OPERATION MANUAL

SYNTHESIZER/FUNCTION GENERATOR

MODEL FGE3250

KIKUSUI ELECTRONICS CORPORATION

Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

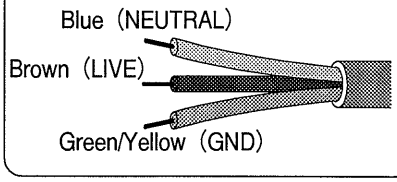
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

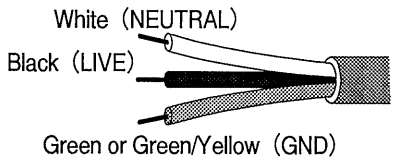
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

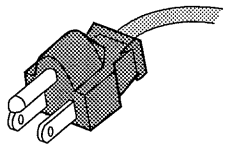
☐ Without a power plug



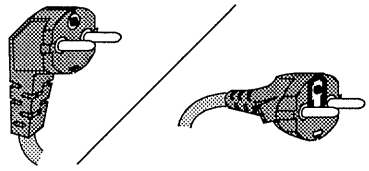
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

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1. GENERAL DESCRIPTION

The Model FGE3250 is a full programmable oscillator consisting of a synthesizer (SYNT) that oscillates at the frequency of 10 Hz to 20 MHz with high stability and a function generator (FG) that oscillates at the frequency of 1 mHz to 20 MHz in various modes.

The FG can generate frequencies in continuous, triggered, gated, and burst modes, and the SYNT can generate frequencies by using not only internal but also external reference signal and can also oscillate in a phase lock mode.

The FGE3250 can produce sine, triangle, square, and pulse waveforms with the maximum output amplitude of 30 volts peak-to-peak at open circuit (output impedance = 50 Ω).

This instrument can output the TLL-level signals also.

Modes are to be set by the tact switches and rotary knobs on the front panel, to increase operationality. Since the selected modes are displayed on the panel, the operator will not be confused even if the modes are combined in various ways. The setting errors are displayed also.

Up to 100 steps sets of front panel settings can be stored in a built-in memory.

In the triggered, gated, and bust modes, the FGE3250 can operate without external trigger signals because it has an internal oscillator.

In addition, the FGE3250 has a VCA function, a VCG function in FG mode, and the output ON/OFF, buzzer ON/OFF, and tact switch ON/OFF functions. The selection of these functions can be controlled by an external computer through GP-IB, so that the FGE3250 can be used for various purposes.

2. SPECIFICATIONS

2.1 Operation Mode

(1) Function Generator (FG)

- Continuous
- Triggered
- Gated
- Burst

(2) Synthesizer (SYNT)

2.2 Control Method

(1) Manual setting

- Tact switch
- Rotary knob

(2) External setting

- GP-IB
- VCG
- VCA

2.3 FG Mode

2.3.1 Oscillation frequency setting

		Frequency/period
(1)	Range	1 mHz to 20 MHz/1000 s to 50 ns
(2)	Resolution	3 digits
(3)	Unit	mHz, Hz, kHz, MHz/s, ms, μs, ns
(4)	Accuracy	±3% for 10 mHz to 10 Hz ±2% for 10 Hz to 1 MHz ±3% for 1 MHz to 20 MHz
(5)	Stability	±0.05% (Stability of 1 kHz frequency against ±10% variation of line voltage)

2.3.2 VCG

(1)	Control voltage	10 mV to 10V approx.
(2)	Oscillation frequency range	1 mHz to 20 MHz
(3)	Frequency change within set range	1:1000 or more
(4)	Input frequency range	DC to 10 kHz
(5)	Input impedance	10 kΩ approx.

2.3.3 Triggered/gated/burst

(1)	Trigger signal	Internal or external
(2)	Triggered frequency	1 mHz to 10 MHz
(3)	External input frequency range	DC to 10 MHz
(4)	Minimum pulse width	25 ns
(5)	Input impedance	10 kΩ approx.
(6)	Trigger signal level	-10V to +10V
	. Resolution	3 digits or 20 mV
	. Accuracy	±100 mV
(7)	Trigger slope	+/-
(8)	Internal signal (TRIG RATE)	100 ns to 100 s
	. Resolution	3 digits
	. Accuracy	±0.02%
(9)	Start/stop phase	0±90 DEG
	. Resolution	2 digits, 1 DEG
(10)	Burst count	1 to 32767

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2.4 SYNT Mode

2.4.1	Oscillation frequency	10 Hz to 20 MHz
	(1) Resolution	5 digits
	(2) Unit	Hz, kHz, MHz
	(3) Accuracy	±(0.002%+5 mHz)
	(4) Stability	±0.001% (Stability of 1 kHz frequency against ±10% variation of line voltage)
	(5) Stability of internal reference oscillator	5 PPM (0 to 40°C)
2.4.2	External reference	
	(1) Input frequency	10 MHz
	(2) Input waveform	TTL or zero-cross signal
2.4.3	External phase lock	
	(1) Phase lock range	Within ±5% of internal setting frequency
	(2) Input waveform	TTL or zero-cross signal

2.5 Output

2.5.1		
	(1) Waveform	Sine (∿), triangle (△), square (⊓), square complement (⊔), pulse (⊓), pulse complement (⊔)
	(2) Voltage	Max. 30 Vp-p (open circuit) at 1 kHz Note: Frequency characteristics
	(3) Output impedance	50 Ω
	(4) Voltage range	0 to 15 Vp-p (50 Ω loaded)
	. Resolution . Accuracy	3 digits or 10 mVp-p ±(2% + 0.2% of FS) at 1 kHz
	(5) Output ON/OFF	Yes

2.5.2 UPPER VOLTAGE SET/LOWER VOLTAGE SET

(1)	Voltage setting range	0 to ±7.5V (Depends on AMPL and OFST)
(2)	Resolution	3 digits or 1 mV

2.5.3 Pulse wave

(1)	Pulse width setting range	0.045 µs to 50 s
(2)	Resolution	3 digits
(3)	Accuracy	±(4% + 5 ns)

2.5.4 Frequency characteristic (based on 1 kHz)

	1mHz	1MHz	10MHz	20MHz
Sine wave	±0.4	±0.8	±1.6	
Triangle wave	±0.4	±1.2	±2.4	

(dB)

2.5.5 Square wave rising/falling time: 15 ns or less (50 Ω loaded)

2.5.6 Sine wave distortion factor: 0.5% (20 Hz to 20 kHz)
1% (20 kHz to 600 kHz)
(at maximum output voltage and with 50 Ω load)

2.5.7 Mutual voltage deviation : Within ±5% between waveforms
(at maximum output voltage and 1 kHz frequency with 50 Ω load)

2.5.8 Amplitude stability : Within ±0.3%
(against the line voltage variation of ±10%)

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2.5.9 DC offset

(1)	Resolution	3-digits or 1 mV
(2)	Accuracy and range	0 to ±7.5V, ±(2%+50mV) :(15≧AMPL≧1V) 0 to ±750mV, ±(3%+5mV) :(1V>AMPL≧100mV) 0 to ±75mV, ±(3%+0.7mV):(100mV>AMPL≧10mV)

2.5.10 VCA

(1)	Controllable frequency range	1 mHz to 20 MHz
(2)	Input resistance	10 kΩ approx.
(3)	Input frequency range	DC to 10 kHz
(4)	Amplitude control range	0 to -30 dB approx. (at maximum output voltage for sine and triangle waveforms)

2.5.11 HF LIMIT

Low-pass filter ON/OFF

2.5.12 TTL OUT

(1)	Output impedance	50 Ω approx.
(2)	Rising/falling time	10 ns approx.

2.6 Built-in Memory

(1) 100 steps

(2) STORE, CALL, EXECUTE

(3) Program steps can be incremented/decremented

(4) Memorized address can be enabled/disabled

(5) Battery back-up period: Approx. 10 days

2.7 GP-IB

(1) All data and modes can be controlled

(2) Device address can be checked on panel surface

(3) SH1, AH1, T6, L2, SR1, RL1, DC1, PP0, DT0, C0

2.8 Insulation Resistance and Withstand Voltage

(1)	Between power source and case	DC500V AC1500V	100 MΩ or more 1 minute (5 mA or less)
(2)	Between signal ground and case	DC 500V	100 MΩ or more

2.9 Power Supply

AC 50/60 Hz — 75 VA approx.

90 - 110V
104 - 125V
180 - 220V
198 - 242V
216 - 250V
} (to be switched)

2.10 Operating Temperature/Humidity Range

(1)	Allowable range	0 - 40°C (32 - 104°F) 85% or less
(2)	Recommended range	5 - 35°C (41 - 95°F) 85% or less

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2.11 Dimensions/Weight

(1)	Dimensions	430(W) × 99(H) × 320(D) mm (16.9(W) × 3.9(H) × 12.6(D) in.)
(2)	Maximum dimensions	445(W) × 119(H) × 380(D) mm (17.5(W) × 4.7(H) × 15.0(D) in.)
(3)	Weight	Approx. 7.2 kg (16 lbs.)

2.12 Accessories

(1)	Accessories	Operation manual 1 0.5A fuse 1

3. PREPARATION FOR USE

3.1 Unpacking and Inspection

Before the FGE3250 is shipped from the factory, it is thoroughly examined mechanically and electrically to guarantee correct operation.

On receiving the instrument, inspect it for the damages that may have been caused during transportation. Should any damages be found, notify the Sales and Service Office.

3.2 Power Requirements

The FGE2350 requires a commercial frequency of 50/60 Hz signal phase. It can be used within the following five ranges of line voltage:

(1) 90 - 110V
(2) 104 - 125V
(3) 180 - 220V
(4) 198 - 242V
(5) 216 - 250V

Check the line voltage to be used and set the relevant switch properly.

* With a minus screwdriver, set the line voltage to be used to the mark "▲".
* Replace the fuse according to the line voltage to be used. The fuse is sealed in a glass tube. When replacing the fuse, see the fuse rating on the rear panel on the instrument.
* The standard model of the instrument is equipped with the power supply cable of AC 125V rating. If the instrument is to be used in the above voltage range (3), (4), or (5), replace the cable with the proper one.
* The metal terminal found on the rear panel is a ground terminal. It is recommended to ground the instrument with this terminal before inserting the power plug into outlet.

3.3 Surrounding Environment

Do not install the instrument near a heat source or in a place subject to direct sunlight. Note that an extraordinary environment (gas, dust, vibration, chemicals, etc.) will extremely shorten the life of the instrument. When controlling the instrument by an external unit remote from it, consider the electromagnetic interference (EMI) such as the logic noise emitted from the external unit. It is desirable to keep the signal line of logic circuit away from the instrument or to use a different power source for the remote unit.

3.4 Terminal Resistance

Since the FGE3250 is a wide-band oscillator whose output impedance is 50Ω, the matching of the output impedance must be done carefully.

With the HF LIMIT function, a good waveform can be output, but the band width is limited when this function is used.

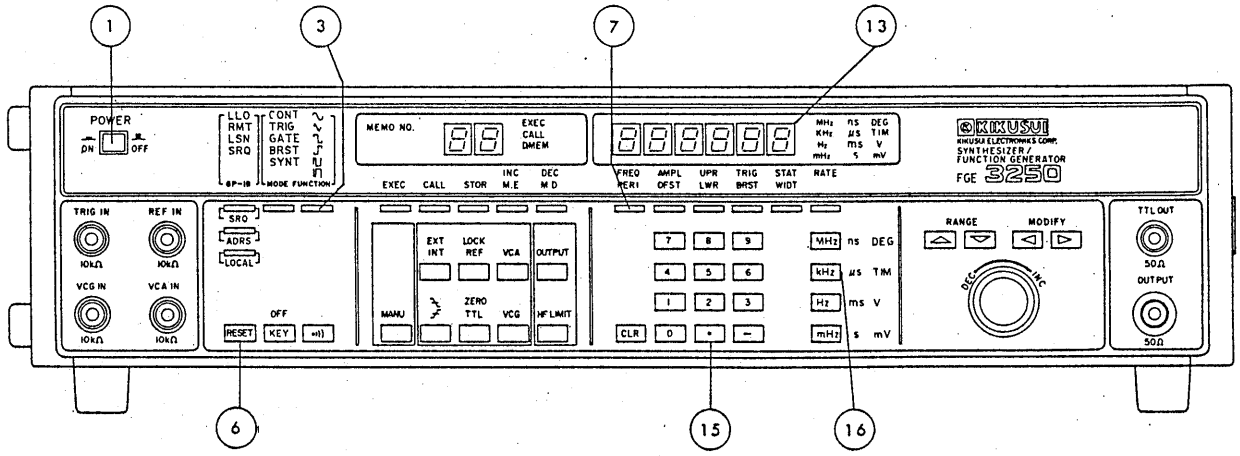
3.5 Excessive Input Prevention

The maximum input voltage at each input terminal is ±30V.
Each output terminal is protected from short circuit, but it may be damaged by the input of external voltage.

3.6 Battery Down

When the power is turned on after it has been turned off for a long time, Error 1 (Er01) may be displayed. This error means excessive discharge of the battery (Ni-Cd) used for the built-in memory backup. Therefore, when this error is reported, the battery must be charged and the content of the memory must be set again.

* To fully charge the battery, keep the power on for approximately five hours.
* Once the battery is charged, the memroy can be backed up for about 10 days.



4. OPERATION

4.1 Panel Operation Procedure

(1) First, turn on the power by (1).
The instrument is initialized, and all the LEDs on the panel surface are turned on for approximately 2 seconds.

(2) When the instrument is initialized, it is automatically set in the FG mode with sine waveform, 1 kHz, 1 Vp-p, offset voltage = 0, and output = OFF.
* See Item (6) "RESET" in Section 4.2 for details.
After this, manipulate the instrument according to the procedures below. Basic operation methods in FG mode and SYNT mode are explained.

EXAMPLE 1
The instrument is to be used in FG mode (as function generator). It is to output a signal of triangle waveform (∧∨) continuously at 315 kHz. The output voltage is to be 5p-p with +2.5V offset. After that, the URP and LWR functions are to be used to obtain a signal of sine waveform (∩) whose peak is +1V and bottom is -5V.

(3) Select the waveform " ∧∨ " by (3).

(4) Select FREQ by (7). (The selected side flickers.)

(5) Input 3 1 5 by (15).

(6) Press kHz at (16).

(7) "315.kHz" is displayed in section (13).

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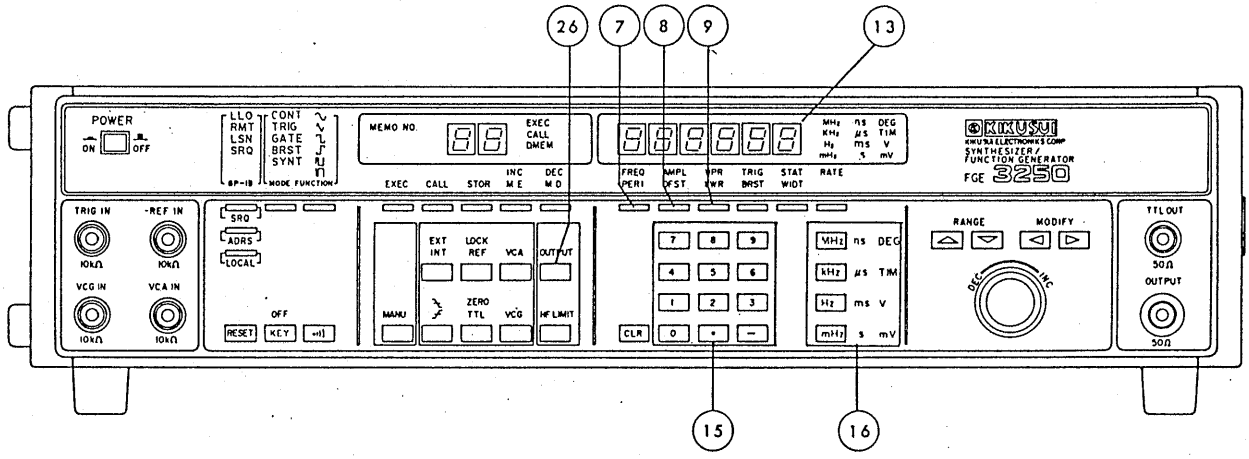


(8) Press (7), and "PERI" is selected to display the period for the currently specified 315 kHz. That is, "3.17μs" is displayed in Section (13).

So far, the waveform and frequency have been specified. The next operation is to specify the output voltage.

(9) Select "AMPL" by (8).

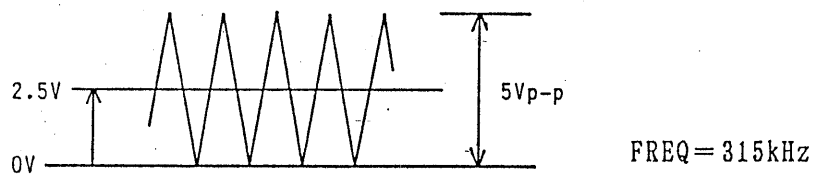
(10) Input 5 V by (15) and (16).
* The unit for AMPL is Vp-p. The output amplitude is calibrated for the peak-to-peak voltage obtained when the output terminal is terminated by 50Ω.

(11) Select "OFST" by pressing (8) again.

(12) Input 2 . 5 V by (15) and (16).
* As in the case of AMPL, the output offset is calibrated by the peak voltage obtained when the output terminal is terminated by 50Ω.

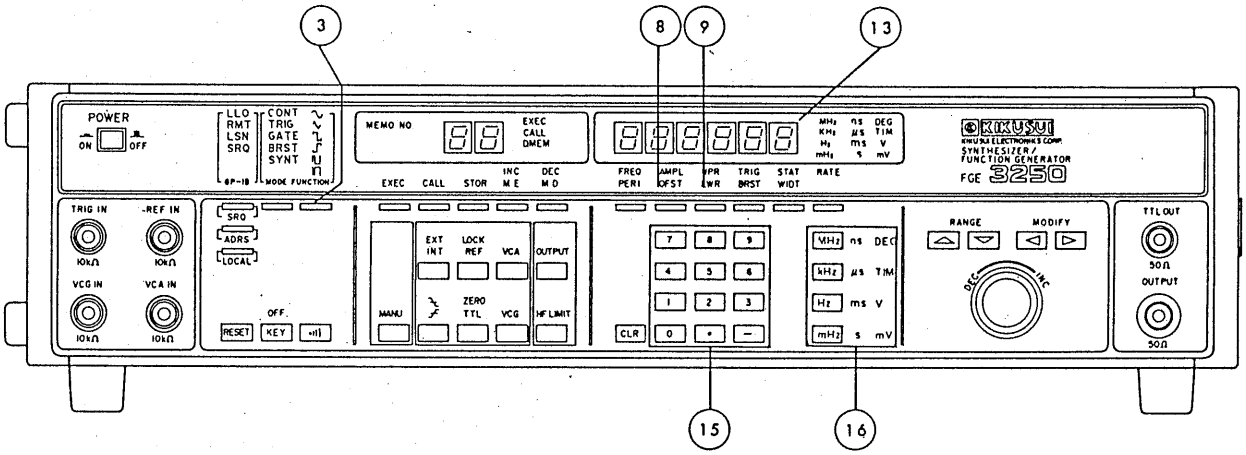
(13) Press the "OUTPUT" button at (26) to turn on the output function. The OUTPUT indicator goes on.

By the above setting, the following signal is output:

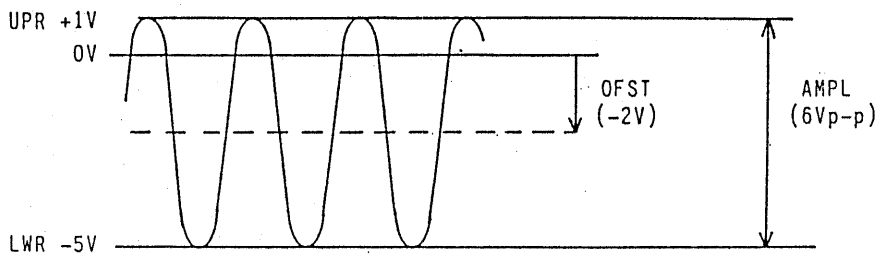


The next operation is to obtain the signal of sine waveform with the UPR and LWR functions.

(14) Select "UPR" by (9).
(15) Input 1 V by (15) and (16).
(16) Select "LWR" by pressing (9) again.
(17) Input − 5 V by (15) and (16).
(18) Select sine waveform (∿) by (3).



By the above setting, the following signal is output:



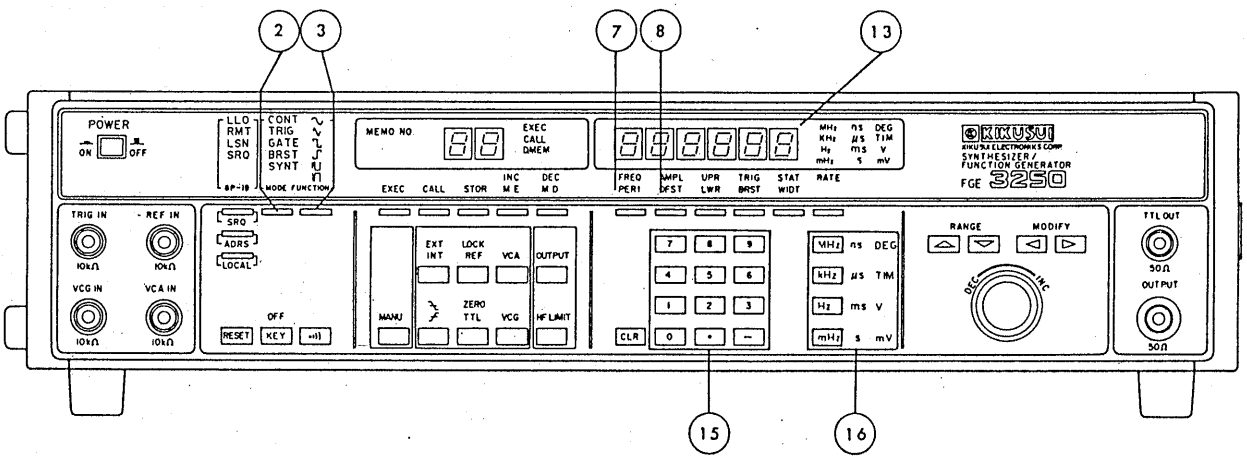
Check the amplitude and offset as follows:

(19) Select "AMPL" by pressing (8) and see if "6.00V" is displayed in (13).

(20) Press (8) again to select "OFST", and see if "-2.00V" is displayed in (13).

Thus, with the UPR and LWR functions, the user can obtain a desired amplitude by setting the peak and bottom values only.

* The above chart shows the relationship among AMPL, OFST, UPR, and LWR. The values of these items may be specified in a desired order, but they must not be contradictory to one another and they must be within the ranges that allow the operation of the instrument.
* See Chapter 9 for the error messages related to these items.
* For more details, see the flowchart and explanation of operation principle in Section 6.7.2.



EXAMPLE 2

The instrument is to be used in SYNT mode (as synthesizer).
It is to output a signal of sine waveform (∿) at the frequency of 1 MHz. The amplitude of the signal is to be 1 Vp-p without offset.
After that, the frequency is to be increased by 100 Hz at a time till reaches 1.0015 MHz.
Further, setting is to be done to reduce the frequency to one-tenth and increase the output voltage to 2 Vp-p, and then the frequency and output voltage are to be changed simultaneously as follows:

1.0015 MHz, 1 Vp-p ⟶ 100.15 kHz, 2 Vp-p

(21) Select "SYNT" by ②.

(22) Select sine waveform (∿) by ③.

(23) Select "FREQ" by ⑦.

(24) Input 1 . 0 0 0 0 MHz by ⑮ and ⑯.
At this stage, "1.0000 MHz" is displayed in ⑬.
The frequency of synthesizer can be specified in up to five digits.

(25) Select "AMPL" by pressing ⑧.

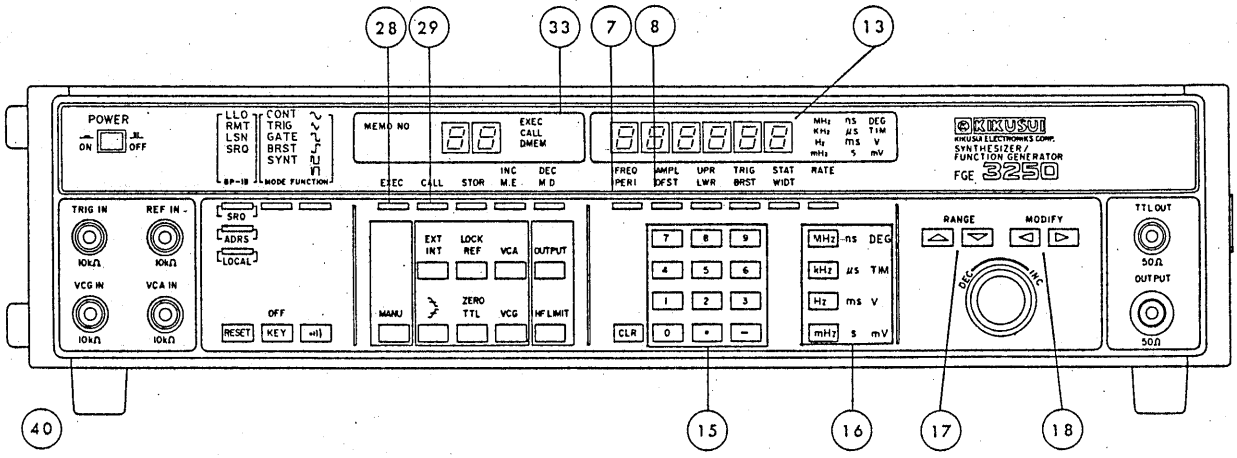
(26) Input 1 V by ⑮ and ⑯.

(27) Select "OFST" by pressing ⑧ again.

(28) Input 0 V by ⑮ and ⑯.

The first setting is completed by the above operation.
The next operation is to increase the frequency to 1.0015 MHz in units of 100 Hz.

(29) Select "FREQ" by ⑦.



(30) Select the lowest digit by "MODIFY" switch by (18).
* The selected digit flickers in the display section in (13).
Use the cursors (◁ and ▷) for selecting digits.

(31) Turn the rotary knob at (18) to the "INC" direction, and the frequency can be changed in units of 100 Hz.

(32) Since the places of digits are shifted automatically, the frequency can be set to 1.0015 MHz.

The next operation is to change the frequency and output voltage at the same time.

(33) Press the "CALL" button at (29).
Then, "CALL" is turned on in (33), meaning that the setting done hereafter will not affect the output signal until the "EXEC" button ((28)) is pressed.

(34) Select "FREQ" by (7).
* This operation may be omitted in this example because "FREQ" is already selected.

(35) Since the current frequency is 1.0015 MHz, press the downward cursor (▽) of "RANGE" at (17) once (to reduce the frequency to one-tenth).

By the above setting, "100.15 kHz" is displayed in (13). If the downward cursor is pressed again, "10.015 kHz" will be displayed.

(36) Select "AMPL" by (8).

(37) Input 2 1 by (15) and (16).

(38) Press the "EXEC" button at (28).

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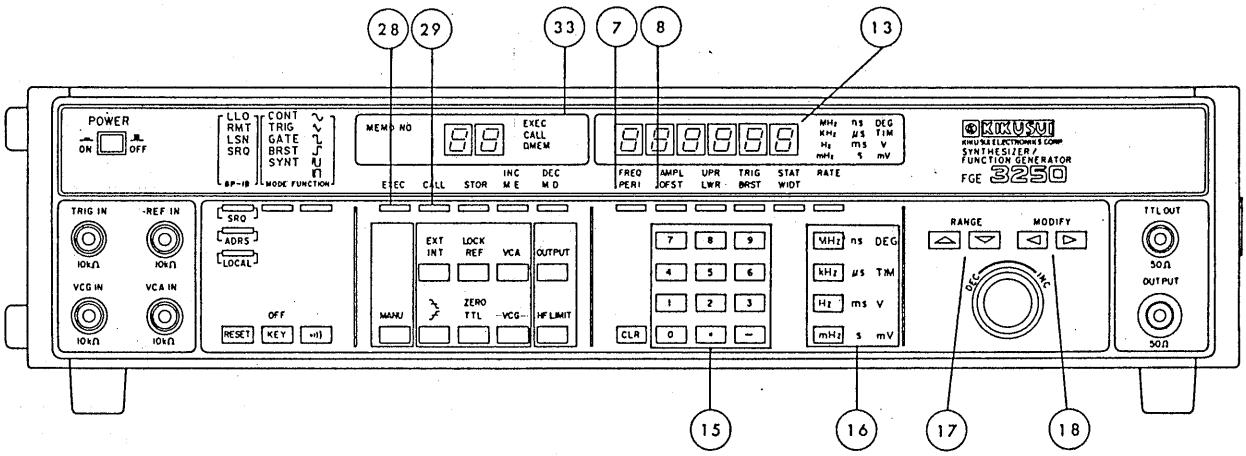
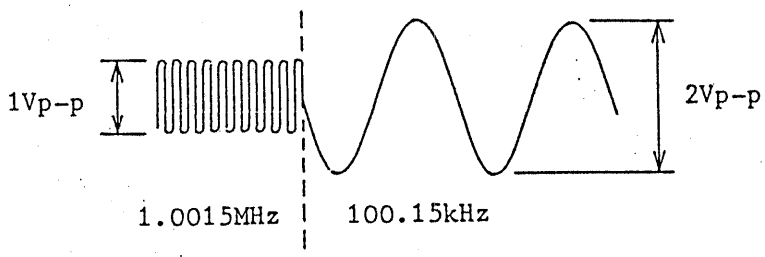
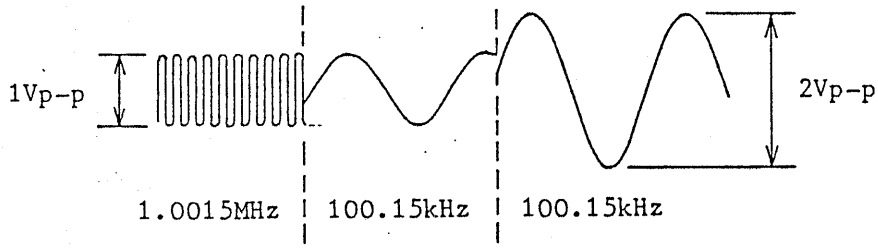


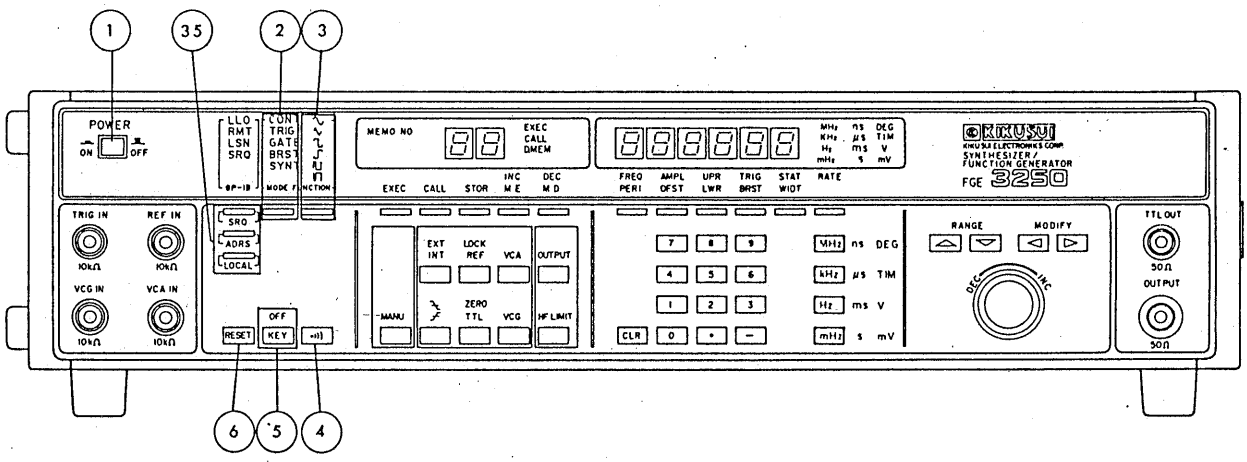
Now, both frequency and voltage of the output signal are changed at the same time. That is, as result of steps (33) to (38), the output signal changes as follows:



If the CALL and EXEC functions are not used, the output signal changes as follows:



Thus, by use of the CALL and EXEC functions, two or more conditions for an output signal can be changed simultaneously.



