

INSTRUCTION MANUAL
MODELS 513,516,517
FUNCTION GENERATORS

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® Box 160 Hillsboro, Oregon
97123 Tel. (503) 648-6661
TWX 910-460-8811
EXACT electronics, inc.

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WAVEFORMS:

Model 513 - sine, square, triangle, sync.

Models 516 and 517 - sine, square, triangle, sync, ramp, pulse.

MODES OF OPERATION:

Model 516 - run, gate, trigger, pulse, burst, sweep.

Model 517 - run, gate, trigger, pulse, burst, linear sweep, log sweep.

DYNAMIC FREQUENCY RANGE: 0.01Hz to 11MHz.

FREQUENCY ACCURACY:

\pm (1% of setting plus 1% of range) 1Hz to 1MHz.

\pm (2% of setting plus 2% of range) 1MHz to 11MHz.

MAIN OUTPUT: 50Ω output impedance.

20V P-P into open circuit.

10V P-P into 50Ω.

MODELS 516 AND 517 RAMP 10V peak into open circuit.

5V peak into 50Ω

ATTENUATOR: 60db in 10db steps plus 20db continuously variable (80db total).

DC OFFSET: Variable, may be switched in or out.

+10 to -10 volts open circuit.

+5 to -5 volts into 50 ohms.

NOTE: Waveform will clip if D.C. offset plus signal exceeds maximum peak voltage.

SQUARE WAVEFORM: Rise and fall, $< 20\text{nsec.}$

Overshoot and ringing, $<5\%$ of maximum P-P amplitude.

SYMMETRY (time): $\pm (1\% + 10\text{nsec})$.

SINE WAVE DISTORTION: <0.5% to 100KHz.

No harmonics <30db down 100KHz to 11MHz.

SINE FREQUENCY RESPONSE: <0.1db to 100KHz. < 2db to 11MHz.

TRIANGLE LINEARITY: 99% to 100KHz.

SYNC OUTPUT: Square wave, 4V P-P open circuit. 100Ω output impedance.

VCF: (Voltage controlled frequency) Approx. 5V input for 1000:1 (three decades) frequency control.

FREQUENCY STABILITY: 0.05% of setting for 10 min.^{typ}
0.25% of setting for 24 hrs.

SECTION 1

SPECIFICATIONS

AMPLITUDE STABILITY: 0.05% of max. P-P amplitude for 10 min.
0.25% of max. P-P amplitude for 24 hrs.

GATE AND TRIGGER MODES: (Models 516 and 517 only).

Input - D.C. coupled, approx. $1K\Omega$ input impedance. Requirements - manual or external voltage of approx. 1 volt for turn on.

RAMP GENERATOR (Models 516 and 517 only).

Frequency range: 100 sec to $10\mu\text{sec}$.

Modes: run, trigger, cal.

Aux ramp output: Typically 5V peak open circuit. 100Ω output impedance.

V:F

Output voltage directly related to frequency. Approx. 5mV to 5V for 1000:1 range.

2.1 FRONT PANEL FAMILIARITY (Fig. 2.1.1)

Controls Common to all models.

1. POWER SWITCH. Connects power to the instrument. Refer to the rear panel for line voltage and fuse requirements.
2. POWER LIGHT. Indicates when power is being applied to the instrument.
3. RANGE. Sets the frequency in decade steps from 10Hz to 10MHz and a 20KHz audio range.
4. START FREQ. (MULTIPLIER). Sets the frequency between decades. The outer knob has 10 steps covering 1 decade below the RANGE setting. The inner knob provides vernier adjustment between steps. The S position (search) on the outer knob allows the inner knob to cover the 3 decades below the RANGE setting. In the sweep mode, Models 516 and 517 only, START FREQ sets the frequency from which the sweep starts.
5. FUNCTION. Selects the output waveform; sine, triangle, square, or ramp.
6. AMPLITUDE. Provides a vernier adjustment of output amplitude from maximum amplitude to $> 20\text{db}$ below maximum amplitude.
7. OFFSET. Enables the DC OFFSET control when depressed.
8. DC OFFSET. Provides $\pm 10\text{V}$ of DC OFFSET ($\pm 5\text{V}$ into 50Ω) at the output.
9. ATTENUATOR. Provides 10db step attenuation from 0db to -60db .
10. OUTPUT. 50Ω output for all waveforms.
11. SYNC OUT. Square wave coincident with the peaks of the output waveforms. $\pm 2\text{V}$ P-P open circuit, 100Ω output impedance.

Controls common to Model 516 and 517 only.

