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FG 501A 2 MHz FUNCTION GENERATOR

Francais Deutsch 日本語

INSTRUCTION MANUAL

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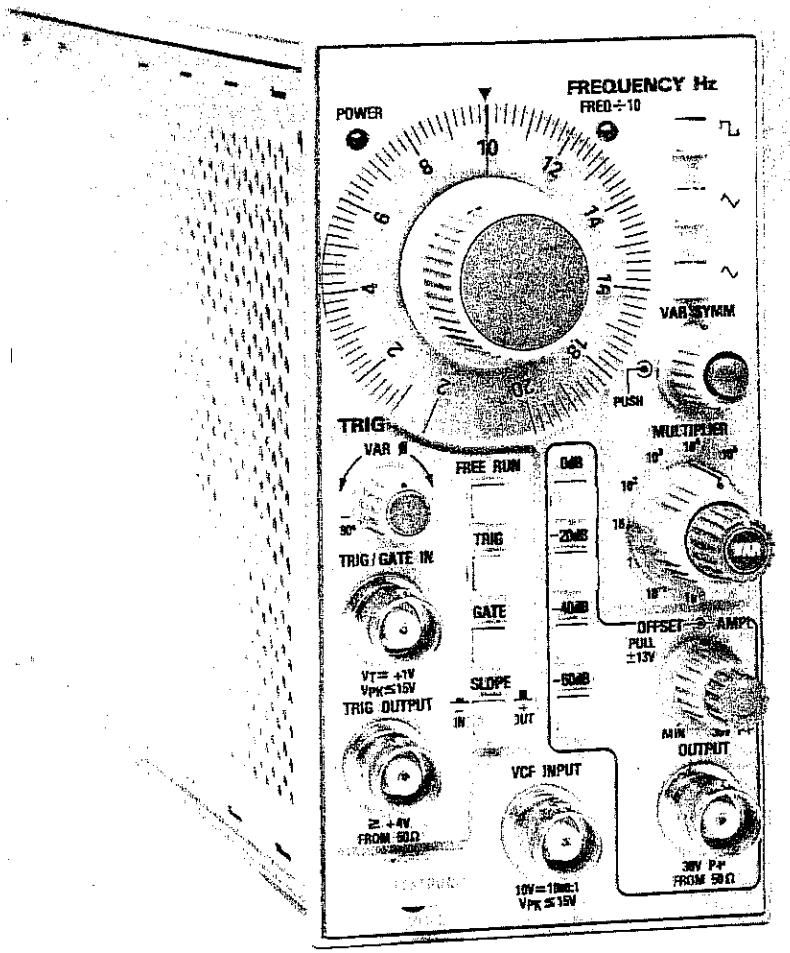

2957-00

FG 501A 2 MHz FUNCTION GENERATOR

SPECIFICATION

INTRODUCTION

This section of the manual contains a general description of the FG 501A and complete electrical, environmental, and physical specifications. Standard accessories are also listed. Instrument option information is located in the back of this manual in a separate section.

INSTRUMENT DESCRIPTION

The FG 501A Function Generator provides low distortion sine, square, triangle, ramp, and pulse waveforms over the frequency range 0.002 Hz to 2 MHz in eight decade steps. Dc offset up to ±13 V is available. Waveform triggering and gating functions, in addition to being slope (+ or −) selectable, are provided with variable phase control capable of up to ±90° phase shift. The symmetry of the output waveform may also be varied from 5 to 95%. Step attenuators provide up to 60 dB of attenuation in 20 dB steps. A variable amplitude control provides an additional 20 dB attenuation.

A voltage-controlled frequency (VCF) input is provided to control the output frequency from an external voltage source. The output frequency can be swept above and below the selected frequency to a maximum of 1000:1 depending on the polarity and amplitude of the VCF input signal and the selected output frequency.

ACCESSORIES

The only accessory shipped with the FG 501A is the Instruction Manual.

PERFORMANCE CONDITIONS

The electrical characteristics are valid with the following conditions:

1. The instrument must have been adjusted at an ambient temperature between +20°C and +30°C and operating at an ambient temperature between 0°C and +50°C.

2. The instrument must be in a non-condensing environment whose limits are described under Environmental.

3. Allow twenty minutes warm-up time for operation to specified accuracy; sixty minutes after exposure to or storage in high humidity (condensing) environment.

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in this manual. Items listed in the Supplemental Information column may not be verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified.

