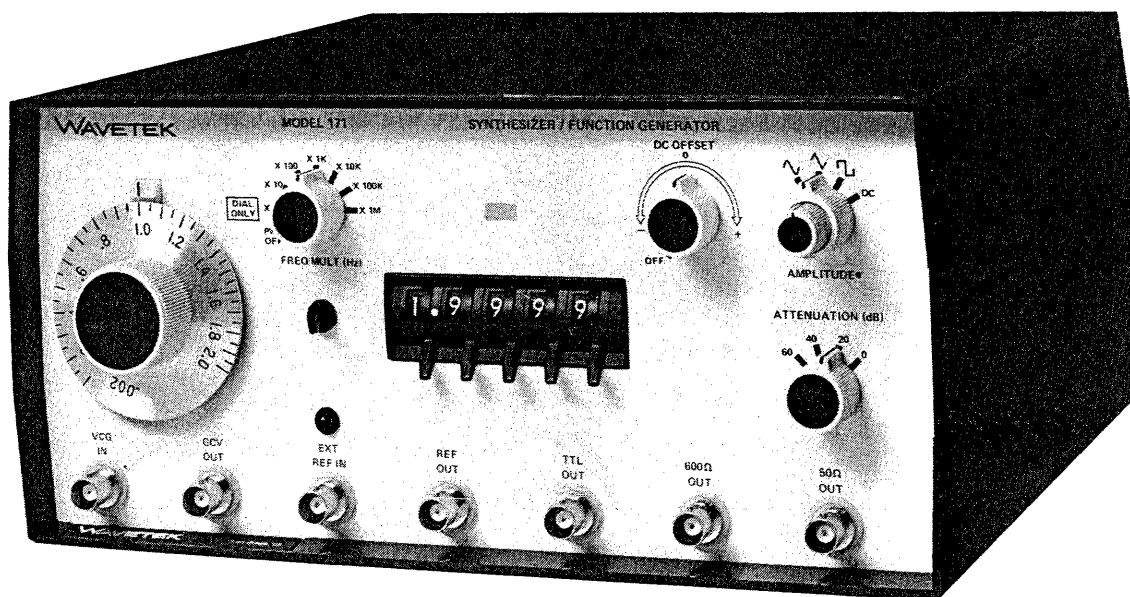


MODEL 171 SYNTHESIZER / FUNCTION GENERATOR



WAVETEK

MODEL 171

SYNTHESIZER/FUNCTION GENERATOR

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Manual Revision: 5/82
Instrument Release: L

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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

INTRODUCTION

1.1 THE MODEL 171

The Wavetek Model 171 Synthesizer/Function Generator is a precision source of sine, triangle and square waveforms and dc voltage. The generator combines the precision frequency of a synthesizer with the versatility and operating convenience of a function generator. The two major modes of operation are synthesizer and function generator.

Function generator output frequency can be varied from 0.1 Hz to 2 MHz in seven ranges manually by dial and remotely by an applied voltage. In addition to this analog control of frequency, the Model 171 has a 4½ digit switch for synthesizer control of function generator frequency. The synthesizer gives precision (0.005%) frequency accuracy and stability (0.0001%/°C) from 1.000 Hz to 1.9999 MHz in six ranges. When the synthesizer is used to set the frequency, in addition to greater frequency accuracy and stability, the waveform purity is improved over that of the function generator alone.

Amplitude of the waveform is continuously variable from 10V peak-to-peak in a matching termination load (50Ω or 600Ω) down to 10 mV peak-to-peak in four ranges of attenuation (0, 20, 40, 60 dB). DC reference of the waveforms can be offset positively and negatively. The synthesizer can be locked to its own internal reference or to an external 1 MHz reference.

1.2 SPECIFICATIONS

The available waveforms, frequencies, amplitudes, operating modes, precision (accuracy) and purity (quality) are listed in the following paragraphs.

1.2.1 Versatility

Output Signals

Sine \sim , triangle ∇ , square \square and DC selectable. TTL pulse \square , 1 MHz reference pulse \square and GCV signal proportional to output frequency are also available.

Control

Generator operates in continuous mode. Frequency is controlled manually by dial or digital switch, or externally thru VCG input voltage. Digital switch is operable between 0.1000 and 1.9999 settings and works with all frequency multipliers except X 1.

Frequency Range

0.1 Hz to 2 MHz in seven overlapping ranges.

Operating Frequency Ranges

FREQ MULT	Range	Digital Resolution
X 1	0.1 Hz to 2 Hz	N. A.
X 10	0.1 Hz to 20 Hz	0.001 Hz
X 100	0.2 Hz to 200 Hz	0.01 Hz
X 1K	0.2 Hz to 2 kHz	0.1 Hz
X 10K	20 Hz to 20 kHz	1.0 Hz
X 100K	200 Hz to 200 kHz	10 Hz
X 1M	2 kHz to 2 MHz	100 Hz

NOTE

Digital switch valid with all frequency multipliers except X 1 (first range). Frequency ratio of 1000:1 on dial, 20:1 on digital switch.

Main Output

\sim , ∇ , \square ; variable to 20V p-p into open circuit and 10V p-p with matching load at either 50Ω OUT or 600Ω OUT. DC offset of waveform (or DC if selected) is adjustable to ±10 volts open circuit and ±5 volts into matching load. Waveform plus offset is limited to ±10V peak (open circuit).

Output waveforms can be attenuated from 0 dB to 80 dB: 60 dB in 20 dB steps plus a 20 dB vernier for continuous variation (20 dB vernier does not affect offset or DC output).

Optional output protection circuit of zeners and fuses protect both output and common sides from inadvertent connection to external voltage or ac line.

DC Offset and DC Output

DC offset of waveform and DC output are selectable and variable thru ±10V (±5V into matching load). Waveform plus offset is limited to ±10V peak (open circuit). Step attenuator attenuates dc level.

Generator Frequency TTL Output

TTL pulse has an approximately 50% duty cycle at generator frequency and can drive up to 20 TTL loads.

Optional TTL buffer circuit provides high power TTL compatible signal capable of driving load impedances as low as 50Ω.

GCV (Generator Controlled Voltage) Output

0 to +2V (nominal, open circuit) proportional to frequency of main generator. Output impedance 600Ω.

VCG (Voltage Controlled Generator) Input

In function generator mode only, VCG voltage as well as dial settings select generator frequency. Frequency may be dc-programmed or ac-modulated by external 0 to 2V signal. Input impedance is 2 kΩ. VCG input can change generator output 1000:1 in function generator mode on all ranges (limited by a minimum VCG frequency of 0.1 Hz).
VCG Input Signal Bandwidth: 100 kHz.
VCG Slew Rate: 0.1 V/μs.

External Reference Input

1 MHz sine or square wave external reference clock signal of 1 Vrms to 10 Vrms. 5 kΩ input impedance.

Reference Output

TTL level 1 MHz pulse train output when in the synthesizer mode.

Optional TTL buffer circuit provides high power TTL compatible signal capable of driving load impedances as low as 50Ω.

1.2.2 Operating Modes

Synthesizer

Operates as a synthesizer with function generator outputs locked to the synthesizer frequency. The frequency is determined by the frequency multiplier switch and the digital switch settings. The digital switch is operable from 0.1000 and 1.9999 on all ranges above the X 1 range.

Voltage Controlled Generator (VCG)

Operates as a conventional VCG. The frequency is controlled by the dial, multiplier switch and external VCG voltage on all ranges.

1.2.3 Horizontal Precision

Synthesizer Operation

Accuracy: 0.005% of setting.
Stability: 1 ppm per degree C.
Internal Frequency Standard: 4 MHz crystal with an aging rate of 20 ppm per year.
Locking Time: Within 10% of final frequency in < 100 ms; within 0.01% of final frequency on X 1K, X 10K, X 100K and X 1M ranges in < 300 ms, X 100 in < 2s, X 10 in < 20s.

Dial/VCG Operation

Dial Accuracy: ±3% of full scale for 0.1 Hz to 200 kHz; ±5% of full scale for 200 kHz to 2 MHz.

Time Symmetry

±1% on all ranges except X 1M range.

1.2.4 Vertical Precision

Amplitude Change With Frequency (Sine)

Less than ±0.1 dB on all ranges thru X 100K.
Less than ±0.5 dB on X 1M range.

1.2.5 Waveform Purity

Harmonic Distortion

Less than 0.5% to 20 kHz (typically 0.2%).
Less than 1.0% to 200 kHz (typically 0.5%).
All harmonics 30 dB below fundamental on X 1M range.

Spurious Signals

Typically 70 dB below fundamental to 20 kHz and 40 dB below fundamental to 2 MHz (in synthesizer mode only).

Integrated Signal to Phase Noise

Typically 30 dB to 200 kHz measured over ±15 kHz bandwidth excluding carrier ±10 Hz (in synthesizer mode only).

Square Wave Rise and Fall Time

Less than 75 ns.

Triangle Linearity

Greater than 99% to 200 kHz.

TTL Pulse Rise and Fall Time

Less than 25 ns (15 ns typical).

1.2.6 Environmental

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

1.2.7 Mechanical

Dimensions

11¼ in./28.6 cm wide; 5¼ in./13.3 cm high; 10¼ in./27.3 cm deep.

Weight

8.5 lb/3.85 kg net; 12 lb/5.5 kg shipping.

1.2.8 Power

90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 18 watts.

NOTE

All specifications apply when frequency dial is between 0.1 and 2.0 or digital switch is between 0.1000 and 1.9999, amplitude is at 10V p-p and output is from the 50Ω BNC into a 50Ω load.

SECTION 2

INITIAL PREPARATION

2.1 UNPACKING INSPECTION

After carefully unpacking the instrument, inspect the external parts for damage to knobs, dials, indicators, surface areas, etc. If there is damage, file a claim with the carrier who transported the instrument. Retain the shipping container and packing material for use in case reshipment is required.

2.2 PREPARATION FOR USE

Before connecting the instrument to line power, be sure the rear panel 115/230V and HI/LO switches are set to the value nearest the line voltage and that the fuse is correct for the switch setting. Be sure that the plug on the power cord is the proper mate for the line receptacle.

AC Line Voltage	Switch A	Switch B	Fuse (SB)
90 - 110	115	LO	3/8 amp
105 - 125	115	HI	3/8 amp
180 - 220	230	LO	3/16 amp
210 - 250	230	HI	3/16 amp

2.3 ELECTRICAL ACCEPTANCE CHECK

This checkout procedure verifies the generator operation. If a malfunction is found, refer to the Warranty in the front of the manual. An oscilloscope, counter, three short lengths of 50Ω coax cable, a 50Ω feedthru load and a 0 to ±2V

voltage source are required (figure 2-1). Circled numbers index controls and connectors to figure 3-1.

1. Preset the generator front panel controls as follows:

Control	Position
Frequency Dial ①	1.0
FREQ MULT	X 1K
Digital Switch ④	1.9999
DC OFFSET	OFF
Waveform Selector ⑥	~
AMPLITUDE	Full cw
ATTENUATION	0
Dial/Digital Switch ②	Toward Dial

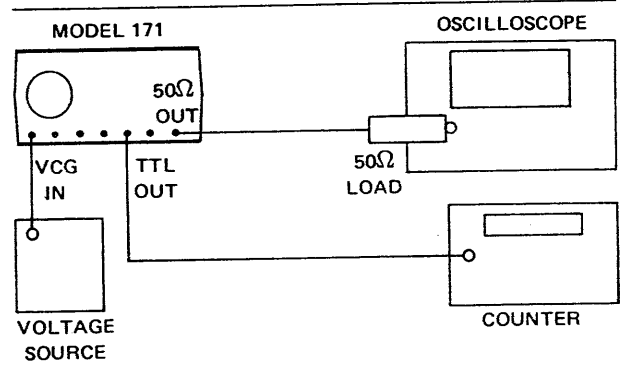


Figure 2-1. Performance Checkout Setup

Table 2-1. Performance Checkout

Step	Control	Position/Operation	Observe
Function			
1	Adjust the oscilloscope for several cycles of sine wave.		
2	Waveform Selector	~ , ⊓ , DC, ~	Waveform changes from ~ to ~ to ⊓ to a 0V dc level then ~ .
Amplitude			
1	AMPLITUDE	Ccw to 12 o'clock	Waveform amplitude reduces.

Table 2-1. Performance Checkout (Continued)

Step	Control	Position/Operation	Observe
2	DC OFFSET	9 o'clock, then slowly to full cw (return to OFF)	Waveform offset negatively, then positively (clipping may occur).
3	ATTENUATION	20, 40, 60 (return to 0)	Waveform amplitude decreases with each step.
Outputs			
1	Remove 50Ω load and reconnect cable. Remove the 50Ω OUT connection and place it on the 600Ω OUT BNC.		Unloaded 50Ω OUT and 600Ω OUT are identical.
2	Remove the 600Ω OUT connection and place it on the TTL OUT.		Square pulse at 1 kHz.
3	Remove the TTL OUT connection and place it on the REF OUT. Flip dial/digital switch selector to digital switch side.		1 MHz pulse.
4	Remove the REF OUT connection and place it on the GCV OUT.		2 Vdc level.
5	Flip dial/digital switch selector to dial side.		1 Vdc level.
Frequency			
1	Remove GCV OUT connection and place on 50Ω OUT.		
2	FREQ MULT	Use each multiplier X 1 thru X 1M (return to X 1).	Observe an increase in frequency while stepping from X 1 to X 1M.
3	Dial	Vary from 2.0 to .2 (return to .2).	Observe a corresponding change in frequency.
4	Connect a 0 to ±2V source to the VCG IN BNC. Vary the voltage positively.		Observe a change in frequency proportional to the change in VCG voltage.
5	Dial	2.0	
6	Voltage Source	Vary the voltage negatively.	Observe a change in frequency proportional to the VCG voltage.
7	Disconnect the voltage source.		
8	Dial/Digital Switch Selector	Switch toward the digital switch.	1.9999 kHz.
9	Digital Switch	Set each position of the digital switch.	Observe counter readout corresponding to set of digital switch.

SECTION 3

OPERATION

3.1 CONTROLS AND CONNECTORS

The generator front panel controls and connections shown in figure 3-1 are keyed by circled numbers to the following descriptions.

① Frequency Dial

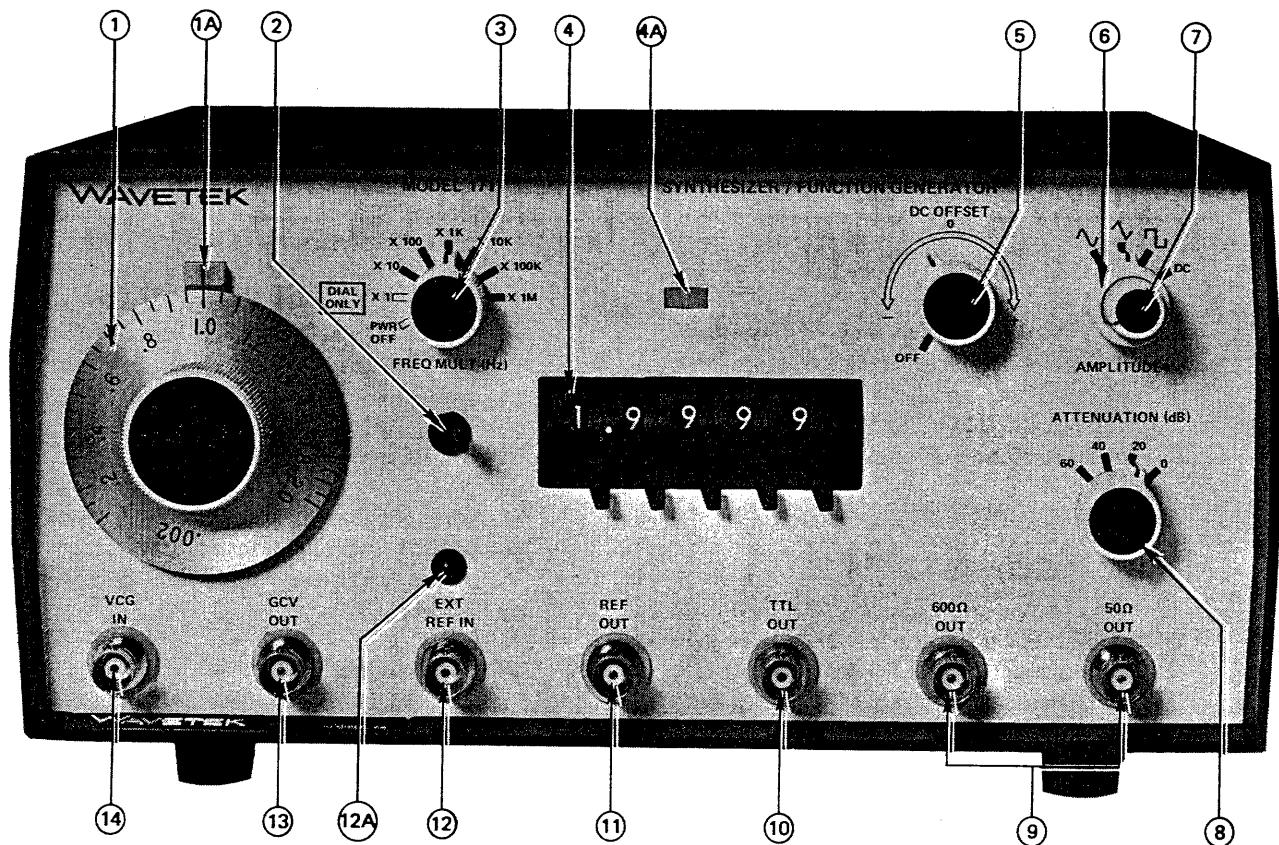
When the frequency dial is selected by the dial/digital switch selector ② the index ①A lights and the frequency output is determined by the dial, FREQ MULT ③ and VCG ⑭ voltage.

② Dial/Digital Switch Selector

Places the instrument in either function generator (dial controlled) or synthesizer (digital switch controlled) mode. Respective dial index ①A or digital switch index ④A lights to indicate operation mode.

③ FREQ MULT (Hz)

Power is turned on when frequency range is selected at FREQ MULT. The multipliers are for the dial ① and digital switch ④ readings and the VCG ⑭ voltage.



④ Digital Switch

When the digital switch is selected by the dial/digital switch selector ② the index ④A lights and the frequency output is determined by the digital switch and the FREQ MULT.

⑤ DC OFFSET

Rotating DC OFFSET clockwise past 12 o'clock offsets dc output or dc center reference of the output waveform positive; when counterclockwise, negative. When OFF, the dc output is signal ground or the output waveform is balanced around signal ground (0V in figure 3-2).