4.2 Front Panel Features

(1) POWER : Push-type power switch. When this switch is pressed and locked, power is supplied to the instrument.

(2) MODE : Oscillation mode selection switch. When this button is pressed, the current mode is switched to the next mode. The modes are switched in a loop as below. The indicator of the selected mode is turned on.

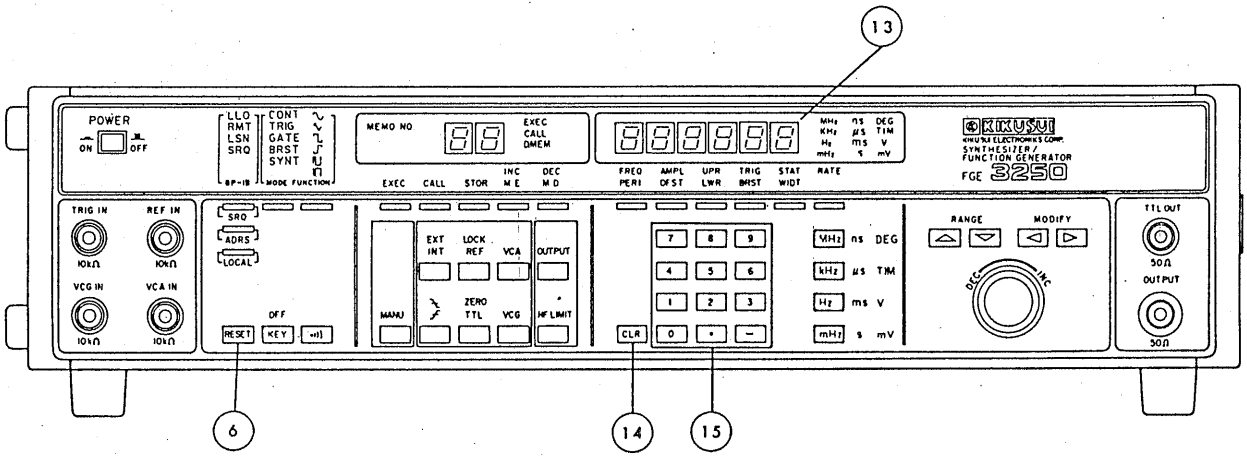
- CONT: Continuous oscillation mode
- TRIG: Triggered oscillation mode
- GATE: Gated oscillation mode
- BRST: Burst oscillation mode
- SYNT: Synthesizer oscillation mode (continuous)

(3) FUNCTION: Output waveform selection switch. When this button is pressed, the current waveform is switched to the next one. The waveforms are switched in a loop as follows:

- ∿ : Sine waveform
- △ : Triangle waveform
- ⊓ : Square waveform
- ⊓ : Square complement waveform
- ⊔ : Pulse waveform (variable pulse width)
- ⊓ : Pulse complement waveform (variable pulse width)

(4) •ı)) : ON/OFF switch for the beep sound generated when a tact switch on panel surface is pressed.

(5) KEY : Determines the effectiveness/ineffectiveness of the tact switches on panel surface. When this button is at the "OFF" position, no data can be input. Use this for preventing incorrect operations. This button does not affect the "SRQ", "ADRS", and "LOCAL" buttons at (35) .



(6) RESET : Reset button of the instrument. Use this button when an error or incorrect operation is found. When the instrument is reset, it enters the following initial state (the state found immediately after power input):

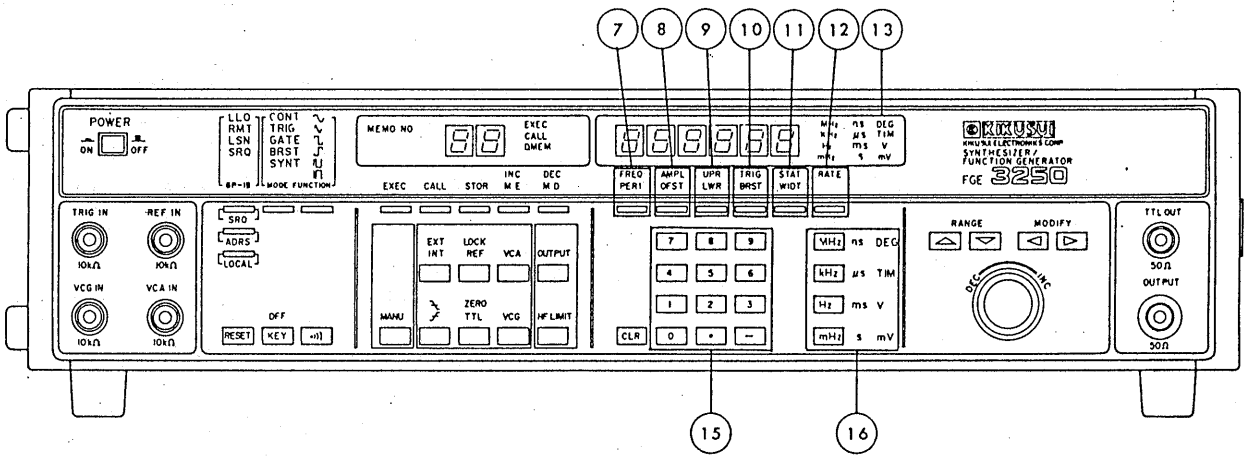
MODE	CONT	VCA	OFF
FUNCTION	∿	VCG	OFF
FREQ	1 kHz	OUTPUT	OFF
AMPLE	1V	HF LIMIT	OFF
OFFSET	0V	KEY	ON
UPR	500mV	•ı))	ON
LWR	-500mV	INT/EXT	INT
TRIG	1V	LOCK/REF	REF
BRST	2 TIME	ZERO/TTL	ZERO
START	0 DEG	∫ / ⅄	∫
WIDT	1μs		EXEC
RATE	10 ms	MEMO	OFF

In relation to the reset operation, the following functions are available:

(1) Lamp test
When power is turned on or "RESET" button is pressed, all the lamps light up for approximately 2 seconds.

(2) Memory all clear
If the "CLR" button ((14)) is pressed during lamp test, all the contents of memory (0 - 99) are cleared and "ALL CL" is displayed in (13) .
When other button is pressed after that, the lamp test is executed again and approximately 2 seconds later, the instrument is initialized and set in active state.

(3) Self-test program
If "1" in (15) is pressed during lamp test, a function diagnosis program is executed. See the section of the function diagnosis program for details.



⑦ - ⑫ : Group of selection switches and indicators to be used for data setting.
The items related to specific modes or functions are lighted, and the selected items flicker.
If an error is found in data setting, the error number is displayed in ⑬ and the item related to the error flickers. Flickering of two or more items means that the error has been found in the relationship between those items.
Use the keys in ⑮ and ⑯ for entering data.

⑦ FREQ/PERI: Use this button for determining whether the oscillation frequency is to be specified in units of hertz or time. The selected state is switched each time this button is pressed.
The relationship between frequency (F) and time (T) is as follows:

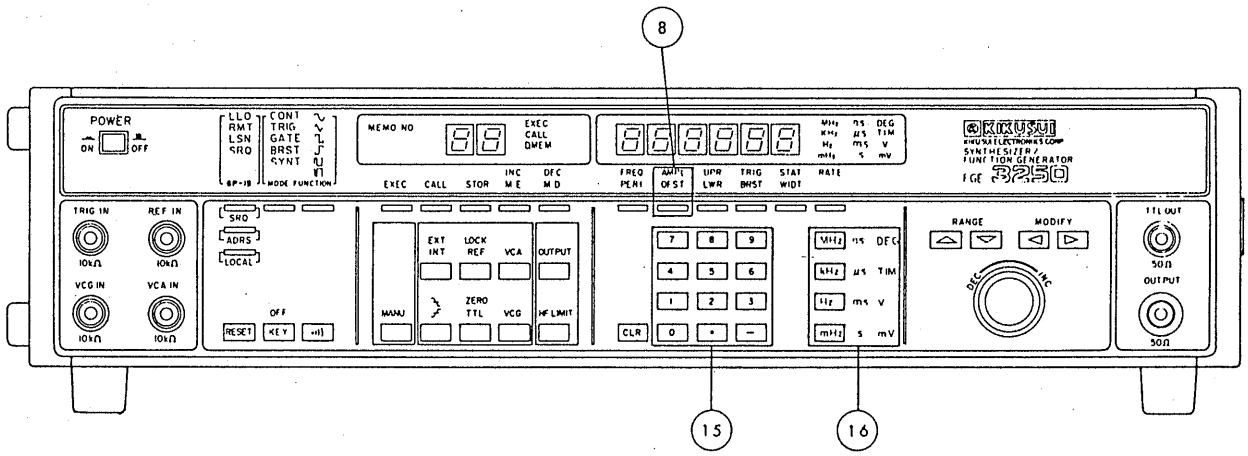
$$F = 1/T$$

The values to be specified by ⑮ and ⑯ must be within the following ranges:

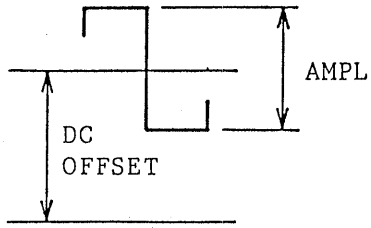
"SYNT" mode : 5 digits for frequency and 3 digits for time 10.000 Hz (100 ms) to 20.000 MHz (50.0 ns)

Other than "SYNT" mode: 3 digits for both frequency and time
1.00 mHz (1000 s) to 20.0 MHz (50.0 ns)

* The "FREQ"/"PERI" button can also be used for knowing the period (time) of the specified frequency or the frequency of the specified period. Press this button, and the frequency or period is displayed.



(8) AMPL/OFST: Amplitude or DC offset selection button.
When "AMPL" is selected, the amplitude is to be specified. The amplitude is calibrated at the peak-to-peak voltage obtained when the terminal is terminated with 50Ω.
When "OFST" is selected, the DC offset is to be specified.
The DC offset is calibrated at the peak voltage obtained when the terminal is terminated with 50Ω.



* Normally, without load, the output voltage value is twice as large as the set value.

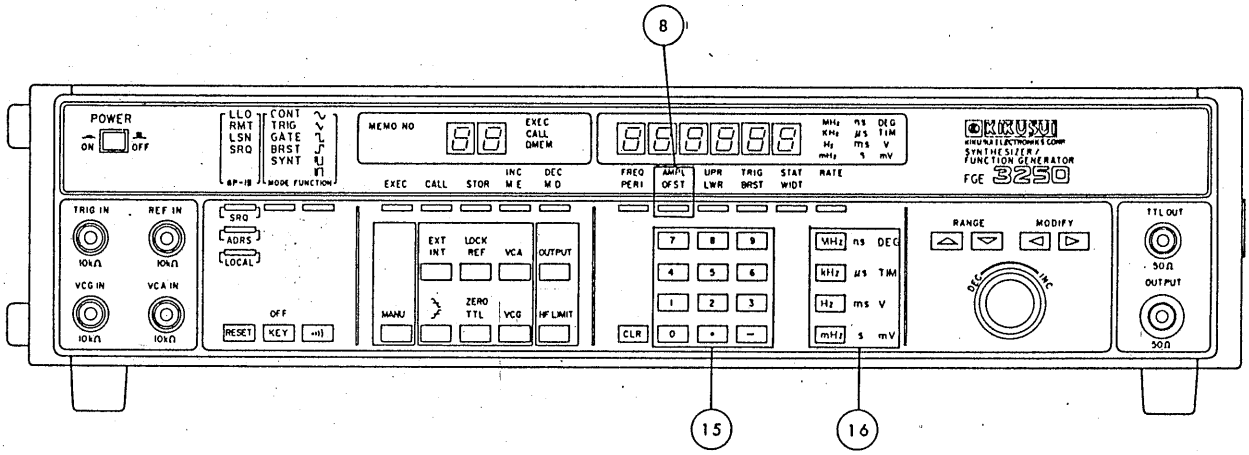
For both "AMPL" and "OFST", the values must be specified by (15) and (16) within three digits. The specification ranges are as follows:

	AMPL(Vp-p)	OFST(Vpeak)
A	15.0V - 500mV	0 - ±7.50V
B	499mV - 50mV	0 - ±750mV
C	49.9mV - 10.0mV	0 - ±75.0mV

For A: $\frac{AMPL}{2} + |OFST| \leqq 7.50V$

For B: $\frac{AMPL}{2} + |OFST| \leqq 750mV$

For C: $\frac{AMPL}{2} + |OFST| \leqq 75.0mV$

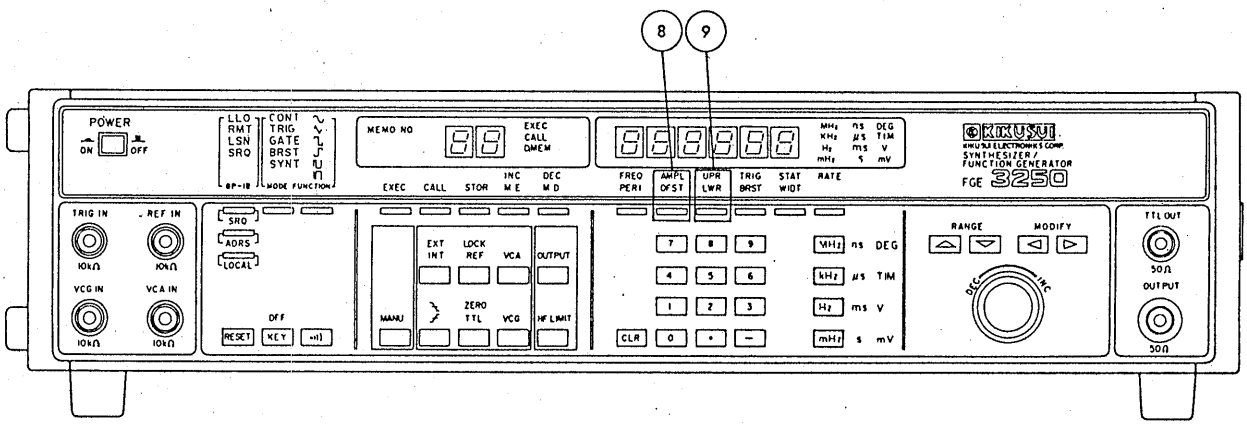


For the DC output (amplitude = 0V), a desired voltage can be generated by specifying "OFST".
The range of "OFST", however, is restricted by the way of specifying the amplitude (0V) as follows:

ZERO V setting ⑮ ⑯		OFST range ⑮ ⑯
0	V	0 - ±7.50V
00.0	V	
0.00	V	
000	mV	0 - ±750mV
00.0	mV	0 - ±75.0mV
0.00	mV	
0	mV	

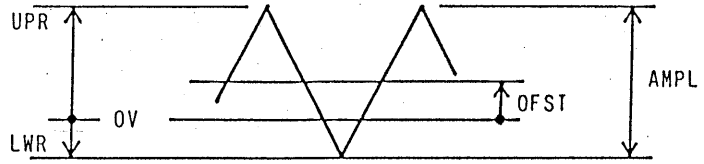
* According to the values specified for "AMPL" and "OFST", the built-in computer sets the relevant items automatically in order to put the instrument in the optimum operation state considering the operation range of each circuit. Since the operation range of each circuit is limited, an error may occur if a great DC offset is specified for a small amplitude.

See the section of operation principle for details.



⑨ UPR/LWR : Use this button for selecting the upper peak voltage ("UPR") or lower peak voltage ("LWR") of amplitude. The peak voltages are calibrated at the peak voltages obtained when the terminal is terminated with 50Ω. The voltages must be specified within three digits in the following range:

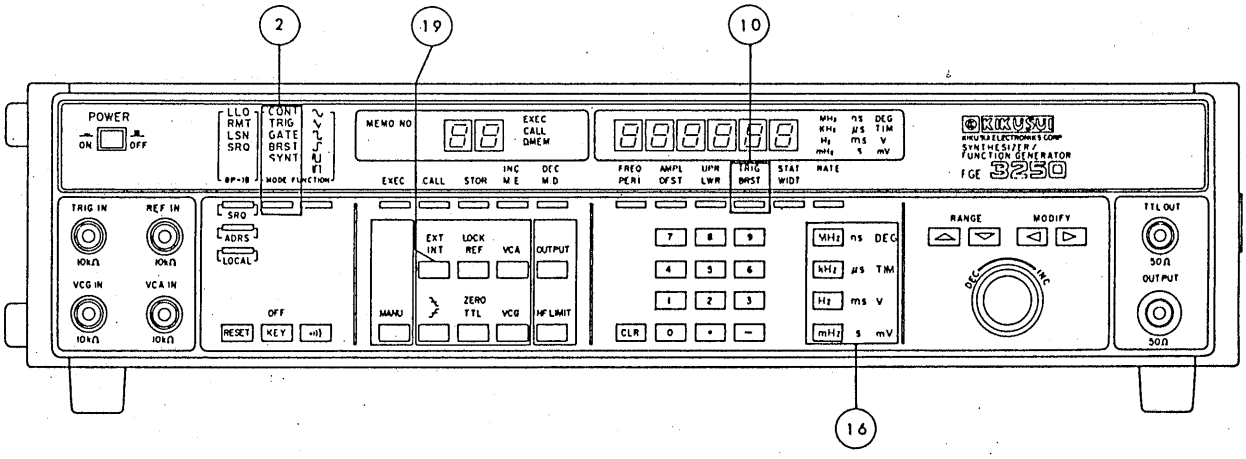
0 to ±7.50V



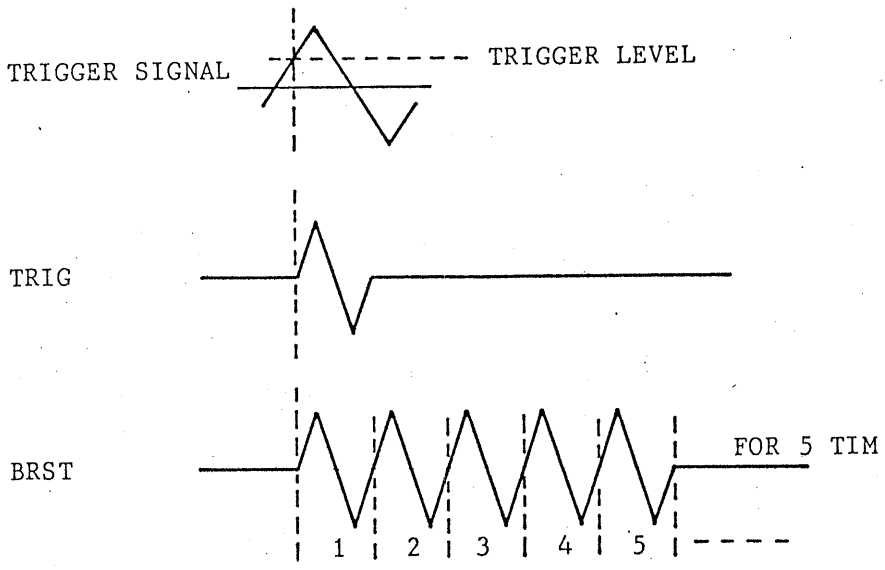
$$UPR = OFST + \frac{AMPL}{2}$$

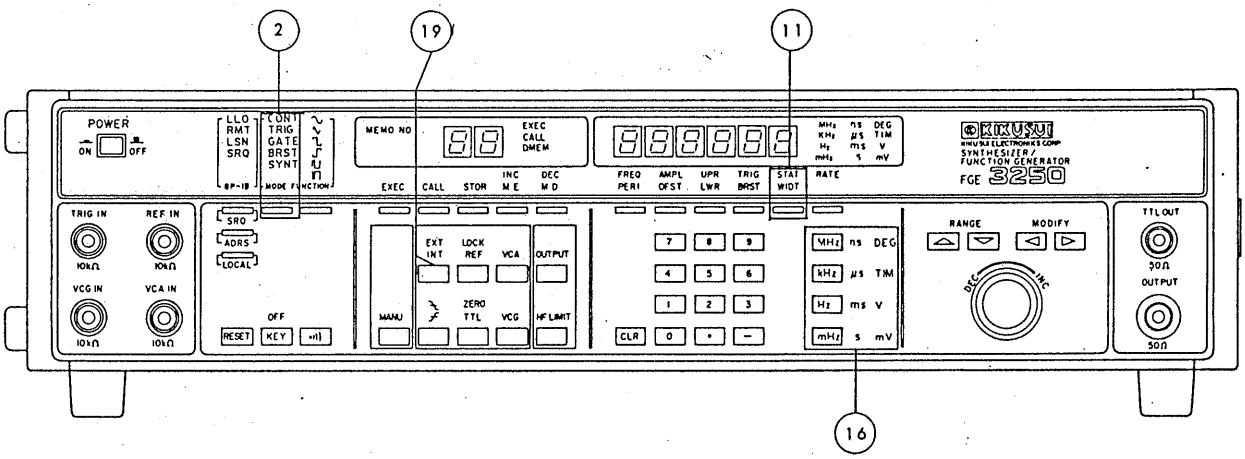
$$LWR = OFST - \frac{AMPL}{2}$$

* UPR, LWR, AMPL, and OFST are related to one another as shown in the above chart.



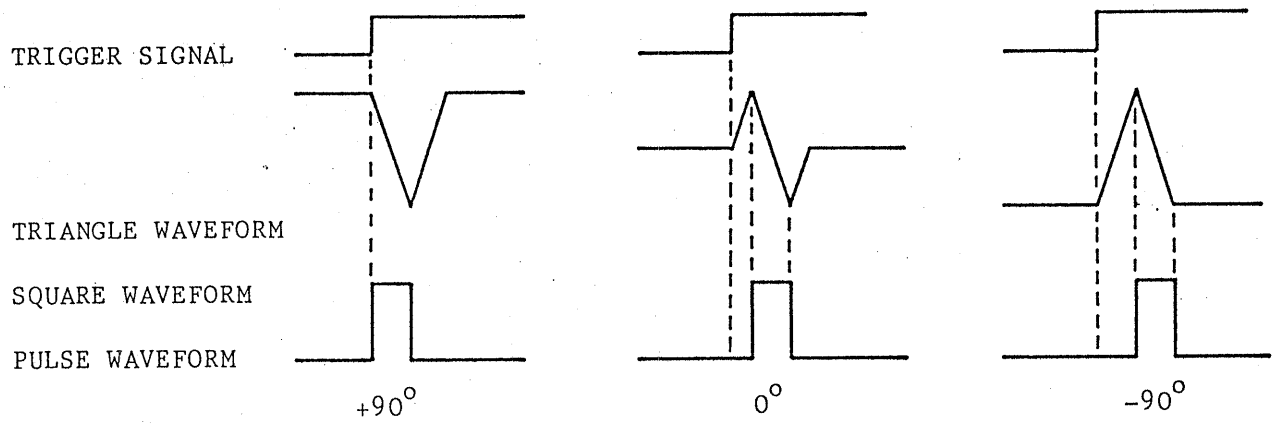
⑩ TRIG/BRST: Determines whether a trigger level is to be specified or a burst count is to be specified.
"TRIG" is effective when either "TRIG", "GATE", or "BRST" is selected by ② and "EXT" is selected by ⑲. When "TRIG" is selected, the user is to specify the level of the comparator for external trigger signal. The level must be expressed within three digits in the range from ±20 mV to ±10V in units of 20 mV.
"BRST" is effective when "BRST" is selected ②. In this mode, the user is to specify the number of burst waves by up to five digits within the range from 1 to 32767. As to the unit, select "TIM" (=TIME) by ⑯.



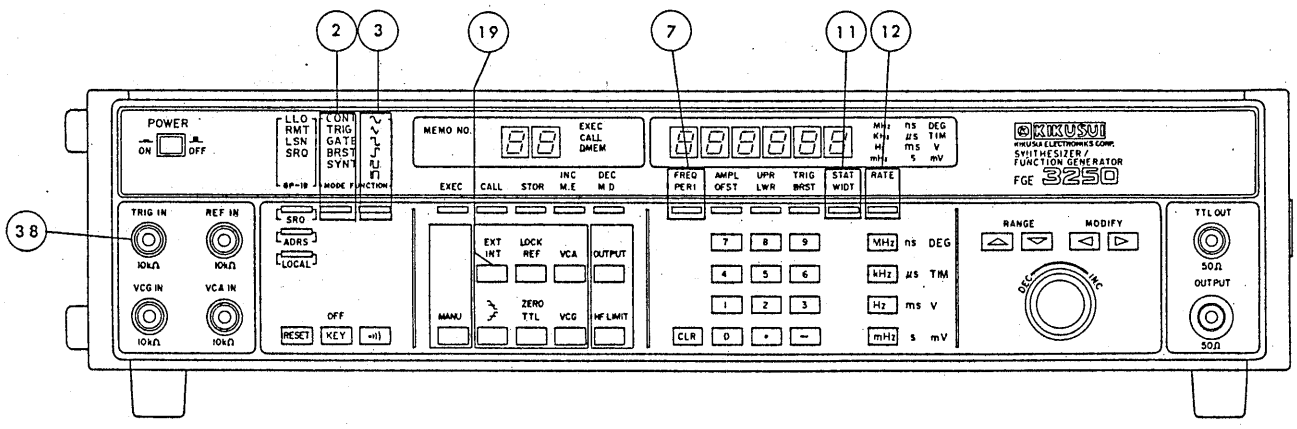


(11) STAT/WIDT: Determines whether a starting phase is to be specified or a pulse width is to be specified.
"STAT" is effective when either "TRIG", "GATE", or "BRST" is selected by (2). In this mode, specify the starting phase by two digits (resolution = 1 DEG) within the range of ±90 degrees. Select "DEG" by (16).

* If a decimal point is used in the input data, the figures below it will be ignored.



* If "INT" is selected by (19) for a signal of square or pulse waveform, the starting phase cannot be observed clearly by oscilloscope. In this case, compare this signal with the internal trigger signal output from "REF OUT" at (46) on the rear panel, and the starting phase can be observed easily.



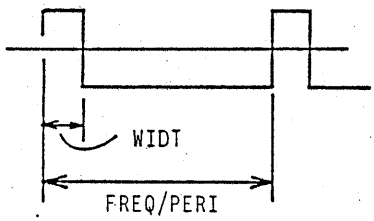
"WIDT" is effective when pulse waveform is selected by ③. Specify the pulse width within three digits.

When "CONT" or "SYNT" is selected by ②, the period is determined by "FREQ"/"PERI" ⑦, but when "TRIG", "GATE", or "BRST" is selected by ② and "INT" is selected by ⑲, the repetition cycle is determined by "RATE" ⑫.

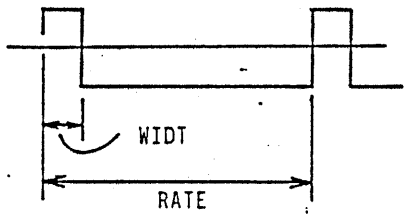
* If "EXT" is selected by ⑲, the repetition cycle is determined by that of the signal input to ㊳.

