

INSTRUCTION MANUAL  
**MODEL 188**  
**4 MHz SWEEP/  
FUNCTION GENERATOR**

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**SAFETY FIRST**

**Protect yourself.** Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wiring carrying the output signals. This instrument can generate hazardous voltages and currents.
- Don't bypass the power cord's ground lead with two-wire extension cords or plug adaptors.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with  $\oplus$  or  $\triangle$ ).
- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.
- Don't plug in the power cord until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the **CAUTION** statements. They point out situations that can cause equipment damage.

**1.1 THE MODEL 188**

The Wavetek Model 188, 4 MHz Sweep/Function Generator, is a precision source of sine, triangle and square waveforms plus dc voltage. All waveforms are front panel variable from 4 mHz to 4 MHz and can be internally or externally modulated. Frequencies are variable linearly or logarithmically within a frequency range. When used as a sweep generator, an internal ramp generator provides a recurring sweep over a 1000:1 (linear) frequency range or 10,000:1 (logarithmic) frequency range. Output can be continuous or the generator can be triggered or gated by an external signal or a front panel switch. Amplitude of the waveforms is variable from 10V peak-to-peak into 50Ω down to 30 mV peak-to-peak. DC reference of the waveform can be offset positively or negatively.

The two selectable waveform outputs are a 20V peak-to-peak maximum and a 2V peak-to-peak maximum (20 dB down from 20 Vp-p); both may be varied over a 30 dB range. Auxilliary outputs are a TTL level sync, a 600Ω sweep ramp and a 600Ω generator control voltage signal whose level is proportional to the main generator frequency.

**1.2 SPECIFICATIONS**

**1.2.1 Versatility**

**Waveforms**

Sine , triangle , square , TTL pulse and dc.

**Operational Modes**

Continuous: Generator runs continuously at selected frequency.

Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.

Gated: As triggered mode, except output continues for duration of gate signal. Last waveform started is completed.

Sweep: An internal ramp generator will sweep the main generator from a lower, start frequency to a higher stop frequency, linearly (3 decades) or logarithmically (4 decades).

Sweep Stop: Frequency switches to high sweep limit. Used to set high frequency limit.

**Frequency Range**

0.004 Hz linear (0.0004 Hz log) to 4 MHz in 7 overlapping decade ranges:

× 1	0.004 (0.0004) to 4 Hz
× 10	0.04 (0.004) to 40 Hz
× 100	0.4 (0.04) to 400 Hz
× 1K	4 (0.4) Hz to 4 kHz
× 10K	40 (4) Hz to 40 kHz
× 100K	400 (40) Hz to 400 kHz
× 1M	4 (0.4)kHz to 4 MHz

**Function Output**

, , selectable and variable to 20 Vp-p (10 Vp-p into 50Ω) HI output, and to 2 Vp-p (1 Vp-p into 50Ω) LO output. Both outputs varied with a 30 dB vernier. Peak output current is 100 mA maximum (HI output) into 50Ω (200 mA peak into a short circuit). Source impedance is 50Ω.

**DC Offset and DC Output**

Waveform offset and dc output selectable and variable through HI and LO BNC outputs. DC output selectable by not selecting a waveform function. HI output is ±10V max (±5V into 50Ω) as offset or Vdc output. Signal-peak plus offset limited to ±10V (±5V into 50Ω). LO output is ±1V max (±0.5V into 50Ω) as is signal-peak plus offset limit. DC offset plus waveform attenuated proportionately at LO (-20 dB) output.

**TTL Sync Output**

TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

**GCV — Generator Control Voltage**

0 to 4.0V open circuit output from 600Ω source impedance. Proportional to frequency of main generator. For use as a horizontal drive signal.

**VCG — Voltage Controlled Generator**

Up to 1000:1 frequency change (linear mode) or up to 10,000:1 change (logarithmic mode) with external 0 to  $\pm 4V$  signal. Upper and lower frequencies limited to maximum and minimum of selected range.

Slew Rate: 2% of range per  $\mu s$  (linear); 0 to 100% of range in 20 ms (logarithmic).

Linearity:  $\pm 0.5\%$  through  $\times 100K$  range;  $\pm 2\%$  on  $\times 1M$  range.

Input Impedance: 2 k $\Omega$ .

**Sweep**

Main generator is frequency modulated by internal sweep generator. Main generator frequency repeatedly rises from frequency set by dial and range button to frequency set by sweep stop knob.

Sweep Mode: Linear (3 decades max) or logarithmic (4 decades max).

Sweep Rate: 30 ms to 1 min. (nominal) continuously adjustable.

