours.
Fan motor	For about 10,000 hours (ambient temperature 25°C) Note) These attach to the articles of consumption, and the exchange becomes a repair for a fee treatment.

Options

Pulse motor control function (factory option)

- This function is effective in BURST OFF or SWEEP OFF.

Waveform	Pulse wave
Mode	Possible during CONT mode or TRIG mode.

OUT pin:

Output voltage	Open collector output withstand voltage: +50 V
Maximum output current	-100 mA
Frequency	DC to 100 kHz

IN1, IN2 pins:

Input voltage	H: 3.15V min, L: 1.35V max
Input impedance	5 k Ω or more
Minimum width	10 μ s

MODES:

LIN-A, LIN-B

Initial frequency (F1):

10 mHz to 100 kHz

Maximum frequency (F2):

10 mHz to 100 kHz (where initial frequency \leq max. frequency)

UP time:

1 ms to 45 s

DOWN time:

1 ms to 45 s

IST count (Note 1):

1 to 16777216 (only during LIN-B mode)

STOP count (Note 2):

1 to 16777216

(Note 1) When $UP \leq 60ms$

$IST\ count > UP \times (F1 \times F2) / 2 + 6ms \times F2$

When $UP > 60ms$

$IST\ count > UP \times (F1 \times F2) / 2 + UP \times F2 \times 0.1$

(Note 2) During LIN-A mode:

When $UP \leq 60ms$

$STOP\ count > UP \times (F1 \times F2) / 2 + 6ms \times F2$

When $UP > 60ms$

$STOP\ count > UP \times (F1 \times F2) / 2 + UP \times F2 \times 0.1$

During LIN-B mode:

When $DOWN \leq 60ms$

$STOP\ count > DOWN \times (F1 \times F2) / 2 + 6ms \times F1$

When $DOWN > 60ms$

$STOP\ count > DOWN \times (F1 \times F2) / 2 + DOWN \times F1 \times 0.1$

Memo

Remote Manual

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1. Remote Control

1.1 General

This instrument can be operated by remote control through an external controller (usually a personal computer) in almost the same way as when you operate it manually using buttons.

Data on measurement results and panel setup can also be transferred by remote control. So you can collect data using a personal computer and configure the automatic measurement system.

There are two ways to operate this instrument by remote control, as described below.

- ① Through the standard RS-232 interface
- ② Through the GP-IB interface

To connect this instrument and a remote personal computer through the GP-IB interface, insert a GP-IB board or card into the expansion slot of the personal computer.

Because up to 15 devices can be connected to one system through the GP-IB interface, it is useful to control this instrument from multiple remote devices.

An RS-232 interface is installed on most personal computers as standard equipment, so you can easily connect this instrument to a remote computer. However, there is a limitation that the RS-232 can control only one unit.

1.2 Restrictions of Remote Control

It is possible to remotely control almost all of the functions provided on this instrument. However, the power switch ON/OFF and various settings about remote control in the SYSTEM menu cannot be controlled remotely.

For details about functions operated through the remote control and control commands, see Chapter 4, Remote control commands.

When operating this instrument through the remote control, the RS-232 interface and GP-IB interface must not be used at the same time. (When using one interface, it is recommended to disconnect other interface cable for safe operation.)

1.3 Remote/Local Control

A state, in which each function of this instrument is remotely controlled by messages sent through the interface, is called "remote mode". On the contrary, a state, in which the instrument is operated by panel key entries, is called "local mode".

In the remote mode, operation of the instrument is controlled by messages sent through the interface. At this time, all panel keys except for the LOCAL ([MENU(ESC)]) key become invalid.

The remote/local mode change procedures of the RS-232 interface may vary from those of the GP-IB interface. For details of RS-232 interface, see section 2.4. For details of GP-IB interface, see section 3.1.5.1.

2. Remote Control Through RS-232 Interface

RS-232 is a serial interface standard for the data exchange process between the computer and connected peripheral device.

This interface standard is defined by the EIA in the U.S.A. and built-into almost all personal computers as a standard input/output interface.

This instrument also has the RS-232 port on its rear panel as a standard accessory.

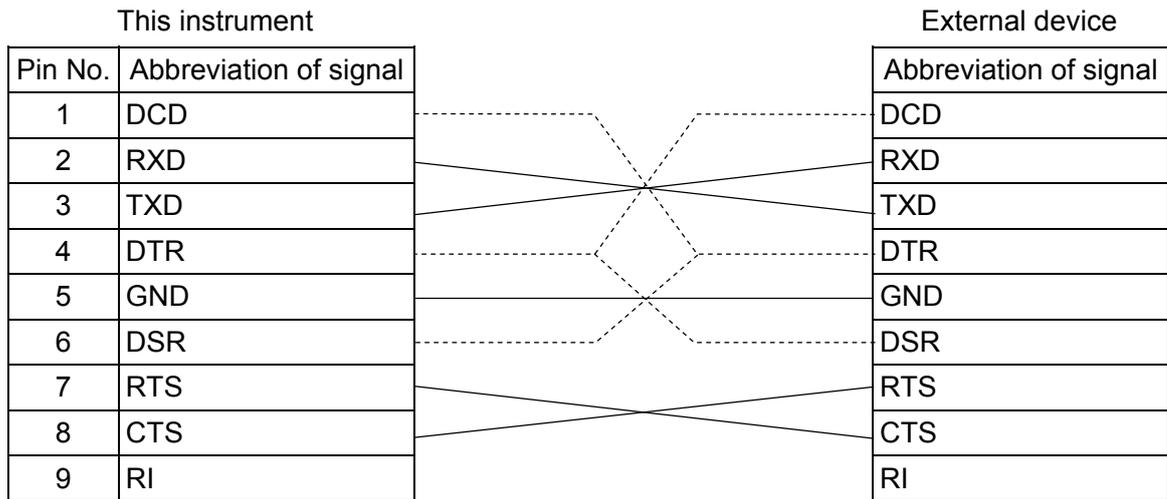
2.1 Connection with External Devices

The RS-232 port of this instrument uses a 9-pin D-SUB connector and inch screws (4-40 UNC).

The following Table shows the signal lines and functions of the RS-232 interface.

Pin No.	Abbreviation of signal	Function	Remarks
1	DCD	Receive carrier detection	Not used in this instrument.
2	RXD	Receive data	
3	TXD	Send data	
4	DTR	Data terminal ready	
5	GND	Signal ground	
6	DSR	Data set ready	Not used in this instrument.
7	RTS	Transmission request	
8	CTS	Transmission enable	
9	RI	Called signal	Not used in this instrument.

To connect this instrument to an external device, use the connection cable having the following wiring. When connecting the instrument to a personal computer, use of cable generally called “cross cable” makes it possible to perform the remote control. However, to ensure safe operation, check the connector shape and pin assignments of both the instrument and computer before connecting to the personal computer, and then prepare a proper cable.



2.2 Communication Mode

This instrument uses the full-duplex communication method. Therefore, the instrument may start sending the response message even while it is receiving the message. Normally, this is not a problem since the data receive buffer is provided. However, if any problem is foreseen, the flow control must be taken into consideration.

This instrument performs the hardware flow control. The instrument does not have other flow controls and the hardware flow control cannot be made invalid.

In this instrument, if the input buffer becomes full, the RTS signal is held off when the messages to the delimiter are received. After the received messages are interpreted and processed, the RTS signal hold off is cancelled.

The size of the input buffer provided in this instrument is 256 bytes. Therefore, care should be taken so that one send message does not exceed 256 bytes.

The size of the output buffer (hereafter referred to as “output queue”) provided in this instrument is 256 bytes. This instrument uses the full-duplex communication method and starts sending the data as soon as the output data is prepared. Therefore, it is not necessary to take care about the size of the output queue. However, the size of the output queue must be considered when performing the flow control. (Do not send the command to this instrument that requests the response exceeding 256 bytes.)

To communicate with an external device, it is absolutely necessary to make the settings of this instrument matched with those of the external device.

Various settings listed below can be made by selecting the RS menu from the SYSTEM menu. (These settings can be made through the remote control.)

(1) Baud rate (RS: Rate)

Any of 300, 600, 1200, 2400, 4800, 9600, 19200(bps) is selected.

(2) Parity bit (RS: Parity)

Any of NONE, EVEN, and ODD is selected.

(3) Stop bit (RS: Stop)

“1” or “2” is selected.

(4) Data Length(RS: Length)

“8” or “7”bit is selected.

(5) Delimiter (RS: DELIM)

“CR+LF” or “LF” is selected.

For details about how to set the external device, see the instruction manual supplied with the external device to perform the setup necessary to communicate with the instrument.

If the baud rate is set at a high speed, the overrun error may occur. If this error occurs frequently, the instrument needs to be operated with the baud rate decreased.

2.3 Synchronization

This instrument can use only hardware flow control for the synchronization in the serial communication with the external device.

To perform the synchronization with the software, it is recommended to create a remote program that the last message unit of the message to be sent to this instrument is used as a query (command that requests the response message from this instrument) and the next message is sent after the response has been received from this instrument.

*OPC? query (see section 4.3.), etc. can be used.

2.4 Remote/Local Control

a. Local mode

In the local mode, operation of the instrument is controlled through panel key operation. The REMOTE LED is off.

This instrument enters the local mode when the power is turned on.

The following two kinds of methods are provided to return the mode from the remote mode to the local mode.

- Turn off the power, and turn it on again.
- Press the LOCAL ([MEN16,U(ESC)]) key.

When the remote mode is returned to the local mode, various settings made in the remote mode, such as measurement condition settings can be used continually.

b. Remote mode

In the remote mode, operation of the instrument is controlled by messages sent through the interface.

All panel key entries except for the LOCAL([MENU(ESC)]) key become invalid.

The REMOTE LED is lit during remote control. If the instrument receives the message from the external device, it then enters the remote mode.

Operation shifts to the remote mode when this instrument receives a message from an external device. When the instrument receives the first byte of the message correctly, it enters the remote mode.

Upon shifting to the remote mode, various settings made in the local mode, such as selection of the output waveform, will continue to be valid.

c. Local lock out mode

This instrument does not support the local lock out mode under the control through the serial interface. If lock out operation is needed, the GP-IB interface must be used.

3. Remote Control Through GP-IB Interface

This chapter describes how to control this instrument through the GP-IB interface.

3.1 Performance

Electrical, mechanical, and functional specifications shall conform to the IEEE Std. 488.1-1987 and JIS C 1901-1987.

The specifications for the commands, formats, and protocols shall conform to the IEEE Std. 488.2-1987.

3.2 Interface Functions

This instrument has the IEEE488.1 subsets about GP-IB as shown in Table 3.2.1.

Table 3.2.1 GP-IB interface functions

SH1	Supports all source handshake functions.
AH1	Supports all acceptor handshake functions.
T6	Specifies and cancels the talker by means of basic talker, serial poll, and MLA.
TE0	Does not support the extended talker function.
L4	Specifies and cancels the listener by means of basic listener and MTA.
LE0	Does not support the extended listener function.
SR1	Supports all the service request functions.
RL1	Supports all the remote local functions.
PP0	Does not support the parallel poll function.
DC1	Supports all device clear functions.
DT1	Supports all device trigger functions.
C0	Does not support the controller function.
E2	Uses the 3-state driver.

3.3 Connections

CAUTION

- Before connecting or disconnecting the cables, always turn off the power to all the devices connected to the GP-IB cable.
- To operate the GP-IB system, turn on all the devices connected to the system bus.