Table 1-1

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
Frequency		Provided in eight decade steps plus variable, with overlap on all ranges.
Range		
Sine-wave, square-wave, and triangle	.002 Hz to 2 MHz	Calibrated portion of dial extends from 20 to 2. Portion of dial from 2 to .2 is uncalibrated .0002 Hz to .002 Hz uncalibrated portion of dial.
Ramp and Pulse	.002 Hz to 200 kHz ±10% calibrated portion of dial.	Measured at 50% duty cycle. .0002 Hz to .002 Hz uncalibrated portion of dial.
Variable Symmetry		
Duty Cycle	≤5% to ≥95%.	Activation of Symmetry control divides output frequency by ≈10.
Output Amplitude	At least 30 V P-P into an open circuit, at least 15 V p-p into 50 Ω. (Front panel only.)	Offset control off.
Output Impedance		Front panel z_o = 50 Ω ±10%. ATTEN in 0 dB position. Rear interface z_o = 600 Ω −10%.
Offset Range	At least ±13 V into open circuit, at least ±6.5 V into 50 Ω. Maximum peak signal plus offset cannot exceed ±15 V into an open circuit, or ±7.5 into 50 Ω. (Front panel only.) Offset reduced by attenuators.	
Frequency Resolution		1 part in 10^4 of full scale with frequency vernier control.
Stability (Frequency)		
Time		≤0.1% for 1 hour, ≤0.5% for 24 hours.
Temperature		Within 2% from .2 Hz to 2 MHz, and within 10% from .002 Hz to .2 Hz. The FREQUENCY Hz dial must be on the calibrated portion. The instrument must be in a temperature between 0° C and +50° C and checked after a 1 hour warmup. VAR SYMM control disabled.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Amplitude Flatness	Measured with 0 dB ATTEN button "IN" and output driving 50 Ω load. (Front panel only.)	
Sinewave (10 kHz Sinewave Ref)	±0.1 dB 20 Hz to 20 kHz ±1.1% ±0.5 dB 20 kHz to 1 MHz ±5.6% ±1 dB 1 MHz to 2 MHz 10.9%	Typically ±.5 dB .002 Hz to 20 Hz.
Squarewave (10 kHz Squarewave Ref)	Peak to peak amplitude within ±0.5 dB of squarewave reference amplitude 20 Hz to 2 MHz.	Typically within ±.5 dB .002 Hz to 20 Hz.
Triangle (10 kHz Triangle Ref)	Peak to peak amplitude within ±0.5 dB of triangle wave reference amplitude 20 Hz to 200 kHz. Within 2 dB 200 kHz to 2 MHz.	Typically within ±.5 dB .002 Hz to 20 Hz.
Sinewave Distortion	≤0.25% 20 Hz to 20 kHz on 10^3 range and below. ≤0.5% 20 kHz to 100 kHz. All harmonics at least 30 dB below fundamental from 100 kHz to 2 MHz.	20° to 30°C. Measured with with average responding THD meter. Measurement bandwidth limited to approximately 300 kHz. Verified at 15 V p-p into 50 Ω load. Must be on calibrated portion of dial. VAR SYMM control off. Offset control off. Trig output driving open circuit.
Squarewave Output	Step ATTEN in 0 dB position.	
Risetime and Falltime	≤25 ns at 15 V p-p into 50 Ω.	
Aberrations (p-p)	≤3% (Front panel only.)	
Pulse Output	Step ATTEN in 0 dB position.	
Risetime and Falltime	≤25 ns at 15 V p-p into 50 Ω.	
Aberrations (p-p)	≤3% (Front panel only.)	
VCF Input	10 V ≥1000:1	Applicable within the range of top dial frequency to top dial frequency/1000. Positive going voltage increases frequency. Maximum Slew Rate = 0.5 V/μs. Maximum input ≤15 V pk.
Ext Trig/Gate Input		
Impedance		≈2 kΩ
Threshold Level	+1 V ±20%.	Maximum input ≤ 15 V pk.
Trigger Output	≥ +4 V into open circuit. ≥ +2 V into 50 Ω.	
Variable Phase Range	At least ±90°	Sine and Triangle only.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Attenuators		60 dB in 20 dB steps. >20 dB additional attenuation with amplitude control.
Accuracy	±1 dB.	Verified at 20 kHz.
Dial Accuracy	Within 3% of full scale, 20 to 12, except within 5% between 0° and 15°C and 35° and 50°C on the 10^5 Multiplier Range.	2 to .2 Uncal.
Triangle		
Linearity		Greater than or equal to 99% 20 Hz to 200 kHz. 97% 200 kHz to 2 MHz (calibrated). Measured from 10% to 90% of waveform.
Time Symmetry	Better than 1% 20 Hz to 200 kHz. 5% 200 kHz to 2 MHz (calibrated).	

Table 1-2

MISCELLANEOUS

Characteristics	Description
Power Consumption	12 W or less. (Plug-in only)
Recommended Adjustment Interval	1000 hours or 6 months, whichever occurs first.
Warm-up Time	20 minutes.

Table 1-3

ENVIRONMENTAL[a]

Characteristics	Description	
Temperature		Meets MIL-T-28800B, class 5.
Operating	0°C to +50°C	
Non-operating	−55°C to +75°C	
Humidity	95% RH, 0°C to 30°C 75% RH to 40°C 45% RH to 50°C	Exceeds MIL-T-28800B, class 5.
Altitude		Exceeds MIL-T-28800B, class 5.
Operating	4.6 Km (15,000 ft)	
Non-operating	15 Km (50,000 ft)	
Vibration	0.38 mm (0.015") peak to peak, 5 Hz to 55 Hz, 75 minutes.	Exceeds MIL-T-28800B, class 5, when installed in qualified power modules.[b]

Table 1-3 (cont)

Characteristics	Description	
Shock	30 G's (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.	Meets MIL-T-28800B, class 5, when installed in qualified power modules.[b]
Bench Handling[c]	12 drops from 45°, 4" or equilibrium, whichever occurs first.	Meets MIL-T-28800B, class 5.
Transportation[c]	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1, and 1A-B-2.	
EMC	Within limits of MIL-461A, and F.C.C. Regulations, Part 15, Subpart J, Class A.	
Electrical Discharge	20 kV maximum charge applied to instrument case.	

[a] With power module.
[b] Refer to TM 500 power module specifications.
[c] Without power module.

Table 1-4

PHYSICAL CHARACTERISTICS

Characteristics	Description
Finish	Plastic/aluminum laminate front panel. Anodized aluminum chassis.
Net Weight	1.88 lbs (.85 kg)
Overall Dimensions	Height 5 in (126mm) Width 2.6 in (67mm) Length 11.9 in (303mm)

OPERATING INSTRUCTIONS

INTRODUCTION

This section of the manual provides operating information required to obtain the most effective performance from the FG 501A. Included are installation and removal instructions, a functional description of the front panel controls, and a general description of the operating modes. Some basic applications of the instrument are also briefly discussed.

INSTALLATION AND REMOVAL

The FG 501A is calibrated and ready to use when received. It operates in one compartment of any TM 500-series power module. Refer to the power module instruction manual for line voltage requirements and power module operation.

CAUTION

To prevent damage to the FG 501A, turn the power module off before installation or removal of the instrument from the mainframe. Do not use excessive force to install or remove.

Check to see that the plastic barriers on the interconnecting jack of the selected power module compartment match the cutouts in the FG 501A circuit board edge connector. If they do not match, do not insert the instrument until the reason is found. When the units are properly matched, align the FG 501A chassis with the upper and lower guides of the selected compartment (see Fig. 2-1). Insert the FG 501A into the compartment and press firmly to seat the circuit board edge connector in the power module interconnecting jack. Apply power to the FG 501A by operating the power switch on the power module.

To remove the FG 501A from the power module, pull the release latch (located in the lower left corner) until the interconnecting jack disengages. The FG 501A will now slide straight out.

REPACKAGING FOR SHIPMENT

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted. Include complete instrument serial number and a description of the service required.

If the original package is not fit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethelene sheeting, or other suitable material, to protect the exterior finish. Obtain a carton of corrugated cardboard of adequate strength and having inside dimensions no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing dunnage or urethane foam between the carton and the instrument, on all sides. Seal the carton with shipping tape or an industrial stapler.