12. RAMP TIME. Sets the decade range in period for the ramp from $10\mu\text{sec}$ to 10sec.
13. RAMP VARIABLE. Provides >10 to 1 vernier control over ramp period above each RAMP TIME setting.
14. RAMP SYNC OUT. Provides a pulse coincident with the peaks of the ramp. $\pm 1\text{V}$, 100Ω output impedance.
15. MODE. Controls the mode of operation.
 - RUN. The main generator is in free run.
 - GATE. The main generator will run for the duration of an externally applied trigger signal or for as long as MAN is depressed and complete the last cycle.
 - TRIG. The main generator will run for 1 cycle for each externally applied trigger signal or each time MAN is depressed.
 - PULSE. The main generator is internally triggered from the ramp generator and runs for 1 cycle at the start of each ramp.
 - BURST. The main generator is internally gated from the ramp. Burst width is set by BURST WIDTH and repetition rate is set by RAMP TIME and RAMP VARIABLE.
16. START PHASE. Sets the start and stop phase for triggered and gated signals.
17. MAN. Provides for manually triggering or gating.
18. TRIG IN. Input for externally triggering and gating both generators. The trigger level is set at approximately 1 volt, $1\text{K}\Omega$ input impedance.

19. STOP FREQ/BURST WIDTH (B). Sets the stop frequency for sweeping. In burst mode, with the outer knob set to B (Burst), the inner, vernier dial, sets the burst width.
20. RAMP CAL. In sweep mode, it provides for holding the main generator at either START FREQ or STOP FREQ.
21. RAMP RUN/TRIG. Sets ramp into either free run or trigger mode.

Model 517 only

22. LIN/LOG. When depressed, frequency control will be converted from linear to logarithmic.

Model 513 only

23. VCF IN. For external control of frequency.

2.2 REAR PANEL FAMILIARITY (Fig. 2.2.1)

Controls common to all models.

1. LINE CORD. Connects to power source, 50Hz to 60Hz and voltage shown on FUSE DATA label.
2. FUSE HOLDER. Holds fuse of type shown in FUSE DATA label.
3. CHASSIS COMMON. Electrically connected to instrument case.
4. CIRCUIT COMMON. Electrically connected to circuit common.

Common to Model 516 and 517 only.

5. RAMP OUT. Auxiliary 5V ramp 100 Ω output impedance.
6. V:F OUT. Voltage proportional to frequency, 0 to 5V, 100 Ω output impedance.
7. VCF IN. For external control of frequency.

