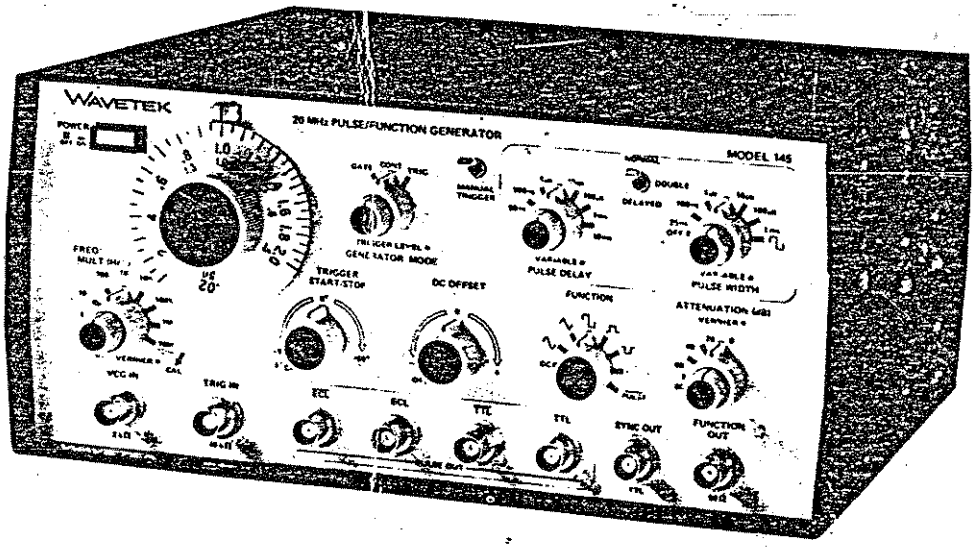
RUSSELL

INSTRUCTION MANUAL

MODEL 145
20 MHz FUNCTION/ PULSE GENERATOR



WAVETEK

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MODEL 145
20 MHz FUNCTION/ PULSE GENERATOR

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SECTION 1
GENERAL DESCRIPTION

1.1 THE MODEL 145

The Model 145 20 MHz Pulse/Function Generator has the versatility of output found in a function generator, plus the pulse characteristics of a pulse generator. It is a precision source of sine, triangle, balanced square, positive square and negative square waveforms, a source of dc levels and a source of normal and inverted pulses. All are front panel and remote control variable in frequency from 0.0001 Hz to 20 MHz (periods from 50 ns to 10,000s). Pulse widths are variable from 25 ns to 1 ms and pulse delays variable from 50 ns to 10 ms. Double pulses (two pulses per period) are also available with variable time between pulses. The logical complement of the pulse is selectable and either pulse or complement are output simultaneously as ECL, $\overline{\text{ECL}}$, TTL, $\overline{\text{TTL}}$ and variable amplitude and offset pulses.

The amplitude controllable output of either waveform or pulse can be varied up to 30 volts peak-to-peak (open circuit) and attenuated up to 80 dB. DC voltage or dc offset of signal is variable by front panel control and by external control between ±15 volts (open circuit). The outputs are also triggerable for one or multiple cycles by front panel switch or remote signal. A voltage representing generator frequency and a TTL level sync pulse at the frequency of the generator are auxiliary outputs.

1.2 SPECIFICATIONS

1.2.1 Versatility

Instrument operates as either a function generator or pulse generator.

1.2.2. Function Generator

Waveforms
Selectable sine ∿ , square ⊓ , triangle △ , positive square ⎍ , negative square ⎎ and dc. TTL sync pulse and fixed amplitude pulses of TTL, $\overline{\text{TTL}}$, ECL and $\overline{\text{ECL}}$, all simultaneously available with function output.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator is quiescent until triggered by an external signal or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of the gate signal.

Frequency Range
0.0001 Hz to 20 MHz in 10 overlapping ranges with approximately 1% vernier control.

Function Output
∿, ⊓ , △ selectable and variable to 30V p-p (15V p-p into 50Ω). ⎍ , ⎎ , to 15 Vp (7.5 Vp into 50Ω). All waveforms and dc can supply 150 mA peak current and may be attenuated to 60 dB in 20 dB steps with an additional 20 dB vernier.

DC Output and DC Offset
Selectable thru FUNCTION OUT output. Controlled by front panel control or by applying an external voltage. Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω). External offset sensitivity approximately −1 V/V with output into open circuit. DC offset and output waveform attenuated proportionately by the 60 dB output attenuator.