The carton test strength for your instrument is 200 pounds.

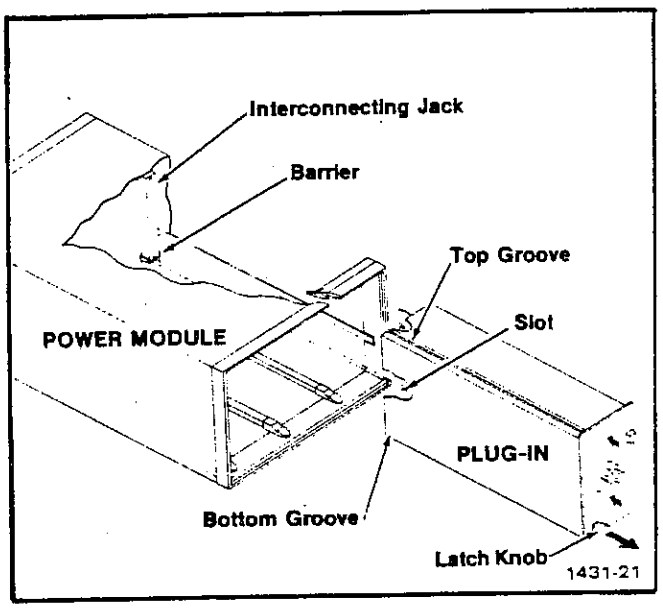

Fig. 2-1. Plug-in installation and removal.

CONTROLS AND CONNECTORS

Although the FG 501A is calibrated and ready to use, the functions and actions of the controls and connectors should be reviewed before attempting to use it. All controls necessary for operation of the instrument are located on the front panel. A brief description of these controls follows. Refer to Fig. 2-2.

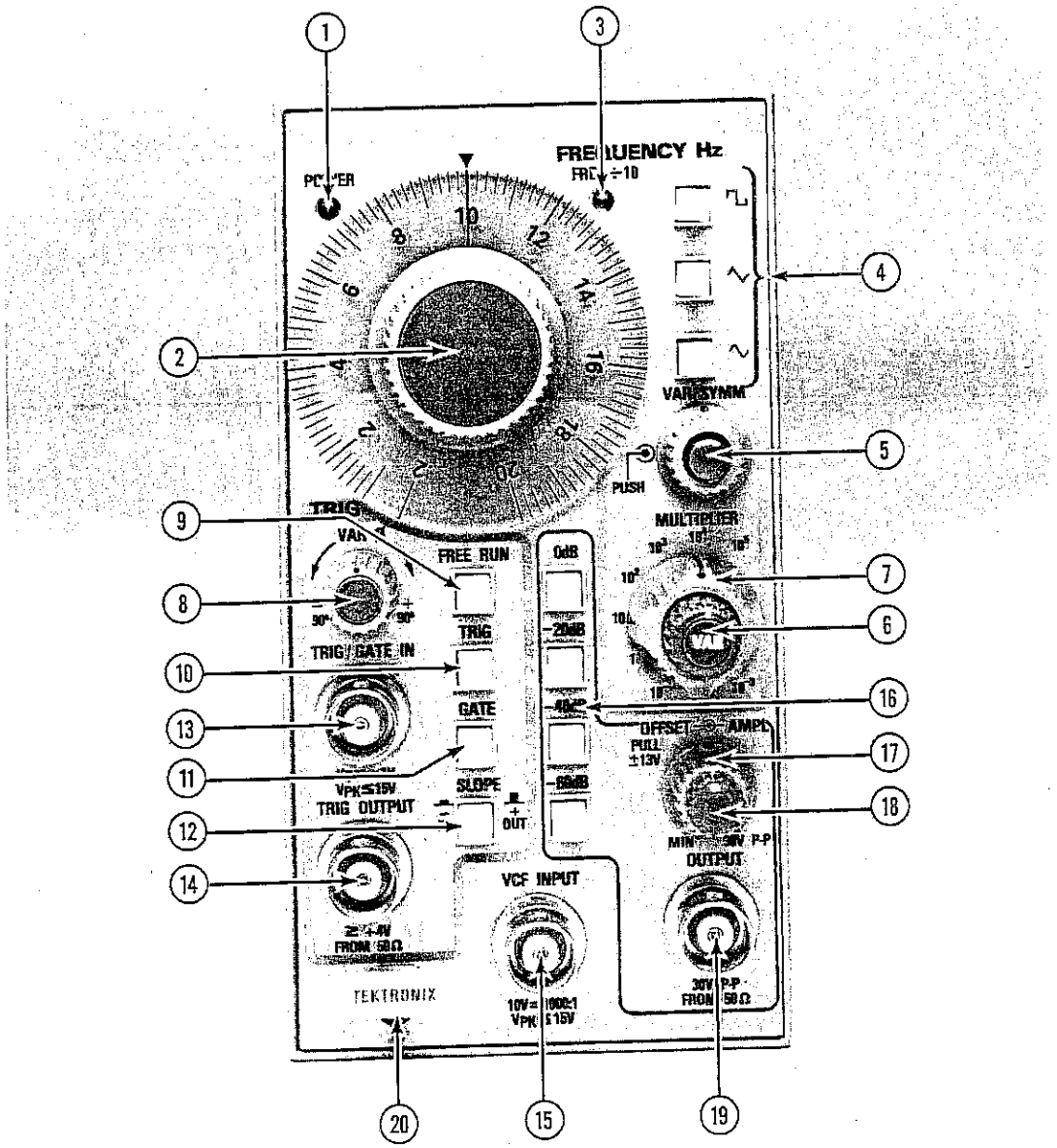

Fig. 2-2. Controls and connectors.

(1) **POWER**—Illuminated when power is applied to the FG 501A.

FREQUENCY CONTROL AND FUNCTION SELECTION

(2) **FREQUENCY Hz**—Selects the frequency of the output waveform in conjunction with the MULTIPLIER control.

(3) **FREQ ÷ 10**—Illuminated when the variable symmetry function is activated.

(4) **FUNCTION BUTTONS**—Select square, triangle, and sine waveforms.

(5) **VAR SYMM**—(push to enable) adjusts time-based symmetry of the selected output waveform. Reduces the frequency of the output waveform by a factor ≈ 10 and illuminates the FREQ ÷ 10 indicator.

