FUNCTION GENERATOR

MODEL: GFG-813

82FG-81300MF

SAFETY TERMS AND SYMBOLS

These terms may appear in this manual or on the prooduct:

WARNING. Warning statements identify condition or practices that could result in injury or loss of life.

CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

The following symbols may appear in this manual or on the product:

ATTENTION
refer to Manual

Protective
Conductor
Terminal

Earth
(Ground)
Terminal

FOR UNITED KINGDOM ONLY

NOTE

This lead/appliance must only be wired by competent persons

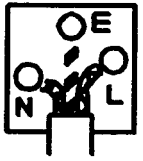
WARNING

THIS APPLIANCE MUST BE EARTHED

IMPORTANT

The wires in this lead are coloured in accordance with the following code:

Green/
Yellow: Earth
Blue: Neutral
Brown: Live(Phase)



As the colours of the wires in main leads may not correspond with the colours marking identified in your plug/appliance, proceed as follows:

The wire which is coloured Green & Yellow must be connected to the Earth terminal marked with the letter E or by the earth symbol ⏚ or coloured Green or Green & Yellow.

The wire which is coloured Blue must be connected to the terminal which is marked with the letter N or coloured Blue or Black.

The wire which is coloured Brown must be connected to the terminal marked with the letter L or P or coloured Brown or Red.

If in doubt, consult the instructions provided with the equipment or contact the supplier.

This cable/appliance should be protected by a suitably rated and approved HBC mains fuse : refer to the rating information on the equipment and/or user instructions for details. As a guide, cable of 0.75mm ^{2} should be protected by a 3A or 5A fuse. Larger conductors would normally require 13A types, depending on the connection method used.

Any moulded mains connector that requires removal/replacement must be destroyed by removal of any fuse & fuse carrier and disposed of immediately, as a plug with bared wires is hazardous if engaged in a live socket. Any re-wiring must be carried out in accordance with the information detailed on this label.

TABLE OF CONTENTS

I. GENERAL INFORMATION

1. INTRODUCTION

This manual contains installation procedures, operating instructions and theory of operation information for the Function Generator.

This section of the manual contains a description of this Function Generator, the performance specifications and characteristics, and instrument identification information.

2. DESCRIPTION

This Function Generator is a compact, wide range, dual function generator consisting of a main generator and a modulation generator. The main generator provides sine, square, or triangle wave outputs over the frequency range of 0.1 Hz to 13MHz. The modulation generator produces sine, square and triangle waveforms with a frequency range of 0.01Hz to 10KHz. The modulation generator can be used to Amplitude Modulate (AM) or Frequency Modulate (FM) the output signal of the main generator. The AM envelope can be adjusted from 0% to 100%; FM can change the carrier frequency up to ±5%.

Frequency Counter is 6 digit, two ranges, high sensitivity. For display the internal generator and external input frequency.

3. SWEEP OUTPUT

For added versatility, this model has a built-in sweep generator which can be used to sweep the frequency of the main generator. The frequency of the main generator can be swept as much as 100:1 on any range.

4. OUTPUT LEVEL

The output voltage can be varied from 0V to 10V peak-to-peak into 50 ohms in four voltage ranges. A front panel control permits continuous adjustment within each voltage range. The dc level of the main generator output can be adjusted within the range of ±10 volts using the front panel offset control. With the OFFSET in the CAL (PUSH) position the dc offset is eliminated.

5. BURST

The burst is either a single pulse or a series of pulses which are rear panel selectable by a slide switch labeled SINGLE and MULTIPLE. The TRIGGER PHASE control adjusts the phase of the signal. FREE RUN disables the burst.

6. SYMMETRY

The main and the modulation generators have separate front panel symmetry adjustments which will vary the symmetry of the output waveforms. The CAL position of each SYM knob will produce symmetrical waveforms. In the SWEEP mode, the SYM adjusts the sweep rate, and CAL selects a 90:10 ramp.

II. SPECIFICATIONS

1. INTRODUCTION

This is a complete list of the Function Generator critical specifications. These specifications are the performance standards or limits against which the instrument can be tested. But some lists supplemental performance characteristics which are not specifications, but are typical characteristics included as additional information for the user.

2. MAIN SPECIFICATIONS

Output Waveforms	:	SINE, SQUARE, TRIANGLE, ± RAMP, PULSE, AM, FM SWEEP, TRIGGER, GATE AND BRUST.
Amplitude	:	>20Vp-p open circuit, >10Vp-p into 50 ohm load (at 1KHz)
Impedance	:	50 ohm ± 10%
Attenuator	:	0dB, 20dB, 40dB, 60dB and >10:1 continuous control.
DC Offset	:	<-10V to >+10V, <-5V to >+5V (50 ohm load)
Variable Symmetry	:	80:20:80 to 1MHz
Display	:	6 digits (0.3" LED display)
Frequency Range	:	0.1Hz to 13 MHz in 8 decades ranges
Dial Accuracy	:	±5% of full scale

3. SINE WAVE

Distortion	:	<0.5% (-46dB) THD from 10Hz to 50KHz
		>30dB below fundamental from 50KHz to 13MHz
Flatness	:	<± 3% from 10Hz to 100KHz
		<±10% from 100KHz to 10MHz

4. TRIANGLE WAVE

Linearity Error	:	<1% at 100Hz

5. SQUARE WAVE

Symmetry	:	<2% 0.1Hz to 100KHz
Rise or Fall Time	:	<18nSec.

6. SYNC OUTPUT

Impedance	:	50 ohm ± 10%
Level :	:	>1Vp-p open circuit

7. MODULATION CHARACTERISTICS

Types	:	AM, FM, SWEEP, TRIGGER, GATE or BURST (INT and EXT)
Waveforms	:	SINE, SQUARE, TRIANGLE RAMP or VARIABLE SYMMETRY PULSE
Frequency Range	:	0.01Hz to 10KHz
Output Level	:	>1Vp-p into 10Kohm
Sine Wave Distortion	:	<2% THD from 10Hz to 10KHz

8. AMPLITUDE MODULATION

Depth : 0 to 100%
Modulation Frequency: 0.01Hz to 10KHz (INT.) DC to 1MHz (EXT.)
Carries 3 dB Bandwidth: <100Hz to >5MHz.
External Sensitivity: <10Vp-p for 100% modulation

9. FREQUENCY MODULATION

Deviation : 0 to ±5% (INT.)
Modulation Frequency: 0.01Hz to 10KHz (INT.). DC to 50KHz (EXT.)

10. SWEEP CHARACTERISTICS

Sweep Width : >100:1
Sweep Rate : 0.01Hz to 10KHz, 90:10 RAMP
Sweep Mode : Linear sweep and symmetry control
Ramp Output : 0 to >-4Vp-p into 5K ohm.

11. GATE CHARACTERISTICS

Start/Stop Phase Range: +90° to -80°
Frequency Range : 0.1Hz to 1MHz (Useful to 10MHz)
Ext Gate Frequency Range: DC to 1MHz, TTL compatible input level.

12. EXT FREQUENCY CONTROL

Range : 1000:1
Input Requirement: 0 to -2V ± 20%, dial set at 10.
Linearity : <0.5% to 1MHz, <5% to 10MHz
Input Impedance : 3.6K ohm ±10%

13. FREQUENCY COUNTER

INT/EXT : Switch selector
Accracy : ± Time base accracy ± 1 count
Time Base : Oscillation frequency 10MHz ± 10PPM (23°C ± 5°C)
Resulation : 0.1Hz, 1Hz, 10Hz, 100Hz, 1KHz
Range : 0.1Hz to 30MHz (EXT. 5Hz to 30MHz)
Sensitivity : ≤20mVrms

14. POWER SOURCE AND CONSUMPTION

AC. 100V, 120V, 220V, 240V ± 10%, 50/60Hz
27W / 36VA , Max.