Sweep Width: Up to 1:1000 (linear) or 1:10,000 (logarithmic) continuously adjustable.

**Sweep Output**

Ramp waveform output with 4V peak into open circuit. Source impedance 600 $\Omega$ . For use as a horizontal drive signal.

**Trigger and Gate**

Input: TTL compatible levels.

Pulse Width: 50 ns minimum.

Repetition Rate: 4 MHz maximum.

**1.2.2 Frequency Precision****Dial Accuracy**

$\pm 5\%$  of full scale.

**Time Symmetry**

Square wave variation from 0.2 to 4.0 on dial less than:  $\pm 1\%$  to 100 kHz;  $\pm 5\%$  to 4 MHz.

**1.2.3 Amplitude Precision**

Sine variation with frequency less than:  $\pm 0.2$  dB on all ranges through X100K, referenced to 1 kHz:  $\pm 1.0$  dB to 4 MHz.

**1.2.4 Waveform Characteristics****Sine Distortion**

Less than: 0.5% on  $\times 1K$  and  $\times 10K$  ranges; 1% on  $\times 1$ ,  $\times 10$ ,  $\times 100$  and  $\times 100K$  ranges. All harmonics 25 dB below fundamental on  $\times 1M$  range.

**Triangle Linearity**

Greater than 99% to 200 kHz.

**Square Wave Rise and Fall Time**

At HI output, less than 50 ns for 10 Vp-p output into 50 $\Omega$  termination.

**1.2.5 General****Environmental**

Specifications apply at 23°C  $\pm 5^\circ C$ . Instrument will operate from 0°C to 50°C ambient temperatures.

**Dimensions**

28.6 cm (11 1/4 in.) wide; 8.9 cm (3 1/2 in.) high; 26.7 (10 1/2 in.) deep.

**Weight**

2.5 kg (5.5 lb) net; 3.6 kg (8 lb) shipping.

**Power**

90 to 128V or 198 to 256V (specify); 48 to 66 Hz; less than 15 watts.

**NOTE**

*All specifications apply for dial between 0.2 and 4.0; amplitude at 10 Vp-p from HI output into 50 $\Omega$  termination.*

**2.1 MECHANICAL INSTALLATION**

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

**2.2 ELECTRICAL INSTALLATION**

**2.2.1 Power Connection**

**WARNING**

To preclude injury or death due to shock, the third wire earth ground must be continuous to the facility power outlet. Before connecting to the facility power outlet, examine extension cords, auto-transformers, etc., between the instrument and the facility power outlet for a continuous earth ground path. The earth ground path can be identified at the plug on the instrument power cord; of the three terminals, the earth ground terminal is the nonmatching shape, usually cylindrical.

**CAUTION**

To prevent damage to the instrument, check for proper match of line and instrument voltage and proper fuse type and rating.

**NOTE**

*Unless otherwise specified at the time of purchase, this instrument was shipped from the factory for operation on a 90 to 128 Vac line supply and with a 1/4 amp slow blow fuse. Instruments configured for 18L to 256 Vac have a 1/8 amp slow blow fuse.*

*Select the appropriate fuse and 115 or 230 switch position at the rear panel when changing power sources.*

**2.2.2 Signal Connections**

Use 3 foot RG58U 50Ω shielded cables equipped with BNC connectors to distribute all input and output signals.

**2.3 ELECTRICAL ACCEPTANCE CHECK**

This checkout procedure is a general verification of generator operation. Should a malfunction be found, refer to the warranty in the front of this manual.

A two channel oscilloscope, four 3 foot 50Ω coax cables with BNC connectors, a coax tee connector and an additional function generator are required for this procedure.

Preset the generator front panel controls as follows:

<b>Control</b>	<b>Position</b>
Dial .....	2.0
MODE .....	CONT (released)
FUNCTION .....	┌
DC OFFSET .....	OFF (ccw)
AMPLITUDE .....	MAX (cw)
FREQUENCY MULTIPLIER .....	× 1K
SWEEP .....	CONT (released)

Set up the oscilloscope, Model 188 and external function generator as shown in figure 2-1 and perform the steps in table 2-1.

**2.4 CHANGING THE OUTPUT IMPEDANCE**

The output impedance is normally:

- HI 10V p-p (50Ω source) into 50Ω.
- LO 1V p-p (50Ω source) into 50Ω.

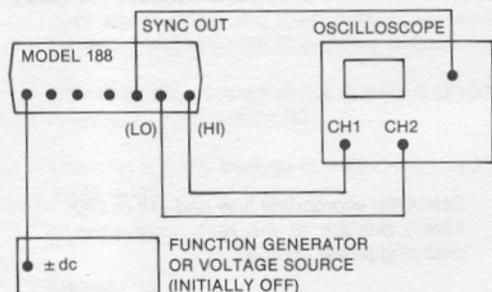


Figure 2-1. First Setup

Amplitude is normally variable over 30 dB for each output with a 50 dB amplitude range available by utilizing both outputs.