(6) **FREQUENCY VERNIER**—For fine adjustment of output frequency to at least 1 part in 10^4 of full scale.

(7) **MULTIPLIER**—Selects the output frequency in eight decade steps in conjunction with the FREQUENCY Hz control.

TRIGGER AND GATE CONTROLS

(8) **VAR Ø**—Selects phase lead or lag, up to ±90°, relative to input trigger or gate waveform.

(9) **FREE RUN**—When pressed causes continuous waveform output.

(10) **TRIG**—When pressed causes output of one cycle of selected waveform for each trigger pulse applied to the TRIG/GATE IN connector.

(11) **GATE**—When pressed causes continuous output of the selected waveform for the duration of the gating pulse.

(12) **SLOPE**—Button selects, in TRIG mode, the slope of the input signal which will trigger the selected output waveform. In GATE mode, whether output gating will occur when the level of the input signal is above or below the threshold level of +1 V.

(13) **TRIG/GATE IN**—Bnc connector used to apply the external trigger or gating signal.

(14) **VCF INPUT**—Bnc connector for applying an external voltage for controlling the output frequency of the generator.

(15) **TRIGGER OUTPUT**—Bnc connector which outputs one positive pulse for each cycle of the selected output waveform.

OUTPUT CONTROLS

(16) **ATTENUATOR BUTTONS**—Attenuate the amplitude of the selected output waveform in 20 dB steps to a maximum of 60 dB when pressed.

(17) **AMPL**—Varies the amplitude of the selected output waveform, between steps of the attenuator buttons.

(18) **OFFSET**—Pull and turn control, concentric with the AMPL control, provides up to ±13 V dc offset of the output waveform.

(19) **OUTPUT**—Bnc connector for output of the selected waveform.

(20) **RELEASE LATCH**—Pull to disengage the FG 501A from the power module.

OPERATING CONSIDERATIONS

OUTPUT CONNECTIONS

The output of the FG 501A is designed to operate as a 50 Ω voltage source working into a 50 Ω load. At higher frequencies, an unterminated or improperly terminated output will cause aberrations on the output waveform. Loads less than 50 Ω will reduce the waveform amplitude.

Excessive distortion or aberrations, due to improper termination, are less noticeable at the lower frequencies (especially with sine and square waveforms). To ensure waveform purity, observe the following precautions:

1. Use good quality 50 Ω coaxial cables and connectors.

2. Make all connections tight and as short as possible.

3. Use good quality attenuators if it is necessary to reduce waveform amplitude applied to sensitive circuits.

4. Use terminations or impedance matching devices to avoid reflections when using long cables (6 feet or more).

5. Ensure that attenuators, terminations, etc. have adequate power handling capabilities for the output waveform.

If there is a dc voltage across the output load, use a coupling capacitor in series with the load. The time constant of the coupling capacitor and load must be long enough to maintain pulse flatness.

RISETIME AND FALLTIME

If the FG 501A is used to measure the rise or falltime of a device, the riestime characteristics of associated equipment should be considered. If the risetime of the device under test is at least 10 times greater than the combined risetimes of the FG 501A and associated equipment, the error introduced will not exceed 1%, and generally can be ignored. When the rise or falltime of the test device is less than 10 times as long as the combined risetimes of the testing system, the actual risetime of the system must be calculated. The risetime of the device under test can be determined once the risetime of the system is known.

IMPEDANCE MATCHING

If the FG 501A is driving a high impedance such as the 1 MΩ input impedance (paralleled by a stated capacitance) of the vertical input of an oscilloscope, connect the transmission line to a 50 Ω attenuator, 50 Ω termination, and then to the oscilloscope input. The attenuator isolates the input capacitance of the device, and the FG 501A is properly terminated.

FIRST TIME OPERATION

The Controls and Connectors pages give a description of the front panel controls and connectors. The waveform selection and frequency determining controls are outlined in blue, the trigger function controls and inputs are outlined in green, and the output controls are outlined in black.

The following exercise will familiarize the operator with most functions of the FG 501A.

NOTE

If any discrepancies are encountered during the exercise, refer the condition to qualified service personnel.

Preset the controls as follows:

Blue section:

FREQUENCY Hz	10
MULTIPLIER	10^2
FREQUENCY VERNIER	Fully cw
WAVEFORM—SINE	in
VAR SYMM	off

Green section:

FREE RUN	in

Black section:

ATTENUATOR	−20 dB
AMPL (variable)	Centered
OFFSET	off

Connect a 50 Ω bnc coaxial cable terminated in 50 Ω to the vertical input of an oscilloscope. Set the oscilloscope controls to:

Vertical	1 V/Div DC Coupled
Horizontal (Time Base)	1 ms/Div

The oscilloscope should display 1 complete cycle per division of the sine waveform (approximately 10 cycles across the graticule).

1. Alternately press the square, triangle and sine buttons and observe the different waveshapes. Return to the preset condition.

2. Alternately press the four attenuator buttons and rotate the AMPL (variable) control to verify that the waveform amplitude changes. Return these controls to the preset condition.

3. Pull the OFFSET knob out and rotate it. Notice the change in dc level of the displayed waveform. Return the OFFSET knob to the in position.

4. Push the VAR SYMM button to release it to the out position. Observe that the FREQ ÷ 10 indicator is illuminated and only one cycle of the output waveform is displayed. Rotate the VAR SYMM control through its range and notice the change in shape of the square, triangle, and sine waveforms (with the appropriate buttons pushed in). Return the controls to the preset condition.

5. Rotate the FREQUENCY control and the MULTIPLIER switch while observing the change in frequency of the displayed waveform. Return these controls to the preset condition.

OPERATING MODES

FREE-RUNNING OUTPUT

The following procedure will provide a free-running output with variable frequency and amplitude.

1. Select the desired waveform.

2. Set the AMPL control fully counterclockwise. Check that the VAR SYMM and OFFSET controls are in the off (in) position.

3. Select the desired frequency with the FREQUENCY Hz dial and MULTIPLIER switch. Frequency equals dial setting times multiplier setting.

4. Connect the load to the FG 501A output connector and adjust the AMPL control for the desired output amplitude.

TRIGGERED OR GATED (BURST) OPERATION

With the FG 501A set for free-running operation, as described in previous paragraphs, apply the triggering or gating signal to the TRIG/GATE IN connector.

