

INSTRUCTION MANUAL
MODEL 187
**4 MHz PULSE/
FUNCTION GENERATOR**

WAVETEK

WAVETEK SAN DIEGO, INC.

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SAFETY

This instrument is wired for earth grounding via the facility power wiring. Do not bypass earth grounding with two wire extension cords, plug adapters, etc.

BEFORE PLUGGING IN the instrument, comply with installation instructions.

MAINTENANCE may require power on with the instrument covers removed. This should be done only by qualified personnel aware of the electrical hazards.

The instrument power receptical is connected to the instrument safety earth terminal with a green/yellow wire. Do not alter this connection. (Reference:  or  stamped inside the rear panel near the safety earth terminal.)

WARNING notes call attention to possible injury or death hazards in subsequent operations.

CAUTION notes call attention to possible equipment damage in subsequent operations.

SECTION 1

GENERAL DESCRIPTION

1.1 THE MODEL 187

The Wavetek Model 187, a 4 MHz Pulse/Function Generator, is a precision source of sine, triangle, square and pulse waveforms plus dc voltage. All waveforms are front panel variable from 4 mHz to 4 MHz and can be frequency modulated and swept with an external signal. Variable width and delay, single or double pulses can be output inverted or normal. Amplitude of the waveforms is variable from 10V peak-to-peak into 50 Ω 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. A TTL level signal at generator frequency is simultaneous with the waveform outputs for synchronization.

1.2 SPECIFICATIONS

1.2.1 Versatility

Instrument operates as either a function generator or pulse generator.

Functions

Sine \sim ; triangle ∇ ; square \square ; fixed baseline normal pulses \uparrow , \downarrow , \square and inverted pulses $\overline{\uparrow}$, $\overline{\downarrow}$, $\overline{\square}$ 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.

Frequency Range

0.004 Hz to 4 MHz in 7 overlapping decade ranges:

$\times 1$	0.004 to 4 Hz
$\times 10$	0.04 to 40 Hz
$\times 100$	0.4 to 400 Hz
$\times 1K$	4 Hz to 4 kHz
$\times 10K$	40 Hz to 40 kHz
$\times 100K$	400 Hz to 400 kHz
$\times 1M$	4 kHz to 4 MHz

Main Outputs (50 Ω OUT)

\sim , ∇ , \square , \uparrow , \downarrow selectable and variable to 20 Vp-p (10 Vp-p into 50 Ω) HI output, and to 2 Vp-p (1 Vp-p into 50 Ω) LO output. $\overline{\uparrow}$, $\overline{\downarrow}$, $\overline{\square}$ selectable and variable from fixed baseline to 10 Vp-p (5 Vp-p into 50 Ω) HI output, and to 1 Vp-p (0.5 Vp-p into 50 Ω) LO output. Both outputs varied with a 30 dB vernier. Peak output current is 100 mA maximum (HI output). Source impedance is 50 Ω .

DC Offset and DC Output

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

Pulse Modes

Square \square : 50% duty cycle.

Pulse: Adjustable width pulse in phase with sync signal.

Delayed Pulse: Pulse delayed with respect to sync out. Pulse delay and pulse width adjustable.

Double Pulse: Time between pulses and time of pulse width adjustable. Second pulse not generated if delay less than width.

Pulse Period Range

250 ns to 250s in 7 overlapping decade ranges.

Pulse Width

100 ns to 100 ms in 3 ranges with vernier control. Has no effect in □ mode.

Pulse Delay

100 ns to 100 ms in 3 overlapping ranges with vernier control.

Sync Output

TTL pulse (50% ±10% duty cycle at generator frequency). Drives up to 20 TTL loads.

VCG—Voltage Controlled Generator

Up to 1000:1 frequency change with external 0 to ±4V signal. Upper and lower frequencies limited to maximum and minimum of selected range.

Slew Rate: 2% of range per μs.

Linearity: ±0.5% through ×100K range; ±2% on ×1M range.

Input Impedance: 2 kΩ.

Trigger and Gate

Input: TTL compatible levels.

Pulse Width: 50 ns minimum.

Repetition Rate: 4 MHz maximum.

1.2.2 Frequency Precision**Dial Accuracy**

±5% of full scale.

Time Symmetry

Duty cycle variation in □ mode, from 0.2 to 4.0 on dial, less than:

±1% to 100 kHz;

±5% to 4 MHz.

1.2.3 Amplitude Precision

Sine variation with frequency less than:

±0.2 dB on all ranges through ×100K, referenced to 1 kHz;

±1.0 dB to 4 MHz.

1.2.4 Function Characteristics**Sine Distortion**

Less than:

0.5% on ×1K and ×10K ranges; 1% on ×1, ×10, ×100 and ×100K ranges.

All harmonics 25 dB below fundamental on ×1M range.

Triangle Linearity

Greater than 99% to 200 kHz.

Pulse Rise and Fall Time

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

1.2.5 General**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; 13.3 cm (5¼ in.) high; 26.7 cm (10½ in.) deep.

Weight

3.5 kg (7.7 lb) net; 5 kg (11.2 lb) shipping.

Power

90 to 128V or 180 to 256V, 48 to 66 Hz; less than 30 watts.

NOTE

All specifications apply for dial between 0.2 to 4.0; amplitude at 10 Vp-p from HI output into 50Ω termination.

SECTION 2

INITIAL PREPARATION

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 180 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 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, two 50Ω terminations, a coax tee connector and an additional function generator are required for this procedure.

Preset the generator front panel controls as follows:

Control	Position
Dial	2.0
FREQUENCY MULTIPLIER	× 1K
MODE	CONT (released)
FUNCTION	
DC OFFSET	OFF
AMPLITUDE	MAX
DELAY	12 o'clock
DELAY RANGE	10 μs-1 ms
WIDTH	12 o'clock
WIDTH RANGE	10 μs-1 ms
PULSE MODE	
PULSE/SQUARE OUTPUT	NORM 

Set up the oscilloscope, Model 187 and external function generator as shown in figure 2-1 and perform the steps in table 2-1.

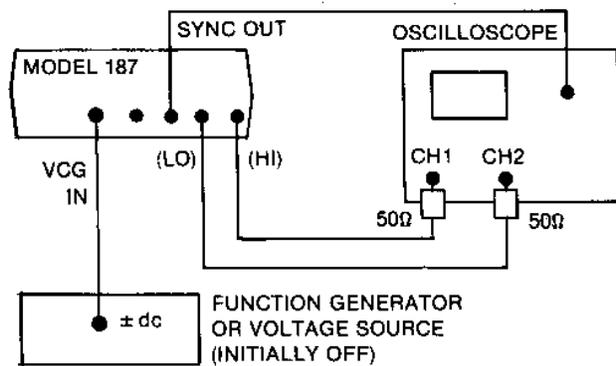


Figure 2-1. First Setup

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 with - 30 dB lowest possible amplitude. 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.

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.

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 \square ; 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 returns 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 \sim and \sim .	Observe \sim and \sim waveforms.
9	MODE	Gate (depress CONT, release TRIG/GATE).	A dc level near zero volts.

Table 2-1. Initial Checkout (Continued)

Step	Control	Position/Operation	Observation
10	MANUAL TRIGGER	Press and hold.	Continuous \sim .
<i>Set up trigger source as shown in figure 2-2. Set trigger source for 100 Hz TTL signal.</i>			
11	---	---	\sim gated on during positive portion of TTL signal on CH2.
12	MODE	Trigger (depress TRIG/GATE)	One \sim cycle during positive portion of TTL signal on CH2.
13		Continuous (release CONT)	
14	FUNCTION	Pulse (depress \square).	Square wave.
15	PULSE MODE	Depress DLY OFF	
16	WIDTH	Vary, return to 12 o'clock	Pulse width varies.
17	AMPLITUDE	Vary, return to MAX.	Upper and lower levels vary.
18	PULSE/SQUARE OUTPUT	Invert pulse (depress NORM/INV)	Phase inversion of pulse relative to sync signal.
19		Release NORM/INV	
20		Depress \square .	
21	AMPLITUDE	Vary, return to MAX.	Upper level varies, lower level remains fixed.
22	PULSE/SQUARE OUTPUT	Depress \square	Negative offset pulse.

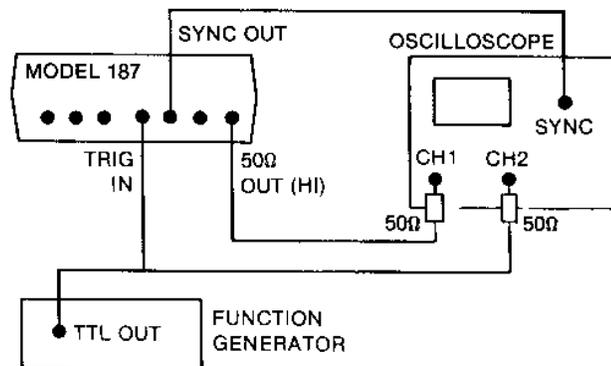


Figure 2-2. Second Setup

Table 2-1. Initial Checkout (Continued)

Step	Control	Position/Operation	Observation
23	AMPLITUDE	Vary, return to MAX.	Lower level varies, upper level remains fixed.
24	PULSE MODE	Depress DLY ON	Pulse position shifts relative to sync signal.
25		Depress DBL PULSE	
26	WIDTH	Decrease (ccw) <i>NOTE: Pulse width must be less than pulse delay.</i>	Double pulses displayed.
27	DELAY Vernier	Vary, return to 12 o'clock.	Double pulse separation varies.
28	WIDTH	Vary.	Width of all pulses vary.



SECTION 3

OPERATION

3.1 CONTROLS AND CONNECTORS

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 voltage at 17 and multiplied by 2 to determine the output signal frequency.
- 2 **Frequency Multiplier**—Pushbutton selects one of seven frequency multipliers for 1 and voltage input at 17.
- 3,4 **Mode Pushbuttons**—Select one of the following three modes:

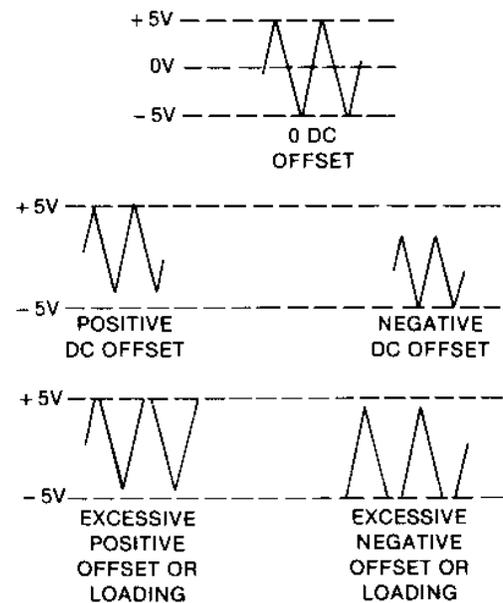
Continuous—3 released, selects continuous output at 50Ω OUT 9 and 11 and SYNC OUT (TTL) 13 connectors.

Trigger—3 and 4 depressed. A dc level output until the generator is triggered by MAN TRIG 5 or with a signal at TRIG IN connector 15. When triggered, the generator output is one cycle of waveform followed by a dc level.

Gate—3 depressed and 4 released. Same as trigger except the output is continuous for the duration of the manual or external trigger signal. The last cycle is always completed.

- 5 **MAN TRIG Pushbutton**—Triggers or gates the output signals when 4 is depressed or released respectively. In the trigger mode, one waveform cycle is output when 5 is pressed. In gate mode, waveform cycles are continuously output as long as 5 is held in.
- 6 **FUNCTION Pushbuttons**—Select sine \sim , triangle ∇ or pulse \square waveform. When all three FUNCTION buttons are released the output is a dc level. Pulse waveform parameters are controlled by the second row of controls.

- 7 **DC OFFSET Knob**—Offsets the 50Ω OUT waveform or gives a dc level (all function switches released) from $-10V$ (ccw, not off) to $+10V$ (cw) ($-5V$ to $+5V$ into 50Ω) at the HI output 9 and from $-1V$ to $+1V$ ($-0.5V$ to $+0.5V$ into 50Ω) at the LO output 14. An OFF position ensures no dc offset. See figure 3-2.



NOTE: Example is HI output into a 50Ω load.

Figure 3-2. DC OFFSET Control

- 8 **AMPLITUDE CONTROL**—CCW rotation reduces waveform amplitude at 50Ω OUTPUTS 9 and 11 by 30 dB while CW increases amplitude. DC and offset voltages are not affected by this control.
- 9 **50Ω OUT HI Connector**—Output for the selected function. Maximum 20 Vp-p (10 Vp-p into 50Ω) with 30 dB continuous amplitude control. 50Ω source impedance. 100 mA peak current for required waveform; 200 mA short circuit current.

10 **PULSE/SQUARE OUTPUT Pushbuttons**—Select the pulse amplitude symmetry relative to the baseline. With DC OFFSET 7 OFF, the baseline is 0V. With DC OFFSET, the baseline is varied by the DC OFFSET control.

—Selects a pulse that maintains amplitude symmetry about the baseline. AMPLITUDE control 8 adjusts the peak-to-peak level of the pulse. See figure 3-3.

—Selects the positive pulse. AMPLITUDE control 8 adjusts the positive peak while the negative peak remains fixed at the baseline. See figure 3-3.

—Selects the negative pulse. Amplitude control 8 adjusts the negative peak while the positive peak remains fixed at the baseline. See figure 3-3.

NORM/INV Pushbutton—Selects normal or inverted pulse output. Inverted pulse is a reversal of the active and inactive levels of the pulse. The net result for a square pulse would be a 180° phase shift with respect to sync pulse. See figure 3-3.

11 **50Ω OUT LO Connector**—Output for the selected function. Maximum 2 Vp-p (1 Vp-p into 50Ω) with 30 dB continuous amplitude control. 50Ω source impedance.

12 **PULSE MODE Pushbuttons**—Select a pulse synchronous with the sync pulse, a pulse delayed with respect to the sync pulse, double pulse (two pulse per pulse period) or a 50% duty cycle pulse.

DBL PULSE Pushbutton—Selects two pulses for each pulse period. In double pulse, DELAY

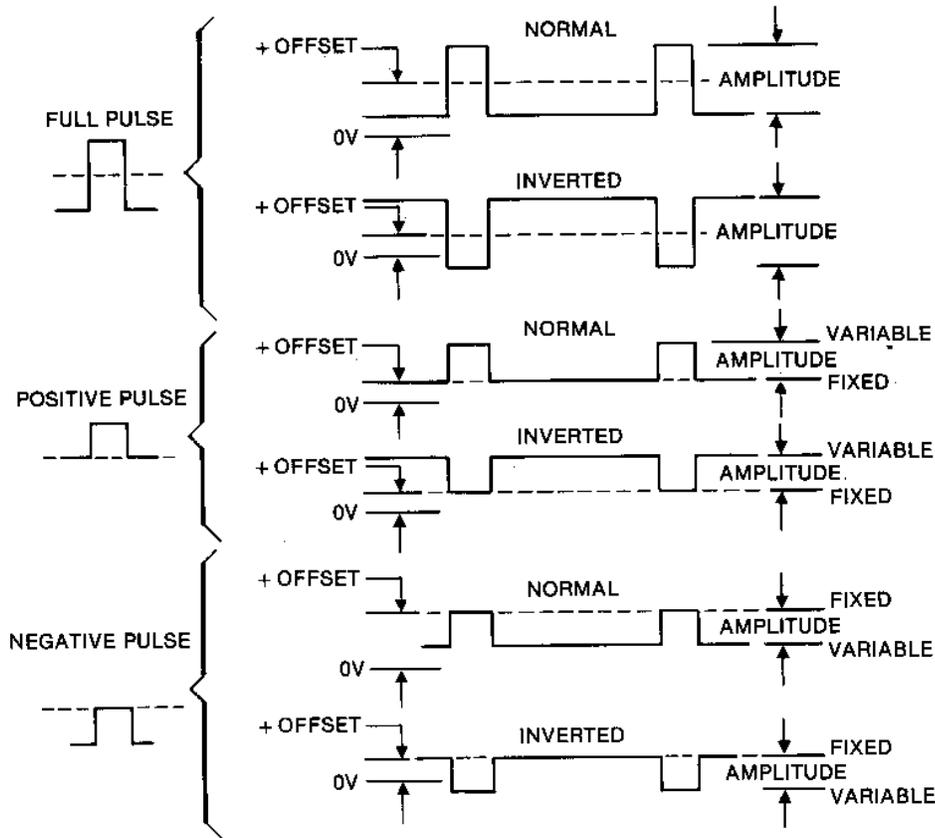


Figure 3-3. PULSE/SQUARE OUTPUT Amplitude/Offset Relationship

RANGE and vernier 16 set the period between the two pulses. WIDTH RANGE and vernier 14 control the pulse width of both pulses. See figure 3-4.

DLY ON Pushbutton—Initiates the DELAY RANGE and vernier 16 to delay the pulse relative to sync output 13.