If simultaneous 600Ω and 50Ω output impedances are desired:

1. Change value of R148 from 499Ω to 604Ω.
2. Remove R149.

The result is:

- HI 10V p-p (50Ω source) into 50Ω.  
 LO 10V p-p (600Ω source) into 600Ω.

Amplitude is variable over 30 dB. Square wave rise and fall time is less than 150 ns. Any value greater than 600Ω may also be substituted for the value of R148 for other output impedances.

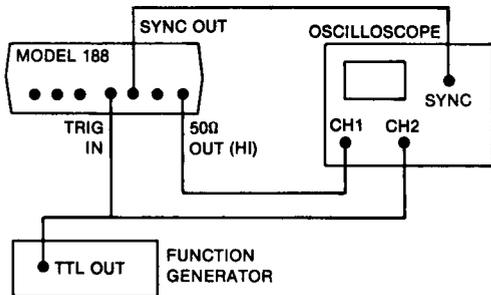
To increase the range of the variable amplitude control in a modified unit beyond 30 dB, decrease the value of R124 as necessary. Waveform quality relative to the standard unit is not guaranteed below -30 dB and above 20 kHz.

Table 2-1. Initial Checkout

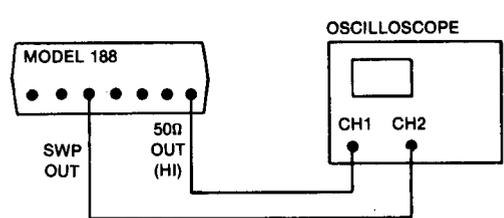
Step	Control	Position/Operation	Observation
1	POWER	ON	±10V square wave on CH1 and ±1V on CH2. Return to CH1 only.
2	Dial	Rotate in both directions. Return to 2.0.	Rotation ccw increases frequency of □ ; rotation cw decreases frequency.
3	FREQUENCY MULTIPLIER	Press each switch sequentially; return to ×1K.	Frequency increases in decade steps, left to right.
4	AMPLITUDE	Rotate ccw.	Amplitude decreases.
5	DC OFFSET	Rotate cw. Return to OFF.	Output immediately offset negative, then moves positive. OFF return it to original level.
6	AMPLITUDE	Rotate cw.	Square returns to original amplitude.
7	Function Generator or DC Voltage Source	Vary input dc voltage; then disconnect VCG IN input.	Frequency increases with positive voltage and decreases with negative voltage.
8	FUNCTION	Press ~, □, ^.	Observe ~, □, ^ waveforms.
9	MODE	Gate (CONT depressed, TRIG/GATE released).	A dc level near zero volts (except □ function).
10	MANUAL TRIGGER	Press and hold.	Continuous

**Table 2-1. Initial Checkout (Continued)**

Step	Control	Position/Operation	Observation
<i>Set up trigger source as shown in figure 2-2. Set trigger source for 100 Hz TTL signal.</i>			
11	---	---	^ gated on during positive portion of TTL signal on CH2.
12	TRIG/GATE	Trigger (depressed)	One cycle per trigger cycle.
13	MODE	Main generator continuous (CONT released)	Setup connectors as shown in figure 2-3. Sync scope on channel 2 input.
14	Dial	Full cw	
15	SWEEP Controls	Linear sweep (CONT depressed, SWP/STOP depressed, LOG/LIN extended, STOP full cw, TIME centered)	Output varies from low frequency to high frequency
16	LIN/LOG Button	Press	Logarithmic distributed sweep when compared to step 15 linear sweep.



**Figure 2-2. Second Setup**



**Figure 2-3. Third Setup**

SECTION 3  
OPERATION

## 3.1 CONTROLS AND CONNECTIONS

The generator front panel controls and connectors are shown in figure 3-1 and keyed to the following descriptions.