15. ACCESSORIES

GTL-101 x 2, AC POWER CORD x 1

16. DIMENSIONS AND WEIGHT

Dimensions : 310(W) x 99(H) x 380(D) m/m
Weight : 5Kg

17. ENVIRONMENTAL CONDITION

Indoor use , Altitude up to 2000m
Operation Temperature & Humidity : 0°C to 35°C, <90%
35°C to 50°C, <70%
Storage Temperature & Humidity : -10°C to 70°C, <80%
Installation Category II , Pollution Degree 2

III. INSTALLATION

1. INTRODUCTION

This section explains how to prepare this Function Generator for use. Included are initial inspection procedures, power and grounding requirements, environmental information, mounting instructions and instructions for repackaging for shipment.

2. INITIAL INSPECTION

This instrument was carefully inspected both mechanically and electrically before shipment. If the shipping container is damaged it should be kept until the contents of the shipment have been checked mechanically and electrically.

3. POWER REQUIREMENTS

This Function Generator can be operated from any source of 100, 120, 220 or 240 volts AC ±10%, of 50Hz to 60Hz frequency. The instrument can be easily adapted to the available line voltage by changing the position of the power module on the rear panel.

4. GROUNDING REQUIREMENTS

For the safety of operating personnel, the instrument must be grounded. The offset pin on the power cable grounds the instrument when plugged into the proper receptacle.

5. INSTRUMENT MOUNTING.

6. BENCH USE

The front of the Function Generator may be elevated for operating convenience by flipping down the bails which are attached to the two front feet of the instrument.

IV. OPERATING INSTRUCTIONS

1. INTRODUCTION

This section contains complete operating instructions for this Function Generator. Included is a brief description of the instrument, a description of controls and connectors, general operating information, and a basic operating procedure.

2. DESCRIPTION

This Function Generator combines two separate function generators in one instrument - a main generator and a modulation generator. The frequency range of the main generator is 0.1Hz to 13MHz in eight decade ranges. The modulation generator frequency range is 0.01Hz to 10KHz. Both the main generator and the modulation generator provide sine, triangle, square, pulse and ramp outputs. The symmetry of all waveforms can be varied over a range of 80:20 to 20:80 on the main generator and is set at 10:90 on the modulation generator.

The main generator can be modulated or triggered

by the modulation generator to provide AM, FM, sweep or burst. The main generator can also be modulated by an external source connected to the MOD connector on the modulation generator. The frequency of the main generator can be externally controlled by applying an AC or DC voltage to the VCO input.

The output attenuator has a range of more than 1000:1 so that output levels ranging from 1mVp-p to 10Vp-p into 50 ohms can be obtained.

This Function Generator has a DC offset capability which allows the DC operating point of the main generator output to be adjusted from -10V to +10V DC (as long as the DC offset plus instantaneous AC does not exceed ±10V). The DC offset can be adjusted using the front panel OFFSET control or set at 0V by pushing the associated CAL button.

3. CONTROLS AND INDICATORS

Figures 3-1 and 3-2 illustrate and describe the function of all front and rear panel controls, connectors and indicators. The description of each item is keyed to the drawing within the figure.

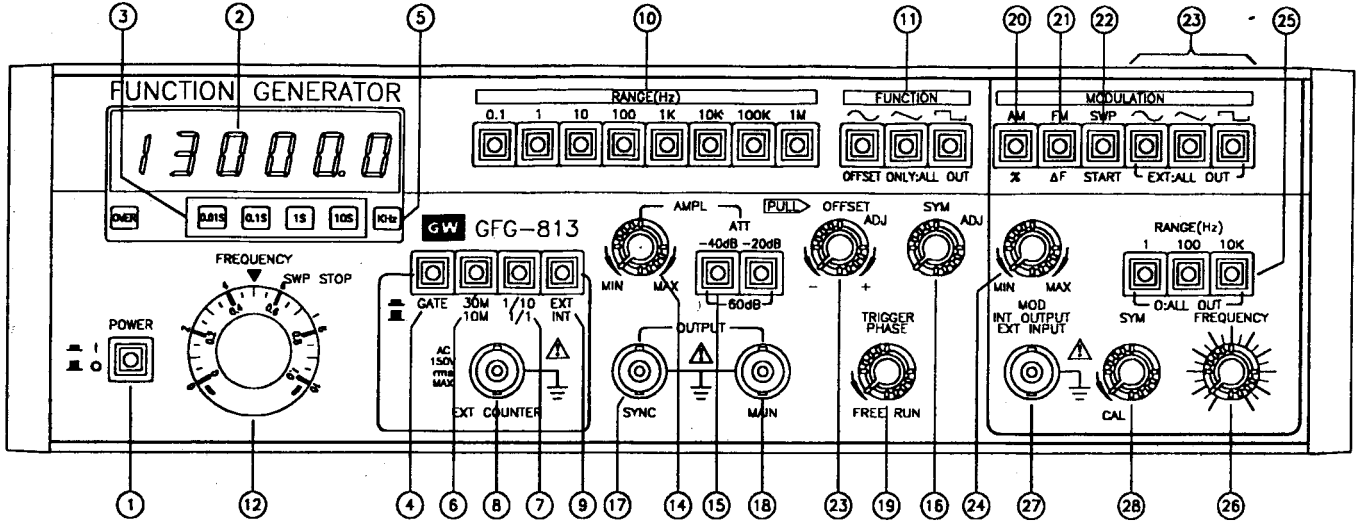


Figure 3-1. FRONT PANEL

(1) POWER: This switch applies or removes AC power. The display (2) is lit when ON.
(2) DISPLAY: Display frequency of internally and externally generated frequency.
(3) GATE SEC: Indicates when frequency counter display is updated. When "GATE SELECT" switch is selected, the LED will flash 10 times per second to 0.01 times per second available.
(4) GATE SELECT: It is selected in steps of 10, 1, 0.1, 0.01 second 4 ranges.
(5) KHz: Indicates whether display is showing KHz.
(6) 10M, 30M: Selected 10MHz and 30MHz 2 ranges of frequency counter.
(7) 1/1, 1/10: It is attenuated external frequency counter input sensitivity of 1/1, 1/10 2 ranges.
(8) EXT COUNTER: External frequency counter input BNC.
(9) INT. EXT.: Selected counting frequency for internal or external input frequency.
(10) RANGE Hz: Pushbuttons select frequency range. RANGE selection times the reading on the FREQUENCY dial determines the output frequency of the main generator.
(11) FUNCTION: Interlocked buttons select one of three functions. When they are all out, the DC level may be set accurately.
(12) FREQUENCY: Sets the desired frequency within the range of any of the RANGE pushbuttons.
(13) OFFSET: R616 sets the DC operating point of any function. Pull position removes the DC offset. Eac + Edc must be less than 10V or clipping of the waveform will occur.
(14) AMPL: Adjust the peak-to-peak amplitude of the waveform. From zero to maximum output volts for the particular range selected.
(15) ATT: It is attenuated in steps of 0dB, 20dB, 40dB, 60dB four ranges.
(16) SYM: Varies the symmetry of output waveforms and the SYNC output. CAL is symmetrical.
(17) SYNC: A square wave 180° out of phase with the main generator. Useful for synchronizing external instruments or driving a counter.
(18) OUTPUT: Terminal for all main generator functions. 20Vp-p into open circuit or 10Vp-p into 50 ohms, in the 0dB attenuator position (Switch all out).
(19) TRIGGER PHASE: Sets the starting phase of the output signal in the burst mode. FREE RUN disables the brust.
(20) AM: Selects amplitude modulation. Functional for internal or external modulation.
(21) FM: Selects frequency modulation. Functional for internal or external modulation.
(22) SWP: Selects sweep mode. This function overrides AM and FM.
(23) ~,⋀,⊓: Select the modulating function. External modulation is possible when all buttons are out, and the modulating signal is applied to the MOD INT-EXT jack.
(24) MIN~MAX: Selects the percent of AM, the deviation in FM, or the start frequency of the SWP.
(25) RANGE Hz: Select one of the three ranges of modulating frequencies. The 0 (All buttons are out) is used to set the start sweep frequency.
(26) Continuous control modulating frequencies with

each range.

(27) MOD INT-EXT: Input for external AM or FM. Waveforms of the modulation generator are also available at this output when internal modulation is used.