If only one cycle of the output waveform per trigger is desired, push the TRIG button and select + or − slope. One output cycle will now be generated for each input trigger cycle.

If more than one cycle of the output waveform is desired, push the GATE button. The output will now be continuous for the duration of the gating waveform. The number of cycles per burst can be approximated by dividing the gating signal duration by the period of FG 501A output frequency.

In triggered or gated operation the PHASE control varies the start of the output waveform by ±90°. This phase change is measured from the 0 V, 0° point on the output waveform.

VOLTAGE CONTROLLED FREQUENCY (VCF) OPERATION

The output frequency of any selected waveform can be swept within a range of 1000:1 by applying an external voltage to the VCF INPUT connector. The polarity of the VCF input signal determines which direction the output frequency sweeps from the selected frequency. A positive (+) going signal increases the frequency while a negative (−) going signal decreases the frequency. The amplitude and polarity of the input voltage can be selected within a range of ±10 V depending on the FREQUENCY Hz dial setting.

The maximum swept frequency range of 1000:1 encompasses the uncalibrated portion of the FREQUENCY Hz dial (<.2 to 2). To ensure that the frequency does sweep at least a range of 1000:1, it is recommended that the FREQUENCY Hz dial be set at .2 and a 0 to +10 V signal be applied to the VCF INPUT connector. It may be necessary

to vary the FREQUENCY VERNIER control to obtain the full 1000:1 swept range or the lowest swept frequency desired.

Since the VCF input amplitude is a linear relationship, the frequency output range can be determined from the VCF input amplitude.

TRIGGER OUTPUT

A +4 V square wave is available from the TRIG OUTPUT connector. The frequency of the trigger output is determined by the frequency of the selected output waveform. One trigger pulse is generated for each positive cycle of the output signal except when square waves are selected. When generating square waves, one trigger pulse is generated for each negative cycle of the output signal. Trigger output impedance is 50 Ω.

BASIC WAVEFORM CAPABILITIES

The following photographs illustrate the basic waveform capabilities of the FG 501A.

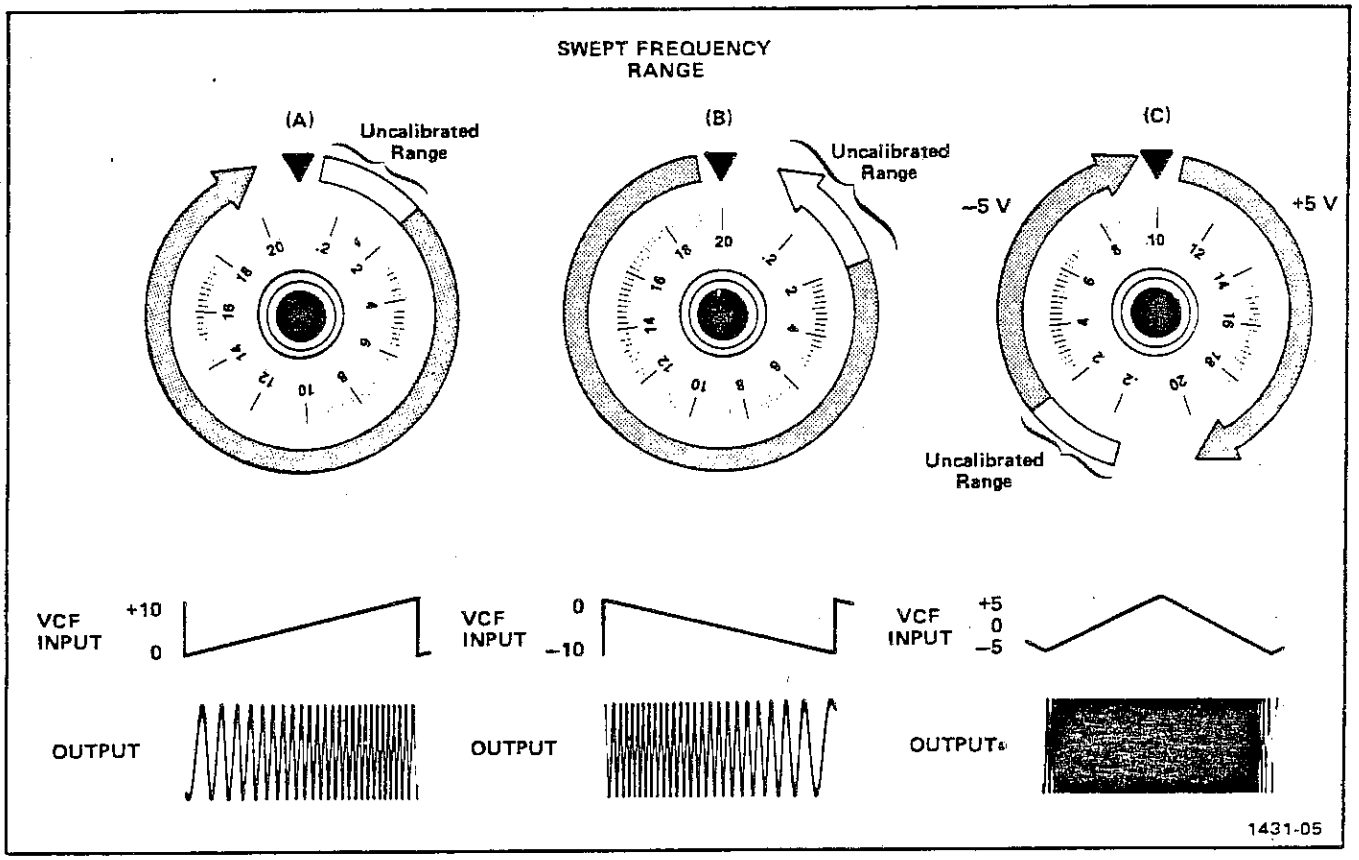

Fig. 2-3. Swept Frequency range with 10 V signals applied to VCF IN connector.