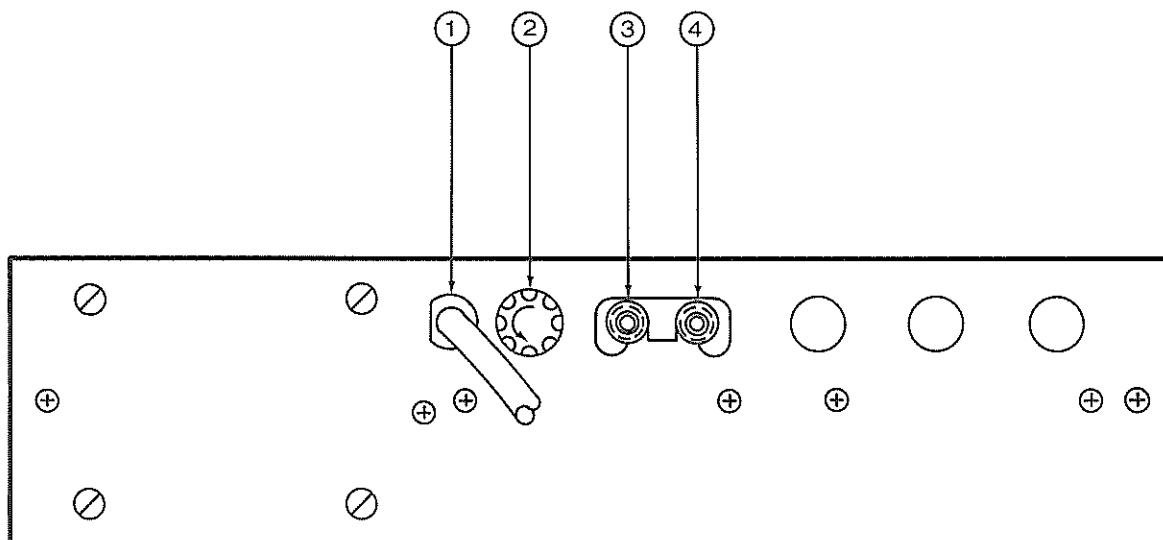


Figure 2.2.1 MODEL 513 REAR PANEL FAMILIARITY

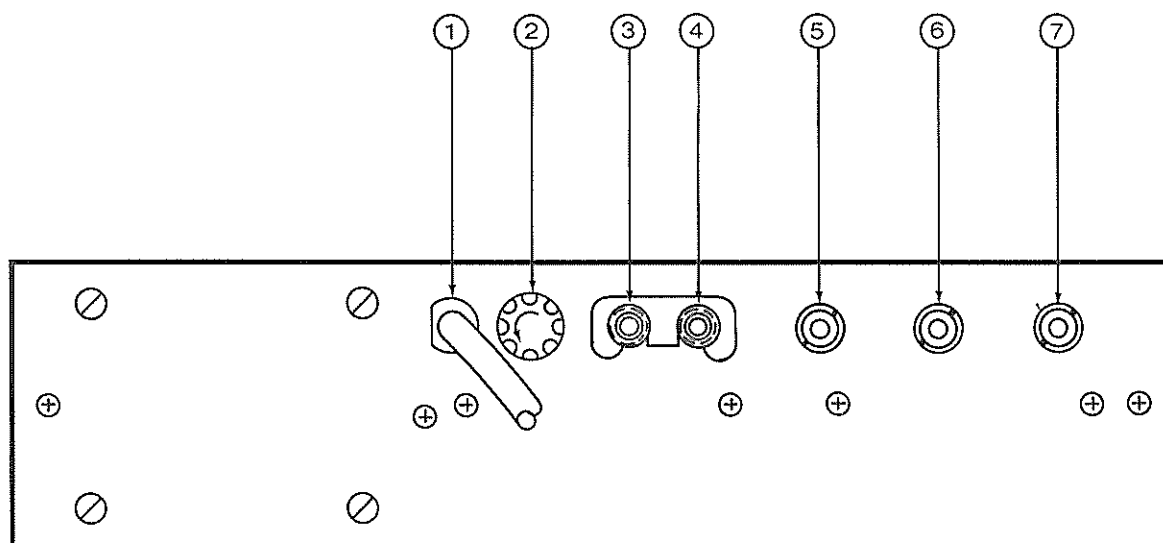


Figure 2.2.2 MODELS 516 AND 517 REAR PANEL FAMILIARITY

2.3 OPERATING INSTRUCTIONS

Common to all models.

2.3.1 FREQUENCY CONTROL

With VCF IN not used, the frequency is defined at START FREQ (MULTIPLIER) times RANGE.

EXAMPLE: Set RANGE to 100KHz; START FREQ (MULTIPLIER) to .37. The frequency is 37KHz. With the START FREQ (MULTIPLIER) outer dial set to S (search) the inner, vernier dial, linearly cover the 3 decades of frequency below RANGE. A typical use for this could be manually sweeping over the audio range, 20Hz to 20KHz. When it is not necessary to have this broad range of vernier frequency control it is recommended that search not be used below the 0.1 mark or degradation of frequency accuracy and stability will occur.

The VCF IN adds considerable versatility to the instrument. With the START FREQ (MULTIPLIER) at S0, fully CCW, VCF IN voltage from 0V to approximately 5V controls the frequency linearly over the 3 decades below RANGE setting with approximately 5V bringing the frequency up to the maximum frequency. This voltage varies slightly from instrument to instrument but should not be allowed to go high enough to cause the frequency to be more than 1.1 times RANGE or waveform distortion will occur. VCF IN can be used for remote frequency programming, phase locking, sweeping, etc.

EXAMPLE: It is desired to sweep from 10KHz to 30KHz in 50msec. Set RANGE to 100KHz; START FREQ (MULTIPLIER) to S0; ramp applied to VCF IN starting at 0.5V and running up to 1.5V in 50msec. An alternative method is to set the START FREQ (MULTIPLIER) to 0.1 and applying a ramp running from 0.0V to 1.0V.

2.3.2 OUTPUT WAVEFORM

There is an endless combination of AMPLITUDE, OFFSET, ATTENUATOR and FUNCTION combinations. As an example, say it is desired to obtain a square wave to drive TTL logic.

EXAMPLE: Set FUNCTION to Square; AMPLITUDE set for 4V P-P into 50 Ω ; set DC OFFSET to bring the negative peak up to +0.4V.

Care should be taken when using DC OFFSET to prevent amplifier clipping. The output amplifier clips at about $\pm 7V$ into 50 Ω . The ATTENUATOR will not prevent clipping, therefore, at 20db pushbutton engages, the maximum output voltage is $\pm 0.7V$.

Common to Models 516 and 517 only.

2.3.3 GATING AND TRIGGERING

There are three methods of gating and triggering the instrument, externally, manually, and internally. Internal gating and triggering are explained in the next section, PULSE AND BURST MODES.

When triggered, the instrument runs for one complete cycle, starting and stopping at the phase or voltage set by START PHASE. Start/stop phase may be set between -90° and $+90^{\circ}$ with FUNCTION set to normal sine or triangle and from 90° to 270° with FUNCTION set to inverted sine or triangle. Normal square always starts at the negative peak and inverted square always starts at the positive peak.