(28) SYM: Varies the symmetry of the modulation output waveform. CAL selects a 90:10 ramp for SWP and symmetrical for all other functions.

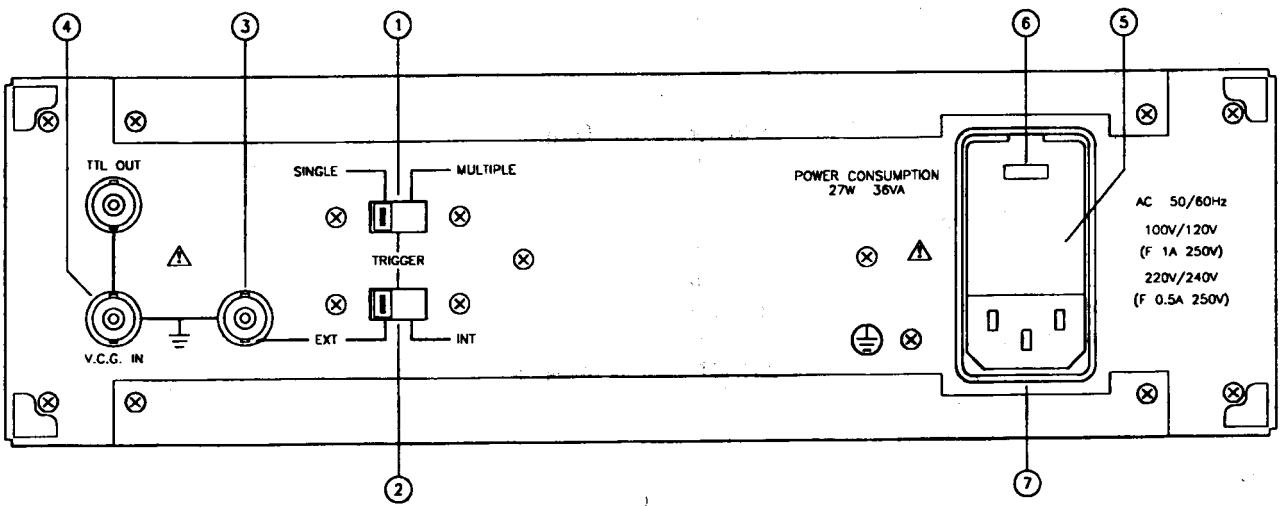


Figure 3-2. REAR PANEL

(1) SINGLE/MULTIPLE: Selects signle cycle or multiple cycles in the burst mode.

(2) TRIGGER: Selects either an internal or external trigger.

(3) EXTERNAL TRIGGER INPUT: For external burst control.

(4) VCF: Input for an external voltage control frequency.

(5) FUSE: Protects the instrument from current overloading.
(6) 100/120/220/240: Power module switches to match the instrument to AC line voltage being used.
(7) POWER RECEPTACLE: Primary power is connected to the instrument via the power cord.

4. GENERAL OPERATING INFORMATION.

5. GROUNDING

To protect operating personnel, the Function Generator chassis must be grounded. All GOOD WILL instruments are equipped with a three-conductor power cord, which, when plugged into the proper receptical, grounds the instrument. The offset pin of the power plug is the ground connection. All input and output commons are connected directly to outer chassis (frame) ground through the offset pin on the power cord.

****
* WARNING *
****

The outer shells of all input and output BNC jacks are connected to the chassis. To protect the operator from electrical shock, DO NOT float this instrument.

6. MAIN GENERATOR OUTPUTS

The main generator has two outputs, a main signal output and a sync output. The main signal output provides the sine, square and triangle outputs. The sync output provides a pulse which can be used for external timing purposes. Both outputs are BNC connectors located on the front panel of the instrument.

7. MAIN SIGNAL OUTPUT

The output of the main generator is DC coupled to supply both AC and DC components of the output waveform. The main generator output level is 10Vp-p into 50 ohms. The SYNC output level is 0.25Vp-p into 50 ohms. Output impedance of both outputs is 50 ohms nominal.

Connections to this output should be made using shielded cables equipped with BNC connectors. The main signal output must be terminated into 50 ohms.

8. SYNC OUTPUT

The SYNC output supplies a one volt rectangular wave which is 180° out of phase with the main generator output signal. The leading edge and the trailing edge of the SYNC pulse occur at the zero corssing point of the output waveform. The frequency and duty cycle of this pulse vary with the main output signal.

By connecting the SYNC output to the input of an appropriate frequency measuring device, the output frequency can be set with greater accuracy and resolution. The SYNC output can also be used to trigger an oscilloscope or synchronize an external oscillator.

9. INPUT CONSTRAINTS

This instrument inputs and outputs are DC coupled. The maximum instantaneous AC plus DC voltages which can be safely applied to the inputs are ±10V. In some applications it may be necessary to connect one of this instrument outputs to an AC or DC source node in a circuit. In these cases, the DC plus instantaneous value of external signal level applied to this instrument outputs must not exceed ±10V.

****
* CAUTION *
****

Exceeding input or output voltages of ±10V (DC plus instantaneous AC) can cause damage to the input or output circuitry of this instrument.

10. MODULATION GENERATOR INTPUT/OUTPUT

The BNC connector of the modulation generator (labeled MOD) serves as both an input and an output. The waveforms from the internal modulation generator (sine, square or triangle) are available at the MOD connector and are useful for synchronizing an oscilloscope when using the AM, FM, or sweep modes. When none of the modulation generator's function buttons is pressed, an external modulation source can be applied through the MOD connector. Refer to the information concerning external operation.

The modulation generator input/output is DC coupled and the impedance is a nominal 8 kilohms.

11. OUTPUT CHARACTERISTICS

The main generator and the modulation generator supply five different output waveforms.

a. Sine
b. Square
c. Triangle
d. Ramp
e. Pulse

12. SINE WAVE OUTPUT

The Total Harmonic Distortion (THD) of the main sine wave, including spurious and harmonics, is less than 0.5% from 10Hz to 50KHz and greater than 30dB below fundamental from 50KHz to 13MHz. The modulation sine wave distortion is less than 2% THD from 10Hz to 10KHz.

13. SQUARE WAVE OUTPUT

The RMS value of a symmetrical (50% duty cycle) square waveform is equal to its peak value. The rise or fall time is less than 18 nanoseconds between the 10% and 90% points of the p-p output square wave. The aberrations, or deviations from the final settling amplitude of the square wave after overshoot, will not very more than ± 10% of the final value.

14. TRIANGLE OUTPUT

The RMS value of the triangle waveform is 0.557 times the peak value. The triangle ramp will not deviate from a staight line any more than 1% of the total peak-to-peak value of the ramp. Non-linearity is, therefore, negligible.

15. RAMP

A ramp output can be obtained from the main generator by selecting the triangle waveform and adjusting the symmetry control knob. The ramp output of the main generator can be varied in amplitude with the AMPLITUDE knob. The ramp output of the modulation generator has a fixed amplitude, however, the slope or retrace time can be varied with the SYM knob on the modulation generator.

16. PULSE

A pulse with a variable amplitude from 0V to 20V p-p into an open circuit, is possible with the main generator. This involves selecting single cycle burst set to start at the zero point with the TRIGGER PHASE knob, and determining the pulse width with the FREQUENCY dial. The SYNC output can deliver a <10 nesc rise time pulse by changing the symmetry of the main generator.

17. GATE OR BURST

The usable frequency range of the burst function is from 0.1Hz to 10MHz. The trigger phase can be started anywhere from -80° to +90°. The stop will be at that point at the termination of the burst (see Figure 3-3).