-
- a. Up to 15 GP-IB devices can be connected to one system.
 - b. The total length of the cables used to connect devices in the system is 20m or less and $2m \times$ (the number of devices making up the system) or less.
 - c. The length of each cable used in the system is freely decided by the person in charge of system configuration.
However, if the length of the cable connecting two devices is 4m or more, noise margin shall be taken into consideration.
 - d. A desired cable connection method (star or daisy chain, etc.) can be selected by the user. However, use of the connection that creates the ground loop is not allowed.
 - e. The number of cable stacks on the connector located on the rear panel of the instrument shall be 3 or less due to mechanical strength.
 - f. The connection cable applicable to the IEEE 488.1 or JIS C 1901 standard shall be used. To improve the reliability of the system, it is recommended to use the cable, on which the EMS measures are taken (connector with metallic housing).
 - g. The GP-IB system needs to be operated in an electrically and mechanically good environment.
 - h. Before configuring the system, see clause 6 and appendix J of JIS C 1901-1987.

3.4 Hardware Addressing

Any address ranging from "0" to "30" can be selected for the listener and talker addresses.

The listener and talker (lower five bits of the code set) of the instrument use a common address.

Effective code set for listener address: Column 0 - 3 and Column 14 of code table 2

Effective code set for talker address: Column 0 - 5 and Column 14 of code table 2

The default address set before shipment from the factory is 4.

MLA: Column 4 of code table 2

MTA: Column 4 of code table 4

To set an address, select the GP-IB menu from the SYSTEM menu of UTILITY. A desired address ranging from "0" to "30" is set.

3.5 Response to Interface Message

3.5.1 Remote/Local control

Each function of the instrument can be controlled remotely by messages sent through the interface.

A state, in which the instrument is controlled by messages sent through the interface, is called “remote mode”.

On the contrary, a state, in which the instrument is operated by panel key entries, is called “local mode”.

This instrument has all the remote and local functions defined in the IEEE Std. 488.1-1987 and JIS C 1901-1987.

For details about transition of the remote and local modes, see the section, RL function, in the specification.

a. Local mode

In the local mode, operation of the instrument is controlled through panel key operation. The REMOTE LED is off.

This instrument enters the local mode when the power is turned on.

The following four kinds of methods are provided to return the mode from the remote mode to the local mode (if the GP-IB interface is used).

- Turn off the power, and turn it on again.
- Set the REN line to “false” (electrically high level).
- Press the LOCAL([MENU(ESC)]) key.
- Set this instrument to listener and send the address command GTL.

When the remote mode is returned to the local mode, various settings made in the remote mode, such as FUNCTION settings can be used continually.

b. Remote mode

In the remote mode, operation of the instrument is controlled by messages sent through the GP-IB interface.

All panel key entries except for the LOCAL([MENU(ESC)]) key become invalid.

The REMOTE LED is lit during remote control.

To change the operation mode of the instrument from the local mode to the remote mode, it is necessary to set this instrument to listener (MLA is received) with the REN line set at “true” (electrically low level).

Various settings made in the local mode, such as FUNCTION settings can be used continually.

c. Local lock out mode

This instrument enters the local lock out mode in any of the following cases.

- The universal command LLO is received in the remote mode.
- The instrument enters the remote mode after the universal command LLO has been received.

In the local lockout mode, it is prevented that the mode is returned to the local mode even though the operator presses the LOCAL([MENU(ESC)]) key.

The operation and response except for that the LOCAL([MENU(ESC)]) key input is ignored are the same as those in the remote mode.

To return the instrument from the local lock out mode to the local mode, set the instrument to listener and send the GTL message. However, when the mode is changed to the remote mode again, the instrument enters the local lock out mode even though the LLO command is not received newly.

To cancel the local lock out mode completely (to return to the remote mode), it is necessary to temporarily change the mode to the local mode in any of the following manner.

- Turn off the power, and turn it on again.
- Set the REN line to “false” (electrically high level).

3.5.2 GET (Group Execute Trigger)

When the address command GET is received with the instrument specified as listener, the same operation of the manual trigger (like pressing MAN key in the trigger mode) is started.

With the continuous mode and the gate mode, the command GET is invalid.

When the instrument receives the GET command, the NDAC signal is held to hold the handshake off until the internal process (starting of the manual trigger) is completed.

3.5.3 DCL · SDC

Upon receiving the universal command DCL (Device Clear), this instrument initializes the device function. The same initialization occurs when this instrument is being set to “listener” and receives the address command SDC (Selected Device Clear).

The DCL or SDC message shows that the following initialization is being executed.

- Data input/output is terminated, and the input buffers and the output queue are cleared.

The MAV bit of status byte register are also cleared. (As a result, the MSS bit may be affected by these operations.) See section 4.2.

- The sweep, burst and MT-MOD is set to OFF.

When this instrument receives the DCL or SDC interface message, the NDAC signal is held to hold the handshake off until the internal microprocessor recognizes the signal receive.

3.6 Delimiter

If this instrument sends <Response Message>, the user can select LF or CR LF as a delimiter (<Response Message Terminator>).

EOI is always sent.

The delimiter is set by the GP-IB I/F sub-menu of the system menu. (The setting cannot be made through the remote interface.)

When this instrument receives the program message, it recognizes any of LF, CR LF, or EOI as the delimiter (<Response Message Terminator>). Note that this recognition is independent of the delimiter setting.

3.7 Input and Output Buffers

This instrument supports a 256-byte input buffer.

When this instrument receives a delimiter, it begins to interpret the commands in the buffer even if the input buffer is not full. This instrument does not receive next messages when interpreting or executing received commands. The handshake is held off by the start byte of the new message. Once the interpretation and execution of commands is completed, this instrument resumes its handshake.

When the input buffer becomes full, the handshake is held off. After the command of the message unit in the buffer has been interpreted and executed, the handshake is restarted.

This instrument supports a 256-byte output buffer (output queue).

If multiple query messages are gathered as one message, care should be taken so that the total byte of the response messages does not exceed 256 bytes.

4. Remote Control Commands

4.1 Message Protocol

This section describes the configuration of the program message that this instrument communicates with the controller, as well as the send and receive operations of the instrument.

For details about data format of each command, see the description of relevant command.

Remarks

The elements defined in IEEE 488.2 are given as follows.

<Program Message>

<Character Program Data>

<Decimal Numeric Program Data>

<Suffix Program Data>

<String Program Data>

<Response Message>

<Character Response Data>

<NR1 Numeric Response Data>

<NR2 Numeric Response Data>

<NR3 Numeric Response Data>

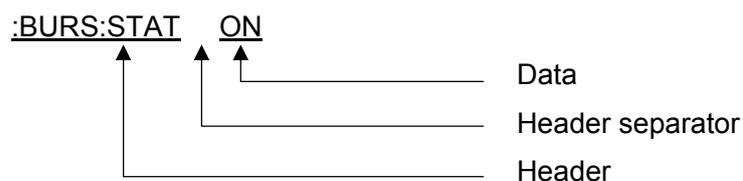
<String Response Data>

<Arbitrary ASCII Response Data>

4.1.1 Message Format

One message unit consists of a header, the data, and a header separator that divides these two major parts.

(Example)



a. Header

The header consists of ASCII characters. The header is composed of one to three mnemonic parts separated by a colon “ : ” and expresses the function or operation of this instrument.

The string in the example above is a command used when setting up this instrument.

When the string is a query that looks for a setting (in which cases, this instrument creates Response Data), the header ends with a question mark “?”.

b. Header separator

This code separates the header and the data. The header separator is a space code (ASCII characters) of at least one character. The <white space> character defined in IEEE 488.2 may be used.

The command without the data part does not need the header separator. Additionally, it is not allowed to omit the data part except for commands without the data part in this instrument.

c. Data

The data is a parameter describing the concrete setting of the function specified in the header. This part may consist of mnemonics (strings) or numerical values.

When multiple parameters are needed, a comma “,” is used to separate respective parameters.

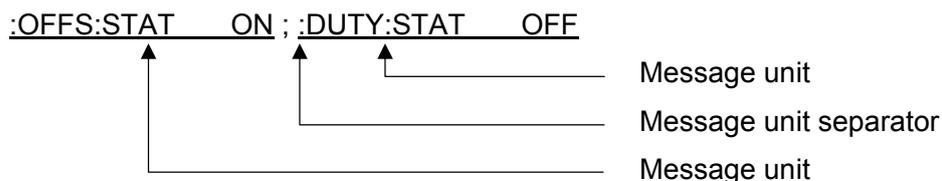
The number of parameters and the configuration depend on the command. For details on the data format, see the description of relevant command.

4.1.2 Multi-commands

Multiple message units can be assembled to configure one message.

Respective message units are separated and connected with a semicolon “;”.

(Example)



The device-specific commands for this instrument are a hierarchical command called <"compound command program header">. For example, the parent command SWE can be combined with subcommands such as CURV, STAR and STOP, to build a header (e.g., :SWE:STAR or :SWE:STOP). When the message units, each of which has a header composed of a common parent command, are combined to build one message, the parent command may be omitted on the second and following message units.

(Example)

:SWE:CURV LOG;;SWE:STAR 1E+3;;SWE:STOP 10E+3

The above message can be written in the following format.

:SWE:CURV LOG;STAR 1E+3;STOP 10E+3

(If the parent command is omitted, care should be taken so that the colon ":" is not put in the header part.)

This function specifies the parent command SWE as the header path.

The header path designation is valid only within the message (until the delimiter). In the next message, the parent command of the start message unit is specified as a header path. Therefore, if the colon ":" for the first character of the header part is omitted at the top of the message, the message is determined as parent command.

(Example)

"DUTY:STAT ON" is interrupted as it equals ":DUTY:STAT ON".

If ": SWE:CURV LOG;STAR 1E+3" is sent as one message, it is interrupted correctly.

However, ":SWE:CURV LOG" is sent with it separated into "STAR 1E+3", it is determined as an error.

(This instrument does not have the STAR parent command.)

If the message is started with a colon ":", this command is determined as a parent command.

The header path is also updated and this command becomes a new header path.

(Example)

:OFFS:STAT ON;VAL 200E-3;;DUTY:STAT ON;VAL 50

 ↑ ↑
 The header path is OFFS. The header path is DUTY.

This instrument does not search for the command along with the command tree. Therefore, if the

message units with different parent commands are determined as one message, a colon ":" is put at the top of the message unit that needs to change the header path.

(Example)

:OFFS:STAT ON;VAL 200E-3;:DUTY:STAT ON;VAL 50

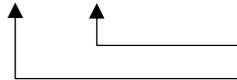
↑
This part cannot be omitted.

The above header path rules do not apply to the common commands (*WAI, *OPC, etc.) defined in IEEE488.2.

The common commands are executed with the header path omitted. However, the header path destination is not broken and the previous header path is valid when interpreting the next message unit after the common command.

(Example)

:DUTY:STAT ON;*WAI;VAL 50



The header path is DUTY.

The common command *WAI is executed correctly.

4.1.3 Query

A message whose header ends with a question mark "?" is called a query. The query is a command used to inquire settings and measurement results. Upon reception of a query, this instrument creates a response message and stores it in the output queue.

When (a part of) the response message remains in the output queue and a new message is received, the current contents of the output queue are cleared, causing a query error (service request event).

Depending on the type of query, the created response message, in which multiple message units are connected by a semicolon ";".

For details of response message format, see the description of relevant query.

4.1.4 Mnemonic

The header mnemonic is formed from ASCII codes for A to Z, 0 to 9, and an underscore "_".

ASCII's A - Z characters are not case-sensitive. In other words, there is no distinction between uppercase and lowercase letters, as they are interpreted in the same way.

Almost all mnemonics are composed of three or four characters, and express the abbreviation of the function name.

In this instrument, the response message unit created corresponding to the query is composed of only data part without header.

The mnemonic of the data part of the response message that the instrument sends is always upper case.