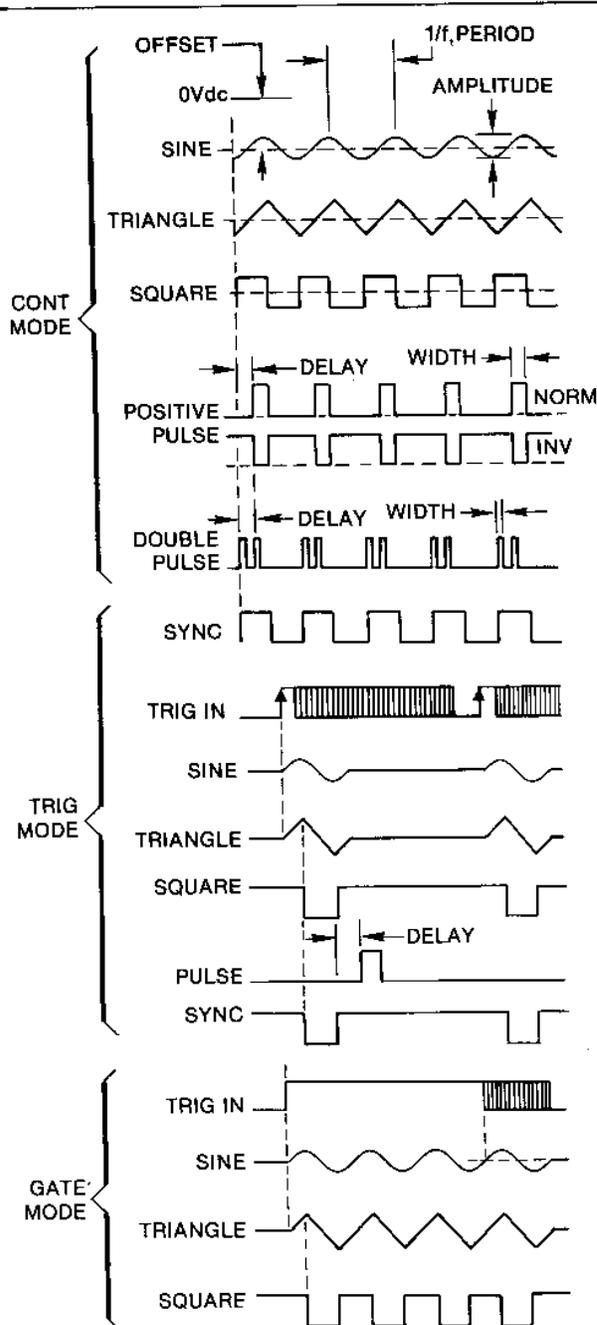


Figure 3-4. Waveform Characteristics

DLY OFF Pushbutton—Inhibits the DELAY RANGE and vernier.

□ Pushbutton—Selects a square wave. WIDTH RANGE and vernier have no effect on the square wave.

13 **SYNC OUT TTL Connector**—Output for a TTL square wave for each generator cycle. To be used for synchronization or as a TTL signal capable of driving 20 TTL loads. SYNC OUT provides reference for pulse delay.

14 **WIDTH Controls**—Sets pulse width in all pulse modes except **□**.

WIDTH RANGE Pushbutton—Select one of three pulse width ranges (0.1 μ s to 10 μ s, 10 μ s to 1 ms, 1 ms to 0.1s) for use with WIDTH vernier.

WIDTH Vernier—Varies the width period within the selected WIDTH RANGE. CW increases pulse width, ccw decreases pulse width.

15 **TRIG IN TTL Connector**—Accepts a TTL level signal to trigger or gate the generator. Triggers on the rising (low to high) transition and gates during the positive (high) portion of the trigger signal.

16 **DELAY CONTROLS**—Set pulse delay in delay and double pulse modes.

DELAY RANGE Pushbuttons—Select one of three pulse delay ranges (0.1 μ s to 10 μ s, 10 μ s to 1 ms, 1 ms to 0.1s) for use with the DELAY vernier. Pulse delay is relative to sync output. In double pulse mode, delay controls the period between the two pulses.

DELAY Vernier—Varies the delay period of the selected DELAY RANGE. CW increases pulse delay and ccw decreases pulse delay.

17 **VCG IN Connector**—Accepts ac or dc voltage to proportionately control frequency within the range determined by the FREQUENCY MULTIPLIER 2. Positive voltage increases the frequency set by the dial 1; negative voltage decreases the frequency.

18 **POWER Pushbutton**—Applies line power to the generator circuits.

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 3-5. 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:

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

*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.

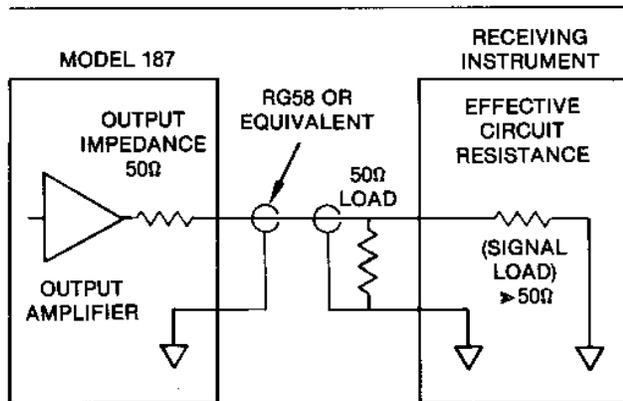


Figure 3-5. Signal Termination

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 keys to figure 3-1.)

Step	Control/Connector	Setting
1	50Ω OUT 9, 11	Connect circuit under test to either output (refer to paragraph 3.2.1)
2	FREQUENCY MULTIPLIER 2	Set to desired range of frequency.
3	Frequency Dial 1	Set to desired frequency within the range.
4	FUNCTION 6	Set to desired waveform. (To select a square wave, depress \square 6, \square 10 and \square 12.
5	DC OFFSET 7	Set as desired. Limited waveform amplitude to prevent clipping (see figure 3-2).
6	AMPLITUDE 8	Select 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 particular ranges 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.

- 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 maximum range (determined by dial end points and frequency multiplier.)

Figure 3-6 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. 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

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 of the upper limit.

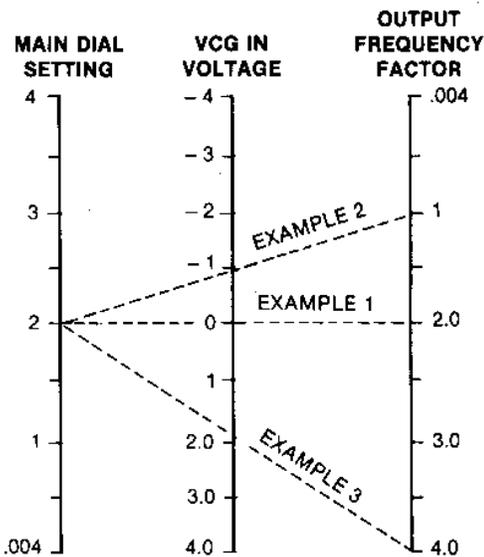


Figure 3-6. VCG Voltage-to-Frequency Nomograph

The up to 1000:1 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 frequency sweep. With the dial set to .004, excursions between 0V and

+4V at the VCG IN provide up to 1000:1 within the set frequency range.

3.2.4 Pulse Generator Operation

Operation as a pulse generator is similar to the manual and VCG controlled generator except a single pulse, double pulse or square wave may be selected.

The following steps describe the pulse operation setup:

Step	Control/Connector	Setting
1	MODE: CONT 3	Release CONT.
2	Frequency dial 1	Select pulse repetition rate.
3	FREQUENCY MULTIPLIER 2	Select pulse repetition rate.
4	FUNCTION 6	Depress \square .
5	PULSE/SQUARE OUTPUT 10	Depress desired pulse output.
6	PULSE MODE 12	Depress desired pulse mode.
7	WIDTH 14	Depress desired pulse width range and select desired pulse width. (Not applicable if 50% duty cycle pulse, \square , was selected.)
8	DELAY 16	Depress desired pulse delay range and select desired pulse delay. (Not applicable if DLY OFF was selected.)
9	DC OFFSET 7	Set as desired. Limit pulse amplitude as necessary to prevent clipping (see figure 3-2).
10	AMPLITUDE 8	Select desired amplitude.

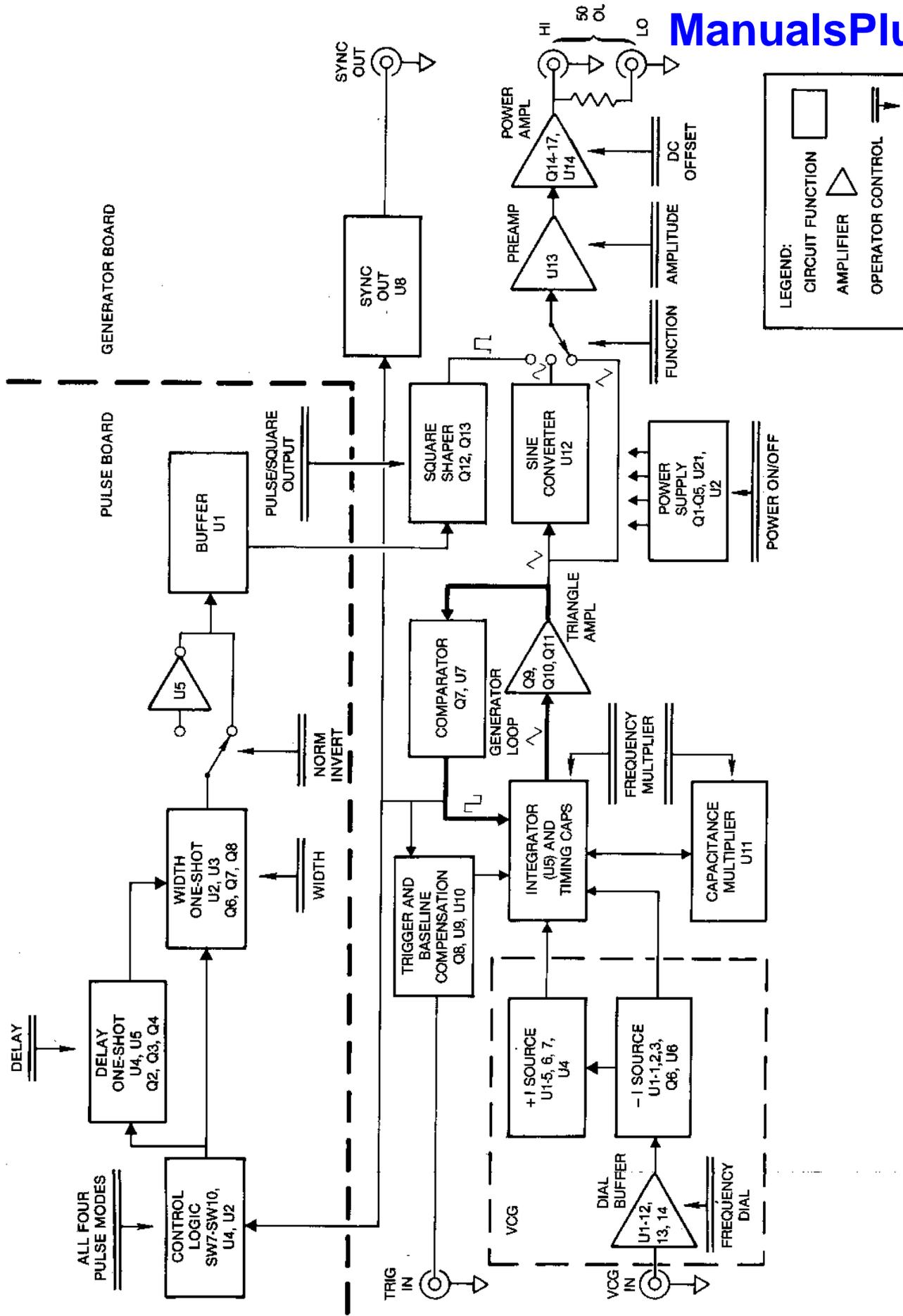


Figure 4-1. Function Block Diagram

SECTION 4

CIRCUIT DESCRIPTION

4.1 INTRODUCTION

This section describes the functions of major circuit elements and their relationships to one another as shown in figure 4-1, functional block diagram.

4.2 GENERATOR BOARD

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 μ A over a 1000:1 (4.0 to .004) range of each frequency multiplier.

The integrator, consisting of the bridge diodes and timing capacitors, is switched by the comparator output. This switching causes either the current source or current sink to charge 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 ± 2 V output is sent back to the integrator and timing capacitor. 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 cur-

rents 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 sent to the trigger flip flop, the integrator and the pulse board one-shots. The one-shot pulse (or square) is sent to the square shaper input. When the \square FUNCTION switch is selected, the square shaper is enabled and converts the pulse into a current signal. The buffered triangle is applied to the ∇ 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 10V peak signal which can drive a 50 Ω termination from a 50 Ω source impedance. The output amplifier drives the 50 Ω OUT HI connector and a resistor divider to produce the 50 Ω 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 2 I 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 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.

4.3 PULSE BOARD

The pulse generator circuitry (figure 4-1) consists of the control logic, delay one-shot, width one-shot, buffer and square shaper.

Selecting \square of the main board, enables the square shaper and allows the signals of one of the four pulse modes to be sent to the preamplifier. The square shaper on the main board and the pulse/square output switching on the pulse board determines whether the output pulse will be unipolar (positive or negative pulse) or bi-polar (negative and positive pulse).

The pulse mode switches select one of the four pulse modes. This pulse system uses two one-shots and control logic combinations to generate the desired pulse output. The logic, which is a part of the one-shots, determines the function of the one-shot (delay or width), selects the proper combination of one-shots needed, and determines how the comparator output of the main board is to be used and shaped for triggering purposes. Since both one-shots function the

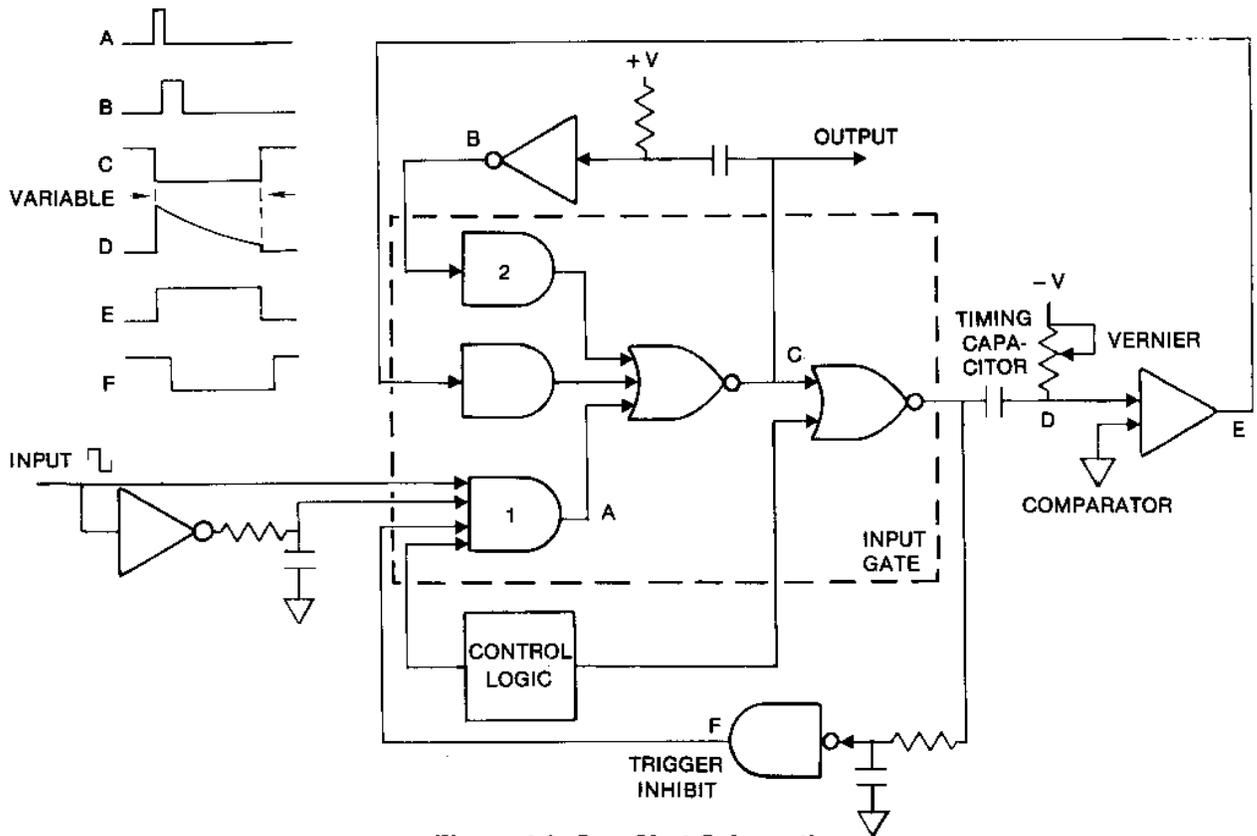


Figure 4-2. One Shot Schematic

same, (figure 4-2) a simplified drawing illustrating one-shot principle of operation is applicable to both one-shots.

An input waveform of any duration is received at two inputs of AND gate 1. Since the signal at one input is inverted and has a RC delay network, the output of gate 1 will have a constant pulse width as shown in waveform (A). The transient spike of pulse (A) is felt at the timing capacitor where the vernier and capacitor create a variable time constant to discharge the pulse as shown by waveform (D). As long as the comparator input (D) is positive, the comparator output (E) will remain positive. This output pulse waveform (E) is feedback, buffered, and inverted before being fed to the output to generate waveform (C). The purpose of AND gate 2, inverter and RC network, is to generate a delayed pulse (B) to latch the output and prevent any spikes. The output of trigger inhibit pulse (F) insures that no other incoming pulse will retrigger the timing capacitor until the capacitor times out.

Once the square or desired pulse has been generated, it is sent to the norm/invert switch where the signal can be inverted relative to the sync out. The signal after being buffered is sent on to the square shaper.