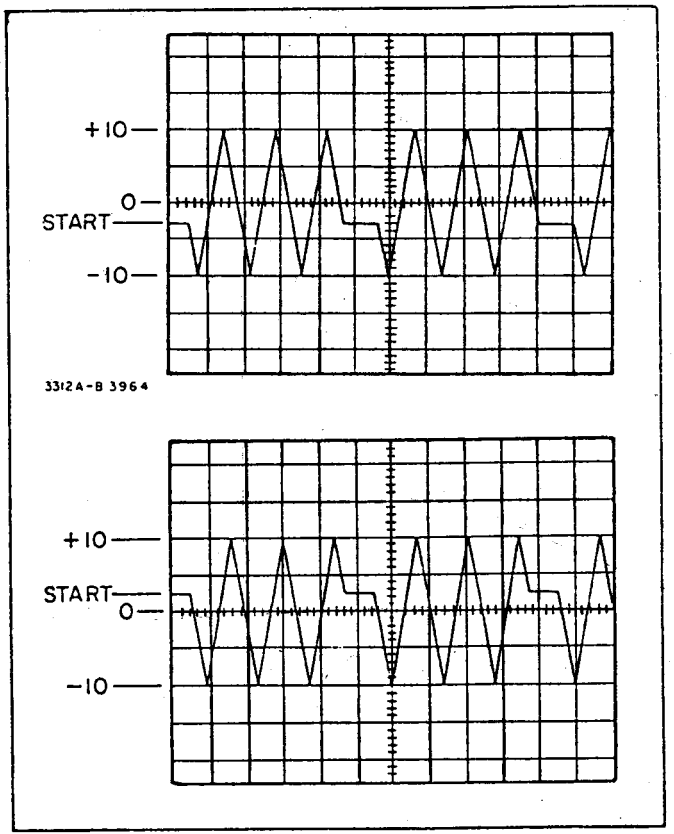


Figure 3-3. Phase Control of Burst

18. AM

The Main Generator output can be amplitude modulated up to 100%. The modulation frequency ranges from 0.01Hz to 10KHz. Any of the modulation generator's functions can be used to AM.

NOTE: This instrument is capable of 100% modulation, i.e., the strength of the modulating signal can be greater than needed to just bring the carrier level to zero. Overmodulation may cause distortion of the modulating information.

The extent of the amplitude variation is expressed as the percentage of modulation. The following formula defines the relationship between Fc and Fm (see Figure 3-4)

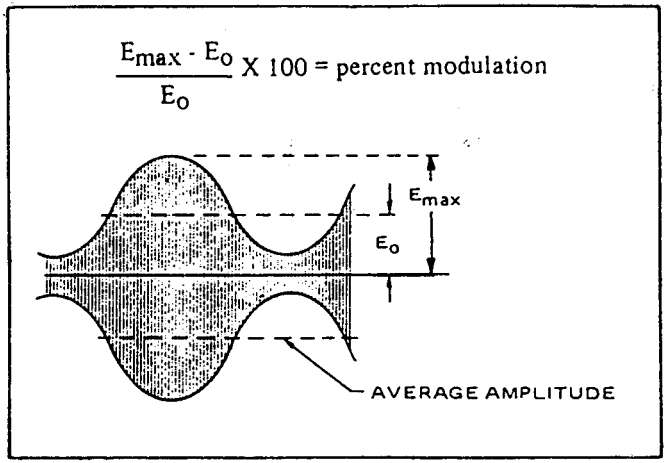


Figure 3-4. Percent Modulation

19. FM

The frequency of the main generator can be varied up to ±5% by the modulation generator. The modulation frequency can be set from 0.01Hz to 10KHz, and any of the modulation waveforms can be used to FM.

20. SWP

When the SWP button is pressed, the modulation generator produces a linear ramp which sweeps the frequency of main generator. With the RANGE Hz knob in the 0Hz position, the "Sweep Start" frequency can be set. The stop frequency, or the frequency at which the sweep terminates, is set with the main frequency dial. The rate of sweep is governed by the SYM knob.

21. EXTERNAL CONTROL

The front panel MOD INT-EXT input/output connector is to be used for external amplitude modulating or frequency modulating the main generator. For AM operation, an external input of less than 10Vp-p will give 100% modulation. For FM operation, the external frequency may be varied from DC to greater than 50KHz. The AM and FM push-buttons must still be used.

The frequency of the main generator can be tuned remotely by applying 0V to -2V DC to the VCO connector on the rear panel. With the dial set to 10, any range can be varied over the entire dial range within the limit set by the range pushbuttons. Frequency modulation can also be accomplished by applying an AC voltage to the VCO

terminal. Simultaneous AM and FM is possible with the VCO input used to vary frequency and the MOD input used for the AM signal.

22. FREQUENCY

The frequency range of the main generator is 0.1Hz to 13MHz in eight overlapping ranges. The dial accuracy is ±5% of full scale which means that the greatest accuracy will be obtained at the high end of the dial. For instance, if the dial were set to "1" on the 1KHz range, the output frequency would be 1KHz ± 650Hz. If, on the other hand, the dial were set to "10" on the 100Hz range, the output frequency would be 1KHz ± 65Hz.

The frequency range of the modulation generator is 0.01Hz to 10KHz. The RANGE Hz knob selects the upper frequency limit and the VERNIER is used to select frequencies within the selected range.

23. AMPLITUDE

The amplitude of the main generator can be adjusted from 0 to 20Vp-p into an open circuit or from 0 to 10Vp-p into 50 ohms. Amplitude of the modulation generator is fixed at 1Vp-p into an open circuit, except in SWP operation.

24. BASIC OPERATING PROCEDURES.

25. INSTRUMENT TURN-ON

a. Check the line voltage at the point of installation.

b. Set the rear panel Line Selector module switches to the setting that corresponds with the line voltage to be used. Line voltage must be within -10% to +10% of the selected voltage setting. Line frequency must be within the range of 48Hz to 66Hz.

c. Verify that the proper fuse is installed in the rear panel fuse holder (In power module switch internally).

Line Setting	Fuse
100V/120V	F 1A 250V
220V/240V	F0.5A 250V

d. Connect the detachable AC power cord to the rear panel power receptacle.

e. Set the LINE switch to the ON position. The display LED will illuminate.

26. FUSE REPLACEMENT AND CLEANING

The main AC line fuse is located on the rear panel next to the line power receptacle. Remove the line power cord before attempting to remove the fuse. Figure 3-5 shows how to replace the fuse.

Remove the AC input power (disconnect and remove the power cord) from the instrument before attempting to clean the instrument. To keep the instrument clean, wipe the case with a damp cloth and detergent. Do not use abrasives or solvents.

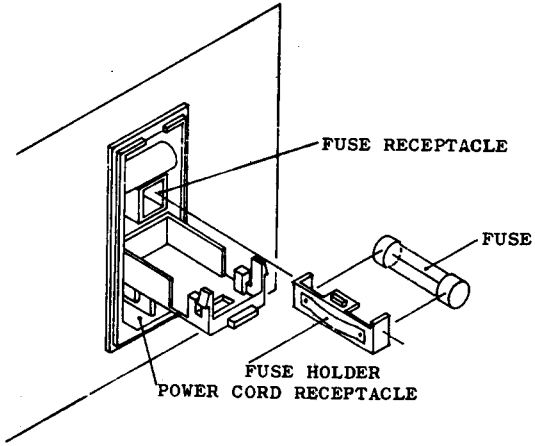


Figure 3-5. Fuse Replacement

27. MAIN GENERATOR OPERATION

The sine triangle and square waveforms, selected with interlocking pushbuttons, are available at the BNC output jack. The RANGE Hz pushbuttons and frequency dial select frequencies from 0.1Hz to 13MHz in eight overlapping ranges. The frequency dial scale must be multiplied by the RANGE Hz setting to obtain the frequency.

With the AMPLITUDE knob in the 0dB position and no load, a 10 volt peak signal is selected. The VERNIER control adjusts the voltage from greater than 10 volts to 1 volt at that setting. In the 20dB position the voltage is adjustable from 1 volt to 0.1 volt; in the 40dB position the voltage is adjustable from 0.1 volts to 0.01 volts: and in the 60dB position from 0.01 volts to 0.

The symmetry of any waveform can be varied with the SYM knob. The square waveform can be varied from symmetrical to a ratio of 80:20 to 20:80 up to 1 MHz.

OFFSET changes the DC level of the waveform. The "PUSH" position eliminates DC offset. The peak AC voltage plus the DC offset should not exceed 10V to avoid clipping of the output waveform.