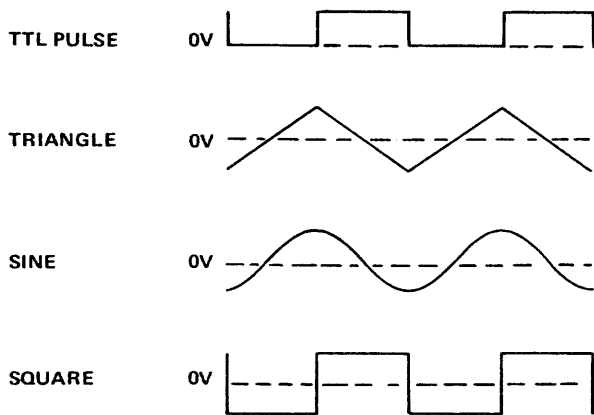


Figure 3-2. Output Waveforms

⑥ \sim , \wedge , \sqcap and DC (Waveforms)

Sine \sim , triangle \wedge and square \sqcap waveforms are selected by the larger of the two concentric controls; the DC position provides a dc voltage output controlled by DC OFFSET. Outputs appear at 50Ω OUT and 600Ω OUT.

⑦ AMPLITUDE

Rotating AMPLITUDE fully clockwise provides maximum peak-to-peak output at 50Ω OUT and 600Ω OUT; rotating counterclockwise gives up to 20 dB attenuation. Also see ATTENUATION ⑧. AMPLITUDE does not affect dc offset or dc output.

⑧ ATTENUATION

With a 600Ω load on the 600Ω OUT connector or a 50Ω load on the 50Ω OUT connector, output voltage for each attenuation is:

Attenuation	Amplitude Control	
	Full cw	Full ccw
0	10V p-p	1V p-p
20	1V p-p	100 mV p-p
40	100 mV p-p	10 mV p-p
60	10 mV p-p	(Not specified)

⑨ 600Ω OUT and 50Ω OUT Connectors

600Ω OUT and 50Ω OUT provide variable frequency and amplitude \sim , \wedge , \sqcap and DC. Maximum signal amplitude is 10V p-p with matching loads (20V p-p into open circuit).

⑩ TTL OUT Connector

A fixed amplitude Transistor-Transistor Logic (TTL) square pulse train of the output frequency. (TTL levels are 0V to 0.4V for a logic low and 2.4V to 5V for a logic high.) The output can drive up to 20 TTL loads. The pulse train can also be used as a synchronizing reference to 50Ω OUT and 600Ω OUT. Phase of output waveforms relative to the TTL pulse is shown in figure 3-1.

⑪ REF OUT Connector

A fixed amplitude Transistor-Transistor Logic (TTL) pulse train of 1 MHz whose origin is an internal clock oscillator or, if indicator ⑫A is lit, the external reference signal of 1 MHz.

⑫ EXT REF IN Connector

Input for a 1 MHz sine or square wave external reference clock signal. The signal must be at least 1 Vrms. Synthesizer frequencies are referenced to this signal when indicator ⑫A is lit.

⑬ GCV OUT Connector

DC excursions at the Generator Controlled Voltage output (GCV OUT) of 0V to about 2V proportionally represents frequency within the range indicated by FREQ MULT.

⑭ VCG IN Connector

DC excursions at the Voltage Controlled Generator input (VCG IN) proportionally control frequency within the range determined by FREQ MULT. Positive voltage increases the frequency set by the dial ①; negative voltage decreases the frequency. Use in function generator mode only.

3.2 OPERATION

Operation is described as function generator operation and synthesizer operation. The generator is ready to operate as soon as a frequency multiplier is selected.

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 the 50Ω OUT connector is shown in figure 3-3. Placing the 50 ohm terminator, or 50 ohm 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 impedance mismatch.

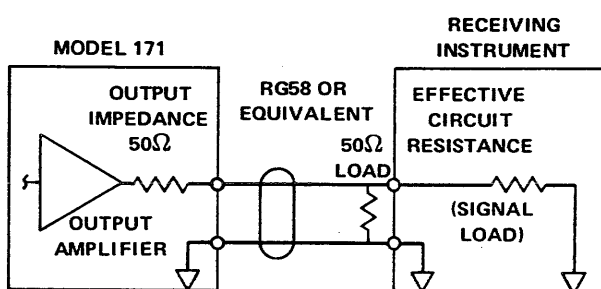


Figure 3-3. Signal Termination

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

Connector	Impedance
50Ω OUT	50Ω
600Ω OUT	600Ω
TTL OUT	*
REF OUT	*
VCG IN	2 kΩ
GCV OUT	600Ω
REF IN	5 kΩ

*The TTL OUT connector 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). REF OUT can drive up to 3 TTL loads. Addition of the TTL buffer option gives these outputs the capability of driving a 50Ω load.

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. (Circled numbers are keys to figure 3-1.)

Step	Control/Connector	Setting
1	50Ω OUT or 600Ω OUT	Connect circuit to either output (refer to paragraph 3.2.1).
2	Dial/Digital Switch Selector ②	Set toward the dial.
3	FREQ MULT	Set to desired range of frequency.
4	Frequency Dial ①	Set to desired frequency within the range.
5	Waveform Selector ⑥	Set to desired waveform.
6	DC OFFSET	Set as desired. Limit waveform amplitude to prevent clipping (see figure 3-4).
7	AMPLITUDE and ATTENUATION	Select for desired amplitude.

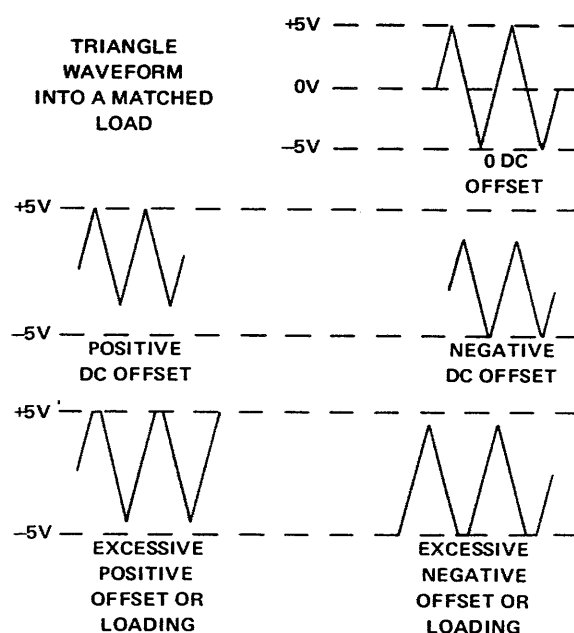


Figure 3-4. DC OFFSET Control

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 with dc levels ($\pm 2V$ 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 dynamic range of the selected frequency range.

Figure 3-5 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.)

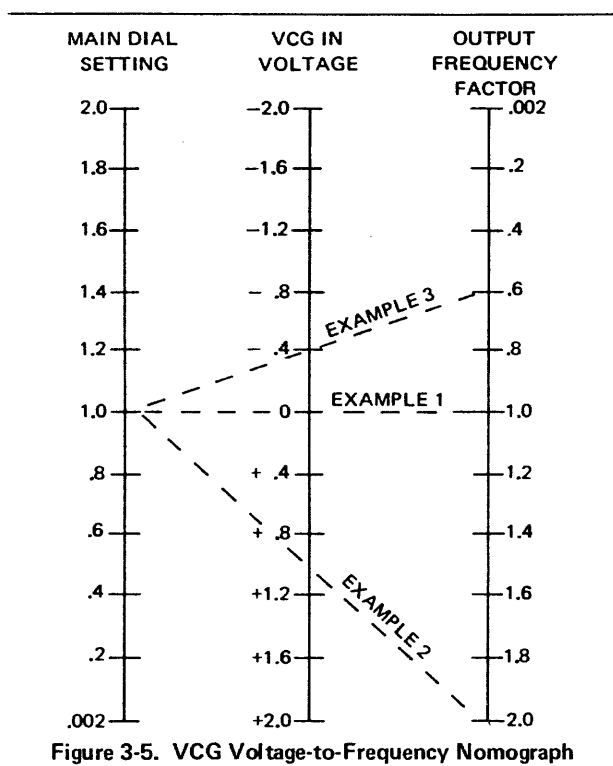


Figure 3-5. VCG Voltage-to-Frequency Nomograph

NOTE

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.

3.2.4 Synthesizer Operation

For synthesizer operation, select the waveform, frequency and amplitude. The following steps demonstrate synthesizer control. (Circled numbers are keys to figure 3-1.)

Step	Control/Connector	Setting
1	50Ω OUT or 600Ω OUT	Connect the circuit to either output (refer to paragraph 3.2.1).
2	Dial/Digital Switch Selector ②	Set toward digital switch.
3	FREQ MULT	Set to desired range of frequency.
4	Digital Switch ④	Set to desired frequency within the range.
5	Waveform Selector ⑥	Set to desired waveform.
6	DC OFFSET	Set as desired. Limit waveform amplitude to prevent clipping (see figure 3-4).
7	AMPLITUDE and ATTENUATION	Select desired amplitude.

Synthesizer frequencies are normally referenced to an internal crystal oscillator. However, an external 1 MHz sine or square wave reference signal can be applied at REF IN; the indicator ⑬A will light, indicating a proper external reference in use.

3.2.5 Monitoring the Synthesizer/Function Generator

Besides the 50Ω OUT and 600Ω OUT main generator outputs, the GCV OUT connector supplies a voltage proportional to the generator frequency, the TTL OUT connector supplies a TTL compatible pulse train at the generator frequency, and the REF OUT supplies a TTL compatible 1MHz pulse train.

The GCV OUT signal is used to drive the frequency axis of an X-Y recorder or oscilloscope; the generator frequency TTL OUT signal is used to synchronize other devices to the generator or to drive TTL level inputs, and the REF OUT signal is used to reference other 171's to a master crystal oscillator.

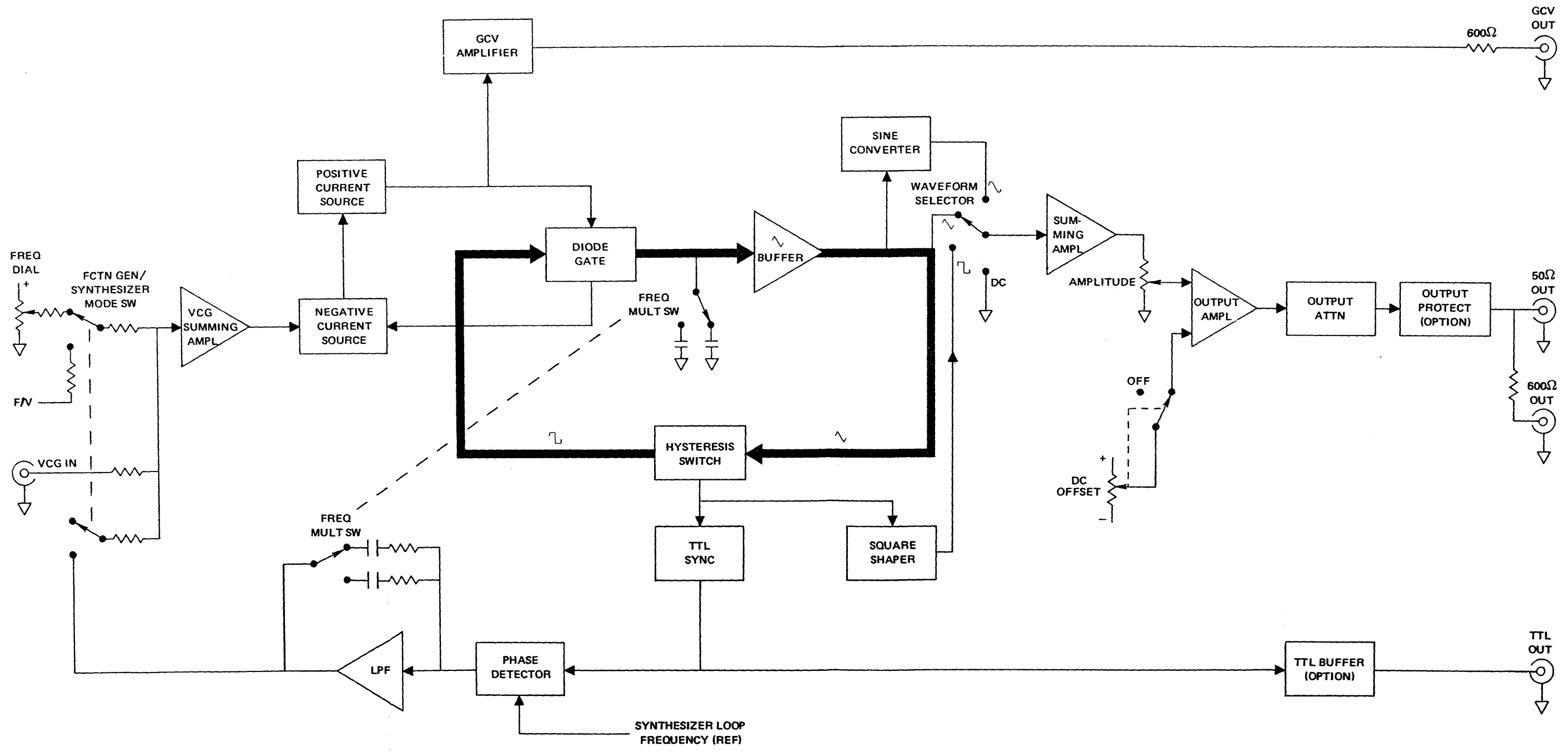


Figure 4-1. Function Generator Block Diagram

SECTION 4

CIRCUIT DESCRIPTION

4.1 FUNCTION GENERATOR

As shown in figure 4-1, the VCG summing amplifier sums the currents from the frequency dial and VCG input connector in function generator mode or from the low pass filter output and the frequency-to-voltage (F/V) converter output in synthesizer mode. The low pass filter is part of the generator frequency phase lock loop which provides a feedback current that corrects generator frequency to be exactly that of the synthesizer loop output. (Phase lock loop operation is described in paragraph 4.5.) The F/V input is also from the synthesizer loop and provides a gross correction to increase the response time of the generator to changes in synthesizer frequency programming.

The VCG summing amplifier is a noninverting buffer whose output current is used to control a positive current source and a negative current source. The currents from the two current sources are equal and opposite polarity and the magnitudes are directly proportional to the current of the VCG summing amplifier output. The diode gate, which is controlled by the hysteresis switch, is used to switch the positive current or the negative current to the integrating capacitor selected by the frequency multiplier. If the positive current is switched into the capacitor, the voltage across the capacitor will increase linearly to generate the positive slope of the triangle wave. If the current is negative, the voltage across the capacitor will decrease linearly to produce the negative slope.

The triangle buffer amplifier is a unity gain amplifier whose output is fed to the hysteresis switch as well as to the sine converter. The hysteresis switch has two voltage limit points (+1.25V and -1.25V). (See figure 4-2.)

During the time the output voltage of the triangle buffer amplifier is increasing, the output voltage of the hysteresis switch is positive, but when the output voltage of the triangle amplifier reaches +1.25V, it triggers the hysteresis switch causing the switch output to become negative. Once the control voltage into the diode gate becomes negative, it will switch the positive current out and switch the negative current in to the integrating capacitor, starting a linear decrease of the voltage across the capacitor. When the decreasing voltage reaches -1.25V, the output of the hysteresis switch will switch back to positive, reversing the process. This action

generates the triangle waveform as shown in figure 4-2. Since the output of the hysteresis switch is a square wave, the result is simultaneous generation of a square wave and triangle wave at the same frequency.

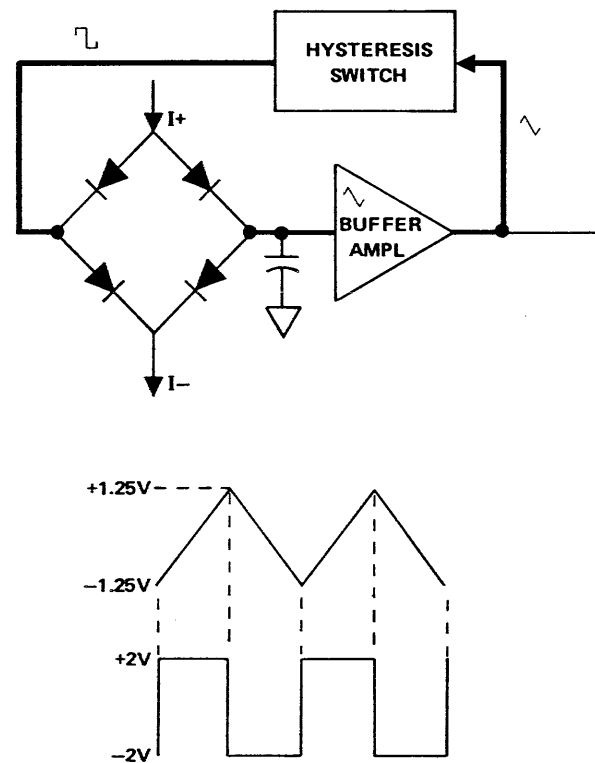


Figure 4-2. Generator Loop and Waveforms

4.2 FREQUENCY CONTROL

The output frequency is determined by the magnitude of the integrating capacitor selected by the frequency multiplier and the magnitude of the positive and negative current sources (figure 4-1). Since the current magnitudes are linearly proportional to the sum of the VCG current, the output frequency will also be linearly proportional to the current sum.

By using current division, the magnitude of the capacitor is effectively increased, allowing the generation of lower fre-

quencies. Figure 4-3 is the simplified diagram showing current divider operation. By reducing integration current precisely by a factor of 10 while holding triangle wave amplitude constant, it is possible to extend the lower frequency range by a factor of 10 with fixed capacitance C. Since points A and B are at the equipotential points, constant current output I can be divided by resistance ratio of R and 9R. Then, integration current of capacitor C is reduced to 0.1 I. The lower current extends the frequency range of the function generator by a factor of 10. The same theory is applied to extend the frequency range by a factor of 100.

4.3 WAVEFORM OUTPUT

The inverted output of the hysteresis switch is fed to the TTL buffer amplifier and also the square wave shaper (figure 4-1). The square wave shaper consists of a shaping circuit which limits the output swing to ± 1.25 volts.

The output signal from the triangle buffer amplifier is applied to the sine converter, which uses a diode-resistor network with nonlinear sections to shape a sine wave.

The sine, triangle or square waveform is fed to the summing amplifier through the waveform selector switch. The output of summing amplifier is fed through the amplitude control to the output amplifier. The output amplifier is an inverting amplifier whose output is capable of driving 10V p-p into selected load impedance.

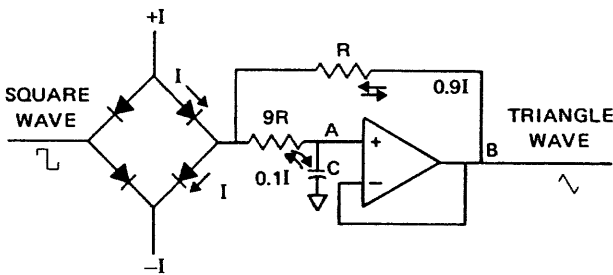


Figure 4-3. Current Divider

4.4 OUTPUT ATTENUATOR AND PROTECTION CIRCUIT

The signal from the output amplifier is routed through an attenuation network for step attenuation. If the optional protection circuit is installed, the instrument output circuits are protected from input voltages by a zener and fuse network protecting both the signal and ground sides of the output BNC's. Two source impedances, 50 and 600 ohms, are provided at the outputs.