The pulse width must be specified within the range from 25 ns to 500 s, and the following condition must be satisfied:

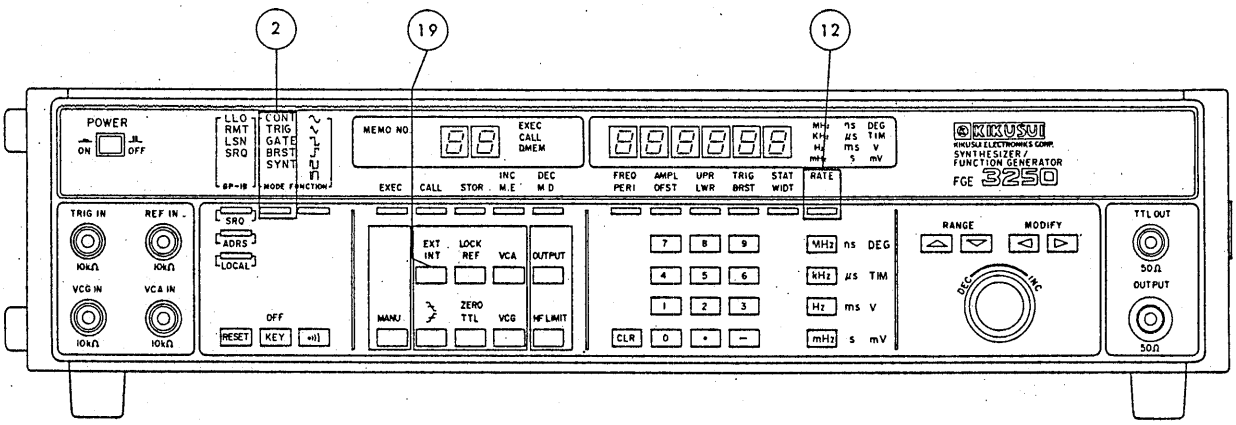
$$WIDT \leqq \frac{PERI}{2} \quad \text{or} \quad WIDT \leqq \frac{RATE}{2}$$



"CONT" or "SYNT" is selected by ②



"TRIG", "GATE", or "BRST" is selected by ② and "INT" by ⑲

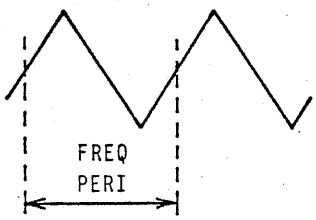


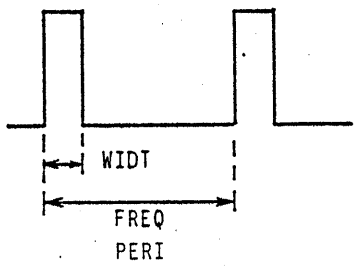
⑫ RATE : This button is effective when "TRIG", "GATE", or "BRST" is selected by ② and "INT" is selected by ⑲.
In this mode, specify the period of the internal trigger created by internal oscillator.
The period must be specified by three digits within the range from 50 ns to 1000 s, and the following conditions must be satisfied:

$$\text{RATE} \geqq \text{WIDT} \times 2$$
$$\text{RATE} \geqq \text{PERI}$$

* Relationship among FREQ, PERI, WIDT, and RATE

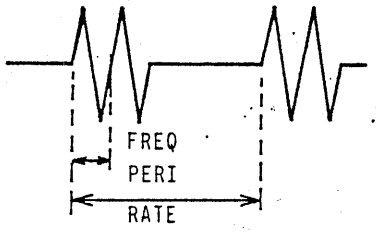
(1) When "CONT" or "SYNT" is selected by ②:

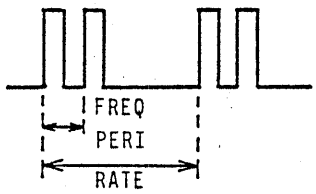




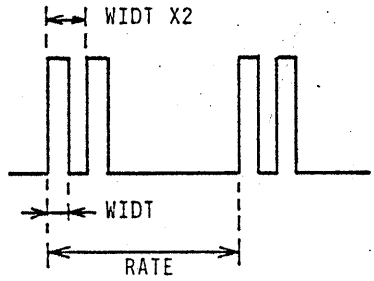
(PULSE WAVEFORM)

(2) When "TRIG", "GATE", or "BRST" is selected by ②:

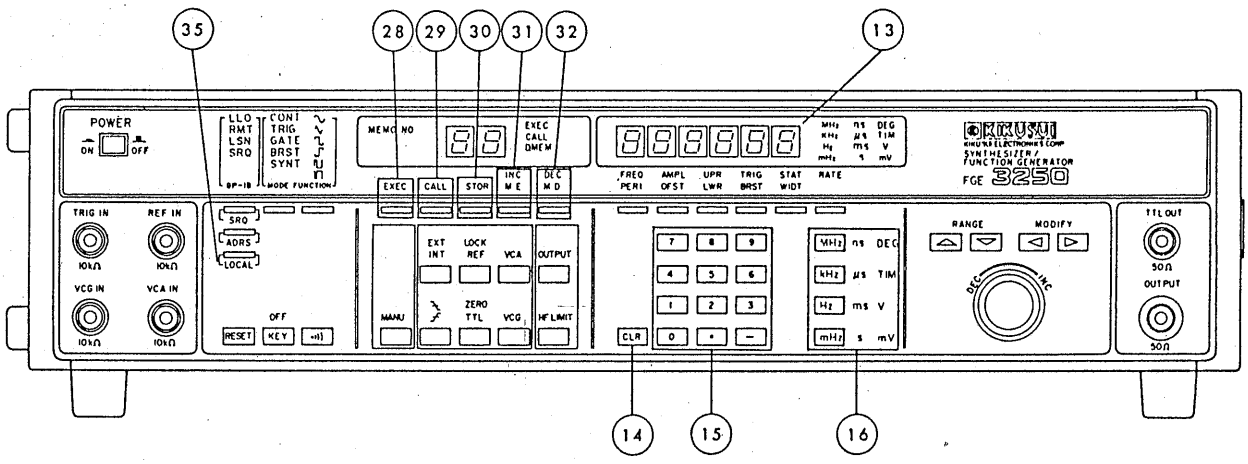




(SQUARE WAVEFORM)



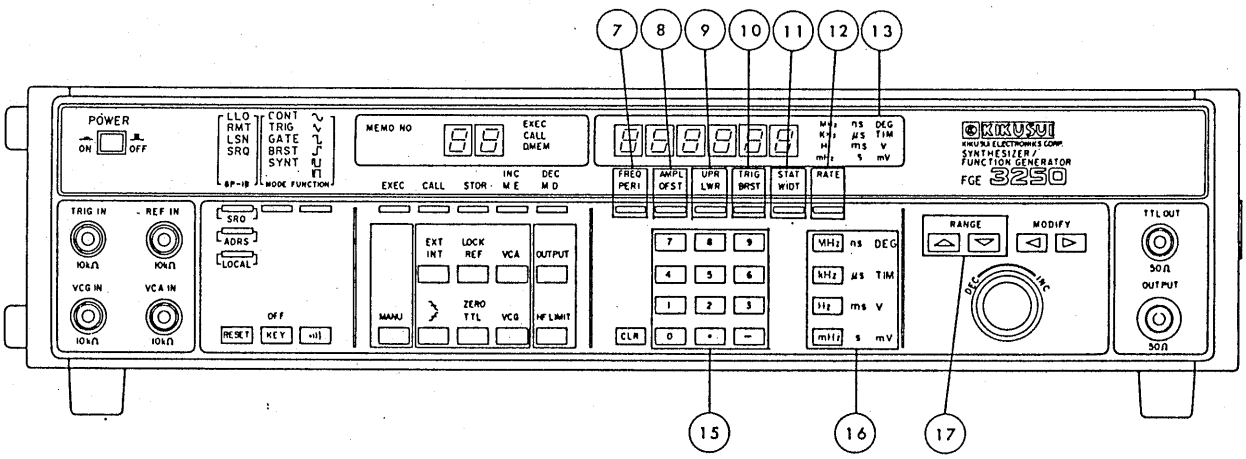
(PULSE WAVEFORM)



⑬ Display section : Displays the numeric data specified by ⑮ and turns on the lamp of the unit specified by ⑯.
The numerals given by the keys of ⑮ are displayed from left to right in the order of the pressing of the keys.
This section also displays error message numbers.
The unit to be used is determined by the specified mode as follows:

FREQ	mHz, Hz, kHz, MHz
PERI	S, mS, μS, nS
WIDT	
RATE	
AMPL	mV, V
OFST	
UPR	
LWR	
TRIG	
BRST	TIM
STAT	DEG

⑭ CLR : Clears the numeric data input by ⑮. Press this button before any of the unit keys (⑯) or memory control switches (㉘ - ㉜), and the input data can be cleared.
Also, this button releases the instrument from the error state caused by the input of ⑮ and ⑯ and sets it in the state found before the input. Note, however, that the errors caused by external input (GP-IB) cannot be cleared by this button. They can be cleared by the pressing of "LOCAL" button (㉟).



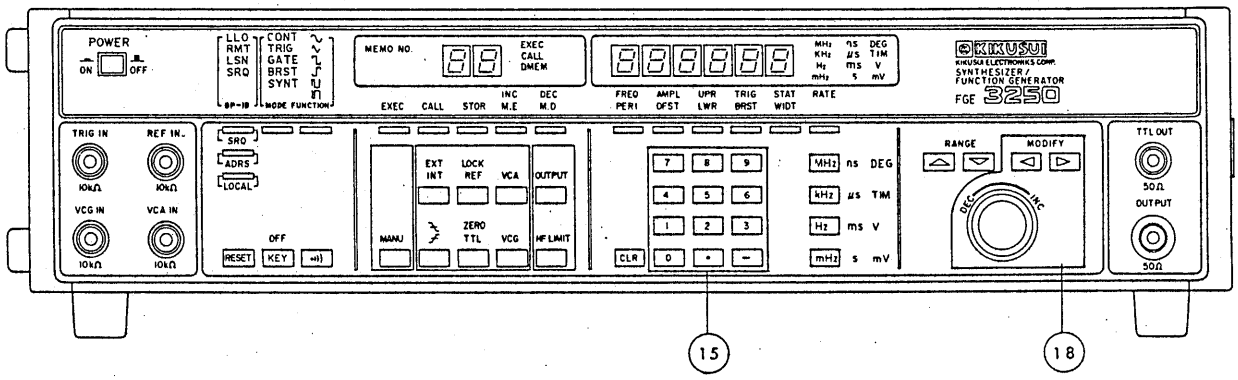
⑮ Numeric data input keys:

Use these keys in combination with the unit keys at ⑯. The number of effective digits is defined for each one of the modes ⑦ to ⑫.
If an error is reported because wrong data has been input, input correct data, and the error will be released.

⑯ Unit keys: Press one of these keys after the data input by ⑮. When the unit key is pressed, the input data is taken by the instrument.
The relationship between unit and mode is described in Item ⑬.

⑰ RANGE : Specifies the ranges of frequency, time, and voltage. Each time the upward or downward cursor is pressed, the frequency, time, or voltage is increased by ten times or decreased to one-tenth respectively.
The functions of these cursors are equivalent to those of unit keys, but these cursors cannot be used when "DEG" or "TIM" is specified.

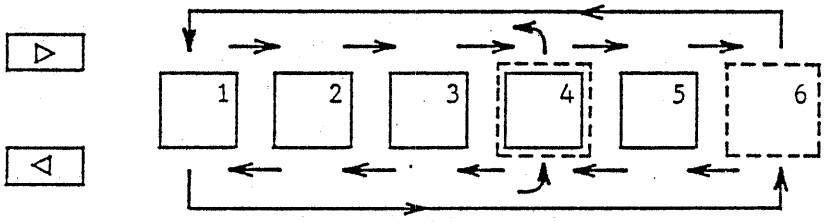
▲ : For higher frequency or voltage and longer time
▼ : For lower frequency or voltage and shorter time



⑱ MODIFY : Numeric data can be input not only by ⑮ but also
INC by a rotary knob.
DEC First, select a desired digit by a MODIFY switch (◀ or ▶), and the selected digit (position) flickers. Then, change the value of the numeric data at that position by turning the rotary knob.
The chart below shows how the flickering position is shifted when each MODIFY switch is pressed. Note some of the positions do not flicker even if they are selected.

* When FREQ is specified in SYNT mode, position 6 does not flicker; in other cases, position 4 does not flicker.

If the flickering is annoying after the data has been set, select position 4 or 6.



If carry or borrow occurs in the numeric data, the flickering position is shifted but the resolution remains unchanged.

INC
9.90 kHz ⟶ 10.0 kHz (Resolution = 100 Hz)
DEC
1.00 kHz ⟶ 900 Hz (Resolution = 100 Hz)

* If the digit of the specific resolution exits no longer as a result of carry or borrow, the numeric data value stops changing.

INC
9.99 kHz ⟶ 10.0 kHz (Changes no more.)
(Resolution = 10 Hz) (The resolution goes to 100 Hz.)

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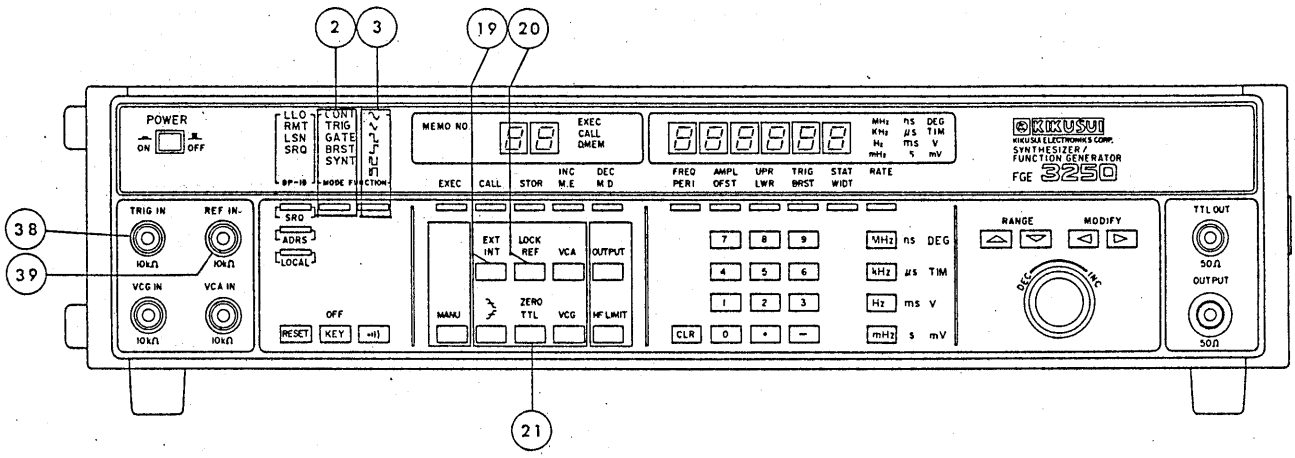


⑲ EXT/INT :

	② TRIG, GATE, BRST	SYNT
EXT	External trigger signal (㊳ TRIG IN)	External reference signal (㊴ REF IN)
INT	Internal RATE signal	Internal reference signal (10 MHz)

⑳ LOCK/REF: This button is effective when "SYNT" and "EXT" are selected by ② and ⑲ respectively.

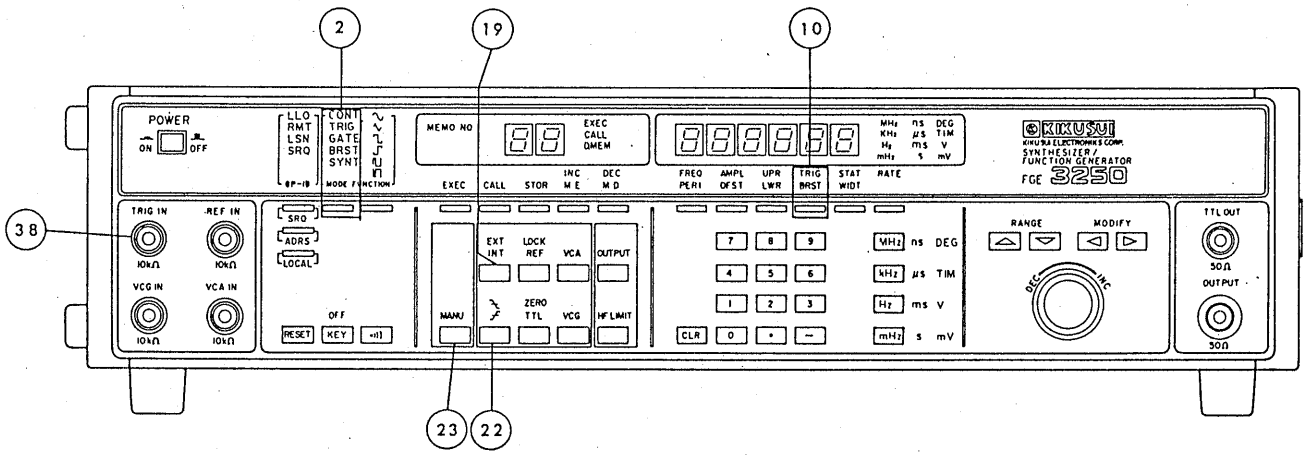
LOCK: If an external signal whose frequency may deviate from the specified frequency within the range of ±5% is input from ㊴ , the phase of the signal generated by the instrument will be locked to that of the external signal. If the phases are not locked, the "SYNT" indicator at ② flickers.

* In the "LOCK" mode, a pulse waveform must not be selected by ③.

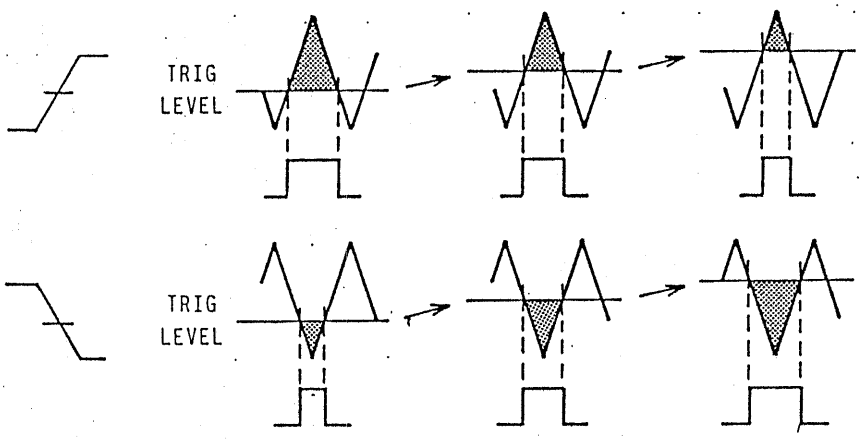
REF: The internal reference clock signal (10 MHz) is replaced by external reference signal. (Apply the external reference signal to ㊴ .)

㉑ ZERO/TTL : This button is effective when "SYNT" and "EXT" are selected by ② and ⑲ respectively.
This button selects the level of the comparator for the external signal used by ⑳ .

ZERO: Zero-crossing signal (0V)
TTL : TTL signal (+1.4V approx.)



(22) ⨍ / ⨍ : This button is effective when "TRIG", "GATE", or "BRST" is selected by (2) and "EXT" is selected by (19). It selects the trigger slope of the external trigger signal input from (38). The trigger level is specified by "TRIG" ((10)).



(23) MANU : Manual trigger button effective when "TRIG", "GATE", or "BRST" is selected by (2) and "EXT" is selected by (19).

TRIG: Press the "MANU" button once, and one trigger signal is generated (1 cycle).

GATE: The gate signal is generated continuously while the "MANU" button is being pressed.

BRST: Press the "MANU" button once, and the specified number of burst signal is generated.

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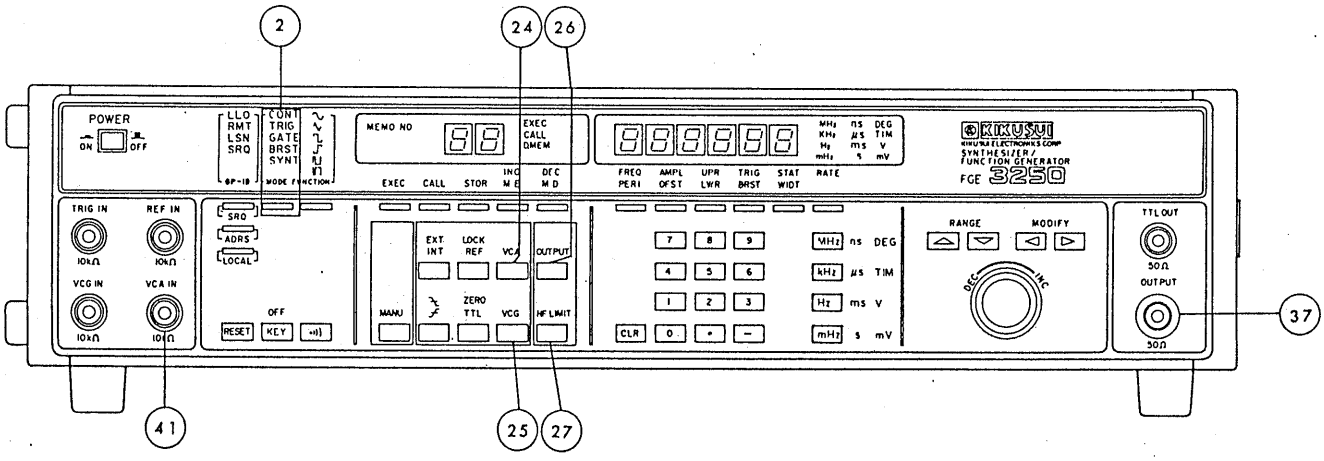
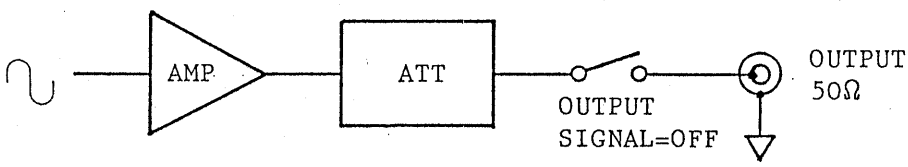


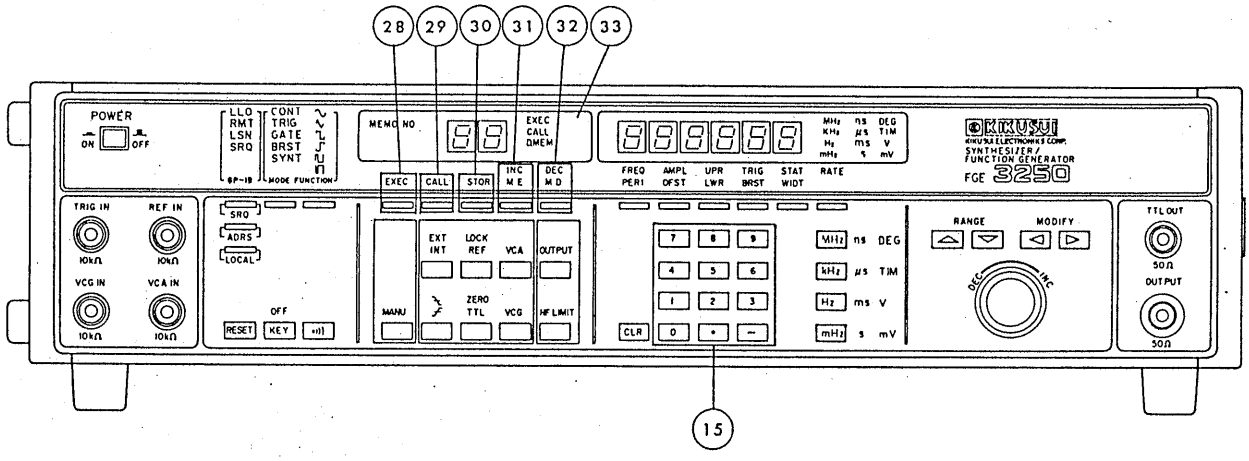
(24) VCA : Determines whether the output amplitude is to be controlled by external analog voltage or not. The output amplitude can be changed within the range from 0 dB to -30 dB at the maximum output voltge. Apply the external analog voltage to (41) or (48). Use the "VCA" function for obtaining amplitude modulation (AM) signals.

(25) VCG : Determines whether the oscillation frequency is to be controlled by external analog voltage or not. When the internally set frequency is "0", the oscillation frequency can be increased by 1,000 times or more at the maximum voltage. Apply the external analog voltage to (40) or (47). Use the VCG function for obtaining frequency modulation (FM) signals.
The "VCG" button is not effective when "SYNT" is selected by (2).

(26) OUTPUT : Output signal (at (37) or (43)) ON/OFF button.
The output signal is ON when the "OUTPUT" indicator is on.
When the output signal is OFF, the output terminal is opened.



(27) HF LIMIT : Cuts the high frequency component of output signal. When this button is turned on, its indicator lights up. The -3 dB attenuation frequency is approximately 9 MHz for sine waveform and 7 MHz for triangle waveform. If this button is turned on for a signal of square waveform, it will take approximately 40 ns for the signal to rise or fall.



(28) EXEC : This button can be used in two ways as follows:

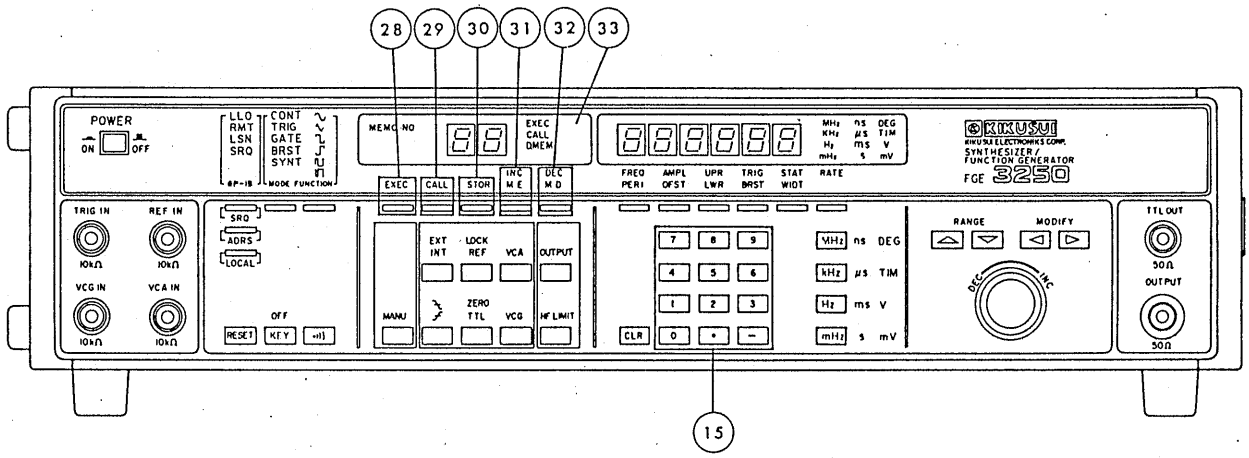
(1) Simultaneous execution of two or more conditions

When two or more conditions of an output signal are to be changed simultaneously, use this button after specifying all the necessary conditions in CALL mode.
Since, in the CALL mode, the setting of switches does not affect the output signal, specify the conditions in this mode and press the "EXEC" button. Then, a signal of the newly specified conditions will be output.

(2) Execution with memory specification

To use the conditions of an output signal stored in memory, input the memory number (0 - 99) by (15) and press the "EXEC" button. Then, the memory number will be displayed in (33) and the output signal will be changed.

* If the memory number is to be incremented or decremented sequentially, specify only the first memory number and use (31) ("INC") or (32) ("DEC"). In this way, the memory number can be updated easily.
* If the "EXEC" button is pressed for a memory area containing no information or for a disabled memory area, an error will be reported. For other points, see Items (31) and (32).
* For both (1) and (2), the "EXEC" indicator in (33) is turned on.



(29) CALL : This button can be used in two ways as follows:

(1) Simultaneous execution of two or more conditions

When the "CALL" button is pressed, the specified conditions are displayed on the panel but the oscillator section is disconnected from the panel display.
Therefore, even if the setting on the panel is changed, the output signal is not affected until the "EXEC" button is pressed.

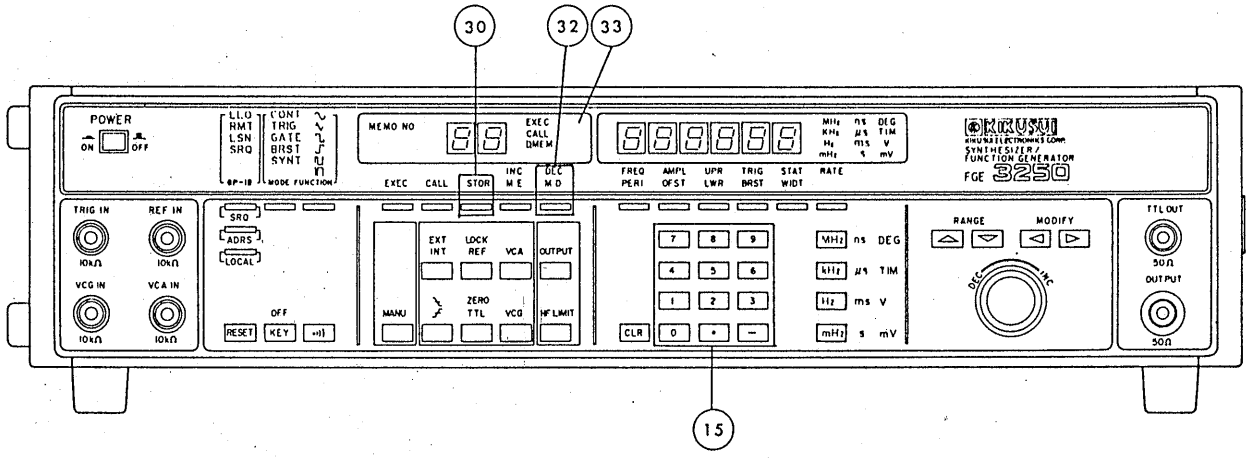
(2) "CALL" with memory specification

To check the content of a memory area, input the relevant memory number (0 - 99) by (15) and press the "CALL" button. Then, the memory number is displayed in (33) but the output signal remains unchanged.

* If the memory number is to be incremented or decremented sequentially, specify only the first memory number and use (31) ("INC") or (32) ("DEC"). In this way, the memory number can be updated easily.
* For both (1) and (2), the "CALL" indicator in (33) is turned on.
  If a memory area containing no data is specified, an error will be reported; if a disabled memory area is specified, the "D.MEM" indicator will be turned on.
* If an inexecutable condition is specified, an error is not reported in CALL mode but it will be reported in EXEC mode.

EXAMPLE:

If "AMPL = 14.0V, OFST = 4.00V" is specified, the plus peak of the output signal would be +11V. Since the output peak voltage must not exceed ±7.5V, an error will be reported in the EXEC mode.
If an evidently incorrect condition, such as "FREQ = 25 MHz", is specified, an error will be reported even in the CALL mode.



(30) STOR : Use this button for writing data (conditions) into memory.

(1) Memory number specification "STOR"

After setting conditions on the panel, input a memory number (0 - 99) by (15) and press the "STOR" button.
Then, the conditions will be memorized by the memory area of the specified memory number, which is displayed in (33) .

(2) Increment "STOR"

Press the STOR button when "MEMO NO" is displayed in (33) , and the memory number will be automatically incremented by 1 and data will be stored in the area of the new memory number (displayed in (33)).
Use this function for specifying different sets of conditions continuously.

* The data is written regardless of the memory adresses disabled by the "M.D" (Memory Disable) button of (32) .
* The conditions to be memorized may be specified by the following 22 items:

MODE		VCG ON/OFF	LWR
FUNCTION		OUTPUT ON/OFF	TRIG
TRIG	INT/EXT	HF LIMIT ON/OFF	BRST
	⨍ / ⨍	FREQ	STAT
SYNT	INT/EXT	PERI	WIDT
	LOCK/REF	AMPL	RATE
	ZERO/TTL	OFST	
VCA	ON/OFF	UPR	

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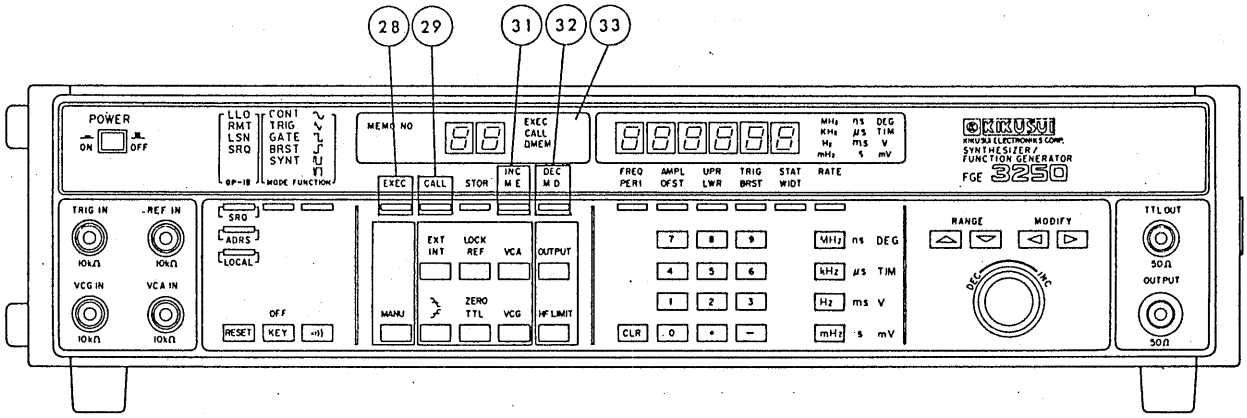


(31) INC/M.E :

(32) DEC/M.D :

(1) "INC", "DEC"

* Operation after the pressing of "EXEC" ((28)) or "CALL" ((29)) button.

Use the "INC" and "DEC" switches for updating memory number for "EXEC" or "CALL".

In the "EXEC" mode, the memory areas containing no data and disabled memory areas are skipped.

In the "CALL" mode, the memory areas containing no data are skipped, but the disabled areas are indicated by their memory numbers displayed with the lighting of the "D.MEM" indicator in (33) .