28. BURST

With the rear panel TRIGGER switch (2) set to INT, the upper slide switch (1) set to either SINGLE or MULTIPLE, and TRIGGER PHASE (19) out of the FREE RUN position, internal burst is initiated. The TRIGGER PHASE knob controls the starting and stopping phase of the output waveform. The SINGLE-MULTIPLE switch selects a single cycle or multiple cycles respectively. Pulses are obtained only when the square wave function is pushed.

The pulse width is set by the main generator's FREQUENCY dial and the modulation generator's RANGE Hz knob sets the repetition rate. The TRIGGER PHASE knob in the FREE RUN position disables the burst (see Figure 3-10 for burst operation).

With the rear panel slide switch (2) set to EXT, an external burst may be applied in either single or multiple cycles. TRIGGER PHASE is still operational. The external gating signal frequency range is from DC to 1 MHz. The input voltages must be TTL compatible.

29. VCO

A DC voltage from 0V to -2V applied to the rear panel VCF connector is sufficient to vary the frequency of the main generator over three decades. Since some DC power supplies induce some noise, a supply similar to the one in Figure 3-6 works well.

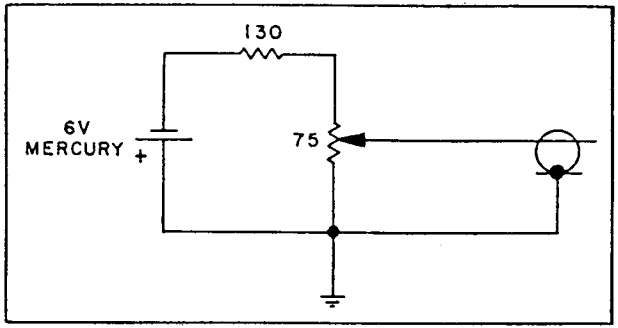
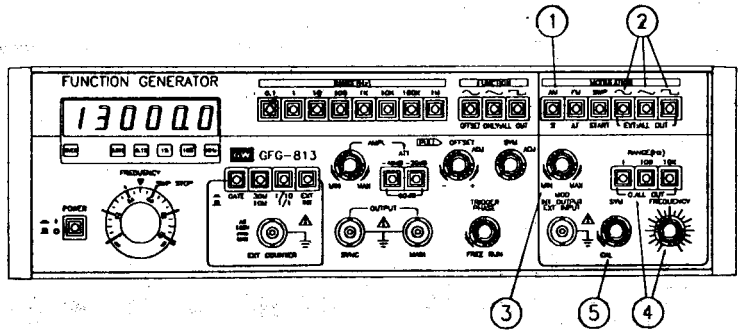


Figure 3-6. External VCO

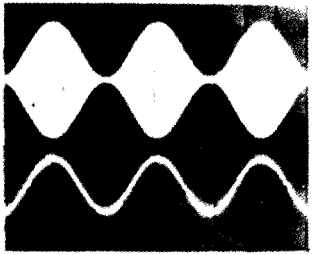
30. MODULATION GENERATOR OPERATION

Figure 3-7 through 3-9 are operating illustrations containing step-by-step operating procedures indexed to theillustrations. The figures describe the operations to be accomplished in achieving the different modes of operation.

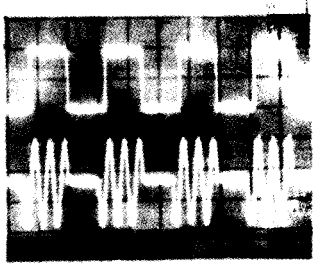
The operating procedure must be performed in the sequence given, as succeeding steps may depend on control settings and results of previous steps. In all cases, it is assumed that the main generator is set to the frequency and amplitude desired and that all modulation generator function pushbuttons are in the OUT position.



1. Press AM pushbutton.
2. Select a function.
3. Set the percent modulation.
4. Set the modulation frequency.
5. SYM in the CAL position.

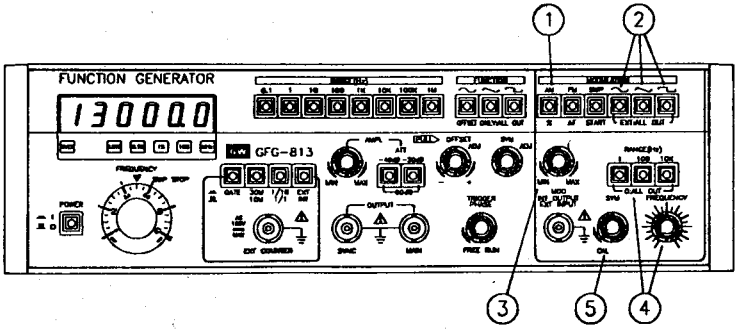


AM with sine wave



AM with square wave

Figure 3-7. AM Operation



1. Press FM pushbutton.
2. Select a Function.
3. Set the desired deviation of frequency.
4. Set the frequency of the change.
5. SYM in CAL position.

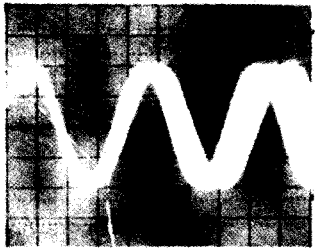
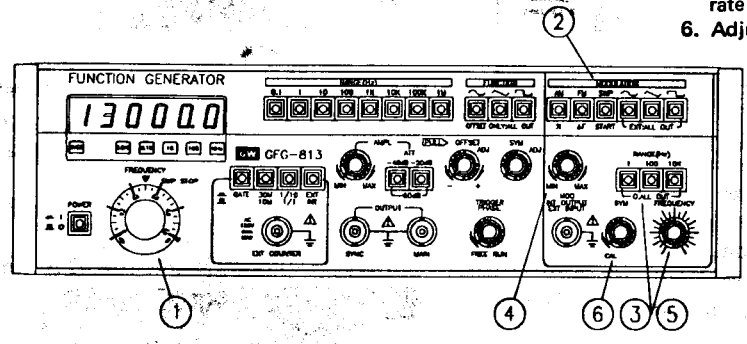


Figure 3-8. FM Operation

1. Set stop frequency.
2. Press SWP button.
3. Set RANGE Hz to 0.
4. Set start frequency.
5. Set RANGE Hz and VERNIER for desired repetition rate.
6. Adjust retrace line.



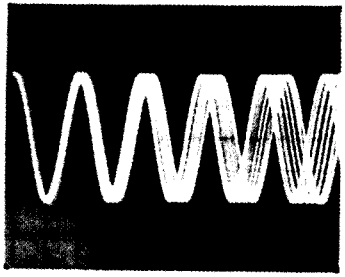
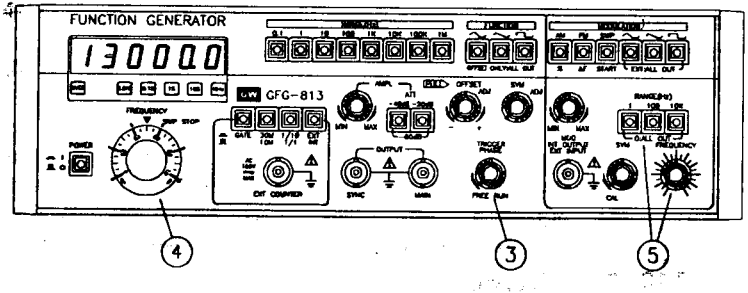
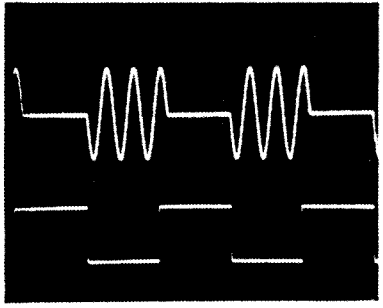
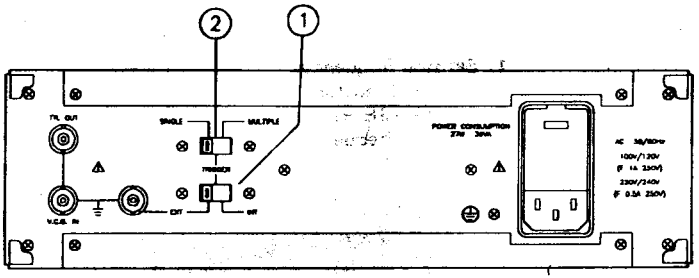


