

SUPPLIED AND SERVICED BY



PHONE (04) 677016

TELEX NZ 3341

P.O. BOX 35097

NAENAE NEW ZEALAND

INSTRUCTION MANUAL

MODEL 145
**20 MHz FUNCTION/
PULSE GENERATOR**

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO WAVETEK. THE INFORMATION IN THIS DOCUMENT IS NOT TO BE USED OR DUPLICATED IN ANY MANNER WITHOUT THE PRIOR APPROVAL IN WRITING OF WAVETEK.

WAVETEK®

SAN DIEGO

9045 Balboa Ave., San Diego, Calif. 92123
P. O. Box 651, San Diego, California 92112
Tel 714/279-2200 TWX 910-335-2007

Rev C— 7/77

N 7 REPRESENTATIVE

CONTENTS

SECTION 1	GENERAL DESCRIPTION	
	1.1 THE MODEL 145	1-1
	1.2 SPECIFICATIONS	1-1
SECTION 2	INSTALLATION	
	2.1 MECHANICAL INSTALLATION	2-1
	2.2 ELECTRICAL INSTALLATION	2-1
	2.3 ELECTRICAL ACCEPTANCE CHECK	2-1
SECTION 3	OPERATION	
	3.1 CONTROLS AND CONNECTIONS	3-1
	3.2 OPERATION	3-4
	3.2.1 Signal Termination	3-4
	3.2.1.1 FUNCTION OUT Signal	3-4
	3.2.1.2 TTL PULSE OUT Signals	3-4
	3.2.1.3 ECL PULSE OUT Signals	3-4
	3.2.1.4 Conversion of SYNC OUT TTL to ECL	3-5
	3.2.2 Pulses	3-5
	3.2.3 Waveforms	3-5
	3.2.4 Voltage Controlled Function Generator Operation	3-6
	3.2.5 Delay of Triggered Pulse	3-7
SECTION 4	CIRCUIT DESCRIPTION	
	4.1 BASIC WAVEFORM DEVELOPMENT	4-1
	4.2 AMPLITUDE OFFSET AND ATTENUATION	4-2
	4.3 TRIGGER AND GATE CONTROL	4-2
	4.4 PULSE OUTPUTS	4-2
	4.5 WIDTH AND DELAY ONE-SHOTS	4-3
SECTION 5	CALIBRATION	
	5.1 FACTORY REPAIR	5-1
	5.2 REQUIRED TEST EQUIPMENT	5-1
	5.3 REMOVING GENERATOR COVERS	5-1
	5.4 CALIBRATION	5-1
SECTION 6	TROUBLESHOOTING	
	6.1 FACTORY REPAIR	6-1
	6.2 TROUBLESHOOTING CHARTS	6-1
	6.3 TROUBLESHOOTING INDIVIDUAL COMPONENTS	6-1
SECTION 7	PARTS AND SCHEMATICS	

1

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 \sim , square \square , triangle ∇ , positive square \sqcap , negative square \sqcup 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

\sim , \square , ∇ selectable and variable to 30V p-p (15V p-p into 50 Ω). \sqcap , \sqcup , to 15 Vp (7.5 Vp into 50 Ω). 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 50 Ω) with signal peak plus offset limited to ± 15 Vdc (± 7.5 Vdc into 50 Ω). 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 50 Ω termination.

GCV — Generator Controlled Voltage

At GCV OUT connector, a 0 to +2V signal proportional to generator frequency. 600 Ω 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:

$\pm 0.2\%$ for 10 Hz to 100 kHz.

$\pm 0.75\%$ for 0.001 Hz to 2 MHz.

Impedance: 2 k Ω .

Trigger and Gate

Input Range: 1V p-p to ± 10 V.

2

SECTION

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

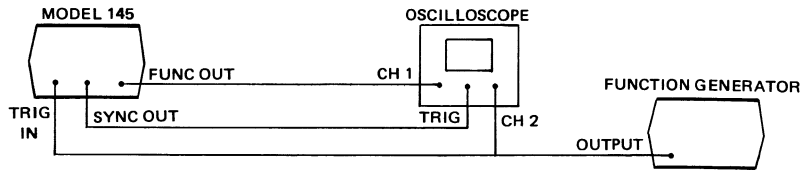


Figure 2-2. Second Setup

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 \wedge .			
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.
<i>NOTE: Select square wave on trigger source.</i>			
17	FUNCTION	PULSE	---
18	PULSE WIDTH	Turn cw to 100 μ s 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 <u>PULSE</u> .	Pulse direction reverses; dc levels remain the same values.
21	NORMAL/DOUBLE/ DELAYED Switch	DELAYED	---
22	PULSE DELAYED	10 μ s 100 μ s	---
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.	---

3

SECTION

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.