4-2

4.5 PHASE LOCK LOOP

A phase lock loop is shown in figure 4-4. The phase detector output is proportional to the difference in frequency between the two inputs. This difference signal is used to control a voltage controlled oscillator (VCO). The VCO output signal is fed back to the phase detector, where the VCO frequency is compared to the reference input to the detector. This reference input is, for example, a constant 1.0000 kHz signal. The loop becomes stable when the VCO frequency equals the reference frequency, at which time the detector difference signal becomes zero.

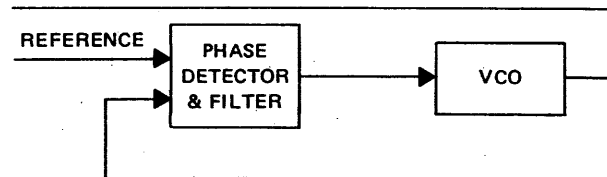


Figure 4-4. Phase Lock Loop

4.6 SYNTHESIZER LOOP

The reference frequency for the synthesizer is provided by an internal 4 MHz crystal or by an external 1 MHz signal (figure 4-5). Either source provides a 1 MHz REF OUT signal which is also reduced to 1.0000 kHz for the reference input to the phase detector.

The phase detector difference signal is a pulse train whose spacing and magnitude reflect the phase difference. The low pass filter (LPF) shown in the synthesizer loop converts this pulse train to a voltage inversely proportional to the phase difference. Noise, particularly 1 kHz, is filtered by the 400 Hz cutoff filter. The dc voltage controls the VCO frequency using a varactor diode as the tunable element.

The programmable divider in the loop ($\div P$) is controlled by the front panel digital switch; for any division of frequency programmed, the loop rapidly drives the phase detector's other input to 1.0000 kHz. For example, if divide by 16000 is programmed, an imbalance is initially set up and the VCO frequency is increased such that $f_{VCO} \div 16000 = 1.0000$ kHz, which returns the loop to a stable condition. (The VCO frequency (f_{VCO}) was 16 MHz.)

The VCO has a tunable range of only 3:1, hence the VCO range has been limited to 8 to 20 MHz. When below 8 MHz from the VCO would be required, a prescaler is placed in the loop, which is also controlled by the digital switch, to keep the division factor large, which in turn keeps VCO frequency greater than 8 MHz. The prescaler output is a 1M to 20 MHz signal. The output of the prescaler is divided by 10 before the frequency ranging circuit to give the frequency equivalent to the digital switch programmed value. The resulting fre-

frequency is divided by a multiple of 10, as controlled by the FREQ MULT range switch, and fed to the function generator phase lock loop (figure 4-1).

A 10k to 200 kHz output is used to create the F/V signal which gives rapid function generator response to frequency changes. A one-shot changes the signal to fixed width pulses whose spacing is frequency dependent. These are converted

to a frequency dependent voltage level at the F/V converter output.

One pole of the function generator/synthesizer mode switch furnishes the ground signal CLK KILL. CLK KILL stops synthesizer loop activity when the instrument is in function generator mode or set on X 1, a dial-only range. Lamps indicating mode are also controlled by this CLK KILL.

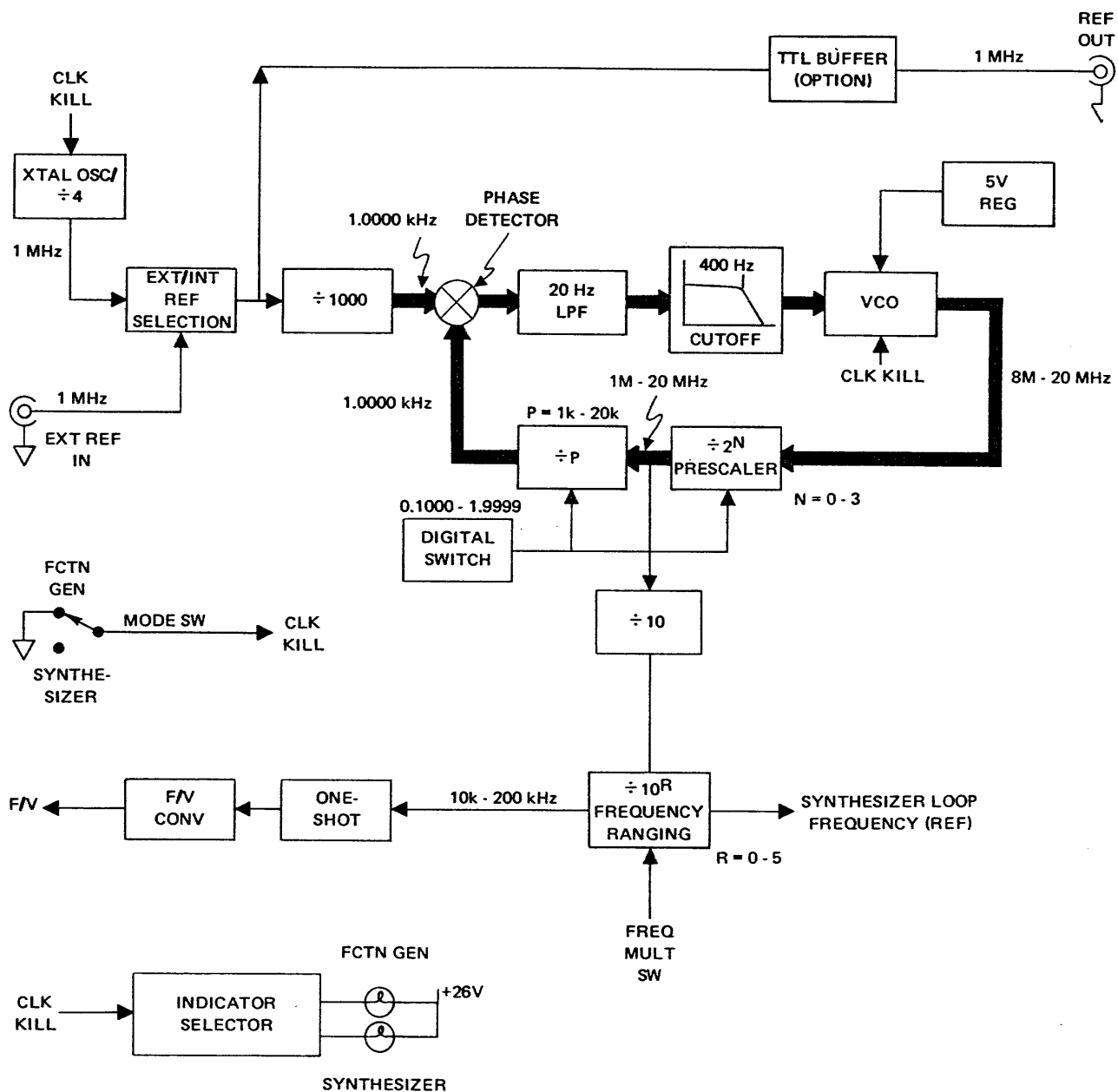


Figure 4-5. Synthesizer Phase Lock Loop

SECTION 5 CALIBRATION

5.1 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 calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

5.2 REQUIRED TEST EQUIPMENT

- DVM (3½ digit)
- Distortion Analyzer (1% F.S.) HP334A
- Oscilloscope (≥ 40 MHz bandwidth, X 10 horizontal magnification, dc triggering to 1 Hz)
- BNC Termination (50Ω ≤ 1%, ≥ 1W)
- Frequency Counter (6 digits, time base accuracy ≥ 50 ppm)
- Low Frequency Spectrum Analyzer HP3580A

5.3 REMOVING GENERATOR COVER

For main board access, remove the four screws in the lower cover, place the instrument on its feet and lift off the top cover. For later access to the synthesizer board, remove the four screws from the inside corners of the lower board that attach it via standoffs to the lower cover. Do not remove the lower cover unless necessary, because it supports front and rear panels.

5.4 CALIBRATION

After referring to the following preliminary data, perform calibration, as necessary, per table 5-1. If performing partial calibration, check previous settings and adjustments for applicability.

1. Unless otherwise noted, all measurements made at the 50Ω OUT connector should be terminated into a 50Ω (≤ 1%, 1W) load.
2. Before connecting the unit to an ac source, check the ac line circuit to make sure the 115/230 volt switch is set at the correct position (see paragraph 2.2).
3. Start the calibration by setting the front panel switches as follows:

```

Dial ..... 2.0
FREQ MULT ..... X 1K
Mode (toggle switch) ..... Toward Dial
Digital Switch ..... 0.1000
DC OFFSET ..... OFF
Function ..... DC
AMPLITUDE ..... ccw
ATTENUATION ..... 0
  
```

4. Allow the unit to warm up at least 30 minutes for final calibration. Start the calibration on main board. All test points are located on the main board.

Table 5-1. Calibration Chart

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
1	Power supply regulation	DVM	TP2 (TP1 ground)		R20	+15 ±0.01V	Main board
2			TP3 (-15V)			-15 ±0.05V	
3	Output dc balance	Scope or DVM	50Ω OUT		R116	0 ±0.01 Vdc	
4					AMPLITUDE: cw		

Table 5-1. Calibration Chart (Continued)

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
5	Distortion	Distortion analyzer (50Ω terminated)	50Ω OUT	Function \sim	R72 R93	Minimum distortion	
6	VCG null	Scope		FREQ MULT: X 100K Function: \sqcap Dial: full cw Scope vert: 2V/div Scope horiz: .5 ms/div	R40	Minimum frequency shift	Adjust generator dial to display one cycle on scope. Alternately short and open VCG IN BNC while adjusting R40.
7	Horizontal symmetry			Scope Horiz: X 10 on	R42	Maximum symmetry	Alternately switch scope triggering from positive to negative slope while adjusting R42.
8				Dial: 01 FREQ MULT: X 10 Scope sweep: 0.1s/div, dc triggering	R60		
9	Frequency accuracy	Counter	50Ω OUT	Dial: 2.0 FREQ MULT: X 1 thru X 10K	R32	Best frequency accuracy over X 1 thru X 10K	
10				FREQ MULT: X 1M Function: \sqcap Dial: 2.0	C37	2.020 MHz	
11				Function: \sqcap, \sim, \sim		Best frequency tracking on X 1M range	
12	Internal reference		REF OUT	Mode toggle switch: towards digital switch	C1	1 MHz \pm 20 Hz	C1 is on synthesizer board.
13	F/V balance	Scope or DVM	TP5 (TP1 common)	FREQ MULT: X 10K Digital Switch: 0.1000	R31	0 \pm 0.1 Vdc	
14	F/V gain			Digital Switch: 0.9999	R28	+1 Vdc approx	
15				Digital Switch: 1.9999		-1 Vdc approx	If necessary, reset R28 for best balance between 0.9999 and 1.9999.
16	Frequency range	Counter	50Ω OUT	FREQ MULT: X 1M thru X 10 Function: \sqcap		Reading \pm 0.005% each setting	

Table 5-1. Calibration Chart (Continued)

Step	Check	Tester	Cal Points	Control Settings	Adjust	Desired Results	Remarks
17	Frequency bits	Counter	50Ω OUT	FREQ MULT: X 10K Digital Switch: 0.1111 thru 0.9999		Proper reading on counter	
18	Spectral purity	Spectrum Analyzer		Function: \sim Digital Switch: 1.9999		Spurious signals below -70 dB. Noise floor below -60 dB.	Set 3580A controls for a 3 Hz bandwidth with minimum smoothing; scanning 20 Hz/div at 5s/div. Check that average of noise floor at $f_0 + 3$ Hz is below -60 dBc and that no line related spurs are above -70 dBc. Keep power lines away from analyzer input.

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 calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

6.2 TROUBLESHOOTING CHART

Troubleshooting charts are given in figures 6-1 thru 6-4. The charts do not cover every possible trouble, but will be an aid in systematically isolating faulty components.

Figure 6-1. Initial Checks

Figure 6-2. Generator Mode Checks

- Sheet 1 Generator Check
- Sheet 2 Generator Loop Check
- Sheet 3 VCG Check
- GCV Check
- TTL Check

Figure 6-3. Power Supply Checks

Figure 6-4. Synthesizer Mode Checks

- Sheet 1 F/V Check
- Sheet 2 Synthesizer Loop Checks
- Sheet 3 Synthesizer Loop Checks
- Sheet 4 Frequency Ranging Check
- Sheet 5 Generator Phase Lock Loop Check
- Sheet 6 Reference Selector Check

6.3 TROUBLESHOOTING INDIVIDUAL COMPONENTS

6.3.1 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.
3. If the collector and emitter voltages are the same, but the base emitter voltage is less than 500 mV 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.

6.3.2 Diode

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

6.3.3 Operational Amplifier (e.g., UA741C, LM318)

1. The "+" and "-" inputs of an operational amplifier will have less than 15 mV voltage difference when operating under normal conditions.
2. If the output voltage stays at maximum positive, its "+" input voltage should be more positive than its "-" input voltage, or vice versa; otherwise, the operational amplifier is defective.

6.3.4 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.

BOTH 600Ω OUT & 50Ω OUT BAD

NOTE: Unless otherwise indicated, test points and designations apply to synthesizer (lower) board and digital switch settings are between 0.1000 and 1.9999.