Figure 3-9. Sweep Operation

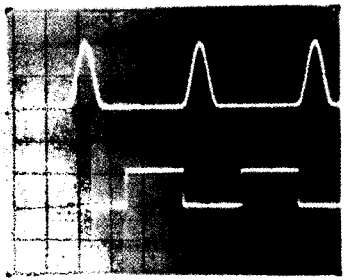




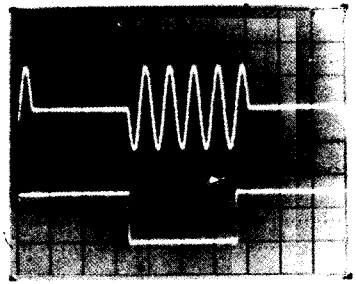


1. Set rear panel slide switch to **INT.**
2. Select either MULTIPLE or SINGLE with rear panel slide switch.
3. Rotate TRIGGER PHASE clockwise to desired phase.
4. Set frequency of burst.
5. Set repetition rate.

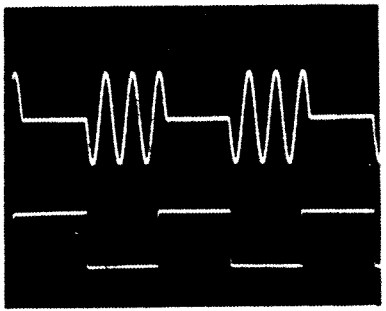
NOTE The phase of the square function is unaffected by TRIGGER PHASE.

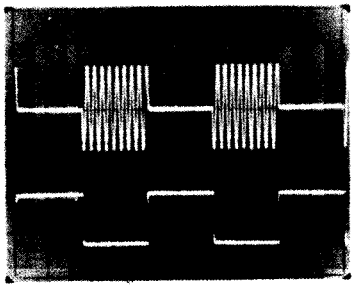


TRIGGER PHASE fully CW, SINGLE mode.



Repetition rate varied, MULTIPLE.





Frequency of burst varied, MULTIPLE mode.

Figure 3-10. Burst Operation

V. THEORY OF OPERATION

1. INTRODUCTION

This section contains a complete theory of operation for this Function Generator. The theory is divided into level:

Basic Block Diagram Description

Detailed circuit descriptions are given for unique complex circuits. These descriptions may be helpful when trouble-shooting the instrument.

2. DESCRIPTION

This instrument combines two separate, independent function generators referred to as the main generator and the modulation generator. The main generator output can be controlled by the modulation generator. The major features of this instrument are the 0.1 Hz to 13 MHz frequency range of the main generator and the AM, FM, sweep and tone burst capabilities of the modulation generator. A basic block diagram of this instrument is shown in Figure 4-1.

3. BASIC BLOCK DIAGRAM DESCRIPTION

The main geneator of this instrument uses a voltage to frequency conversion technique. A triangle waveform is generated by charging and discharging a capacitor from a constant current source. The time required to charge and discharge the capacitor determines the period of one cycle and, therefore, the frequency.

The triangle waveform from the Triangle Generator is applied to the Voltage Comparator which acts as an amplitude limiter. As the triangle waveform alternately crosses the upper and lower switching levels of the limiter input, a square wave is generated at the output of the Voltage Comparator. This square wave is fed back to the Triangle Generator where it controls the charge/discharge cycle of the triangle output.

To obtain a sine wave, the triangle wave is shaped by a diode network in the Sine Shaper. The diode network serves as a non-linear load which varies the attenuation of the input triangle according to its level.

The modulation generator can amplitude modulate, frequency modulate, sweep, or initiate a burst from, the main generator output. Sweep and frequency modulation modes control the voltage output of the tuning amplifier which determines the frequency. In amplitude modulation, the main signal is routed through a balanced modulator where it is mixed with the modulating signal. The percent of modulation is controlled by the level of the modulating signal.

The tone burst is accomplished by gating the main generator output on and off. Multiple or single cycle operation is determined by the duration of the low state of the Burst Control.

The output amplifier has separate parallel paths for the high and low frequencies. This gives it wide bandwidth and a high slew rate to maintain good square and triangle wave shape without compromising DC stability and low offset. An integrated-circuit operational amplifier is used for the low frequencies while the AC-coupled

high-frequency path is optimized for wide bandwidth. The two paths are summed in the final gain stage and then buffered through cascaded emitter-followers to the output.

The Output Attenuator provides selectable attenuation for the output and an impedance match to the 50 ohm output terminal. The attenuator reduces the amplitude of the output signal by factors of 0dB, 20dB, 40dB or 60dB.

This instrument can be divided into three major sections:

1. Main Generator Section
2. Output Section
3. Modulation Section

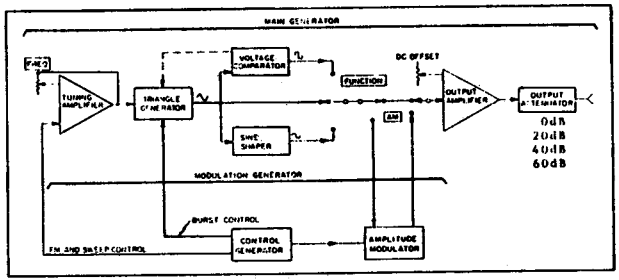


Figure 4-1. Basic Block Diagram

4. MAIN GENERATOR SECTION

5. TUNING AMPLIFIER

The Tuning Amplifier is a summing amplifier which sums any current from the V.C.F. INPUT or the modulation source with the current present at the input of the amplifier. The output voltage of the amplifier is a weighted average of the input signal voltages. The Frequency Control (Dial) varies the amount of voltage seen at the output of the Tuning Amplifier, which determines the frequency.

6. SYMMETRY SWITCH AND VERNIER

The front panel Symmetry Switch operates in two modes. With the front panel control in the PUSH position (Figure 4-2) the output of the Tuning Amplifier is connected, through two nominal 5kohm resistors, to the non-inverting input of U202 and the inverting input of U203. Because the gain of U202 is equal to that of U203, the magnitude of the votage at the emitters of Q201 and Q202 is equal, but due to the inversion of U203, the emitter of Q201 is positive with respect to ground and the emitter of Q202 is negative with respect to ground. In the calibrated position, equal currents flow through R216 and R217.

During variable symmetry operation (Figure 4-3), the output of the Tuning Amplifier goes to the wiper arm of the symmetry Vernier, and the junction of R216 and R217 is grounded. Adjusting the position of the wiper arm varies the input resistance of U202 and U203 and, therefore, the gain. The emitters of Q201 and Q202 will

remain opposite in polarity, but the magnitude of the voltage will differ. In addition, different currents will flow through R216 and R217, which means different currents in the integrating capacitance, so that the output waveform will no longer have a 50% duty cycle. Instead, the duty cycle may be varied from 80% to 20% or 20% to 80%.

