INSTRUCTION MANUAL

Model 145
145-S-620, 145-S-872 & 145-S-1021
20 MHz Pulse/Function Generator
WARRANTY

Wavetek warrants that all products manufactured by Wavetek conform to published Wavetek specifications and are free from defects in materials and workmanship for a period of one (1) year from the date of delivery when used under normal conditions and within the service conditions for which they were furnished.

The obligation of Wavetek arising from a Warranty claim shall be limited to repairing, or at its option, replacing without charge, any product which in Wavetek's sole opinion proves to be defective within the scope of the Warranty. In the event Wavetek is not able to modify, repair or replace non-conforming defective parts or components to a condition as warranted within a reasonable time after receipt thereof, Buyers shall be credited for their value at the original purchase price.

Wavetek must be notified in writing of the defect or nonconformity within the Warranty period and the affected product returned to Wavetek's factory or to an authorized service center within (30) days after discovery of such defect or nonconformity.

For product warranties requiring return to Wavetek, products must be returned to a service facility designated by Wavetek. Buyer shall prepay shipping charges, taxes, duties and insurance for products returned to Wavetek for warranty service. Except for products returned to Buyer from another country, Wavetek shall pay for return of products to Buyer.

Wavetek shall have no responsibility hereunder for any defect or damage caused by improper storage, improper installation, unauthorized modification, misuse, neglect, inadequate maintenance, accident or for any product which has been repaired or altered by anyone other than Wavetek or its authorized representative and not in accordance with instructions furnished by Wavetek.

Exclusion of Other Warranties

The Warranty described above is Buyer's sole and exclusive remedy and no other warranty, whether written or oral, is expressed or implied. Wavetek specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. No statement, representation, agreement, or understanding, oral or written, made by an agent, distributor, representative, or employee of Wavetek, which is not contained in the foregoing Warranty will be binding upon Wavetek, unless made in writing and executed by an authorized Wavetek employee. Under no circumstances shall Wavetek be liable for any direct, indirect, special, incidental, or consequential damages, expenses, losses or delays (Including loss of profits) based on contract, tort, or any other legal theory.
INSTRUCTION MANUAL

Model 145
145-S-620, 145-S-872 & 145-S-1021
20 MHz Pulse/Function Generator

© 1983 Wavetek

This document contains information proprietary to Wavetek and is provided solely for instrument operation and maintenance. The information in this document may not be duplicated in any manner without the prior approval in writing from Wavetek.

Model 145-S-620 is a standard Wavetek Model 145 modified to provide a SYMMETRY control on the rear panel. This control allows the waveform time symmetry to be continuously adjusted over a 19:1 to 1:19 range. When this control is switched on, the generator operates at approximately 1/10 of the selected frequency. All procedures and descriptions in this manual assume that the SYMMETRY control is in the OFF position.

Model 145-S-872 is identical to the standard Model 145 except for the addition of an elapsed time meter installed on the rear panel.

Model 145-S-1021 is identical to the standard Model 145 except for the addition of both the SYMMETRY control and an elapsed time meter installed on the rear panel.

Option parts lists, assembly drawings and schematics as well as those for the Standard Model 145 are contained in Section 7 of this manual.

Wavetek
Instruments Division
9045 Balboa Ave.
San Diego, CA 92123
Tel: (619) 279-2200
800-223-9885
Fax: (619) 565-7942

Manual Revision 3/92
Manual Part Number 1300-00-0101
CONTENTS

SECTION 1  GENERAL DESCRIPTION

1.1  MODEL 145 ......................................................................................... 1-1
1.2  SPECIFICATIONS ............................................................................. 1-1
1.3  EQUIPMENT REQUIRED ................................................................. 1-2

SECTION 2  INITIAL PREPARATION

2.1  MECHANICAL INSTALLATION ......................................................... 2-1
2.2  ELECTRICAL INSTALLATION ......................................................... 2-1
2.3  ELECTRICAL ACCEPTANCE CHECK .............................................. 2-1
2.4  PREPARATION FOR SHIPMENT ................................................. 2-4
2.5  PREPARATION FOR STORAGE ................................................... 2-4
2.6  PREPARATION FOR EXTENDED STORAGE .............................. 2-4

