MODEL 171 SYNTHESIZER/FUNCTION GENERATOR

WAVETEK
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This warranty does not apply to any products repaired or altered by persons not authorized by Wavetek, or not in accordance with instructions furnished by Wavetek. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

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Any recommendations made by Wavetek for use of its products are based upon tests believed to be reliable, but Wavetek makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for Wavetek any liability in connection with the sale of our products other than set forth herein.
CONTENTS

SECTION 1  INTRODUCTION
1.1  THE MODEL 171 ......................................... 1-1
1.2  SPECIFICATIONS ....................................... 1-1

SECTION 2  INITIAL PREPARATION
2.1  UNPACKING INSPECTION .................................. 2-1
2.2  PREPARATION FOR USE .................................. 2-1
2.3  ELECTRICAL ACCEPTANCE CHECK ....................... 2-1

SECTION 3  OPERATION
3.1  CONTROLS AND CONNECTORS ............................. 3-1
3.2  OPERATION ................................................ 3-3
3.2.1  Signal Termination .................................... 3-3
3.2.2  Manual Function Generator Operation ................ 3-3
3.2.3  Voltage Controlled Function Generator Operation .... 3-3
3.2.4  Synthesizer Operation .................................. 3-4
3.2.5  Monitoring the Synthesizer/Function Generator ....... 3-4

SECTION 4  CIRCUIT DESCRIPTION
4.1  FUNCTION GENERATOR .................................. 4-1
4.2  FREQUENCY CONTROL .................................... 4-1
4.3  WAVEFORM OUTPUT ..................................... 4-2
4.4  OUTPUT ATTENUATOR AND PROTECTION CIRCUIT ......... 4-2
4.5  PHASE LOCK LOOP ...................................... 4-2
4.6  SYNTHESIZER LOOP ..................................... 4-2

SECTION 5  CALIBRATION
5.1  FACTORY REPAIR ....................................... 5-1
5.2  REQUIRED TEST EQUIPMENT ............................. 5-1
5.3  REMOVING GENERATOR COVER ......................... 5-1
5.4  CALIBRATION ............................................ 5-1

SECTION 6  TROUBLESHOOTING
6.1  FACTORY REPAIR ....................................... 6-1
6.2  TROUBLESHOOTING CHART .............................. 6-1
6.3  TROUBLESHOOTING INDIVIDUAL COMPONENTS .......... 6-1

SECTION 7  PARTS AND SCHEMATICS
7.1  DRAWINGS ............................................... 7-1
7.2  ORDERING PARTS ....................................... 7-1
7.3  ADDENDA ................................................ 7-1
SAFETY

This instrument is wired for earth grounding via the facility power wiring. Do no 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: O or Δ 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.
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 \( \triangle \), square \( \square \) and DC selectable. TTL pulse \( \uparrow\downarrow \), 1 MHz reference pulse \( \uparrow\downarrow\) 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

<table>
<thead>
<tr>
<th>FREQ MULT</th>
<th>Range</th>
<th>Digital Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>X 1</td>
<td>0.1 Hz to 2 Hz</td>
<td>N. A.</td>
</tr>
<tr>
<td>X 10</td>
<td>0.1 Hz to 20 Hz</td>
<td>0.001 Hz</td>
</tr>
<tr>
<td>X 100</td>
<td>0.2 Hz to 200 Hz</td>
<td>0.01 Hz</td>
</tr>
<tr>
<td>X 1K</td>
<td>0.2 Hz to 2 kHz</td>
<td>0.1 Hz</td>
</tr>
<tr>
<td>X 10K</td>
<td>20 Hz to 20 kHz</td>
<td>1.0 Hz</td>
</tr>
<tr>
<td>X 100K</td>
<td>200 Hz to 200 kHz</td>
<td>10 Hz</td>
</tr>
<tr>
<td>X 1M</td>
<td>2 kHz to 2 MHz</td>
<td>100 Hz</td>
</tr>
</tbody>
</table>

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
\( \sim\), \( \triangle\), \( \square\) ; 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; 10% 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.
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.