The square shaper is involved in all four pulse modes; refer to sheet 1 of the main generator schematic 0103-00-0850. The square shaper is activated by placing a reverse bias on either CR31 for positive pulse or CR30 for negative pulse. Both are reversed bias for bipolar operation. By pressing \overline{F} of the pulse board, a negative voltage is removed from cathode of CR31, causing it to become reverse biased. Since CR31 removes the positive output pulse from emitter of Q12 while forward biased, the pulse is now forced to travel through CR17 which shapes the output pulse before sending it to the preamplifier. Similarly, pressing \overline{G} removes a positive forward bias voltage on the anode of CR30 which shorts the negative pulse. CR30 thus becomes reverse biased and the output of emitter Q13 is allowed to pass through square shaping diode CR18. Output switching for \overline{H} simply causes CR30 and CR31 to be reversed simultaneously. Refer to appendix A for voltage values of CR31 cathode and CR30 anode for all output modes and waveform possibilities.

4.3.1 Square

Now refer to pulse board schematic 0103-00-0843 sheet 1. Selecting square causes the control logic

to inhibit the delay and width one-shots. This is done by placing a ground on U2 pin 10 and a +5 volts on U3 pin 3 to disengage the width one-shot and by leaving a ground on U4 pin 2 and U5 pin 2, to disengage the delay one-shot.

The comparator output is fed through U4 AND gate pin 6 since pins 4 and 5 are high, to pin 8 of U4 where the signal is inverted. From U4 pin 8 the square goes to U3 pin 8.

The signal is passed through U3 pin 10 (because pin 9 is low) to U2 pin 6. Since AND gate pin 4 and 5 are high, the signal is fed out NOR gate pin 8 and inverted. Here the signal travels on to buffer U1.

Two points can be observed about the control logic for this mode. First, for NOR gates of U4 and U2 to pass any signal, three of the unused inputs need to be at a logic low. Hence, the control logic must cause three of the AND gates feeding one of the NO gates to be low, and must cause the AND gate which will pass the signal to have all inputs high other than the signal input. Tracing from the square switch to the AND gates of U4 and U2 will reveal how this is accomplished. Note that these criteria must be met in the other modes also. Second, the circuitry which generates a one-shot triggering pulse (A) as illustrated in figure 4-2, is not needed when in square mode. Hence, the control logic effectively disables U4 pins 1 and 11 triggering input signal by grounding pin 13 of U4 and disables U2 11 and 12 by placing a +5 volts on U3 pin 5 (thus placing a low on U2 pin 12).

4.3.2 Delay Off

In DLY OFF mode the control logic inhibits the delay one-shot and enables the width one-shot. The delay one-shot is inhibited in the same manner as described for square mode. The width one-shot is enabled by placing a high on U2 pin 10 and placing a low on U3 pin 3. U4 AND gate pins 1 and 11 are enabled by placing a high on U2 pin 10 and placing a low on U3 pin 3. U4 AND gate pins 1 and 11 are enabled which causes a trigger pulse of constant duration from NOR gate pin 8. The negative transition of this pulse is fed to U3 pin 8 and is inverted and delayed before being fed to pin 9 of U3. The resulting output of U3 pin 10 is a smaller pulse width than that observed at pin 8 of U4 and a pulse which is positive. This pulse then triggers the one-shot in a manner as described for figure 4-2. Added to this one-shot are the timing capacitors for greater width variation. Refer to appendix B for voltage values of Q6, Q7 and Q8. Refer to figure 4-3

for timing and detailed point by point tracing of DLY OFF.

4.3.3 Delay On

In DLY ON mode the input control logic enables both one-shots. The width one-shot is enabled as described for DLY OFF and the pulse delay one-shot is enabled by placing a +5 volts on U4 pin 2 and U5 pin 2. The positive transition of the square wave triggers the delay one-shot. This results in an output at U4 pin 8

that has a variable low because of pulse width one-shot. Again this works as described for figure 4-2 with added capacitors to increase the delay pulse. The width one-shot is now set to trigger on the positive transition of the delay pulse. This is done by disabling U2 AND gate pin 5 to process the positive transition from U4 pin 8. The resulting triggering pulse corresponds to pulse (A) of figure 4-2. This trigger pulse will be felt at U2 pin 8 and will trigger the width one-shot. The width pulse will be variable as in DLY OFF. Refer to figure 4-4 for a more complete examination of this mode.

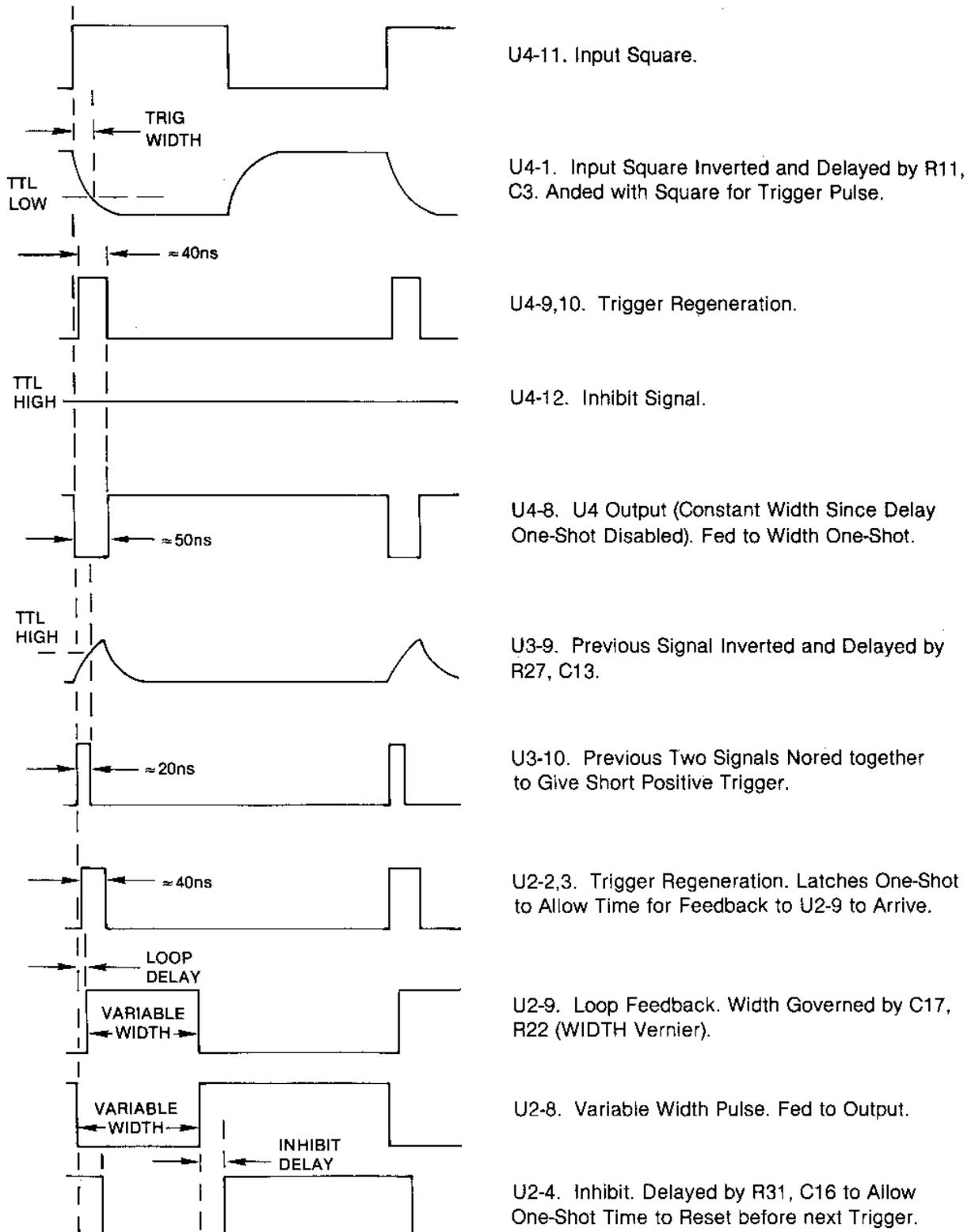


Figure 4-3 Delay Off Mode Timing Chart

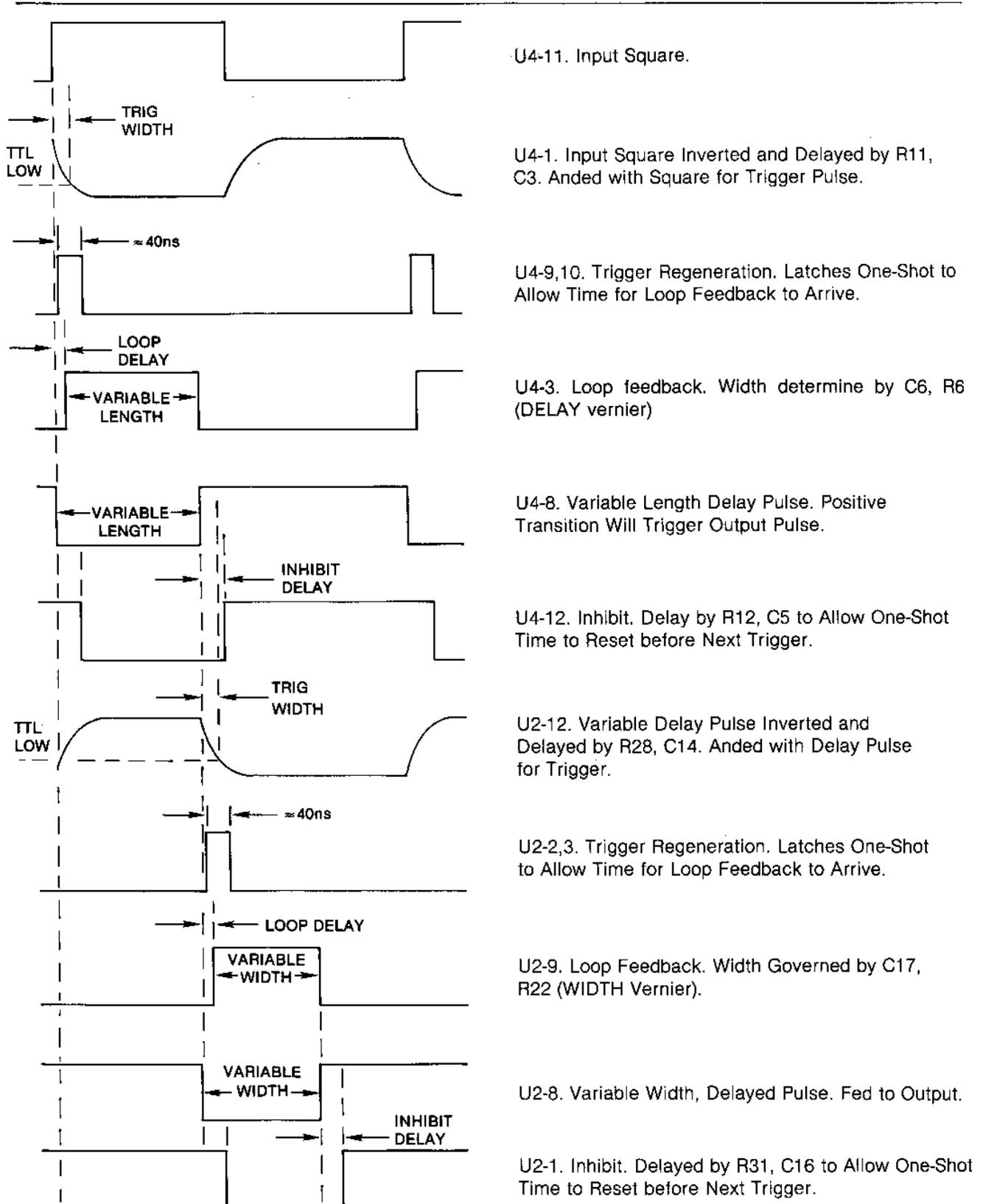
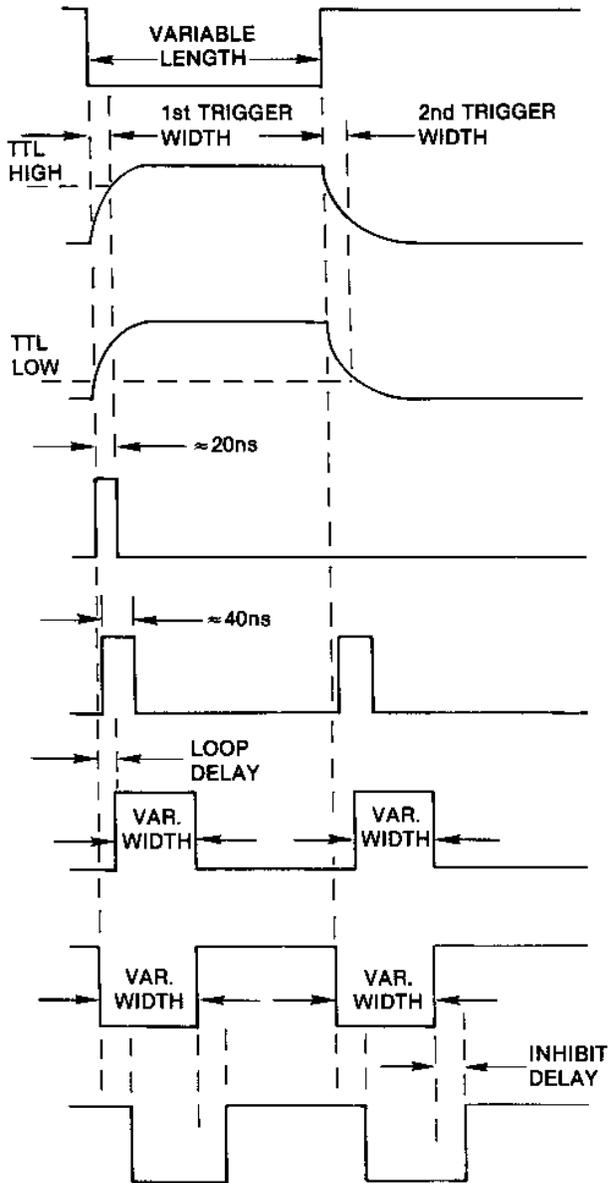


Figure 4-4. Delay On Mode Timing Chart

4.3.4 Double Pulse

DBL PULSE works exactly as the delayed pulse except that the logic low on U2 pin 5 is changed to a

logic high. This allows the width one-shot to be triggered on the negative transition for U4 pin 8 via U3 pins 8, 9 and 10 and on the positive transition via U3 pins 6, 5 and 4 with AND gate U2 pin 12. For analysis refer to figure 4-5.



U4-8. Delay Pulse (same as Generated in DLY ON Mode).

U3-9. Delay Pulse Inverted and Delayed by R27, C13. Nored with Delay Pulse to Give First Trigger.

U2-12. Delay Pulse Inverted and Delayed by R28, C14. Anded with Delay Pulse to Give Second Trigger.

U2-6. First Trigger Pulse.

U2-2,3. Trigger Regeneration. Latches One-Shot to Allow Time for Loop Feedback to Arrive. Occurs for Both Triggers.

U2-9. Loop Feedback. Widths Governed by C17, R22 (WIDTH Vernier). Both Pulses Have Equal Width.

U2-8. Double Pulse with Variable Width and Delay. Fed to Output.

U2-1,4. Inhibit. Delay by R31, C16 to Allow One-Shot Time to Reset before Next Trigger.

Figure 4-5. Double Pulse Mode Timing Chart

SECTION 5

ALIGNMENT

5.1 FACTORY REPAIR

Wavetek maintains a factory department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for alignment or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

5.2 REQUIRED TEST EQUIPMENT

Voltmeter Millivolt dc measurement
 (1% accuracy)
 Oscilloscope ≥ 60 MHz bandwidth
 Counter 4 MHz (0.1% accuracy)
 50 Ω 1% accuracy, 2W
 Distortion Analyzer To 400 kHz
 RG58U Coax Cable 3 ft length BNC
 male contacts

5.3 REMOVING GENERATOR COVERS

1. Invert the instrument and remove the four screws in the bottom cover (ref: drawing 0102-00-0844 in section 7).
2. Turn the instrument upright; remove the top cover for access to generator alignment controls.
3. For access to the pulse board, remove the screws securing the bottom cover to the generator board, replace the top cover invert the instrument and remove the bottom cover.
4. When alignment is complete, secure both covers.

NOTE

Remove the cover only when it is necessary to make adjustments or measurements.

5.4 ALIGNMENT

After referring to the following preliminary data, perform alignment, as necessary, per table 5-1. If performing partial alignment, check previous settings and adjustments for applicability. See figures 5-1 and 5-2 for alignment control location.

The completion of these alignment procedures returns the instrument to correct calibration. All limits and tolerances given in these procedures are alignment guides and should not be interpreted as instrument specifications. Instrument specifications are given in section 1 of this manual.

1. All measurements made at the FUNCTION OUT connector must be terminated into a 50 Ω ($\pm 1\%$) load.
2. Start the alignment by connecting the unit to an appropriate ac power source and setting the front panel switches as follows.

POWER ON
 Frequency Dial 4.0
 FREQ MULT (Hz) $\times 1K$
 MODE COUNT CONT (released)
 FUNCTION 
 DC OFFSET OFF
 AMPLITUDE MAX
 PULSE MODE 
 PULSE/SQUARE
 OUTPUT NORM (released), 

3. Allow the unit to warm up at least 30 minutes for final alignment. Keep the instrument cover on to maintain heat. Remove cover only to make adjustments or measurements.