4.1.5 Data Format

a. <Character Program Data> / <Character Response Data>

As with header mnemonics, <Character Program Data> and <Character Response Data> are data are formed from a combination of ASCII codes for A to Z, 0 to 9, and an underscore “_”.

:FUNC SIN;;OFFS:STAT ON

In this example, SIN, which are the parameters for the :FUNC command and ON, which are the parameters for the : OFFS:STAT command respectively, serve as the <Character Program Data>.

Uppercase /small letter can exist together as well as the mnemonic of the header.

This instrument always creates upper case <Character Response Data> for the <Response Message>.

b. <Numeric Program Data> / <Numeric Response Data>

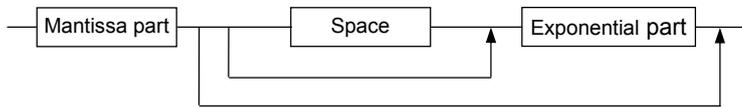
Numerical data can be formatted as an integer (NR1), real number (NR2), or exponent (NR3). If the message is described in the form of ":OFFS:VAL 200E-3", "200E-3" corresponds to the numeric program data. The following numerical values are all interpreted as identical values.

$0.2 = 200E-3 = 2e-1 = 20E-2 = 200e-3$

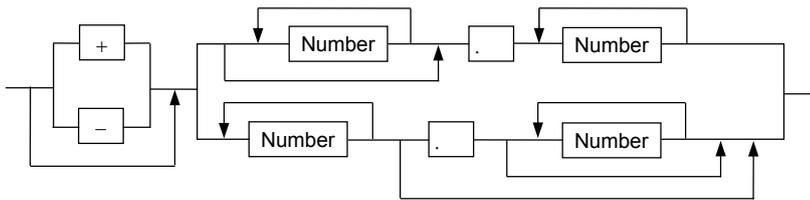
In addition, the suffix showing physical unit "V" or "Hz" is divided into two parts: one is the unit itself (e.g., V (volts) or Hz (hertz)); and the other is the multiplier for the unit, i.e., m (milli) or k (kilo).

This instrument does not support the suffix.

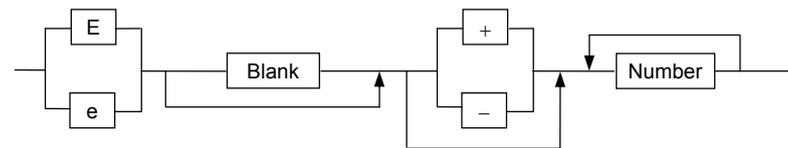
The <Decimal Numeric Program Data> received by this instrument can have any of the formats listed below.



The format of the mantissa part is shown below.



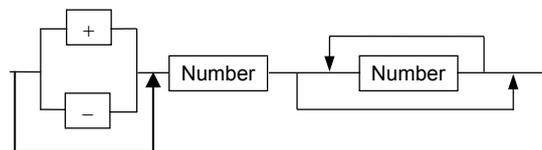
The format of the exponential part is shown below.



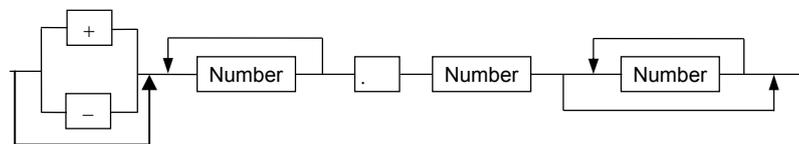
Remarks: Space or blank in the above format includes <white space> defined in IEEE488.2.

<Numeric Response Data> sent by this instrument can have any of the formats listed below.

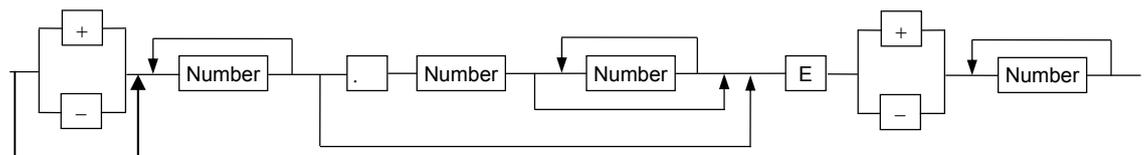
NR1 (Integer) type



NR2 (Real number) type



NR3 (Exponent) type



c. <Arbitrary ASCII Response Data>

This data is response data created by this instrument composed of text characters including ASCII characters not allowed in <Character Response Data> and <Numeric Response Data>.

If a new query message unit exits between the query returning <Arbitrary ASCII Response Data> and delimiter, the response is not created for such query and this state is determined as a query error.

Important : The range of <Decimal Numeric Program Data> that this instrument can interpret is as follows.

Integer and real number format

This format is a numeric character string of 15 characters or less including the sign and decimal point, and the integer part is a maximum of 11 digits. If a numeric character string exceeding this length is received, an execution error will occur and the parameter will be invalid.

Therefore, an absolute value of 100000000000 or more will result in an error.

Exponent format

Mantissa part : This part is a numeric character string of 12 characters or less including the sign and decimal point, and the integer part is a maximum of 11 digits. If a numeric character string exceeding this length is received, an execution error will occur and the parameter will be invalid.

Exponent part : This part is a numeric character string of 3 characters or less excluding the sign, and values of up to ± 15 are valid. If a numeric character string exceeding this value is received, an execution error will occur and the parameter will be invalid.

4.2 Status Report Structure

4.2.1 Service Requests (SRQ)

If an operation is completed or an error occurs, this instrument outputs a service request using a GP-IB interface (i.e., it sets the SRQ line to "L").

While only one SRQ line, which is wired-OR connection, is used on the bus line for the service request, this instrument has multiple service request events. To identify the cause of the service request, the controller must execute a serial poll or read the internal status register of this instrument.

When using a RS-232 interface, the service request or serial polling cannot be used. Therefore, it is necessary to make a program that the controller reads the status register inside the instrument when necessary.

4.2.2 Status Byte Register

This register allows serial polling via the GP-IB system bus or a readout using a *STB? query.

This register is the last stage of the hierarchical status information on this instrument.

This register consists of 8 bits; these bits have the following contents.

(Bit 7)	This instrument does not use bit 7 of the status byte register. Bit 7 is always set to 0.
RQS (bit 6)	When serial polling is executed, a message is returned as bit 6 of the status byte of serial poll response. A message is generated when other bits in the status byte register (ESB, MAV) are masked by the service request enable register, and consequently, the logical sum of all bits is changed from 0 to 1. RQS is cleared when the logical sum described above is changed from 1 to 0, the power is turned on, or serial polling is executed.
MSS (bit 6)	A message is returned as bit 6 of the STB? query response. MSS connects the logical sum of all bits when other bits in the status byte register (ESB, MAV) are masked by the service request enable register.
ESB (bit 5)	A message is returned as bit 5 of the serial poll or STB? query response. This is a summary message connected to the logical sum when the standard event status register is masked by standard event status register.
MAV (bit 4)	A message is returned as bit 4 of the serial poll or STB? query response. This is a summary message connected to the output queue.
(Bit 3)	This instrument does not use bit 3 of the status byte register. Bit 3 is always set to 0.
(Bit 2)	This instrument does not use bit 2 of the status byte register. Bit 2 is always set to 0.
(Bit 1)	This instrument does not use bit 1 of the status byte register. Bit 1 is always set to 0.
(bit 0)	This instrument does not use bit 0 of the status byte register. Bit 0 is always set to 0.

4.2.3 Service Request Enable Register (SRE)

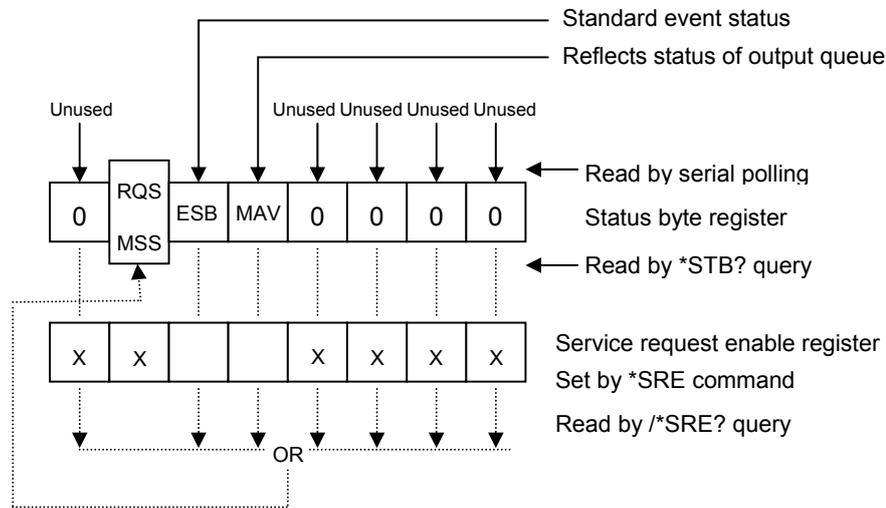
The service request enable register masks the status byte register. A message is returned to the RQS or MSS bit, depending on the result of masking. (Consequently, this register masks the SRQ output of GP-IB.)

The mask pattern is can be set using the *SRE command and read using the *SRE? query.

Whether or not the contents of this register are cleared (to 0) as the power is turned on is set using the *PSC command.

This does not directly affect the GP-IB device clear message and the *CLS command.

Structure of status byte register



4.2.4 Standard Event Status Register

This register can be read using the *ESR? query. After the contents of this register are masked by the standard event status enable register, the logical sum of all bits is connected to the ESB bit of the status byte register.

The contents of this register are cleared (that is, set to 0) when the register is read using the *CLS command or *ESR? query.

This register consists of 8 bits, and each bit has the following contents.

- PON (bit 7) After the power is turned on, this bit is set to 1.
- (Bit 6) This instrument does not use bit 6. Bit 6 is always set to 0.
- CME (bit 5) If a command error occurs, this bit is set to 1.
This indication shows that some error exists in the command syntax.
- EXE (bit 4) If an execution error occurs, this bit is set to 1. This indication shows that the command cannot be executed or could not be completely normally.
- DDE (bit 3) If a device-specific error occurs, this bit is set to 1.
This instrument does not have regulations of the factor which device-specific error occurs. This instrument does not use bit 3. Bit 3 is always set to 0.
- QYE (bit 2) If a query error occurs, this bit is set to 1.
This indication shows that an error occurs when the controller attempts to read the message from this instrument without sending the query command, or the next message is sent before the response message has not been completely read.

The contents of this output queue are cleared (that is, set to 0) when the power is turned on or the device clear command is executed. When the output queue is not empty and a new program message is sent before the controller reads all the data bytes, a query error occurs and the contents of the output queue are also cleared.

When using a RS-232 interface, the serial polling cannot be used. As a result, the MAV bit cannot be utilized efficiently. (As the MAV bit status is read using the *STB? query, the contents of the previous queue are already sent.)

Additionally, this instrument uses the full-duplex communication. Therefore, the instrument receives the program message even though the output queue is not empty (data sending). As a result, the query error is not given.

4.3 Common Commands

This section describes the commands defined in the IEEE Std. 488.2 standard, which are built-into this instrument.

4.3.1 *IDN? Query (identification)

The instrument can be recognized through the system interface using the *IDN? query.

Query syntax

*IDN?

Response message **TEXIO,<model_number>,0,<software_revision><NL>**

The response is composed of four fields separated by a comma. Each field has the following meaning.

Field 1	Manufacturer name	TEXIO
Field 2	Model name	FG-281
Field 3	Serial number	Always set at 0. This instrument does not support this field.
Field 4	Firmware level	ASCII numeric value (unsigned <NR2>)

Remarks

The response data uses four fields to form the <Arbitrary ASCII Response Data> format. Therefore, the *IDN? query must be the last query in <Program Message>.