<table>
<thead>
<tr>
<th>AC Line Voltage</th>
<th>Switch A</th>
<th>Switch B</th>
<th>Fuse (SB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 - 110</td>
<td>115</td>
<td>LO</td>
<td>3/8 amp</td>
</tr>
<tr>
<td>105 - 125</td>
<td>115</td>
<td>HI</td>
<td>3/8 amp</td>
</tr>
<tr>
<td>180 - 220</td>
<td>230</td>
<td>LO</td>
<td>3/16 amp</td>
</tr>
<tr>
<td>210 - 250</td>
<td>230</td>
<td>HI</td>
<td>3/16 amp</td>
</tr>
</tbody>
</table>

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 ±12V 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:

<table>
<thead>
<tr>
<th>Control</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Dial</td>
<td>1.0</td>
</tr>
<tr>
<td>FREQ MULT</td>
<td>X 1K</td>
</tr>
<tr>
<td>Digital Switch</td>
<td>1.9999</td>
</tr>
<tr>
<td>DC OFFSET</td>
<td>OFF</td>
</tr>
<tr>
<td>Waveform Selector</td>
<td>1</td>
</tr>
<tr>
<td>AMPLITUDE</td>
<td>Full cw</td>
</tr>
<tr>
<td>ATTENUATION</td>
<td>0</td>
</tr>
<tr>
<td>Dial/Digital Switch</td>
<td>Toward Dial</td>
</tr>
</tbody>
</table>

![Figure 2-1. Performance Checkout Setup](image)

<table>
<thead>
<tr>
<th>Table 2-1. Performance Checkout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Function</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Amplitude</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Step</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

**Outputs**

1. Remove 50Ω load and reconnect cable. Remove the 50Ω OUT connection and place it on the 600Ω OUT BNC.

2. Remove the 600Ω OUT connection and place it on the TTL OUT.

3. Remove the TTL OUT connection and place it on the REF OUT. Flip dial/digital switch selector to digital switch side.

4. Remove the REF OUT connection and place it on the GCV OUT.

5. Flip dial/digital switch selector to dial side.

**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.
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.
Digital Switch

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

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).

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:

<table>
<thead>
<tr>
<th>Attenuation</th>
<th>Full cw</th>
<th>Full ccw</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10V p-p</td>
<td>1V p-p</td>
</tr>
<tr>
<td>20</td>
<td>1V p-p</td>
<td>100 mV p-p</td>
</tr>
<tr>
<td>40</td>
<td>100 mV p-p</td>
<td>10 mV p-p</td>
</tr>
<tr>
<td>60</td>
<td>10 mV p-p</td>
<td>(Not specified)</td>
</tr>
</tbody>
</table>

600Ω OUT and 50Ω OUT Connectors

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

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.

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 is lit, the external reference signal of 1 MHz.

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 is lit.

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.

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 ; 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](image)

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

<table>
<thead>
<tr>
<th>Connector</th>
<th>Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>50Ω OUT</td>
<td>50Ω</td>
</tr>
<tr>
<td>600Ω OUT</td>
<td>600Ω</td>
</tr>
<tr>
<td>TTL OUT</td>
<td>*</td>
</tr>
<tr>
<td>REF OUT</td>
<td>*</td>
</tr>
<tr>
<td>VCG IN</td>
<td>2 kΩ</td>
</tr>
<tr>
<td>GCV OUT</td>
<td>600Ω</td>
</tr>
<tr>
<td>REF IN</td>
<td>5 kΩ</td>
</tr>
</tbody>
</table>

*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.)

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

![Figure 3-4. DC OFFSET Control](image)

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 (±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.)

<table>
<thead>
<tr>
<th>MAIN DIAL SETTING</th>
<th>VCG IN VOLTAGE</th>
<th>OUTPUT FREQUENCY FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>-2.0</td>
<td>.002</td>
</tr>
<tr>
<td>1.8</td>
<td>-1.6</td>
<td>.2</td>
</tr>
<tr>
<td>1.6</td>
<td>-1.2</td>
<td>.4</td>
</tr>
<tr>
<td>1.4</td>
<td>-.8</td>
<td>.6</td>
</tr>
<tr>
<td>1.2</td>
<td>-.4</td>
<td>.8</td>
</tr>
<tr>
<td>1.0</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>.8</td>
<td>.4</td>
<td>1.2</td>
</tr>
<tr>
<td>.6</td>
<td>.8</td>
<td>1.4</td>
</tr>
<tr>
<td>.4</td>
<td>+1.2</td>
<td>1.6</td>
</tr>
<tr>
<td>.2</td>
<td>+1.6</td>
<td>1.8</td>
</tr>
<tr>
<td>+2.0+2.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 100:1 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.)

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

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 6-1. Function Generator Block Diagram
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 4.6.) 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-
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.

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.

4.5 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.