Sync Output
A TTL level pulse. Will drive 50Ω termination.

GCV — Generator Controlled Voltage
At GCV OUT connector, a 0 to +2V signal proportional to generator frequency. 600Ω source impedance.

VCG — Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to 2 volt signal to VCG IN connector. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs.
Linearity:
±0.2% for 10 Hz to 100 kHz.
±0.75% for 0.001 Hz to 2 MHz.
Impedance: 2 kΩ.

Trigger and Gate
Input Range: 1V p-p to ±10V.

10 kΩ, 33 pF.
25 ns minimum.
Rate: 10 MHz maximum.
Triggered Signal Start/Stop Point (sine and tri-
Approximately −90° to +90° to 2 MHz.

quency Precision

ry
range from X .01 Hz to X 1 MHz.
range on X 10 MHz.

etry
variation less than:
.001 Hz to 200 kHz
20 Hz to 20 kHz

plitude Precision

Change With Frequency
n less than:
0.001 Hz to 200 kHz
200 kHz to 2 MHz
2 to 20 MHz

ator Accuracy
0 dB step at 2 kHz.

veform Characteristics

ion
< 100 Hz to X 10 kHz.
< .01 to X 10 Hz and X 100 kHz.
s 34 dB below fundamental on X 1 MHz.
s 26 dB below fundamental on X 10 MHz.

Rise/Fall Times
ON OUT < 20 ns for 15V p-p output into 50Ω

se Generator

ts
plitude pulse, and simultaneous fixed ECL, nd $\overline{\text{TTL}}$ pulses and TTL sync pulse. All outputs Ω terminations.

Modes
triggered and gated plus the following.
e: Adjustable width pulse in phase with sync

se: Pulse delayed with respect to normal pulse. nd pulse width adjustable.
e: Two pulses for every period. Time between ulse width adjustable. Minimum period 100 ns.

Pulse Period Range
50 ns to 10,000s in 10 overlapping ranges with approximately 1% vernier control.

Pulse Width
25 ns to 1 ms in 5 overlapping ranges with vernier control. Includes OFF and square wave.

Pulse Delay
50 ns to 10 ms in 6 overlapping ranges with vernier control.

Duty Cycle
Duty cycles to 70% for periods > 100 ns (< 10 MHz); for periods < 100 ns (> 10 MHz) duty cycles are approximately 50%.

Function Output
Variable to 30V p-p (15V p-p into 50Ω). DC offset and attenuation are same as for function generator.

Pulse Rise/Fall Times
At FUNCTION OUT, < 20 ns for 15V p-p output into 50Ω load.

1.2.7 General

Stability
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.
Percentages apply to amplitude, frequency and dc offset.

Environmental
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to 50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 14.5 cm (5¾ in.) high; 27.3 cm (10¾ in.) deep.

Weight
5 kg (11 lb) net; 6.6 kg (14½ lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 30 watts.

NOTE

All specifications apply from 0.1 to 2.0 on frequency dial when FUNCTION OUT output is at maximum and 50Ω terminated. Function generator specifications apply when PULSE WIDTH control is OFF.

SECTION 2
INSTALLATION

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, autotransformers, 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 with the power transformer connected for operation on a 108 to 132 Vac line supply and with a 0.5 amp slow blow fuse.

Conversion to other input voltages requires a change in rear panel fuse-holder voltage card position and slow blow fuse according to the following table and procedure.

Card Position	Input Vac	Fuse
100	90 to 105	0.5 amp
120	108 to 126	0.5 amp
220	198 to 231	0.25 amp
240	216 to 252	0.25 amp

1. Open fuse holder cover door and rotate fuse pull to left to remove the fuse.
2. Select operating voltage by orienting the printed circuit board to position the desired voltage on the top left side. Push the board firmly into its module slot.
3. Rotate the fuse-pull back into the normal position and insert the correct fuse into the fuse holder. Close the cover door.
4. Connect the ac line cord to the mating connector at the rear of the unit and the power source.

2.2.2 Signal Connections

Use 3 foot RG58U 50Ω shielded cables equipped with female 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 female BNC connectors, a coax tee connector and a function generator are required for this procedure.

Preset the generator front panel controls as follows:

Set up the oscilloscope, Model 145 and external generator as shown in figure 2-1.