- 1 **Frequency Dial** — Settings under the dial index mark summed with **21** and multiplied by **4** determine the output signal frequency and the sweep start frequency in sweep mode. The dial is engraved with both linear and logarithmic scales; outer scale linear and inner scale logarithmic.
- 2 **POWER Button** — Turns generator ON and OFF.
- 3 **STOP Knob** — Sets the upper frequency limit when **CONT 5** is depressed and **SWP/STOP 6** is extended.
- 4 **FREQUENCY MULTIPLIER Controls** — Selects one of seven frequency multipliers for dial **1** setting.
- 5 **CONT Button** — Selects sweep submode to main generator's continuous mode. Extended is continuous (nonsweep) mode while depressed is sweep mode. Sweep is from a low frequency set by **1** to a high frequency set by **3**. Main generator mode control **8** must be in continuous mode (extended).
- 6 **SWP/STOP Button** — When button is depressed (and **5** depressed and **8** extended) selects repetitive sweep of the main generator frequency. When button is extended, the frequency is stopped at the upper sweep limit with upper frequency being set by **STOP** control **3**.
- 7 **LIN/LOG Button** — Selects linear or logarithmic frequency distribution of sweep.

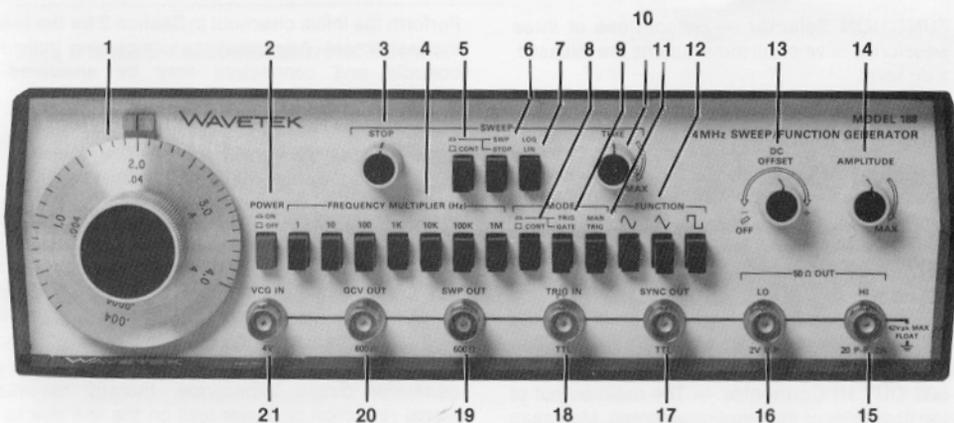


Figure 3-1. Controls and Connectors

VCG and main dial within a frequency range. Linear operation is selected when the button is extended. Logarithmic operation is selected when the button is depressed.

- 8, 9 Generator MODE Controls** — Selects one of the following three modes:

**CONT** — **8** released. Continuous output at 50Ω OUT **15** and **16** and SYNC OUT (TTL) **17** connectors.

**TRIG** — **8** and **9** pressed. DC level output until generator triggered by the MAN TRIG **11** or with a signal at the TRIG IN connector **18**. When triggered, the generator output is one cycle of waveform followed by a dc level.

**GATE** — **8** pressed and **9** released. As for TRIG except the output is continuous for the duration of the manual or external trigger signal. The last cycle started is always completed.

- 10 TIME Knob** — Sets the sweep time by controlling the period of the sweep ramp generator.
- 11 Manual Trigger Button** — Triggers or gates the output signals when generator mode is TRIG or GATE (**8** pressed). In trigger mode, one waveform cycle is output when the button is pushed. In gate mode, waveform cycles are continuously output as long as the button is held in.
- 12 FUNCTION Selector** — Selects one of three waveforms or when all three buttons are released, a dc level.
- 13 DC OFFSET Control** — Offsets the 50Ω OUT waveforms or gives dc levels from -10V to +10V (-5V to +5V into 50Ω) at **15** and from -1V to +1V (-0.5V to +0.5V into 50Ω) at **16**. An OFF position ensures no offset.
- 14 AMPLITUDE Control** — Ccw rotation reduces waveform amplitudes at **15** and **16** by 30 dB. DC and offset voltages are not affected by this control.
- 15 50Ω OUT HI Connector** — The main output of the generator at the function selected. Maximum 20 Vp-p (10 Vp-p into 50Ω) with 30 dB continuous amplitude control. 50Ω source impedance.
- 16 50Ω OUT LO Connector** — Same as **15** except 20 dB (1/10) lower in amplitude.

- 17 TTL OUT Connector** — A TTL square for each cycle of the generator. To be used for synchronization or as a TTL signal capable of driving 20 TTL loads.
- 18 TRIG IN Connector** — Accepts a TTL signal to trigger or gate the generator. Triggers on the rising (low to high) transition and gates during the positive (high) portion of the triggering signal.
- 19 SWP OUT Connector** — Supplies a ramp waveform with an approximate 4V peak into an open circuit. For use as a horizontal drive signal. Source impedance is 600Ω.
- 20 GCV OUT Connector** — Provides a 0 to 4V open circuit output proportional to the frequency of the main generator. For use as a horizontal drive signal. Source impedance is 600Ω.
- 21 VCG IN Connector** — Accepts ac or dc voltages to proportionately control frequency within the range determined by the FREQUENCY MULTIPLIER **4**. Positive voltage increases the frequency set by the dial **1**; negative voltage decreases the frequency. The VCG IN will not drive the generator frequency beyond the normal dial limits of a range. Input impedance is 2 kΩ.