If this rule is violated, the query error is given and the response message corresponding to the queries after the *IDN? query are not created and sent.

4.3.2 *RST Command (reset)

When this instrument receives the *RST command, it initializes the internal setup to its default values made before shipment from the factory.

At this time, however, the settings about the RS-232 and GP-IB interfaces are not changed.

This command does not initialize remote-related settings (such as the settings about the RS-232 baud rate and GP-IB addresses) directly. However, the remote-related settings are initialized at the next power-on because this command changes the setup settings at power-on to INI (this means that the system every time starts up initializing the internal setup). Consequently, after you issued this command, make sure to return the setup settings at power-on to LAST.

(Refer to Section 4.4.6.2.1.1 "SET/SET? Command/Query".)

Command syntax

*RST

4.3.3 *TST? Query (test)

When this instrument receives the *TST? query, it starts the internal test and stores the response in the output queue showing whether or not the test is completed without error.

Query syntax

*TST?

Response message <result>

<result> shows the test results in the <NR1 Numeric Response Data> format.

If the test is passed, the response message becomes "0".

If the test error occurs, the response message becomes "-330".

4.3.4 *OPC/*OPC? Command/Query (operation complete)

When this instrument receives the *OPC command, it sets the operation completion message (OPC bit) of the standard event status register to “1” after the operation of the devices, which are specified by commands and queries sent before this command, has been completed.

When this instrument receives the *OPC? query, it stores the ASCII character “+1” into the output queue instead of setting of the OPC bit (the ASCII character “1” is not set in the standard event status register).

Command syntax

*OPC

Query syntax

*OPC?

Response message +1

The response message is “+1” in the <NR1 Numeric Response Data> format.

4.3.5 *WAI Command (wait)

When this instrument receives the *WAI command, it holds the execution of subsequent commands and queries until the operation of the devices, which are specified by commands and queries sent before this command, has been completed.

Command syntax

*WAI

4.3.6 *CLS Command (clear status)

The *CLS command clears both the standard event status register and device specific event register of this instrument. Additionally, this command clears the summary bit in the status byte register influenced by the contents of these registers and queues.

Command syntax

*CLS

4.3.7 *ESE/*ESE? Command/Query (event status enable)

The *ESE command is used to set each bit of the standard event status enable register.

It is possible to obtain the current contents of the standard event status enable register using the *ESE? query.

Command syntax

*ESE <mask_arg>

<mask_arg> is a parameter to set the standard event status enable register and is a numeric value ranging from “0” to “255” in the <Decimal Numeric Program Data> format.

One meaning is assigned to each bit of the standard event status register. When a bit corresponding to the enable register is set to “1”, relevant event becomes enabled (this affects the status byte register). On the contrary, when a bit is set to “0”, relevant event becomes disabled (this does not affect the status byte).

Query syntax

*ESE?

Response message <mask>

<mask> is a numeric value ranging from “0” to “181” in the <NR1 Numeric Response Data> format that the setting of each bit in the standard event status enable register is weighted by exponentiation of “2”.

Remarks Structure of standard event status enable register

Bit	Weighting	Meaning
7	128	PON-Power ON
6	64	(URQ)-Not used in this instrument.
5	32	CME-Command error
4	16	EXE-Execution error
3	8	DDE-Device specific error – Not use in this instrument.
2	4	QYE-Query error
1	2	(RQC)-Not used in this instrument.
0	1	OPC-Operation complete

This instrument does not use bit 1, 3 and 6. Therefore, even though all bits of this register are set at “1”, the maximum value of the response message becomes 181 (=255 – 64– 8 – 2).

4.3.8 *ESR? Query (event status register)

It is possible to obtain the current contents of the standard event status register using the *ESR? query.

When the contents of the event status register are read, they are then cleared.

Query syntax

*ESR?

Response message <status>

<status> is a numeric value ranging from “0” to “181” in the <NR1 Numeric Response Data> format that the value of each bit in the standard event status register is weighted by exponentiation of “2”.

Remarks Structure of standard event status register

Bit	Weighting	Meaning
7	128	PON-Power ON
6	64	(URQ)-Not used in this instrument.
5	32	CME-Command error
4	16	EXE-Execution error
3	8	DDE-Device specific error-Not used in this instrument.
2	4	QYE-Query error
1	2	(RQC)-Not used in this instrument.
0	1	OPC-Operation complete

This instrument does not use bit 1, 3 and 6. Therefore, even though all bits of this register are set at “1”, the maximum value of the response message becomes 181 (=255 – 64 – 8 – 2).

4.3.9 *PSC/*PSC? Command/Query (power on status clear)

The *PSC command controls the automatic clear of the service request enable register, standard event status enable register, and hardware-specific event enable register groups at power on.

The values set by the *PSC command can be obtained using the *PSC? query. If the value of the response data is “0”, the status of each enable register is retained even while the power is off. If the value of the response data is “1”, this shows that each of above enable registers is cleared when the power is turned on again.

Command syntax

*PSC <psc_flag_arg>

<psc_flag_arg> is a parameter for setting the power-on status clear flag and is a numeric value in the <Decimal Numeric Program Data> format.

When set to “0”, the status of each enable register is retained even while the power is turned off.

When <psc_flag_arg> is set at “1” (value other than “0”), each enable register is cleared when the power is turned on again.

Query syntax

*PSC?

Response message <psc_flag>

<psc_flag> is a numeric value showing the contents of the power on status clear flag and is normally “0” or “1” in the <NR1 Numeric Response Data> format.

4.3.10 *SRE/*SRE? Command/Query (service request enable)

The *SRE command is used to set each bit of the service request enable register.

It is possible to obtain the current contents of the service request enable register using the *SRE? query.

Command syntax

*SRE <mask_arg>

<mask_arg> is a parameter to set the service request enable register and is a numeric value ranging from “0” to “255” in the <Decimal Numeric Program Data> format.

One meaning is assigned to each bit of the service request enable register. When a bit corresponding to the enable register is set to “1”, relevant event becomes enabled (this causes the service request to occur). On the contrary, when a bit is set to “0”, relevant event becomes disabled (this does not cause the service request to occur).

Query syntax

*SRE?

Response message <mask>

<mask> is a Numeric ranging from “0” to “49” in the <NR1 Numeric Response Data> format that the setting of each bit in the service request enable register is weighted by exponentiation of “2”.

Remarks Structure of service request enable register

Bit	Weighting	Meaning
7	128	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
6	64	RQS/MSS-Request service/message summery status
5	32	ESB-Event status
4	16	MAV-Message available
3	8	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
2	4	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
1	2	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
0	1	XXX-Since this instrument does not use this bit, the bit is always set at “0”.

The response data is created assuming that bit 6 is always “0” regardless of the designation of the *SRE command parameter. However, note that this bit is always determined as enable during actual operation.

Since the instrument does not use bits 0-3 and 7, and the response of bit 6 is “0”, the maximum value of the response message becomes 48 (=32 + 16) even though all bits of this register are set at “1”.

4.3.11 *STB? Query (status byte)

The status byte and master summary status bit (MSS message) can be read using the *STB? query.

Query syntax

*STB?

Response message <status>

<status> is a numeric value ranging from “0” to “112” in the <NR1 Numeric Response Data> format that the value of each bit in the status byte register is weighted by exponentiation of “2”.

Remarks Structure of status byte register

Bit	Weighting	Meaning
7	128	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
6	64	RQS/MSS-Request service/message summary status
5	32	ESB-Event status
4	16	MAV-Message available
3	8	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
2	4	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
1	2	XXX-Since this instrument does not use this bit, the bit is always set at “0”.
0	1	XXX-Since this instrument does not use this bit, the bit is always set at “0”.

This instrument does not use bit 0-3 and 7. Therefore, even though all bits of this register are set at “1”, the maximum value of the response message becomes 112 (= 64 + 32 + 16).

When the contents of the status byte register are read using the *STB? query, the MSS message is used for bit 6 instead of RQS in conformity with the IEEE488.2 standard. Other bits become the same values read by the serial polling.

The MSS message is obtained by logical OR of all bits except for bit 6 after the contents of the status byte register are masked (logical AND) according to the contents of the service request enable register.

The RQS message is basically retained in the status byte register until the serial polling is performed. On the contrary, the MSS message affects the internal status of the device at real-time.

4.3.12 *TRG Command (trigger)

When this instrument receives the *TRG command, it starts the manual trigger.

With the continuous mode and the gate mode, the command TRG is invalid with the same as GET.

Command syntax

*TRG

4.3.13 *RCL Command (recall)

The setup file saved in the internal memory of this instrument can be recalled using the *RCL <register_number_arg> command.

Command syntax

*RCL <register_number_arg>

<register_number_arg> is used to specify a parameter for setting of the file No. to be recalled and is a numeric value ranging from “1” to “9” in the <Decimal Numeric Program Data> format.

A numeric value corresponding to the register No. to be selected for the save/recall operation of the local operation is specified.

Remarks

If <register_number_arg> is omitted, the command error is given.

If an integer value that <register_number_arg> is rounded is below 1 and 10 or more, the execution error is given and the recall operation is not performed.

4.3.14 *SAV Command (save)

The setup information is saved into the internal memory of this instrument using the *SAV <register_number_arg> command.

Command syntax

*SAV <register_number_arg>

<register_number_arg> is used to specify a parameter for setting of the file No. to be saved and is a numeric value ranging from “1” to “9” in the <Decimal Numeric Program Data> format.

A numeric value corresponding to the register No. to be selected for the save/recall operation of the local operation is specified.

Remarks

If an integer value that <register_number_arg> is rounded is below 1 and 10 or more, the execution error is given and the save operation is not performed.

4.4 Device-specific Commands

This chapter describes the device-specific commands for this instrument. Common commands for this instrument are described in section 4.3.

4.4.1 Basic Setting Related Commands

4.4.1.1 GMOD/GMOD? Command/Query (oscillation mode)

The oscillation mode is specified using the :GMOD <oscillation mode type> command.

The current oscillation mode can be read using the :GMOD? query.

Command syntax

:GMOD <oscillation mode type>

<oscillation mode type>, a parameter for specifying the oscillation mode, is CONT, GATE, or TRIG in the <Character Program Data> format.

The oscillation modes specified by each mnemonic are as follows:

CONT Continuous oscillation mode

GATE Gate oscillation mode

TRIG Trigger oscillation mode

Remarks

The burst function cannot be used in the gate oscillation mode. If the gate oscillation mode is selected while the burst function is ON, an execution error is posted, and after the burst function is switched OFF, the gate mode is entered. Conversely, while the gate oscillation mode is selected, the burst function cannot be switched ON.

The pulse motor modulation function (optional) cannot be used in the gate oscillation mode. If the gate oscillation mode is specified while the pulse motor modulation function is ON, an execution error is posted, and after the pulse motor modulation function is switched OFF, the gate mode is entered. Conversely, if the pulse motor modulation function is switched ON while the gate oscillation mode is selected, the oscillation mode will change to the continuous oscillation mode.

Query syntax

:GMOD?

Response message <oscillation mode>

<oscillation mode> indicates the current oscillation mode and is CONT, GATE, or TRIG mnemonic in the <Character Response Data> format.

4.4.1.2 MGAT/MGAT? Command/Query (manual gate)

The manual gate open or close setting is specified using the :MGAT <manual gate setting> command.

The current manual gate open/close setting can be read using the :MGAT? query.

Command syntax

:MGAT <manual gate setting>

<manual gate setting>, a parameter for specifying the manual gate open/close setting, is either OPEN or CLOS in the <Character Program Data> format.

The manual gate settings specified by each mnemonic are as follows:

OPEN Open state

CLOS Closed state

Remarks

The MGAT command is valid only when the oscillation mode is set to the gate oscillation mode. In all other cases, an execution error will occur.