Control	Position
Dial	1.0
GENERATOR MODE	CONT
TRIGGER LEVEL	9 o'clock
PULSE DELAY	1 μs ‖ 10 μs
PULSE DELAY VARIABLE	12 o'clock
NORMAL/DOUBLE/DELAYED	NORMAL
PULSE WIDTH	OFF
PULSE WIDTH VARIABLE	12 o'clock
ATTENUATION	0
ATTENUATION VERNIER	Full cw
FUNCTION	⊓
DC OFFSET	OFF
TRIGGER START/STOP	0° CAL
FREQ/PERIOD MULT	1K
VERNIER	Full cw

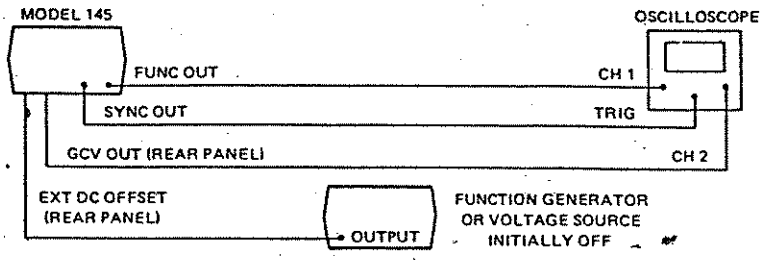


Figure 2-1. Initial Setup

Table 2-1. Acceptance Procedure

ep	Control	Position/Operation	Observe
1	POWER	ON	1 kHz square wave.
2	Dial	Rotate dial. Return to 1.0.	Rotation ccw increases frequency of square on one channel and dc level on other channel; cw decreases frequency and dc level.
3	FREQ/PERIOD MULT	Rotate switch. Return to 1K.	Rotation cw increases frequency; ccw decreases frequency (dc level not affected).
4	VERNIER	Rotate ccw. Return to CAL.	Rotation ccw gives a small decrease in frequency.
5	ATTENUATION	Rotate ccw. Return to 0.	Rotation ccw reduces square wave amplitude.
6	ATTENUATION VERNIER	Rotate ccw.	Square wave amplitude decreases.
7	DC OFFSET	Rotate cw. Return to OFF.	Square wave is immediately offset below previous level; then waveform moves up to a positive level. OFF returns waveform to original position. (Clipping occurs at ±15V.)
8	Function Generator or Voltage Source	Vary input voltage.	Waveform dc level varies.
	Remove EXT DC OFFSET IN cable and connect to VCG IN connector. Remove GCV OUT cable.		
9	Function Generator or Voltage Source	Vary input voltage; then disconnect input.	Frequency increases with increased voltage, decreases with decreased voltage.
0	ATTENUATION VERNIER	Rotate cw.	– – –
1	FUNCTION	Rotate to DC, ∿, ∿, ⊓, ⊓, ⊔, then ∿.	Note dc level on scope. ∿, ∿ and ⊓ should be centered on dc level. ⊓ should rest on dc level, ⊔ should rise to dc level.
2	GENERATOR MODE	GATE	A dc level.
3	MANUAL TRIG	Press down.	A series of sine waves.

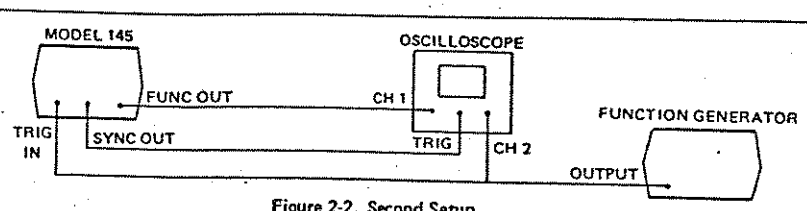


Figure 2-2. Second Setup

Table 2-1. Acceptance Procedure (Continued)