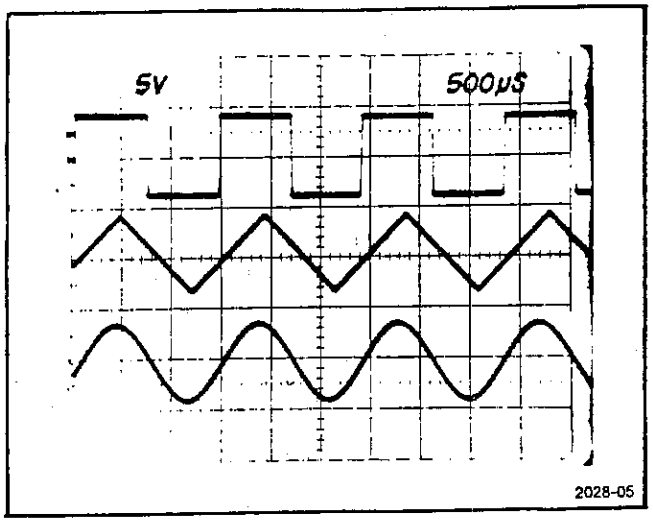

Fig. 2-4. BASIC FUNCTIONS. Square, triangle, and sine waveforms selected by front panel pushbuttons.

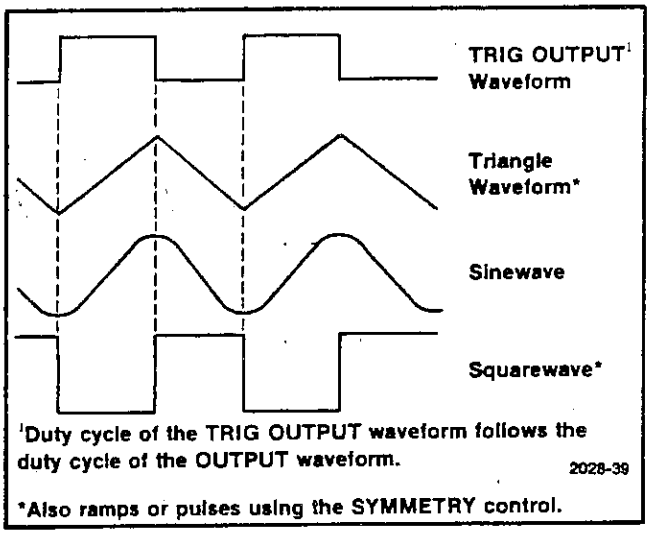

Fig. 2-6. Phase relationships between OUTPUT waveforms and the TRIG OUT waveform.

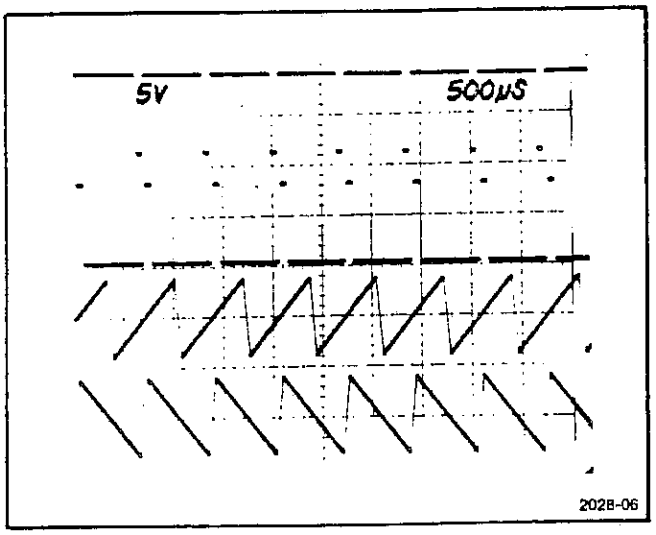

Fig. 2-5. RAMPS AND PULSES. These are obtained from the basic waveforms by using the SYMMETRY control.

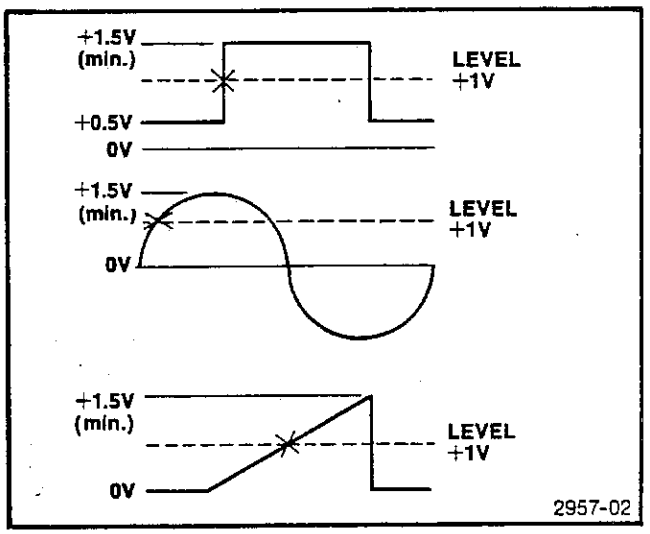

Fig. 2-7. Trigger Signal amplitude requirements and triggering points.

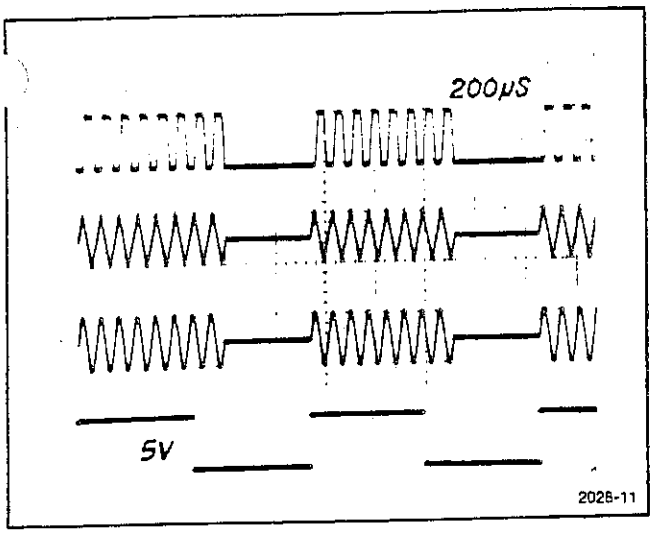

Fig. 2-8. GATED OPERATION. The top three traces are various output waveforms and the bottom trace is the gating waveform applied to the trigger INPUT connector with the GATE pushbutton pressed in. Note the additional cycle completed after the waveforms are gated off.