## 3.2 OPERATION

Perform the initial checkout in Section 2 for the feel of the instrument. Any questions concerning individual controls and connectors may be answered in paragraph 3.1.

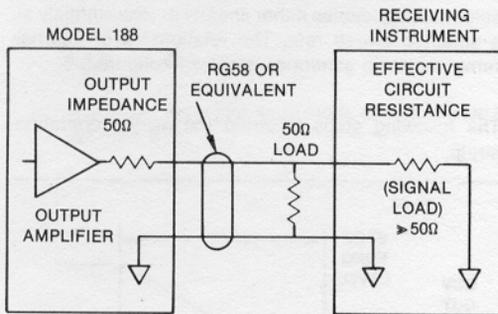
### 3.2.1 Signal Termination

Proper signal termination, or loading, of the generator connectors is necessary for its specified operation. For example, the proper termination of either of the 50Ω OUT connectors is shown in figure 3-2. Placing the 50Ω terminator, or 50Ω resistance, in parallel with a higher impedance, matches the receiving instrument input impedance to the coax characteristic and generator output impedance, thereby minimizing signal reflection or power loss on the line due to impedance mismatch.

The input and output impedances of the generator connectors are listed below.

Connector	Impedance
50Ω OUT (HI)	50Ω
50Ω OUT (LO)	50Ω
SYNC OUT (TTL)	*
TRIG IN	*
VCG IN	2 kΩ
SWP OUT	600Ω
GCV OUT	600Ω

\*The TTL OUT connector is diode protected and can drive up to 20 Transistor-Transistor-Logic (TTL) loads (low level between 0V and 0.4V, and high level between 2.4V and 5V). It should not be connected to resistive load less than 600Ω. The TRIG IN connector accepts TTL logic levels, is diode protected, and requires 500 μA drive from a high level output.



**Figure 3-2. Signal Termination**

### 3.2.2 Manual Function Generator Operation

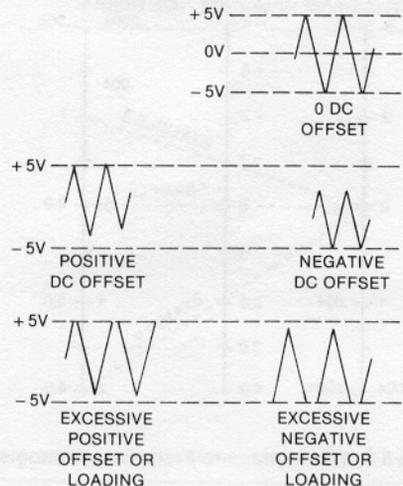
For basic operation, select the waveform frequency and amplitude. The following steps demonstrate manual control of the function generator. (Bold numbers are keyed to figure 3-1.)

Step Control/Connector	Setting
1 50Ω OUT <b>15 16</b>	Connect circuit to either output (refer to paragraph 3.2.1).
2 FREQUENCY MULTIPLIER <b>4</b>	Set to desired range of frequency.
3 Frequency Dial <b>1</b>	Set to desired frequency within the range.
4 SWEEP's CONT <b>5</b>	Extended.

5 FUNCTION <b>12</b>	Set to desired waveform.
6 DC OFFSET <b>13</b>	Set as desired. Limit waveform amplitude to prevent clipping (see figure 3-3).
7 AMPLITUDE <b>14</b>	Set for desired amplitude.

### 3.2.3 Voltage Controlled Function Generator Operation

Operation as a voltage controlled function generator (VCG) is as for a manually controlled function generator, only the frequency within a particular range is additionally controlled by an external voltage ( $\pm 4V$  excursions) injected at the VCG IN connector. Perform the steps given in paragraph 3.2.2, only set the frequency dial to determine a reference from which the frequency is to be voltage controlled:

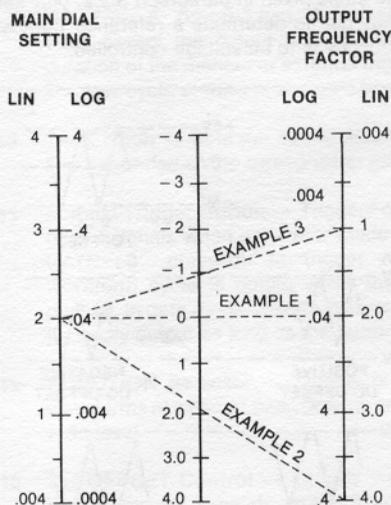


**Figure 3-3. DC OFFSET Control**

1. For frequency control with positive dc inputs at VCG IN, set the dial for a lower frequency limit.
2. For frequency control with negative dc inputs at VCG IN, set the dial for an upper frequency limit.
3. For modulation with an ac input at VCG IN, set the dial at the desired center frequency. Do not

exceed the limits of the selected frequency range.