SECTION 3  OPERATION

3.1  CONTROLS AND CONNECTIONS ............................................... 3-1
3.2  OPERATION .......................................................... 3-4
3.2.1  Signal Termination ................................................................... 3-4
3.2.2  Pulses ....................................................................................... 3-5
3.2.3  Waveforms ............................................................................... 3-5
3.2.4  Voltage Controlled Function Generator Operation .................. 3-6
3.2.5  Delay of Triggered Pulse ........................................................ 3-7

SECTION 4  CIRCUIT DESCRIPTION

4.1  BASIC WAVEFORM DEVELOPMENT ............................................ 4-1
4.2  AMPLITUDE, OFFSET AND ATTENUATION ............................. 4-2
4.3  TRIGGER AND GATE CONTROL ................................................. 4-2
4.4  PULSE OUTPUTS ........................................................................... 4-2
4.5  WIDTH AND DELAY ONE-SHOTS .............................................. 4-3

SECTION 5  MAINTENANCE

5.1  FACTORY REPAIR ................................................................. 5-1
5.2  INSPECTION AND PERFORMANCE VERIFICATION ............. 5-1
5.3  REQUIRED TEST EQUIPMENT .................................................. 5-1
5.4  REMOVING GENERATOR COVERS ........................................... 5-1
5.5  CALIBRATION ............................................................................ 5-1

SECTION 6  TROUBLESHOOTING

6.1  FACTORY REPAIR ................................................................. 6-1
6.2  TROUBLESHOOTING CHARTS .................................................. 6-1
6.3  TROUBLESHOOTING INDIVIDUAL COMPONENTS ..................... 6-1
6.4  DISASSEMBLY/REASSEMBLY INSTRUCTIONS FOR BENCH INSTRUMENT ......................................................... 6-2
6.5  DISASSEMBLY/REASSEMBLY INSTRUCTIONS FOR RACK MOUNTED INSTRUMENT ......................................................... 6-3
CONTENTS (Continued)

SECTION 7 PARTS LIST AND SCHEMATICS

7.1 DRAWINGS ........................................................................................................ 7-1
7.2 ERRATA ........................................................................................................... 7-1
7.3 ORDERING ...................................................................................................... 7-1
7.4 INDEX OF FEDERAL SUPPLY CODES ....................................................... 7-1
7.5 CAPACITOR VARIANCE ............................................................................... 7-3

ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Initial Setup</td>
<td>2-2</td>
</tr>
<tr>
<td>2-2</td>
<td>Second Setup</td>
<td>2-3</td>
</tr>
<tr>
<td>3-1</td>
<td>Controls and Connectors</td>
<td>3-1</td>
</tr>
<tr>
<td>3-2</td>
<td>Signal Termination</td>
<td>3-4</td>
</tr>
<tr>
<td>3-3</td>
<td>ECL Terminations</td>
<td>3-4</td>
</tr>
<tr>
<td>3-4</td>
<td>Pulse Characteristics</td>
<td>3-5</td>
</tr>
<tr>
<td>3-5</td>
<td>Waveform Characteristics</td>
<td>3-6</td>
</tr>
<tr>
<td>3-6</td>
<td>VCG Voltage-to-Frequency Nomograph</td>
<td>3-7</td>
</tr>
<tr>
<td>3-7</td>
<td>Pulse Delay From Trigger</td>
<td>3-7</td>
</tr>
<tr>
<td>4-1</td>
<td>Overall Block Diagram</td>
<td>4-0</td>
</tr>
<tr>
<td>4-2</td>
<td>Basic Generator and Timing Diagram</td>
<td>4-1</td>
</tr>
<tr>
<td>4-3</td>
<td>Trigger Circuit and Timing</td>
<td>4-3</td>
</tr>
<tr>
<td>4-4</td>
<td>Normal Mode Timing</td>
<td>4-4</td>
</tr>
<tr>
<td>4-5</td>
<td>Delayed Mode Timing</td>
<td>4-4</td>
</tr>
<tr>
<td>4-6</td>
<td>Double Mode Timing</td>
<td>4-5</td>
</tr>
<tr>
<td>4-7</td>
<td>Width and Delay One-Shots</td>
<td>4-5</td>
</tr>
<tr>
<td>5-1</td>
<td>Generator Board</td>
<td>5-5</td>
</tr>
<tr>
<td>5-2</td>
<td>Trig/Pulse Board</td>
<td>5-7</td>
</tr>
<tr>
<td>6-1</td>
<td>Initial Checks, Generator Board</td>
<td>6-6</td>
</tr>
<tr>
<td>6-2</td>
<td>Generator Loop Checks, Generator Board</td>
<td>6-7</td>
</tr>
<tr>
<td>6-3</td>
<td>VCG Checks, Generator Board</td>
<td>6-8</td>
</tr>
<tr>
<td>6-4</td>
<td>Generator Output Checks, Generator Board</td>
<td>6-9</td>
</tr>
<tr>
<td>6-5</td>
<td>Trigger and Gate Mode Checks, Trig/Pulse Board</td>
<td>6-10</td>
</tr>
<tr>
<td>6-6</td>
<td>Power Supply Checks, Trig/Pulse Board</td>
<td>6-12</td>
</tr>
<tr>
<td>6-7</td>
<td>Generator Input and Output Checks</td>
<td>6-14</td>
</tr>
<tr>
<td>6-8</td>
<td>Pulse Mode Checks, Trig/Pulse Board</td>
<td>6-16</td>
</tr>
<tr>
<td>6-9</td>
<td>Pulse Generator Checks, Trig/Pulse Board</td>
<td>6-18</td>
</tr>
</tbody>
</table>