Query syntax

:MGAT?

Response message <manual gate>

<manual gate> indicates the current manual gate setting and is OPEN, CLOS, or DIS mnemonic in the <Character Response Data> format.

Remarks

The MGAT? query is valid only when the oscillation mode is set to the gate oscillation mode. In all other cases, the response will be DIS and an execution error will be posted.

4.4.1.3 AMPL/AMPL? Command/Query (waveform amplitude and DC voltage value)

The amplitude is specified using the :AMPL <amplitude value setting> command.

The current value of the amplitude setting can be read using the :AMPL? query.

Command syntax

:AMPL <amplitude value setting>

<amplitude value setting>, a parameter for setting the amplitude, is a numeric value in the <Decimal Numeric Program Data> format.

The range of settings is as follows.

When output waveform is DC : -5.00 V to +5.00 V

mantissa part is 3 digits max., the minimum setting
resolution is 1 mV

When output waveform is non-DC, and

When offset is OFF : 50.0 mV to 10.0 V

When offset is ON : $|\text{offset voltage}| + \text{amplitude}/2 \leq 5.025\text{V}$

(numeric values are set assuming a 50 Ω termination)

When values exceed this range, they are pushed back within the valid setting range (an execution error is posted).

Valid numbers have a maximum mantissa part of 3 digits (same as in the case of local), the 4th digit onward will be rounded off.

Suffixes are not accepted. Use only numeric parameters in units of V.

Remarks

The amplitude setting and offset setting have the same priority level. The AMPL command can only set values within the limited range already set by the offset value. Conversely, the OFFS:VAL command can only set offset values within the limited range already set by the output amplitude value.

When the output waveform is non-DC, the sign of the mantissa part is ignored. Even for negative numbers, the amplitude is set by taking the absolute value. Negative potentials can be set only when the output waveform is DC.

When switching the output waveform from DC to non-DC, the amplitude value is determined to be twice the absolute value of the set value. At this time, if the amplitude value is less than 50 mV, it is pinned to 50 mV.

When switching the output waveform from non-DC to DC, the amplitude value is determined to be one half of the set value.

Query syntax

:AMPL?

Response message <amplitude value>

<amplitude value> indicates the current value of the amplitude setting and is a numeric value in <NR3 Numeric Response Data> format.

The response data has a mantissa part of 3 digits (or less) and an exponent part that is a multiple of 3 (basically corresponds to the display).

4.4.1.4 FREQ/FREQ? Command/Query (output frequency)

The frequency is specified using the :FREQ <frequency setting> command.

The current value of the frequency setting can be read using the :FREQ? query

Command syntax

:FREQ <frequency setting>

<frequency setting>, a parameter for setting the frequency, is a numeric value in the <Decimal Numeric Program Data> format.

A maximum of 5 digits is valid for the mantissa part, and the minimum setting resolution is 10 mHz. The value of one digit that exceeds the allowable setting resolution is rounded off.

Upper limit values differ depending on the output waveform setting.

Sine wave, Square wave : 10 mHz to 15.000 MHz

Ramp wave, Pulse wave, Triangular wave : 10 mHz to 100 kHz

DC : Frequency setting invalid

If the value is out of the limits, an execution error is generated and the setting is pushed back within the limits.

Suffixes are not accepted. Use only numeric parameters in units of Hz.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored. The frequency setting is invalid when the output waveform is DC, the sweep function is ON, or the pulse motor modulation is ON. If a FREQ command is received while in the DC, sweep ON or pulse motor modulation ON states, an execution error is generated and the parameter ignored.

Query syntax

:FREQ?

Response message <frequency>

<frequency> indicates the current value of the frequency setting and is a numeric value in the <NR3 Numeric Response Data> format.

The exponent part of the response data is a multiple of 3 (basically corresponds to the display).

Remarks

The frequency setting is invalid when the output waveform is DC, the sweep function is ON, or the pulse motor modulation is ON. If a FREQ? query is received while in the DC, sweep ON or pulse motor modulation ON states, an execution error is generated and a value of 9.91E+37 returned.

4.4.1.5 FUNC/FUNC? Command/Query (output waveform)

The output waveform is specified using the :FUNC <output waveform setting> command.

The current value of the output waveform setting can be read using the :FUNC? query.

Command syntax

:FUNC <output waveform setting>

<output waveform setting>, a parameter for setting the output waveform, is SINE, SIN, TRI, SQU, PULS, RAMP or DC in the <Character Program Data> format.

The waveforms specified by each mnemonic are as follows:

SINE or SIN	Sine wave
TRI	Triangular wave
SQU	Square wave
PULS	Pulse wave
RAMP	Ramp wave
DC	DC (direct current)

Remarks

In response to switching of the output waveform, various limitations are generated.

The upper limit of the oscillation frequency differs depending on the waveform. If the frequency setting value exceeds the upper limit after the output waveform is switched, the frequency setting is pushed back to the allowable upper limit value for the waveform. When the frequency setting is pushed back, an execution error is posted. Frequency settings related to the sweep function are similar.

Setting of the duty ratio is only valid with a square wave, pulse wave or ramp wave. Setting of the duty ratio is invalid for all other waveforms. In this case, the duty function is OFF and waveform switching has priority.

When the waveform is switched between DC and another waveform, the amplitude value setting is converted to twice or a half of its value.

When DC is selected, the sweep, burst, duty, offset, initial phase setting, and modulation functions become invalid. In this case, DC waveform selection has priority.

The parameter SIN is actually SINE, but the abbreviation SIN is customarily used. With this instrument, both SIN and SINE can be used to specify a sine wave.

Query syntax

:FUNC?

Response message < waveform type setting >

< waveform type setting > indicates the current output waveform setting, and is SIN, TRI, SQU, PULS, RAMP or DC mnemonic in the <Character Response Data> format.

4.4.1.6 OFFS Related Commands/Queries (offset)

4.4.1.6.1 STAT/STAT? Command/Query (offset function)

ON/OFF of the offset function is specified using the :OFFS:STAT <status setting> command.

The current ON/OFF status of the offset function can be read using the :OFFS:STAT? query.

Command syntax

:OFFS:STAT <status setting>

<status setting>, a parameter for specifying ON/OFF of the offset function, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the offset function is OFF, otherwise it is ON.

Remarks

If an :OFFS:STAT ON command is attempted while the waveform type is DC, an execution error will be generated and the offset function will remain OFF.

Query syntax

:OFFS:STAT?

Response message <status>

<status> indicates the current ON/OFF status of the offset function and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

Remarks

In response to receipt of an :OFFS:STAT? query while the output waveform is DC, an execution error is generated and then a value of 0 (i.e. OFF) is returned unconditionally.

4.4.1.6.2 VAL/VAL? Command/Query (offset value)

The offset potential is specified using the :OFFS:VAL <offset value setting> command.

The current value of the offset potential setting can be read using the :OFFS:VAL? query.

Command syntax

:OFFS:VAL <offset value setting>

<offset value setting>, a parameter for specifying the offset voltage, is a numeric value in the <Decimal Numeric Program Data> format. Numeric values are set assuming a 50 Ω termination.

The valid setting range is $|\text{offset voltage}| + \text{amplitude} / 2 \leq 5.025 \text{ V}$.

When the value is outside the limit, an execution error is generated and, giving priority to the amplitude setting value, the offset setting value is rounded to a value within the limit.

The setting resolution is 3 digits of the mantissa part or 1 mV, and the value of the next digit is rounded off.

Suffixes are not accepted. Use only numeric parameters in units of V.

Remarks

If an :OFFS:VAL command is implemented while the :OFFS:STAT setting is OFF, regardless of the parameter value, an execution error will be generated and the parameter discarded.

When :OFFS:VAL=0, even if :OFFS:STAT=ON, the [OFS] key is turned off.

If an :OFFS:VAL command is attempted while the output waveform is DC, an execution error will be generated and the setting value will not change.

Query syntax

:OFFS:VAL?

Response message <offset value>

<offset value> indicates the current offset voltage and is a numeric value in the <NR3 Numeric Response Data> format.

The response data has a mantissa part of 3 digits (or less) and an exponent part that is a multiple of 3 (basically corresponds to the display).

Remarks

In response to receipt of an :OFFS:VAL? query while in the :OFFS:STAT=OFF state, an execution error is posted and an internal value is returned.

In response to receipt of an :OFFS:VAL? query while the output waveform is DC, an execution error is posted and then a value of 9.91E+37 is returned unconditionally.

4.4.1.7 Duty Related Commands/Queries (duty)

4.4.1.7.1 STAT/STAT? Command/Query (duty function)

ON/OFF of the duty function is specified using the :DUTY:STAT <status setting> command.

The current ON/OFF status of the duty function can be read using the :DUTY:STAT? query.

Command syntax

:DUTY:STAT <status setting>

<status setting>, a parameter for specifying ON/OFF of the duty function, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the duty function is OFF, otherwise it is ON.

Remarks

If a DUTY:STAT ON command is received while the output waveform is a type for which the duty function cannot be turned ON, an execution error occurs. Internal settings are not changed.

Query syntax

:DUTY:STAT?

Response message <mode>

<status> indicates the current ON/OFF status of the duty function and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

In response to receipt of a DUTY:STAT? query while the output waveform is a type for which the duty function cannot be ON (sine wave, triangular wave, DC), an execution error is posted and then a value of 0 (i.e. OFF) is returned unconditionally.

4.4.1.7.2 VAL/VAL? Command/Query (duty ratio)

The duty ratio is set using the :DUTY:VAL <duty ratio setting> command.

The current value of the duty ratio setting can be read using the :DUTY:VAL? query.

Command syntax

:DUTY:VAL <duty ratio setting>

<duty ratio setting>, a parameter for setting the duty ratio, is a numeric value in the <Decimal Numeric Program Data> format.

The setting resolution is 0.1%. After the parameter is converted into a real number format, the digit at the 2nd decimal place is rounded off. The valid setting range differs depending on the output waveform. Moreover, in the case of a square wave, the valid setting range differs depending on the frequency. If the value is outside the limits, an execution error is generated and the setting value is rounded to a value within the limits. Suffixes are not accepted. Use only numeric parameters in units of %.

Remarks

Negative numbers are not accepted as parameters. They will cause an execution error to occur and the parameter to be ignored. If a command to set the duty ratio is received while the output waveform is a type for which the duty function cannot be turned ON, an execution error is generated and the parameter ignored.

If the :DUTY:VAL command is implemented while the :DUTY:STAT setting is OFF, regardless of the parameter value, an execution error will be generated and the parameter ignored.

Caution

Separate duty ratio setting values are internally stored for each output waveform. When switching the output waveform, be aware that the duty ratio setting will also change.

Query syntax

:DUTY:VAL?

Response message <duty ratio>

<duty ratio> indicates the value of the current duty ratio setting and is a numeric value in the <NR2 Numeric Response Data> format.

Remarks

Response data is in the format of XXX.X. The number of digits above the decimal point varies depending on the setting value.

When DUTY:STAT=OFF, an execution error is posted and an internal value is returned.

In the case of an output waveform type for which duty function cannot be ON, an execution error is posted and -1.0 is returned.

4.4.1.8 OUTP/OUTP? Command/Query (waveform output)

ON/OFF of the waveform output is specified using the :OUTP <status setting> command.

The current ON/OFF status of the waveform output can be read using the :OUTP? query.

Command syntax

:OUTP <status setting>

<status setting>, a parameter for specifying ON/OFF of the waveform output, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, waveform output is OFF, otherwise it is ON.

Query syntax

:OUTP?

Response message <status>

<status> indicates the current ON/OFF status of the waveform output and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

4.4.2 Initial Phase Setting Commands

4.4.2.1 STAT Command/Query (initial phase setting function)

ON/OFF of the initial phase setting function is specified using the :PHAS:STAT <status setting> command.