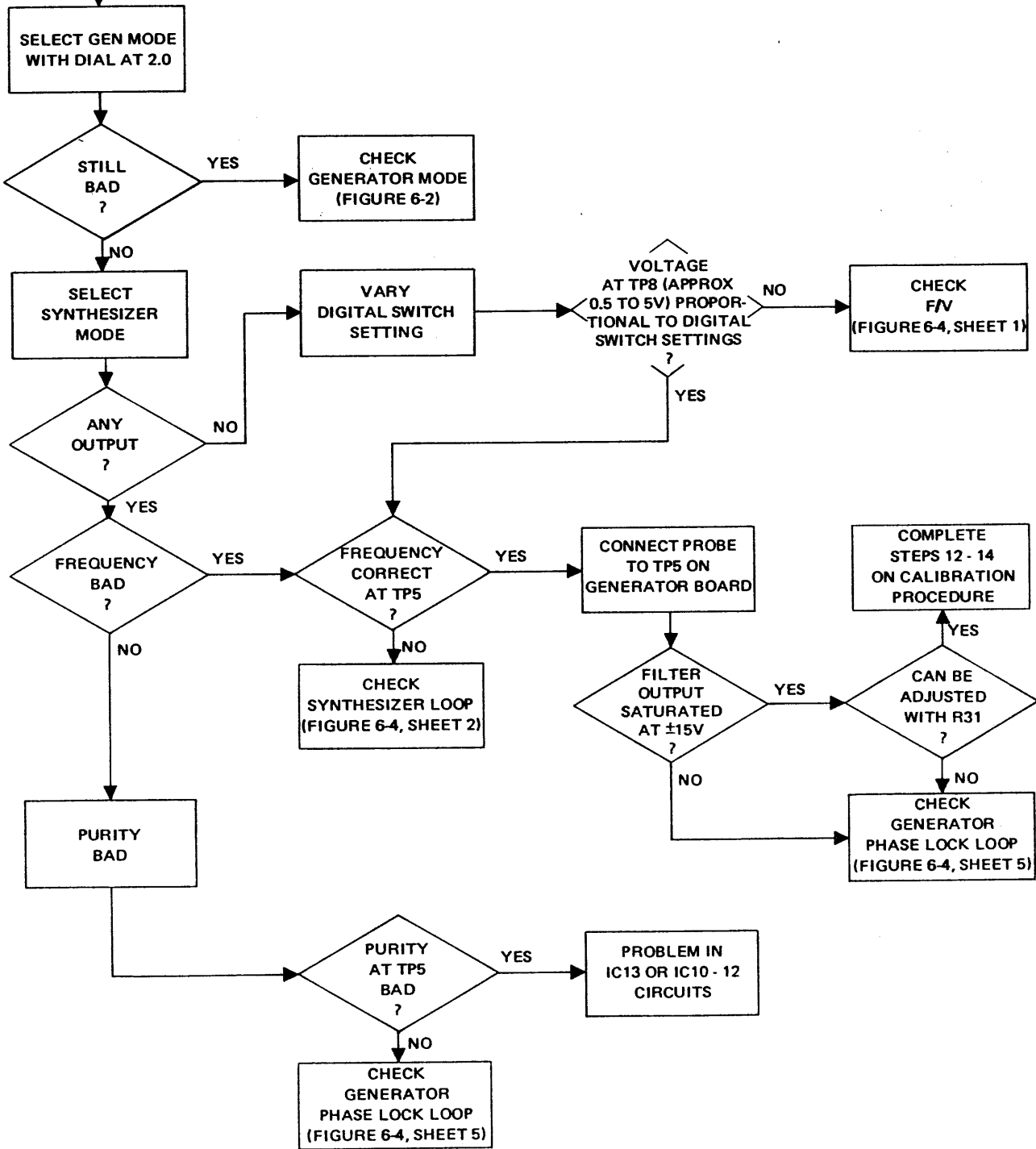


Figure 6-1. Initial Checks

GENERATOR CHECK

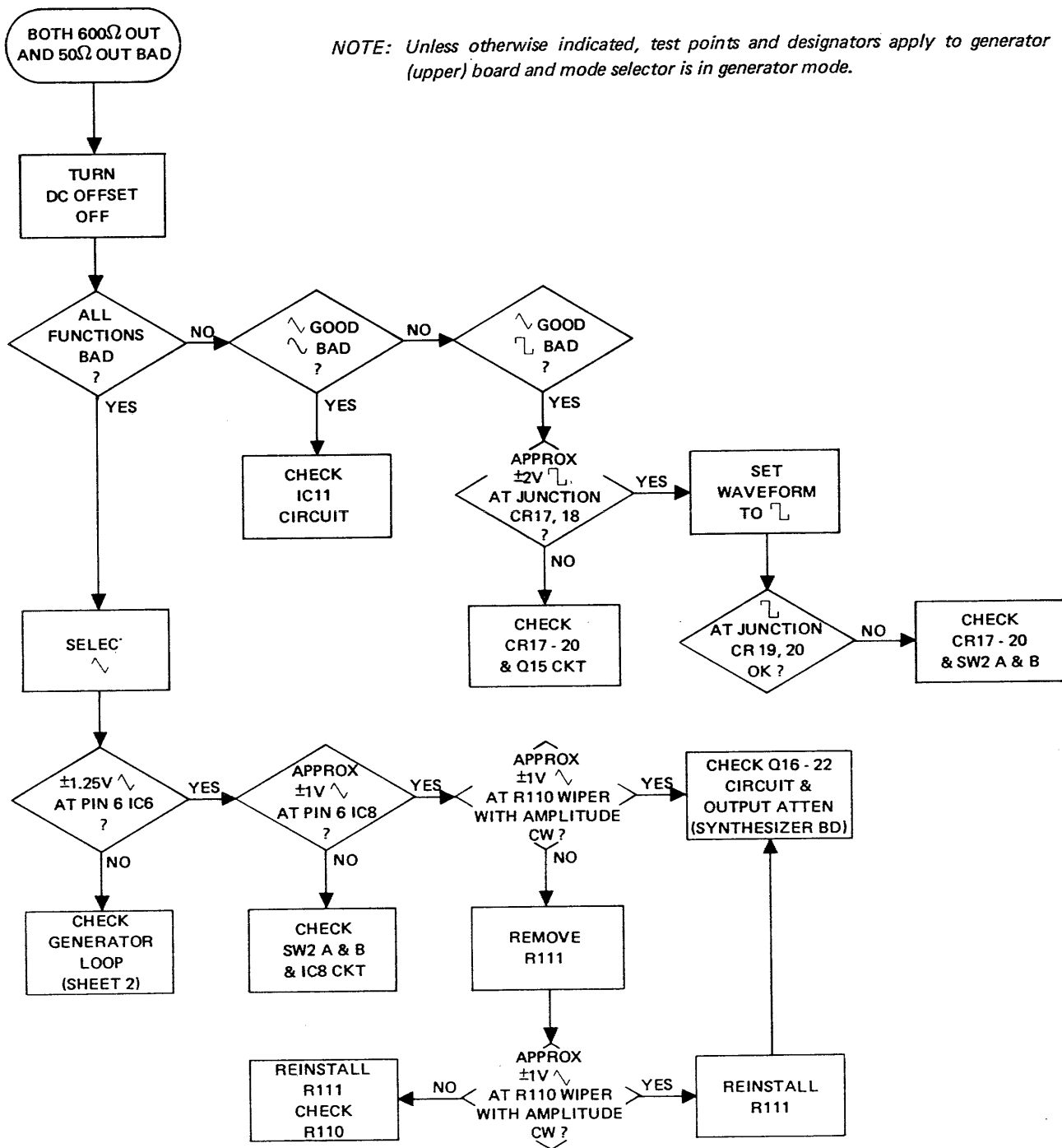
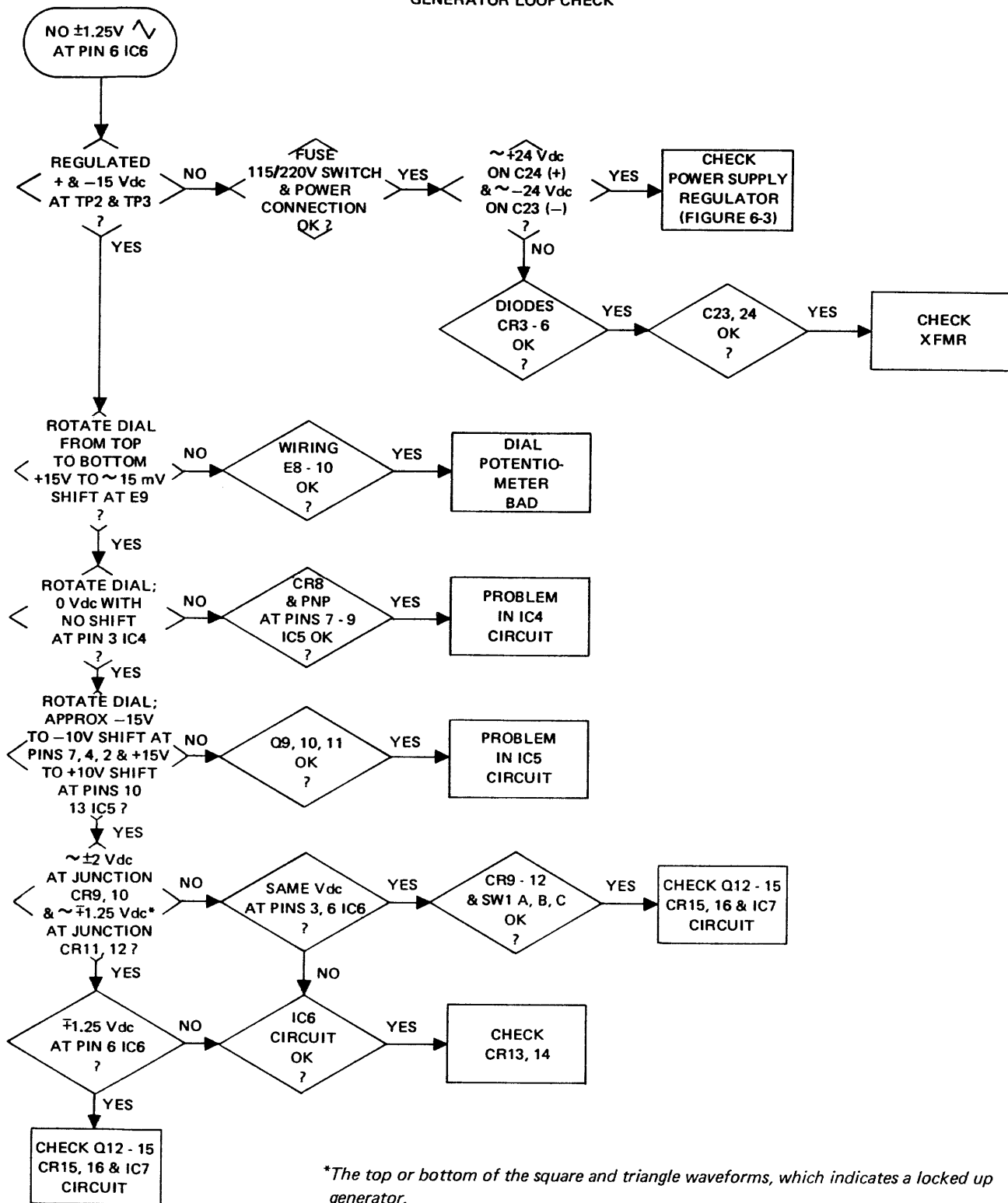


Figure 6-2. Generator Mode Checks (Sheet 1 of 3)

GENERATOR LOOP CHECK



*The top or bottom of the square and triangle waveforms, which indicates a locked up generator.

Figure 6-2. Generator Mode Checks (Sheet 2 of 3)

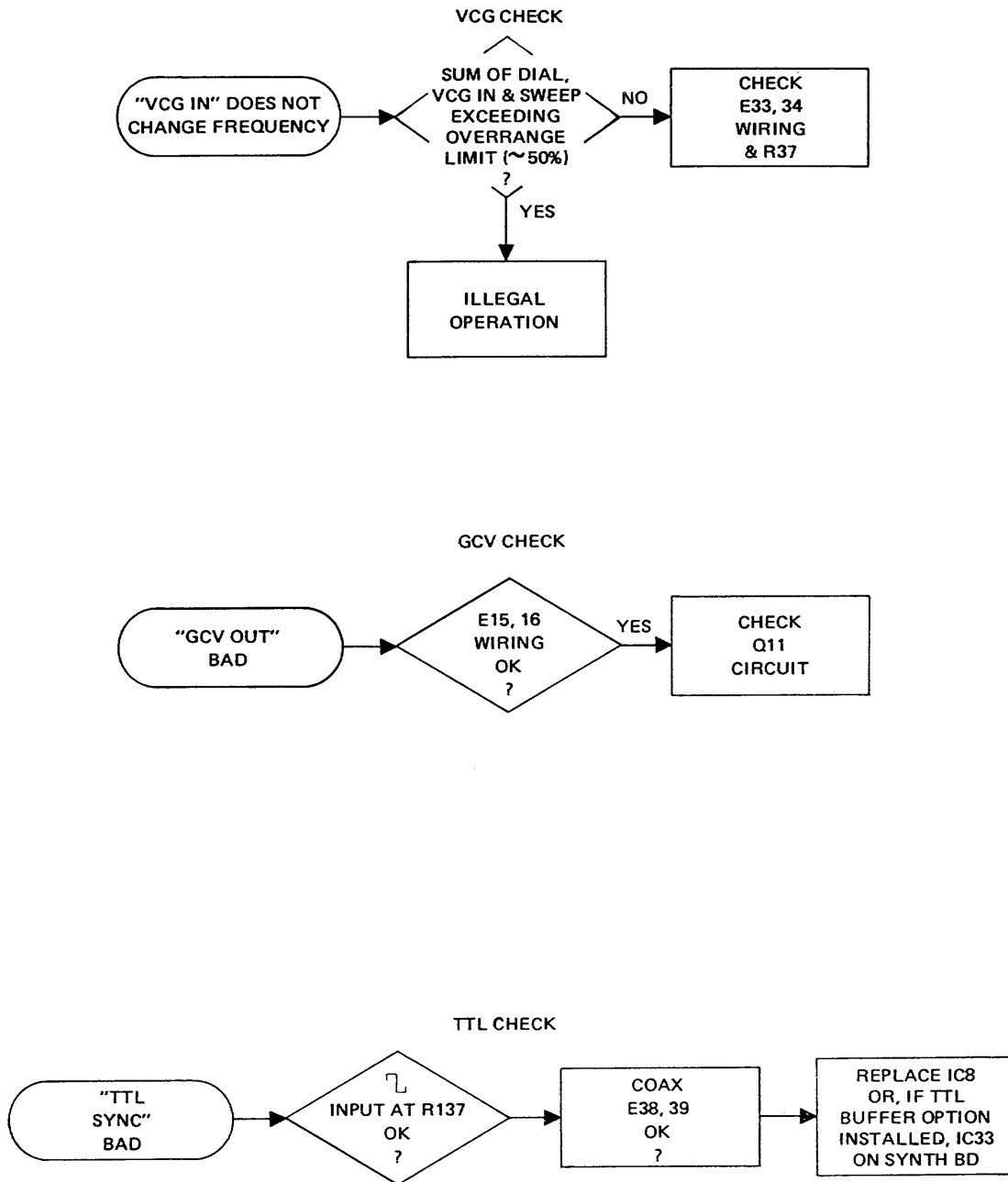


Figure 6-2. Generator Mode Checks (Sheet 3 of 3)

POWER SUPPLY REGULATOR CHECK

NOTE: Test points and designators apply to generator (upper) board.

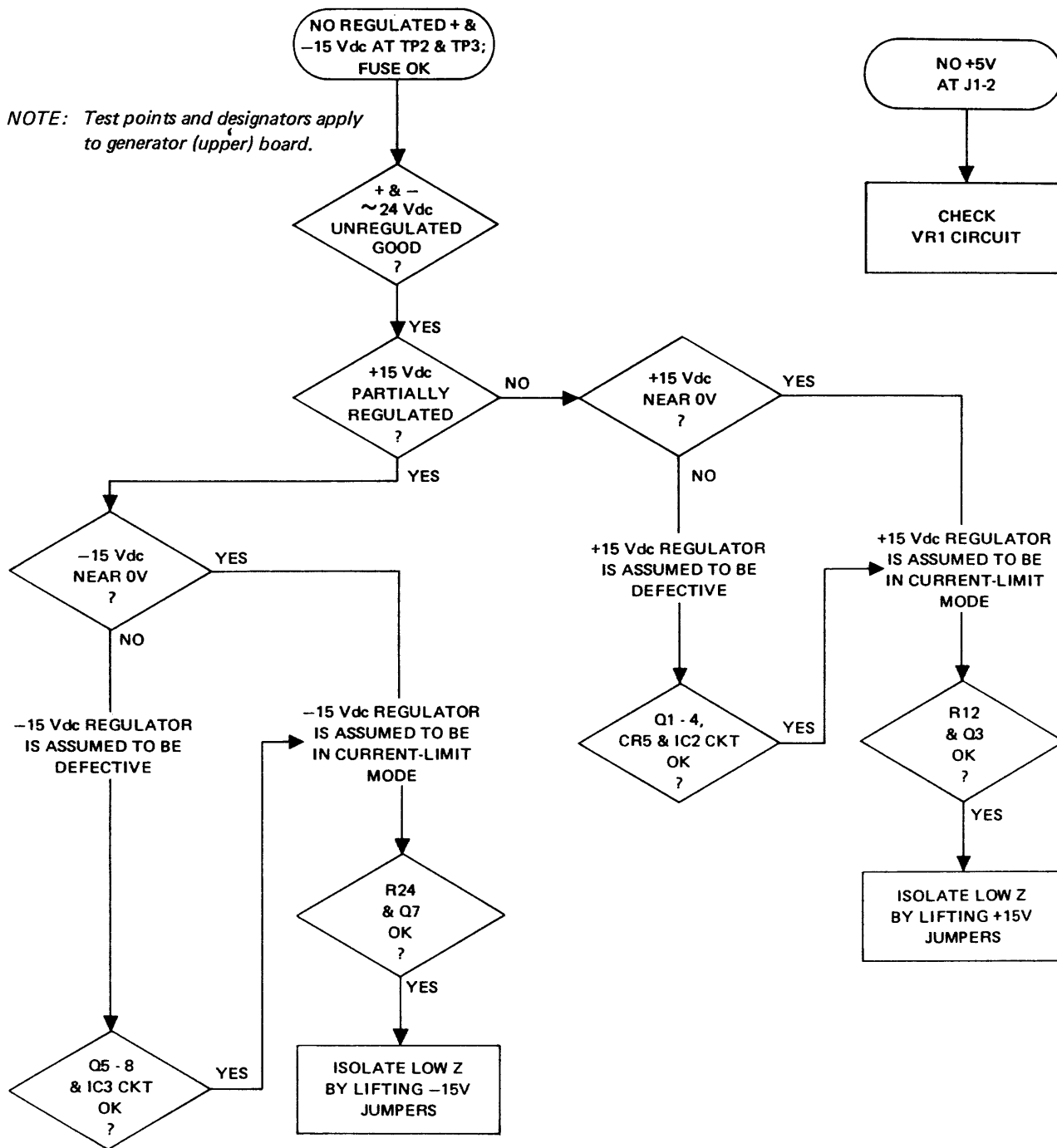


Figure 6-3. Power Supply Checks

F/V CHECK

NOTE: Unless otherwise indicated, test points and designations apply to synthesizer (lower) board and digital switch settings are between 0.1000 and 1.9999.

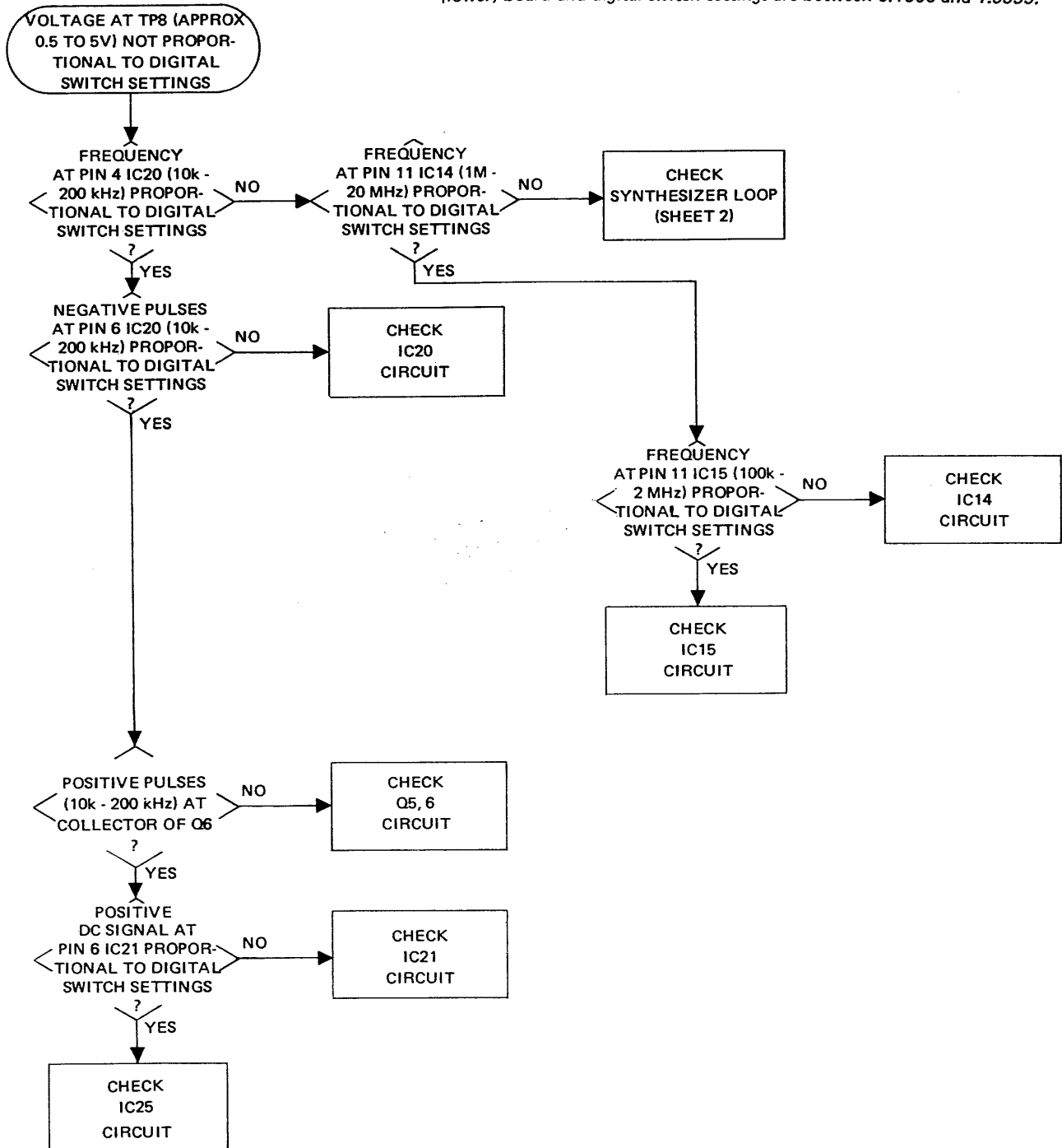


Figure 6-4. Synthesizer Mode Checks (Sheet 1 of 6)