NOTE

The following illustrations appear at the rear of this manual in the order shown.

<table>
<thead>
<tr>
<th>Drawing Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>0102-00-0101</td>
<td>Instrument Assembly and Parts List</td>
</tr>
<tr>
<td>0004-00-0101</td>
<td>Instrument Schematic</td>
</tr>
<tr>
<td>0102-00-0575</td>
<td>Chassis Assembly</td>
</tr>
<tr>
<td>1101-00-0575</td>
<td>Chassis Assembly Parts List</td>
</tr>
</tbody>
</table>
ILLUSTRATIONS (Continued)

<table>
<thead>
<tr>
<th>Drawing Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>0103-00-0556</td>
<td>Generator Board Schematic</td>
</tr>
<tr>
<td>1100-00-0556</td>
<td>Generator Board Parts Locator</td>
</tr>
<tr>
<td>0101-00-0556</td>
<td>Generator Board Assembly (Sheets 2 and 3)</td>
</tr>
<tr>
<td>1100-00-0556</td>
<td>Generator Board Parts List</td>
</tr>
<tr>
<td>0101-00-1008</td>
<td>Current Limiter Board Parts Locator and Parts List</td>
</tr>
<tr>
<td>0103-00-0565</td>
<td>Trigger/Pulse Board Schematic</td>
</tr>
<tr>
<td>1100-00-0565</td>
<td>Trigger/Pulse Board Parts Locator</td>
</tr>
<tr>
<td>0101-00-0565</td>
<td>Trigger/Pulse Board Assembly (Sheet 2)</td>
</tr>
<tr>
<td>1100-00-0565</td>
<td>Trigger/Pulse Board Parts List</td>
</tr>
<tr>
<td>0102-00-0621</td>
<td>Rack Mount Assembly and Parts List</td>
</tr>
<tr>
<td>1101-00-3243</td>
<td>Chassis Assembly</td>
</tr>
<tr>
<td>1100-00-3243</td>
<td>Chassis Parts List</td>
</tr>
<tr>
<td>1104-00-3245</td>
<td>Generator Board Schematic</td>
</tr>
<tr>
<td>1101-00-3245</td>
<td>Generator Board Assembly</td>
</tr>
<tr>
<td>1100-00-3245</td>
<td>Generator Board Parts List</td>
</tr>
<tr>
<td>0102-00-0221</td>
<td>Option 001 5000 Hour Timer Assembly and Parts List</td>
</tr>
<tr>
<td>0102-00-0442</td>
<td>Option 003 5000 Hour Timer Assembly</td>
</tr>
<tr>
<td>1000-00-0442</td>
<td>Option 003 5000 Hour Timer Parts List</td>
</tr>
</tbody>
</table>
PROTECT YOURSELF. Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wiring carrying the output signals. This instrument can generate hazardous voltages and currents.

- Don't bypass the power cord's ground lead with two-wire extension cords or plug adaptors.

- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with ☼ or ⚡).

- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.

- Don't plug in the power cord until directed to by the installation instructions.

- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.

- Pay attention to the WARNING statements. They point out situations that can cause injury or death.

- Pay attention to the CAUTION statements. They point out situations that can cause equipment damage.
1.1 THE MODEL 145

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

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

1.2 SPECIFICATIONS

1.2.1 Versatility

Instrument operates as either a function generator or pulse generator.

1.2.2 Function Generator

Waveforms
Selectable sine √, square ⅛, triangle △, positive square △, negative square △ and dc. TTL sync pulse and fixed amplitude pulses of TTL, TTL, ECL and ECL, all simultaneously available with function output.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator is quiescent until triggered by an external signal or manual trigger, then generates one cycle at selected frequency.

Gated: As triggered mode, except generator oscillates for the duration of the gate signal.

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

Function Output
\( \sqrt{ \cdot}, \sqrt{ \cdot}, \sqrt{ \cdot} \) selectable and variable to 30 Vp-p (15 Vp-p into 500). \( \sqrt{ \cdot}, \sqrt{ \cdot}, \sqrt{ \cdot} \), to 15 Vp (7.5 Vp into 500). All waveforms and dc can supply 150 mA peak current and may be attenuated to 60 dB in 20 dB steps with an additional 20 dB vernier.

DC Output and DC Offset
Selectable thru FUNCTION OUT output. Controlled by front panel control or by applying an external voltage. Adjustable between a minimum of ±14.4 Vdc (±7.2 Vdc into 500) with signal peak plus offset limited to ±14.4 Vdc (±7.2 Vdc into 500). External offset sensitivity approximately 1 VV with output into open circuit. DC offset and output waveform attenuated proportionately the 60 dB output attenuator.

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

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

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to 2 volt signal to VCG IN connector. Upper and lower frequencies limited to maximum and minimum of selected range.

Slew Rate: 2% of range per μs.

Linearity:
±0.2% for 10 Hz to 200 kHz.
±0.75% for 0.001 Hz to 2 MHz.

Impedance: 2 kΩ.

Trigger and Gate
Input Range: 1 Vp-p to ±10V.
Impedance: 10 kΩ, 33 pF.
Pulse Width: 25 ns minimum.
Repetition Rate: 10 MHz maximum.
Adjustable Triggered Signal Start/Stop Point (sine and triangle only): Approximately $-90^\circ$ to $+90^\circ$ to 2 MHz.

1.2.3 Frequency Precision

Dial Accuracy
±3% of full range from X .01 Hz to X 1 MHz.
±5% of full range on X 10 MHz.

Time Symmetry
Square wave variation less than:
±1% from 0.001 Hz to 200 kHz
±0.5% from 20 Hz to 20 kHz

1.2.4 Amplitude Precision

Amplitude Change With Frequency
Sine variation less than:
±0.1 dB for 0.001 Hz to 200 kHz
±0.5 dB for 200 kHz to 2 MHz
±3.0 dB for 2 to 20 MHz

Step Attenuator Accuracy
0.3 dB per 20 dB step at 2 kHz.

1.2.5 Waveform Characteristics

Sine Distortion
<0.5% on X 100 Hz to X 10 kHz.
<1.0% on X .01 to X 10 Hz and X 100 kHz.
All harmonics 34 dB below fundamental on X 1 MHz.
All harmonics 26 dB below fundamental on X 10 MHz.

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

1.2.6 Pulse Generator

Pulse Outputs
Variable amplitude pulse, and simultaneous fixed ECL, ECL, TTL and TTL pulses and TTL sync pulse. All outputs can drive 50Ω terminations.

Operational Modes
Continuous, triggered and gated plus the following.
Normal Pulse: Adjustable width pulse in phase with sync signal.
Delayed Pulse: Pulse delayed with respect to normal pulse. Pulse delay and pulse width adjustable.
Double Pulse: Two pulses for every period. Time between pulses and pulse width adjustable. Minimum period 100 ns.

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

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

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

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

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

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

1.2.7 General

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

Environmental
Specifications apply at 23°C ± 5°C. Instrument will operate from 0°C to 50°C ambient temperatures.