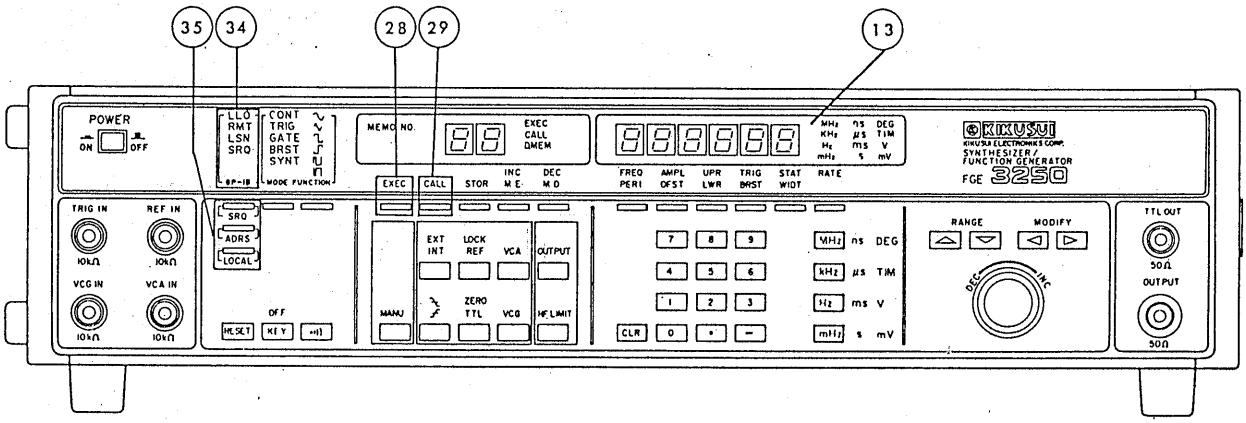
(2) "M.E", "M.D"

Specify the number of a disabled memory area and press the "M.E." (Memory Enable) button; then, that area will be enabled.

Specify the number of an enabled memory area and press the "M.D" (Memory Disable) button; then, that area will be disabled.

* When the "M.D" button is pressed, the "D.MEM" indicator in (33) is turned on.

* Programmed memory contents can be masked and recovered by the "M.D" and "M.E" switches respectively.



(33) Memory section display:

"MEMO NO.": Memory number (0 - 99)
Comes on when the memory is used.

"EXEC" : Execution indicator
Comes on when the "EXEC" button ((28)) is used.

"CALL" : Comes on when the "CALL" button ((29)) is used.

"D.MEM" : comes on when the specified memory number is disabled.

(34) GP-IB display:

Indicates the status of the instrument in GP-IB mode.

"LLO" : Local lock-out

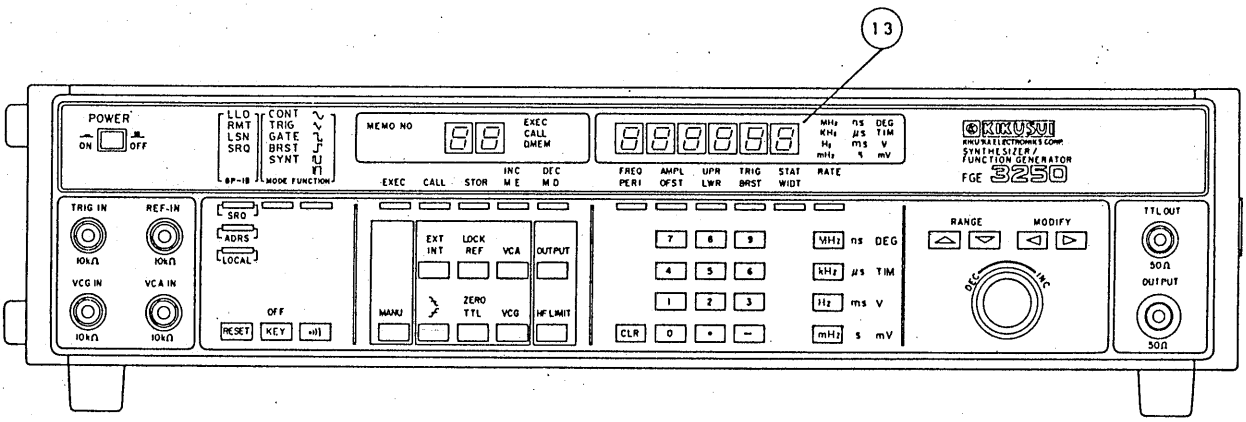
"RMT" : Remote

"LSN" : Listener

"SRQ" : Transmit a service request

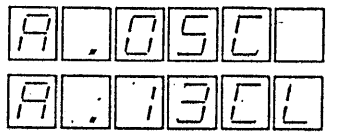
(35) "SRQ", "ADRS", "LOCAL":

"SRQ" : For "KEY SRQ ON" (See the section of GP-IB)
When the "SRQ" button is pressed, a service request signal is generated on bus line and the "SRQ" indicator in (34) is turned on till the status byte is read by the controller through serial polling.
Use this button for issuing a service request to the controller.



ADRS : Press the "ADRS" button, and the device address and terminator specified by switch (50) on the rear panel will be displayed in (13). Press any other button, and (13) will be cleared.

EXAMPLE:



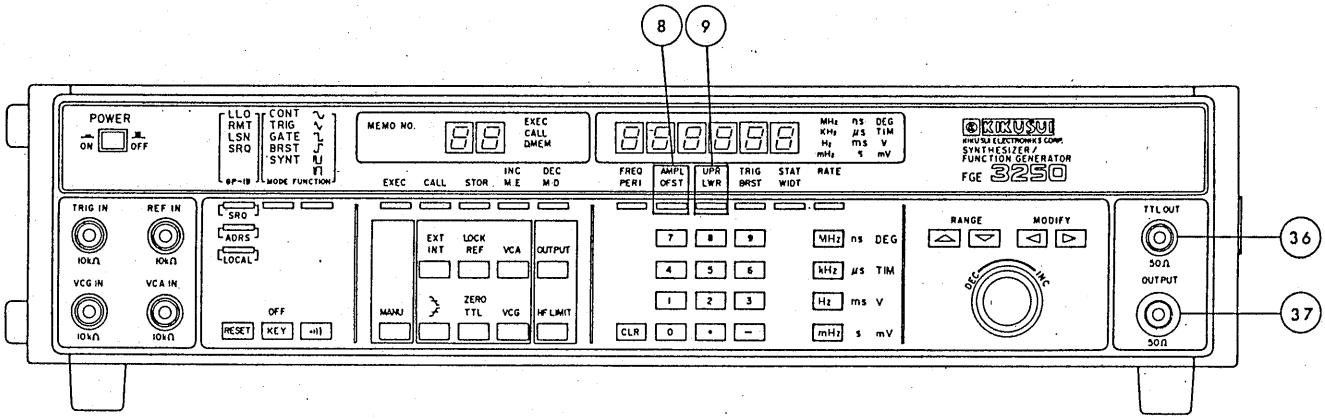
Address 5 CR

Address 13 CR+LF

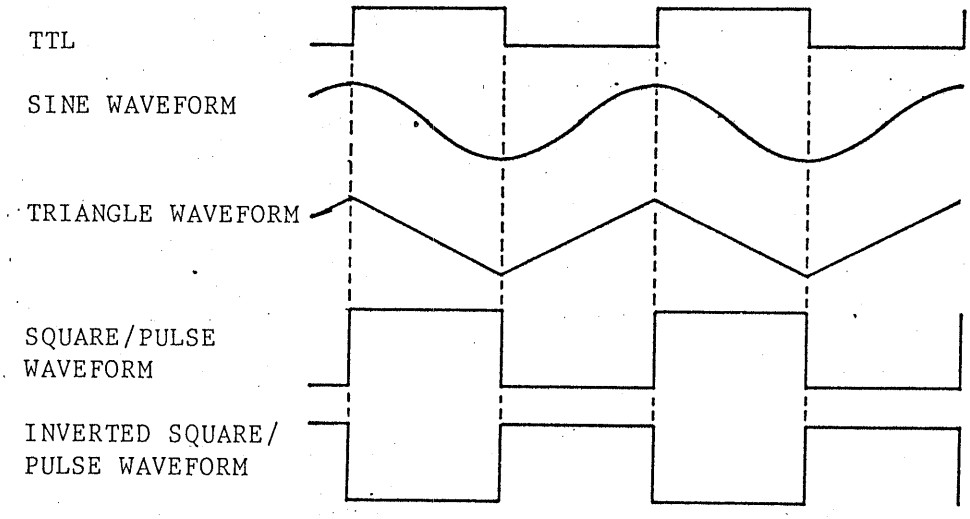
* After changing the address or terminator, press the "ADRS" button.

LOCAL : Press the "LOCAL" button when the instrument is in remote ("RMT") mode, and it will be set in local mode.

* This button is ineffective in "LLO" (Local lock-out) mode.

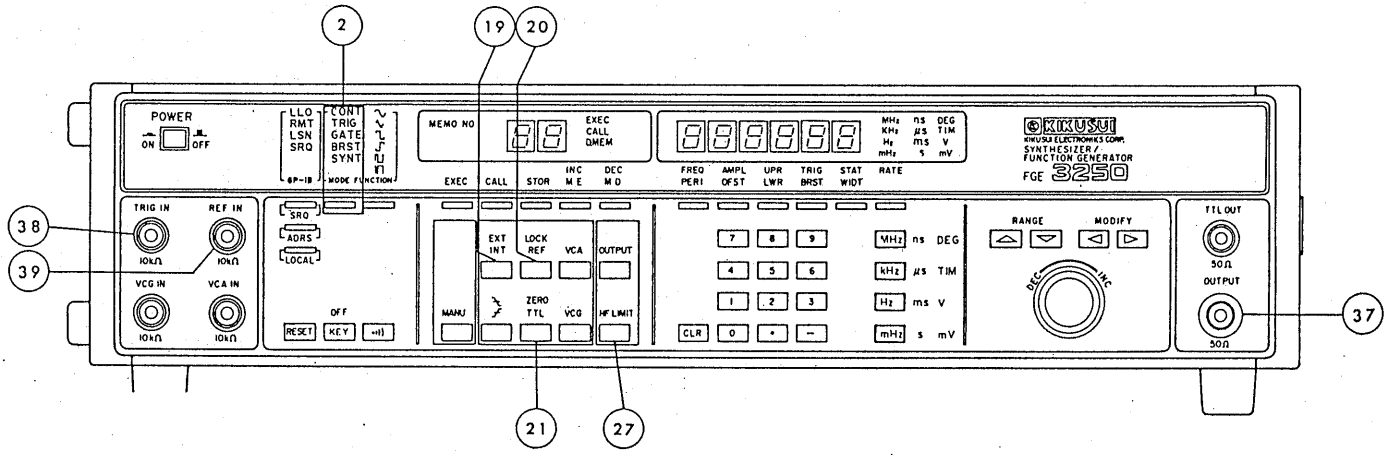


(36) TTL OUT : Output terminal of the TTL level signal synchronized with oscillation frequency.
The output impedance is 50Ω, and the relationship between this signal and each waveform with respect to phase is as follows:



(37) OUTPUT : Output terminal of the signal specified in each mode.
The output impedance is 50Ω, and the maximum output amplitude is 30 Vp-p (15 Vp-p for 50Ω termination) at open circuit.

* The values for "AMPL"/"OFST" ((8)) and "UPR"/"LWR" ((9)) are calibrated at the values obtained when the terminal is terminated by 50Ω. Be sure to use a 50Ω coaxial cable (3D-2V, RG-58A/U, etc.) and terminate the cable by 50Ω. If the impedance is not matched correctly, good characteristics may not be obtained.



* If "HF LIMIT" ((27)) is used, good waveforms can be obtained even though the impedance may not be matched exactly. In this case, however, the frequency band is limited.

* The output terminal is also provided at (43) on the rear panel. To use this terminal, set switch (50) on the rear panel to the "R" position. (See the chart of rear panel in Section 4.3.)

F: Signals are output from terminal (37) on front panel.

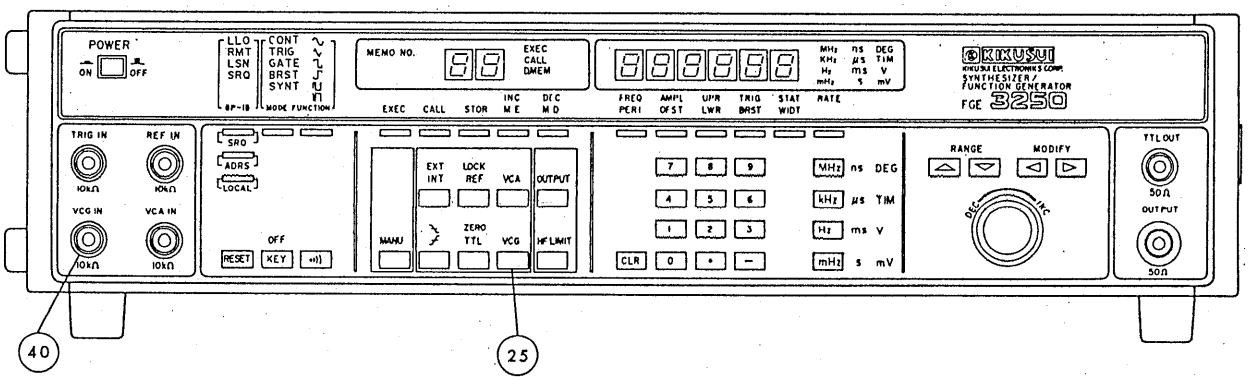
R: Signals are output from terminal (43) on rear panel.

(38) TRIG IN : External trigger signal input terminal used when "TRIG", "GATE", or "BRST" is selected by (2) and "EXT" is selected by (19) .

Maximum input voltage: ±30V
Maximum trigger level: ±10V
Input impedance : 10 kΩ

(39) REF IN : External reference signal input terminal used when "SYNT" is selected by (2). When "REF" is selected by (20) , input a signal of 10 MHz, and when "LOCK" is selected by (20) , input a signal of the frequency that may deviate from the internally set one within the range of ±5%. Select (21) according to the input signal level.

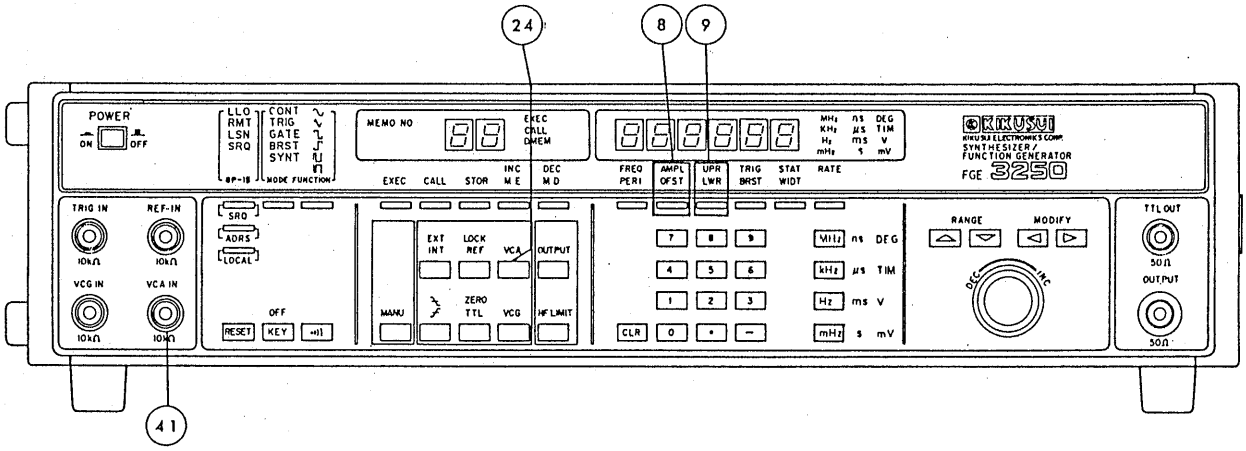
Maximum input voltage: ±30V
Input impedance : 10 kΩ



(40) VCG IN : External input terminal used in the "VCG" mode specified by (25).
The frequencies proportioned to 10 mV to 10V are obtained. The relationship between the internally set frequency and voltage is as follows:

0.001 Hz - 0.009 Hz	1 - 9 V
0.01 Hz - 0.099 Hz	1 - 9.9 V
0.1 Hz - 0.999 Hz	1 - 9.99V
1 Hz - 9.99 Hz	1 - 9.99V
10 Hz - 99.9 Hz	1 - 9.99V
100 Hz - 999 Hz	1 - 9.99V
1 kHz - 9.99 kHz	1 - 9.99V
10 kHz - 99.9 kHz	1 - 9.99V
100 kHz - 999 kHz	1 - 9.99V
1 MHz - 9.99 MHz	1 - 9.99V
10 MHz - 20 MHz	1 - 2 V

* The voltage corresponding to internal frequency is added to the voltage input from "VCG IN" terminal. So, if the oscillation frequency is to be determined only by the external voltage, set the internal frequency to 0 Hz.



* When the internal frequency is set to 0 MHz, 0 kHz, 0 Hz, or 0 mHz, a signal of low frequency is output, but this is not considered as an error.
* As to the control voltage, the following condition must be satisfied:

  10V ≧ (External input voltage + Internally set voltage) ≧ 10 mV
* Maximum input voltage: ±30V

EXAMPLE

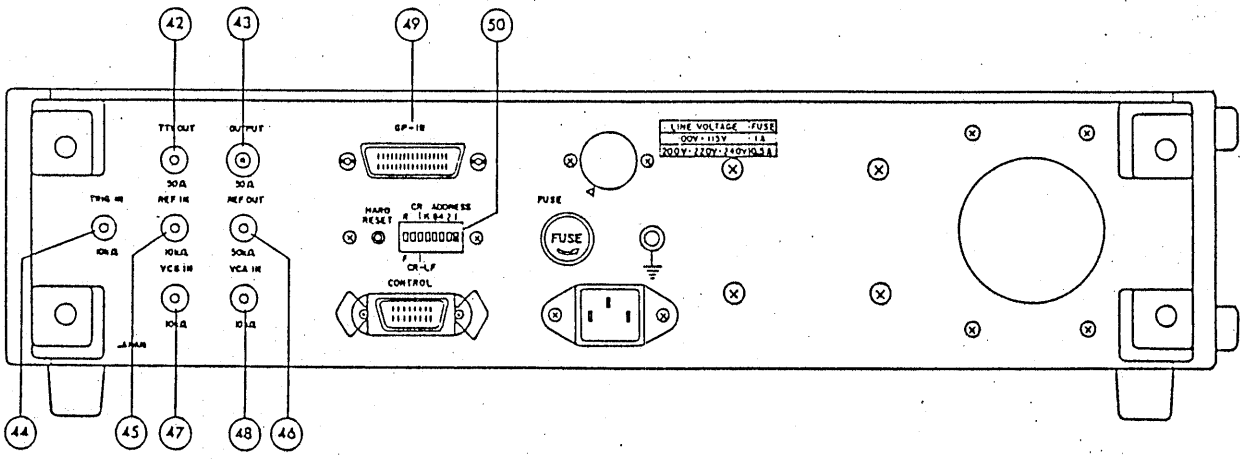
If the internal frequency is set to 3 kHz, which corresponds to 3V, the frequency of 3 kHz to 10 kHz can be controlled by the external voltage of 0V to 7V because 10V minus 3V is equal to 7V. If a negative voltage can be input, the frequency of 10 Hz to 10 kHz can be controlled by the voltage of -2.99V to 7V.

(41) VCA IN : External input terminal used in the "VCA" mode specified by (24).

The output amplitude can be controlled by external voltage. The relationship between the input voltage and output amplitude when "OFST" and "AMPL" are set to 0V is as follows:

AMPL setting	VCA IN input	Output
0.00 V	+10 V - 0	15 Vp-p - 0
000 mV		1.5 Vp-p - 0
00.0 mV		150 mVp-p - 0

* The output amplitude control range varies greatly with the values set for AMPL, OFST, UPR, and LWR. See the section of operation principles and use the VCA function carefully so that the waveforms may not be clipped.
* Even if a waveform is clipped, an error will not be reported. The errors related to amplitude are caused only by incorrect combination of (8) and (9).
* Maximum inpu voltage: ±30V



4.3 Rear Panel Features

(42) TTL OUT : The function of this terminal is the same as that of (36) on front panel. These two terminals must not be used at the same time.

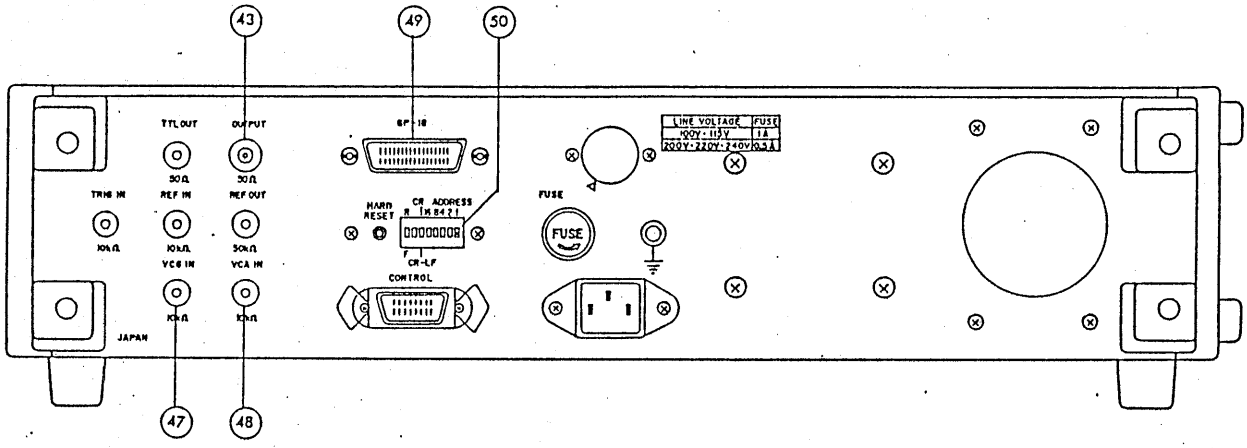
(43) OUT PUT : The function of this terminal is the same as that of (37) on front panel. The signal is output from this terminal when the switch at (50) is set to the "R" position.

(44) TRIG IN : The function of this terminal is the same as that of (38) on front panel. These two terminals must not be used at the same time.

(45) REF IN : The function of this terminal is the same as that of (39) on front panel. These two terminals must not be used at the same time.

(46) REF OUT : A TTL level signal is output. The output impedance is 50Ω.
The output TTL level signal varies by mode as follows:

(TRIG•INT)	Trigger signal of internal clock oscillator is output
(GATE•INT)	
(BRST•INT)	
Pulse signal	
(SYNT•INT)	Internal reference frequency (10 MHz)
SYNT EXT REF	Internal clock oscillator output ≒ Output frequency
SYNT EXT LOCK	"REF IN" signal is converted into TTL level signal and output REF IN=REF OUT
Other mode	No output L level



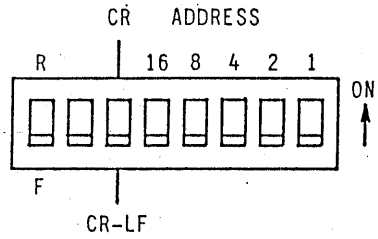
(47) VCG IN : The function of this terminal is the same as that of (40) on front panel. These two terminals must not be used at the same time.

(48) VCA IN : The function of this terminal is the same as that of (41) on front panel. These two terminals must not be used at the same time.

(49) GP-IP connector : Connects the instrument to GP-IB controller. Use a cable that conforms to the "IEEE-488" Standard. When using GP-IB, ground the case of the instrument and the controller for the purpose of safety and for preventing external noise. The GP-IB sub circuit is electrically insulated from the instrument case and oscillator input/output terminals.
* See the section of GP-IB interface for details.

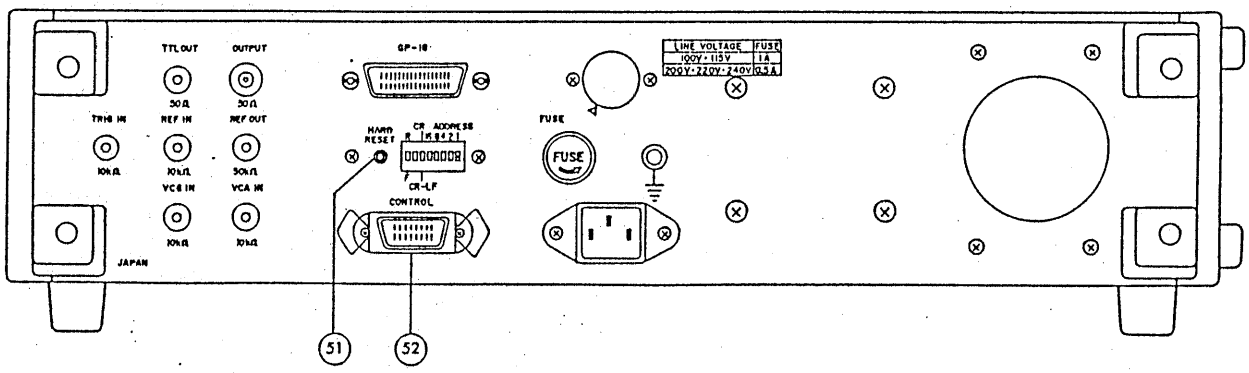
(50) GP-IB address switch:

1, 2, 4, 8, 16: Specify the device address of the instrument by five bits (binary). The device address may be 0 to 30 (decimal).



CR/CR-LF: Specify the GP-IB command delimiter. Select CR or CR-LF according to the controller specifications.
* If the controller specifications designate LF only, set this switch to CR-LF.

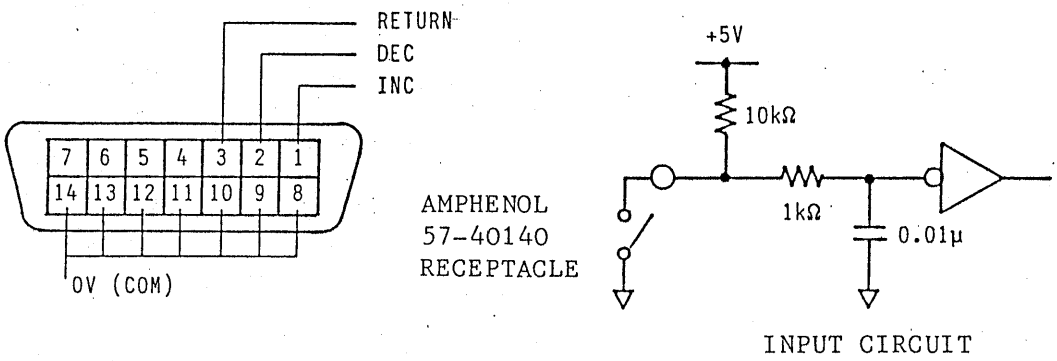
R/F: Output terminal changing switch, irrelevant to GP-IB. If this switch is set to "R" position, signal is output to (43) on real panel; if it is set to "F" position, signal is output to (37) on front panel. The signal cannot be output to (43) and (37) at the same time.



(51) HARD RESET : Built-in micro computer reset switch.
The function of this switch is the same as that of the RESET switch ((6)) on front panel.
This switch need not be manipulated during normal operation; use it to release the instrument from the stopped state caused by such an error as the GP-IB bus handshake error.

* Since this is a sunken push-button switch, push it by the tip of a ball-point pen or some other thin stick.

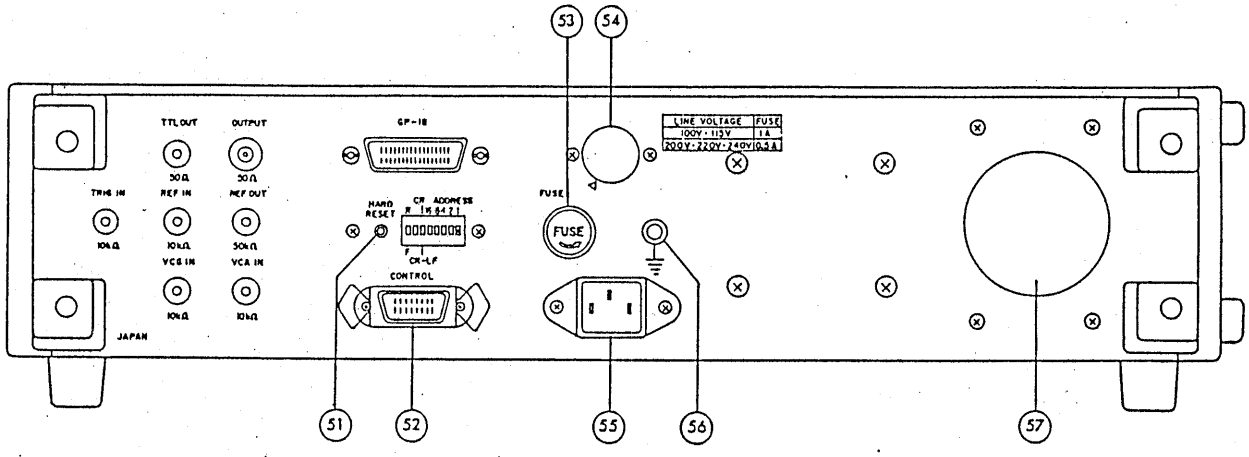
(52) CONTROL : External input connector for memory control.
If this connector is used, the memory number can be incremented/decremented by an external device without GP-IB.
The input signal is of TTL level, and negative logic applied to it. A pull-up resistor is added to intern circuit.



INC : Memory number +1
DEC : Memory number -1
RETURN: Control returns to the lowest memory number

* The plug that matches this connector is Amphenol 57-30140.

* The functions of this connector are the same as those of switches (31) and (32) on front panel.



(53) FUSE : Fuse in AC line.
Use a fuse of the rating that matches the line voltage.
* See Item (54).
Fuse size: 6.4φ × 30 mm

(54) LINE VOLTAGE : Line voltage selector.
Before switching line voltages, be sure to pull out the power plug from outlet.

SELECT SW	LINE VOLTAGE	FUSE
100V	90 - 110V	1 A
115V	104 - 125V	
200V	180 - 220V	0.5A
220V	198 - 242V	
240V	216 - 250V	

* Set the SELECT SW of the line voltage to be used to the mark "▲" by a screwdriver.

(55) LINE : Connect the instrument to the AC power source through this connector, using the power cord supplied with the instrument.
The power cord supplied with the standard model is of AC 125V rating. For the SELECT SW of 200V or higher, use a cable that matches the voltage. A ground pin is connected to the case. Ground the instrument by that pin for the purpose of safety and for preventing external noise.

(56) Ground terminal : Grounding terminal for the case.
Ground the case with this terminal for the purpose of safety and for preventing external noise. The input/output terminals and internal circuits of the instrument electrically insulated from the case.

(57) Cooling fan : Cooling air inlet.
Leave a space of at least 10 cm between the wall and the instrument. Do not block the exhaust port in the bottom. When the air filter becomes dirty, take it out and clean it.

5. GP-IB INTERFACE

5.1 General Description

Since the standard model of the FGE3250 has a built-in GP-IB interface, it can be connected to GP-IB, a measurement bus that conforms to IEEE-488-1978 Standard.