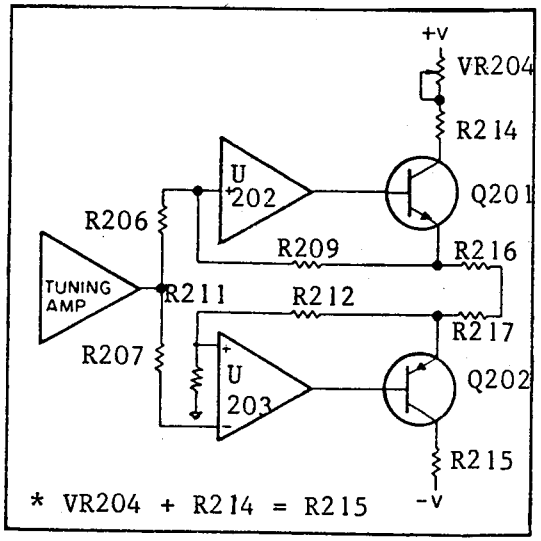


Figure 4-2. Calibrated Symmetry

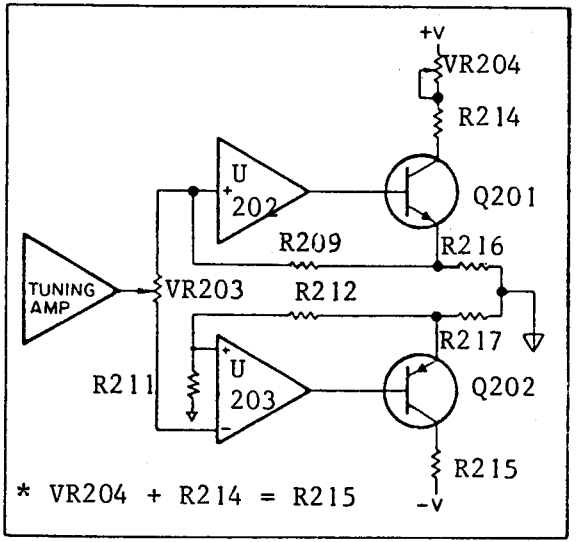


Figure 4-3. Variable Symmetry

7. POSITIVE AND NEGATIVE CURRENT SOURCES

The voltages set up by the symmetry stage are transferred to the integrating current sources through two operational amplifiers. Since amplifier input impedance is near infinity, zero current flows into the amplifier, consequently the voltage across VR204 + R214 and R215 will appear across R218 and R220 respectively. The collector diodes of Q205 and Q206 are current sources controlled by the emitter current established by R218 and R220. The RANGE Hz switches change the parallel resistances

of R218 and R220 which influence the ramp time of the integrating capacitance and, therefore, the frequency.

8. DIODE SWITCH

The gating circuit of the Diode Switch allows for the charge or discharge of the integrating capacitance. The high speed comparator, U301 controls the signal path through the switch. When pin 2 of U301 is high, D204 and D207 are conducting, D202 and D205 are reverse biased, and the integrating capacitor charges. When pin 2 goes low, D202 and D205 conduct, D204 and D207 are reverse biased, and the integrating capacitor discharges.

When the diode switch is reverse biased there is a diode capacitance which distorts the peak of the triangle (see Figure 4-4). This distortion is removed by the level shifting circuit of Q303 and C501. The square wave at the collector of Q303 is passed through the AC voltage divider of C501 and VC201 and added to the triangle wave to eliminate the "drop-off" caused by diode capacitance.

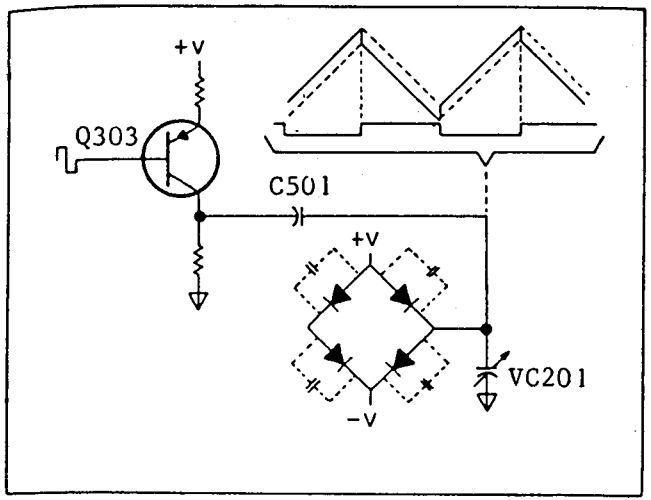


Figure 4-4. Level Shifter

9. INTEGRATING CAPACITANCE

The integrating capacitors are VC201, C214, C215, C216, C217, and C218. Because the current charging and discharging is constant, except for direction, the voltage across the integrating capacitance will be triangular. The resulting waveform is varied in frequency by changing the current and capacitance with connections through the RANGE Hz switches and the FREQUENCY dial.

10. BUFFER AMPLIFIER

The Buffer Amplifier has a gain of one and consists

of a FET input and a push-pull output. The high input impedance of the FET provides isolation, and the emitter followers Q209 and Q210, form a push-pull circuit. Diodes D209 and D210 are temperature compensating diodes.

11. COMPARATOR

While the integrating capacitor is charging, the positive-going ramp is applied to pin 4 of U301. The positive-going ramp is compared in magnitude, to the square wave on pin 2. Upon coincidence, the Comparator changes state, reversing the biasing of the gating diodes, and the integrating capacitance discharges. Coincidence of the negative-going ramp with the square wave now at its negative limit, switches the Comparator back to the original state, completing one cycle of operation.

The square wave output of U301 pin 5 is processed by a ±5V diode clamping network to provide the square wave output.

12. SYNC GENERATOR

The Sync Generator is a simple divider network which attenuates the output of the ± 5V clamp. The sync output is, therefore, always a square wave in phase with the main generator (180° out of phase with the square wave output due to output amplifier inversion) and under the control of the Symmetry Switch.

13. SINE SHAPER

The triangle wave from the Buffer Amplifier is connected through R401 to the sine synthesizing diodes. The diodes of the sine network are reverse biased by the resistive dividers made up of R402, R403, R406, etc. As the triangle ramp goes positive, the bias is overcome and the diodes in the lower half turn on to produce a non-linear loading effect on the triangle wave. When the ramp reaches a negative level, the upper half of the sine shaping network begins to load the triangle wave thus shaping the negative half of the wave. The diodes in this section are selected for their soft turn-on characteristics to insure a smooth sine-shaped curve.

Transistors Q401, Q402, Q403 and Q404 compensate for thermal changes. This insures that the proper bias level is maintained over a wide temperature range. In this instrument, the sine shaper is followed by a low-pass LC filter that has a sharp cutoff at 14MHz. This filter attenuates third harmonics substantially at generator frequencies above 5 MHz, enabling the instrument to produce sine waves with all harmonics more than 30dB below the fundamental up to its maximum frequency.

14. OUTPUT SECTION

The output section consists of the Output Amplifier and the Output Attenuator.

The amplifier system has a voltage gain of - X16 and has been impedance matched on both sides. The AC signal is coupled through Q701 and Q702 and Q703. To obtain a frequency response that extends to zero, the main output is direct coupled to U701 and then to the complementary stage of Q704 and Q706. The DC offset is summed into pin 2 of U701 via R704. In the CAL

position, R704 is opened and no offset is summed into the output amplifier.

The output is DC coupled to the output attenuator. The step attenuator consists of resistive attenuator sections of 20dB steps with an impedance of 50 ohms.

15. MODULATION GENERATOR.

16. SIGNAL GENERATOR

Basic to this circuit are the integrator U801 and the comparator U802 (Figure 4-5). By integrating the square wave at its input the integrator generates a triangle wave. The level of the triangle is then compared to the square wave and when the voltage at the input node to the comparator equals zero [R1 (E3 - E2/R1 + R2) = E2] the comparator output switches states. The square wave output from the comparator is then inverted, clamped and fed back to the inverter to control the generation of the triangle wave.

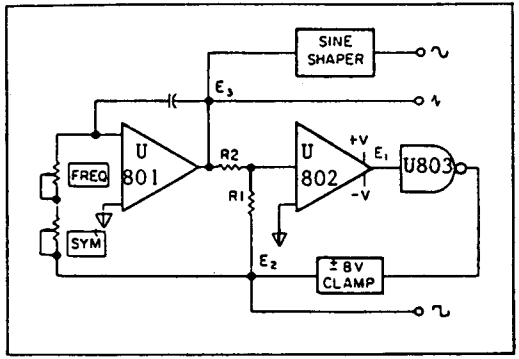


Figure 4-5. Signal Generator

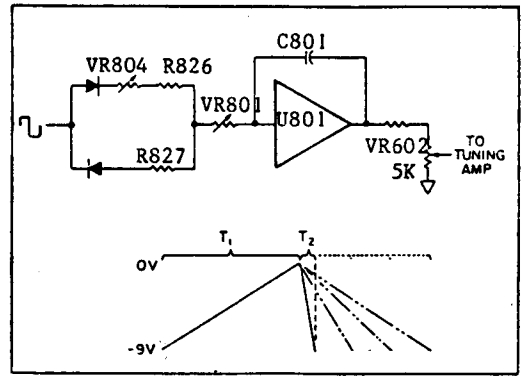


Figure 4-7. Sweep Operation

17. AMPLITUDE MODULATION

The AM modulator is a balanced modulator which mixes the carrier signal from the main generator with the modulation signal from the modulation generator. The carrier frequency is applied to pin 8 of U601 and the modulation signal is input to pin 4. Modulation amplitude control resistor VR602 attenuates the modulation signal to control the envelope of the output signal.