Dimensions
28.6 cm (11 1/4 in.) wide; 13.3 cm (5 1/4 in.) high; 27.3 cm (10 3/4 in.) deep.

Weight
5 kg (11 lb) net; 6.6 kg (14 1/2 lb) shipping.

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

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

Equipment required is given in table 1-1.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacturer's Part Number</th>
<th>Alternate Part Number</th>
<th>Application Acceptance</th>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope</td>
<td>TEK 465</td>
<td>TEK 475</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Voltmeter</td>
<td>Fluke 8000A</td>
<td>Fluke 8010A</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Distortion Analyzer</td>
<td>HP334A</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Counter</td>
<td>HP5300B</td>
<td>HP5345A</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Function Generator</td>
<td>Wavetek 180</td>
<td>Wavetek 148</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>DC Voltage Source</td>
<td>JF 332</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>50Ω Termination</td>
<td>TEK 011-0099-00</td>
<td>Fluke Y9103</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3 Foot Coax Cables</td>
<td>TEK 012-0057-01</td>
<td>Pomona 4964-SS-36</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Coax Tee Connector</td>
<td>TEK 103-0030-00</td>
<td>Pomona 3285</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

**WARNING**
To preclude injury or death due to shock, the third wire earth ground must be continuous to the facility power outlet. Before connecting to the facility power outlet, examine extension cords, autotransformers, etc., between the instrument and the facility power outlet for a continuous earth ground path. The earth ground path can be identified at the plug on the instrument power cord; of the three terminals, the earth ground terminal is the nonmatching shape, usually cylindrical.

**CAUTION**
To prevent damage to the instrument, check for proper match of line and instrument voltage and proper fuse type and rating.

**NOTE**
Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 108 to 132 Vac line supply and with a 0.5 amp slow blow fuse.

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

<table>
<thead>
<tr>
<th>Card Position</th>
<th>Input Vac</th>
<th>Fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>90 to 105</td>
<td>0.5 amp</td>
</tr>
<tr>
<td>120</td>
<td>108 to 126</td>
<td>0.5 amp</td>
</tr>
<tr>
<td>220</td>
<td>198 to 231</td>
<td>0.25 amp</td>
</tr>
<tr>
<td>240</td>
<td>216 to 252</td>
<td>0.25 amp</td>
</tr>
</tbody>
</table>

1. Open fuse holder cover door and rotate fuse pull to left to remove the fuse.

2. Select operating voltage by orienting the printed circuit board to position the desired voltage on the top left side. Push the board firmly into its module slot.

3. Rotate the fuse-pull back into the normal position and insert the correct fuse into the fuse holder. Close the cover door.

4. Connect the ac line cord to the mating connector at the rear of the unit and the power source.

2.2.2 Signal Connections

Use 3 ft RG58U 50Ω shielded cables equipped with female BNC connectors to distribute all input and output signals.

2.3 ELECTRICAL ACCEPTANCE CHECK

This checkout procedure is a general verification of generator operation: Should a malfunction be found, refer to the warranty in the front of this manual.

Refer to table 1-1 for equipment required for this procedure.

Preset the generator front panel controls as follows:

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

<table>
<thead>
<tr>
<th>Control</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial</td>
<td>1.0</td>
</tr>
<tr>
<td>GENERATOR MODE</td>
<td>CONT</td>
</tr>
<tr>
<td>TRIGGER LEVEL</td>
<td>9 o'clock</td>
</tr>
<tr>
<td>PULSE DELAY</td>
<td>1 μs</td>
</tr>
<tr>
<td>PULSE DELAY VARIABLE</td>
<td>12 o'clock</td>
</tr>
<tr>
<td>NORMAL/DIPOLE/DELAYED</td>
<td>NORMAL</td>
</tr>
<tr>
<td>PULSE WIDTH</td>
<td>OFF</td>
</tr>
<tr>
<td>PULSE WIDTH VARIABLE</td>
<td>12 o'clock</td>
</tr>
<tr>
<td>ATTENUATION</td>
<td>0</td>
</tr>
<tr>
<td>ATTENUATION VERNIER</td>
<td>Full cw</td>
</tr>
<tr>
<td>FUNCTION</td>
<td>1</td>
</tr>
<tr>
<td>DC OFFSET</td>
<td>OFF</td>
</tr>
<tr>
<td>TRIGGER START/STOP</td>
<td>0° CAL</td>
</tr>
<tr>
<td>FREQ/PERIOD MULT</td>
<td>1K</td>
</tr>
<tr>
<td>VERNIER</td>
<td>Full cw</td>
</tr>
</tbody>
</table>
### Figure 2-1. Initial Setup