The current ON/OFF status of the initial phase setting function can be read using the :PHAS:STAT? query.

Command syntax

:PHAS:STAT <status setting>

<status setting>, a parameter for specifying ON/OFF of the initial phase setting function, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the initial phase setting function is OFF, otherwise it is ON.

Remarks

When :PHAS:STAT ON is set, corresponding to the :PHAS:VAL setting value, internal data for signal oscillation is recalculated.

If :PHAS:STAT ON is attempted while the output waveform is DC, an execution error occurs and setting values of the initial phase setting function do not change.

Query syntax

:PHAS:STAT?

Response message <status>

<status> indicates the current setting status of the initial phase setting function and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

In response to receipt of an :PHAS:STAT? query while the output waveform is DC, an execution error is posted and then a value of 0 (i.e. OFF) is returned unconditionally.

4.4.2.2 VAL Command/Query (initial phase value)

The initial phase value is specified using the :PHAS:VAL <initial phase value setting> command.

The current value of the initial phase setting can be read using the :PHAS:VAL? query.

Command syntax

:PHAS:VAL <initial phase value setting>

<initial phase value setting>, a parameter for specifying the initial phase value, is a numeric value in the <Decimal Numeric Program Data> format.

The setting range is from -359.9 to +359.9.

The setting resolution is up to the first decimal place, and the digit at the next decimal place is rounded off.

If the value is outside the range, an execution error is generated and the setting value is rounded to a value within the range.

Suffixes are not accepted. Use only numeric parameters in units of ° (degrees).

Remarks

If setting by :PHAS:VAL is attempted while the output waveform is DC, an execution error occurs and the setting value is not changed.

Caution

When a VAL subcommand is received, after :PHAS:STAT is set OFF, the internal setting value is overwritten. After specifying the initial phase value with the VAL subcommand, set :PHAS:STAT to ON.

Query syntax

:PHAS:VAL?

Response message <initial phase value>

<initial phase value> indicates the current value of the initial phase setting and is a numeric value in the <NR2 Numeric Response Data> format.

The response data is a signed numeric value up to the first decimal place.

Remarks

In response to receipt of a :PHAS:VAL? query while the output waveform is DC, an execution error is posted and then a value of +0.0 is returned unconditionally.

4.4.3 Sweep Related Commands

When the CURV subcommand/query and subsequent :SWE:xxxx commands (See section 4.4.3.2 and the following sections) are received, each subcommand is answered after the sweep is set OFF.

Various device internal settings and recalculations, for implementation of the sweep function according to the settings made by subcommands, are to be performed while SWE:STAT ON is specified.

After all settings by subcommand are complete, specify SWE:STAT ON.

4.4.3.1 STAT/STAT? Command/Query (sweep function)

ON/OFF of the sweep function is specified using the :SWE:STAT <status setting> command.

The current ON/OFF status of the sweep function can be read using the :SWE:STAT? query.

Command syntax

:SWE:STAT <status setting>

<status setting>, a parameter for specifying ON/OFF of the sweep function, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the sweep function is OFF, otherwise it is ON.

Remarks

If a command to set the sweep function to ON arrives while the burst function or pulse motor modulation function (optional) is ON, the burst or other function is turned OFF, an execution error is posted, and the sweep function is set ON.

The sweep function is invalid when the output waveform is DC. If a command to set :SWE:STAT to ON is attempted while the waveform type is selected as DC, an execution error will be posted and the parameter ignored.

Query syntax

:SWE:STAT?

Response message <status>

<status> indicates the current ON/OFF status of the sweep function and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

Remarks

The sweep function is invalid when the output waveform is DC. If a :SWE:STAT? query is received when the waveform type is selected as DC, an execution error is generated and 0 (indicating OFF) is returned.

4.4.3.2 CURV/CURV? Command/Query (sweep mode)

Switching between the linear sweep and the logarithmic sweep is performed, using the :SWE:CURV <sweep mode setting> command, after the sweep function is set OFF.

The current sweep mode setting can be read using the :SWE:CURV? query.

Command syntax

:SWE:CURV <sweep mode setting>

<sweep mode setting>, a parameter for specifying the sweep mode, is LIN or LOG in the <Character Program Data> format.

The sweep modes specified by each mnemonic are as follows:

LIN	Linear sweep
LOG	Logarithmic sweep

Remarks

The sweep function is invalid when the output waveform is DC. If a SWE:CURV setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Query syntax

:SWE:CURV?

Response message <sweep mode>

<sweep mode> indicates the current sweep mode setting, and is LIN, LOG, or DIS mnemonic in the <Character Response Data> format.

Remarks

The sweep function is invalid when the output waveform is DC. If a SWE:CURV? query is received while the waveform type is selected as DC, an execution error is posted and the response is DIS.

4.4.3.3 STAR/STAR? Command/Query (start frequency)

The sweep start frequency is specified, using the :SWE:STAR <start frequency setting> command, after the sweep function is set OFF.

The current value of the sweep start frequency setting can be read using the :SWE:STAR? query.

Command syntax

:SWE:STAR <start frequency setting>

<start frequency setting>, a parameter used to specify the start frequency setting, is a numeric value in the <Decimal Numeric Program Data> format.

A maximum of 5 digits is valid for the mantissa part, and the minimum setting resolution is 10 mHz. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Upper limit values differ depending on the waveform type setting.

Sine wave, Square wave : 10 mHz to 15.000 MHz

Ramp wave, Pulse wave, Triangular wave : 10 mHz to 100 kHz

If the parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

Suffixes are not accepted. Use only numeric parameters in units of Hz.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored. The sweep function is invalid when the waveform type is DC. If a SWE:STAR setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Caution

Depending on the relative sizes of the value of the sweep start frequency setting and the value of the sweep stop frequency setting, it is determined whether the sweep becomes a down-sweep or an up-sweep.

Query syntax

:SWE:STAR?

Response message <start frequency>

<start frequency> indicates the current sweep start frequency and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

The sweep function is invalid when the output waveform is DC. If a SWE:STAR? query is received while the waveform type is selected as DC, an execution error is generated and the response is a value of 9.91E+37.

4.4.3.4 STOP/STOP? Command/Query (stop frequency)

The sweep stop frequency is specified, using the :SWE:STOP <stop frequency setting> command, after the sweep function is set OFF.

The current value of the sweep stop frequency setting can be read using the :SWE:STOP? query.

Command syntax

:SWE:STOP <stop frequency setting>

<stop frequency setting>, a parameter used for setting the sweep stop frequency, is a numeric value in the <Decimal Numeric Program Data> format.

A maximum of 5 digits is valid for the mantissa part, and the minimum setting resolution is 10 mHz. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Upper limit values differ depending on the waveform type setting.

Sine wave, Square wave : 10 mHz to 15.000 MHz

Ramp wave, Pulse wave, Triangular wave : 10 mHz to 100 kHz

If the parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

Suffixes are not accepted. Use only numeric parameters in units of Hz.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The sweep function is invalid when the waveform type is DC. If a SWE:STOP setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Caution

Depending on the relative sizes of the value of the sweep start frequency setting and the value of the sweep stop frequency setting, it is determined whether the sweep becomes a down-sweep or an up-sweep.

Query syntax

:SWE:STOP?

Response message <stop frequency>

<stop frequency> indicates the current sweep stop frequency and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

The sweep function is invalid when the output waveform is DC. If a SWE:STOP? query is received while the waveform type is selected as DC, an execution error is generated and the response is a value of 9.91E+37.

4.4.3.5 TIME/TIME? Command/Query (sweep time)

The sweep time is specified, using the :SWE:TIME <sweep time setting> command, after the sweep function is set OFF.

The current value of the sweep time setting can be read using the :SWE:TIME? query.

Command syntax

:SWE:TIME <sweep time setting>

<sweep time setting>, a parameter used for setting the sweep time, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is 1 ms to 500 s.

If the parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

A maximum of 3 digits is valid for the mantissa part, and the minimum setting resolution is 1 ms. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Suffixes are not accepted. Use only numeric parameters in units of s (seconds).

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The sweep function is invalid when the waveform type is DC. If a SWE:TIME setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Query syntax

:SWE:TIME?

Response message <sweep time>

<sweep time> indicates the current sweep time setting and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

The sweep function is invalid when the output waveform is DC. If a SWE:TIME? query is received while the waveform type is selected as DC, an execution error is generated and the response is a value of 9.91E+37.

4.4.3.6 INT/INT? Command/Query (repeat time interval)

The sweep repeat time interval is specified, using the :SWE:INT <repeat cycle setting> command, after the sweep function is set OFF.

The current value of the sweep repeat time interval setting can be read using the :SWE:INT? query.

Command syntax

:SWE:INT <repeat time interval setting>

<repeat time interval setting>, a parameter used for setting the sweep repeat time interval, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is 1 ms to 500 s.

If the parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

A maximum of 3 digits is valid for the mantissa part, and the minimum setting resolution is 1 ms. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Suffixes are not accepted. Use only numeric parameters in units of s (seconds).

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The sweep function is invalid when the waveform type is DC. If a SWE:INT setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Query syntax

:SWE:INT?

Response message <repeat time interval setting>

<repeat time interval setting> indicates the current setting of the sweep repeat time interval and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

The sweep function is invalid when the waveform type is DC. If a SWE:INT? query is received while the waveform type is selected as DC, an execution error is generated and the response is a value of 9.91E+37.

4.4.3.7 TYPE/TYPE? Command/Query (post-completion oscillation type)

The post-sweep oscillation mode is specified, using the :SWE:TYPE <post-completion oscillation type setting> command, after the sweep function is set OFF.

The current setting of the post-sweep oscillation type can be read using the :SWE:TYPE? query.

Command syntax

:SWE:TYPE <post-completion oscillation type setting>

<post-completion oscillation type setting>, a parameter for specifying the oscillation type after completion of the sweep, is STOP or CONT in the <Character Program Data> format.

The oscillation types specified by each mnemonic are as follows:

STOP	Oscillation stops when the sweep is completed.
CONT	Oscillation continues even after the sweep is completed.

Remarks

The sweep function is invalid when the waveform type is DC. If a SWE:TYPE setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Query syntax

:SWE:TYPE?

Response message <post-completion oscillation type>

<post-completion oscillation type> indicates the current oscillation type setting after the sweep is completed and is STOP, CONT or DIS mnemonic in the <Character Response Data> format.

Remarks

The sweep function is invalid when the waveform type is DC. If a SWE:TYPE? query is received while the waveform type is selected as DC, an execution error is posted and the response is DIS.

4.4.3.8 MARK/MARK? Command/Query (marker frequency)

The marker frequency is specified, using the :SWE:MARK <marker frequency setting> command, after the sweep function is set OFF.

The current value of the marker frequency setting can be read using the :SWE:MARK? query.

Command syntax

:SWE:MARK <marker frequency setting>

<marker frequency setting>, a parameter for setting the marker frequency, is a numeric value in the <Decimal Numeric Program Data> format.

A maximum of 5 digits is valid for the mantissa part, and the minimum setting resolution is 10 mHz. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Upper limit values differ depending on the waveform type setting.

Sine wave, Square wave : 10 m Hz to 15.000 MHz

Ramp wave, Pulse wave, Triangular wave : 10 mHz to 100 kHz

Additionally, there is the restriction that the parameter must be between the sweep start frequency and the sweep stop frequency.

If the parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

Suffixes are not accepted. Use only numeric parameters in units of Hz.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The sweep function is invalid when the waveform type is DC. If a SWE:MARK setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Query syntax

:SWE:MARK?