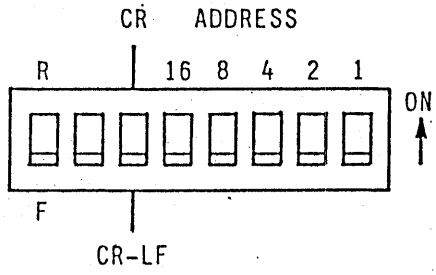
With use of the GP-IB interface, measuring instruments, controllers, and peripheral units can be connected to one another in parallel by one cable. Since this interface, compared with conventional interfaces, has high extensionality, is easy to handle, and makes the instrument compatible with the products of other manufacturers, the user can organize not only a simple system but also an automatic measuring system of highly sophisticated functions by simply connecting units by a bus cable.

Since the ground line for signals, case of the instrument, and GP-IB are completely insulated from one another, the system containing the instrument can be used without fear of the troubles that may be caused by the ground loop between analog circuits and GP-IB.

Further, by combining the GP-IB functions with the built-in memory functins, the instrument can be applied to various uses.

5.2 GP-IB Address Setting

Before using the GP-IB, specify the address of the instrument by the DIP switch on the rear panel. Also, select CR or CR-LF as the terminator to be used in data transmission. The specified address and terminator can be confirmed by the "ADRS" key on the front panel.



1,2,4,8,16: Use these switches for specifying address. The address is the sum of the values given above the switches set to the ON position. It may be specified within the range from 0 to 30.

CR/CR-LF : Use this switch for selecting terminator. Select CR-LF for LF only.

5.3 Interface Functions

Code	Function and explanation
SH1	Source handshake function
AH1	Acceptor handshake function
T6	Basic talker function Serial poll function
L2	Listener
SR1	Service request function
RL1	Remote/local function
PP0	No parallel poll capability
DC1	Device clear function
DT0	No device trigger capability
C0	No controller function

5.4 Address Commands and Universal Commands

GTL : GO TO LOCAL
Terminates remote mode and sets the instrument in local mode. "LLO" and "RMT" lamps are turned off.

LLO : LOCAL LOCK OUT
Locks out the local mode and invalidates the "LOCAL" button on front panel.
The "LLO" lamp is turned on.

DCL : DEVICE CLEAR
Initializes the instrument. (See Item ⑥ "RESET".)

SDC : SELECTED DEVICE CLAR
Initializes the instrument only when it is selected by the address.

SPE : SERIAL POLL ENABLE
Enables serial polling.

SPD : SERIAL POLL DISABLE
Disables serial polling.

IFC : INTERFACE CLEAR
Initializes the GP-IB interface.

When an interface error is found, the "IFC" command is issued from the controller to initialize the interface.

5.5 Bus Line Commands

[Mode and function setting]

The commands listed below specify the operation modes and functins of the instrument. Each of the commands corresponds a switch or indicator on the panel, and when a command is issued, the corresponding lamp is turned on.

Function		Command
CONT		M0
TRIG		M1
GATE		M2
BRST		M3
SYNT		M4
		F0
		F1
		F2
		F3
		F4
		F5
	INT	T0
	EXT	T1
TRIG		T2
		T3
	MANUAL	
	ON	T4
	OFF	T5

Function		Command
SYNT	INT	S0
	EXT	S1
	REF	S2
	LOCK	S3
	TTL	S4
	ZERO	S5
VCG	OFF	C0
	ON	C1
VCA	OFF	C2
	ON	C3
OUTPUT	OFF	C4
	ON	C5
HF LIMIT	OFF	C6
	ON	C7

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[Numeric data setting]

Function	Command	Function	Command
FREQ	D0	mHz, S, mV	U0
PERI	D1	Hz, mS, V	U1
AMPL	D2	kHz, μS, TIM	U2
OFST	D3	MHz, nS, DEG	U3
UPR	D4		
LWR	D5		
TRIG	D6		
BRST	D7		
STAT	D8		
WIDT	D9		
RATE	DA		

Use the above commands for specifying numeric data. Since they correspond to switches or indicators on the panel, issue them in the same order as the switches or indicators would be set for numeric data input. When one of these commands is issued, the lamp of the corresponding item flickers and the specified value is displayed. When two or more items are specified, the last specified item flickers.

Example: FREQ1.3kHz ⟶ D01.3U2
OFST2V ⟶ D32U1

[Memory control]

Function	Command
EXEC	E0
CALL	E1
STOR	E2
INC, ME	E3
DEC, MD	E4
Memory all clear	E5

These commands correspond to the memory control keys on the panel. To specify a memory area for a command, input the memory number after the command.

Example: To store data into memory 5 ⟶ E25

[Panel control]

The panel control commands correspond to the "•))", "KEY", and "RESET" buttons on the panel.

Function	Command
•)) OFF	P0
ON	P1
KEY OFF	P2
ON	P3
RESET	P4

[GP-IB RSQ flag setting]

The FGE3250 issues an SRQ signal when the "SRQ" button on the panel is pressed or when an error is found. In the initial state, the instrument is not ready for issuing the SRQ signal, but it is set in the SRQ ready state by the "SRQ ON" command.

Function	Command
Error SRQ OFF	R0
ON	R1
KEY SRQ OFF	R2
ON	R3

[VCG commands]

The VCG commands set the ranges to be used in VCG mode (internal frequency = 0). When one of these commands is exeucted, the internal frequency is set to 0 and the instrument keeps the range determined by the command. For example, executing command "G1" is equivalent to setting internal frequency to 00.0 mHz.

Range	FREQ setting/display	Command
1 mHz	0.00 mHz	G0
10 mHz	00.0 mHz	G1
100 mHz	000 mHz	G2
1 Hz	0.00 Hz	G3
10 Hz	00.0 Hz	G4
100 Hz	000 Hz	G5
1 kHz	0.00 kHz	G6
10 kHz	00.0 kHz	G7
100 kHz	000 kHz	G8
1 MHz	0.00 MHz	G9
10 MHz	00.0 MHz	GA

[VCA commands]

The VCA commands set the ranges to be used in VCA mode (internal amplitude = 0, offset = 0). When one of these commands is executed, the internal frequency and amplitude are set to 0 and the instrument keeps the range determined by the command. For example, executing command A1 is equivalent to specifying AMPL=000mV and OFST=0V.

Range	AMPL setting/display	ATT	Command
10 mV	00.0 mV	-40 dB	A0
100 mV	000 mV	-20 dB	A1
1 V	0.00 V	0 dB	A2

5.6 Data Format

The commands expressed in ASCII are received through the GP-IB interface and stored in a buffer memory. When a CR(LF) character is found, the commands in the buffer memory are checked for errors and executed in rotation as received.

A space or comma may be inserted between commands in order to make the program readily understandable. All the characters except the space and comma are recognized as significant data.

CR: Carriage return
LF: Line feed (for CR-LF)

Example 1: M3CR(LF)
This command specifies Mode 3, that is, "BRST" mode.

Example 2: MOF1D01.23U2CR(LF)
CONT, $\wedge\!\!\vee$, FREQ=1.23kHz
MO, F1, D␣1.23U2CR(LF)

Syntactic rules

(1) The maximum number of input characters terminated with CR(LF) is 80. If more than 80 characters are input, an error will be reported and the commands will not be executed.

(2) If an input character is not a bus line command character, an error will be reported.

(3) If two or more commands having the same function exist in one line, the last input command has the priority. Note, however, that the commands that are not executed may be inspected for errors.

Example: MO, M1, CR
MO ("CONT") and M1 ("TRIG") are specified, but only M1 ("TRIG") is executed.

(4) If a command is input when the FGE3250 is not set in a ready state by a mode or function command, an error will not be reported but that command will not be executed.

(5) Since a string of commands are executed sequentially in the order of input, specify numeric data after specifying mode or function. In the "EXEC" mode, an error may be reported depending on the numeric data input order. To prevent the error, specify the numeric data in "CALL" mode and then switch the instrument to the "EXEC" mode.

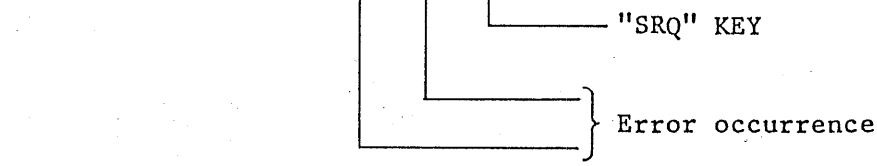
5.7 Service Request (SRQ)

The FGE3250 can issue an SRQ signal when the "SRQ" button on the panel is pressed or when an error occurs. When the SRQ signal is issued, the "SRQ" lamp on the panel is turned on to indicate transmission of the signal. When the controller receives the SRQ signal, it enters a serial polling state by an SRQ processing program, reads the status byte sent from the FGE3250 to know the address of the instrument requesting service and the content of the requested service, and performs the SRQ processing. The "SRQ" lamp is turned off when the status byte has been sent.

In the initial power on conditions, the SRQ signal is not issued even when the "SRQ" button is pressed or an error is found because the SRQ flag is off. When the SRQ flag is turned on, the instrument is set in the SRQ ready state.

Status byte (positive logic)

D8	D7	D6	D5	D4	D3	D2	D1
0	1	0	0	0			



D1: The "SRQ" button has been pressed.

D2: Command or format error

D3: Numeric data error

"SRQ" button

Use the "SRQ" button for issuing a service request to the controller manually. For example, this button may be used for requesting new data or for notifying the starting/stopping of measurement. Thus, with this button, the user can perform automatic measurement without touching the controller.

5.8 Program Example

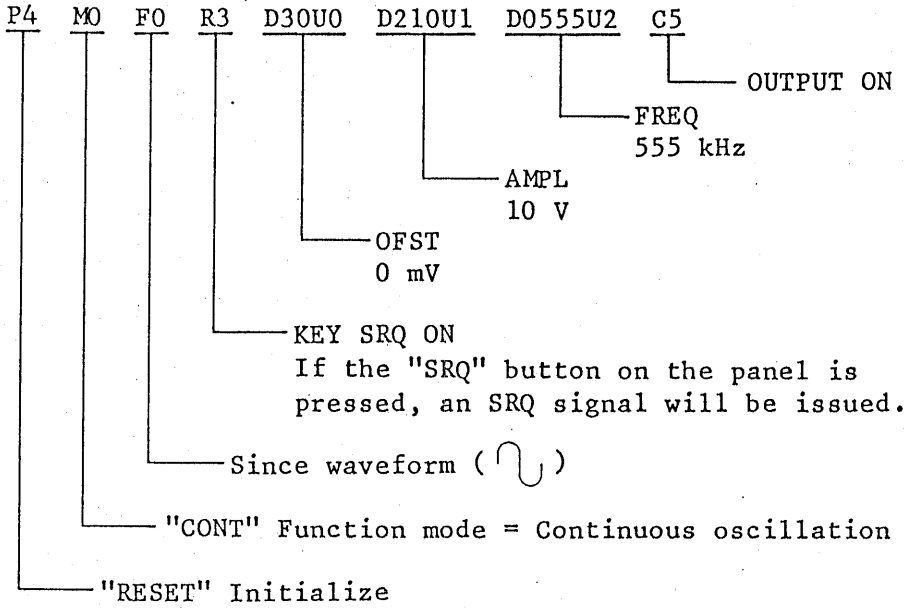
```
10 !  ********************************************************
20 !  DEMO PROG.  ***** FGE3250 *****    NOV,22,1985 [9845B]
30 !  ********************************************************
40    OUTPUT 701;"P4M0F0R3D30U0D210U1D0555U2C5"
50    ON INT #7 GOTO 170  ! enable END-OF-LINE branches.
60    CONTROL MASK 7;128  ! set up interrupt condition.
70    CARD ENABLE 7       ! enable card for interrupts.
80    WAIT 3000
90    STATUS 701;St1
100   PRINT "STATUS St1=";St1
110   OUTPUT 701;"F1,D0,12.5,U2"
120   PAUSE
130   GOTO 40
140   !
150   !
160   !
170   STATUS 701;St2
180   PRINT "STATUS St2=";St2
190   OUTPUT 701;"C4"
200   END
```

Explanation of the above program (for HP9845B)

Line No.

10, 20, 30 — Comment lines

40 — The following message are sent from I/O port "7" of computer to the device of GP-IB address "1":



* The messages can be programmed continuously without space.

50, 60, 70 — Program for interrupt
When execution is interrupted by SRQ, the control jumps to line 170.

80 — The state specified by line 40 is maintained for 3 seconds.

Lines 90-130:
Process to be executed when no interrupt is reported

90 — The status byte is read.

100 — The status byte is displayed.

8632032

110	Different messages are sent to change the setting of FGE3250. (∧∨, FREQ 12.5kHz) * A comma space may be inserted between messages to make the program easy to understand. Commas and spaces are not treated as data.
170	Since an interrupt has occurred, the status byte of the device is read.
180	The status byte is displayed. St2=65 The value "65", expressed in equivalent decimal code, means that the SRQ bit (bit 7) is on.
190	The output of FGE3250 is turned off. * Only the necesary messages can be sent.

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6. OPERATION PRINCIPLES

6.1 Block Diagram

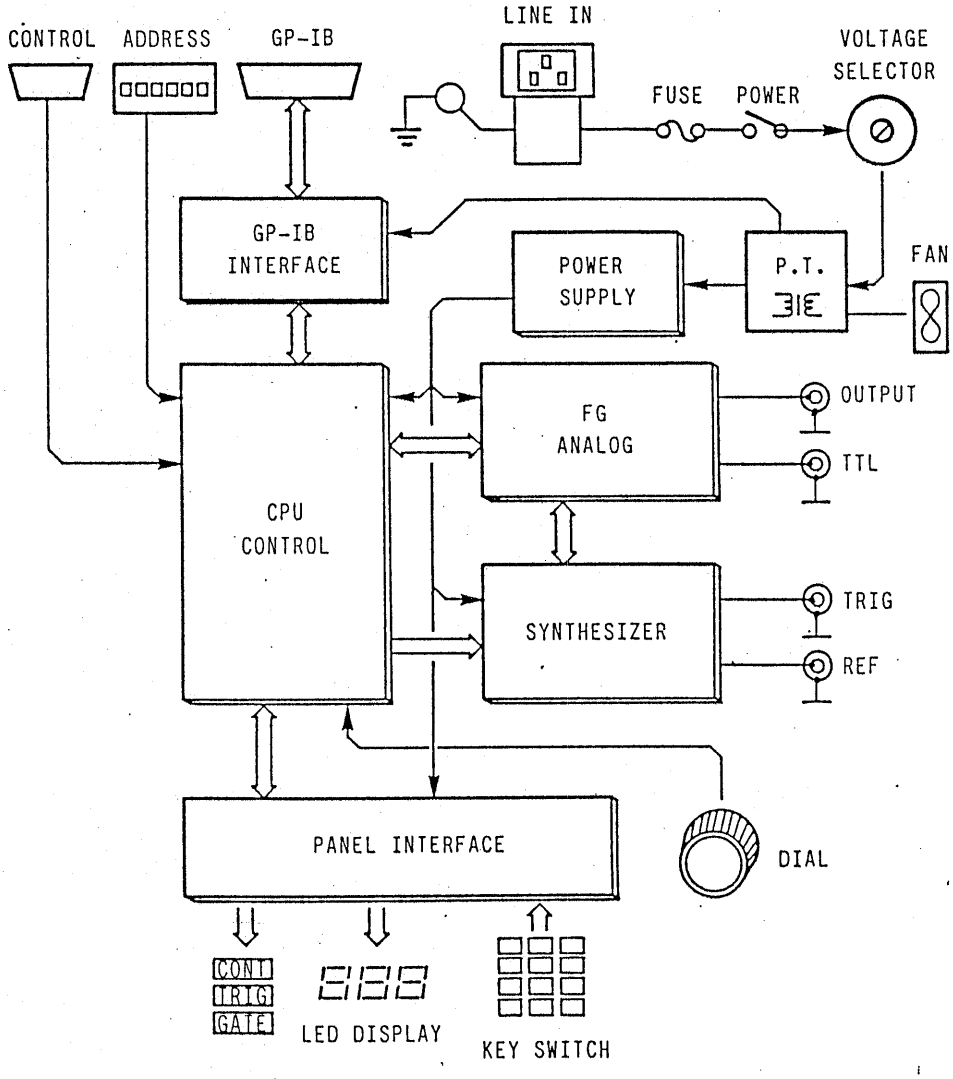


Fig. 6.1.1

Figure 6.1.1 shows the overall block diagram of the FGE3250. The instrument consists of six major printed circuit boards, namely, POWER SUPPLY, CPU CONTROL, PANEL INTERFACE, SYNTHESIZER, FG ANALOG, and GP-IB INTERFACE.

(1) POWER SUPPLY

Supplies the DC power to be used by the circuits of the instrument.

(2) CPU CONTROL

This block has a micro computer (CPU), memories (RAM, ROM), and various interfaces and controls the operation of the instrument. Figure 6.1.2 shows the block diagram of the CPU CONTROL board.

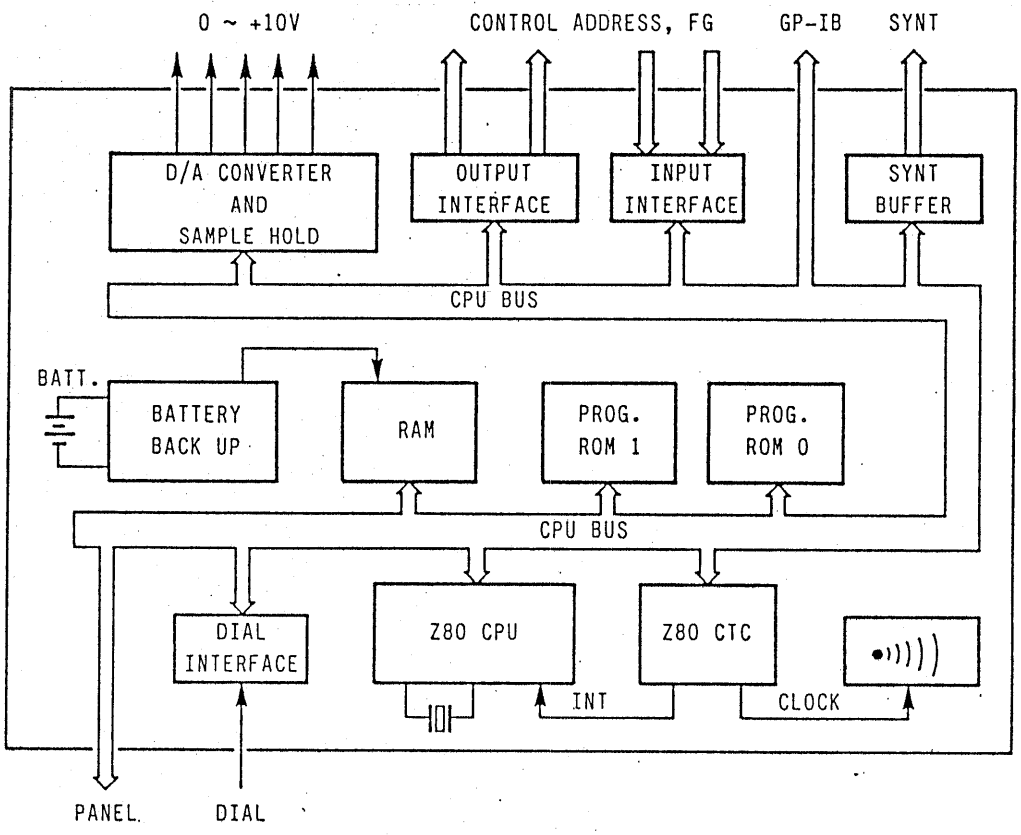


Fig. 6.1.2

(3) PANEL INTERFACE

Special LSIs are used for the 7-segment display and LED indicators for dynamic lighting. The 7-segment display and LEDs are turned on/off by the control of Z80 CPU. When a key switch is pressed, data of the pressed switch is stored in memory through LSI, and the CPU controls the instrument according to the data in the memory.

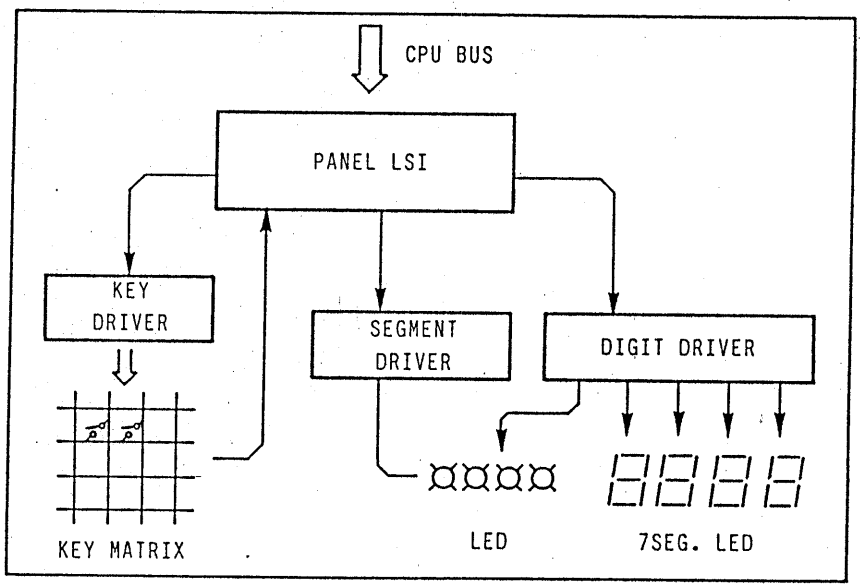


Fig. 6.1.3

(4) SYNTHESIZER

This block consists of an internal clock PLL generator, main PLL integration amplifier, burst counter, and trigger input circuit. Combined with the FG board, it is used for synthesizer oscillation and triggered oscillation.

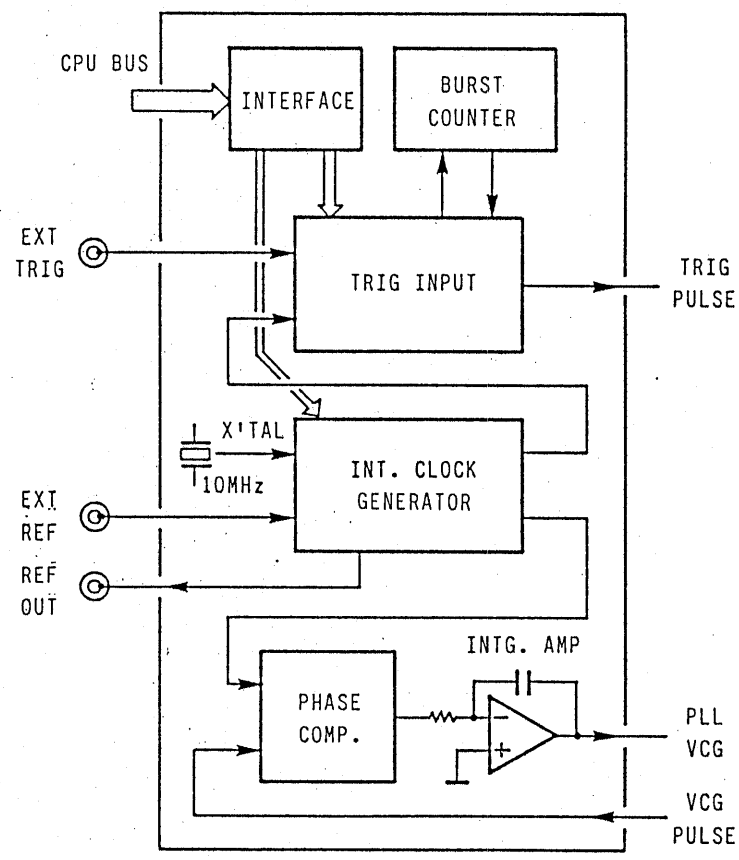


Fig. 6.1.4

(5) FG ANALOG

This block consists of a VCG oscillator, since converter, trigger circuit, VCA amplifier, output amplifier, and attenuator. It is used as the main circuit of the function generator.

Figure 6.1.5 shows the block diagram.

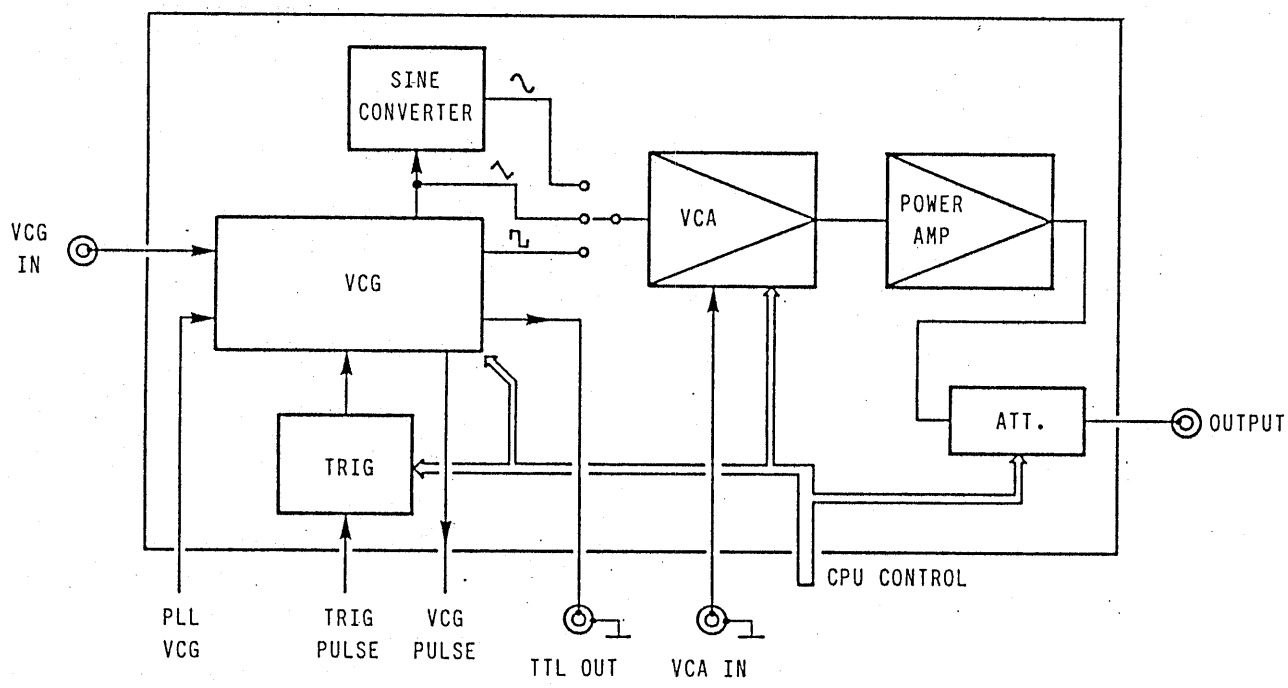


Fig. 6.1.5

(6) GP-IB INTERFACE

The GP-IB bus of the instrument is completely insulated from the internal CPU bus and input/output connectors by photo couplers. Therefore, no problems are caused by the potential difference between the GP-IB bus and signal common line.

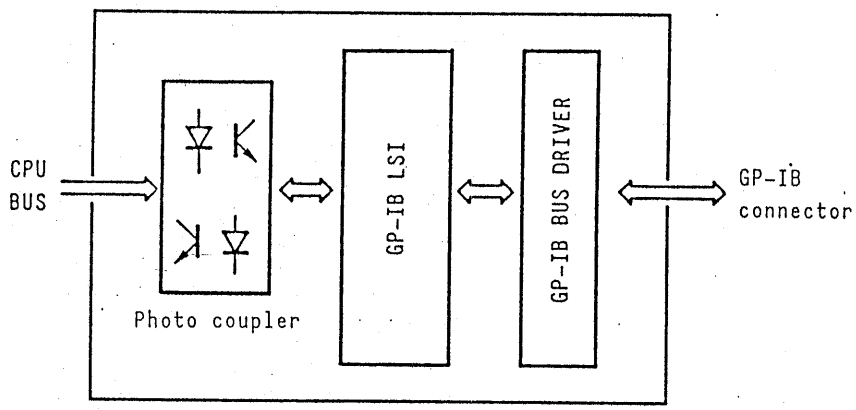


Fig. 6.1.6

6.2 Basic Operation for Oscillation

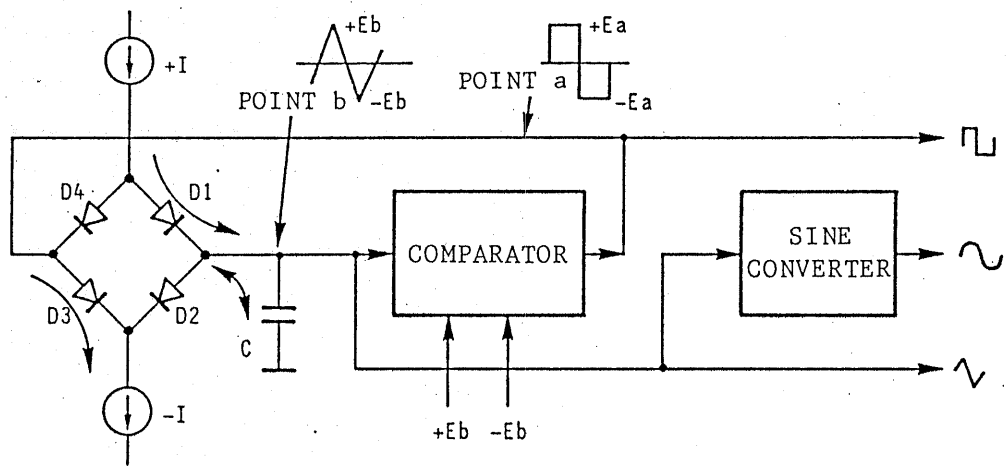


Fig. 6.2.1

Figure 6.2.1 shows the basic block diagram of the main oscillator for FGE3250 Function Generator. The oscillator consists of plus and minus constant current sources, diode switch, integration capacitor, comparator, and sine converter.

Assume that the electric charge of Capacitor C is 0 and the comparator output voltage at point "a" is +Ea in the initial state. Then, D1 and D3 of the diode switch are on and D2 and D4 are off, and the current of +I flows to Capacitor C; as a result, the electric potential at point "b" rises with a positive slope. When the electric potential at point "b" reaches the upper limit of the comparator, that is, +Eb, the voltage output from the comparator is inverted and becomes -Ea at point "a". Consequently, D2 and D4 of the diode switch are turned on and D1 and D3 are turned off. Then, the electric potential at point "b" falls with a negative slope because the current of -I flows to Capacitor C. When the electric potential at point "b" reaches -Eb, the voltage output from the comparator is inverted again to raise the electric potential at point "b" to +Eb. As this series of operations are executed continuously signals of square and triangle waveforms are generated at points "a" and "b" respectively.

The oscillation frequency may be determined by the upper/lower limit of comparator voltage (±Eb), capacitance of Capacitor C, and value of the constant current source (±I), then the FGE3250 uses Capacitor C for switching frequency ranges and ±I for continuous variation of frequency.

To obtain the signal of sine waveform, the signal of triangle waveform obtained at point "b" in Fig. 6.2.1 is passed through the broken-line approximation circuit of sine converter.