Step	Control	Position/Operation	Observe
	Set up a trigger source as shown in figure 2-2. Trigger on triangle waveform. Set trigger source at 100 Hz ∿.		
14	TRIGGER LEVEL	Rotate knob. Set for several cycles.	Knob varies number of cycles gated.
15	GENERATOR MODE	TRIG	One cycle per trigger cycle.
16	TRIGGER START/STOP	Rotate knob, then to 0° CAL.	CW starts sine wave at +90°; ccw starts sine wave at −90°. Fully cw gives continuous sine waves.
	NOTE: Select square wave on trigger source.		
17	FUNCTION	PULSE	– – –
18	PULSE WIDTH	Turn cw to 100 μs ⫿ 1 ms.	Pulse appears.
19	PULSE WIDTH VARIABLE	Rotate, then to 12 o'clock	CW increases pulse width; ccw decreases pulse width.
20	FUNCTION	PULSE, then $\overline{\text{PULSE}}$.	Pulse direction reverses; dc levels remain the same values.
21	NORMAL/DOUBLE/ DELAYED Switch	DELAYED	– – –
22	PULSE DELAYED	10 μs ⫿ 100 μs	– – –
23	PULSE DELAYED VARIABLE	Turn knob.	Pulse moves horizontally.
24	NORMAL/DOUBLE/ DELAYED Switch	DOUBLE	– – –
25	PULSE DELAYED VARIABLE	Turn knob to resolve two pulses.	– – –

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 POWER Switch

Turns generator on and off.

② Frequency Dial

Settings under the dial index mark multiplied by ⑰ determine the output signal frequency. The dial calibration marks correspond to the frequency (black) numbers only. The period (grey) numbers are approximations only. Refer to table 3-1 for quick period/frequency conversion. The frequency can be varied by the vernier ⑰ and the VCG signal ⑯.

③ GENERATOR MODE Switch

Selects one of the following three modes.

CONT — Continuous output at FUNCTION OUT, SYNC OUT and, if PULSE WIDTH is on, PULSE OUT connectors.

TRIG — DC level output at all six output connectors until the generator is triggered by MANUAL TRIGGER switch or with a signal at the TRIG IN connector. When triggered, the generator output is one cycle of waveform or one pulse period followed by a dc level.

GATE — As for TRIG except the output is continuous for the duration of the trigger signal at TRIG IN. The last cycle or period started is completed.

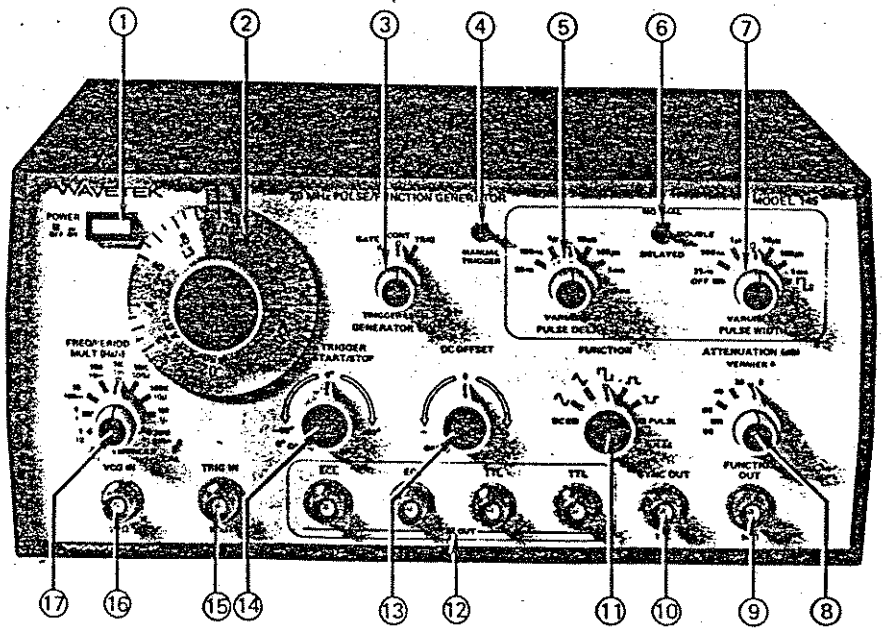


Figure 3-1. Controls and Connectors

Table 3-1. Period to Frequency Conversion

Converted Frequency Dial Values
(Based on f = 1/T where ⌐⌙)
|←T→|

Freq	Time	Freq	Time	Freq
2	2.3	.44	4.1	.24
1.67	2.4	.42	4.2	.24
1.43	2.5	.4	4.3	.23
1.25	2.6	.39	4.4	.23
1.11	2.7	.37	4.5	.22
1	2.8	.36	4.6	.22
.91	2.9	.35	4.7	.21
.83	3	.33	4.8	.21
.77	3.1	.32	4.9	.2
.71	3.2	.31	5	.2
.67	3.3	.3		
.63	3.4	.29		
.59	3.5	.29		
.56	3.6	.28		
.53	3.7	.27		
.5	3.8	.26		
.48	3.9	.26		
.46	4	.25		

Symbols
M = 10^6
k = 10^3
m = 10^{-3}
μ = 10^{-6}
n = 10^{-9}

ıe dial calibration marks when setting period time, ɟ must be converted to frequency.