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 (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
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) HP334A
Distortion Analyzer (1% F.S.)
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

<table>
<thead>
<tr>
<th>Step</th>
<th>Check</th>
<th>Tester</th>
<th>Cal Points</th>
<th>Control Settings</th>
<th>Adjust</th>
<th>Desired Results</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power supply</td>
<td>DVM</td>
<td>TP2 (TP1</td>
<td></td>
<td>R20</td>
<td>+15 ±0.01V</td>
<td>Main board</td>
</tr>
<tr>
<td></td>
<td>regulation</td>
<td></td>
<td>ground)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>TP3 (-15V)</td>
<td></td>
<td></td>
<td>−15 ±0.05V</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Output dc</td>
<td>Scope or DVM</td>
<td>50Ω OUT</td>
<td></td>
<td>R116</td>
<td>0 ±0.01 Vdc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>balance</td>
<td></td>
<td></td>
<td>AMPLITUDE: ccw</td>
<td>R141</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Step</th>
<th>Check</th>
<th>Tester</th>
<th>Cal Points</th>
<th>Control Settings</th>
<th>Adjust</th>
<th>Desired Results</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Frequency</td>
<td>Counter</td>
<td>50Ω OUT</td>
<td>FREQ MULT: X 10K</td>
<td></td>
<td>Proper reading on counter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bits</td>
<td></td>
<td></td>
<td>Digital Switch: 0.1111 thru 0.9999</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Spectral</td>
<td>Spectrum</td>
<td></td>
<td>Function: ^</td>
<td></td>
<td>Spurious signals below −70 dB. Noise floor below −60 dB.</td>
<td>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 f₀ + 3 Hz is below −60 dBc and that no line related spurs are above −70 dBc. Keep power lines away from analyzer input.</td>
</tr>
<tr>
<td></td>
<td>purity</td>
<td>Analyzer</td>
<td></td>
<td>Digital Switch: 1.9999</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.
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

NOTE: Unless otherwise indicated, test points and designators apply to generator (upper) board and mode selector is in generator mode.

- BOTH 600Ω OUT AND 50Ω OUT BAD
- TURN DC OFFSET OFF

- ALL FUNCTIONS BAD?
  - YES
  - NO
    - GOOD
      - NO
        - BAD
          - NO
            - IC11 CIRCUIT
        - YES
          - APPROX 22V \( \ominus \) AT JUNCTION CR17, 18?
            - NO
              - CHECK CR17 - 20 & Q15 CKT
            - YES
              - SET WAVEFORM TO \( \ominus \)
                - NO
                  - AT JUNCTION CR19, 20 OK?
                - YES
                  - CHECK CR17 - 20 & SW2 A & B

- SELECT

- \( \pm 1.25V \ominus \) AT PIN 6 IC8?
  - YES
  - NO
    - APPROX \( \pm 1V \ominus \) AT PIN 6 IC8?
      - NO
        - CHECK GENERATOR LOOP (SHEET 2)
      - YES
        - APPROX \( \pm 1V \ominus \) AT R110 WIPER WITH AMPLITUDE CW?
          - NO
            - CHECK SW2 A & B & IC8 CKT
          - YES
            - REMOVE R111
              - APPROX \( \pm 1V \ominus \) AT R110 WIPER WITH AMPLITUDE CW?
                - NO
                  - REINSTALL R111
                - YES
                  - REINSTALL R111

Figure 6-2. Generator Mode Checks (Sheet 1 of 3)
**GENERATOR LOOP CHECK**

- NO ±1.25V at Pin 6 IC6
  - Regulated + & -15 Vdc at TP2 & TP3
    - YES
    - NO
      - Fuse 115/220V Switch & Power Connection OK?
        - YES
          - ~12Vdc on C24 (+) & ~-24 Vdc on C23 (-)
            - YES
              - Check Power Supply Regulator (Figure 6-3)
            - NO
        - NO
          - Diodes CR3-6 OK?
            - YES
              - C23, 24 OK?
                - YES
                  - Check Xfmr
                - NO
                  - Check CR13, 14
            - NO
              - Check Q12-15 CR15, 16 & IC7 Circuit
    - NO
      - Rotate Dial from Top to Bottom +15V to ~15 mV Shift at E9
        - YES
        - NO
          - Wiring EB-10 OK?
            - YES
              - Dial Potentiometer Bad
            - NO
              - Rotate Dial; 0 Vdc with NO Shift at Pin 3 IC4
        - YES
        - NO
          - CR8 & PNP at Pins 7-9 IC5 OK?
            - YES
              - Problem in IC4 Circuit
            - NO
              - Rotate Dial; Approx -15V to -10V shift at Pins 7, 4, 2 & +15V to +10V shift at Pins 10, 13 IC5?
                - YES
                  - Q9, 10, 11 OK?
                    - YES
                      - Problem in IC5 Circuit
                    - NO
                      - ~12 Vdc at Junction CR9, 10 & ~1.25 Vdc* at Junction CR11, 12?
                        - YES
                          - Same Vdc at Pins 3, 6 IC6?
                            - YES
                              - CR9 - 12 & SW1 A, B, C OK?
                                - YES
                                  - Check Q12-15 CR15, 16 & IC7 Circuit
                                - NO
                                  - Check CR13, 14
                            - NO
                              - ~1.25 Vdc at Pin 6 IC6?
                                - YES
                                  - Check Q12-15 CR15, 16 & IC7 Circuit
                              - NO
                                - Check CR13, 14
                        - NO
                          - Check CR13, 14
                    - NO
                      - Check CR13, 14
                - NO
                  - Check CR13, 14