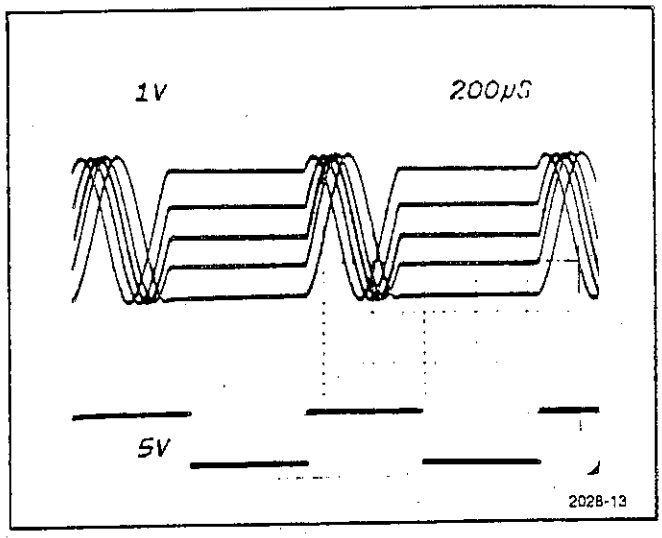

Fig. 2-10. PHASE CONTROL OPERATION. This photograph illustrates PHASE control usage in the triggered mode. The five super-imposed traces illustrate the effect of the phase control. This control provides ±90° of shift. The bottom trace is the triggering waveform.

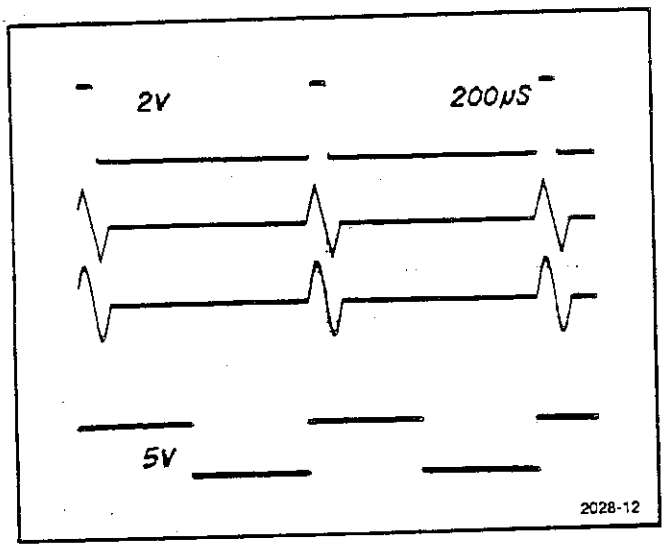

Fig. 2-9. TRIGGERED OPERATION. The top three traces are the various output traces selected. The bottom trace is the triggering waveform applied to the trigger INPUT connector with the TRIG mode selected. Note that only one cycle of the output waveforms is completed.

APPLICATIONS

RESPONSE ANALYSIS

The FG 501A is particularly suited for determining response characteristics of circuits or systems. This application utilizes the VCF input of the FG 501A to sweep the generator over a range of frequencies. Refer to the Voltage Controlled Frequency (VCF) Operation discussion under Operating Modes for additional information.

1. Connect the equipment as shown in Fig. 2-11.

2. Set the MULTIPLIER selector and FREQUENCY Hz dial for the desired upper or lower frequency limit (depending on the direction you wish to sweep).

3. Apply the desired waveform to the VCF INPUT connector. (A positive-going waveform will increase the frequency while a negative-going waveform will decrease it.)

4. Adjust the amplitude of the VCF input waveform for the desired output frequency range.

5. Observe the response characteristics on the monitoring oscilloscope.

The frequency at which a displayed response characteristic occurs can be determined by first removing the VCF input waveform, then manually adjusting the FREQUENCY Hz dial to again obtain the particular characteristic observed in the swept display and reading that frequency on the FREQUENCY Hz dial.

TONE-BURST GENERATION OR STEPPED FREQUENCY MULTIPLICATION

The FG 501A can be used as a tone-burst generator or frequency multiplier for checking tone-controlled devices. This application utilizes a ramp generator, such as the TEKTRONIX RG 501, as a VCF signal source and a pulse generator, such as the TEKTRONIX PG 501, as a gating signal source.

The following procedure describes a technique for obtaining a tone-burst or frequency multiplied output