SYNTHESIZER LOOP CHECK

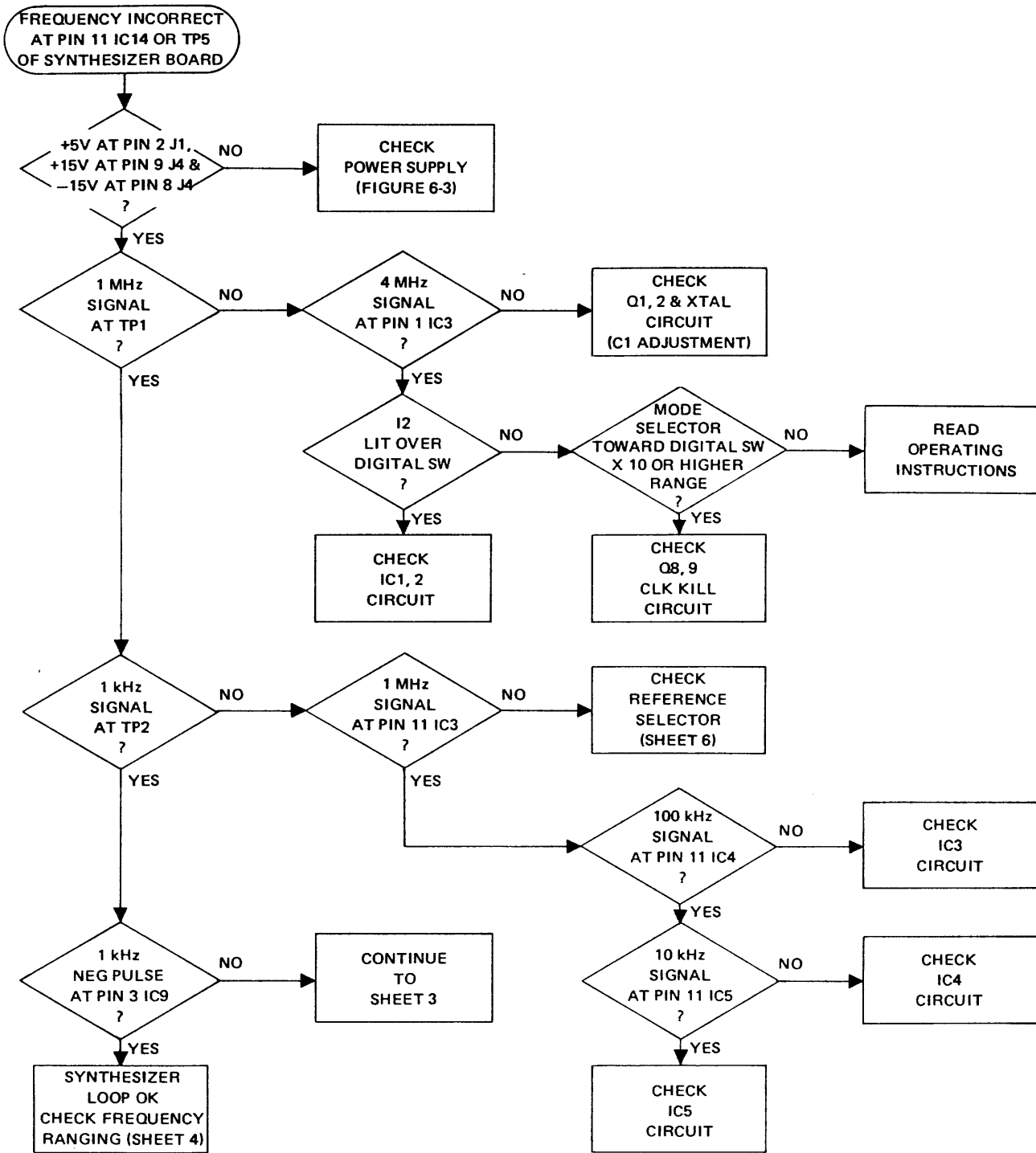


Figure 6-4. Synthesizer Mode Checks (Sheet 2 of 6)

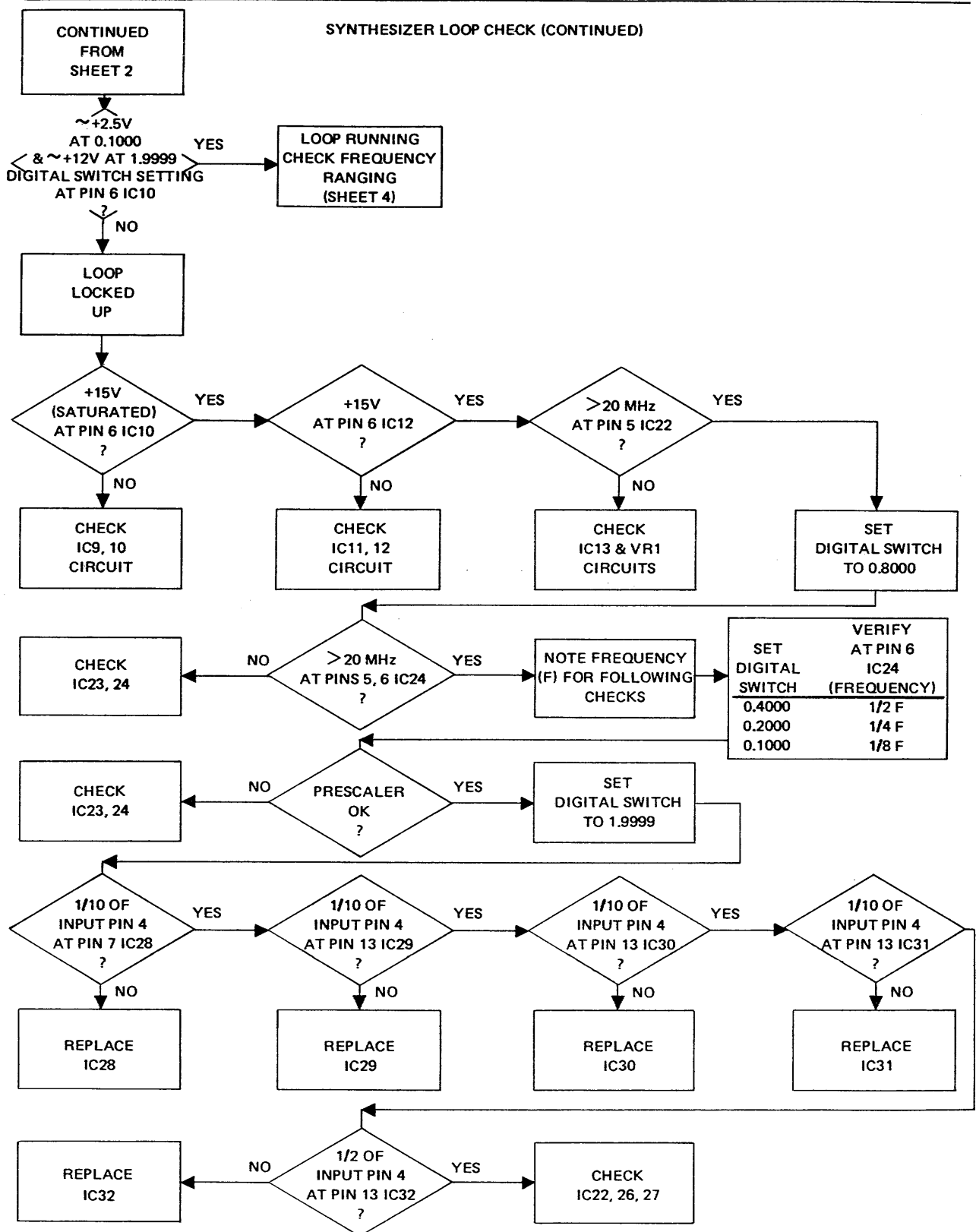


Figure 6-4. Synthesizer Mode Checks (Sheet 3 of 6)

FREQUENCY RANGING CHECK

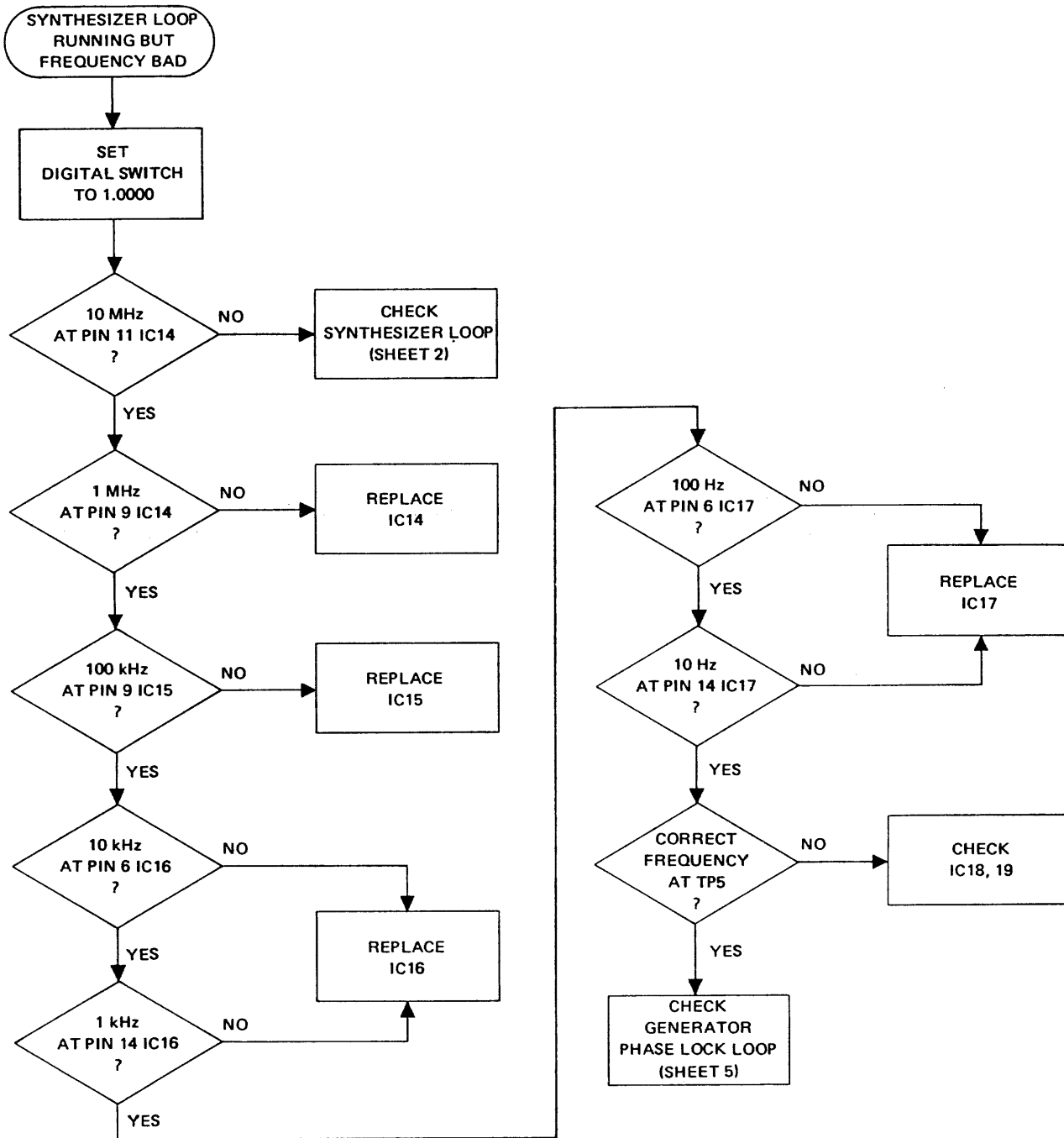


Figure 6-4. Synthesizer Mode Checks (Sheet 4 of 6)

GENERATOR PHASE LOCK LOOP CHECK
(GENERATOR BOARD)

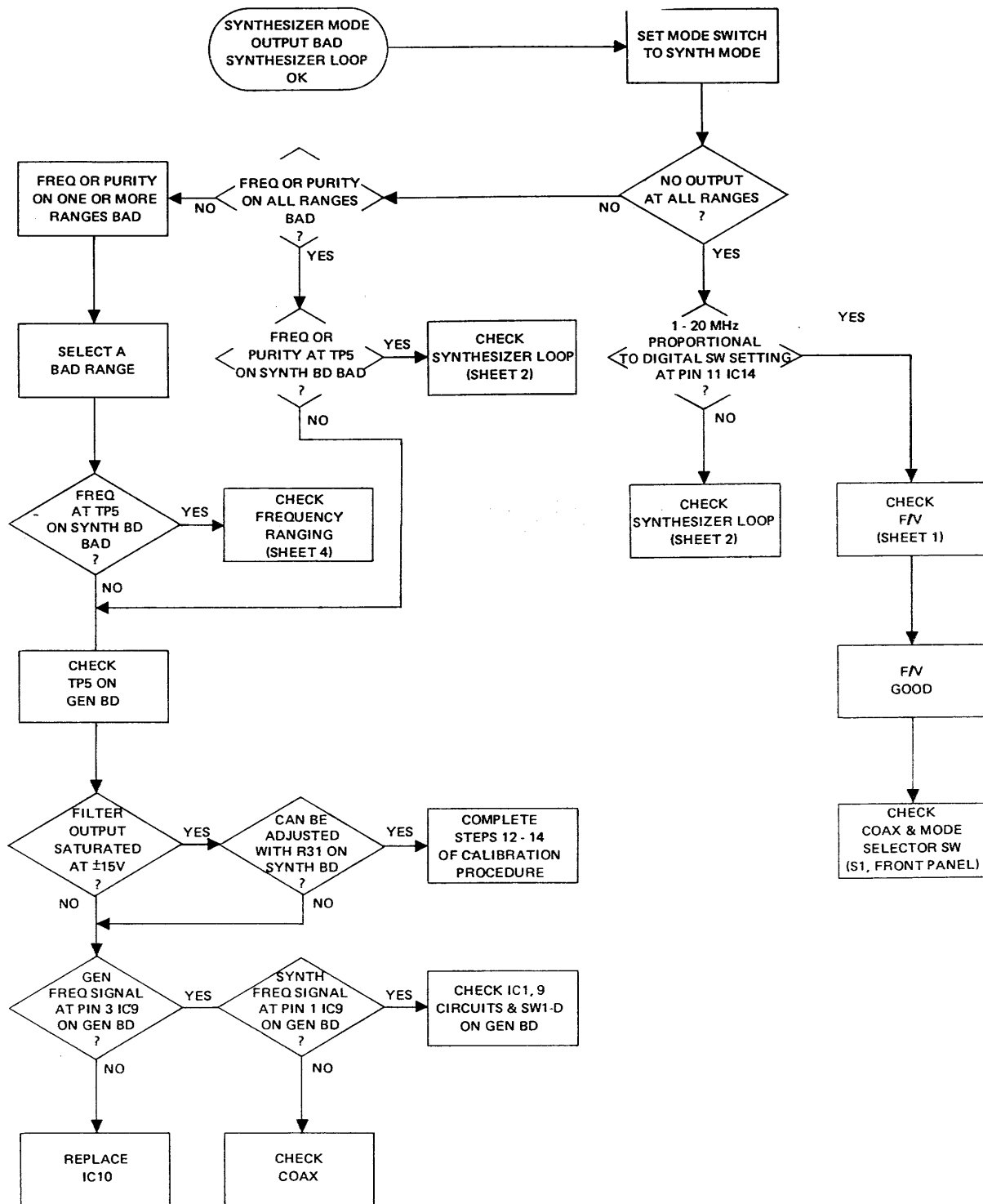


Figure 6-4. Synthesizer Mode Checks (Sheet 5 of 6)

REFERENCE SELECTOR CHECK

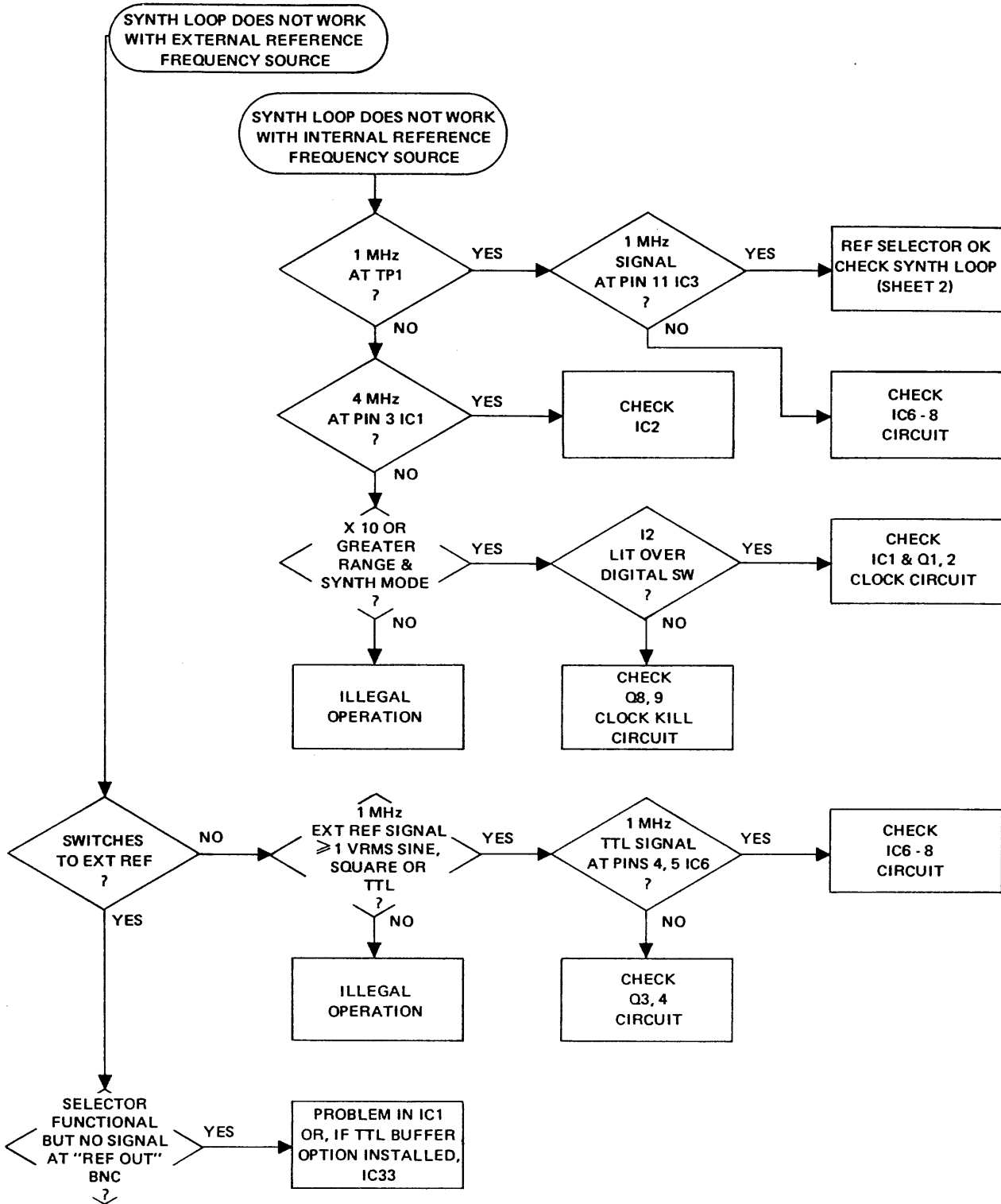


Figure 6-4. Synthesizer Mode Checks (Sheet 6 of 6)

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 ORDERING PARTS

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

7.3 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.