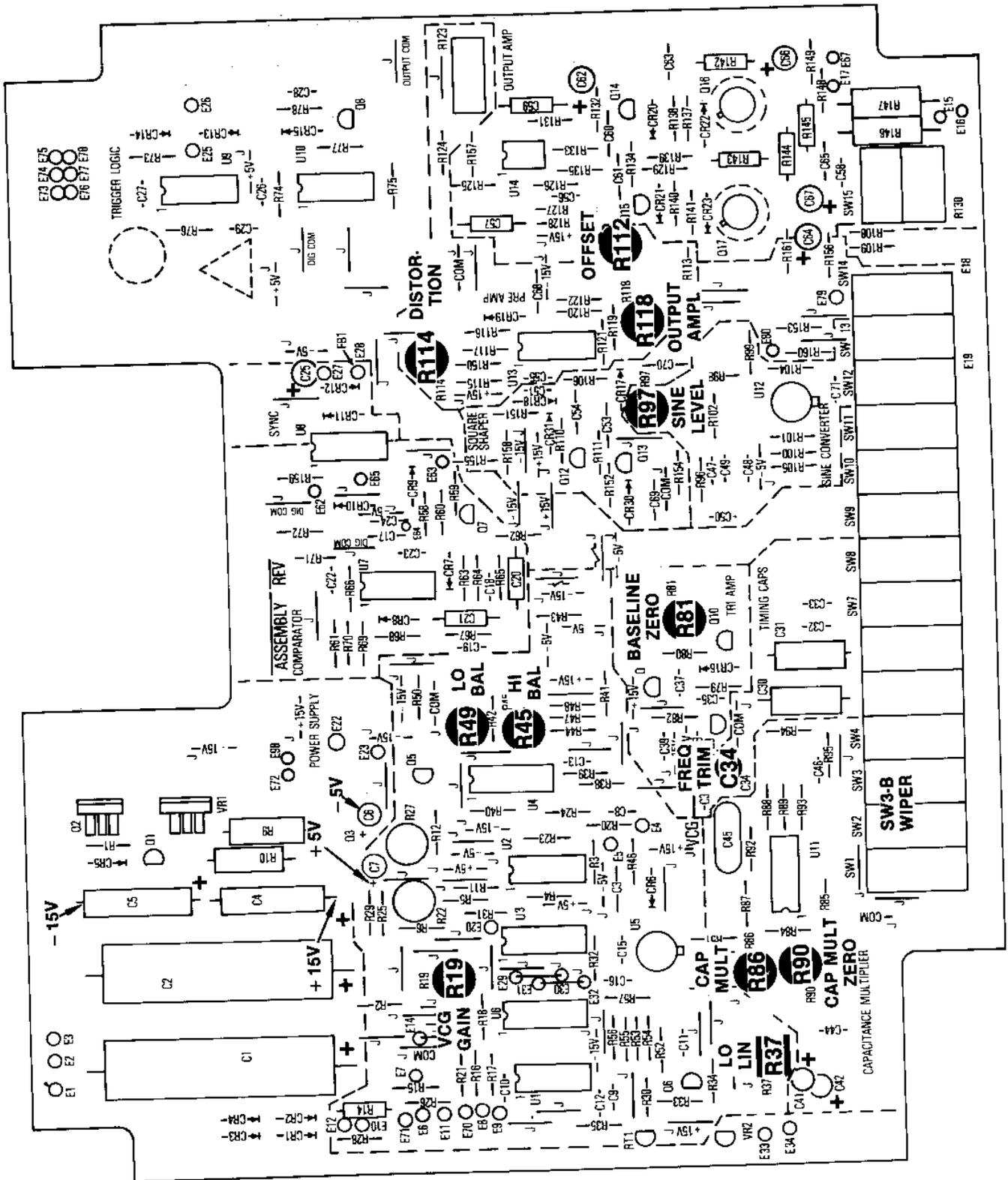


Figure 5-1. Generator Board Alignment Points

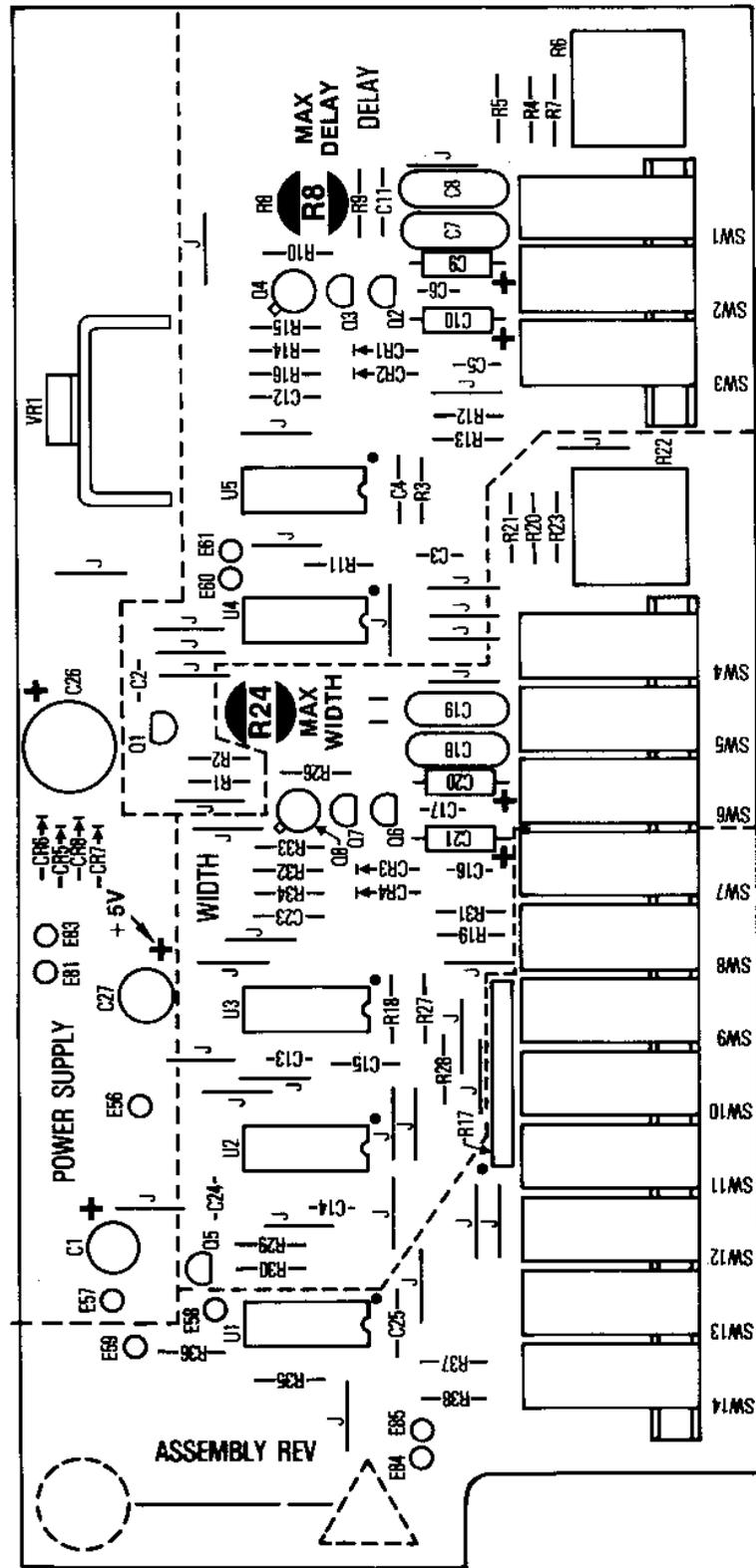


Figure 5-2. Pulse Board Alignment Points

Table 5-1. Alignment Procedure

NOTE: Open columns indicate previous entry remains applicable.

Step	Check	Tester	Test Point	Control Setting	Adjust	Result	Remark
1	Power Supply	Voltmeter	C4 +	Paragraph 5.4, Step 2		+ 15 ± .75V	Verify ± 15V should track within 30 mV
2			C5 -			- 15 ± .75V	
3			C7 +			+ 5 ± .25V	Verify.
4			C6 -			- 5 ± .25V	

Replace top cover, turn the instrument over and remove the bottom cover, make check of step 5 and replace the cover, turn the instrument over again and continue with step 6.

5			C27 +			+ 5 ± .25V	
6	Capacitor Multiplier Zero		SW3-B		R90 CAP MULT ZERO	0V ± 2mV	
7	Approximate Bottom of the Dial Frequency	Counter	50Ω OUT HI (terminate into 50Ω)	Dial: .004 FREQ MULT: 10K	R37 LO LIN	20 to 25 ms period	
8	Bottom of the Dial Symmetry	Scope			R49 LO BAL	Equalize (+) and (-) half cycles	Set scope to (-) trigger; display one full cycle. Align positive transition to center of screen. Multiply the horizontal display × 10. Set scope to (+) trigger; adjust R49 to align negative transition with center of screen
9	Bottom of the Dial Frequency	Counter		FREQ MULT: × 1K	R37 LO LIN	350 ± 50 ms period	
10	Top of the Dial Symmetry	Scope		Dial: 4.0	R45 HI BAL	Equalize (+) and (-) half cycles	Same method as step 8, except adjust R45.
11	Top of the Dial Frequency	Counter		Dial: 4.0 FREQ MULT: × 1K	R19 VCG GAIN	4 + .02 kHz	
12			FREQ MULT: × 10K			40 ± .8 kHz	Verify
13			FREQ MULT: × 1M		C34 FREQ TRIM	4 ± .02 MHz	
14			FREQ MULT: × 100K			400 ± 8 kHz	Verify. If necessary, trim by changing value of C33
15			FREQ MULT: × 100		R86 CAP MULT	2.5 ± .05 ms	
16			FREQ MULT: × 10			25 ± .5 ms	Verify

Table 5-1. Alignment Procedure (Continued)

Step	Check	Tester	Test Point	Control Setting	Adjust	Result	Remark
17				FREQ: $\times 1$		250 ± 5 ms	Verify
18	Sine Distortion	Distortion Analyzer		FUNCTION: \sim FREQ MULT: $\times 1K$	R97 SIN LEVEL R114 DISTOR- TION	Adjust for minimum distortion	It may be necessary to reduce amplitude to 5V peak
19	Output Amplitude	Scope		FUNCTION: \sim	R118 OUTPUT AMPL	10 Vp-p (+ .3V/-0V)	
20	Output Offset	Voltmeter		FUNCTION: \sim	R112 OFFSET	0 ± 50 mV	
21	Baseline Zero	Scope		MODE: Trigger	R81 BASELINE ZERO	0 ± 75 mV	It may be necessary to trim the baseline with R80

Replace top cover, turn the instrument over and remove the bottom cover. The following adjustments will be on the pulse board.

22	Pulse Width			MODE: CONT FREQ MULT: 10K FUNCTION: \square PULSE MODE: DLY OFF WIDTH RANGE: .1 μ s- 10 μ s WIDTH Vernier: MAX PULSE/SQUARE: \square	R24 MAX WIDTH	12 (-0/+1) μ s pulse width as shown in fig. 5-3.	Scope horizontal: 2 μ s/div Scope trigger. External Trigger Source: 187 SYNC OUT.
23	Pulse Delay			PULSE MODE: DLY ON DELAY RANGE: .1 μ s- 10 μ s DELAY Vernier: MAX	R8 MAX DELAY	12 (-0/+1) μ s pulse delay as shown in fig. 5-4.	Pulse delay is relative to sync output.

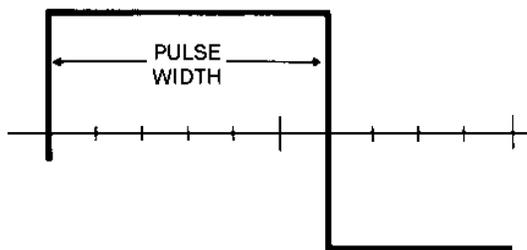


Figure 5-3. Pulse Width

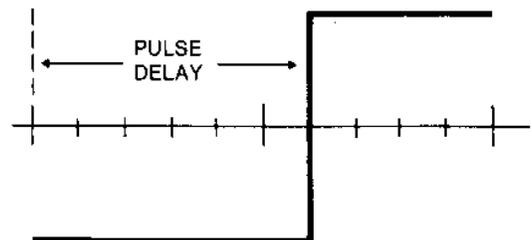
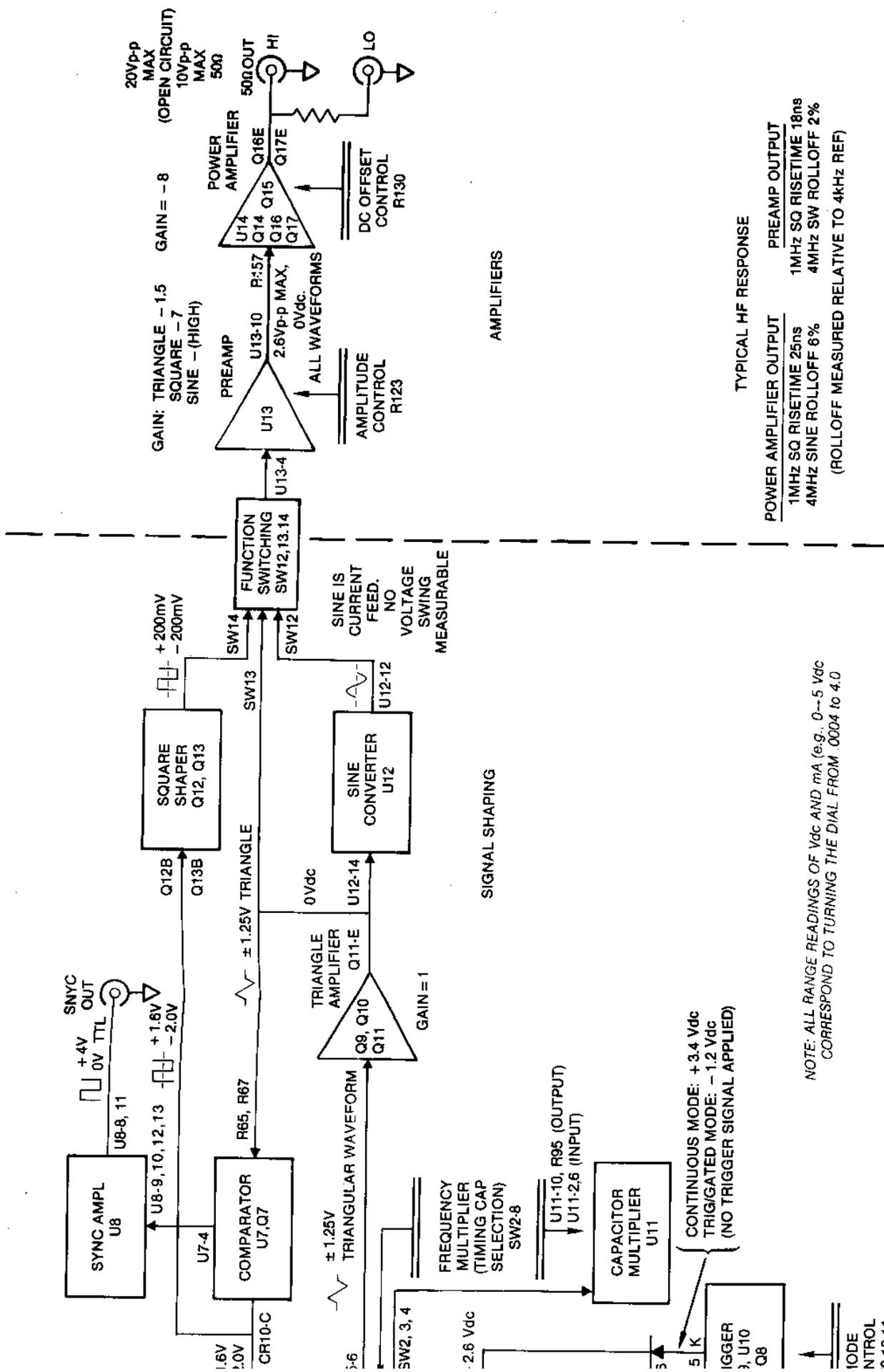


Figure 5-4. Pulse Delay



SECTION 6

TROUBLESHOOTING

6.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for alignment or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

6.2 BEFORE YOU START

CAUTION

To prevent damage to components, turn unit off while removing or replacing components, connectors or pc boards.

Since no troubleshooting guide can possibly cover all the potential problems, the aim of this guide is to give

a methodology which if applied consistently will lead to the problem area.

This troubleshooting guide is arranged to aid you in meeting the following goals.

1. Symptom recognition (listing of possible problem).
2. Symptom elaboration (front panel manipulation to isolate problems).
3. Isolation to the faulty function.
4. Isolation to the faulty circuit.
5. Isolation to the faulty component.

The functional blocks and their purpose are listed in table 6-1 as a supplement to figures 4-1 and 6-1. All information presented will revolve around this list. Figure 6-1 is the generator board portion of figure 4-1 annotated with troubleshooting data.

Table 6-1. Purpose of Each Circuit

Functional Block	Purpose
Power Supply	Supply regulated ± 15 Vdc and ± 5 Vdc to all circuits.
Dial Buffer	Buffer amplifier (voltage gain = $-\frac{1}{3}$). For isolation between the frequency dial pot and the following circuits.
-I Source	Constant current source (negative). The output level of which can be set from 0 to approximately 2.26 mA by the output of the dial buffer. The current output, applied to the integrator, results in the linear negative-going triangle slope. The -I source also outputs a second 0 to 2.26 mA to the +I source.
+I Source	Constant current source (positive). The output level of which can be set from 0 to approximately 2.26 mA by the output (U6-9) of the -I source. The current output, applied to the integrator, results in the linear positive-going triangle slope.