Figure 3-4 is a nomograph with examples of dial and voltage effects. Example 1 shows that with 0V VCG input, frequency is determined by the main dial setting, 2 (linear mode) or .04 (logarithmic mode) in this example. Example 2 shows that with a positive VCG input, output frequency is increased. Example 3 shows that with a negative VCG input, output frequency is decreased. (Note that the Output Frequency Factor column value must be multiplied by a frequency range multiplier to give the actual output frequency.)



**Figure 3-4. VCG Voltage-to-Frequency Nomograph**

**NOTE**

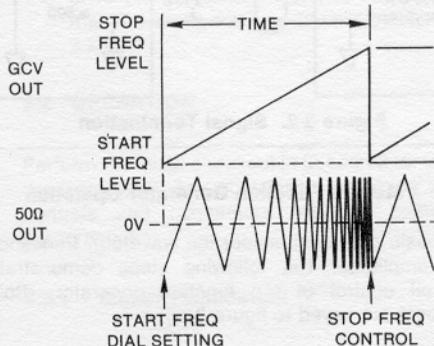
*Nonlinear operation may result when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range limits. The upper limit is four times the multiplier setting, and the lower limit is 1/1000th (linear) or 1/10,000 (logarithmic) of the upper limit.*

The up to 1000:1 (linear) or 10,000:1 (logarithmic) VCG sweep of the generator frequencies available in each range results from a 4V excursion at the VCG IN connector. With the frequency dial set to 4.0, excursions between -4V and 0V at VCG IN provide the up to 1000:1 (lin) or 10,000:1 (log) frequency sweep. With the dial set to .004 (linear) or .0004 (logarithmic), excursions between 0V and +4V at the VCG IN provide up to 1000:1 (linear) or 10,000:1 (logarithmic) sweep within the set frequency range.

### 3.2.4 Sweep Generator Operation

Operation as a sweep generator is similar to manually controlled generator operation except the main generator can be repetitively swept between two selected frequencies either linearly or logarithmically at a selected sweep rate. The relationship of internal ramp and main generator is shown in figure 3-5.

The following steps describe the sweep operation setup.



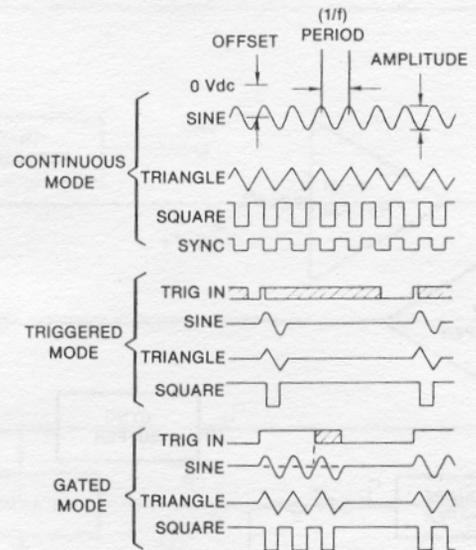
**Figure 3-5. Effect of Sweep Time and Width on Output Frequency**

Step	Control	Setting
1	MODE: CONT 8	Press to release. (Continuous mode of main generator is necessary for sweep.)

Step	Control	Setting
2	Frequency dial <b>1</b>	Select sweep start frequency.
3	SWEEP's CONT <b>5</b>	Depressed. (Selects sweep submode of main generator's continuous operation.)
4	SWP/STOP <b>6</b>	Press to release. (Extended allows setting of stop frequency.)
5	STOP <b>3</b>	Select the stop frequency. (The stop frequency will always be higher than the start frequency.)
6	Time <b>10</b>	Sets the internal sweep rate.

### 3.2.5 Waveforms

Waveform timing for each mode of operation is shown in figure 3-5.