*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)
Figure 6-3. Power Supply Checks
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 2 of 6)
Figure 6-4. Synthesizer Mode Checks (Sheet 3 of 6)
FREQUENCY RANGING CHECK

SYNTHESIZER LOOP RUNNING BUT FREQUENCY BAD

SET DIGITAL SWITCH TO 1.0000

10 MHz AT PIN 11 IC14?

YES

CHECK SYNTHESIZER LOOP (SHEET 2)

NO

1 MHz AT PIN 9 IC14?

YES

REPLACE IC14

NO

100 kHz AT PIN 9 IC15?

YES

REPLACE IC15

NO

10 kHz AT PIN 6 IC16?

YES

REPLACE IC16

NO

1 kHz AT PIN 14 IC16?

YES

CORRECT FREQUENCY AT TP5?

YES

CHECK GENERATOR PHASE LOCK LOOP (SHEET 5)

NO

100 Hz AT PIN 6 IC17?

YES

REPLACE IC17

NO

10 Hz AT PIN 14 IC17?

YES

CHECK IC18, 19

NO

Figure 6-4. Synthesizer Mode Checks (Sheet 4 of 6)
Figure 6-4. Synthesizer Mode Checks (Sheet 5 of 6)
SYNTH LOOP DOES NOT WORK WITH EXTERNAL REFERENCE FREQUENCY SOURCE

SYNTH LOOP DOES NOT WORK WITH INTERNAL REFERENCE FREQUENCY SOURCE

1 MHz AT TP1?

NO

1 MHz SIGNAL AT PIN 11 IC3?

YES

NO

4 MHz AT PIN 3 IC1?

YES

CHECK IC2

NO

X 10 OR GREATER RANGE & SYNTH MODE

YES

NO

ILLEGAL OPERATION

12 LIT OVER DIGITAL SW?

YES

CHECK IC1 & Q1, 2 CLOCK CIRCUIT

NO

CHECK Q8, 9 CLOCK KILL CIRCUIT

SWITCHES TO EXT REF?

NO

YES

1 MHz EXT REF SIGNAL ≥ 1 V RMS SINE, SQUARE OR TTL

NO

ILLEGAL OPERATION

YES

1 MHz TTL SIGNAL AT PINS 4, 5 IC6?

YES

CHECK IC6 - 8 CIRCUIT

NO

CHECK Q3, 4 CIRCUIT

SELECTOR FUNCTIONAL BUT NO SIGNAL AT "REF OUT" BNC

PROBLEM IN IC1 OR, IF TTL BUFFER OPTION INSTALLED, IC33

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

<table>
<thead>
<tr>
<th>CHASSIS</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Drawing</td>
<td>7-2</td>
</tr>
<tr>
<td>Schematic</td>
<td>7-3</td>
</tr>
<tr>
<td>Parts List</td>
<td>7-4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MAIN BOARD</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Drawing</td>
<td>7-6</td>
</tr>
<tr>
<td>Schematic</td>
<td>7-7</td>
</tr>
<tr>
<td>Parts List</td>
<td>7-8</td>
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<th>Page No.</th>
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<tbody>
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<td>7-10</td>
</tr>
<tr>
<td>Schematic</td>
<td>7-11</td>
</tr>
<tr>
<td>Parts List</td>
<td>7-12</td>
</tr>
</tbody>
</table>
### WaveTec Parts List

<table>
<thead>
<tr>
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<th>Part Description</th>
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**Reference Designation**

- Diodes
- Transistors
- Resistors
- Capacitors
- Inductors
- Transformers
- Switches
- Connectors
- Connectors
- Connectors

**Important Notes**

- All parts are subject to change without notice.
- Refer to the latest version of the parts list for updated information.

**Part List Details**

- Part Number: 1234567890
- Revision: 1.0
- Date: 01/01/2023

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**Additional Information**

- Manufacturer: WaveTek
- Date Code: 1201
- Part Number: XYZ1234567890

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**Part List Instructions**

- Use parts as specified.
- Replace all parts as necessary.
- Keep records of all changes.

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**Reference Designation**

- ICs
- Resistors
- Capacitors
- Inductors
- Connectors

**Important Notes**

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**Part List Details**

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