Set generator for a 23 μs pulse period.

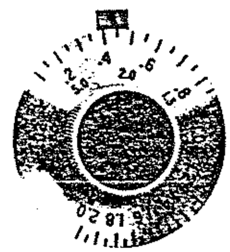
1. Find the number 23 (or .23, 2.3, etc.) in the Time column. Note its form and Freq equivalent.

Time	Freq
2.3	.44

2. Express 23 μs using the 2.3 form: 2.3 X 10^{-5}.

3. Set FREQ/PERIOD MULT switch to the equivalent of 10^{-5}: 10μ.

4. Set the dial to the frequency equivalent of 2.3: .44.



NOTE: Refer to paragraph 1.2 for dial accuracy.

TRIGGER LEVEL Control

Determines the level at which the input trigger signal at the TRIG IN connector (15) is accepted as a trigger or gate in the trigger and gate modes. The trigger level can be varied from fully cw, where a positive-going excursion thru approximately −10V is a trigger, to fully ccw, where a positive-going excursion thru approximately +10V level is a trigger.

MANUAL TRIGGER Switch

Triggers or gates the output signal when GENERATOR MODE switch (3) is at TRIG or GATE. In trigger mode, one cycle is output when the switch is pressed. In gate mode, cycles are continuously output as long as the switch is held down.

NOTE

Set TRIGGER LEVEL (3) fully ccw.

(5) PULSE DELAY Control

When NORMAL/DOUBLE/DELAYED switch (6) is at DELAYED, PULSE DELAY selects one of six time ranges for delay of pulse with respect to the undelayed signal leading edge. When (6) is at DOUBLE, PULSE DELAY selects the time between double pulse leading edges.

VARIABLE Control

Inner knob selects delay time within the range selected by the outer knob.

(6) NORMAL/DOUBLE/DELAYED Switch

Selects the pulse parameters as follows:

NORMAL – Pulse of width and frequency set by front panel switches appears at TTL, $\overline{TTL}$, ECL,

$\overline{\text{ECL}}$ and FUNCTION OUT connectors with synchronous leading edges to the sync pulse (10) trailing edge.

DOUBLE – As NORMAL plus an additional pulse in each pulse period delayed from the first pulse leading edge by time (5).

DELAYED – As NORMAL, except the pulse leading edge is delayed from the normal pulse leading edge by time (5).

(7) PULSE WIDTH Control

Outer knob selects the range for the width of all pulses except sync. Has OFF and square wave detents. When in OFF position, the 145 has no PULSE OUT outputs. The square wave (⊓⊔) detent is normally used to check the 50% period point; PULSE DELAY (5) has no effect. For the best square wave output, set FUNCTION (11) to ⊓⊔ .

VARIABLE Control

Inner knob selects pulse width within the range selected by the outer knob.

(8) ATTENUATION Control

Outer knob reduces output voltage level of all outputs at FUNCTION OUT with increasing steps of attenuation.

VERNIER Control

Inner knob is a 20 dB vernier which controls the output within the steps of the outer knob. DC and offset voltages are not affected by this control.

(9) FUNCTION OUT Connector

The only output for the functions other than fixed amplitude pulse. At this output the functions and pulses are controllable in amplitude and dc offset; the other outputs furnish fixed amplitude pulses only.

(10) SYNC OUT Connector

Furnishes a TTL pulse for each cycle or period of the generator. To be used for scope or similar synchronization. Refer to paragraph 3.2.1.4 for conversion to an ECL sync pulse.

(11) FUNCTION Switch

Selects one of eight output signals: dc, waveforms or pulses.

(12) PULSE OUT

Four standard pulses for logic circuits as follows (PULSE WIDTH (7) must be other than OFF):

TTL Connector – Furnishes a transistor-transistor-logic level pulse whose occurence and duration are controllable. Levels are typically < 0.5V quiescent, > 2.0V active into a 50Ω termination.

$\overline{\text{TTL}}$ Connector – Same as TTL connector except active and quiescent levels are reversed.

ECL Connector – Furnishes an emitter-coupled logic level pulse with controllable occurence and duration. Levels are typically −1.8V quiescent, −0.9V active into a 50Ω termination connected to −2 volts. Refer to paragraph 3.2.1.3 for ECL loading instructions.