**Figure 3-5. Waveform Characteristics**

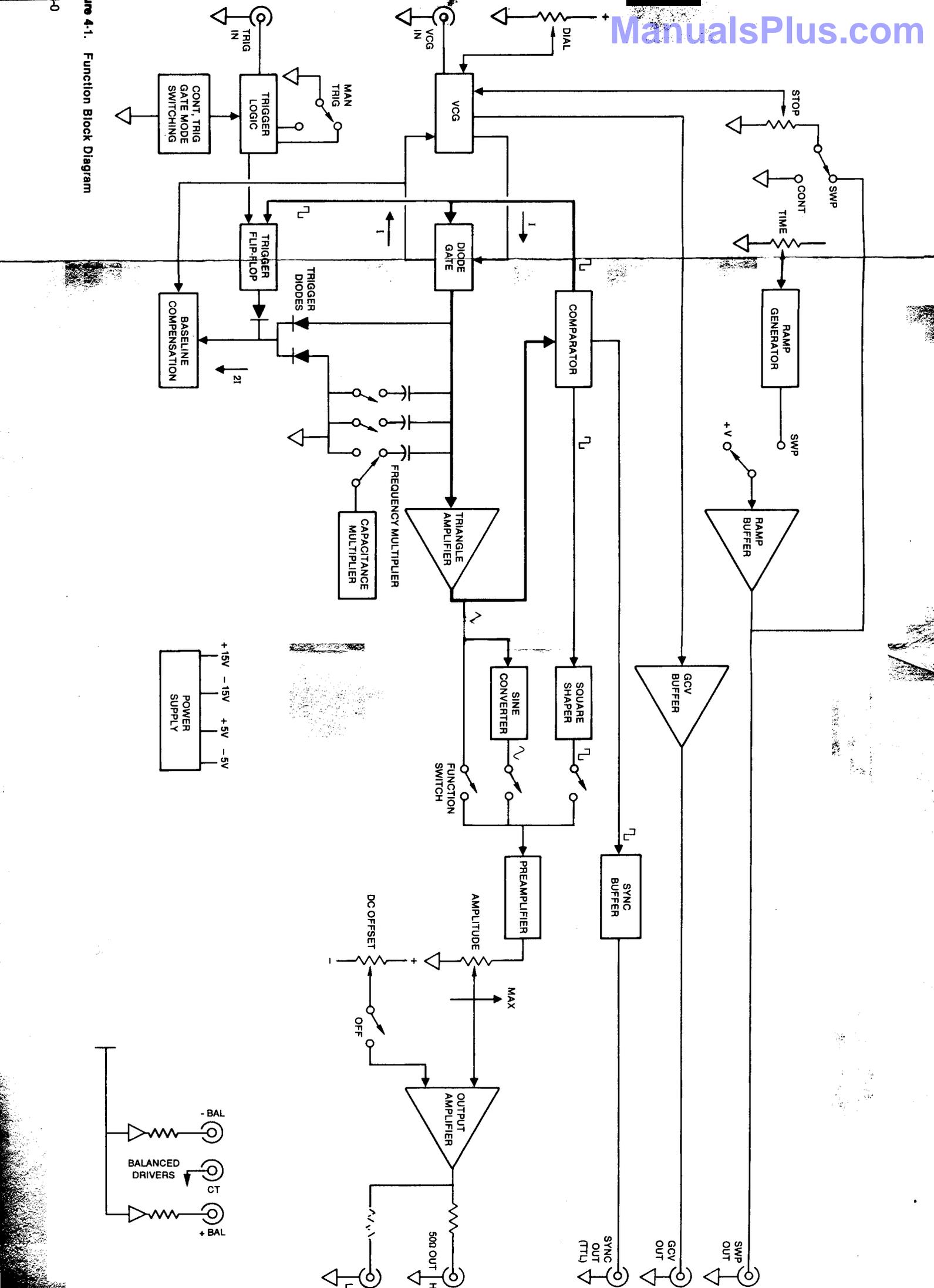


Figure 4-1. Function Block Diagram

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## SECTION 4

### CIRCUIT DESCRIPTION

This section describes the functions of major circuit elements and their relationships to one another as shown in figure 4-1, functional block diagram. The following sections in this manual provide more detailed information for maintaining the instrument.

As shown in figure 4-1, the VCG (Voltage Control of Generator) sums voltage inputs from the frequency dial and the VCG IN connector. This sum voltage controls the magnitude of a complementary current source and current sink. This current varies linearly from approximately 2 mA to 2  $\mu$ A over a 1000:1 (4.0 to .004) range or logarithmically from approximately 2 ma to 0.2  $\mu$ a over a 10,000:1 (4.0 to .0004) range of each frequency multiplier. The VCG also controls the trigger baseline compensation circuit, which consists of another current sink at twice the current magnitude.