Table 6-1. Purpose of Each Circuit (continued)

Functional Block	Purpose
Integrator	Forms a linear triangular waveform as a result of alternate application of + and - charging current to a timing capacitor. Alternation is controlled by a square-wave signal applied from the comparator. This is accomplished through the use of a diode bridge, timing capacitors and appropriate range switching.
Triangle Buffer	Unity-gain FET-input noninverting buffer amplifier. Provides sufficient drive for the following circuits.
Comparator	Monitors the output of the triangle buffer and provides a control signal to the integrator that results in the generation of alternate positive- and negative- going linear ramps. The input of the comparator contains peak detection circuits that determine the $\pm 1.25V$ peak levels of the resultant triangular waveform. The input circuits also contain R-C lead networks which "roll off" the triangle peaks during high frequency operation. The networks compensate for normal circuit delays, thus maintaining good dial tracking in the X100K and X1M frequency ranges. The control signal output to the integrator takes the form of a square wave which is also applied to trigger, sync and square shaper circuits.
Capacitor Multiplier	Used only in X1, X10 and X100 frequency multiplier ranges, this circuit shunts 90% (in X100), 99% (in X10) or 99.9% in (X1) of the current available from the $\pm I$ sources away from the timing capacitor, effectively "multiplying" the value of the timing capacitor by 10, 100 or 1000.
Sync Amplifier	Provides TTL level square wave (fan-out of 20) at the generator frequency to the front panel.
Trigger	Provides non-continuous generator operation by controlling application of the \pm charging currents to the timing capacitor. In triggered mode, one cycle of waveform is generated each time the trigger input is driven to a TTL high level. In gated mode, the generator continues to run as long as the trigger input is held at a TTL high.
Trigger Baseline Compensation	Ensures that the output of the integrator remains at 0Vdc in triggered/gated operation with no trigger input.

Table 6-1. Purpose of Each Circuit (continued)

Functional Block	Purpose
Square Shaper	Conditions the square wave from the comparator to proper amplitude and waveshape by clipping the top and bottom of the waveform.
Sine Converter	Inputs triangular waveform and, through the use of nonlinear resistor-diode circuitry, outputs a sinusoidal current.
Preamp	Inputs selected waveform and amplifies it to 2.6Vp-p for input to the power amplifier. Gain is -1.5 in triangle, -7 in square. It is current fed.
Power Amplifier	Complementary symmetry amplifier. Capable of delivering 10Vp-p into 50Ω . Gain is -8 (open circuit) -4 (into 50Ω)
Width One-shot	Variable Width.
Delay One-shot	Variable Delay
Control Logic	Control.

6.3 STARTING

When confronted with a problem, initially check the power supplies (figure 6-2). Once the power supplies are determined to be good, use the front panel manipulation to isolate the problem and refer to table 6-2, an index of the troubleshooting tables by indications of common problems. Table 6-2 and referenced figures do not cover every possible trouble, but, when used in conjunction with circuit descriptions and schematics, will be an aid in systematically isolating faulty components.

Once the problem is isolated to the smallest possible number of components, test individual components. Paragraph 6.4 suggests methods of testing many of the commonly used components.

6.4 TROUBLESHOOTING INDIVIDUAL COMPONENTS

6.4.1 Transistor

1. A transistor is defective if more than one volt is measured across its base-emitter junction in the forward direction.

2. A transistor when used as a switch may have a few volts reverse bias voltage across base emitter junction.
3. If the collector and emitter voltages are the same, but the base emitter voltage is less than 500mV forward voltage (or reversed bias), the transistor is defective.
4. A transistor is defective if its base current is larger than 10% of its emitter current (calculate currents from voltage across the base and emitter series resistors).
5. In a transistor differential pair (common emitter stages), either their base voltages are the same in normal operating condition, or the one with less forward voltage across its base emitter junction should be off (no collector current); otherwise, one of the transistors is defective.

6.4.2 Diode

A diode (except a zener) is defective if there is greater than one volt (typically 0.7 volt) forward voltage across it.

Table 6-2. Fault Isolation

Note: Return as many of the front panel controls as possible to their initial settings and still retain the problem. The troubleshooting tables generally begin at these initial settings and specify all subsequent setups. Preset the front panel controls as follows:

Control	Position
Frequency Dial	4.0
POWER	ON
MODE	CONT
FREQ. MULT	1K
FUNCTION	
PULSE MODE	
PULSE/SQUARE OUTPUT	NORM.
DC OFFSET	OFF
AMPLITUDE	MAX

Problem	Figure
Power Supply	6-2
Symmetry or Frequency (Power Supplies OK)	6-3
Improper Amplitude or Waveshape of Any Function	6-5
No Output (Power Supplies OK)	6-6
No Square and Pulse Output Only (Power Supplies OK)	6-7

6.4.3 Operational Amplifier

1. The "+" and "-" inputs of an operational amplifier will have less than 15 mV voltage difference when operating under normal conditions.
2. When the output of the amplifier is connected to the "-" input (voltage follower connection), the output should be the same voltage as the "+" input voltage; otherwise, the operational amplifier is defective.

3. If the output voltage stays at maximum positive, the "+" input voltage should be more positive than "-" input voltage, or vice versa; otherwise, the operational amplifier is defective.

6.4.4 FET Transistor

1. No gate current should be drawn by the gate of an FET transistor. If so, the transistor is defective.
2. The gate-to-source voltage is always reverse biased under a normal operating condition; e.g., the source voltage is more positive than the gate voltage for 2N5485, and the source voltage is more negative than gate voltage for a 2N5462. Otherwise, the FET is defective.
3. If the device supplying gate voltage to an FET saturates, the FET has too large a V_{gs} (pinch off) for the circuit and should be replaced.

6.4.5 Capacitor

1. Shorted capacitors have zero volts across their terminals.
2. Opened capacitor can be located (but not always) by using a good capacitor connected in parallel with the capacitor under test and observing the resulting effect.

6.4.6 Digital TTL IC's (e.g. 7400 Series)

1. The device is operating correctly if the output high state is $> +2.4V$ and low state is $< +0.5V$.
2. The input must show the same two levels as in step 1. If the levels are between $+0.8V$ and $+2.0V$, the connection to the driving circuit output is open.

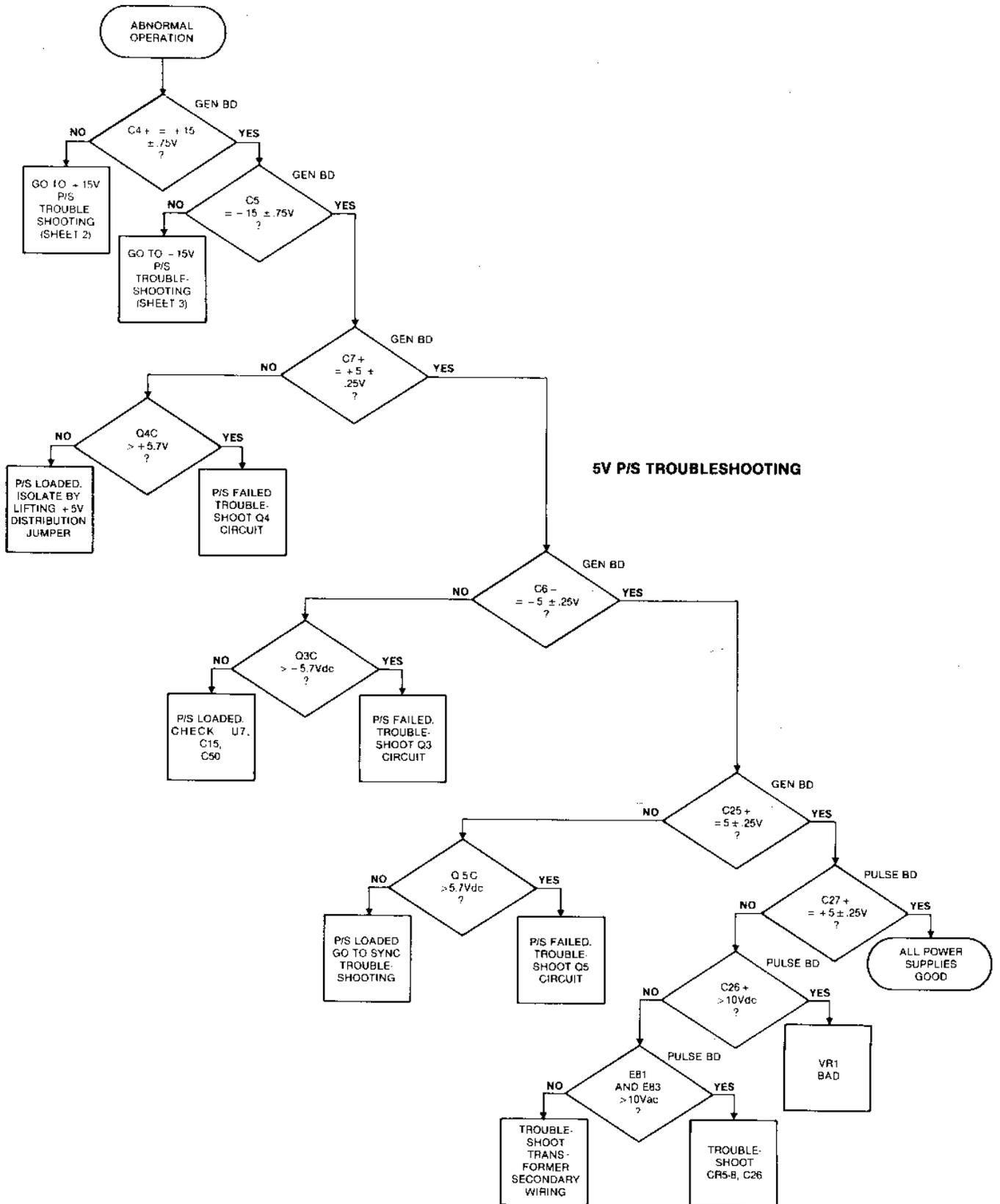


Figure 6-2. Power Supply Troubleshooting (Sheet 1)

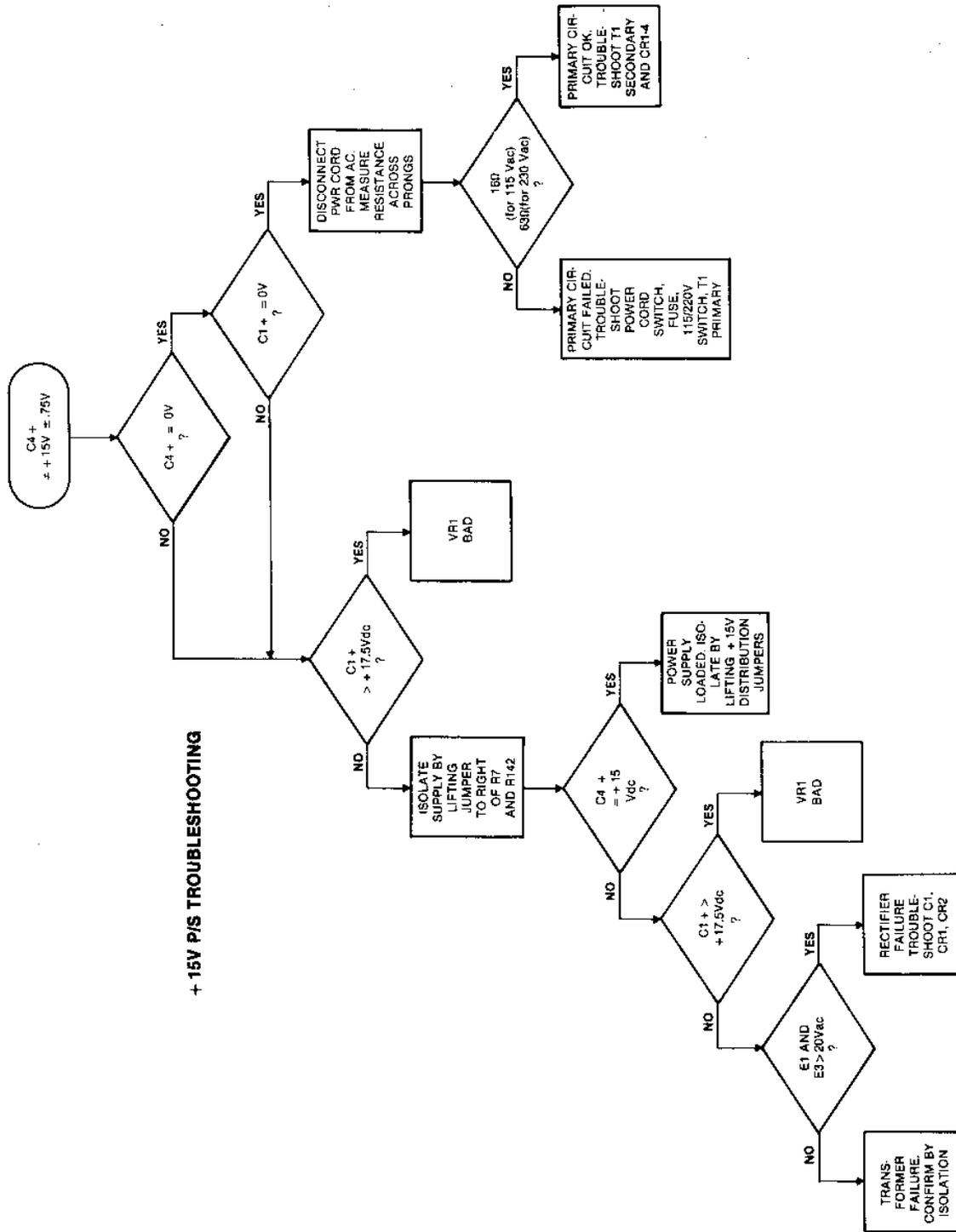


Figure 6-2. Power Supply Troubleshooting (Sheet 2)

- 15V P/S TROUBLESHOOTING

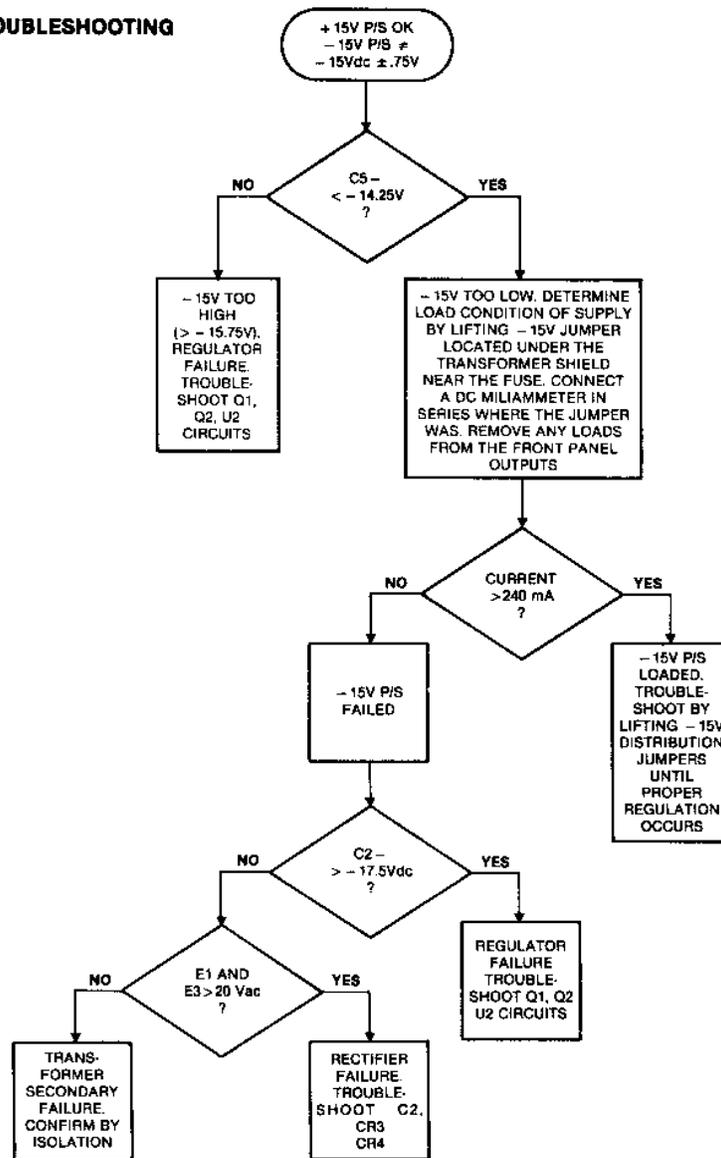


Figure 6-2. Power Supply Troubleshooting (Sheet 3)

NOTES ON BOTTOM-OF-DIAL (BOD) FAILURES

If BOD symmetry will not adjust, go to triangle mode and inspect linearity of the waveform.

Curvature of both sides of the triangle indicates a leak on line or in U5. Check BOD on X1K through X1M to check timing capacitors C30-C33. Measure voltage drop across R51: if any current is flowing, problem is in Q9, C34, C35, C36. If no current is flowing, problem is in U5.

A non-symmetrical triangle with or without curvature on one side only is an indication of failure in one current source or a leaky diode in U5. Determination of the failed circuit can be made by the following steps:

1. Measure voltage drop across R32 or R40. These drops should be equal and be in the 2 to 20 mV range.
2. Measure drops across R47 and R54. If either of these voltages is different from that measured in step 1, the problem lies in the circuit which shows the different voltage; that is, if the drop across R47 is different, problem is U4. If the voltage across R54 is different, the problem is U6. If all drops appear good, the problem is probably in U5. If changing U5 yields no improvement, the problem may still be a very small leak on the triangle generation line Q9, C34, C35, C36.