6.3 Triggered Oscillation Basic Operation

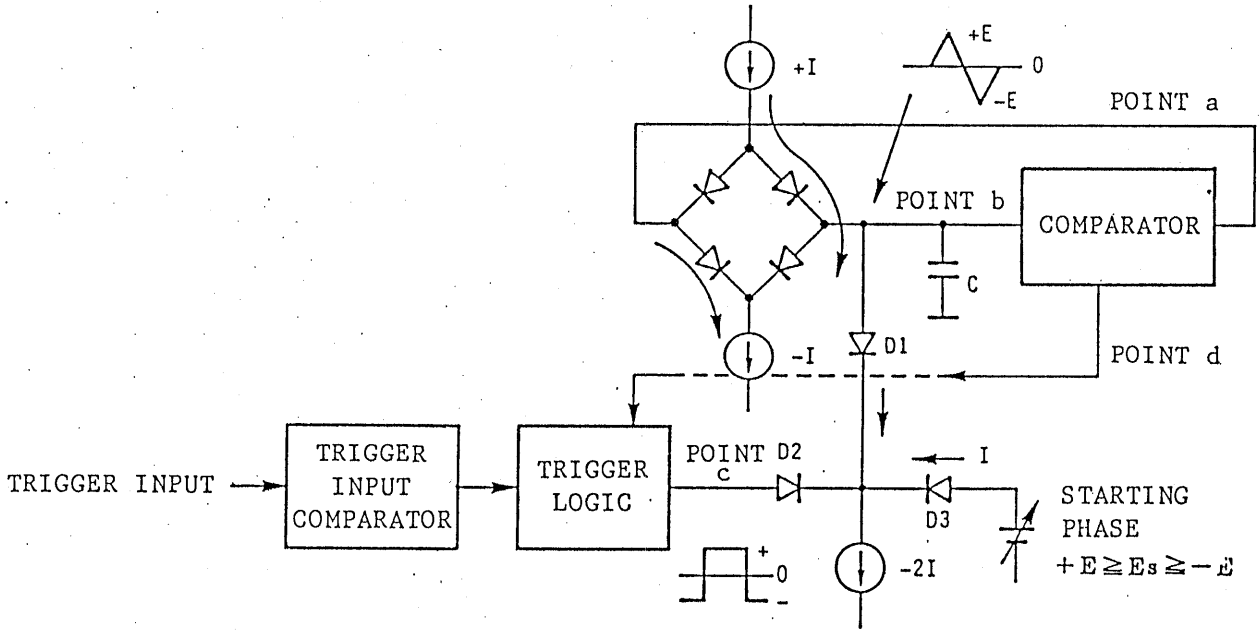


Fig. 6.3.1

Figure 6.3.1 shows the basic block diagram of the main oscillator trigger circuit.

Before a trigger signal is input, the electric potential at point "c" (trigger logic circuit output point) is negative and D2 is off. At this time, the electric potential at point "a" (comparator output point) is positive and the diode switch tries to charge Capacitor C with the current of +I, but D1 and D3 is turned on and +I flows to D1. Also, D3 is turned on and current I flows through D3 because a constant current source of -2I is provided. Since the forward voltage at D1 (VD1) is equal to that at D3 (VD3), the electric potential at point "b" is determined by the starting phase voltage (ES). By changing the starting phase voltage within the range from +E to -E ($+E \geqq ES \geqq -E$), the starting phase can be changed.

When the trigger signal is input, the trigger comparator is activated and the electric potential at point "c" (trigger logic circuit output point) is inverted to positive position. Then, D2 is turned on and D1 and D3 are turned off. Since D1 is turned off, Capacitor C is charged with the current of +I and the electric potential at point "b" rises. After that, the oscillation described in Section 6.2 is started.

When the electric potential at point "b" falls to invert the comparator output voltage, a signal to indicate the end of one cycle oscillation is output to point "d" and the trigger logic circuit is reset. When this circuit is reset, the electric potential at point "c" becomes negative again and D2 is turned off. Since, at this stage, the voltage at poin "b" is lower than ES, it is raised by the current of +I till it reaches the level of ES. When the voltage at point "b" becomes equal to ES, it is fixed at that level and the triggered oscillation is terminated.

The oscillation can be done in a desired mode (triggered/gated/burst) as the reset signal from point "d" is controlled in the trigger logic circuit.

6.4 Synthesizer Oscillation Basic Operation

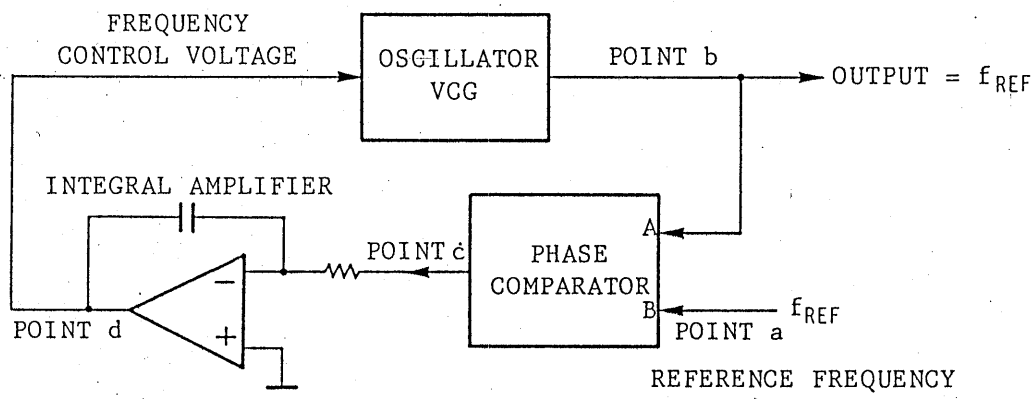


Fig. 6.4.1

Figure 6.4.1 shows the basic block diagram of a synthesizer oscillator in PLL (Phase-locked loop) method. It consists of a voltage-controlled frequency oscillator (VCO), phase comparator, and integral amplifier.

The PLL circuit is a kind of frequency negative feed-back circuit, and the frequency of the voltage-controlled oscillator in the closed loop is always matched to the input signal frequency.

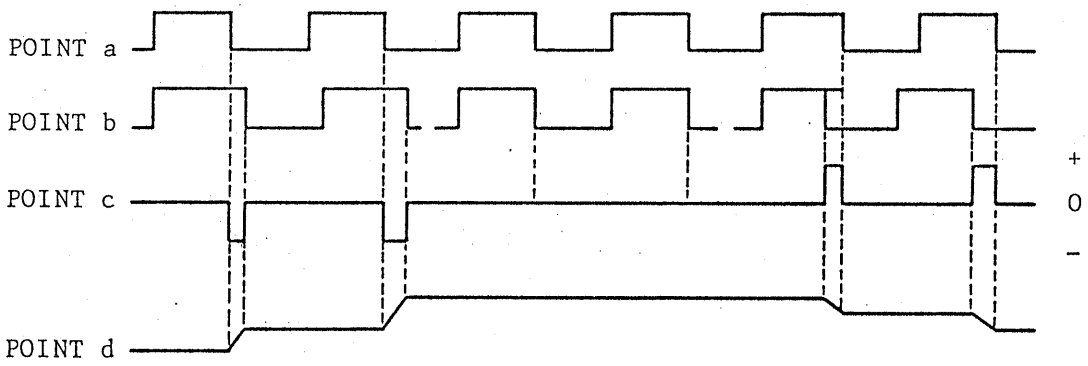


Fig. 6.4.2

Figure 6.4.2 shows the models of the waveforms at point "a", "b", "c" and "d" in Fig. 6.4.1. The phase comparator compares the phase of the signal input to point A with that of the signal input to point B and outputs a negative pulse when the phase is delayed (low frequency) and a positive pulse when the phase is advanced (high frequency). The pulse signal output from the phase comparator is integrated by the integral amplifier and becomes an analog signal observed at point "d". As the oscillator frequency is controlled by this analog signal (the frequency is increased in proportion to the voltage at poind "d"), the oscillator output signal will have the same phase (frequency) as f_{REF} because of the function of the negative feed-back loop.

If a 1/N frequency devider is set between the oscillator output and phase comparator input A, the oscillation frequency can be increased by N times ($f_{REF} \times N$). This principle is applied to the internal clock oscillator.

The frequency of the signal output from the oscillator is controlled accurately by the changing of the frequency of f_{REF} input to point B of the phase comparator. The synthesizer oscillation principle is applied to the main oscillator, and its oscillation frequency is controlled by the frequency of f_{REF}.

Accurate oscillation frequency can be obtained by the PLL synthesizer principle, but this principle may not be suitable for the continuous change of frequency because the negative feed-back loop has an integral amplifier and the frequency is not stable immediately after it is changed.

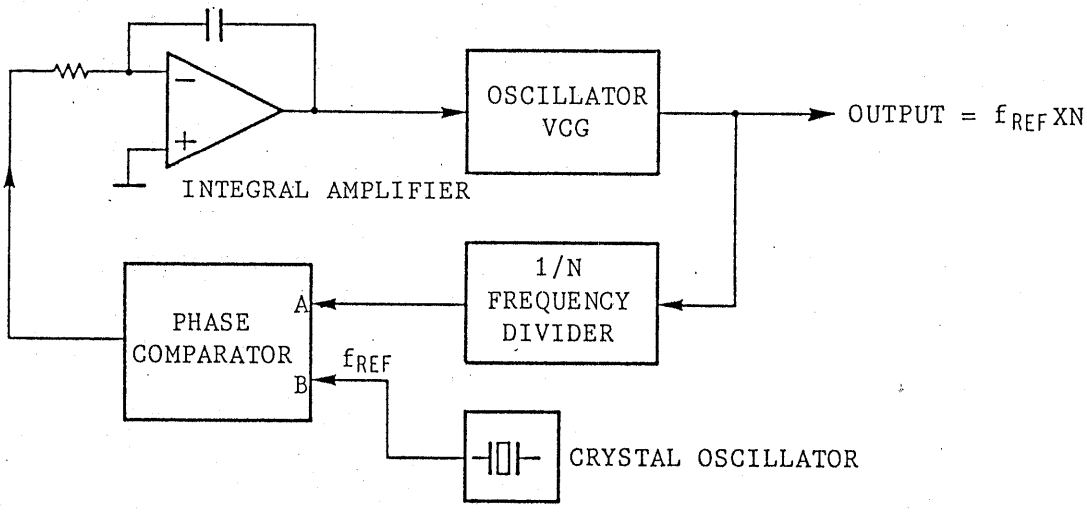


Fig. 6.4.3 Internal Clock Oscillator Basic Block Diagram

6.5 Oscillation Modes

6.5.1 Continuous mode

The continuous mode is the basic oscifllation mode of the main oscillation. In this mode, the sine, triangle, and square waveforms can be obtained.

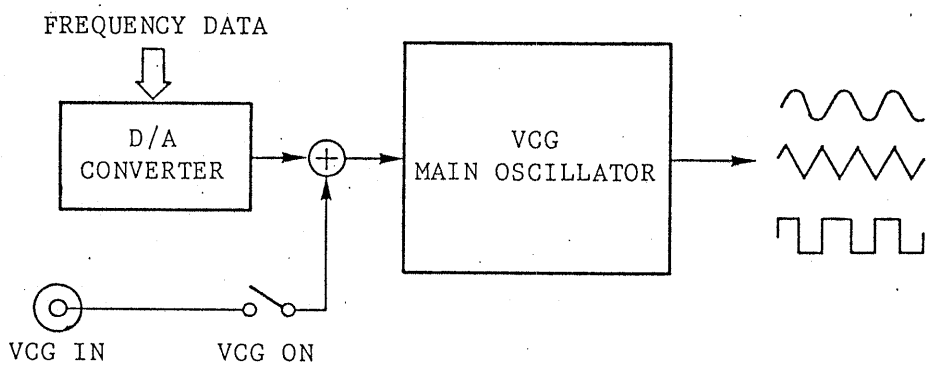


Fig. 6.5.1

6.5.2 Triggered mode

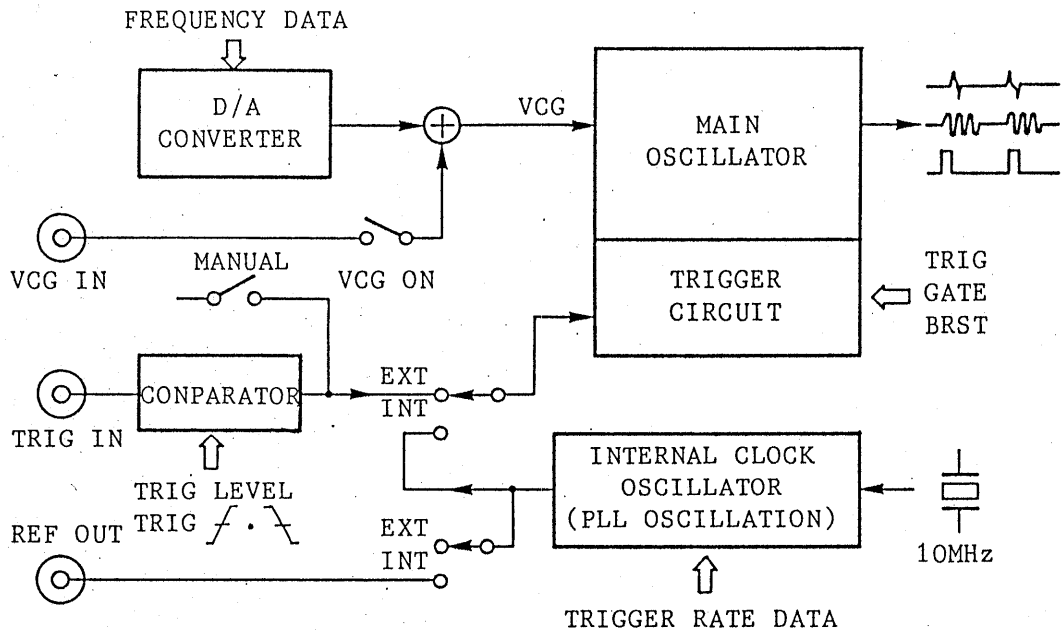
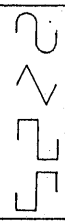
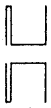
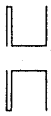


Fig. 6.5.2

Figure 6.5.2 shows the trigger oscillator block diagram. Either an internal clock signal, an external signal, or a signal generated by manual switch may be input to the trigger circuit, and the mode selection (TRIG, GATE, or BRST) is done within the trigger circuit. When TRIG INT is specified, the internal clock signal used as the trigger signal is output to REF OUT.

Signals of pulse waveform is also generated by the same block configuration. The output waveform is the same as the square waveform in TRIG mode, but the numeric data setting is different (see the table below). The pulse width can be modulated by the signal from VCG IN.

		D/A converter	Internal clock
TRIG GATE BRST		FREQ	RATE
TRIG GATE BRST		WIDT	RATE
CONT SYN		WIDT	FREQ

6.5.3 Synthesizer oscillation (REF)

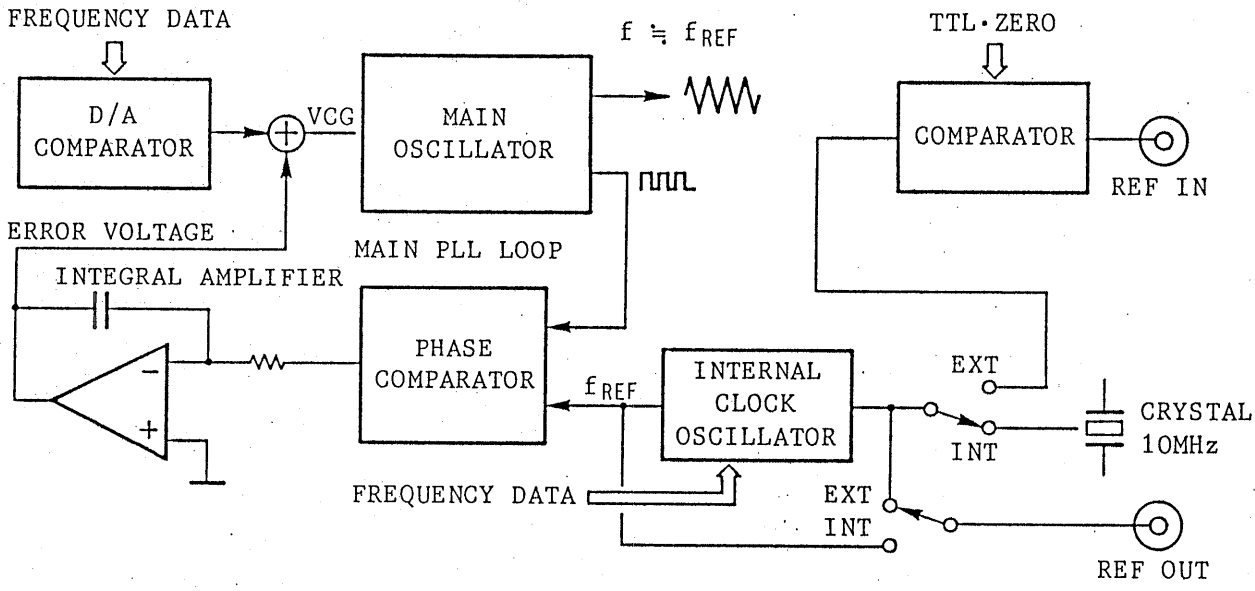


Fig. 6.5.3

Figure 6.5.3 shows the block diagram for SYNT.INT and SYNT.EXT.REF. In the SYNT.REF mode, the frequency output from the internal clock oscillator is used as the reference frequency (f_{REF}) and PLL synthesizer oscillation is performed. The reference frequency (10 MHz) of the internal clock oscillator is provided either by the signal output from a built-in crystal oscillator or by an external signal (10 MHz), and the "INT"/"EXT" button is used for selecting the signal to provide the frequency. When the switch is set to "INT" side, the frequency of the crystal oscillator is output to the "REF OUT" terminal, and when it is set to the "EXT" side, the internal clock oscillator output frequency (f_{REF}) is output to the "REF OUT" terminal.

6.5.4 Synthesizer oscillation (LOCK)

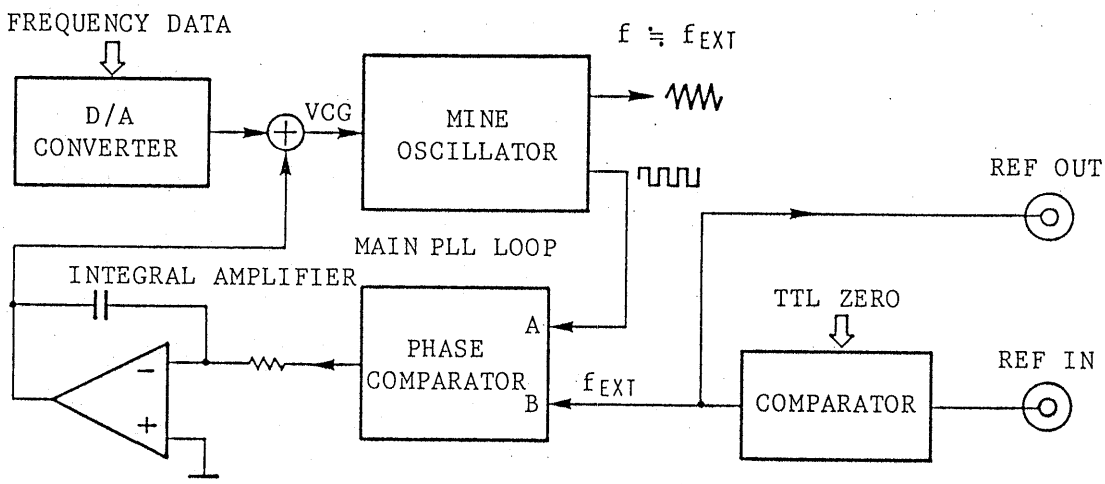


Fig. 6.5.4

Figure 6.5.4 shows the block diagram for the SYNT.EXT.LOCK mode. In the SYNT.EXT.LOCK mode, PLL synthesizer oscillation is performed using the frequency of an external signal directly as reference frequency (f_{EXT}). If the internally set frequency (D/A converter) is greatly different from f_{EXT} the main oscillator frequency cannot follow f_{EXT}; therefore, f_{EXT} must not deviate from the internally set frequency beyond the range of ±5%.

6.6 Oscillation Frequency Setting Circuit (VCG)

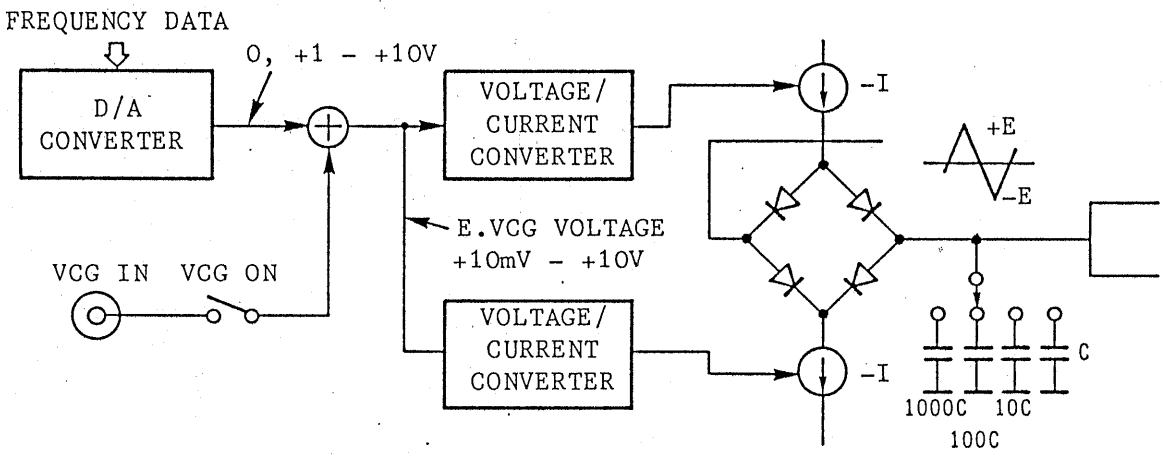


Fig. 6.6.1

Figure 6.6.1 shows the main oscillator frequency setting circuit block diagram. The oscillation frequency is proportioned to current I and inversely proportioned to the capacitance of Capacitor C. Since current I is proportioned to VCG voltage E, the frequency is also proportioned to VCG voltage E. The FGE3250 uses a capacitor for switching frequency ranges in units of ten times and the voltage of D/A converter (+1 to +10V) for changing the frequency in each range. Thus, the instrument can perform wide band oscillation.

The relationships between the user-specified frequencies, ranges, and VCG voltages are as follows:

Specified frequency	Range	VCG voltage
1.00 m - 9.99 mHz	1 mHz	+1 - +10V
10.0 m - 99.9 mHz	10 mHz	+1 - +10V
100 m - 999 mHz	100 mHz	+1 - +10V
1.00 - 9.99 Hz	1 Hz	+1 - +10V
10.0 - 99.9 Hz	10 Hz	+1 - +10V
100 - 999 Hz	100 Hz	+1 - +10V
1.00 k - 9.99 kHz	1 kHz	+1 - +10V
10.0 k - 99.9 kHz	10 kHz	+1 - +10V
100 k - 999 kHz	100 kHz	+1 - +10V
1.00 M - 9.99 MHz	1 MHz	+1 - +10V
10.0 M - 20.0 MHz	10 MHz	+1 - +2V

VCG (Voltage Controlled Generator) and Frequency Modulation

Turn on the "VCG" button and apply voltage to the "VCG IN" terminal, and the oscillation frequency can be controlled by the voltage.
The voltage of the D/A converter is added to the voltage input from VCG IN, and the sum of the voltages is called VCG voltage.
When VCG voltage is within the following range, the oscillation frequency can be expressed by the equation below:

$+10V \geqq$ VCG voltage $\geqq +10$ mV

$f = N + R \times E$

f: Oscillation frequency
N: Internally set frequency
E: VCG IN voltage
R: Range

Equation 6.6.1

The relationships between the VCG oscillation ranges and the ways of setting frequency "0" are as follows:

Range	0 setting	VCG frequency	VCG IN
1 mHz	0.00 mHz	10 m - 1 mHz	10V - 1V
10 mHz	00.0 mHz	100 m - 1 mHz	10V - 100 mV
100 mHz	000 mHz	1 Hz - 1 mHz	10V - 10 mV
1 Hz	0.00 Hz	10 Hz - 10 mHz	10V - 10 mV
10 Hz	00.0 Hz	100 Hz - 100 mHz	10V - 10 mV
100 Hz	000 Hz	1 kHz - 1 Hz	10V - 10 mV
1 kHz	0.00 kHz	10 kHz - 10 Hz	10V - 10 mV
10 kHz	00.0 kHz	100 kHz - 100 Hz	10V - 10 mV
100 kHz	000 kHz	1 MHz - 1 kHz	10V - 10 mV
1 MHz	0.00 MHz	10 MHz - 10 kHz	10V - 10 mV
10 MHz	00.0 MHz	20 MHz - 100 kHz	2V - 10 mV

Pulse Width Modulation (PWM)

In the pulse wave oscillation mode, the pulse width can be modulated. One cycle time is twice as long as the specified pulse width, and its inverse number is the oscillation frequency. The table below lists the relationships between the values of "WIDT" and oscillation frequency ranges. In the pulse wave mode, the values of WIDT must not be set to "0".

WIDT setting	Range
25.0 n - 50.0 nS	10 MHz
50.1 n - 500 nS	1 MHz
501 n - 5.00 µS	100 kHz
5.01 µ - 50.0 µS	10 kHz
50.1 µ - 500 µS	1 kHz
501 µ - 5.00 mS	100 Hz
5.01 m - 50.0 mS	10 Hz
50.1 m - 500 mS	1 Hz
501 m - 5.00 S	100 mHz
5.01 - 50.0 S	10 mHz
50.1 - 500 S	1 mHz

6.7 Oscillation Output Circuit (VCA)

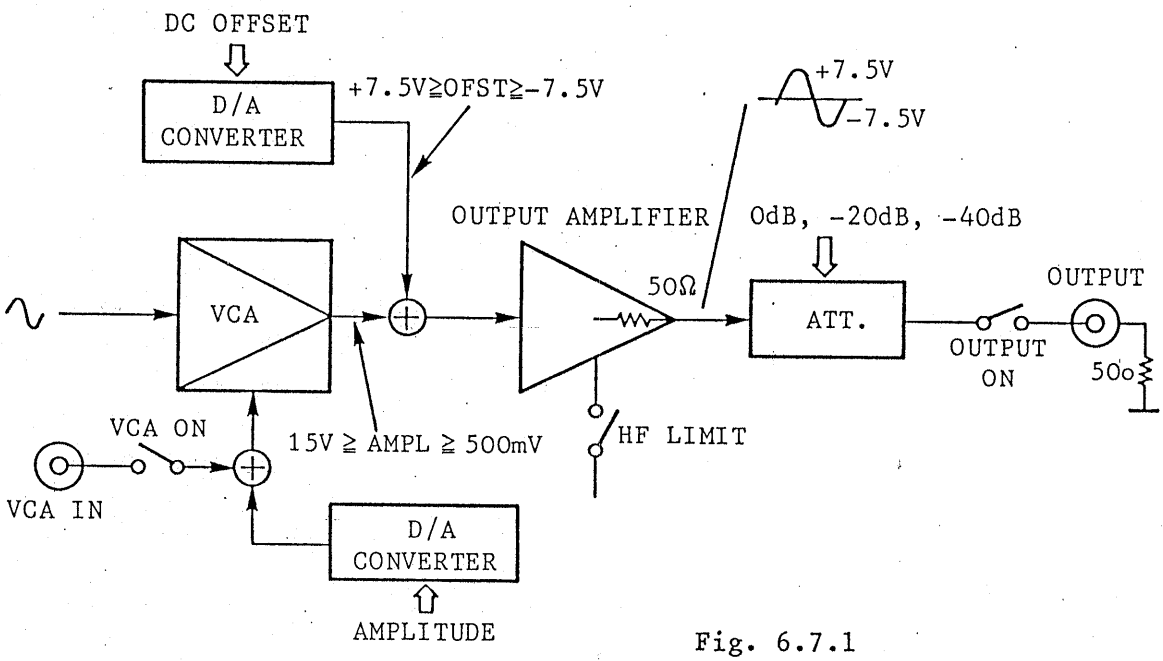


Fig. 6.7.1

Figure 6.7.1 shows the OUTPUT CIRCUIT BLOCK DIAGRAM.

6.7.1 Setting of "UPR" and "LWR"

As Fig. 6.7.1 shows, the output voltage is determined by only two factors, namely, "AMPL" and "OFST", but since "AMPL" and "OFST" can be calculated from "UPR" and "LWR", the user may specify "UPR" and "LWR" for the output voltage. The calculation formulas are as follows:

$$AMPL = UPR - LWR, \quad OFST = \frac{UPR + LWR}{2}$$

6.7.2 Output circuit operation

According to the values specified for "AMPL" and "OFST", the built-in computer sets sections of the FGE3250 to put the instrument in the optimum operating state automatically, considering the operational range of each circuit. Since there is a limit to the operational range of each circuit, an error may be reported if a great DC offset is specified for a small amplitude. Figure 6.7.2 shows the flowchart of the program to determine the operating range.

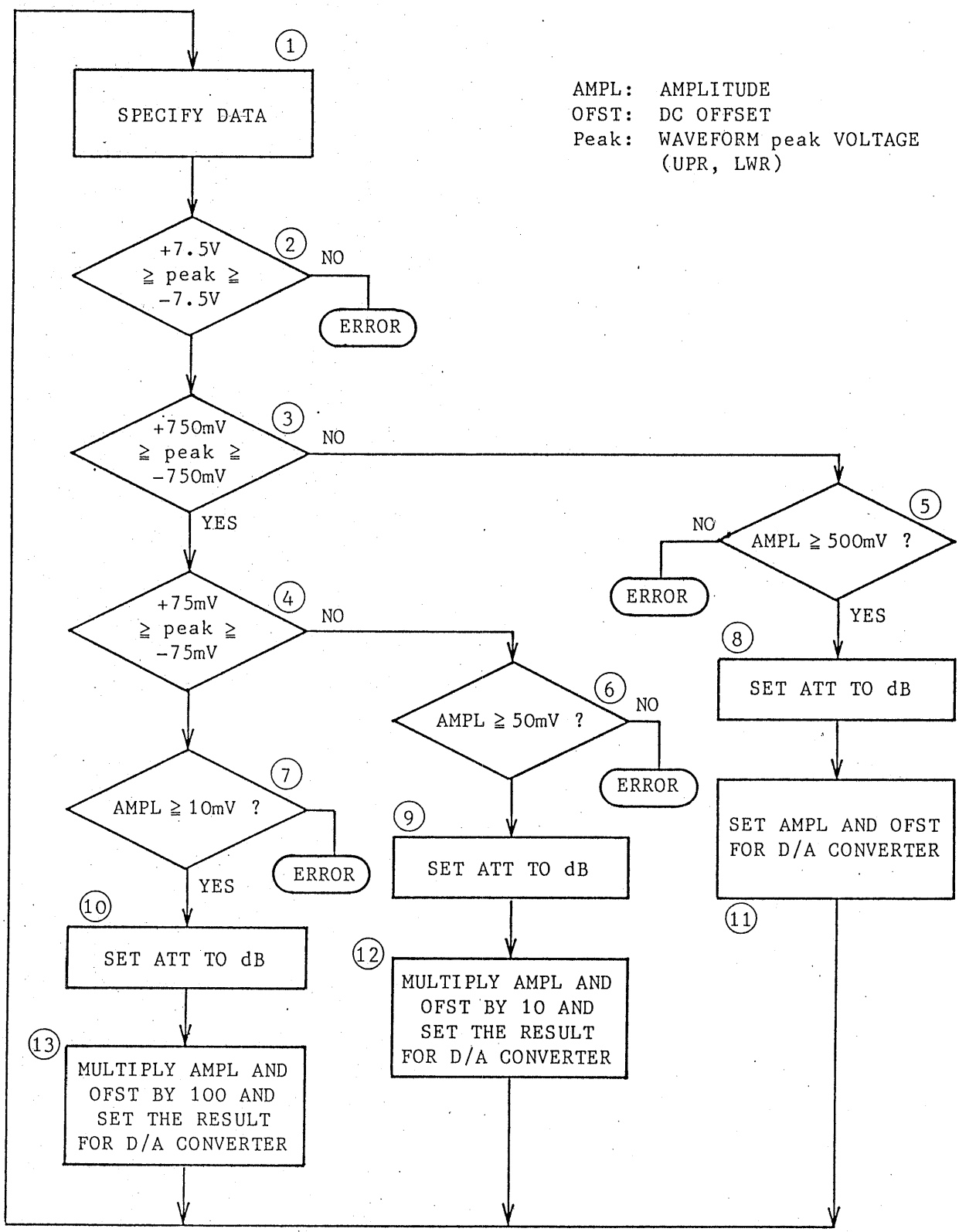


Fig. 6.7.2

[Explanation of Figure 6.7.2]

① Input the "AMPL" and "OFST" data using the panel switches.