The diode gate, controlled by the comparator output, connects either the current source or the current sink to the timing capacitor selected by the frequency multiplier. When the current source is switched in, the charge on the timing capacitor will rise linearly, producing the positive-going triangle slope. Likewise, the current sink produces the negative-going triangle slope.

The triangle amplifier is a unity gain amplifier whose output is fed to the comparator and to the output circuits. The comparator operates as a window detector with limit points set to the triangle peaks. The  $\pm 2V$  output is sent back to the diode gate and to the output circuits. When the output is +2V, the triangle is positive-going until the +1.25V limit is reached and the comparator output switches to -2V. When the output is -2V, the triangle is negative-going until the -1.25V limit is reached and the comparator output switches back to +2V, repeating the process. In this manner, the basic function generator loop, the bold path in figure 4-1, produces simultaneous generation of triangle and square waves at the same frequency.

The output frequency is determined by the magnitude

of the timing capacitor selected by the frequency multiplier switches and by the magnitude of the currents supplied to and removed from it. Since the currents are linearly proportional to the sum of the VCG inputs, so will be the output frequency.

To extend the lower frequency capability of the generator, a capacitance multiplier circuit divides VCG currents by 10 (effectively multiplying the timing capacitor by 10) for each of the lower 3 multiplier ranges.

The TTL square from the comparator is buffered and sent to the SYNC OUT TTL connector. The other side is sent to the trigger flip-flop and to a level shifter to produce the  $\pm 2V$  bipolar square for the diode gate and the square shaper circuits. The square shaper converts the square into a current signal and applies it to the  $\square$  FUNCTION switch. The buffered triangle is applied to the  $\triangle$  FUNCTION switch and to the sine converter input. The sine converter, using the nonlinear characteristics of its diodes, converts the triangle into a sinusoidal current for the  $\sim$  FUNCTION switch.

The selected function is sent to the preamplifier, where it is inverted and buffered. The preamplifier output goes to the output amplifier through the AMPLITUDE control where it is summed with offset voltage from the DC OFFSET control. Here, waveform and offset are inverted and amplified to a  $\pm 10V$  peak signal which can drive a 50 $\Omega$  termination from a 50 $\Omega$  source impedance. The output amplifier drives the 50 $\Omega$  OUT HI connector and a resistor divider producing the 50 $\Omega$  OUT LO output.

Noncontinuous modes of operation (trigger and gate) result from allowing or preventing the VCG current source from charging the timing capacitor. Whenever the trigger flip-flop output is low, each of the two trigger diodes conduct a current I, sourcing 2I to the baseline compensation circuit. This removes the current I from the VCG current source and forces a 0V baseline at the triangle amplifier input.

When the CONT switch is released, trigger logic is inhibited from passing any trigger signals and the trigger flip-flop output is held high. This prevents the trigger diodes from conducting and the generator loop operates continuously.

When the CONT switch is pressed, the generator loop is held at the 0V baseline. Pressing the TRIG/GATE switch puts the instrument in triggered mode and any external or manual trigger signals at the trigger logic input will be transformed into a narrow pulse corresponding to the low-to-high transition of the trigger input. This pulse sets the trigger flip-flop high and allows the generator loop to run. When the triangle negative peak is reached, the comparator low-to-high transition clocks the trigger flip-flop low and, when the 0V baseline level is reached, the generator loop again stops. The result is a single cycle generated after the triggering signal corresponding to 0 to 360° of phase. Successive triggered waveforms always start at the same 0° point.

Releasing the TRIG/GATE switch puts the instrument in the gated mode. This is identical to the triggered mode, except the trigger flip-flop is held high for the full duration of the triggering signal. The generator produces continuous waveforms during the time the external signal is high or the manual trigger switch is

held in. The last triggered cycle started is always completed and successive gated bursts always start at the 0° point.

When sweep mode is selected by a combination of the main generator in continuous mode and the ramp generator switches set to SWP, the ramp generator is enabled and a ramp voltage becomes part of the control voltage in the VCG circuit to control the main generator frequency. Ramp period, variable from 30 ms to 1 minute, is set by the TIME Control. Ramp generator output is buffered to drive the sweep output and VCG circuit. The ramp magnitude supplying the VCG input is controlled by the STOP potentiometer.

Selecting the stop switch position biases the buffer amplifier to a level equal to the positive peak of the ramp (+V). In this static mode the upper sweep limit can be set by the STOP Control.

When the CONT position of the SWEEP switch is selected the ramp generator is disabled and the buffered ramp is disconnected from the VCG input.

The GCV (Generator Control Voltage) from the VCG circuit is a resultant voltage from the three VCG inputs: dial, VCG IN and sweep ramp. This voltage is buffered and made available at the GCV BNC.