$\overline{\text{ECL}}$ Connector – Furnishes an output like the ECL output, except active and quiescent levels are reversed.

(13) DC OFFSET Control

Offsets the waveform or dc level at (9) from −15V to +15V (open circuit; ±7.5V into 50Ω). An OFF position ensures no offset.

(14) TRIGGER START/STOP Control

Sets the start and stop point of the selected waveform (sine or triangle only) appearing at (9). Usually used in the trigger mode and in combination with (13) to create desired waveforms. 0° CAL position ensures conventional waveforms symmetrical about 0 Vdc.

(15) TRIG IN Connector

Accepts a 1V p-p to 10V external signal to trigger the generator. (Up to ±50V will not damage circuitry.) Triggers on rising edge of input which crosses TRIGGER LEVEL (3) setting from negative to positive.

(16) VCG IN Connector

Accepts 0 to +2V ac or dc voltages to vary up to 1000:1 the frequency and period of the outputs.

upper and lower limits are defined by the imum and minimum dial (2) settings multi- f by (17) . VCG input will not drive the gen- or beyond the normal dial limits of a range.

Q/PERIOD MULT Switch

outer knob selects one of ten frequency/period ipliers for the dial (2) setting. Frequency, period, are noted at each setting.

:NER Control

ne adjustment of the frequency dial (2) ng.

DC OFFSET IN Connector (Rear Panel)

ied voltage offsets the selected waveform rly. Offset is 1V for each −1V applied with ut connected into an open circuit. Maximum t is ±7.5V. Offset is affected by the attenua- (8)

OUT Connector (Rear Panel)

connector gives a 0 to +2V signal propor- l to the frequency of the generator within given range. The signal can be used as the ve for X-Y recorders.

TION

nitial checkout in Section 2 for the feel of the ny questions concerning individual controls s may be answered in paragraph 3.1.

l Termination

JNCTION OUT Signal

termination, or loading, of the generator con- ssary for its specified operation. For example,

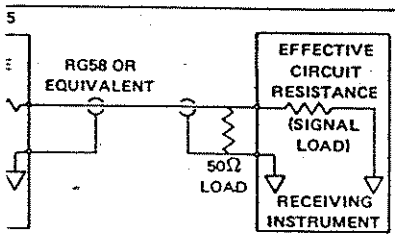


Figure 3-2. Signal Termination

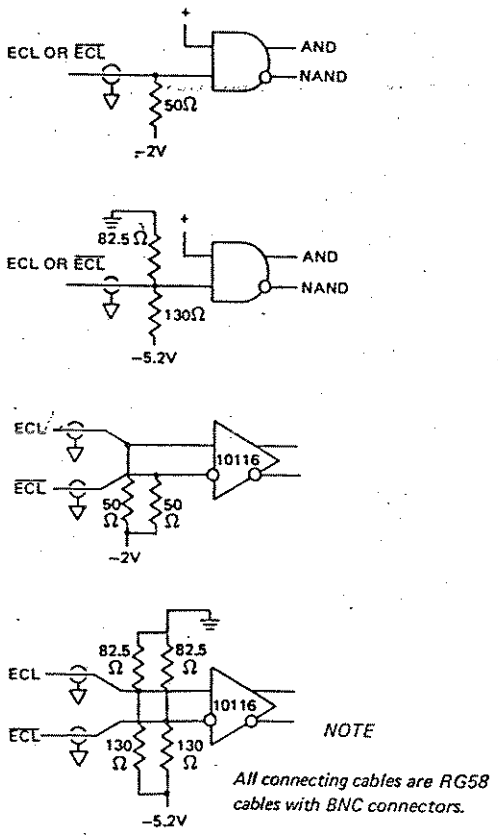
the proper termination of the main output is shown in figure 3-2. Placing the 50Ω terminator, or 50Ω resistance, in parallel with a higher impedance matches the receiving instrument input impedance to the generator output impedance, thereby minimizing signal reflection or power loss on the line due to phase angle mismatch.

3.2.1.2 TTL PULSE OUT Signals

The TTL and $\overline{\text{TTL}}$ PULSE OUT outputs can drive 50Ω and higher impedance terminations.

3.2.1.3 ECL PULSE OUT Signals

The ECL and $\overline{\text{ECL}}$ PULSE OUT outputs are driven by MC10124's. The signals must be properly terminated at the point that they enter an external ECL circuit. Several connection possibilities are shown in figure 3-3.