Response message <marker frequency>

<marker frequency> indicates the current value of the marker frequency setting and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

The sweep function is invalid when the waveform type is DC. If a SWE:MARK? query is received while the waveform type is selected as DC, an execution error is generated and the response is the value of 9.91E+37.

4.4.4 Burst Function Related Commands

When the ONC command/query and subsequent :BURS:xxxx commands (See section 4.4.4.2 and the following section) are received, each subcommand is answered after the burst function is set OFF.

Various device internal settings and recalculations, for implementation of the burst function according to the settings made by subcommands, are to be performed while BURS:STAT ON is specified.

After all settings by subcommand are complete, specify BURS:STAT ON.

4.4.4.1 STAT Command/Query (burst function)

ON/OFF of the burst function is specified using the :BURS:STAT <status setting> command.

The current ON/OFF status of the burst function can be read using the :BURS:STAT? query.

Command syntax

:BURS:STAT <status setting>

<status setting>, a parameter for specifying ON/OFF of the burst function, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the burst function is OFF, otherwise it is ON.

Remarks

If a command to set the burst function to ON arrives while the sweep function is ON, the sweep function is turned OFF, an execution error is posted, and the burst function is set ON.

The burst function cannot be set ON when the oscillation mode is gate oscillation mode. Attempting to do so will cause an execution error.

The burst function is invalid when the output waveform is DC. If a command to set :BURS:STAT to ON is attempted while the waveform type is selected as DC, an execution error will be posted and the parameter ignored.

Query syntax

:BURS:STAT?

Response message <status>

<status> indicates the current ON/OFF status of the burst function and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

Remarks

The burst function is invalid when the output waveform is DC. If a :BURS:STAT? query is received while the waveform type is selected as DC, an execution error is posted and 0 (indicating OFF) is returned.

If a :BURS:STAT? query is received when the oscillation mode is gate oscillation, an execution error is posted and 0 (indicating OFF) is returned.

4.4.4.2 ONC/ONC? Command/Query (burst ON-COUNT)

The burst ON-COUNT is specified, using the :BURS:ONC <burst ON-COUNT> command, after :BURS:STAT is set OFF.

The current value of the burst ON-COUNT setting can be read using the :BURS:ONC? query.

Command syntax

:BURS:ONC <burst ON-COUNT>

<burst ON-COUNT>, a parameter for setting the burst ON-COUNT, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is the integers from 1 to 65536.

The digit at the first decimal place is rounded off and an integer value is set.

If the parameter is outside the limits, an execution error is generated and the parameter is pushed back within the limits.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The burst function is invalid when the output waveform is DC. If a :BURS:ONC setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Query syntax

:BURS:ONC?

Response message <burst ON-COUNT>

<burst ON-COUNT> indicates the current value of the burst ON-COUNT setting and is a numeric value in the <NR1 Numeric Response Data> format.

Remarks

The burst function is invalid when the output waveform is DC. If a :BURS:ONC? query is received while the waveform type is selected as DC, an execution error is posted and 0 is returned.

4.4.4.3 OFFC/OFFC? Command/Query (burst OFF-COUNT)

The burst OFF-COUNT is specified, using the :BURS:OFFC <burst OFF-COUNT> command, after :BURS:STAT is set OFF.

The current value of the burst OFF-COUNT setting can be read using the :BURS:OFFC? query.

Command syntax

:BURS:OFFC <burst OFF-COUNT>

<burst OFF-COUNT>, a parameter for setting the burst OFF-COUNT, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is the integers from 1 to 65536.

The digit at the first decimal place is rounded off and an integer value is set.

If the parameter is outside the limits, an execution error is generated and the parameter is pushed back within the limits.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The burst function is invalid when the output waveform is DC. If a :BURS:OFFC setting is attempted while the waveform type is selected as DC, an execution error is posted and the parameter ignored.

Query syntax

:BURS:OFFC?

Response message <burst OFF-COUNT>

<burst OFF-COUNT> indicates the current value of the burst OFF-COUNT setting and is a numeric value in the <NR1 Numeric Response Data> format.

Remarks

The burst function is invalid when the output waveform is DC. If a :BURS:OFFC? query is received while the waveform type is selected as DC, an execution error is posted and 0 is returned.

4.4.5 Modulation Function Related Commands

The only modulation function for this instrument is the pulse motor modulation function (optional).

4.4.5.1 TYPE/TYPE? Command/Query (modulation type)

The pulse motor modulation function is specified as the modulation type using the :MOD:TYPEMT command.

The currently selected modulation type can be read using the :MOD:TYPE? query.

Command syntax

:MOD:TYPE <modulation type setting>

<modulation type setting>, a parameter for selecting the modulation type, is a mnemonic in the <Character Program Data> format. MT is the only parameter permitted with this instrument.

Remarks

If pulse motor control option is not installed, an execution error will occur when MT is specified.

If pulse motor control option is installed, even without specifying MT with the :MOD:TYPE command, :MOD:TYPE will be internally set as MT.

Caution

When the pulse motor control option is not installed, this command only generates an execution error and does not constitute any meaning besides that.

Also, when the pulse motor control option is installed, regardless of the specification of this command, the modulation type internal setting becomes MT.

Therefore, the :MOT:TYPE command is not really an effective command for this instrument. It is only included for the purpose of future scalability.

Query syntax

:MOD:TYPE?

Response message <modulation type>

<modulation type> indicates the currently specified modulation type and is the MT or DIS mnemonic in the <Character Response Data> format.

Remarks

If the pulse motor modulation option is not installed, the response is DIS. So that the query can be used to check whether the option is installed, it does not cause an execution error.

4.4.5.2 STAT/STAT? Command/Query (modulation function)

ON/OFF of the modulation function is specified using the :MOD:STAT <status setting> command.

The current ON/OFF status of the modulation function can be read using the :MOD:STAT? query.

Command syntax

:MOD:STAT <status setting>

<status setting>, a parameter for specifying ON/OFF of the modulation function, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the modulation function is OFF, otherwise it is ON.

Remarks

When MT is specified as the :MOD:TYPE (when the pulse motor modulation option is installed), setting :MOD:STAT to ON specifies the waveform type as a pulse wave, and if the oscillation mode is gate oscillation mode, the mode should be changed to continuous oscillation mode.

When the pulse motor modulation option is not installed, the modulation function is invalid for this instrument. If attempted to set it ON, an execution error is posted.

Query syntax

:MOD:STAT?

Response message <status>

<status> indicates the current ON/OFF status of the modulation function and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

Remarks

If the pulse motor modulation option is not installed, the modulation function is invalid for this instrument. When :MOD:STAT? query is received, a value of 0 (indicating OFF) is always returned and an execution error posted.

4.4.5.3 Pulse Motor Modulation Related Commands

Commands/queries related to pulse motor modulation are optional.

If the option is not installed, an error is generated when those commands/queries related to pulse motor modulation are received.

When the MODE subcommand/query and subsequent :MT:xxxx commands (See section 4.4.5.3.1 and the following sections) are received, each subcommand is answered after :MOD:STAT is set OFF.

Various device internal settings and recalculations, for implementation of the modulation function according to the settings made by subcommands, are to be performed while MOD:STAT ON is specified.

After all settings by subcommands are complete, specify MOD:STAT ON.

The commands/queries are as follows.

4.4.5.3.1 MODE/MODE? Command/Query (pulse motor modulation mode)

The pulse motor modulation mode is specified, using the :MT:MODE <mode setting> command, after the modulation function is set OFF.

The current setting of the pulse motor modulation mode can be read using the :MT:MODE? query.

Command syntax

:MT:MODE <mode setting>

<mode setting>, a parameter for specifying the pulse motor modulation mode, is LINA or LINB in the <Character Program Data> format.

The modulation modes specified by each mnemonic are as follows:

LINA	LIN-A mode: SLOW DOWN according to sensor input
LINB	LIN-B mode: SLOW DOWN according to pulse count

Remarks

If the motor control option is not installed, the modulation function is invalid. If MT:MODE setting is attempted while the option is not installed, an execution error is posted and the parameter ignored.

Query syntax

:MT:MODE?

Response message <mode>

<mode> indicates the current setting of the pulse motor modulation mode and is LINA, LINB, or DIS mnemonic in the <Character Response Data> format.

Remarks

If the pulse motor modulation option is not installed, an execution error is generated and DIS is returned.

4.4.5.3.2 FREQ/FREQ? Command/Query (initial frequency, maximum frequency)

The initial frequency and maximum frequency are specified, using the :MT:FREQ <initial frequency setting>, <maximum frequency setting> command, after the modulation function is set OFF.

The current values of the initial frequency setting and maximum frequency setting can be read using the :MT:FREQ? query.

Command syntax

:MT:FREQ <initial frequency setting>, <maximum frequency setting>

This command requires the 2 parameters of <initial frequency setting> and <maximum frequency setting>. The 2 parameters must be in the above-indicated order and separated by a comma. Regardless of the setting, parameters cannot be omitted.

<initial frequency setting> is a parameter for setting the initial frequency, and <maximum frequency setting> is a parameter for setting the maximum frequency. Both are numeric values in the <Decimal Numeric Program Data> format.

The valid setting range is from 10 mHz to 100 kHz.

If a parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

A maximum of 5 digits is valid for the mantissa part, and the minimum setting resolution is 10 mHz. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Valid combinations are only those in which (initial frequency) \leq (maximum frequency). In the case of an invalid combination, an execution error is generated and the internal settings are not changed.

Suffixes are not accepted. Use only numeric parameters in units of Hz.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

Caution

Changing the settings of the initial and maximum frequencies affects the valid setting range (i.e. lower limit values) of the :MT:FIRS and :MT:STOP settings. If conflicting values are set, settings by the :MT:FREQ command have priority, and values set by :MT:FIRS and :MT:STOP are automatically corrected to those within the valid setting range. (An execution error is posted.)

Query syntax

:MT:FREQ?

Response message <initial frequency>, <maximum frequency>

The response message is 2 types of numeric values in the <NR3 Numeric Response Data> format which are separated by a comma. <initial frequency> indicates the current initial frequency setting, and <maximum frequency> indicates the current maximum frequency setting.

Remarks

If the pulse motor modulation option is not installed, an execution error is generated and the value of 9.91E+37 is returned.

4.4.5.3.3 UP/UP? Command/Query (time until maximum frequency)

The time until maximum frequency is specified, using the :MT:UP <up time setting> command, after the modulation function is set OFF.

The current setting value of the time until maximum frequency can be read using the :MT:UP? query.

Command syntax

:MT:UP <up time setting>

<up time setting>, a parameter for setting the time until maximum frequency, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is from 1 ms to 45 s.

If the parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

A maximum of 3 digits is valid for the mantissa part, and the minimum setting resolution is 1 ms. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Suffixes are not accepted. Use only numeric parameters in units of s (seconds).

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The modulation function is invalid if the pulse motor modulation option is not installed. If a :MT:UP setting is attempted while the option is not installed, an execution error is posted and the parameter ignored.

Caution

Changing the setting of the time until maximum frequency affects the valid setting range (i.e. lower limit values) of the :MT:FIRS and :MT:STOP settings. If conflicting values are set, the setting by the :MT:UP command has priority, and values set by :MT:FIRS and :MT:STOP are automatically corrected to those within the valid setting range. (An execution error is posted.)

Query syntax

:MT:UP?

Response message <up time>

<up time> indicates the current setting of the time until maximum frequency and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

The modulation function is invalid if the pulse motor modulation option is not installed. If the pulse motor modulation option is not installed and a :MT:UP? query is received, an execution error is generated and the value of 9.91E+37 is returned.

4.4.5.3.4 DOWN/DOWN? Command/Query (time until initial)

The time until initial frequency is specified, using the :MT:DOWN <down time setting> command, after the modulation function is set OFF.