18. FREQUENCY MODULATION AND SWEEP

During FM and sweep operation the output of the modulation generator is applied directly to the Tuning Amplifier of the main generator. In FM operation (Figure 4-6), VR602 controls the percent of deviation in frequency of the carrier waveform. The change in frequency is limited

to ± 5% of the carrier frequency by current limiting resistor R626. All three functions of the modulation generator are available for modulating the main generator output frequency.

When the SWP pushbutton is pressed, resistors R826 and R827 are selected. If VR804 is in the CAL position, the output of U801 is a 90:10 ramp (Figure 4-7). As VR804 is rotated clockwise, t_2 increases and flyback time is increased.

The 0Hz position of the RANGE Hz knob allows pin 5 of U803 to go high producing a low at pin 6 of U803 and at the emitter of Q802. Q802 begins to conduct, turning Q801 on and forming a loop with U802, Q802, Q801 and U801. In SWP the square wave is held at its high level and the triangle wave ramps to -10V then stops. Start frequency, for the sweep of the main generator output, can then be selected with VR602. VR602 affects the frequency of the main generator by determining the negative voltage level at which the ramp starts. Taking the RANGE Hz knob out of the 0Hz position starts the modulation geneator running and, as the ramp voltage approaches zero volts, the output frequency of the main generator approaches the frequency of the dial setting.

19. BURST

At any setting other than FREE RUN, the tone burst gate is operable. The start/stop phase of the tone burst is determined by VR501 (Figure 4-8) and the transistor array U502. The signal always stops in the same phase as it started.

When TRIGGER PHASE is in FREE RUN the line from the Burst Control is open and U501 pin 2 is pulled low by the negative supply causing a high at the output of U502. As a result Q501 and U502 (c) turn on and U502 (a) and (b) turn off. With U502 (a) off, D501 is reverse biased and no charge is drawn off the integrating capacitor allowing the main generator to free run.

In TRIGGER PHASE a low from the burst control appears on U501A pin 2 forcing the output of U501A high and starting the burst. When the burst control line goes high again followed by a positive transition of the square wave (at U501A pin 1) the output of U501A goes low. Q501 now turns off allowing TRIGGER PHASE POT, VR501, to determine the voltage at the base of U502 (e) and in turn at the base of U502 (c). When the voltage from the main generator (via the BUFFER AMPLIFIER) appearing at the base of U502 (b) equals that at the base of U502 (c), both U502 (a) and (b) turn on and U502 (c) turn off. D501 forward biases and clamps the integrator output to the voltage at the base of U502 (c) (which was originally determined by TRIGGER PHASE POT, VR501). With the integrator output held at that level the comparator does not switch the current sources resulting in a DC level at the square wave output. When the burst control goes low again the voltage on the integrating capacitor will determine the phase at which the burst restarts. Thus, VR501 controls the start/stop phase.

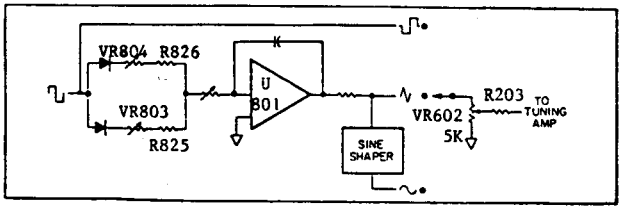


Figure 4-6. FM Operation

20. MULTIPLE CYCLE BURST MODE

The main generator is gated off when the burst logic sees a positive square wave transition after the burst input to U501 pin 2 goes high. If the main square wave is already high, the main generator will not be gated off until the main square wave first goes low then returns high. The waveforms in Figure 4-9 should serve to clarify the operation of the burst logic.

21. SINGLE CYCLE BURST MODE

In single cycle operation, U501A pin 2 is driven from U503, a monostable one-shot multivibrator. After being inverted the output of U501 is normally high. Triggering of U503 causes U501A pin 2 to go low for 40 nanoseconds, after which it returns to its quiescent high state. This 40 nanosecond low pulse is sufficient to start the main generator. Since pin 2 almost immediately returns to a high state, the main generator runs until the triangle returns to its start/stop phase position, at which time the generator stops, completing one cycle of operation.

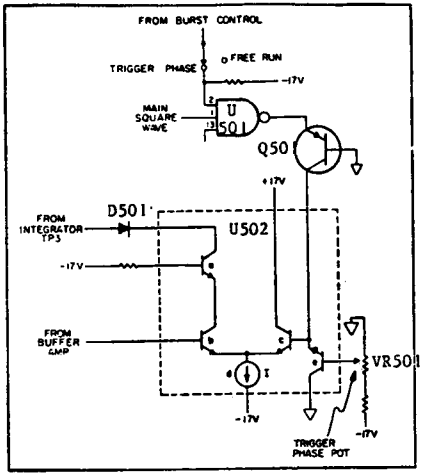


Figure 4-8. U502 Burst Amplifier Array

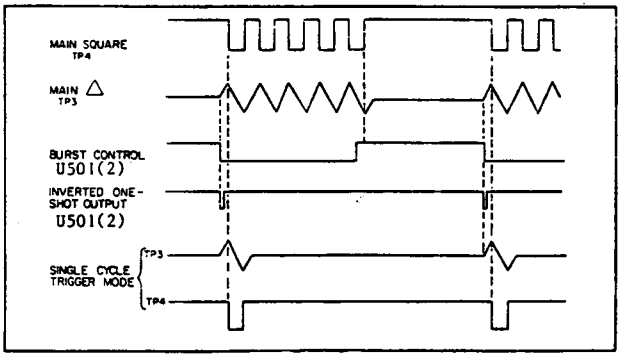


Figure 4-9. Burst Time Relation Waveforms

EC Declaration of Conformity

We

GOOD WILL INSTRUMENT CO., LTD.

(1) NO. 95 - 11, Pao Chung Rd., Hsin-Tien City, Taipei Hsien, Taiwan

(2) Plot 522, Lorong Perusahaan Baru 3, Prai Industrial Estate, 13600 Prai, Penang, Malaysia

declare that the below mentioned product

GFG-813

are herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Law of Member States relating to Electromagnetic Compatibility (89/336/EEC,92/31/EEC,93/68/EEC) and Low Voltage Equipment Directive (73/23/EEC).

For the evaluation regarding the Electromagnetic Compatibility and Low Voltage Equipment Directive, the following standards were applied:

EN 61326-1: Electrical equipment for measurement, control and laboratory use—EMC requirements (1997+A1:1998)					
Conducted Emission	EN 55022 class B	(1994)	Electrostatic Discharge	IEC 1000-4-2	(1995)
Radiated Emission	EN 55011 class B	(1991)	Radiated Immunity	IEC 1000-4-3	(1995)
Current Harmonics	EN 61000-3-2	(1995)	Electrical Fast Transients	IEC 1000-4-4	(1995)
Voltage Fluctuations	EN 61000-3-3	(1995)	Surge Immunity	IEC 1000-4-5	(1995)
----------	----------	----------	Conducted Susceptibility	EN 61000-4-6	(1996)
----------	----------	----------	Power Frequency Magnetic field	EN 61000-4-8	(1993)
----------	----------	----------	Voltage Dip/Interruption	EN 61000-4-11	(1994)

Low Voltage Equipment Directive 73/23/EEC	
Low Voltage Directive	**EN 61010-1:1993**