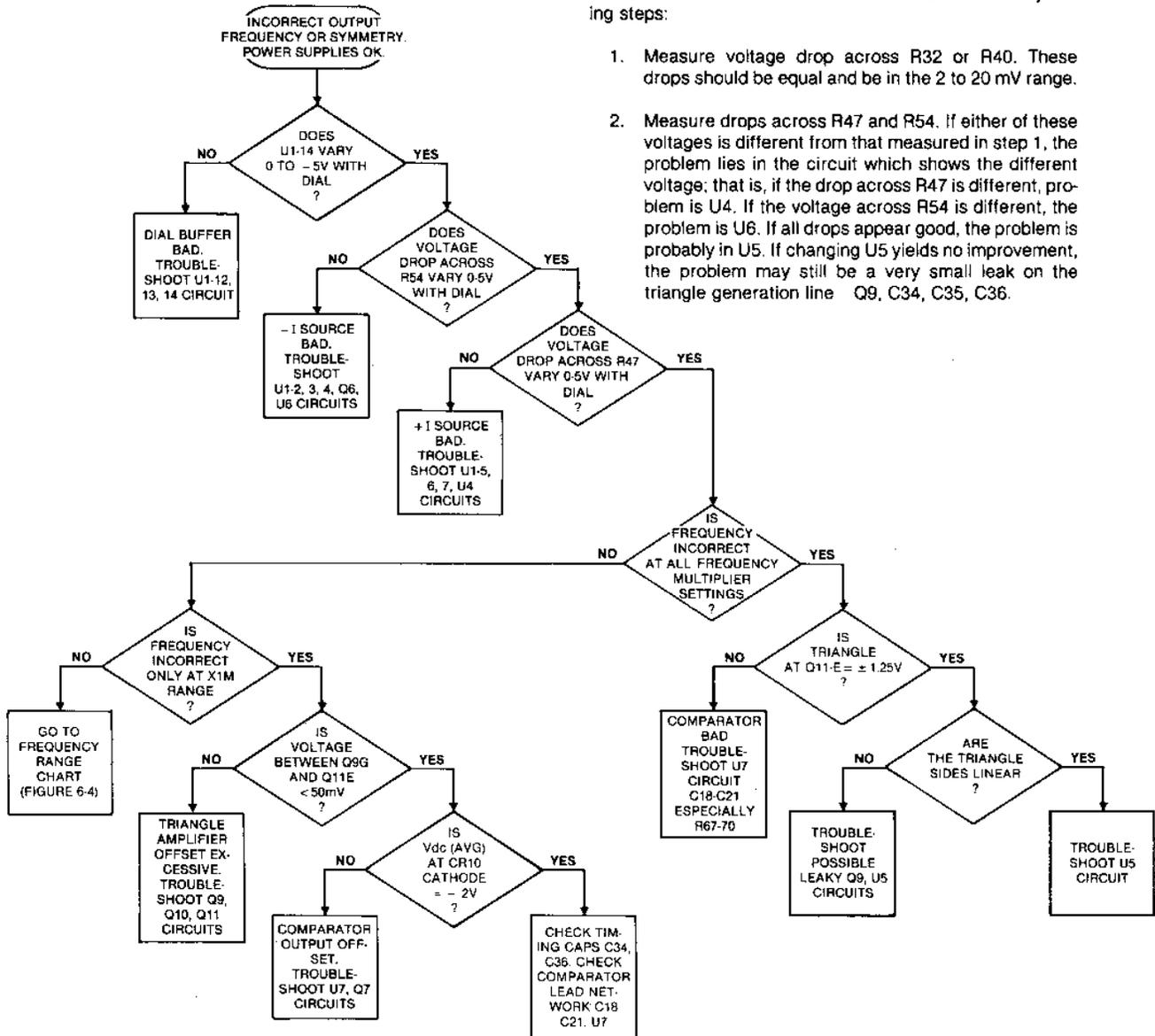


Figure 6-3. Symmetry or Frequency Problems

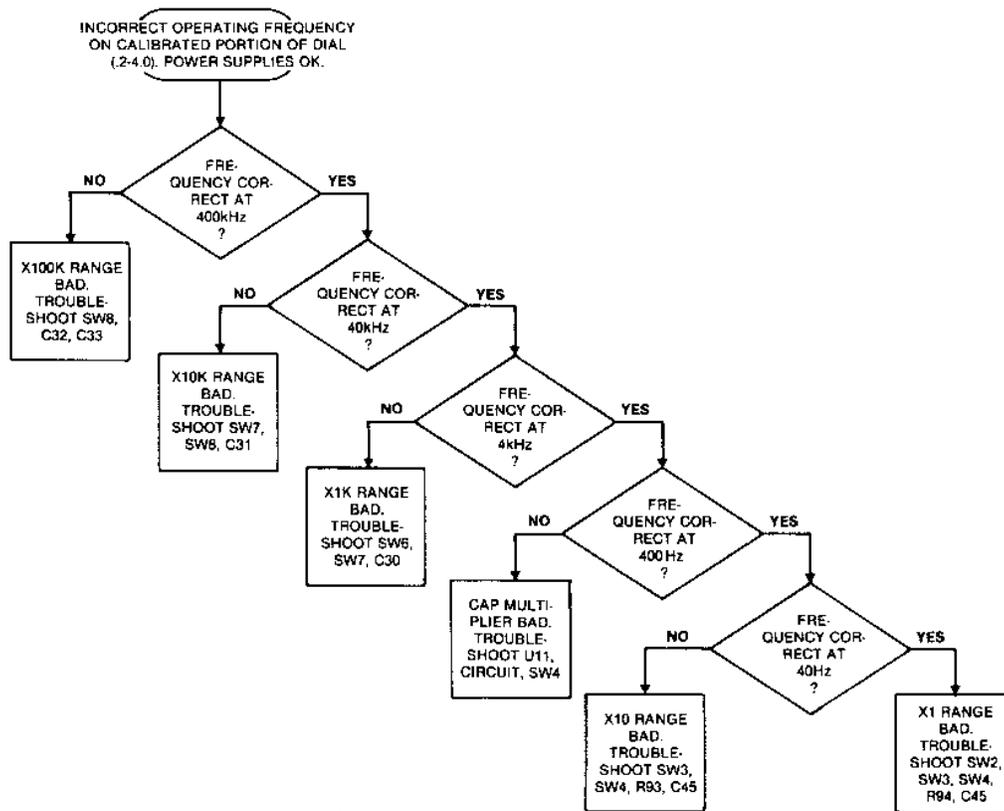


Figure 6-4. Frequency Calibration Problems

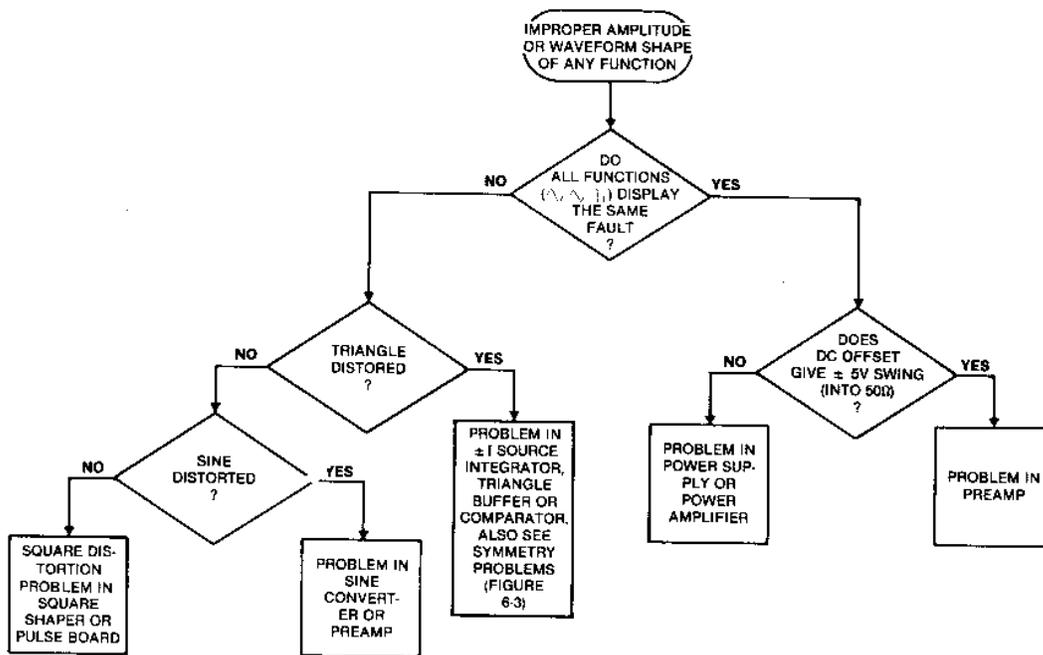


Figure 6-5. Improper Amplitude or Waveshape

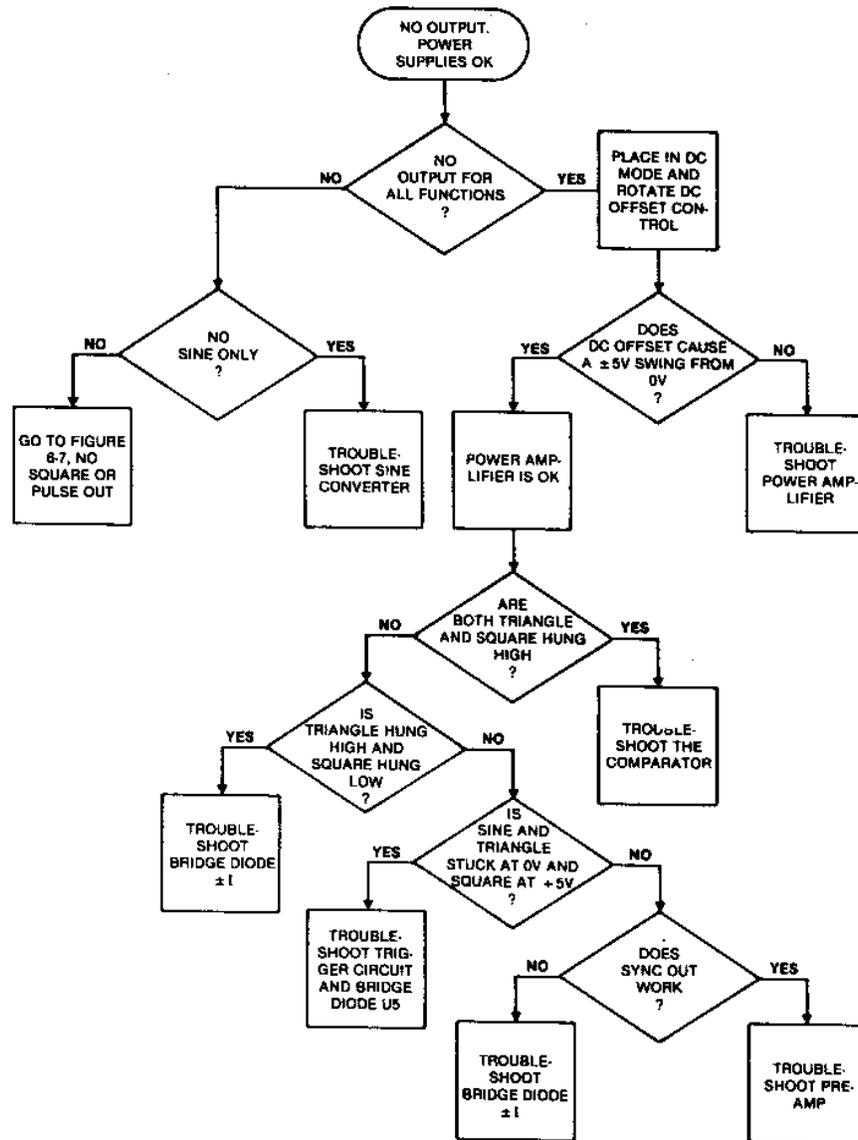


Figure 6-6. No Output

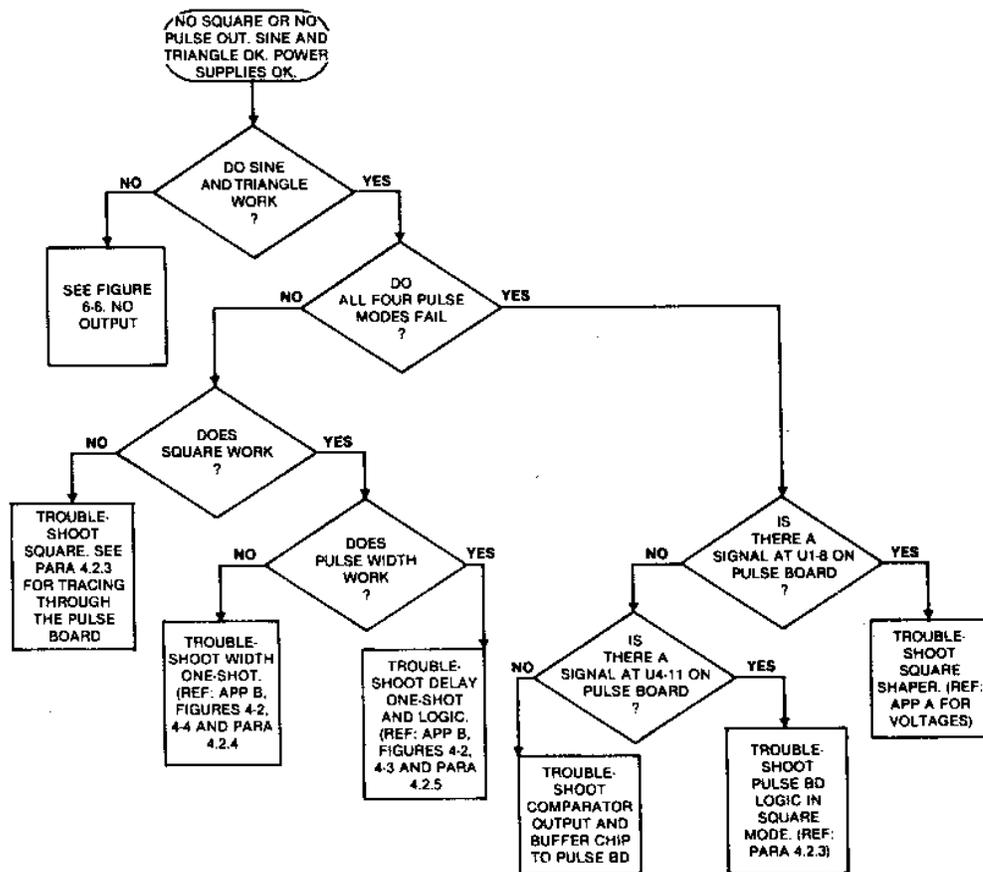


Figure 6-7. No Square or No Pulse Output Only

7

SECTION 7

PARTS AND SCHEMATICS

7.1 DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

7.2 ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to summarize the changes made

and are inserted immediately inside the rear cover. If no such pages exist, the manual is correct as printed.

7.3 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit, and, if applicable, the function performed.

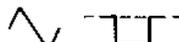
NOTE

An assembly drawing number is not necessarily the assembly part number. However, the assembly parts list number is the assembly part number.

Drawing	Drawing No.
Instrument Schematic	0004-00-0174
Chassis Assembly	0102-00-0844
Chassis Parts Lists	1101-00-0844
Generator Board Schematic	0103-00-0850
Generator Board Assembly	1100-00-0850
Generator Board Parts List	1100-00-0850
Pulse Board Schematic	0103-00-0843
Pulse Board Assembly	1100-00-0843
Pulse Board Parts List	1100-00-0843