The current setting value of the time until initial frequency can be read using the :MT:DOWN? query.

Command syntax

:MT:DOWN <down time setting>

<down time setting>, a parameter for setting the time until initial frequency, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is from 1 ms to 45 s.

If the parameter is outside the limits, an execution error is generated and the parameter is rounded to a value within the limits.

A maximum of 3 digits is valid for the mantissa part, and the minimum setting resolution is 1 ms. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Suffixes are not accepted. Use only numeric parameters in units of s (seconds).

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The modulation function is invalid if the pulse motor modulation option is not installed. If a :MT:DOWN setting is attempted while the option is not installed, an execution error is posted and the parameter ignored.

Caution

Changing the setting of the time until initial frequency affects the valid setting range (i.e. lower limit values) of the :MT:FIRS and :MT:STOP settings. If conflicting values are set, the setting by the :MT:DOWN command has priority, and values set by :MT:FIRS and :MT:STOP are automatically corrected to those within the valid setting range. (An execution error is posted.)

Query syntax

:MT:DOWN?

Response message <down time>

<down time> indicates the current setting of the time until initial frequency and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

The modulation function is invalid if the pulse motor modulation option is not installed. If the pulse motor modulation option is not installed and a :MT:DOWN? query is received, an execution error is generated and the value of 9.91E+37 is returned.

4.4.5.3.5 FIRS/FIRS? Command/Query (pulse count until slowdown)

The pulse count until slowdown is specified, using the :MT:FIRS <pulse count setting> command, after the modulation function is set OFF.

The current setting value of the pulse count until slowdown can be read using the :MT:FIRS? query.

Command syntax

:MT:FIRS <pulse count setting>

<pulse count setting>, a parameter for setting the pulse count until slowdown, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is the integers from 1 to 16777216.

The digit at the first decimal place is rounded off and an integer value is set.

The valid setting range (i.e. lower limit value) is affected by the settings of the initial frequency, maximum frequency and time until maximum frequency.

If the parameter is outside the limits, an execution error is posted and the parameter is pushed back within the limits and set.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

This command is valid only when the :MT:MODE setting is LINB. At all other times, an execution error will be generated.

The modulation function is invalid if the pulse motor modulation option is not installed. If a MT:FIRS setting is attempted while the option is not installed, an execution error is posted and the parameter ignored.

Query syntax

:MT:FIRS?

Response message <pulse count>

<pulse count> indicates the current setting value of the pulse count until slowdown and is a numeric value in the <NR1 Numeric Response Data> format.

Remarks

This query is valid only when the :MT:MODE setting is LINB. At all other times, an execution error will be generated and a value of 0 will be returned.

If the pulse motor modulation option is not installed, an execution error is generated and a value of 0 is returned.

4.4.5.3.6 STOP/STOP? Command/Query (pulse count until oscillation stops)

The pulse count until oscillation stops is specified, using the :MT:STOP <pulse count setting> command, after the modulation function is set OFF.

The current setting value of the pulse count until oscillation stops can be read using the :MT:STOP? query.

Command syntax

:MT:STOP <pulse count setting>

<pulse count setting>, a parameter for setting the pulse count until oscillation stops, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is the integers from 1 to 16777216.

The digit at the first decimal place is rounded off and an integer value is set.

The valid setting range (i.e. lower limit value) is affected by the settings of the initial frequency, maximum frequency, time until maximum frequency, and time until initial frequency.

If the parameter is outside the limits, an execution error is posted and the parameter is pushed back within the limits and set.

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

The modulation function is invalid if the pulse motor modulation option is not installed. If a MT:STOP setting is attempted while the option is not installed, an execution error is posted and the parameter ignored.

Query syntax

:MT:STOP?

Response message <pulse count>

<pulse count> indicates the current setting value of the pulse count until oscillation stops and is a numeric value in the <NR1 Numeric Response Data> format.

Remarks

If the pulse motor modulation option is not installed, an execution error is generated and a value of 0 is returned.

4.4.5.3.7 WAIT/WAIT? Command/Query (reciprocating operation wait time)

The wait time is specified, using the :MT:WAIT <wait time setting> command, after the modulation function is set OFF.

The current value of the wait time setting can be read using the :MT:WAIT? query.

Command syntax

:MT:WAIT <wait time setting>

<wait time setting>, a parameter for setting the wait time, is a numeric value in the <Decimal Numeric Program Data> format.

The valid setting range is from 10 ms to 100 s.

If the parameter is outside the limits, an execution error is generated and the parameter is pushed back within the limits.

A maximum of 3 digits is valid for the mantissa part, and the minimum setting resolution is 1 ms. The value of the digit part that exceeds the allowable setting resolution is rounded off.

Suffixes are not accepted. Use only numeric parameters in units of s (seconds).

Remarks

Negative numbers are not accepted as parameters. They cause an execution error to occur and the parameter to be ignored.

Query syntax

:MT:WAIT?

Response message <wait time>

<wait time> indicates the current wait time setting and is a numeric value in the <NR3 Numeric Response Data> format.

Remarks

If the pulse motor modulation option is not installed, an execution error is generated and the value of 9.91E+37 is returned.

4.4.6 Miscellaneous

4.4.6.1 TPOL/TPOL? Command/Query (external trigger polarity)

The polarity of the trigger signal that is input to the external trigger pin is specified using the :TPOL command.

The polarity setting of the trigger signal that is input to the external trigger pin can be read using the :TPOL? query.

Command syntax

:TPOL <polarity setting>

<polarity setting>, a parameter for setting the polarity of the external trigger signal, is POS or NEG in the <Character Program Data> format.

The polarities specified by each mnemonic are as follows:

- POS + : Oscillation starts at the rising edge
- NEG - : Oscillation starts at the falling edge

Query syntax

:TPOL?

Response message <polarity>

<polarity> indicates the current external trigger signal polarity setting and is either POS or NEG mnemonic in the <Character Response Data> format.

4.4.6.2 System Setting Related Commands

Various settings related to system setup are possible using the :SYST:xxxx command group.

4.4.6.2.1 Power Related Subcommands

Various power-on setup and various power-saving related settings are possible using the :SYST:POW:xxxx command group.

4.4.6.2.1.1 SET/SET? Command/Query (setup flag)

Using the :SYST:POW:SET <setup flag setting> command, it is specified whether settings prior to the last power-off are retained, or factory default settings are used.

The setting of whether settings prior to the last power-off are retained, or factory default settings are used, can be read using the :SYST:POW:SET? query.

Command syntax

:SYST:POW:SET <setup flag setting>

<setup flag setting>, a parameter for specifying the setup state at the time of power-on, is either LAST or INI in the <Character Program Data> format.

The setup states specified by each mnemonic are as follows:

LAST	Setup is saved even when the power is off.
INI	Factory default settings are used for the setup at the time of power-on.

Query syntax

:SYST:POW:SET?

Response message <setup flag>

<setup flag> indicates the currently specified power-on setup state, and is either LAST or INI mnemonic in the <Character Response Data> format.

Remarks

If you set the setup flag to INI, the remote-related settings (such as the settings about the RS-232 baud rate and GP-IB addresses) will be also initialized at the next power-on.

If you use the remote-related settings other than the default ones made before shipment from the factory, make sure to set the setup flag to LAST.

4.4.6.2.1.2 OUT/OUT? Command/Query (output pin flag)

Using the :SYST:POW:OUT <output flag setting> command, it is specified whether the ON/OFF status of the waveform output at the time of next power-on will be the same as the status prior to the last power-off, or whether it will be OFF.

Whether the ON/OFF status of the waveform output at the next power-on will be the same as the status prior to the last power-off, or whether it will be OFF, can be read using the :SYST:POW:OUT? query.

Command syntax

:SYST:POW:OUT <output flag setting>

<output flag setting>, a parameter for setting ON/OFF of the waveform output at the time of power-on, is either LAST or OFF in the <Character Program Data> format.

The states specified by each mnemonic are as follows:

LAST	Sets the waveform output ON/OFF at the time of power-on in the same state as that prior to the last power-off
OFF	Sets the waveform output OFF at the time of power-on

Query syntax

:SYST:POW:OUT?

Response message <output flag>

<output flag> indicates the current ON/OFF setting of the waveform output at the time of power-on, and is either LAST or OFF mnemonic in the <Character Response Data> format.

Remarks

If the waveform output is ON at the time of power-on, make sure to set the setup flag to LAST, because INI of the setup flag has priority over LAST of the output flag even and the waveform output at the time of power-on is OFF.

4.4.6.2.1.3 SLE/SLE? Command/Query (sleep time)

The time until entering the low-power mode is specified using the :SYST:POW:SLE <sleep time setting> command.

The time until entering the low-power mode can be read using the :SYST:POW:SLE? query.

Command syntax

:SYST:POW:SLE <sleep time setting>

<sleep time setting>, a parameter for setting the time (minutes) until entering the low-power mode, is 0, 10, 20, 30, 40, 50, or 60 in the <Character Program Data> format. The value of 0 indicates the function is OFF.

Query syntax

:SYST:POW:SLE?

Response message <sleep time>

<sleep time> indicates the current setting of the time until entering the low-power mode, and is 0, 10, 20, 30, 40, 50, or 60 mnemonic in the <Character Response Data> format.

4.4.6.2.1.4 SIMM Command (sleep transfer)

The low-power mode is immediately entered using the :SYST:POW:SIMM command.

Command syntax

:SYST:POW:SIMM

There is no data part in this command.

4.4.6.2.2 Beep Sound Related Settings (beep)

4.4.6.2.2.1 KEY/KEY? Command/Query (keypush sound)

ON/OFF of the keypush sound is specified using the :SYST:BEEP:KEY <status setting> command.

The ON/OFF setting of the keypush sound can be read using the :SYST:BEEP:KEY? query.

Command syntax

:SYST:BEEP:KEY <status setting>

<status setting>, a parameter for specifying ON/OFF of the keypush sound, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the keypush sound is OFF, otherwise it is ON.

Query syntax

:SYST:BEEP:KEY?

Response message <status>

<status> indicates the ON/OFF status of the keypush sound and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

4.4.6.2.2.2 ERR/ERR? Command/Query (error beep)

ON/OFF of the error beep sound is specified using the :SYST:BEEP:ERR<status setting> command.

The ON/OFF setting of the error beep sound can be read using the :SYST:BEEP:ERR? query.

Command syntax

:SYST:BEEP:ERR <status setting>

<status setting>, a parameter for specifying ON/OFF of the error beep sound, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the error beep sound is OFF, otherwise it is ON.

Query syntax

:SYST:BEEP:ERR?

Response message <status>

<status> indicates the ON/OFF status of the error beep sound, and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.

4.4.6.2.3 STAT/STAT? Command/Query (synchronous output)

ON/OFF of the synchronous output is specified using the :SYST:SYNC:STAT command.

The current ON/OFF setting of the synchronous output can be read using the :SYST:SYNC:STAT? query.

Command syntax

:SYST:SYNC:STAT <sync out setting>

<sync out setting>, a parameter for specifying ON/OFF of the synchronous output, is ON or OFF in the <Character Program Data> format, or a numeric value in the <Decimal Numeric Program Data> format. If the result of rounding the numeric value is 0, the synchronous output is OFF, otherwise it is ON.

Query syntax

:SYST:SYNC:STAT?

Response message <sync out>

<sync out> indicates the current status of the synchronous output and is the numeric value of 1 or 0 in the <NR1 Numeric Response Data> format. 1 indicates ON and 0 indicates OFF.



TEXIO TECHNOLOGY CORPORATION

7F Towa Fudosan Shin Yokohama Bld.

2-18-13, Shin Yokohama, Kouhoku-ku, Yokohama, Kanagawa, 222-0033 Japan

<http://www.texio.co.jp/>