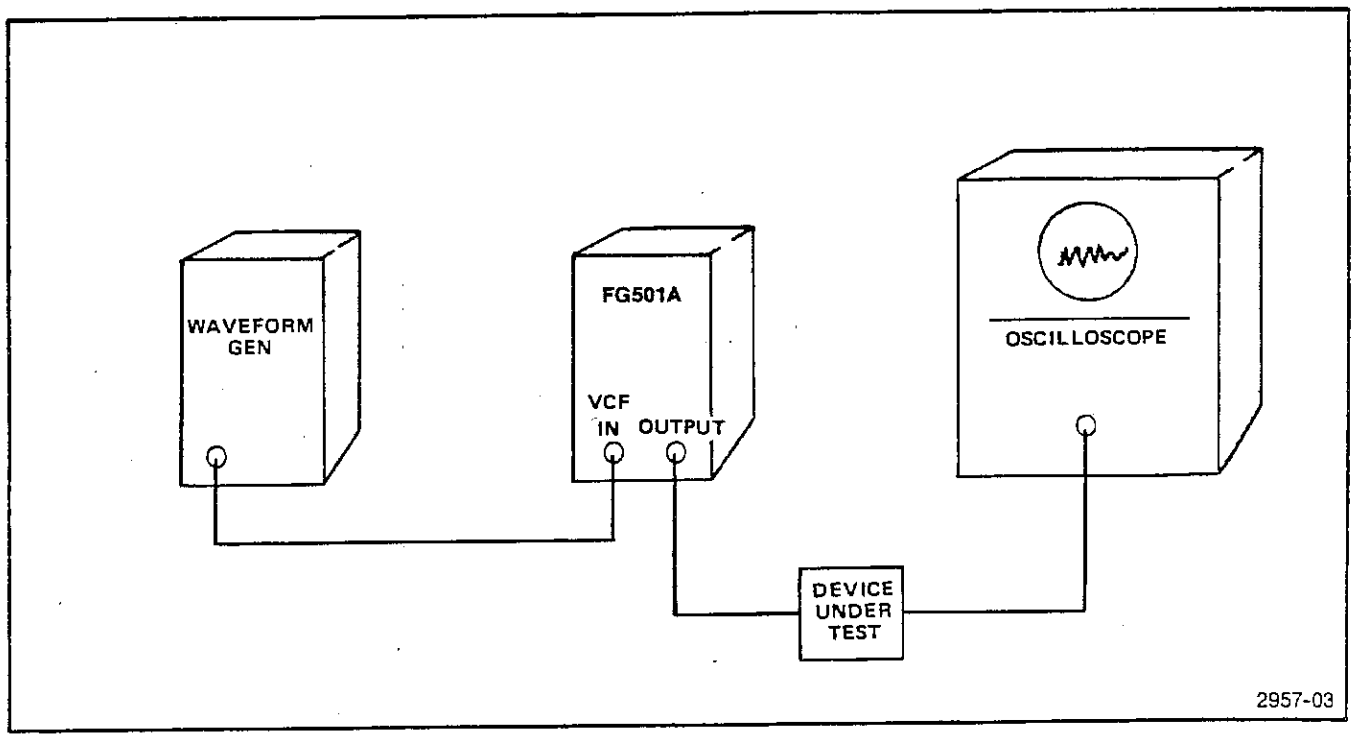

Fig. 2-11. Analyzing circuit or system response.

from the FG 501A. Refer to the Gated (burst) Output and Variable Phase and the Voltage-controlledFrequency (VCF) Output discussions under Operation for additional information.

1. Connect the equipment as shown in Fig. 2-12.

2. Push the GATE button in and set the PHASE control to the desired phase.

3. Set the ramp generator for the desired ramp duration and polarity.

4. Adjust the pulse generator period for the desired number of bursts within the selected ramp duration. Adjust the pulse generator duration for the desired burst width.

5. Select the sweep frequency range by adjusting the FREQUENCY Hz dial for one end of the sweep range (upper or lower limit depending on the polarity of the ramp). Then, adjust the ramp generator amplitude for the other swept frequency limit.

Various other tone-burst or frequency multiplied characteristics can be obtained by using different gating input waveforms, i.e., triangle, sine, square, etc.

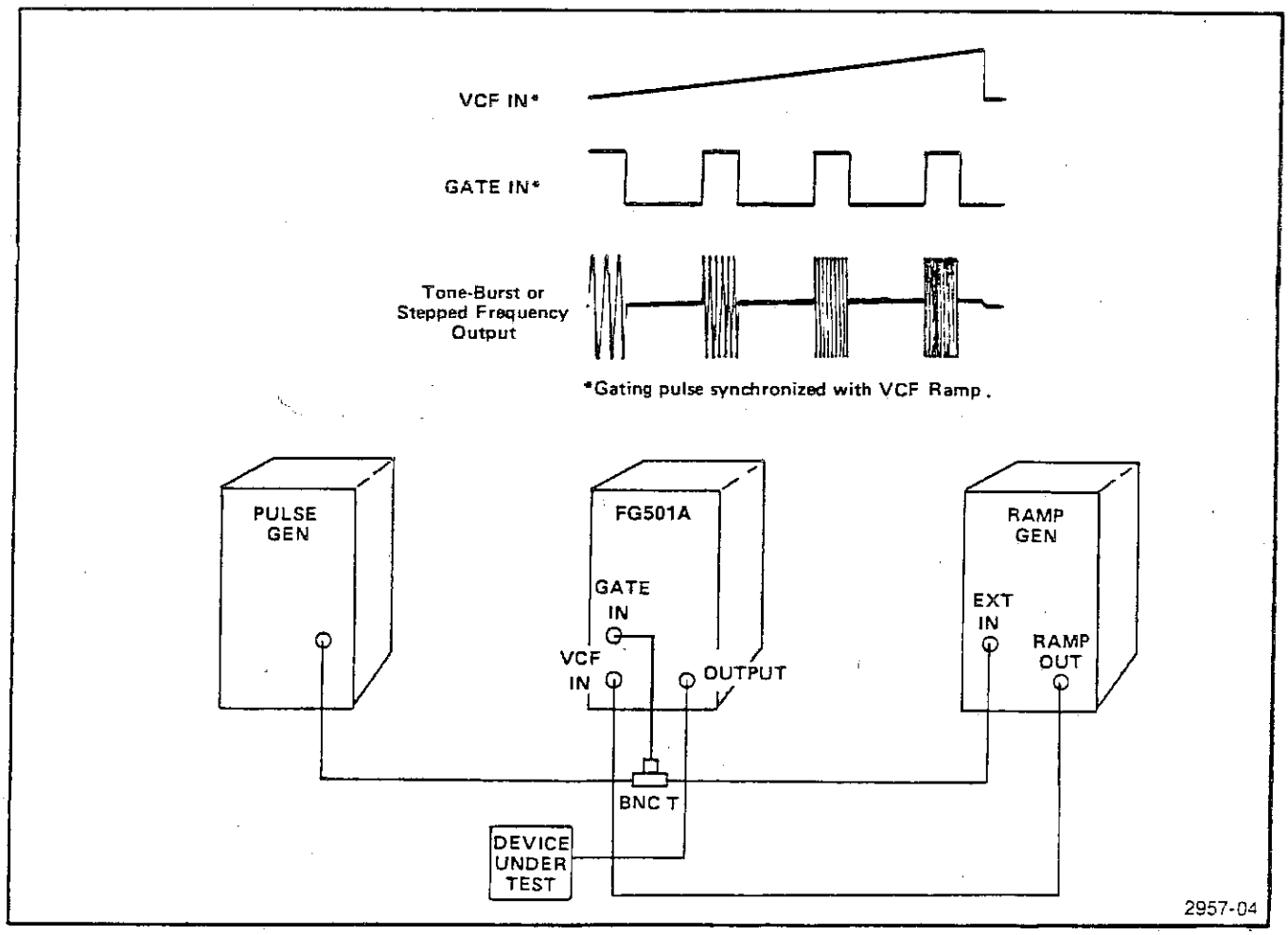

Fig. 2-12. Tone-burst generation or stepped frequency multiplication.