	Page No.
CHASSIS	
Assembly Drawing	7-2
Schematic	7-3
Parts List	7-4
MAIN BOARD	
Assembly Drawing	7-6
Schematic	7-7
Parts List	7-8
SYNTHESIZER BOARD	
Assembly Drawing	7-10
Schematic	7-11
Parts List	7-12

REV	ECN	BY	DATE	APP
A	ECN 1603	Ro	10/10/76	
B	ECN 1808	JRM	9-9-8	
C	ECN 2467	LDU	11-4-8	

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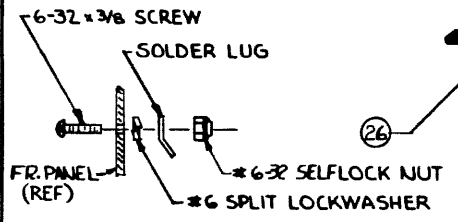
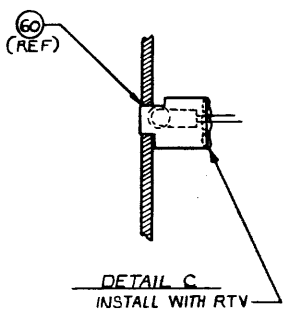
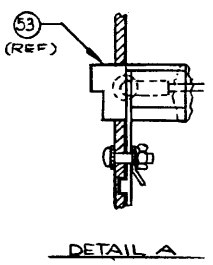
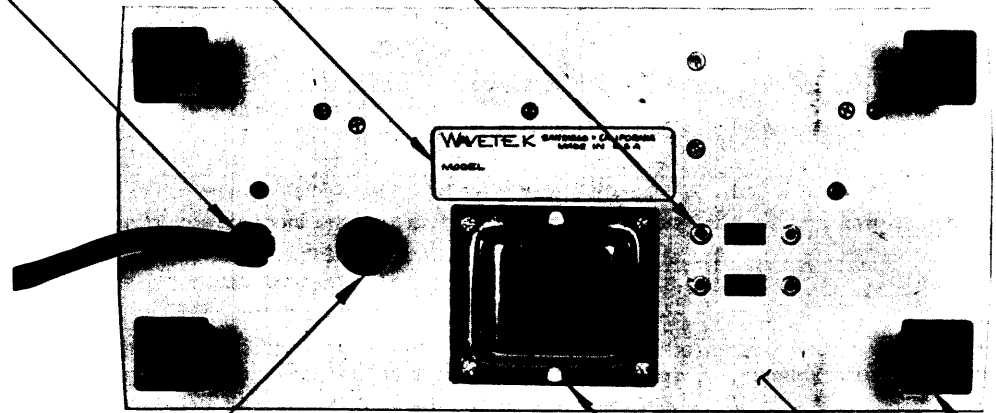
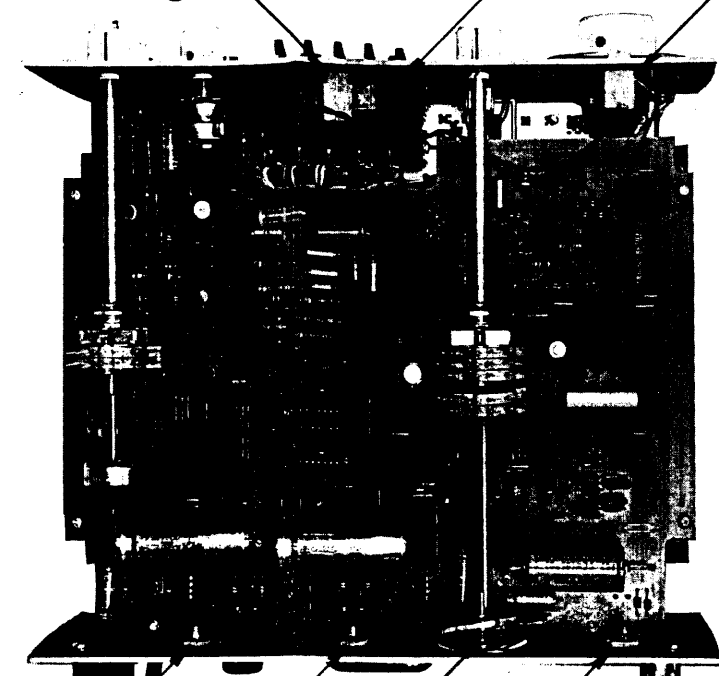
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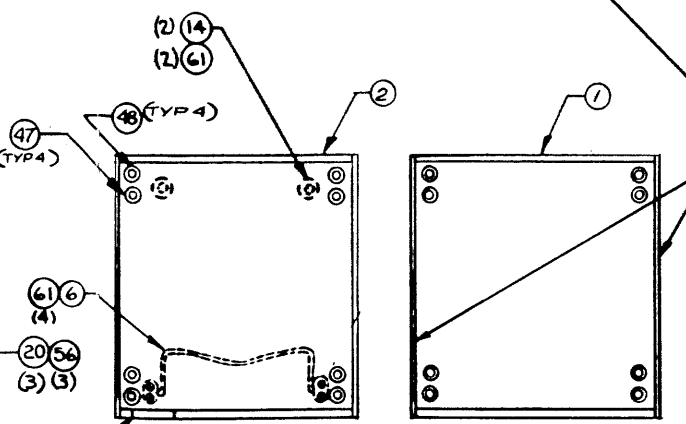
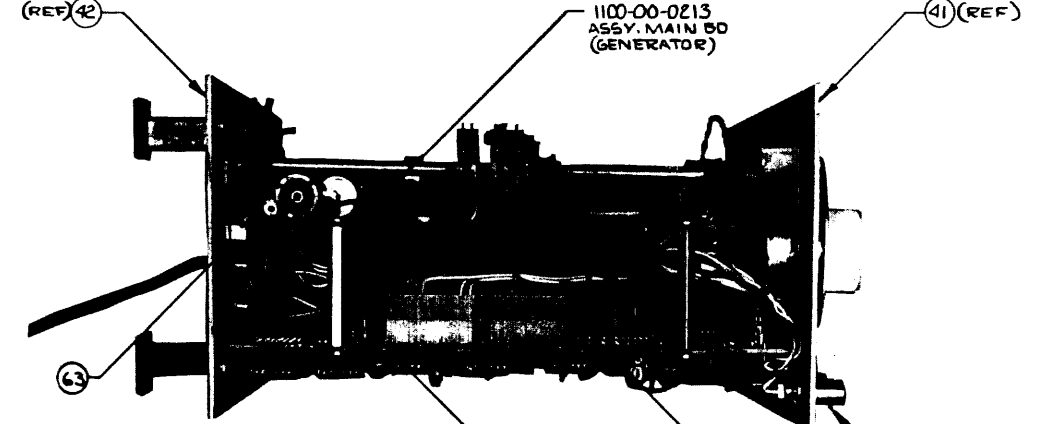
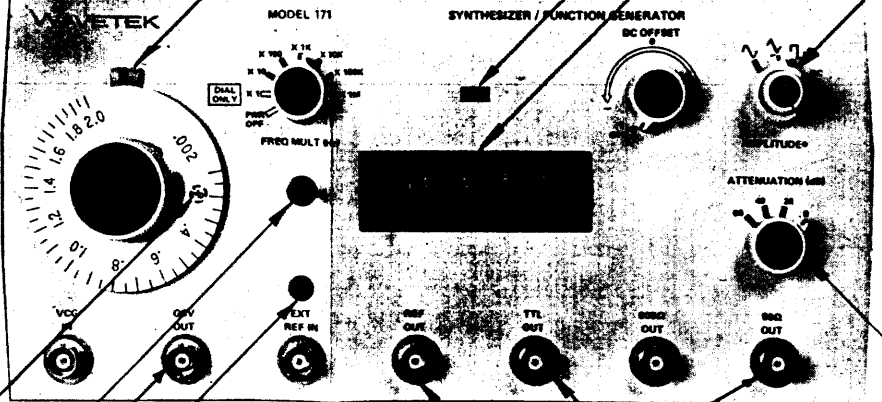
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DETAIL B
HARDWARE STACK UP FOR GROUND LUG (TYP 3 PLACES)
NOTE: ALL CONNECTIONS TO BE MECHANICALLY SECURE TO LUGS PRIOR TO SOLDERING GROUND WIRES.



TOP & BOTTOM COVERS - WITH BAIL KIT - (EXTENDER NOT SHOWN)

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DATE: 10/10/76		TITLE: ASSEMBLY CHASSIS
MATERIAL: T.O.	PROJENGR: T.O.		
FINISH: WAVETEK PROCESS	RELEASE APPROV: [Signature]	SCALE: 1:1	MODEL NO: 171
	DO NOT SCALE DWG		DWG NO: 0102-00-0510
			REV: C
			CODE IDENT: 23338
			SHEET 1 OF 1

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REV ECH BY DATE APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFR-PART-NO	MFR	NAVETEK NO.	QTY/PT
NONE	ASSY DRWG, CHASSIS	0102-00-0510	WVTK	0102-00-0510	1
NONE	DIAL ASSY	180-027	WVTK	1201-00-0027	1
55	TRANSFORMER	171-886	WVTK	1204-00-0486	1
7	END BELL	110-333	WVTK	1400-00-0174	1
63	SPACER	8480	WVTK	1400-00-0653	2
36	PLATE, NAME	139-305	WVTK	1400-00-2180	1
53	INDICATOR, DIAL	180-303	WVTK	1400-00-4970	1
1	COVER, TOP	180-300-1	WVTK	1400-00-5000	1
62	EXPANDER	180-301	WVTK	1400-00-5010	2
5	POST	180-302	WVTK	1400-00-5020	4
2	COVER, BOTTOM	180-300-2	WVTK	1400-00-5030	1
57	CORD HOLDER	1400-00-5409	WVTK	1400-00-5409	1
41	PANEL, FT	1400-00-5740	WVTK	1400-00-5740	1
42	PANEL, REAR, AND	1400-00-5753	WVTK	1400-00-5753	1
60	INDICATOR FROM: 1400-00-4970	1400-00-5769	WVTK	1400-00-5769	1
9	I.D. LABEL	1400-00-9110	WVTK	1400-00-9110	1
C2	CAP, CER, 100PF, 1KV	DD-101	CRL	1500-01-0111	1

WAVETEK PARTS LIST TITLE CHASSIS ASSEMBLY NO. 1101-00-0510 REV E PAGE: 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFR-PART-NO	MFR	NAVETEK NO.	QTY/PT
61	SPEEDNUT, SELF RETAIN	C7494-632-4	TINW	2800-09-0003	6
14	FAST, CHASSIS	1591-C11	USECO	2800-09-0022	2
18	WASHER, SHOULDER	266R	SMITH	2800-27-0004	14
12	STRAIN RELIEF BUSH	SR6R-1	MEYCO	2800-37-0003	1
59	FERRITE BEAD	56-590-65/3B	FEHRE	3100-00-0001	1
40	LED	T1L-220	TI	4899-00-0006	1
58	WAFER FROM: 5104-02-0007	5104-98-0001	WVTK	5104-98-0001	2
28	SW ASSY SLIDE HI-LO	3N422-FT-MK	UID	5105-00-0001	1
23	SWITCH ASSY SLIDE	46256-LF	SHCFT	5105-00-0002	1
24	SOLDER GUARD	46256-LF-5G	SHCFT	5105-09-0001	2
45	SWITCH, TOGGLE	7301P3D2N	C&K	5106-00-0018	1
44	SWITCH	28-W-62-C	DIGITN	5107-00-0006	1
29	PWR CORD	0-7789-008-GY	PACRD	6001-80-0004	1

WAVETEK PARTS LIST TITLE CHASSIS ASSEMBLY NO. 1101-00-0510 REV E PAGE: 3

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFR-PART-NO	MFR	NAVETEK NO.	QTY/PT
C3	CAP, CER, .01MF, 50V	CK-103 LONG LEAD	CRL	1500-01-0300	1
16	BNC CONN	KC-7946	KING	2100-01-0002	7
50	CONN, 9PIN	09-50-7091	MOLEX	2100-02-0051	4
19	SOLDER LUG	1497	SMITH	2100-04-0012	7
NONE	SOLDER LUG	1485-6	SMITH	2100-04-0025	3
51	PIN	08-50-0105	MOLEX	2100-05-0025	54
20	STD KNOB	RB-67-1-SB-M	ROGAN	2400-01-0008	3
21	COAX KNOB SET	RB-67-1-SB+0-M+9	ROGAN	2400-01-0009	1
15	LAMP	CM7-7876	CHMIN	2400-02-0013	2
10	FUSE, 250V, 1/8A, SR	313-375	LITFU	2400-05-0009	1
11	FUSE HOLD	031-1e53/031-1666	SCHUR	2400-05-0012	1
56	BUSHING NYLINEW	4L2FF	THOMN	2800-01-0002	4
47	STANDOFF, MALE/FEMALE .750 H., .250 HEX, 4-40	1443-M03-F05-440	UNJCP	2800-02-0009	4
48	STANDOFF, MALE/FEMALE 1.750 H., .250 HEX 8-32	1475-M03-F05-832	UNJCP	2800-02-0010	4
6	BAIL ASSY W/FT	180-500	WVTK	2800-06-0010	1

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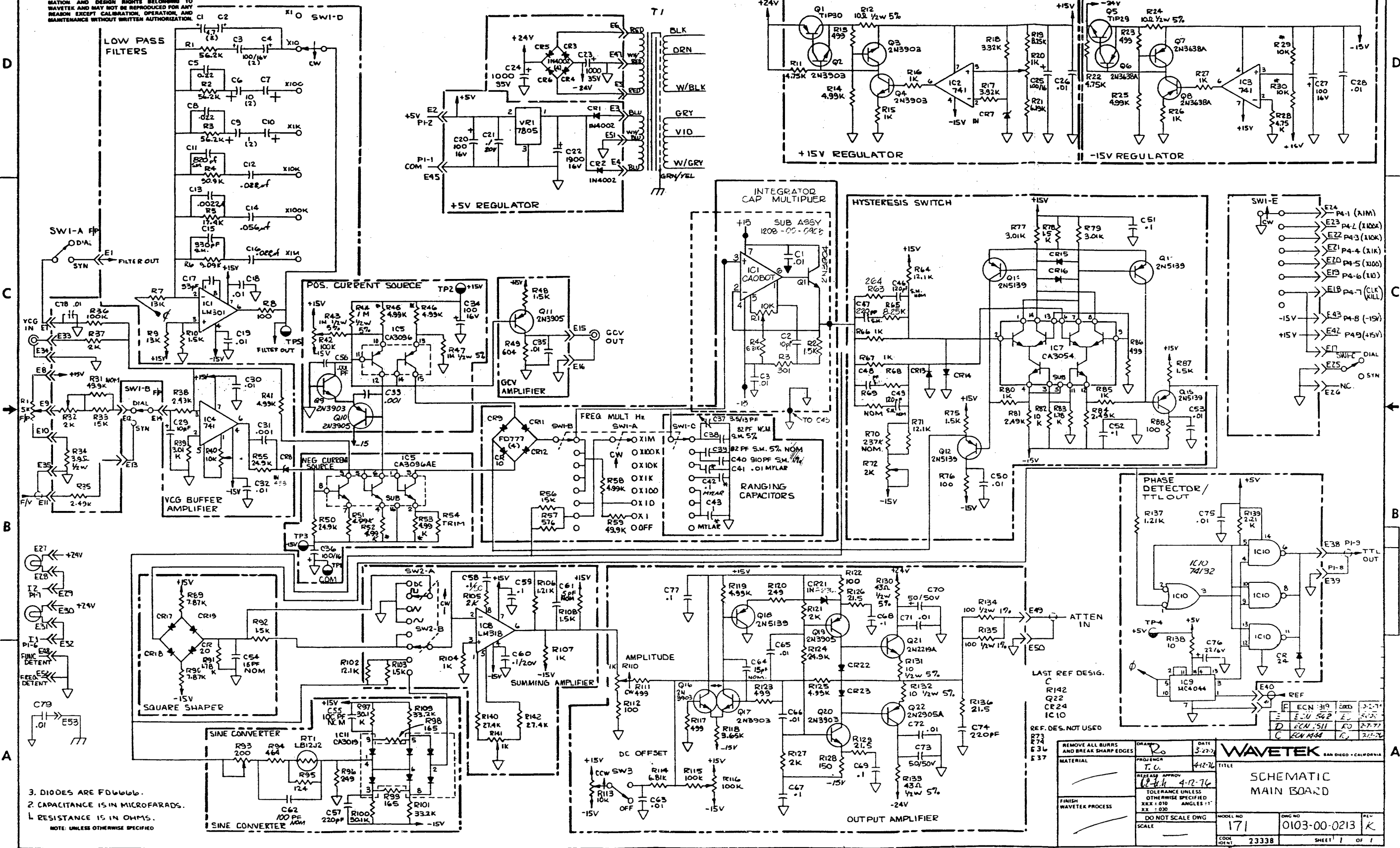
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K	2258, 2570	REV	ECN	BY	DATE	APP
		REV	ECN	BY	DATE	APP
		REV	ECN	BY	DATE	APP

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.



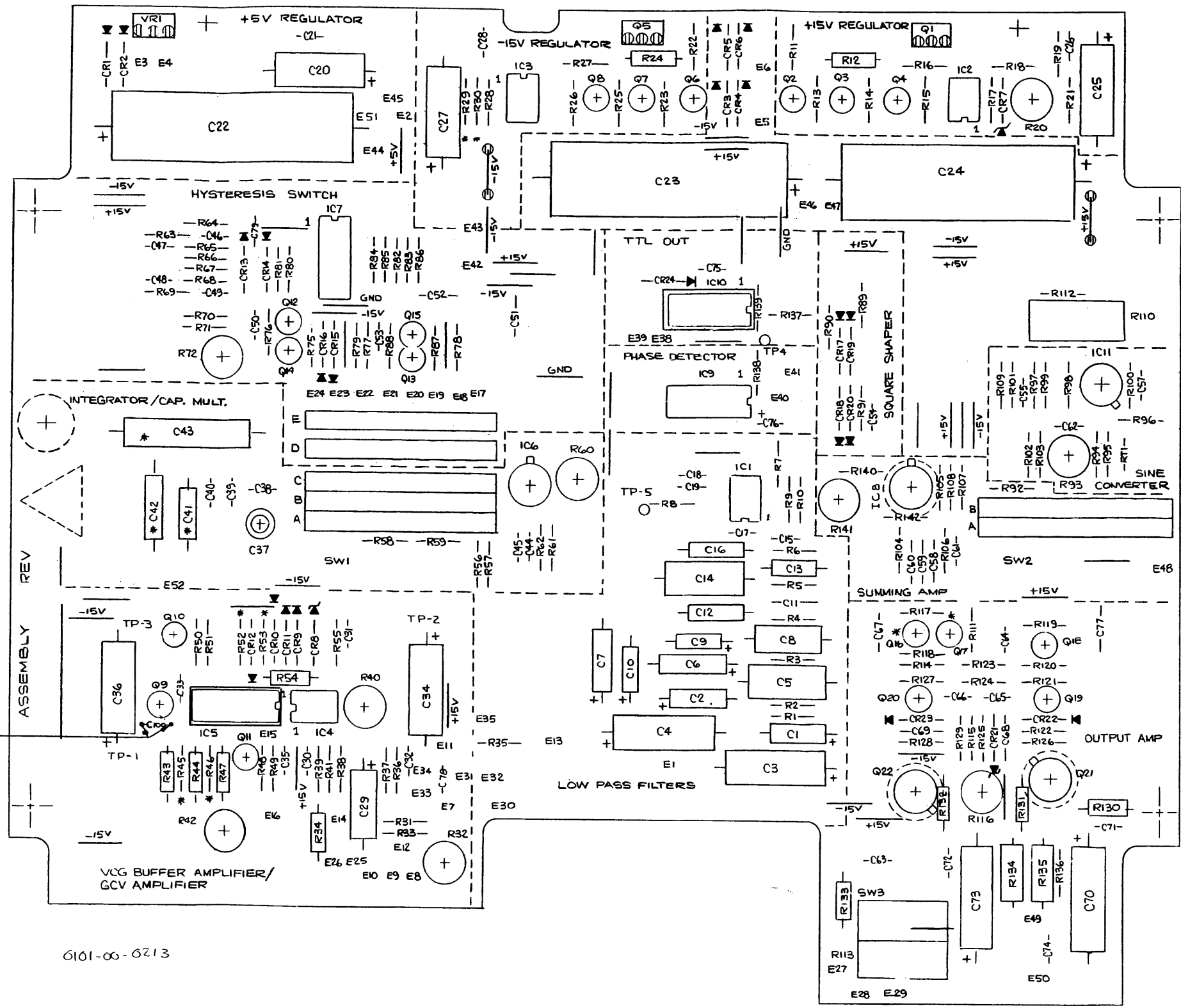
3. DIODES ARE FD6666.
 2. CAPACITANCE IS IN MICROFARADS.
 1. RESISTANCE IS IN OHMS.
 NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES		DATE	3-22-76
DRAWN		PROFESSOR	T.C.
RELEASE APPROV		DATE	4-12-76
FINISH WAVETEK PROCESS		TOLERANCE UNLESS OTHERWISE SPECIFIED	XXX: 010 ANGLES: 11
SCALE		DO NOT SCALE DWG	
CODE		MODEL NO	171
SHEET		DWG NO	0103-00-0213
REV		REV	K
23338		SHEET	1 OF 1

WAVETEK SAN DIEGO - CALIFORNIA
SCHEMATIC MAIN BOARD

REV	ECN	BY	DATE	APPR
B	ECN 1521	RD	2-18-77	
C	ECN 819	BD	10-2-78	
D	ECN 2467	LOU	11-4-80	KZHC
E	2593	LOU	2-2-81	KZHC

DRILL AND INSTALL .001 CAP
SCRAPE AWAY SOLDER
RESIST AND SOLDER TO
GROUND PLANE AND
COLLECTOR OF 3903



0101-00-0213

WAVETEK
0101-00-0213E
MAIN BD
MODEL 171
SHEET 1 OF 2
(SHEET 3 IS 8" SIZE)

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REV ECH BY DATE APP

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION, AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.