External triggering is accomplished by setting MODE to TRIG and applying a signal to TRIG IN. The trigger level is approximately 1V and the trigger signal must drop approximately 100mV below the trigger level before retriggering. The shape of the trigger signal does not matter.

EXAMPLE: To obtain one cycle of a 10KHz sine wave every 1msec starting at 180° , set RANGE to 10KHz; MULTIPLIER to 1.0; MODE to TRIG; START PHASE centered; FUNCTION to inverted sine. Apply a signal to TRIG IN of 1KHz and at least 1V peak. CAUTION: The frequency of the trigger signal must be less than the generator frequency for proper operation.

Manual triggering is possible using MAN. Each time MAN is depressed, the generator runs for one cycle.

The ramp can be triggered when RAMP RUN/TRIG is disengaged. A triggered ramp always starts at 0V and returns to 0V after one cycle.

For external gating set MODE to GATE. In this mode the generator will run for the time the external trigger signal is above the trigger level and complete the last cycle.

EXAMPLE: To obtain 3 cycles of a 10KHz sine wave every 1msec starting at 180° . Use the same control settings as in the previous example but with MODE set to GATE and apply a trigger signal of 1KHz that is above 1 volt for at least 0.2msec but less than 0.3msec.

For manual gating, MAN is held in for the desired gate time.

2.3.4 PULSE AND BURST MODES

In these modes the ramp generator is used in place of the external trigger signal.

For pulse mode MODE is set to PULSE and RAMP RUN/TRIG is engaged. The pulse repetition rate is set by RAMP TIME and RAMP VARIABLE.

EXAMPLE: To obtain a .1msec positive square pulse every 2msec. Set START FREQ to 0.5; RANGE to 10KHz; MODE to PULSE; FUNCTION to square; RAMP TIME to 1msec; measure RAMP SYNC OUT and adjust RAMP VARIABLE for a 2msec period; RAMP RUN/TRIG engaged. Note that, when triggering a square wave, the period of the pulse is one half that of sine and triangle.

To obtain bursts, the MODE is set to BURST, RAMP RUN/TRIG is engaged and STOP FREQ/BURST WIDTH is set to B with the vernier knob used to control burst width.

EXAMPLE: To obtain a burst of 5, 0.1msec pulses, 1msec apart, once every 2msec. Use same control settings as the previous example but with MODE to BURST and STOP FREQ/BURST WIDTH to B.5. BURST WIDTH may need to be adjusted slightly to get 5 pulses.

CAUTION: In both PULSE and BURST, the ramp must run slower than the main generator for proper operation.

2.3.5 SWEEP MODE

In sweep mode the ramp is used to sweep the frequency of the main generator. START FREQ sets the sweep start freq, STOP FREQ/BURST WIDTH is used to set the stop freq, RANGE sets the maximum possible frequency. The frequency may be swept up or down depending on the start and stop freq settings. RAMP TIME and RAMP VARIABLE is used to set the sweep period or sweep rate. A triggered sweep is available by disengaging RAMP RUN/TRIG and either applying an external trigger signal or using MAN. When sweep is triggered, the main generator sweeps from the start frequency to the stop frequency, returns to the start frequency and holds at that frequency. In this mode, the start frequency may be measured when the ramp is not triggered. Stop frequency can be measured by depressing RAMP CAL which causes the main generator to jump to the stop frequency and hold.

EXAMPLE: To sweep a sine wave from 50KHz to 30KHz at a rate of 1KHz per msec or in 20msec each time MAN is depressed. Set START FREQ to 0.5; STOP FREQ to 0.3; RANGE to 100KHz. MODE to SWEEP; FUNCTION to SINE; RAMP TIME to 10msec; adjust RAMP VARIABLE for the positive portion of RAMP SYNC OUT to be 20msec; RAMP RUN/TRIG released. Depress MAN.

An auxiliary ramp output is provided which can be used for driving an X:Y recorder when making frequency response plots.

Model 517 only

2.3.6 LOG FREQUENCY CONTROL

When LIN/LOG is depressed, the main generator frequency is controlled logarithmically instead of linearly, i.e., frequency is proportional to the exponential of the applied voltage. This is useful in frequency response plots when it is desired that the frequency scale be logarithmic. The auxiliary RAMP OUT can be used to drive the frequency scale.

Models 516 and 517 only

2.3.7 DC OUTPUT.

The instrument may be used as a source of DC voltage by placing it in a triggered square mode and not applying a trigger signal. AMPLITUDE and ATTENUATOR are used to set the voltage. Positive or negative voltage is obtained by selecting negative or positive square respectively.