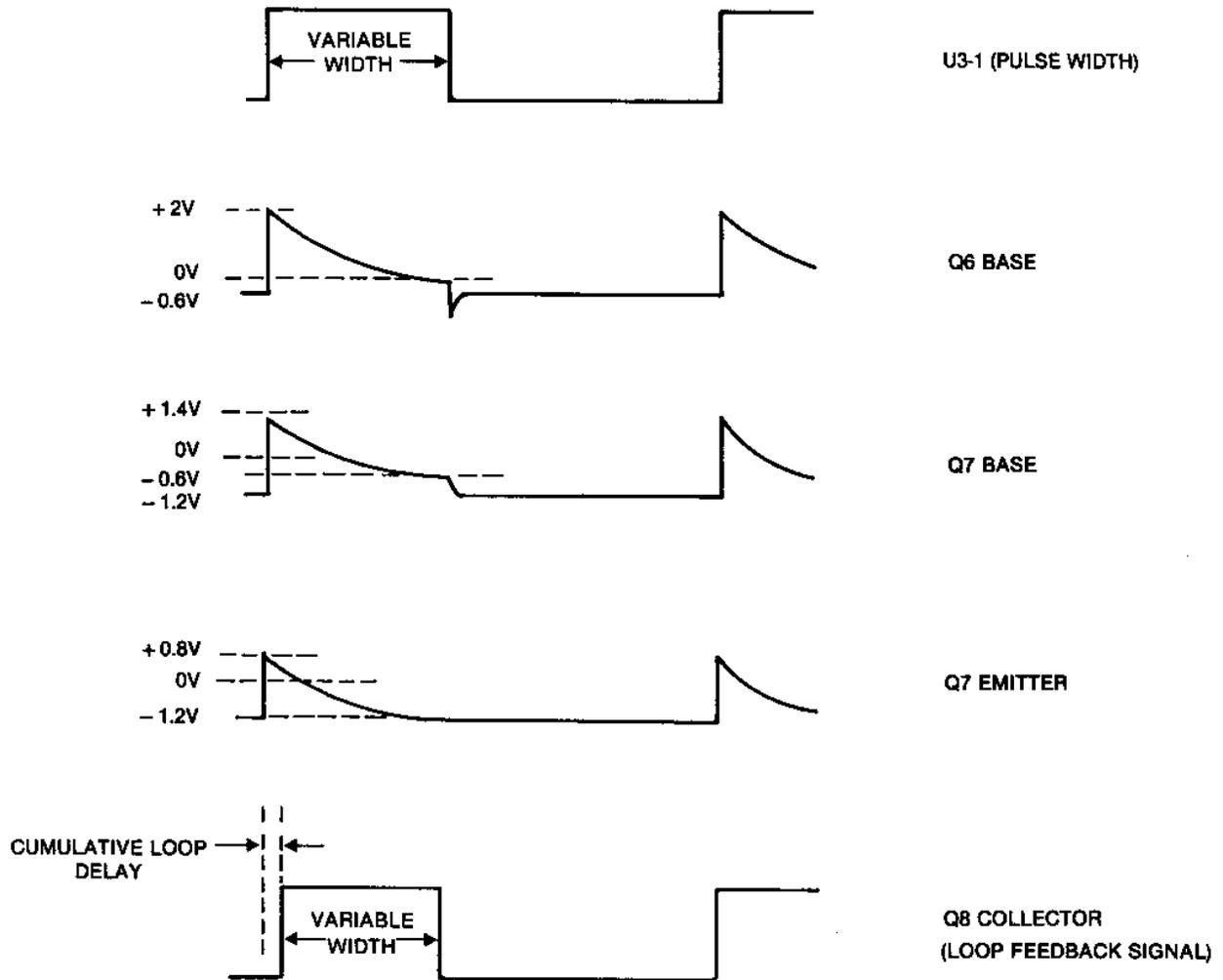
APPENDIX A

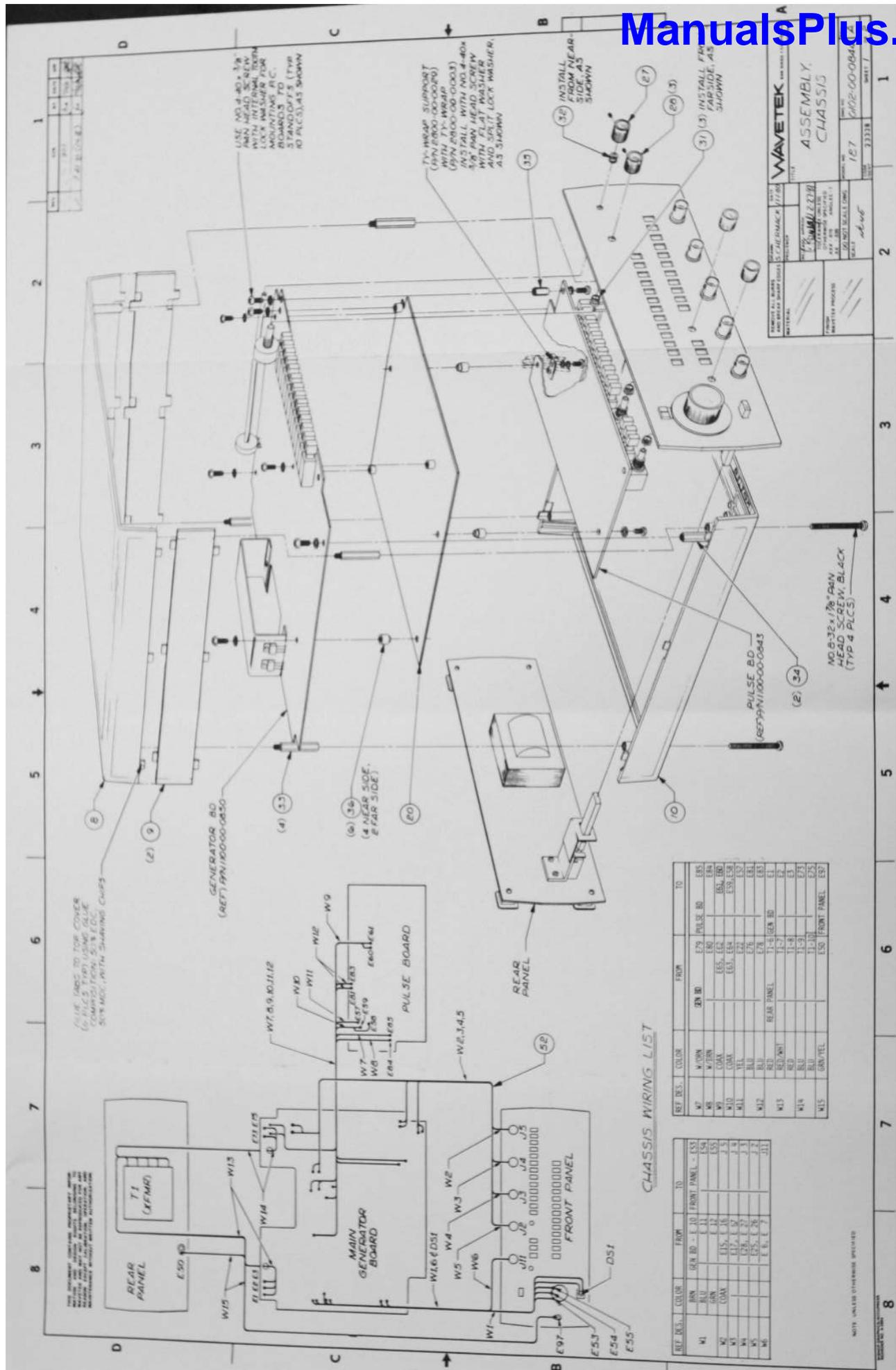
SQUARE SHAPER CONTROL VOLTAGES (MAIN BOARD)

	CR31 Cathode	CR30 Anode
	+15V	-3.4V
	+15V	+2.4V
	-2.5V	-3.4V
	-2.5V	+2.5V
	-2.5V	+2.5V
	-2.5V	+4.3V
	-2.5V	+4.3V

APPENDIX B

WIDTH ONE-SHOT WAVEFORMS (BOTH ONE-SHOTS IDENTICAL)





USE NO. 4-40 x 3/8 AN IN HEAD SCREW WITH INTERMEDIATE MOUNTING STANDOFFS TO MOUNT BOARDS TO CHASSIS AS SHOWN

GENERATOR BO (REF) PN/100-00-0850

(6) 24 (4 NEAR SIDE, 2 FAR SIDE)

PULSE B.O (REF) PN/100-00-0843

NO. 8-32 x 1 7/8 PAN HEAD SCREW, BLACK (TYP 4 PLCS)

REAR PANEL (KFM)

PULSE BOARD

REAR PANEL

FRONT PANEL

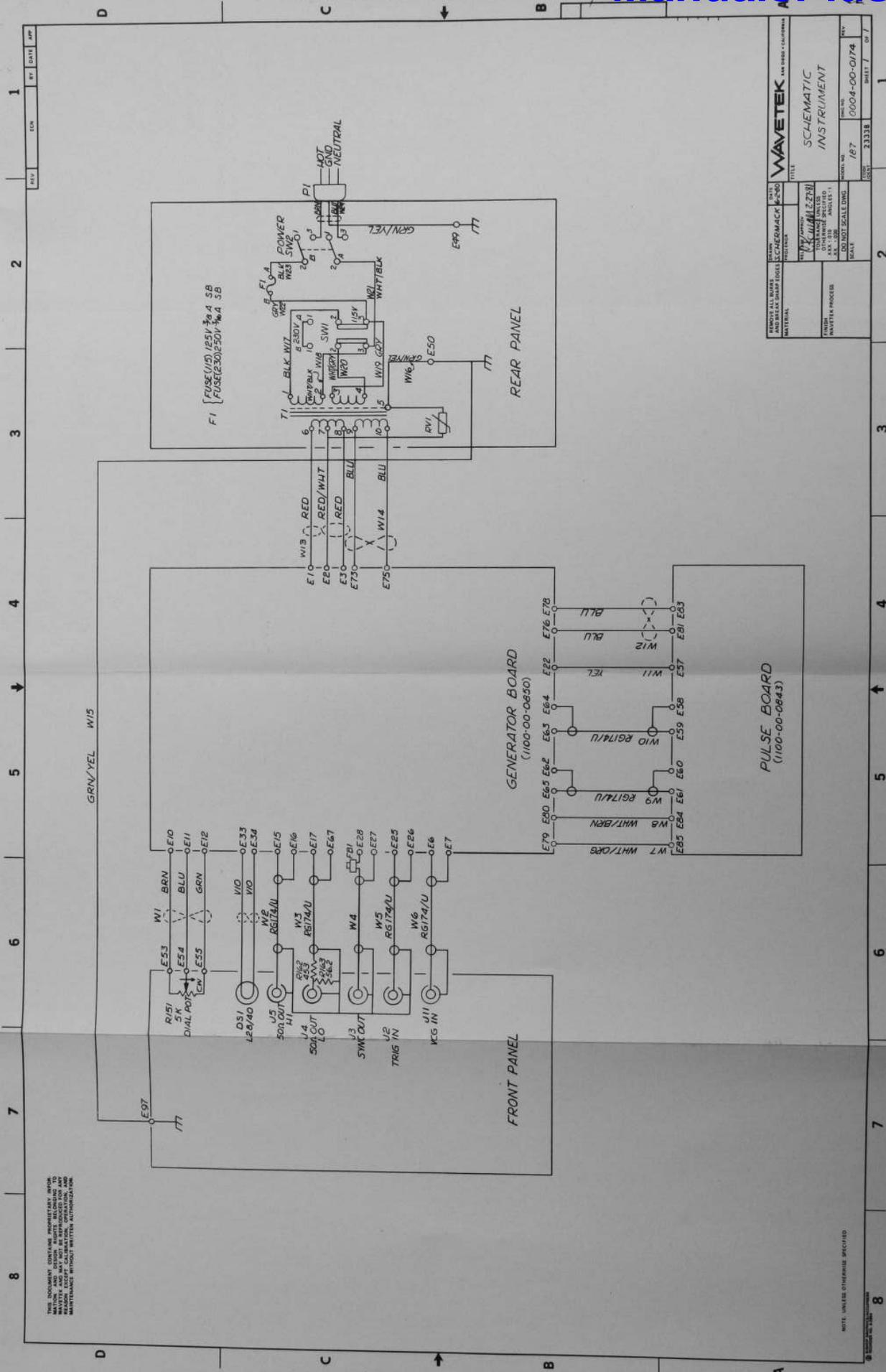
MAIN GENERATOR BOARD

CHASSIS WIRING LIST

REF DES.	COLOR	FROM	TO
W7	W/ORN	E79	PULSE BO E85
W8	W/ORN	E80	E84
W9	COAX	E85, E86	REAR PANEL E84, E86
W10	COAX	E83, E84	E59, E58
W11	BLU	E82	E81
W12	BLU	E78	E81
W13	RET/WHI	11-4	REAR PANEL E1
W14	RED	11-4	E3
W15	GRN/PYL	E50	FRONT PANEL E57

REF DES.	COLOR	FROM	TO
M1	BLU	GEN BO - 11	FRONT PANEL - E54
M2	COAX	E15, E16	E55
M3	BLU	E17, E18	J-5
M4	WHT	E19, E20	J-4
M5	WHT	E21, E22	J-3
M6	WHT	E23, E24	J-2
M7	WHT	E25, E26	J-1

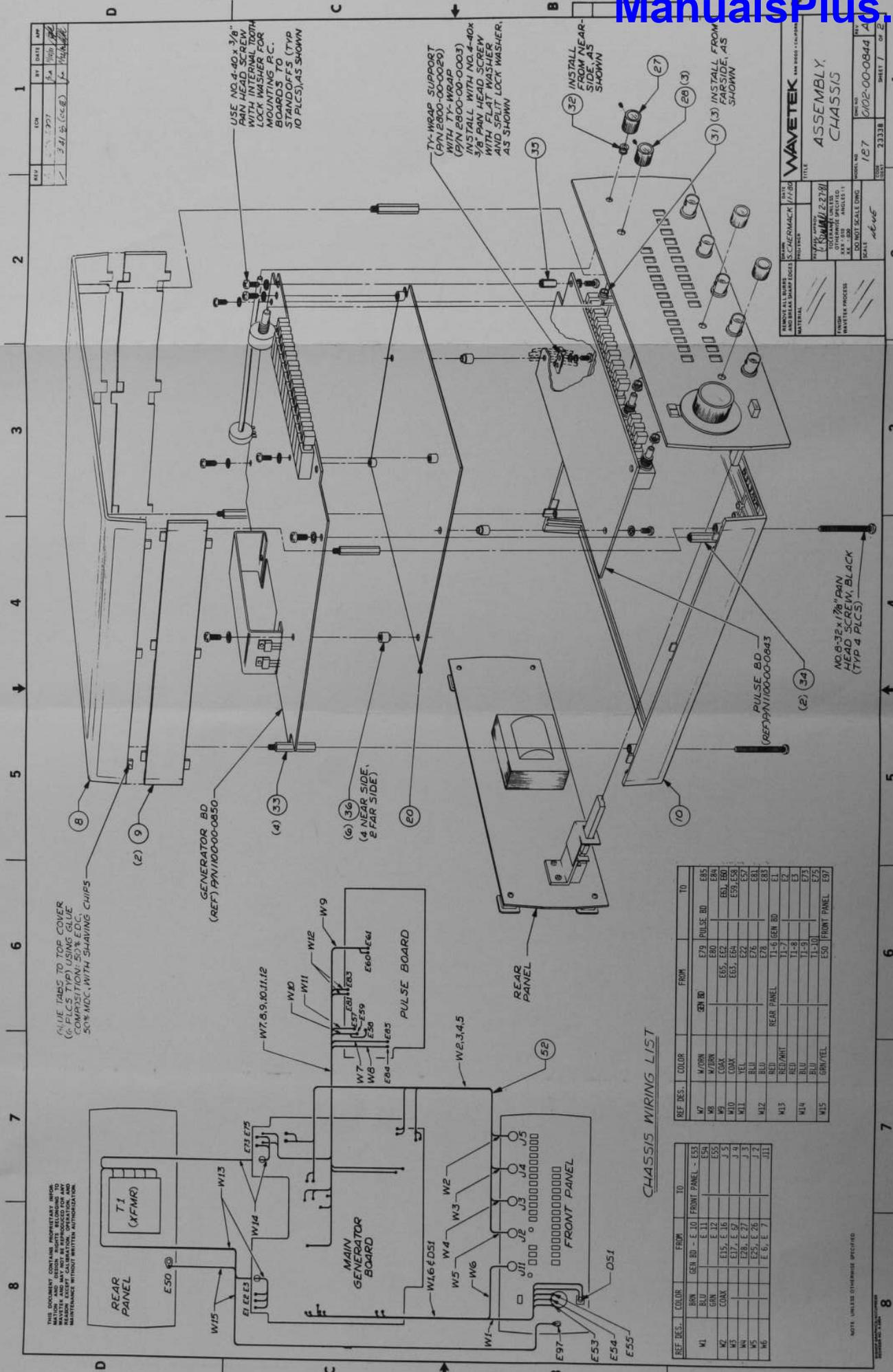
WAVETEK
ASSEMBLY CHASSIS
127 33338
100-00-0843
REV. 1



THIS SCHEMATIC SHOWS THE INSTRUMENT AS SHOWN IN THE PHOTOGRAPH. THE INSTRUMENT IS SHOWN WITH THE FRONT PANEL REMOVED. THE INSTRUMENT IS SHOWN WITH THE FRONT PANEL REMOVED. THE INSTRUMENT IS SHOWN WITH THE FRONT PANEL REMOVED.

NOTE: UNLESS OTHERWISE SPECIFIED, ALL COMPONENTS ARE TO BE OBTAINED FROM THE MANUFACTURER'S LISTING.

REV.	DATE	APP.
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<p>WAVETEK SCHEMATIC INSTRUMENT</p>		
PROJECT NO.	REV. NO.	DATE
0004-00-0174	187	
SCALE	DO NOT SCALE DIMS	
33338		
<p>WAVETEK SCHEMATIC INSTRUMENT</p>		
PROJECT NO.	REV. NO.	DATE
0004-00-0174	187	
SCALE	DO NOT SCALE DIMS	
33338		



REV	CON	BY	DATE	APP
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2	1	1	1/77	1
3	1	1	1/77	1

USE NO. 4-40 x 3/8" PAN HEAD SCREW WITH WASHERS OR MOUNTING P.C. STANDOFFS (TYP 10 PLS), AS SHOWN

TY-WRAP SUPPORT (P/N 2800-00-0026) WITH TY-WRAP (P/N 2800-00-0003) 3/8" TALL WITH NO. 4-40x 3/8" PAN HEAD SCREW WITH ELASTIC WASHER AND SPLIT LOCK WASHER, AS SHOWN

INSTALL FROM NEAR SIDE AS SHOWN

INSTALL FROM FAR SIDE, AS SHOWN

NO. 6-32 x 1/8" PAN HEAD SCREW, BLACK (TYP 4 PLS)

GLUE TABS TO TOP COVER (6 PLS TYP) USING GLUE COMPOSITION: 50% EDC, 50% MDC, WITH SHAVING CHIPS

GENERATOR BD (REF) P/N 100-00-0850

PULSE BD (REF) P/N 100-00-0843

REAR PANEL

FRONT PANEL

MAIN GENERATOR BOARD

T1 (XFMR)

REAR PANEL

FRONT PANEL

MAIN GENERATOR BOARD

T1 (XFMR)

REAR PANEL

FRONT PANEL

MAIN GENERATOR BOARD

T1 (XFMR)