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REFERENCE DESIGNATORS	PART DESCRIPTION	DRG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	REFERENCE DESIGNATORS	PART DESCRIPTION	DRG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	REFERENCE DESIGNATORS	PART DESCRIPTION	DRG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG. MAIN	0101-00-0213	WVTK	0101-00-0213	1	C1 C2	CAP. TANT. 4.7MF. 35V	150D475X9035B2	SPRAG	1500-74-7502	2	R115 R36	RES. MF. 1/8W. 1%. 100K	RN55D-1003F	TRW	4701-03-1003	2
NONE	SCHEMATIC. MAIN	0103-00-0213	WVTK	0103-00-0213	1		CAP. SET. POLY. MIXED MATCHED SET	180-501-101	WVTK	1509-80-0008	1	R138	RES. MF. 1/8W. 1%. 10	RN55D-10R0F	TRW	4701-03-1009	1
NONE	GA DRWG. MAIN	0107-00-0213	WVTK	0107-00-0213	1							R106 R137	RES. MF. 1/8W. 1%. 1.21K	RN55D-1211F	TRW	4701-03-1211	2
R60	PCA. PIGGYBACK BOARD	171-0908	WVTK	1208-00-0908	1	C41	CAP. POLY. .01MF. 100V PART OF 1509-80-0008 QTY(1)					R102 R64 R71	RES. MF. 1/8W. 1%. 12.1K	RN55D-1212F	TRW	4701-03-1212	3
1	SPACER	B480	WVTK	1400-00-0653	4							R95	RES. MF. 1/8W. 1%. 124	RN55D-1240F	TRW	4701-03-1240	1
C61T	CAP. CER. 5PF. 1KV	DD-050	CRL	1500-00-5011	1	C42	CAP. POLY. .1MF. 100V PART OF 1509-80-0008 QTY(1)					R7 R9	RES. MF. 1/8W. 1%. 13K	RN55D-1302F	TRW	4701-03-1302	2
C100- C31 C33	CAP. CER. .001MF. 1KV	DD-102	ARCO	1500-01-0211	3							R128	RES. MF. 1/8W. 1%. 150	RN55D-1500F	TRW	4701-03-1500	1
C79	CAP. CER. .01MF. 1KV	GAP-103	CRL	1500-01-0309	1	C43	CAP. POLY. .1MF. 100V PART OF 1509-80-0008 QTY(1)					R10 R103 R108 R48 R75 R78 R87 R92	RES. MF. 1/8W. 1%. 1.5K	RN55D-1501F	TRW	4701-03-1501	8
C18 C19 C26 C28 C30 C32 C35 C50 C53 C63 C65 C66 C71 C72 C75 C78	CAP. CER. MN. .01MF. 50V	CAC0225U103Z100A	CORNG	1500-01-0310	16	NONE	MAIN	1700-00-0213	WVTK	1700-00-0213	1	R33 R36	RES. MF. 1/8W. 1%. 15K	RN55D-1502F	TRW	4701-03-1502	2
C21 C51 C52 C58 C59 C60 C67 C68 C69 C77	CAP. CER. MON. .1MF. 50V	CAC03ZU104Z050A	CORNG	1500-01-0405	10	2	SKT. IC. 14PIN	C8814-01.	TI	2100-03-0011	1	R98 R99	RES. MF. 1/8W. 1%. 165	RN55D-1650F	TRW	4701-03-1650	2
C54T C64T	CAP. CER. 15PF. 1KV	DD-150	ARCO	1500-01-5011	2	3	SKT. IC. 16PIN	16-DIP	CINCH	2100-03-0022	1	R5	RES. MF. 1/8W. 1%. 17.4K	RN55D-1742F	TRW	4701-03-1742	1
C57 C74	CAP. CER. 220PF. 1KV	DD-221	ARCO	1500-02-2111	2	NONE	SOLDER LUG	1497	SMITH	2100-04-0012	2	R83 R91	RES. MF. 1/8W. 1%. 1.78K	RN55D-1781F	TRW	4701-03-1781	2
C17	CAP. CER. 33PF. 1KV	DD-330	CRL	1500-03-3011	1	4	TERM	200081	USECO	2100-05-0009	13	R105 R121 R127 R37	RES. MF. 1/8W. 1%. 2K	RN55D-2001F	TRW	4701-03-2001	4
C56	CAP. CER. 330PF. 1KV	DD-331	ARCO	1500-03-3111	1	NONE	TERM	201081	USECO	2100-05-0011	1	R126 R129 R136	RES. MF. 1/8W. 1%. 21.5	RN55D-21R5F	TRW	4701-03-2159	3
C62T	CAP. CER. 82PF. 1KV	DD-820	CRL	1500-08-2011	1	5	PIN. MALE	61182-2	AMP	2100-05-0020	2	R139	RES. MF. 1/8W. 1%. 2.21K	RN55D-2211F	TRW	4701-03-2211	1
C46T C49T	CAP. MICA. 120PF. 500V	DM15-121J	ARCO	1500-11-2100	2	6	STANDOFF 1.750 H. .250 HEX	P-609-M03-F05-440	WVTK	2800-02-0016	4	R70	RES. MF. 1/8W. 1%. 237K	RN55D-2373F	TRW	4701-03-2373	1
WAVETEK PARTS LIST TITLE MAIN ASSEMBLY NO. 1100-00-0213 PAGE: 1 REV L					WAVETEK PARTS LIST TITLE MAIN ASSEMBLY NO. 1100-00-0213 PAGE: 3 REV L					WAVETEK PARTS LIST TITLE MAIN ASSEMBLY NO. 1100-00-0213 PAGE: 5 REV L							

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REFERENCE DESIGNATORS	PART DESCRIPTION	DRG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	REFERENCE DESIGNATORS	PART DESCRIPTION	DRG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT	REFERENCE DESIGNATORS	PART DESCRIPTION	DRG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT			
C47 C48	CAP. MICA. 220PF. 500V	DM15-221J	ARCO	1500-12-2100	2	7	4-40	NF-207	WAKE	2800-11-0001	3	R35 R38 R81 R84	RES. MF. 1/8W. 1%. 2.49K	RN55D-2491F	TRW	4701-03-2491	4			
C15	CAP. MICA. 330PF. 500V	DM15-331J	ARCO	1500-13-3100	1	8	HEAT SINK	10160	METRS	2800-11-0004	2	R124 R50 R55	RES. MF. 1/8W. 1%. 24.9K	RN55D-2492F	TRW	4701-03-2492	3			
C38T C39T	CAP. MICA. 82PF. 500V	DM15-820J	ARCO	1500-18-2000	2	R110	TRANSIPAD	180-401	WVTK	4600-01-0207	1	R63T	RES. MF. 1/8W. 1%. 274	RN55D-2740F	TRW	4701-03-2740	1			
C11	CAP. MICA. 820PF. 300V	DM15-821F	ARCO	1500-18-2101	1	R141 R20	POT. CONT. 1K	91AR1K	BECK	4600-01-0209	2	R140 R142	RES. MF. 1/8W. 1%. 27.4K	RN55D-2742F	TRW	4701-03-2742	2			
C40	CAP. 910PF. 100V. 1%	DM15-911F	ARCO	1500-19-1101	1	R40	POT. TRIM. 1K	91AR10K	BECK	4600-01-0315	1	R69T	RES. MF. 1/8W. 1%. 301	RN55D-3010F	TRW	4701-03-3010	1			
C20 C25 C27 C3 C34 C36 C4	CAP. ELECT. 100MF. 16V	500D1070016DC7	SPRAG	1500-31-0101	7	R116 R42	POT. TRIM. 10K	91AR100K	BECK	4600-01-0402	2	R39 R77 R79	RES. MF. 1/8W. 1%. 3.01K	RN55D-3011F	TRW	4701-03-3011	3			
C23 C24	CAP. ELECT. 1000MF. 35V	39D10860356L6	SPRAG	1500-31-0212	2	R93	POT. TRIM. 100K	91AR200	BECK	4600-02-0101	1	F100 R97	RES. MF. 1/8W. 1%. 30.1K	RN55D-3012F	TRW	4701-03-3012	2			
C22	CAP. ELECT. 1900MF. 15V	39D19860156L4	SPRAG	1500-31-9201	1	R32 R72	POT. TRIM. 200	91AR2K	BECK	4600-02-0201	2	R18	RES. MF. 1/8W. 1%. 3.32K	RN55D-3321F	TRW	4701-03-3321	1			
C70 C73	CAP. ELECT. 50MF. 50V	500D506050DD7	SPRAG	1500-35-0003	2	R113	POT. SWITCH. 10K	9H-1879	CTS	4602-01-0300	1	R101 R109	RES. MF. 1/8W. 1%. 33.2K	RN55D-3322F	TRW	4701-03-3322	2			
C13	POLY. .0022MF. 200V	192P22292	SPRAG	1500-42-2204	1	R12 R131 R132 R24	RES. C. 1/2W. 5%. 10	RC206F-100	STKPL	4700-25-0100	4	R118	RES. MF. 1/8W. 1%. 3.65K	RN55D-3651F	TRW	4701-03-3651	1			
C12 C16 C8	POLYE. .022MF. 200V	192P22392	SPRAG	1500-42-2304	3	R34	RES. C. 1/2W. 5%. 3.9	RC206F-3R9	STKPL	4700-25-0399	1	R17	RES. MF. 1/8W. 1%. 3.92K	RN55D-3921F	TRW	4701-03-3921	1			
C5	CAP. POLYE. .22MF. 80V	192P2249RB	SPRAG	1500-42-2403	1	R130 R133	RES. C. 1/2W. 5%. 43	RC206F-430	STKPL	4700-25-0430	2	R94	RES. MF. 1/8W. 1%. 464	RN55D-4640F	TRW	4701-03-4640	1			
C14	POLY. .056MF. 200V	192P56392	SPRAG	1500-45-6304	1	R43 R44 R47	RES. C. 1/2W. 5%. 1H	RC206F-105	STKPL	4700-25-1004	3	R11 R22 R28	RES. MF. 1/8W. 1%. 4.75K	RN55D-4751F	TRW	4701-03-4751	3			
C37	VARI. 3.5-13PF. 250V	7S-TRIKO-02 3.5/13PF	TRIKO	1500-51-3000	1	R112 R122 R76 R8 R88	RES. MF. 1/8W. 1%. 100	RN55D-1000F	TRW	4701-03-1000	5	R111 R117 R123 R13 R23 R86	RES. MF. 1/E. 1%. 499	RN55D-4990F	TRW	4701-03-4990	6			
C10 C9	CAP. TANT. 1MF. 35V	150D105X9035A2	SPRAG	1500-71-0502	2	R104 R107 R15 R16 R26 R27 R66 R67 R80 R85	RES. MF. 1/8W. 1%. 1K	RN55D-1001F	TRW	4701-03-1001	10	R119 R125 R14 R25 R41 R51 R58	RES. MF. 1/8W. 1%. 4.99K	RN55D-4991F	TRW	4701-03-4991	7			
C29 C6 C7	CAP. TANT. 10MF. 20V	150D106X9020B2	SPRAG	1500-71-0601	3	R82	RES. MF. 1/8W. 1%. 10K	RN55D-1002F	TRW	4701-03-1002	1	R31T R59	RES. MF. 1/8W. 1%. 49.9K	RN55D-4992F	TRW	4701-03-4992	2			
C76	CAP. TANT. 22MF. 15V	196D226X9015KA1	SPRAG	1500-72-2601	1	WAVETEK PARTS LIST TITLE MAIN ASSEMBLY NO. 1100-00-0213 PAGE: 2 REV L					WAVETEK PARTS LIST TITLE MAIN ASSEMBLY NO. 1100-00-0213 PAGE: 4 REV L					WAVETEK PARTS LIST TITLE MAIN ASSEMBLY NO. 1100-00-0213 PAGE: 6 REV L				

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REMOVE ALL BURRS AND BREAK SHARP EDGES MATERIAL	DATE	WAVETEK SAN DIEGO - CALIFORNIA TITLE PARTS LIST MAIN BOARD
PROJ ENGR	RELEASE APPROV	
TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES 1° XX ± .030		
FINISH WAVETEK PROCESS	DO NOT SCALE DWG	
SCALE	MODEL NO. 171	DWG NO. 1100-00-0213
CODE 23338	SHEET 1 OF 2	REV L

NOTE: UNLESS OTHERWISE SPECIFIED

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R1 R2 R3	RES. MF. 1/8W. 1%. 56. 2K	RN55D-5622F	TRW	4701-03-5622	3
R57	RES. MF. 1/8W. 1%. 576	RN55D-5760F	TRW	4701-03-5760	1
R49	RES. MF. 1/8W. 1%. 604	RN55D-6040F	TRW	4701-03-6040	1
R21	RES. MF. 1/8W. 1%. 6. 19K	RN55D-6191F	TRW	4701-03-6191	1
R114	RES. MF. 1/8W. 1%. 6. 81K	RN55D-6811F	TRW	4701-03-6811	1
R89 R90	RES. MF. 1/8W. 1%. 7. 87K	RN55D-7871F	TRW	4701-03-7871	2
R19 R65 R68	RES. MF. 1/8W. 1%. 8. 25K	RN55D-8251F	TRW	4701-03-8251	3
R6	RES. MF. 1/8W. 1%. 9. 09K	RN55D-9091F	TRW	4701-03-9091	1
R4	RES. MF. 1/8W. 1%. 90. 9K	RN55D-9092F	TRW	4701-03-9092	1
R134 R135	RES. MF. 1/2W. 1%. 100	RN65D-1000F	TRW	4701-23-1000	2
R29 R30	RES. SET. 2-10K. 1/8W QTY: 2: 4701-03-1002	142-501-64A	WVTK	4789-00-0019	1
R45 R46 R52 R53	RES. SET. 4-4. 99K. 1/8W QTY: 4: 4701-03-4991	180-500-100A	WVTK	4789-00-0039	1
CR21	DIODE. ZENER 6.2V	1N823A	NPC	4801-01-0823	1
CR7 CR8	DIODE	1N4581	MICRO	4801-01-4581	2
CR1 CR2 CR3 CR4 CR5 CR6	DIODE	SCE-1	SEMT	4801-02-0001	6
CR10 CR11 CR12 CR9	DIODE	FD-777	FAIR	4807-02-0777	4
WAVETEK PARTS LIST		TITLE MAIN	ASSEMBLY NO. 1100-00-0213 PAGE: 7		REV L

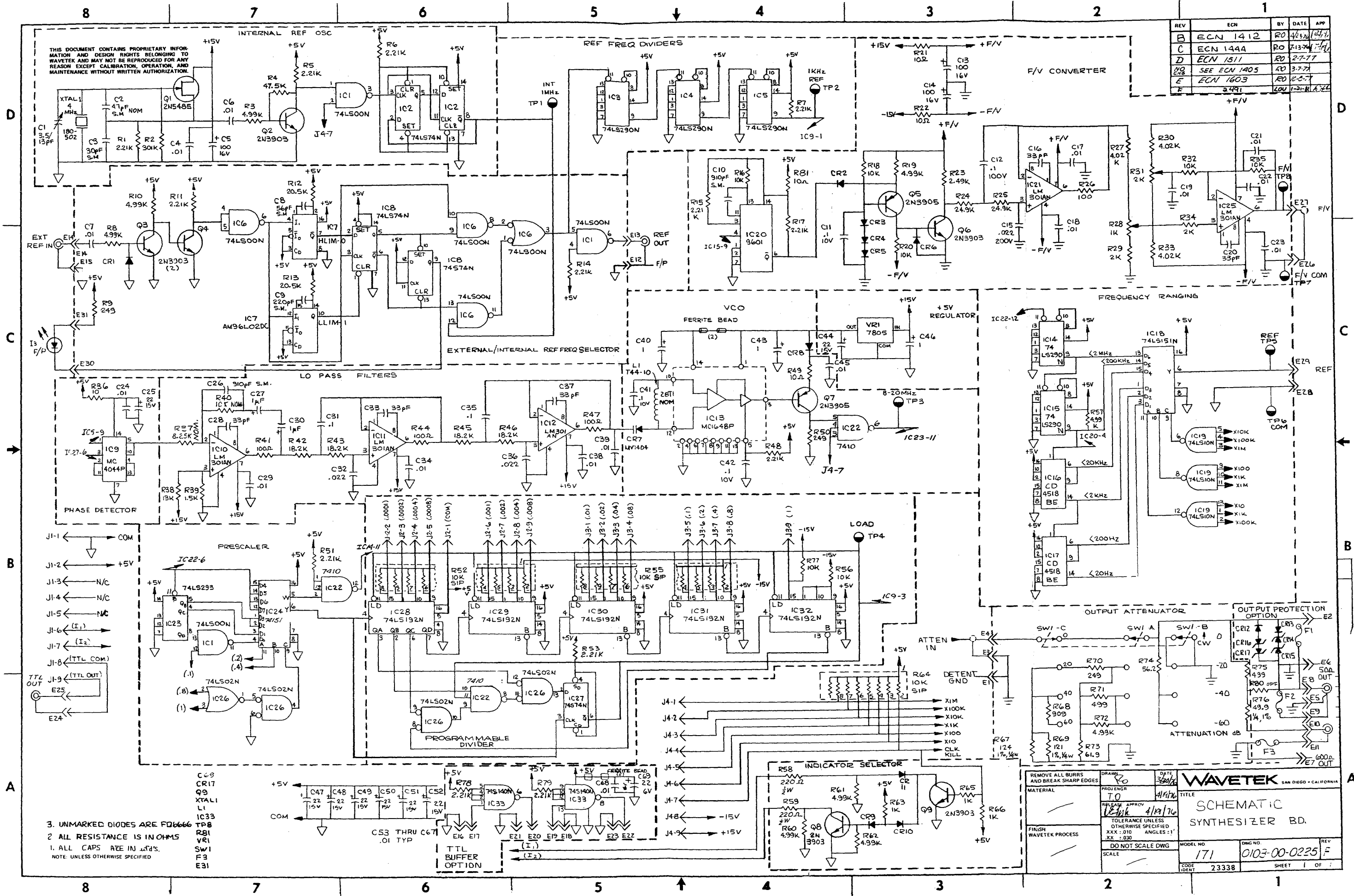
REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
CR13 CR14 CR15 CR16 CR17 CR18 CR19 CR20 CR22 CR23 CR24	DIODE	FD-6666	FAIR	4807-02-6666	11
Q21	TRANS	2N2219A	NSC	4901-02-2191	1
Q22	TRANS	2N2905A	NSC	4901-02-9051	1
Q6 Q7 Q8	TRANS	2N3638A	CARTR	4901-03-6381	3
Q2 Q20 Q3 Q4 Q9	TRANS	2N3903	NSC	4901-03-9030	5
Q10 Q11 Q19	TRANS	2N3905	ITT	4901-03-9050	3
Q12 Q13 Q14 Q15 Q18	TRANS	2N5139	FAIR	4901-05-1390	5
Q5	TRANS	TIP-29	TI	4902-00-0290	1
Q1	TRANS	TIP-30	TI	4902-00-0300	1
Q16 Q17	TRANS. M/PR/2N3903 QTY: 2: 4901-03-9030	182-503-102	WVTK	4998-00-0015	1
9	WAFER	147-400	WVTK	5104-02-0015	7
NONE	SWITCH STOP	215-33-001-01-22	CTS	5104-07-0003	2
NONE	DETENT MOD FROM: 5104-01-0010	180-313	WVTK	5104-99-0024	1
NONE	DETENT MOD FROM: 5104-01-0010	180-314	WVTK	5104-99-0025	1
RT1	THERMISTER	LB12J2	FNML	5300-00-0002	1
WAVETEK PARTS LIST		TITLE MAIN	ASSEMBLY NO. 1100-00-0213 PAGE: 8		REV L