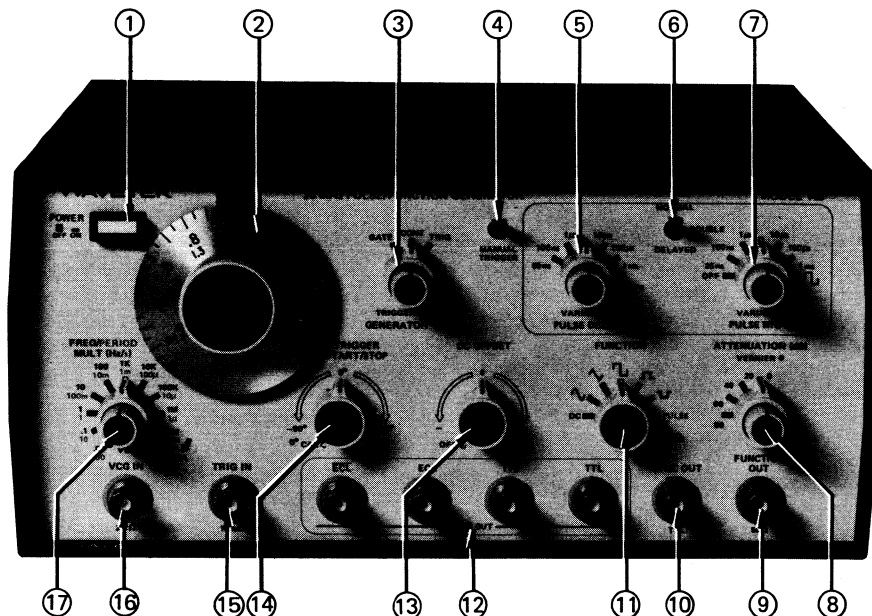


Figure 3-1. Controls and Connectors

$\overline{\text{ECL}}$ 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 occurrence 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 occurrence 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.

3.2.1.4 Conversion of SYNC OUT TTL to ECL

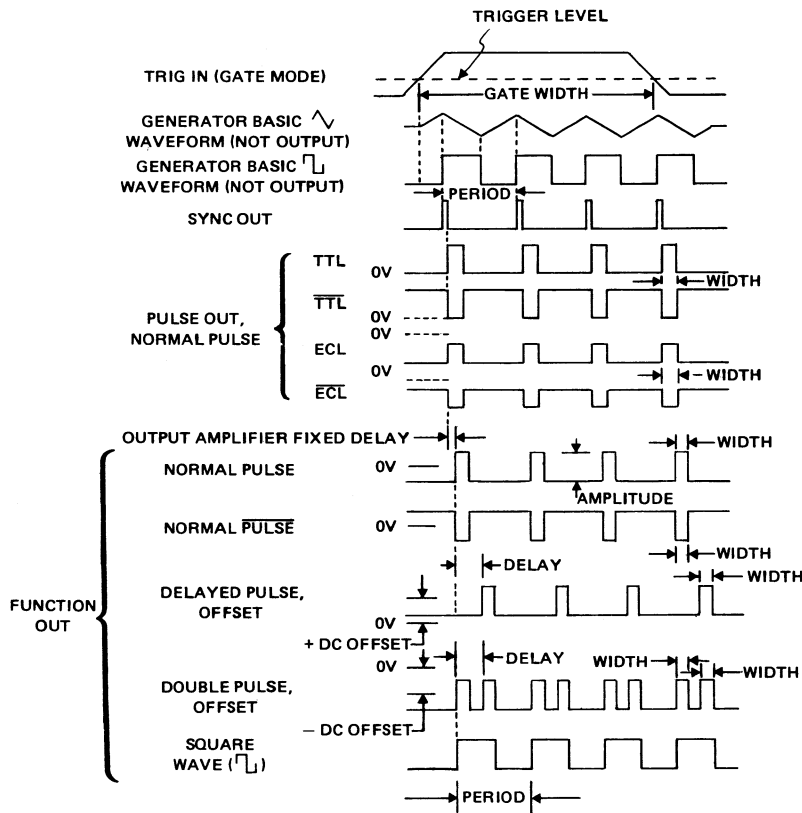
The SYNC OUT TTL pulse can be converted to an ECL pulse by rerouting two jumpers on the trigger/pulse printed circuit board. Disconnect jumper at E24 and connect to E25. Disconnect jumper at E27 and connect to E28. The two jumpers are correctly routed from E25 to E26 and from E28 to E29 for ECL operation. 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: \overline{TTL} , $\overline{\overline{TTL}}$, \overline{ECL} , $\overline{\overline{ECL}}$ double pulse, delayed pulse and 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