② NO : Since the range of voltage allowed by the output amplifier is ±7.5V, the waveform will be clipped if the amplitude is beyond this range. Even if the value of "AMPL" is small, a great value for "OFST" may cause an error.

③ NO : The waveform peak that exceeds 750 mV is allowed only when the attenuator (ATT) is set to 0 dB. The control branches to ATT = 0 dB.

④ NO : When the waveform peak is equal to or lower than 750 mV but higher than 75 mV, the attenuator must be set to -20 dB.

YES: When the peak is equal to or lower than 75 mV, the attenuator is set to -40 dB.

⑤ NO : Since the VCA can control only the amplitude within the range from 15 Vp-p to 500 mVp-p, the amplitude smaller than 500 mVp-p is considered as an error under the condition of ATT = 0 dB.

YES: Allowable data. ATT is set to -0 dB by step ⑧ and "AMPL" and "OFST" values are set to D/A converter by ⑪ .

⑥ NO : Under the condition of ATT = -20 dB, the amplitude smaller than 50 mVp-p is an error.

YES: Allowable data. ATT is set to -20 dB by step ⑨ and the values of "AMPL" and "OFST" are multiplied by 10 and set for the D/A converter by ⑫ . Even if the values are multiplied by 10, the signal is output correctly because they are reduced to one-tenth by the attenuator.

⑦ NO : The minimum value allowed for "AMPL" is 10 mV. A value less than 10 mV is an error.

YES: Allowable data. ATT is set to -40 dB by step ⑩ and the values of "AMPL" and "OFST" are multiplied by 100 and set for the D/A converter by ⑬ .

The relationship between "AMPL" and ATT when OFST is 0V is as follows:

AMPL	ATT	Output amplifier
15.0V - 1.51V	0 dB	15.0V - 1.51V
1.50V - 151mV	-20 dB	15.0V - 1.51V
150mV - 10.0mV	-40 dB	15.0V - 1.00V

The followable data according to the flowchart in Fig. 6.7.2 can be graphed as shown in Fig. 6.7.3.

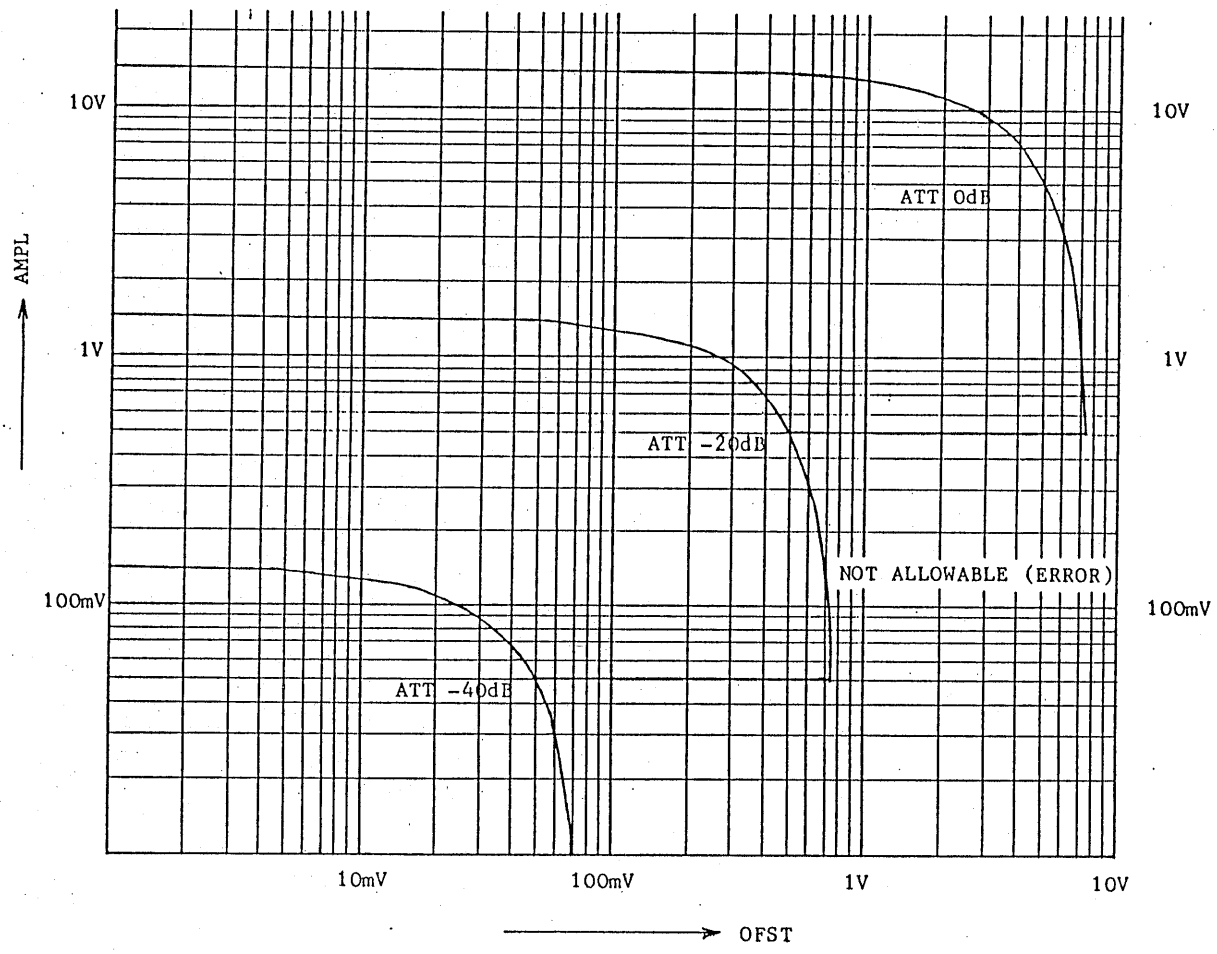


Fig. 6.7.3

6.7.3 VCA (Voltage Controlled Amplitude)

Turn on the "VCA" switch and apply voltage to the VCA IN terminal, and the output amplitude can be controlled. The voltage from the D/A converter is added to the voltage input from "VCA IN", and the sum of the voltages is called VCA voltage. The relationship between the input voltage and output amplitude is as follows:

$$A = N + K \times E$$

A: Output amplitude
N: Internally set amplitude (AMPL)
K: 1.5 for 0 dB
0.15 for -20 dB
0.015 for -40 dB
E: "VCA IN" input voltage

Equation 6.7.1

Constant K represents the change in output amplitude per 1 volt of "VCA IN" input voltage, and it varies with the attenuator value.

$$\frac{15 \text{ Vp-p}}{10 \text{ } V_{IN}} = 1.5\text{V/V} \quad \text{(for 0 dB)}$$

The relationships between the "0" setting of "AMPL", values of ATT, and offset ranges are as follows:

0 setting	ATT	DC offset	Maximum amplitude
0.00V	0 dB	+7.5V ≧ OFST ≧ -7.5V	15 Vp-p
000mV	-20 dB	+750 mV ≧ OFST ≧ -750 mV	1.5V Vp-p
00.0mV	-40 dB	+75 mV ≧ OFST ≧ -75 mV	150 mVp-p

7. APPLICATION EXAMPLES

7.1 Sweep Wave

A linear sweep wave of 10 Hz to 10 kHz is to be generated with the repetition cycle of 10 seconds.

1)	MODE	CONT
2)	FUNC	∿
3)	VCG	ON
4)	FREQ	0.00 kHz
5)	OUTPUT	ON

From Equation 6.6.1 ($f = N + E \times R$):

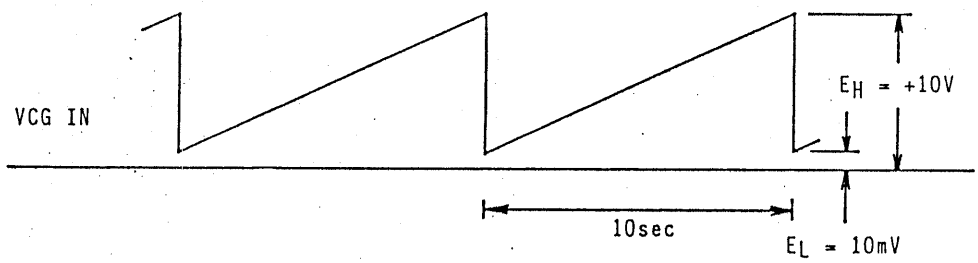
f: Oscillation frequency
N: Internally set frequency
E: VCG IN voltage (V)

$$E_L = \frac{f_L - N}{R} = \frac{0.01 - 0}{1}$$

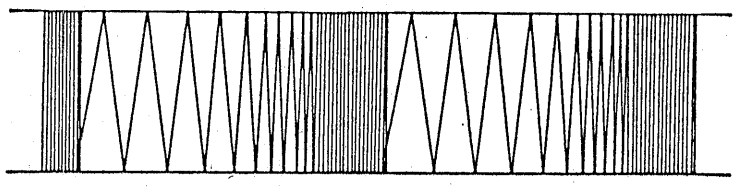
$$E_L = +10mV$$

$$E_H = \frac{f_H - N}{R} = \frac{10 - 0}{1}$$

$$E_H = +10V$$



Output waveform (example: triangle waveform)



GP-IB command examples

1) M0 F1 C1 D0 0.00 U2 C5

2) M0 F1 C1 G6 C5

7.2 FM Wave

An FM wave whose center frequency is 5 MHz, modulating width is 20 kHz, and modulating frequency is 1 kHz is to be output.

1) MODE CONT
2) FUNC ∿
3) VCG ON
4) FREQ 5.00 MHz
5) OUTPUT ON

From Equation 6.6.1 ($f = N + E \times R$):

f: Oscillation frequency
N: Internally set frequency
E: VCG IN voltage (V)

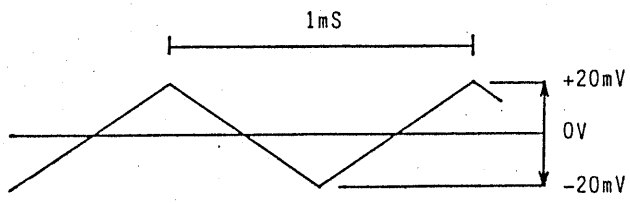
$$E_H = \frac{f_H - N}{R} = \frac{5.02 - 5}{1}$$

$$E_H = +20mV$$

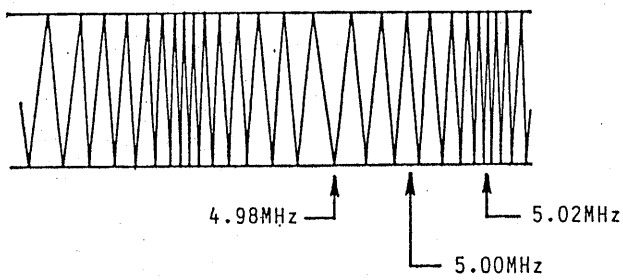
$$E_L = \frac{f_L - N}{R} = \frac{4.98 - 5}{1}$$

$$E_L = -20mV$$

VCG input waveform



Output waveform



GP-IB command example

1) M0 F1 C1 D0 5.00 U3 C5

7.3 AM Wave

An AM wave whose carrier frequency is 1 MHz, amplitude is 10 Vp-p, modulation factor is 20%, and modulating frequency is 1 kHz is to be output.

1)	MODE	CONT
2)	FUNCTION	∿
3)	VCA	ON
4)	FREQ	1.00MHz
5)	AMPL	10V
6)	OUTPUT	ON

From Equation 6.7.1 ($A = N + K \times E$):

A: Output amplitude [Vp-p]
N: Internally set amplitude
E: VCA IN voltage (V)
K: VCA constant
1.5 for ATT=0dB

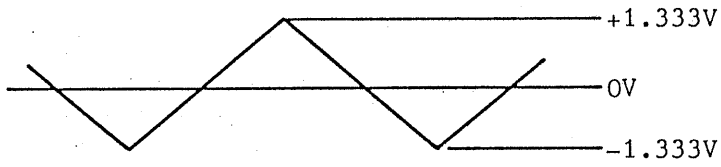
$$E_H = \frac{A_H - N}{K} = \frac{12 - 10}{1.5}$$

$$E_H = 1.333V$$

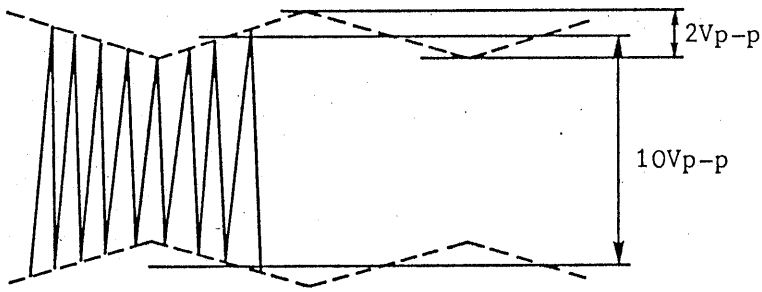
$$E_L = \frac{A_L - N}{K} = \frac{8 - 10}{1.5}$$

$$E_L = -1.333V$$

VCA input waveform



Output waveform



GP-IB command example

1) M0 F1 C3 D0 1 U3 D2 10 U1 C5

7.4 Line Voltage Variation Operation Test

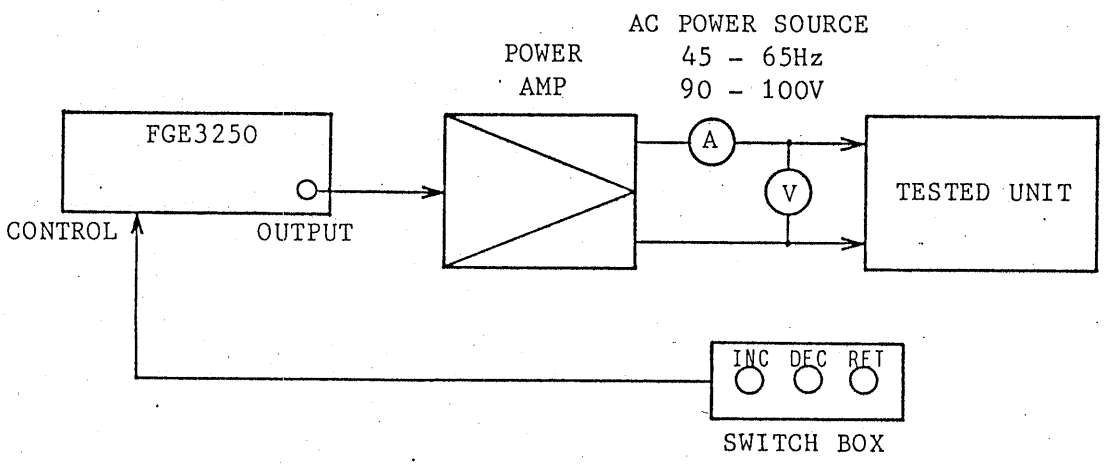


Fig. 7.4.1

Figure 7.4.1 shows the connection diagram for the power source variation operation test to be performed with the use of the internal memory and memory external control function. Program the test conditions in the memory and execute operation tests one by one by pressing the buttons on the switch box.

For example, the test conditions may be specified as follows:

MEMO 0 - OUTPUT OFF (100V, 50Hz)
1 - 100V 50Hz
2 - 90V 50Hz
3 - 110V 50Hz
4 - 100V 45Hz
5 - 90V 45Hz
6 - 110V 45Hz
7 - 100V 55Hz
8 - 90V 55Hz
9 - 110V 55Hz

Memory setting procedure

(1) POWER ON (RESET); CLR : The entire memory is cleared.
(2) Select "SYNT", "∿", "FREQ"=50Hz, and "AMPL"=0V.
(3) Set "OUTPUT" to ON and select AC 100V for "AMPL" by dial.
(4) "OUTPUT" OFF, 0 , STOR : A program is stored in Memory 0.
(5) "OUTPUT" ON, STOR: A program is stored in Memory 1.
(6) Select AC 90V for "AMPL" by dial and press STOR : Memory 2
(7) Select AC 110V for "AMPL" by dial and press STOR : Memory 3
(8) Set "FREQ"=45Hz, select AC 100V, and press STOR : Memory 4
(9) Select AC 90V and press STOR : Memory 5
(10) Select AC 110V and press STOR : Memory 6
(11) Set "FREQ"=55Hz, select AC 100V, and prss STOR : Memory 7
(12) Select AC 90V and press STOR : Memory 8
(13) Select AC 110V and press STOR : Memory 9

Testing procedure

(1) Press 0 and EXEC , and the program in Memory 0 is executed, but OUTPUT is set to OFF. Connect the tested unit to the FGE3250.

(2) Press the INC button on the switch box, and the program in Memory 1 is executed for an operation test.

(3) Press the INC button again, and the program in Memory 2 is executed. Operation tests are executed one by one as the INC button is pressed.

(4) After the program in Memory 0 has been executed, replace the tested unit. Then, start the testing again.

(5) Use the DEC button, and the memory number will be decremented, that is, the programs will be executed in reverse order.
Press the RET button, and the control will return to Memory 0.
By disabling some of the memories, unnecessary test conditions can be skipped.

Example programming by GP-IB

"P4 E5 E1 M4 F0 C4 D0 50 U1 D2 0 U1 E2 0"

"D2 ○○○ U1 C5 E2 1"

"D2 ○○○ U1 E2 2"

"D2 ○○○ U1 E2 3"

"D0 45 U1 D2 ○○○ U1 E2 4"

"D2 ○○○ U1 E2 5"

"D2 ○○○ U1 E2 6"

"D0 55 U1 D2 ○○○ U1 E2 7"

"D2 ○○○ U1 E2 8"

"D2 ○○○ U1 E2 9"

"E0 0"

8. FUNCTION DIAGNOSIS

8.1 Function Diagnostic Test Program (TEST 1)

Input the numeric value "1" by ⑮ during the lamp test executed by the pressing of "RESET" button (⑥), and the FGE3250 will enter "Test Program Mode 1" to allow diagnosis of the function generator by oscilloscope.

The function diagnostic test program starts from Memory 0, and the setting for the instrument will change each time the "INC"/"DEC" button is pressed. So, check the signal output from the instrument by an oscilloscope while pressing the "INC"/"DEC" button.

* To terminate this test operation, press the "RESET" button (⑥).

MEMO NO.	Setting				
0	Initial setting RESET state				
	[FUNCTION and OUTPUT ON function test]	FREQ	AMPL	OFST	WIDT
1	Sine waveform	1kHz	1Vp-p	0V	
2	Triangle waveform	↓	↓	↓	
3	Square waveform				
4	Square complement waveform				
5	Pulse waveform				200μs
6	Pulse complement waveform	↓	↓	↓	↓
	[Frequency test in range]	FUNCTION	AMPL	OFST	
7	FREQ = 1kHz		1Vp-p	0V	
8	2kHz		↓	↓	
9	5kHz				
10	7kHz				
11	9.99kHz	↓	↓	↓	

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MEMO NO.	Setting				
	[Frequency range test]	FUNCTION		AMPL	OFST
12	FREQ = 9.99mHz			1Vp-p	0V
13	99.9mHz				
14	999mHz				
15	9.99Hz				
16	99.9Hz				
17	999Hz				
18	9.99kHz				
19	99.9kHz				
20	999kHz				
21	9.99MHz				
22	20MHz				
	[Pulse width test]	FUNCTION	FREQ	AMPL	OFST
23	WIDT = 1mS		33.3Hz	1Vp-p	0V
24	WIDT = 2mS				
25	WIDT = 5mS				
26	WIDT = 7mS				
27	WIDT = 9.99mS				

MEMO NO.	Setting					
	[Synthesizer frequency test]			FUNCTION	AMPL	OFST
28	FREQ = 1kHz				1Vp-p	0V
29	2kHz					
30	3kHz					
31	5kHz					
32	7kHz					
33	9.99kHz					
	[Synthesizer frequency range test]			FUNCTION	AMPL	OFST
34	FREQ = 10Hz				1Vp-p	0V
35	100Hz					
36	1kHz					
37	10kHz					
38	100kHz					
39	1MHz					
40	10MHz					
41	20MHz					
	[Trigger rate test]	FUNCTION	FREQ	AMPL	OFST	STAT
42	RATE = 3mS		500Hz	1Vp-p	0V	0DEG
43	5mS					
44	7mS					
45	10.1mS					
46	101mS					
47	1.01S					
48	10.1S					

MEMO NO.	Setting					
	[Starting phase test]	FUNCTION	FREQ	AMPL	OFST	RATE
49	STAT = +90DEG		333Hz	1Vp-p	0V	10mS
50	+50DEG		↓	↓	↓	↓
51	+20DEG					
52	0DEG					
53	-20DEG					
54	-50DEG					
55	-90DEG					
	[Gated oscillation test]	FUNCTION	FREQ	AMPL	OFST	STAT	RATE
56			2kHz	1Vp-p	0V	0DEG	10mS
	[Burst oscillation test]	FUNCTION	FREQ	AMPL	OFST	STAT	RATE
57	BRST = 2		10kHz	1Vp-p	0V	0DEG	2mS
58	3	↓	↓	↓	↓	↓	↓
59	4						
60	10						
61	20						
62	50						
63	100						
	[HF LIMIT test]	FUNCTION	FREQ	AMPL	OFST		
64	HF LIMIT OFF.		5MHz	1Vp-p	0V		
65	HF LIMIT ON	↓	↓	↓	↓		

MEMO NO.	Setting			
	[AMPL test]	FUNCTION	FREQ	OFST
66	AMPL = 15V		1kHz	0V
67	10V			
68	5V			
69	2V			
70	1V			
71	200mV			
72	100mV			
73	20mV			
	[OFFSET test]	FUNCTION	FREQ	AMPL
74	OFST = +7.5V		1kHz	0V
75	+5V			
76	+2V			
77	0V			
78	-2V			
79	-5V			
80	-7.5V			

* The above tests are done on the FGE3250 independently, but the following tests require the application of an external signal to the instrument:

MEMO-NO.	Setting for FGE3250	External input signal
81	[VCG test] VCG : ON, FUNCTION:  FREQ: 5kHz, OFST : 0V AMPL: 1Vp-p	VCG IN:  or  FREQ : 100Hz AMPL : 1Vp-p
82	[VCA test] VCA : ON, FUNCTION:  FREQ: 100kHz, OFST : 0V AMPL: 1Vp-p	VCA IN:  or  FREQ : 1kHz AMPL : 8Vp-p
83 84	[MANUAL TRIG test] MODE: GATE, FUNCTION:  FREQ: 2kHz, OFST : 0V AMPL: 1Vp-p  TRIG: 1V  TRIG: -1V	WITHOUT EXT. SIG. *) OUTPUT SIG. at "PUSH MANU KEY"
85 86	[EXT TRIG,  , and  Test] MODE: GATE, FUNCTION:   TRIG: 1V  TRIG: 1V	TRIG IN:  FREQ : 100Hz AMPL : 8Vp-p
87 88 89 90 91	[Trigger level test] FREQ: 2kHz, OFST: 0V AMPL: 1Vp-p, STAT: 0DEG EXT TRIG: 5V TRIG: 2V TRIG: 0V TRIG: -2V TRIG: -5V	TRIG IN:  FREQ : 100Hz AMPL : 12Vp-p MIN

MEMO-NO.	Setting for FGE3250	External input signal
92	[SYNT.EXT.REF test] FREQ: 1kHz, OFST: 0V AMPL: 1Vp-p, ZERO	REF IN:  FREQ : 10MHz AMPL : 2Vp-p MIN
93	[SYNT.EXT.LOCK test] FREQ: 5kHz, OFST: 0V AMPL: 1Vp-p, ZERO	REF IN:  FREQ : 5kHz AMPL : 2Vp-p MIN
94 95 96	[REF OUT test] LOW LEVEL REF FREQ: 10MHz INT TRIG SIG. FREQ: 1kHz	
97	INT PLL SIG. FREQ, 2kHz, ZERO	REF IN:  FREQ : 10MHz AMPL : 2Vp-p MIN
98 99	EXT REF SIG. FREQ: 5kHz, ZERO EXT REF SIG. FREQ: 5kHz, TTL	REF IN:  FREQ : 5kHz AMPL : 5Vp-p MIN

* Even if the INC button is pressed, the memory number does not return from 99 to 0.
To terminate the test operation, press the RESET button (⑥).

9. ERROR MESSAGES

When incorrect setting is done, the FGE3250 displays an error number as error message. The error number is cleared when the next button is pressed. If an error is found in numeric data, the relevant data item indicator (⑦ - ⑫) flickers.

Er 01: Battery down
The memory backup battery has been discharged excessively. The battery must be charged. Explanation in Section 3.6.

[Numeric data error]

Er 02: FREQ < 1 mHz
PERI > 1000 s
WIDT > 500 s
RATE > 1000 s
Any setting that implies the frequency of less than 1 mHz is not allowed.

For SYNT: FREQ < 10 Hz
PERI > 100 ms
WIDT > 50 ms
In the synthesizer mode, any setting that implies the frequency of less than 10 Hz is not allowed.

Er 03: FREQ > 20 MHz
PERI < 50 ns or PERI = 0
WIDT < 25 ns
RATE < 50 ns
Any setting that implies the frequency of more than 20 MHz is not allowed.

Er 04: "AMPL" must not be smaller than 10 mV.

Er 05: "AMPL" must not be greater than 15 V.

Er 06: OFST > +7.5V, -7.5V > OFST

The DC offset ("OFST") must be within the range of ±7.5V.

Er 07: The value of "AMPL" is contradictory to that of OFST.

See the operation principle in Section 6.7.

Er 08: UPR > +7.5V, +750 mV, or +75 mV

The signal is clipped because the peak voltage on the plus side is greater than the above values.

Er 09: LWR < -7.5V, -750 mV, or -75 mV

The signal is clipped because the peak voltage on the minus side is smaller than the above values.

Er 10: UPR < LWR

The plus peak voltage is smaller than the minus peak voltage.

Er 11: TRG > +10V, -10V TRIG

The trigger voltage ("TRIG") must be within the range of ±10V.

Er 12: BRST > 32767, 1 > BRST

The burst count must be within the range from 1 to 32,767.

Er 13: The starting phase must be within the range of ±90°.

Er 14: $FREQ > \frac{1}{WIDT \times 2}$, PERI < WIDT × 2

Any setting that makes the signal exceed duty 50% is not allowed.

Er 15: $FREQ < \frac{1}{RATE}$, PERI > RATE

The trigger rate must be longer than 1 cycle time.

Er 16: RATE < WIDT × 2

The setting that makes the signal exceed duty 50% is nor allowed.

Er 17: RATE = 0
The trigger rate must not be set to 0.

[Numeric key error]

Er 20: More than seven characters have been keyed in.

Er 21: The input memory number is not within the range from 0 to 99.

Er 22: Data has been specified with a minus sign although a negative value is not allowed to it.

Er 23: Numberic data of six or more digits was input and a unit key was pressed. (The maximum number of digits for numeric data is 5.)

[Memory manipulation error]

Er 30: The memory specified for "EXEC" or "CALL" contains no data.

Er 31: The memory specified for "EXEC" is disabled (D.MEM).

Er 32: The memory number exceeded 99 during "STOR" by automatic increment.

Er 33: Memory error (The memory is checked after the memory all clear operation.)

[GR-IB error]

Er 40: Input buffer overflow. Bus commands of more than 80 characters (including CR/LF) have been specified in one line.

Er 42: Bus command or format error.

[Mode error]

Er 50: Pulse wave cannot be specified in the mode of "SYNT"."EXT". "LOCK".

APPENDIX GP-IB PROGRAM EXAMPLES

This section gives some examples of the programs for GP-IB controlled by NEC PC-9801. The example programs are simple programs to be executed in a system consisting of the controller and only one unit of FGE3250 without input of external signals such as VCG and VCA. The programs are coded in BASIC. (In the example programs, the device address for FGE3250 is set to 1 (decimal).)

(1) Program to send data

```
10  REM "FGE-1"    FGE3250 GP-IB    PC-9801                    1986.2.20  maki
20  PRINT "*** demo prog. No.1 ***   [ change mode and others ]" :PRINT
30  ISET IFC
40  ISET REN
50  CMD DELIM=0
60  CMD TIMEOUT=5
70    PRINT @1;"P4,C5"                              :PRINT "   (reset & output=on)"
80     GOSUB 200                                    :PRINT
90    PRINT @1;"M1D0500U1D20.5U1D3.5U1DA5000U2" :PRINT "at TRIG mode"
100    GOSUB 200
110   PRINT @1;"M2,D1 1U1,D4,500U0,D50U2,DA10U1":PRINT "at GATE mode"
120    GOSUB 200
130   PRINT @1;"C4 M3 D7 4U2 D8,-90U3 DA15U1 C5":PRINT "at BRST mode"
140    GOSUB 200
150   PRINT @1;"M4,D2 1 U1,D3 0 U1,D0 914.37 U1":PRINT "at SYNT mode"
160    GOSUB 200                                    :PRINT
170   PRINT @1;"P4"                                 :PRINT "   (reset)"
180 END
200    REM *** WAIT ROUTINE ***
210    FOR A=1 TO 2500 :NEXT A
220    RETURN
```

```
*** demo prog. No.1 ***   [ change mode and others ]

   (reset & output=on)

at TRIG mode
at GATE mode
at BRST mode
at SYNT mode

   (reset)
```

Explanation of program

30 Interface Clear is sent to initialize the interface.

40 Remote Enable is turned true to set the interface in remote mode.

50 The delimiter is specified. 0="CR+LF"

60 The time-out limit value is specified. Approximately 5 seconds.

The initial setting for program is done by the above steps 30-60. These steps apply to all the example programs given in this section.