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
IC1	IC	LH 301AN	NSC	7000-03-0100	1
IC8	IC	LH318H	AMD	7000-03-1800	1
IC2 IC3 IC4	IC	MA-741	FAIR	7000-07-4100	3
IC11	IC	CA-3019	FAIR	7000-30-1900	1
IC7	IC	CA-3054	RCA	7000-30-5400	1
IC5	IC	CA-3096AE	RCA	7000-30-9600	1
VR1	VOLTAGE REGULATOR	7805393	FAIR	3000-78-0500	1
IC10	IC	74132	TI	8007-41-3200	1
IC9	IC	MC4044P	MOT	8100-40-4400	1
WAVETEK PARTS LIST		TITLE MAIN	ASSEMBLY NO. 1100-00-0213 PAGE: 9		REV L

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO - CALIFORNIA	
MATERIAL	PROJ ENGR		TITLE PARTS LIST MAIN BOARD	
	RELEASE APPROV			
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX : .010 ANGLES : 1' XX : .030		MODEL NO. 171	DWG NO. 1100-00-0213
	DO NOT SCALE DWG	SCALE	REV L	
			CODE IDENT 23338	SHEET 2 OF 2

NOTE: UNLESS OTHERWISE SPECIFIED

REV	ECN	BY	DATE	APP
B	ECN 1412	RO	4/13/76	RO
C	ECN 1444	RO	7-13-76	RO
D	ECN 1511	RO	2-7-77	RO
E	SEE ECN 1405	RO	3-7-77	RO
F	ECN 1603	RO	10-5-77	RO
			2491	LOU



- C-9
 - CR17
 - Q9
 - XTAL1
 - L1
 - IC33
 - TP8
 - R81
 - V1
 - SW1
 - F3
 - E31
3. UNMARKED DIODES ARE F06666
 2 ALL RESISTANCE IS IN OHMS
 1. ALL CAPS ARE IN uF'S.
 NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES

DATE: 4/19/76

PROJ ENGR: TO

RELEASE APPROV: [Signature]

TOLERANCE UNLESS OTHERWISE SPECIFIED
 XXX-.010 ANGLES: 1°
 XX-.030

DO NOT SCALE DWG

SCALE: _____

FINISH WAVETEK PROCESS

WAVETEK SAN DIEGO - CALIFORNIA

TITLE: SCHEMATIC SYNTHESIZER BD.

MODEL NO: 171

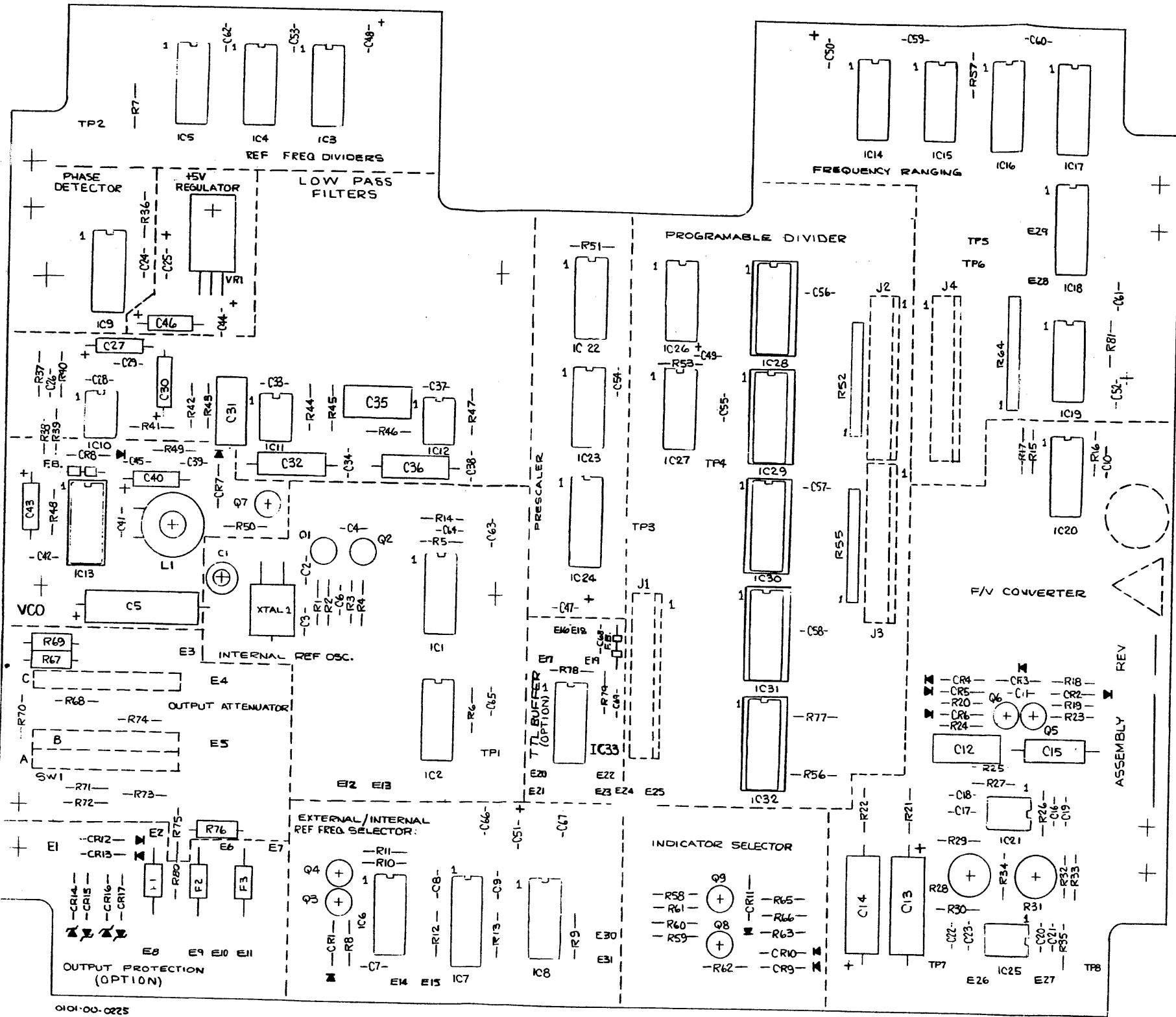
DWG NO: 0103-00-0235

REV: F

EDGE IDENT: 23338

SHEET 1 OF 1

REV	ECN	BY	DATE	APP
E	ECN 1809	JRM	7-78	
F	ECN 2467	LDU	11-78	



0101-00-0225

WAVETEK
 0101-00-0225 F
 SYNTHESIZER BD.
 R4-3305
 [Signature] 4-30-76
 1 of 2

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REV ECN BY DATE APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFG-PART-NO	MFG	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG. SYNTH	0101-00-0225	WVTK	0101-00-0225	1
NONE	SCHEMATIC. SYNTH	0103-00-0225	WVTK	0103-00-0225	1
NONE	QA PROC. SYNTH	0107-00-0225	WVTK	0107-00-0225	1
L1	TRANS. TORROID	5600-00-0011	WVTK	1204-00-0518	1
1	SPACER	144-306	WVTK	1400-00-2123	2
2	SHIELD	1400-00-5823	WVTK	1400-00-5823	1
C17 C18 C19 C21 C22 C23 C24 C29 C34 C38 C39 C4 C45 C53 C54 C55 C56 C57 C58 C59 C6 C60 C61 C62 C63 C64 C65 C66 C67 C7	CAP. CER. .01MF. 50V	CK-103 LONG LEAD	CRL	1500-01-0300	30
C11 C41 C42	CAP. CER. .1MF. 10V	UK10-104 LONG LEAD	CRL	1500-01-0402	3
C16 C20 C28 C33 C37	CAP. CER. 33PF. 1KV	DD-330 LONG LEAD	CRL	1500-03-3001	5
C9	CAP. MICA. 220PF. 500V	DM15-221J	ARCO	1500-12-2100	1
C3	CAP. MICA. 30PF. 500V	DM15-300J	ARCO	1500-13-0000	1
C2T	CAP. MICA. 47PF. 500V	DM15-470J	ARCO	1500-14-7000	1
C8	CAP. MICA. 56PF. 500V	DM15-560J	ARCO	1500-15-6000	1
C10 C26	CAP. 910PF. 100V. 5%	DM15-911J	ARCO	1500-19-1100	2
C13 C14 C5	CAP. ELECT. 100MF. 16V	500D107G016DC7	SPRAG	1500-31-0101	3

WAVETEK PARTS LIST
TITLE: PCA, SYNTHESIZER
ASSEMBLY NO. 1100-00-0225
PAGE: 1
REV H

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFG-PART-NO	MFG	WAVETEK NO.	QTY/PT
R31	POT. TRIM. 2K	91AR2K	BECK	4600-02-0201	1
R58 R59	RES. C. 1/2W. 5%. 220	RC20GF-221	STKPL	4700-25-2200	2
R26 R41 R44 R47	RES. MF. 1/8W. 1%. 100	RN55D-1000F	TRW	4701-03-1000	4
R63 R65 R66	RES. MF. 1/8W. 1%. 1K	RN55D-1001F	TRW	4701-03-1001	3
R16 R18 R20 R32 R35 R40T R56 R77	RES. MF. 1/8W. 1%. 10K	RN55D-1002F	TRW	4701-03-1002	8
R21 R22 R36 R49 R81	RES. MF. 1/8W. 1%. 10	RN55D-10R0F	TRW	4701-03-1009	5
R38	RES. MF. 1/8W. 1%. 13K	RN55D-1302F	TRW	4701-03-1302	1
R39	RES. MF. 1/8W. 1%. 1.5K	RN55D-1501F	TRW	4701-03-1501	1
R42 R43 R45 R46	RES. MF. 1/8W. 1%. 18.2K	RN55D-1822F	TRW	4701-03-1822	4
R29 R34	RES. MF. 1/8W. 1%. 2K	RN55D-2001F	TRW	4701-03-2001	2
R12 R13	RES. MF. 1/8W. 1%. 20.5K	RN55D-2052F	TRW	4701-03-2052	2
R1 R11 R14 R15 R17 R48 R5 R51 R53 R6 R7	RES. MF. 1/8W. 1%. 2.21K	RN55D-2211F	TRW	4701-03-2211	11
R50 R70 R9	RES. MF. 1/8W. 1%. 249	RN55D-2490F	TRW	4701-03-2490	3
R23	RES. MF. 1/8W. 1%. 2.49K	RN55D-2491F	TRW	4701-03-2491	1
R24 R25	RES. MF. 1/8W. 1%. 24.9K	RN55D-2492F	TRW	4701-03-2492	2
R2	RES. MF. 1/8W. 1%. 301K	RN55D-3013F	TRW	4701-03-3013	1

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFG-PART-NO	MFG	WAVETEK NO.	QTY/PT
G1	TRANS	2N5485	MOT	4901-05-4850	1
SW1A SW1B SW1C	WAFER	142-SW1-1	WVTK	5104-02-0013	3
NONE	SWITCH STOP	215-33-001-01-22	CTS	5104-07-0003	1
SW1	MODIFIED DETENT FROM: 5104-01-0010	5104-99-0026	WVTK	5104-99-0026	1
IC10 IC11 IC12 IC21 IC25	IC	LM 301AN	NSC	7000-03-0100	5
IC16 IC17	IC	CD4518BE	RCA	8000-45-1810	2
IC1 IC6	IC	74LS00	TI	8000-74-0010	2
IC26	IC	74LS02	TI	8000-74-0210	1
IC22	IC	7410	TI	8000-74-1000	1
IC19	IC	74LS10	TI	8000-74-1010	1
IC27	IC	74S74	TI	8000-74-7401	1
IC2 IC8	IC	74LS74	TI	8000-74-7410	2
VR1	VOLTAGE REGULATOR	7805393	FAIR	8000-78-0500	1
IC20	IC	8601/9601	FAIR	8000-86-0100	1
IC7	IC	96L02	FAIR	8000-96-0210	1
IC24	IC	74151	TI	8007-41-5100	1

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFG-PART-NO	MFG	WAVETEK NO.	QTY/PT
C12 C31 C35	CAP. POLYE. .1MF. 100V	225P10491WD3	SPRAG	1500-41-0444	3
C15 C32 C36	POLYE. .022MF. 200V	192P22392	SPRAG	1500-42-2304	3
C1	VARI. 3.5-13PF. 250V	7S-TRIKO-02 3.5/13PF	TRIKO	1500-51-3000	1
C27 C30 C40 C43 C46	CAP. TANT. 1MF. 35V	150D105X9035A2	SPRAG	1500-71-0502	5
C25 C44 C47 C48 C49 C50 C51 C52	CAP. TANT. 22MF. 15V	196D226X9015KA1	SPRAG	1500-72-2601	8
NONE	SYNTHESIZER 8D	1700-00-0225	WVTK	1700-00-0225	1
J1 J2 J3 J4	CONN. 9PIN	09-60-1091	MOLEX	2100-02-0052	4
SKT6	SKT. IC. 14PIN	14-DIP	CINCH	2100-03-0011	1
SKT1 SKT2 SKT3 SKT4 SKT5	SKT. IC. 16PIN	16-DIP	CINCH	2100-03-0022	5
NONE	SOLDER LUG	1497	SMITH	2100-04-0012	1
3	PIN. MALE	61182-2	AMP	2100-05-0020	27
XTAL1	CRYSTAL. 4MHZ	180-502	WVTK	2300-99-0004	1
4	STANDOFF. SHAGE .625 H. .250 HEX 6-32. .062 MAT'L	1531B-5/8	USECO	2800-02-0004	4
5	FERRITE BEAD	56-590-65/3B	FERRX	3100-00-0001	2
R28	POT. TRIM. 1K	91AR1K	BECK	4600-01-0209	1

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFG-PART-NO	MFG	WAVETEK NO.	QTY/PT
R27 R30 R33	RES. MF. 1/8W. 1%. 4.02K	RN55D-4021F	TRW	4701-03-4021	3
R4	RES. MF. 1/8W. 1%. 47.5K	RN55D-4752F	TRW	4701-03-4752	1
R71 R75	RES. MF. 1/8. 1%. 499	RN55D-4990F	TRW	4701-03-4990	2
R10 R19 R3 R57 R60 R61 R62 R72 R8	RES. MF. 1/8W. 1%. 4.99K	RN55D-4991F	TRW	4701-03-4991	9
R74	RES. MF. 1/8W. 1%. 56.2	RN55D-56R2F	TRW	4701-03-5629	1
R73	RES. MF. 1/8W. 1%. 61.9	RN55D-61R9F	TRW	4701-03-6199	1
R37T	RES. MF. 1/8W. 1%. 8.25K	RN55D-8251F	TRW	4701-03-8251	1
R68	RES. MF. 1/8W. 1%. 909	RN55D-9090F	TRW	4701-03-9090	1
R69	RES. MF. 1/4W. 1%. 121	RN60D-1210F	TRW	4701-13-1210	1
R67	RES. MF. 1/4W. 1%. 124	RN60D-1240F	TRW	4701-13-1240	1
R76	RES. MF. 1/4W. 1%. 49.9	RN60D-49R9F	TRW	4701-13-4999	1
R52 R55 R64	RES MODULE	4310R-101-103	BOURN	4770-00-0008	3
CR7	DIODE	MV1404	MOT	4803-02-1404	1
CR1 CR10 CR11 CR2 CR3 CR4 CR5 CR6 CR8 CR9	DIODE	FD-6666	FAIR	4807-02-6666	10
Q2 Q3 Q4 Q6 Q8 Q9	TRANS	2N3903	NSC	4901-03-9030	6
Q5 Q7	TRANS	2N3905	ITT	4901-03-9050	2

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFG-PART-NO	MFG	WAVETEK NO.	QTY/PT
IC18	IC	74LS151	TI	8007-41-5110	1
IC28 IC29 IC30 IC31 IC32	IC	74LS192	TI	8007-41-9210	5
IC14 IC15 IC3 IC4 IC5	IC	74LS290	TI	8007-42-9010	5
IC23	IC	74LS293	TI	8007-42-9310	1
IC13	IC	MC1648P	MOT	8100-16-4810	1
IC9	IC	MC4044P	MOT	8100-40-4400	1

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NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR	TITLE	
FINISH WAVETEK PROCESS	RELEASE APPROV	PARTS LIST PCA, SYNTHESIZER	
	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES: 1° XX ±.030		MODEL NO.
SCALE	DO NOT SCALE DWG	171	DWG NO. 110-00-0225
SCALE	SCALE	171	REV H
CODE	23338	SHEET	OF 1