NOTE

All connecting cables are RG58 cables with BNC connectors.

Figure 3-3. ECL Terminations

3.2.1.4 Conversion of SYNC OUT TTL to ECL

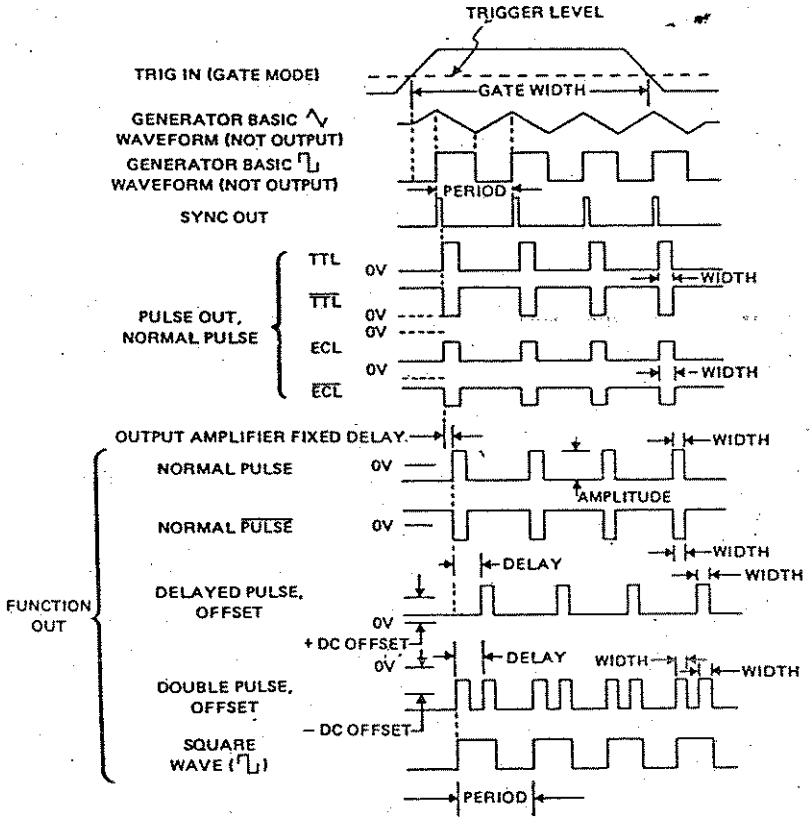
The SYNC OUT TTL pulse can be converted to an ECL pulse by rerouting two jumpers on the trigger/pulse printed circuit board. Disconnect jumper at E24 and connect to E25. Disconnect jumper at E27 and connect to E28. The two jumpers are correctly routed from E25 to E26 and from E28 to E29 for ECL operation. Instrument disassembly is covered in paragraph 5.3.

3.2.2 Pulses

See figure 3-4 for definition of controllable pulse characteristics.

3.2.3 Waveforms

See figure 3-5 for definition of controllable waveform characteristics.



NOTES

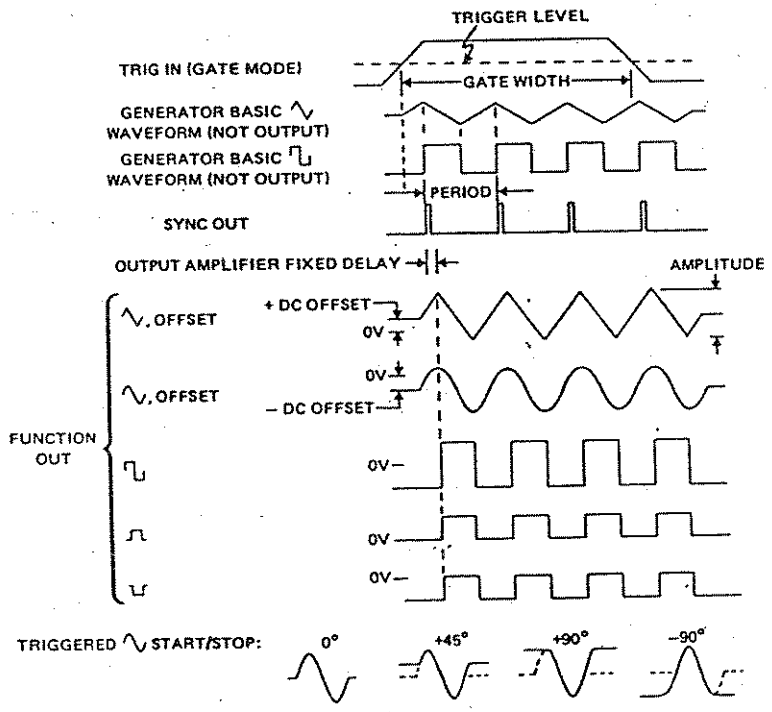
1. *Not Shown: TTL, $\overline{TTL}$, ECL, $\overline{ECL}$ double pulse, delayed pulse and $\overline{pulse}$.*
2. *Pulse period is determined by the generator frequency setting unless in trigger mode, in which case it is determined by trigger frequency.*
3. *In trigger mode, just one period is generated for each trigger pulse.*
4. *DC offset plus pulse peak voltage > | 7.5V | causes pulse clipping.*