70 PRINT @1;"P4,C5"
The parameters (Device Messages) in quotation marks (" ") are sent to the instrument (FGE3250 in this example) assigned to deivce address 1 (decimal).
P4: RESET (initialize)
C5: OUTPUT=ON

80 The state specified by step 70 is continued for several seconds.

90 Parameter values are set as below. The parameters not indicated by this step keep the values specified by step 70.

M1	:	M0 (CONT) has been specified by P4, but it is changed to M1 (TRIG).
D0500U1	:	D0 (frequency) is set to 500U1 (Hz).
D20.5U1	:	D2 (amplitude) is set to 0.5U1 (V).
D3.5U1	:	D3 (offset) is set to .5U1 (V).
DA5000U2	:	DA (rate) is set to 5000U2 (μs), that is, 5 ms.

* 0.5 V may be expressed as either 0.5U1, .5U1, or 5000U0.

100 The state specified by step 90 is continued for several seconds.

110 New parameter values are set for the state specified by step 90.
* A comma (,) or blank ( ) may be inserted between commands to make the program easy to read (the commas and blanks between commands are ignored). Note, however, that each command must be continuous. (For example, "M0", "D1", and "U2" must not be expressed as "M 0", "D 1" and "U,2".)

120 The state specified by step 110 is continued for several seconds.

130 New parameter values are set for the state specified by step 110.
Since C4 (OUTPUT=OFF) is placed at the beginning and C5 (OUTPUT=ON) is placed at the end of parameters, the waveform does not change during transmission of the parameters; only the waveform specified finally is output when C5 is received.

140 The state specified by step 130 is continued for several seconds.

150 New parameter values are set for the state specified by step 130.

160 The state specified by step 150 is continued for several seconds.

170 P4 (RESET) is send to set the instrument in the initial state again.

180 End

200-220 These steps form a wait time routine to keep the current state.

(2) Program to change waveform

```
10  REM "FGE-2"    FGE3250 GP-IB    PC-9801                    1986.2.19  maki
20  PRINT "*** demo prog. No.2 ***   [ change function ]" :PRINT
30  ISET IFC
40  ISET REN
50  CMD DELIM=0
60  CMD TIMEOUT=5
70    PRINT @1;"P4,C5"               :PRINT "   (reset & output=on)" :PRINT
80    FOR F=0 TO 5
90      F$="F"+MID$(STR$(F),2)
100     PRINT @1; F$                 :PRINT F$,
110     FOR W=1 TO 1000 :NEXT W
120   NEXT F                         :PRINT
130   PRINT @1;"P4"                  :PRINT "   ( reset )"
140 END
```

```
*** demo prog. No.2 ***   [ change function ]
   (reset & output=on)
F0          F1          F2          F3          F4          F5
   ( reset )
```

After sending P4 (RESET) and C5 (OUTPUT=ON), this program sends F0 (sine waveform), F1 (triangle waveform), F2 (square waveform), F3 (square complement waveform), F4 (pulse waveform), and F5 (pulse complement waveform) sequentially. Then, it sends P4 (RESET) again in the end.
All the parameters except FUNCTION keep their initial values because their values are not changed after P4 is sent by step 70.

Example of program

```
30-60   Initial setting for program
   70   P4 (RESET) and C5 (OUTPUT=ON) are sent.
   80   FOR F=0 TO 5
        F is changed form 0 to 5.
   90   The data values are set. (Since blanks are not allowed
        within command, MID$ is used. F$ is replaced by F0, F1,
        F2, F3, F4, and F5 as the value of F is changed. If MID$
        is not used, the parameter would be set as "F 0" and a
        command error would be reported.)
  100   The specified values are sent.
  110   FOR-NEXT to keep the specified state
  120   NEXT F
  130   P4 (RESET) is sent.
  140   End
```

(3) Program to change frequency and amplitude

```
10  REM "FGE-3"    FGE3250 GP-IB    PC-9801                    1986.2.20  maki
20  PRINT "*** demo prog. No.3 ***   [ change amplitude at each frequency ]"
30  ISET IFC
40  ISET REN
50  CMD DELIM=0
60  CMD TIMEOUT=5
70    PRINT @1;"P4"
80    PRINT :PRINT SPC(68);"( reset )";
90    FOR A=0 TO 3
100     IF A=0 THEN D$="m"
110     IF A=1 THEN D$=" "
120     IF A=2 THEN D$="k"
130     IF A=3 THEN D$="M"
140     FOR B=0 TO 2
150       IF A=3 AND B=2 THEN GOTO 280
160       X=2*10^B
170       PRINT
180       PRINT @1;"D0"+STR$(X)+"U"+MID$(STR$(A),2)+"C5"
190       PRINT"  FREQ=";SPC(4-LEN(STR$(X)));X;D$;"Hz" :PRINT "                ";
200       FOR C=0 TO 3
210         IF C<2 THEN B$="m" ELSE B$=" "
220         Y=15*10^C
230         PRINT @1;"D2"+STR$(Y)+"U0"
240         IF Y>1000 THEN Y=Y/1000
250         PRINT"   AMPL=";Y;B$;"V";
260         FOR W=1 TO 1000 : NEXT W
270       NEXT C
280     NEXT B
290   NEXT A
300   PRINT @1;"P4"
310   PRINT :PRINT :PRINT SPC(68);"( reset )"
320 END
```

```
*** demo prog. No.3 ***   [ change amplitude at each frequency ]

                                                                  ( reset )
  FREQ=   2 mHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ=  20 mHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ= 200 mHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ=   2  Hz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ=  20  Hz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ= 200  Hz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ=   2 kHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ=  20 kHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ= 200 kHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ=   2 MHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V
  FREQ=  20 MHz
                  AMPL= 15 mV   AMPL= 150 mV   AMPL= 1.5  V   AMPL= 15  V

                                                                  ( reset )
```

This program changes the frequency from 2 mHz to 20 MHz and amplitude from 15 mV to 15 V.

Explanation of program

The parameters of frequency and amplitude are sent by steps 180 and 230 respectively.
In steps 200-270, variable C is used for changing amplitude and variable W is used for setting wait time. As to the frequency, variable A is used for specifying the range (mHz, Hz, kHz, MHz) and variable B is used for specifying the value in each range. The value in each range can be changed by X and Y and the wait time can be changed by W.

(4) Program to change frequency in synthesizer mode

```
 10  REM "FGE-4"    FGE3250 GP-IB    PC-9801                    1986.2.21  maki
 20  PRINT "*** demo prog. No.4 ***   [ change frequency at SYNT mode ]" :PRINT
 30  ISET IFC
 40  ISET REN
 50  CMD DELIM=0
 60  CMD TIMEOUT=5
 70    INPUT "     f= ";I
 80    INPUT "  STEP= ";J
 90    PRINT @1;"P4,M4"
100    PRINT :PRINT "   (reset , SYNT)" :PRINT
110    FOR A=2 TO 3
120      IF A=2 THEN M=2:N=2:A$="k" ELSE M=0:N=1:A$="M"
130      FOR B=M TO N
140        IF A=3 AND B=1 AND I>20000 THEN GOTO 270
150        X=I*(10^B)/10000 :Y=10^B
160        GOSUB 300
170        PRINT "      -      ";
180        IF A=3 AND B=1 THEN O=20000 ELSE O=99999!
190        FOR C=I TO O-J STEP J
200          PRINT @1;"C4,D0"+STR$(C*Y/10000)+"U"+MID$(STR$(A),2)+"C5"
210          FOR W=1 TO 2000 :NEXT W
220        NEXT C
230        X=C*(10^B)/10000
240        GOSUB 300 :PRINT
250      NEXT B
260    NEXT A
270    PRINT @1;"P4"
280    PRINT :PRINT "   ( reset )"
290 END
300        REM *** PRINT USING ROUTINE ***
310        IF B=0 THEN PRINT USING "###.####";X; :GOTO 330
320        IF B=1 THEN PRINT USING "###.###";X; ELSE PRINT USING "###.##";X;
330        PRINT SPC(LEN(STR$(Y)));A$;"Hz";
340        RETURN
```

```
*** demo prog. No.4 ***   [ change frequency at SYNT mode ]

     f=  12345
  STEP=  500

   (reset , SYNT)

123.45    kHz      -     998.45    kHz
  1.2345  MHz      -       9.9845  MHz
 12.345   MHz      -      19.845   MHz

   ( reset )
```

This program changes frequency in synthesizer mode. By specifying 5-digit numeric data for f and selecting a desired input for STEP, the user can change the frequency in a desired way. For the frequency of 10 Hz to 100 Hz, a wait time of approximately 10 seconds is required till the waveform is stabilized. For the frequency of 1 kHz to 20 MHz, the required wait time is approximately 1 second. (In the above program, the wait time is provided by FOR-NEXT of step 210.)

(5) Program to write data to memory

```
10  REM "FGE-5"    FGE3250 GP-IB    PC-9801                    1986.2.24  maki
20  PRINT "*** demo prog. No.5 ***   [ input memory ]" :PRINT
30  ISET IFC
40  ISET REN
50  CMD DELIM=0
60  CMD TIMEOUT=5
70    PRINT @1;"P4,E5"          :PRINT "  ( reset & memory all clear )" :PRINT
80    PRINT @1;"E2 00"          :PRINT " 00 "," - keep - "
90    PRINT @1;"D2 10U1,E2 1"   :PRINT " 01 ","              ",,"ampl =  10  V"
100   PRINT @1;"F4D9500U2E202"  :PRINT " 02 ","pulse         ",,"widt = 500 uS"
110   PRINT @1;"F5,D0 100U1,E23":PRINT " 03 ","comp.pulse    ",,"freq = 100  Hz"
120   PRINT @1;"D4  0 U1,E2"    :PRINT " 04 ","              ",,"upr  =   0  V"
130   PRINT @1;"F1E2"           :PRINT " 05 ","triangle wave"   :PRINT :PRINT
140   PRINT @1;"P4,P0,E2 09"    :PRINT " 09 ","reset,buzzer:off":PRINT :PRINT
150   FOR A=12 TO 98
160     PRINT A,
170     F=A MOD 3
180     PRINT @1;"F"+MID$(STR$(F),2)
190     IF F=0 THEN PRINT "sine     wave",,
200     IF F=1 THEN PRINT "triangle wave",,
210     IF F=2 THEN PRINT "square   wave",,
220       IF A>35 THEN GOTO 270
230       B=FIX((A-12)/3) :B=(7-B)*(-1)^B
240       PRINT "ofst =  ";B;" V"
250       PRINT @1;"D3"+STR$(B)+"U1"+"E2"+STR$(A)
260       GOTO 420
270         IF A>56 THEN GOTO 320
280         B=FIX((A-33)/3)
290         PRINT "brst =  ";B;"TIM"
300         PRINT @1;"M3,D2 5U1,D7"+STR$(B)+"U2,E2"
310         GOTO 420
320           IF A>77 THEN GOTO 380
330           B=(3*FIX((A-57)/3))+1
340           PRINT "rate =  ";
350           PRINT @1;"DA"+STR$(B)+"U1,E2"
360           PRINT USING"##";B; :PRINT "  mS"
370           GOTO 420
380             B=15*FIX((A-78)/3) :B=B*(-1)^A
390             PRINT "stat = ";
400             PRINT @1;"D8"+STR$(B)+"U3,E2"
410             PRINT USING"###";B; :PRINT "  DEG"
420     IF (A MOD 10)=9 THEN PRINT
430   NEXT A
440   PRINT @1;"P4 E2 99"
450   PRINT " 99 ","reset" :PRINT :PRINT
460     R=INT(RND*10+1)
470     PRINT @1;"M3F1D0"+STR$(R*150)+"U1D2"+STR$(R)+"U1D71U2D890U3DA7U1,E2 07"
480     PRINT " 07 ","triangle brst",,"F="R*150"Hz A="R"V B=1TIM S=90DIG R=7ms"
490     PRINT @1;"P4,F4,D9"+STR$(R*50)+"U2,D45U1,D50U1,D0"+STR$(R*100)+"U1,E208"
500     PRINT " 08 ","pulse         ",,"F="R*100"Hz W="R*50"uS U=5V L=0V"
510   REM ***** output *****
520   PRINT @1;"P4,E0 00"
530   FOR A=0 TO 96
540     PRINT @1;"C5"
550     FOR W=0 TO 1000 :NEXT W
560     PRINT @1;"C4,E3"
570   NEXT A
580 END
```

```
*** demo prog. No.5 ***   [ input memory ]

  ( reset & memory all clear )

00            - keep -
01                                        ampl =  10  V
02          pulse                         widt = 500 uS
03          comp.pulse                    freq = 100  Hz
04                                        upr  =   0  V
05          triangle wave

09          reset,buzzer:off

12          sine     wave                 ofst =   7  V
13          triangle wave                 ofst =   7  V
14          square   wave                 ofst =   7  V
15          sine     wave                 ofst =  -6  V
16          triangle wave                 ofst =  -6  V
17          square   wave                 ofst =  -6  V
18          sine     wave                 brst =   5  V
19          triangle wave                 brst =

50          square   wave                 brst =   5 TIM
51          sine     wave                 brst =   6 TIM
52          triangle wave                 brst =   6 TIM
53          square   wave                 brst =   6 TIM
54          sine     wave                 brst =   7 TIM
55          triangle wave                 brst =   7 TIM
56          square   wave                 brst =   7 TIM
57          sine     wave                 stat =
58          triangle wave                 stat =  45
59          square   wave                 stat = -45  DEG

90          sine     wave                 stat =  60  DEG
91          triangle wave                 stat = -60  DEG
92          square   wave                 stat =  60  DEG
93          sine     wave                 stat = -75  DEG
94          triangle wave                 stat =  75  DEG
95          square   wave                 stat = -75  DEG
96          sine     wave                 stat =  90  DEG
97          triangle wave                 stat = -90  DEG
98          square   wave                 stat =  90  DEG
99          reset

07          triangle brst                 F= 150 Hz A= 1 V B=1TIM S=90DIG R=7ms
08          pulse                         F= 100 Hz W= 50 uS U=5V L=0V
```

Explanation of program

70 P4 (RESET) and P5 (MEMORY ALL CLEAR) are sent.
P5 clears all the data from memory.

80 The current state is written at address 00.
E2 00: Stores data at address 00.

90 The amplitude is changed to 10 V from the state of step 80, and the new setting is written at address 01.
* For a one-digit address, the high-order "0" may be omitted.

100-140 The specified parameter values are written at the specified addresses.

* For continuous addresses, the address value after E2 (STORE) may be omitted.

150-430 The specified parameter values are written at the sequential addresses.

440 The reset state is written at the specified address.

510-570 The written data is output sequentially starting from address 00.

(6) Program to read data from memory

```
10  REM "EGE-6"    FGE3250 GP-IB    PC-9801                    1986.2.25  maki
20  PRINT "*** demo prog. No.6 ***   [ line up output memory ]"
30  ISET IFC
40  ISET REN
50  CMD DELIM=0
60  CMD TIMEOUT=5
70  ON SRQ GOSUB 500
80    PRINT SPC(50);"*) input memory already"
90    PRINT @1;" P4,R1,R3"
100   PRINT "   (reset)"
110   PRINT :PRINT "   disable data is it or not ?"
120   PRINT SPC(18);"( MEMO NO. / not=100 )";
130   INPUT D
140   IF D<>100 THEN PRINT @1;"E4"+STR$(D) :PRINT SPC(36);"and "; :GOTO 130
150   PRINT :PRINT "   enable data is it or not ?"
160   PRINT SPC(18);"( MEMO NO. / not=100 )";
170   INPUT E
180   IF E<>100 THEN PRINT @1;"E3"+STR$(E) :PRINT SPC(36);"and "; :GOTO 170
190     PRINT  :PRINT "*** at < CALL xx > ***"
200     E$="1"
210     GOTO 240
220       PRINT  :PRINT "*** at < EXEC xx > ***"
230       E$="0"
240       FOR A=0 TO 99
250       PRINT :PRINT "MEMO NO.    ";A;
260         SRQ ON
270         PRINT @1;"C4,E"+E$+STR$(A)+"C5"
280         FOR W=0 TO 2000 :NEXT W
290       NEXT A
300       PRINT :PRINT
310     IF E$="1" THEN GOTO 220
320 END
500   REM *** SRQ ROUTINE ***
505   FOR W=0 TO 300  :NEXT W
510   POLL 1,B
520   PRINT "=SRQ :IEEE(4)=";IEEE(4);
530   IF IEEE(4)=65 THEN PRINT "  ******** SRQ key ******** "; :GOTO 560
540   PRINT "  without data";
550   IF E$="0" THEN PRINT "  or disable memory";
560   RETURN
```

```
*** demo prog. No.6 ***   [ line up output memory ]
                                                    *) input memory already
   (reset)

   disable data is it or not ?
                  ( MEMO NO. / not=100 ) 3
                                         and  18
                                         and  55
                                         and  66
                                         and  77
                                         and  88
                                         and  99
                                         and  12
                                         and  100

   enable data is it or not ?
                  ( MEMO NO. / not=100 ) 12
                                         and  99
                                         and  77
                                         and  100

*** at < CALL xx > ***

MEMO NO.    0
MEMO NO.    1
MEMO NO.    2
MEMO NO.    3
MEMO NO.    4
MEMO NO.    5
MEMO NO.    6 =SRQ :IEEE(4)= 68   without data
MEMO NO.    7
MEMO NO.    8
MEMO NO.    9
MEMO NO.    10 =SRQ :IEEE(4)= 68   without data
MEMO NO.    11 =SRQ :IEEE(4)= 68   without data
MEMO NO.    12
MEMO NO.    13
MEMO NO.    14 =SRQ :IEEE(4)= 65   ******** SRQ key ********
MEMO NO.    15
MEMO NO.    16
MEMO NO.    17
MEMO NO.    18
MEMO NO.

*** at < EXEC xx > ***

MEMO NO.    0
MEMO NO.    1
MEMO NO.    2 =SRQ :IEEE(4)= 65   ******** SRQ key ********
MEMO NO.    3 =SRQ :IEEE(4)= 68   without data  or disable memory
MEMO NO.    4
MEMO NO.    5
MEMO NO.    6 =SRQ :IEEE(4)= 68   without data  or disable memory
MEMO NO.    7
MEMO NO.    8
MEMO NO.    9
MEMO NO.    10 =SRQ :IEEE(4)= 68   without data  or disable memory
MEMO NO.    11 =SRQ :IEEE(4)= 68   without data  or disable memory
MEMO NO.    12
MEMO NO.    13
MEMO NO.    14
MEMO NO.    15
MEMO NO.    16
MEMO NO.    17
MEMO NO.    18 =SRQ :IEEE(4)=                                  memory
MEMO NO.    19
MEMO NO.    20
```

This program reads and outputs data from memory.
Since the SRQ flag is on (see program example (7)), the key interrupt state and the state accessing to the memory address containing no data or attempted to output disabled data directly are indicated as follows:

IEEE(4)=68 Numeric data error (addressing error)
IEEE(4)=65 SRQ key has been pressed

Explanation of program

70 When Service Request is received, control branches to the subroutine of step 500.

90 P4 (RESET) and "SRQ flag setting = ON" are sent.
R1: Error SRQ = ON
R3: Key SRQ = ON

140 Disabled data address is sent.

180 Enabled data address is sent.

270 Memory data is read and OUTPUT=ON is sent.

(7) Program to use SRQ flag

```
10  REM "FGE-7"    FGE3250 GP-IB    PC-9801                    1986.2.28  maki
20  PRINT "*** demo prog. No.7 ***   [ key SRQ & error SRQ ]" :PRINT
30  ISET IFC
40  ISET REN
50  CMD DELIM=0
60  CMD TIMEOUT=5
70  ON SRQ GOSUB 500
80    PRINT @1;"P4,P0,R1,R3"
90    FOR A=0 TO 99
100     PRINT :PRINT USING "##";A; :PRINT "     ";
110     R=INT(RND*11+1)-1 :S=INT(RND*12+1)-1
120     IF R=0 THEN PRINT "   freq = ";R;"Hz ",
130     IF R=1 THEN PRINT "   peri = ";R;"mS ",
140     IF R=2 THEN PRINT "   ampl = ";R;" V ",
150     IF R=3 THEN PRINT "   ofst = ";R;" V ",
160     IF R=4 THEN PRINT "   upr  = ";R;" V ",
170     IF R=5 THEN PRINT "   lwr  = ";R;" V ",
180     IF R=6 THEN PRINT "   trig = ";R;"mS ",
190     IF R=7 THEN PRINT "   brst = ";R;"tim",
200     IF R=8 THEN PRINT "   stat = ";R;"dig",
210     IF R=9 THEN PRINT "   widt = ";R;"mS ",
220     IF R=10 THEN PRINT "  R=";R;" S=";S,
230     IF R=7 THEN PRINT @1;"C4,D"+MID$(STR$(R),2)+STR$(S)+"U2,C5" :GOTO 260
240     IF R=8 THEN PRINT @1;"C4,D"+MID$(STR$(R),2)+STR$(S)+"U3,C5" :GOTO 260
250     PRINT @1;"C4,D"+MID$(STR$(R),2)+STR$(S)+"U1,C5"
260     SRQ ON :REM
270     FOR W=0 TO 2000 :NEXT W
280   NEXT A
290 END
```

```
500   REM *** SRQ ROUTINE ***
505     FOR W=0 TO 300  :NEXT W
510   POLL 1,B
520   PRINT "SRQ:IEEE(4)=";IEEE(4);
530   IF IEEE(4)=65 THEN PRINT "****** SRQ key on ******";
540   IF IEEE(4)=66 THEN PRINT "* command,format error *";
550   IF IEEE(4)=68 THEN PRINT "*** suuchi data error **";
560   RETURN
```

```
*** demo prog. No.7 ***   [ key SRQ & error SRQ ]

 0        freq =  0 Hz
 1       R= 10  S= 11        SRQ:IEEE(4)= 66 * command,format error *
 2        upr  =  4  V       SRQ:IEEE(4)= 68 *** suuchi data error **
 3        widt =  9 mS
 4       R= 10  S= 4         SRQ:IEEE(4)= 66 * command,format error *
 5        peri =  1 mS
 6        freq =  0 Hz
 7        ampl =  2  V
 8        ampl =  2  V
 9        peri =  1 mS       SRQ:IEEE(4)= 65 ****** SRQ key on ******
10        upr  =  4  V
11        ampl =  2  V
12        freq =  0 Hz
13        upr  =  4  V
14       R= 10  S= 11        SRQ:IEEE(4)= 66 * command,format error *
15        ampl =  2  V
16        brst =  7 tim
17        freq =  0 Hz
18        brst =  7 tim      SRQ:IEEE(4)= 65 ****** SRQ key on ******
19        stat =  8 dig
20        widt =  9 mS
21       R= 10  S= 2         SRQ:IEEE(4)= 66 * command,format error *
22        peri =  1 mS
23       R= 10  S= 8         SRQ:IEEE(4)= 66 * command,format error *
24        upr  =  4  V       SRQ:IEEE(4)= 68 *** suuchi data error **
25        brst =  7 tim
26        ampl =  2  V
27        peri =  1 mS
28        upr  =  4  V
29        brst =  7 ti
```

This program indicates errors in send data and pressing of SRQ key. In the above example, data is produced from random numbers and the errors in the data are displayed.

IEEE(4)=65: Means that the SRQ key has been pressed.

IEEE(4)=66: Means that a command and format error has been found.

IEEE(4)=68: Means that a numeric data error has been found.

＊ GP－IB COMMAND TABLE

○ MODE, FANCTION SETTING

・MODE

C O N T	M 0
T R I G	M 1
G A T E	M 2
B R S T	M 3
S Y N T	M 4

・FUNCTION

Sine waveform	F 0
Triangle waveform	F 1
Square waveform	F 2
Square complement waveform	F 3
Pulse waveform	F 4
Pulse complement waveform	F 5

VCG	OFF	C 0
	ON	C 1
VCA	OFF	C 2
	ON	C 3
OUTPUT	OFF	C 4
	ON	C 5
HF LIMIT	OFF	C 6
	ON	C 7

・SYNT

	INT	S 0
	EXT	S 1
	REF	S 2
	LOCK	S 3
	TTL	S 4
	ZERO	S 5

・TRIG

	INT	T 0
	EXT	T 1
	⨍	T 2
	⨎	T 3
MANUAL	ON	T 4
	OFF	T 5

○ NUMERIC DATA SETTING

F R E Q	D 0
P E R I	D 1
A M P L	D 2
O F S T	D 3
U P R	D 4
L W R	D 5
T R I G	D 6
B R S T	D 7
S T A T	D 8
W I D T	D 9
R A T E	D A

mHz, S, mV	U 0
Hz, mS, V	U 1
KHz, μS, TIM	U 2
MHz, nS, DEG	U 3

○ PANEL CONTROL

・)))	OFF	P 0
	ON	P 1
KEY	OFF	P 2
	ON	P 3
RESET		P 4＊

○ MEMORY CONTROL

E X E C	E 0
C A L L	E 1
S T O R	E 2
I N C・M E	E 3
D E C・M D	E 4
Memory all clear	E 5

○ SRQ FLAG SETTING

Error SRQ	OFF	R 0
	ON	R 1
KEY SRQ	OFF	R 2
	ON	R 3

○ VCG COMMAND

Range	FREQ setting/display	Command
1 mHz	0.00 mHz	G 0
10 mHz	00.0 mHz	G 1
100 mHz	000 mHz	G 2
1 Hz	0.00 Hz	G 3
10 Hz	00.0 Hz	G 4
100 Hz	000 Hz	G 5
1 KHz	0.00 KHz	G 6
10 KHz	00.0 KHz	G 7
100 KHz	000 KHz	G 8
1 MHz	0.00 MHz	G 9
10 MHz	00.0 MHz	G A

○ VCA COMMAND

Range	AMPL setting/display	ATT	Command
10 mV	00.0 mV	－40dB	A 0
100 mV	000 mV	－20dB	A 1
1 V	0.00 V	0 dB	A 2

(INITIAL STATE) ＊RESET P4

MODE	CONT	VCA	OFF
FUNCTION	∿	VCG	OFF
FRFQ	1 KHz	OUTPUT	OFF
AMPL	1 V	HFLIMIT	OFF
OFF SET	0 V	KEY	ON
UPR	500 mV	・)))	ON
LWR	－500 mV	INT/EXT	INT
TRIG	1 V	LOCK/REF	REF
BRST	2TIME	ZERO/TTL	ZERO
STAT	0 DEG	⨍/⨎	⨍
WIDT	1 μS		EXEC
RATE	10 mS	MEMORY	OFF

(STATUS BYTE)

D8	D7	D6	D5	D4	D3	D2	D1
0	1	0	0	0			

(POSITIVE LOGIC)

- D1 — SRQ KEY
- D2 — COMMAND FORMAT ERROR
- D3 — NUMERIC DATA ERROR

Notes on the sending of SRQ signal

1. Operation outline

When sending SRQ signal, the instrument is waiting for serial poll by the controller. If the controller does not perform the serial poll, the instrument sets a remote message (one data item ending with a delimiter in the case of device message) into a buffer register. The remote message is shifted to an execution register and the operation designated by it is executed when the next remote message is received in the next cycle.

Therefore, execution of a delimited device message is delayed by one cycle.

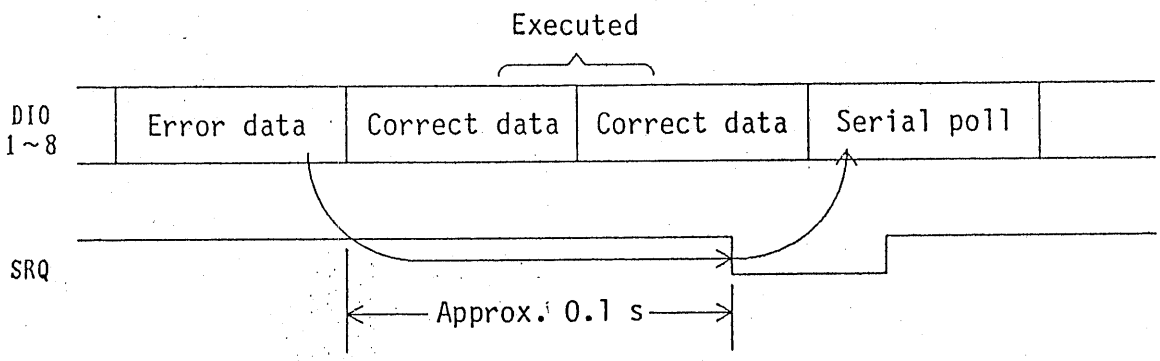
When an interface message, such as DCL or SDC, is received, on the other hand, it is stored in the buffer register but the operation designated by it is executed immediately. In this case, the buffer register contains no data till the next device message is received.

If the controller performs the serial poll normally, the above procedure is not taken; the messages are set in the execution register and the designated operations are executed.

2. SRQ signal delay

The instrument can send SRQ signal for the SRQ switch on panel, numeric data error, and command/format error. Since it takes time for the instrument to judge the occurrence of an error or the pressing of the SRQ switch, approximately 0.1 second at maximum is required before the SRQ signal is sent onto to the GP-IB.

Therefore, the remote messages received after the error data and before the serial poll are executed by a controller as follows:



* See Section 5.7 for the details of SRQ.

3. Summary of the operations related to remote messages during SRQ

Remote message	State after operation		SRQ signal
IFC	The instrument remains in the previous state	LOCS	Continued (Note 1)
DCL SDC	The instrument is set in the initial power-on state, but the following functions are not affected: Buzzer ON/OFF (P0, P1) Key ON/OFF (P2, P3) SRQ flag ON/OFF (R0, R1, R2, R3)	REMS RWLS LWLS	Continued
GTL	The operation designated by the content of buffer register is executed (Notes 3 and 5)	LOCS LWLS	Continued (Note 1)
LLO	The operation designated by the content of buffer register is executed (Notes 3 and 4)	RWLS LWLS	Continued

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Remote message	State after operation		SRQ signal
"P4" (Reset)	(1) For the first "P4"+ (delimiter), the operation designated by the content of buffer register is executed. (2) For the second "P4"+ (delimiter), the instrument is set in the initial power-on state, but the following functions are not affected: Buzzer ON/OFF (P0, P1) Key ON/OFF (P2, P3) The SRQ flag is turned off.	REMS RWLS	Stopped (Note 2)
RESET switch on panel (6)	The instrument is set in the initial power-on state	LOCS	Stopped
LOCAL switch on panel (35)	The operation designated by the content of buffer register is executed (Notes 3 and 4)	LOCS RWLS LWLS	Continued (Note 1)
ADRS switch on panel (35)	The device address is displayed	REMS RWLS LWLS	Continued
SRQ switch on panel (35)	Key SRQ operation	REMS RWLS LWLS	Continued

Notes: 1. If the operator inputs error data by switch on panel in LOCS or LWLS, the instrument stops sending the SRQ signal and turns off the SRQ lamp.

2. If the instrument receives error data after the first "P4"+(delimiter), it stops sending the SRQ signal and turns off the SRQ lamp.

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3. If the buffer register is empty, the instrument remains in the same state or is released from error data (returns to the previous state).
4. When the instrument is in RWLS or LWLS, the operation designated by the content of buffer register is not executed.
5. When the instrument is in LWLS, the operation designated by the content of buffer register is not executed.

* LOCS: LOCAL STATE
REMS: REMOTE STATE
RWLS: REMOTE WITH LOCKOUT STATE
LWLS: LOCAL WITH LOCKOUT STATE

4. If the hand shake is not done correctly (because of hang up, etc.), press the RESET switch (6) on panel.

* When the instrument is in LOCS, press the RESET switch (6) after releasing KEY OFF (5).