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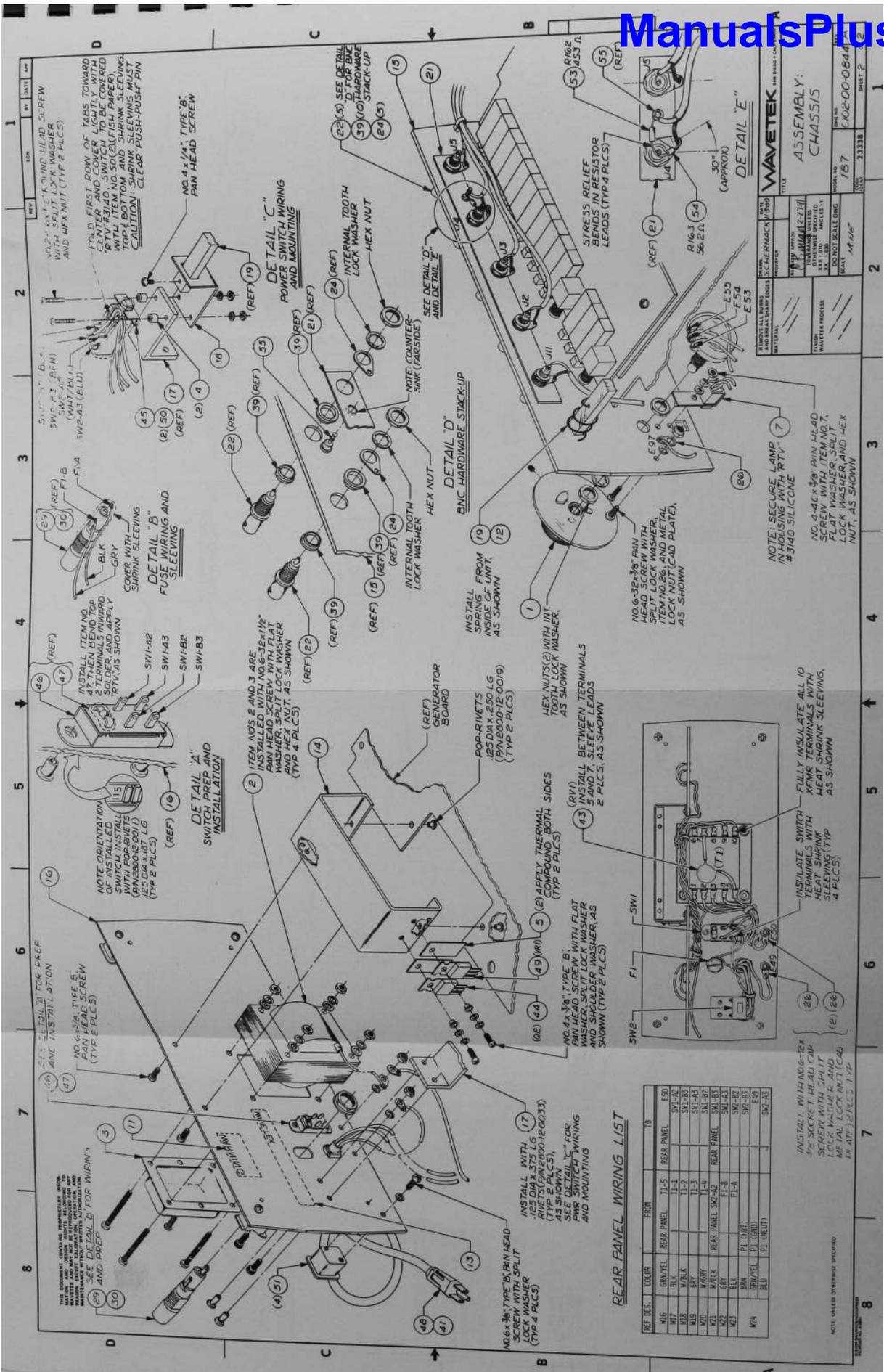
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T1 (XFMR)



WAVETEK
ASSEMBLY:
CHASSIS

SCALE: 1/8" = 1"

DATE: 1/87

REV: 33338

SHEET 2

REMOVE ALL WIRING FROM CHASSIS MARKED WITH THIS SYMBOL

WAVETEK

WAVETEK PROCESS

WAVETEK

NOTE: SECURE LAMP IN HOUSING WITH RTV #3140 SILICONE

NO. 4-40 x 3/8" PAN HEAD SPLIT LOCK WASHER, FLAT WASHER, SPLIT LOCK NUT, AND HEX NUT, AS SHOWN

INSTALL WITH RTV #3140 SILICONE

NO. 4-40 x 3/8" PAN HEAD SPLIT LOCK WASHER, FLAT WASHER, SPLIT LOCK NUT, AND HEX NUT, AS SHOWN

HEX NUTS (2) WITH INT. TOOTH LOCK WASHER, AS SHOWN

HEX NUTS (2) BETWEEN TERMINALS AND T. SLEEVE LEADS, AS SHOWN

APPLY THERMAL COMPOUND BOTH SIDES (RV1) (TYPE P PLCS)

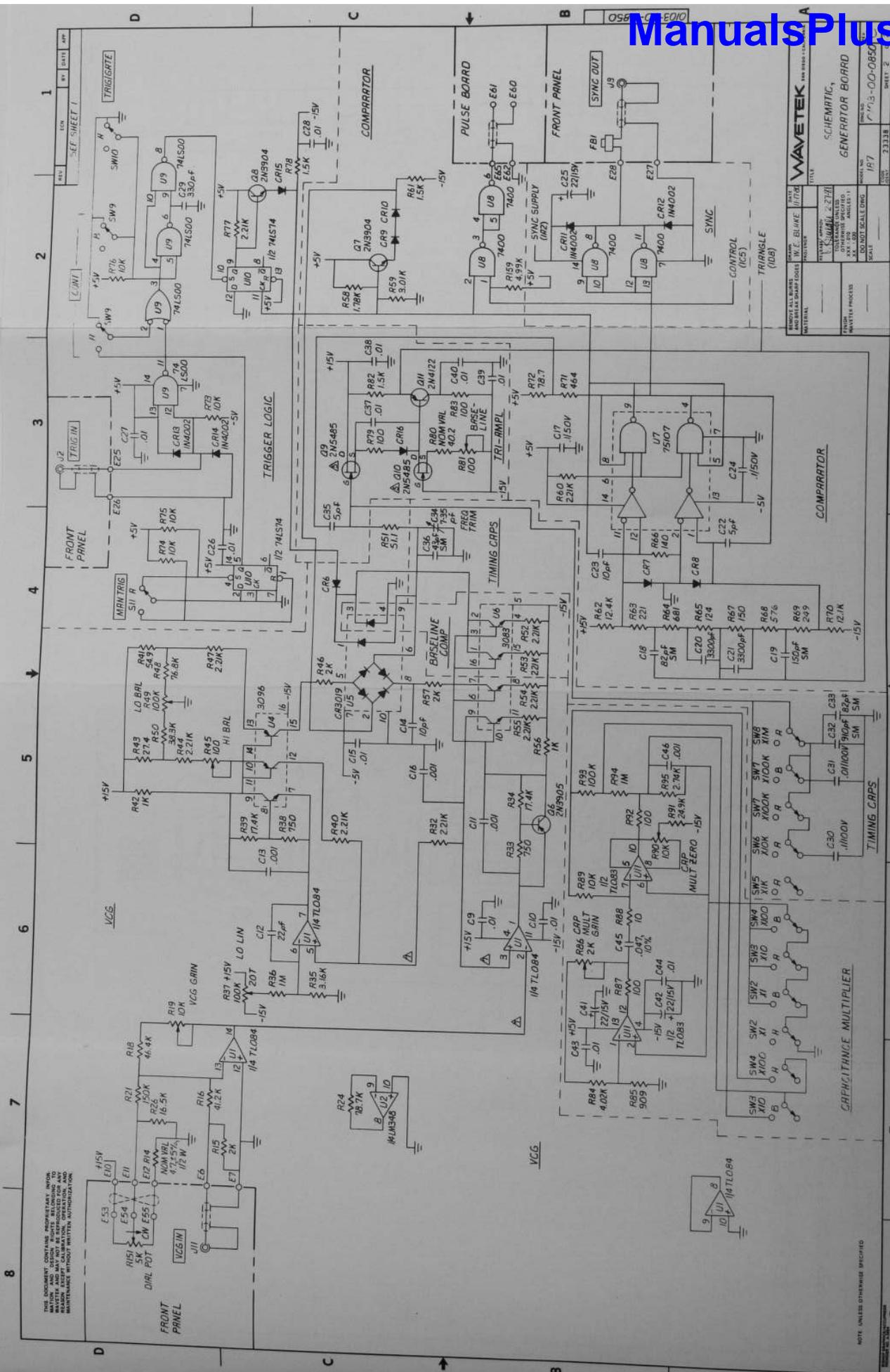
ITEM NOS 2 AND 3 ARE INSTALLED WITH NO. 6-32 x 1/2" SPLIT LOCK WASHER, SPLIT LOCK WASHER, SPLIT LOCK NUT, AND HEX NUT, AS SHOWN (TYPE P PLCS)

INSULATE SWITCH TERMINALS WITH HEAT SHRINK SLEEVING (TYP 4 PLCS)

FULLY INSULATE ALL 10 X-FEM TERMINALS WITH HEAT SHRINK SLEEVING (TYP 4 PLCS)

INSTALL WITH NO. 6-32 x 1/2" SOCKET HEAD CAP SCREW WITH SPLIT LOCK WASHER AND METAL LOCK NUT (C4) IN RTV #3140 SILICONE

NOTE: UNLESS OTHERWISE SPECIFIED

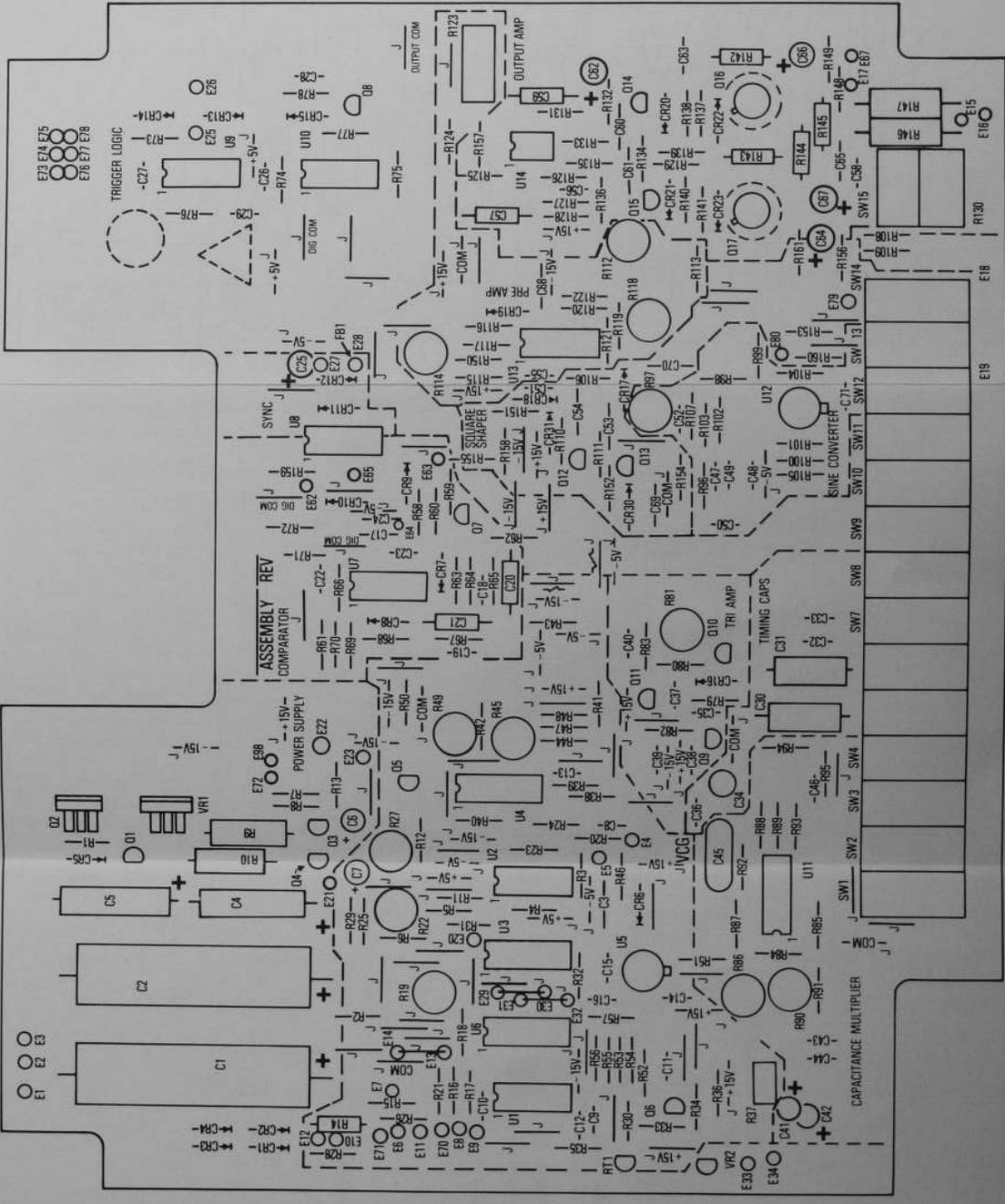


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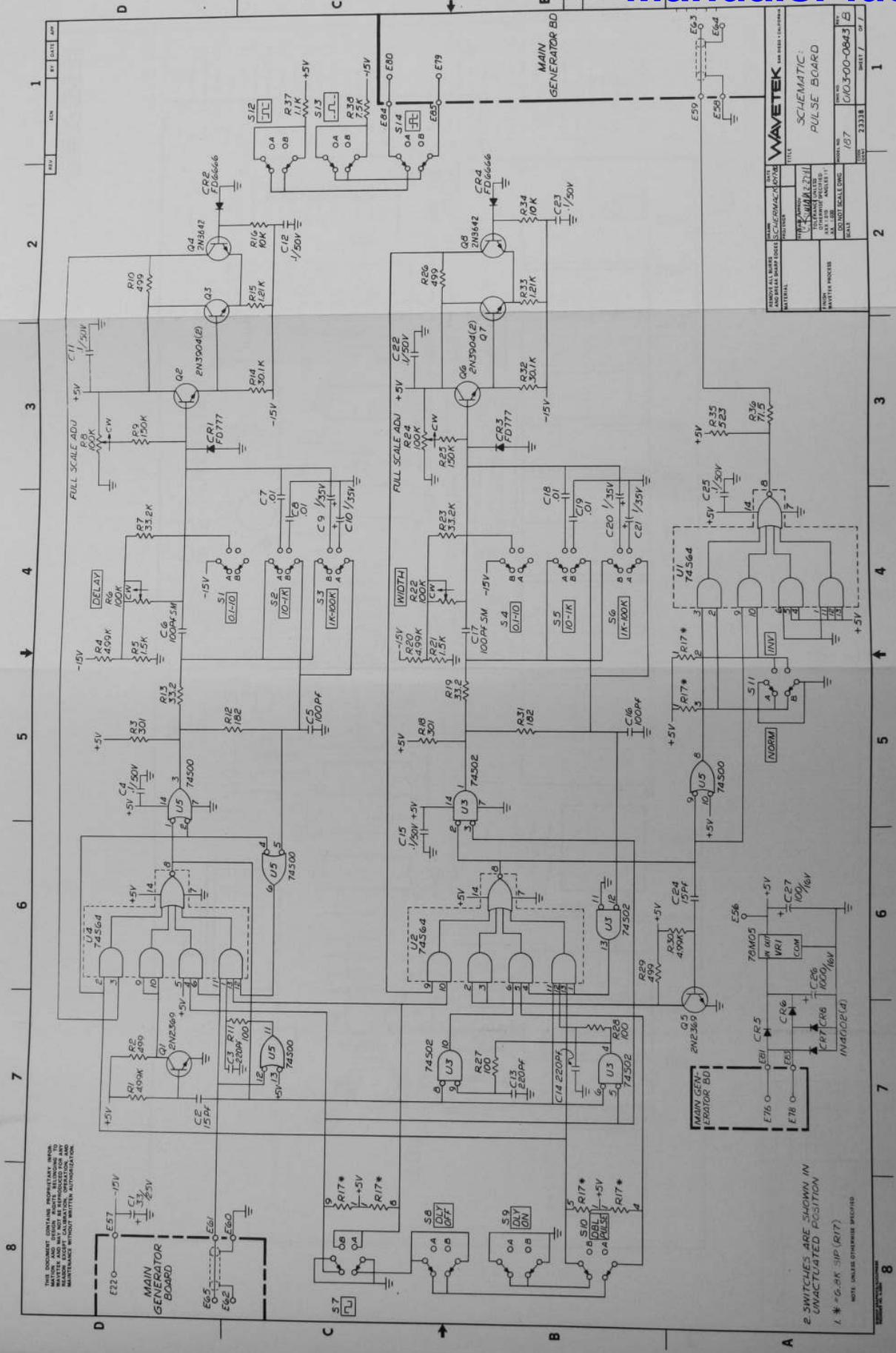
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WAVETEK
 SCHEMATIC
 GENERATOR BOARD
 MODEL: 713-00-0850
 PART: 1/87
 REV: 3338
 SHEET 2

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TITLE		WAVE TEK	
GENERATOR BD		100-00-0850	
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MATERIAL		WAVE TEK	
PROCESS		WAVE TEK	
SHEET		SHEET 1	



DATE	REV	BY	DATE	APP
WAVETEK				
SCHEMATIC: PULSE BOARD				
PART NO. 1003-00-0843 1B				
REV. 107				
ISSUE 23338				
SHEET 7 OF 7				

THIS SCHEMATIC IS THE PROPERTY OF WAVETEK CORPORATION. IT IS TO BE USED ONLY FOR THE PURPOSES SPECIFIED IN THE ORIGINAL ORDER. NO PARTS OF THIS SCHEMATIC ARE TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM, WITHOUT WRITTEN AUTHORIZATION.

2 SWITCHES ARE SHOWN IN UNACTUATED POSITION
1. * = 1/2 WATT 5% (R17)

NOTE: UNLESS OTHERWISE SPECIFIED

SEE DOCUMENTS CONTAINING IDENTIFYING MARKS, MATRICES, AND SYMBOLS WHICH BELONG TO MANUFACTURERS OF MATERIALS, EQUIPMENT, AND TOOLS. THESE MARKS, MATRICES, AND SYMBOLS ARE NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

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