Figure 3-4. Pulse Characteristics

age Controlled Function Generator Operation

a voltage controlled function generator (VCG) inually controlled function generator, only the thin particular ranges is additionally controlled (±2V excursions) injected at the VCG IN con- he frequency dial to a reference from which / is to be voltage controlled.

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 dial at desired center frequency. Do not exceed the maximum dial range of the selected frequency range.



-iod is controlled by the generator frequency setting.

trigger mode, just one period is generated for each trigger pulse.

: offset plus peak waveform voltage > | 7.5V | causes waveform clipping.

Figure 3-5. Waveform Characteristics

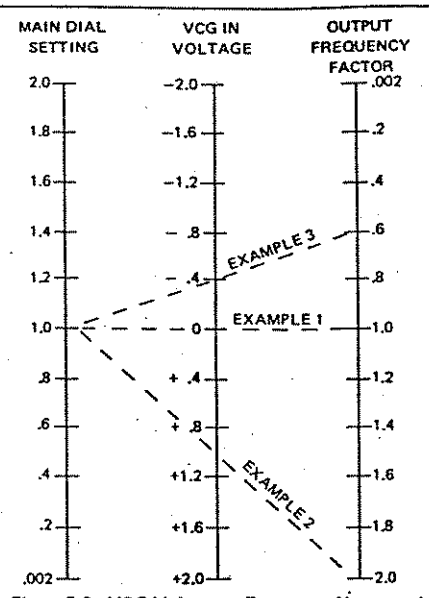


Figure 3-6. VCG Voltage-to-Frequency Nomograph

Figure 3-6 is a nomograph with examples of dial and voltage effects. Example 1 shows that with 0V VCG input, frequency is as determined by the main dial setting, 1.0 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.)

NOTE

The frequency vernier must be rotated fully ccw for 1000:1 range.

Nonlinear operation results when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range setting (2 times the multiplier setting) or in the other direction, 1/1000th of the range setting.

The up to 1000:1 VCG sweep of the generator frequencies available in each range results from a 2V excursion at the VCG IN connector. With the frequency dial set to 2.0, excursions between −2V and 0V at VCG IN provide the up to 1000:1 frequency sweep. With the dial set to .002, excursions between 0V and +2V at VCG IN provide the up to 1000:1 sweep within the set frequency range.

3.2.5 Delay of Triggered Pulse

Additional pulse delay is available in triggered mode. Not only is the PULSE DELAY usable, but the ¼ cycle delay between trigger acceptance and sync pulse shown in figure 3-7 can also be variable delay.

Merely determine the delay desired and apply this formula for the frequency setting:

$$\text{Frequency in Hz} = \frac{1}{(4 \cdot \text{delay in seconds})}$$

Then, adjust the pulse width for your desired pulse. Practical range with the frequency dial and multiplier is 1 ms to 42 minutes. Delay control range is 50 ns to 10 ms.

Frequency vernier and start/stop control also affect the delay. So, for accurate frequency dial control of delay, set these at their cal positions.

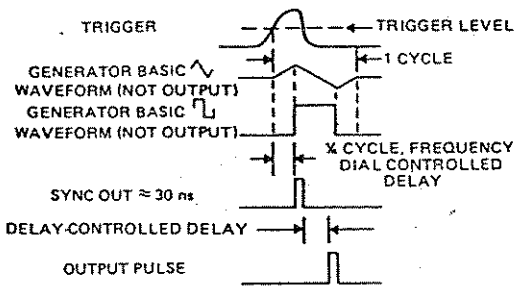


Figure 3-7. Pulse Delay From Trigger