Table 2-1. Acceptance Procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Control</th>
<th>Position/Operation</th>
<th>Observe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>POWER</td>
<td>ON</td>
<td>1 kHz square wave.</td>
</tr>
<tr>
<td>2</td>
<td>Dial</td>
<td>Rotate dial. Return to 1.0</td>
<td>Rotation ccw increases frequency of square on one channel and dc level on other channel; cw decreases frequency and dc level.</td>
</tr>
<tr>
<td>3</td>
<td>FREQ/PERIOD MULT</td>
<td>Rotate switch. Return to 1K</td>
<td>Rotation cw increases frequency; ccw decreases frequency (dc level not affected).</td>
</tr>
<tr>
<td>4</td>
<td>VERNIER</td>
<td>Rotate ccw. Return to CAL</td>
<td>Rotation ccw gives a small decrease in frequency.</td>
</tr>
<tr>
<td>5</td>
<td>ATTENUATION</td>
<td>Rotate ccw. Return to 0.</td>
<td>Rotation ccw reduces square wave amplitude.</td>
</tr>
<tr>
<td>6</td>
<td>ATTENUATION VERNIER</td>
<td>Rotate ccw.</td>
<td>Square wave amplitude decreases.</td>
</tr>
<tr>
<td>7</td>
<td>DC OFFSET</td>
<td>Rotate cw. Return to OFF.</td>
<td>Square wave is immediately offset below previous level; then waveform moves up to a positive level. OFF returns waveform to original position. (Clipping occurs at ±15V.)</td>
</tr>
<tr>
<td>8</td>
<td>Function Generator or Voltage Source</td>
<td>Vary input voltage.</td>
<td>Waveform dc level varies.</td>
</tr>
</tbody>
</table>

Remove EXT DC OFFSET IN cable and connect to VCG IN connector. Remove GCV OUT cable.

<table>
<thead>
<tr>
<th>Step</th>
<th>Control</th>
<th>Position/Operation</th>
<th>Observe</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Function Generator or Voltage Source</td>
<td>Vary input voltage; then disconnect input.</td>
<td>Frequency increases with increased voltage, decreases with decreased voltage.</td>
</tr>
<tr>
<td>10</td>
<td>ATTENUATION VERNIER</td>
<td>Rotate cw.</td>
<td>Square wave amplitude increases.</td>
</tr>
<tr>
<td>11</td>
<td>FUNCTION</td>
<td>Rotate to DC, ( \wedge ), ( \wedge ), ( \wedge ), ( \wedge ), ( \wedge ), ( \wedge ), ( \wedge ), then ( \wedge )</td>
<td>Note dc level on scope. ( \wedge ), ( \wedge ) and ( \wedge ) should be centered on dc level. ( \wedge ) should rest on dc level, ( \wedge ) should rise to dc level.</td>
</tr>
<tr>
<td>12</td>
<td>GENERATOR MODE</td>
<td>GATE</td>
<td>A dc level.</td>
</tr>
<tr>
<td>13</td>
<td>MANUAL TRIG</td>
<td>Press down.</td>
<td>A series of sine waves.</td>
</tr>
</tbody>
</table>
### Table 2-1. Acceptance Procedure (Continued)

<table>
<thead>
<tr>
<th>Step</th>
<th>Control</th>
<th>Position/Operation</th>
<th>Observe</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>TRIGGER LEVEL</td>
<td>Rotate knob. Set for several cycles.</td>
<td>Knob varies number of cycles gated.</td>
</tr>
<tr>
<td>15</td>
<td>GENERATOR MODE</td>
<td>TRIG</td>
<td>One cycle per trigger cycle.</td>
</tr>
<tr>
<td>16</td>
<td>TRIGGER START/STOP</td>
<td>Rotate knob, then to 0° CAL.</td>
<td>CW starts sine wave at +90°; ccw starts sine wave at -90°. Fully cw gives continuous sine waves.</td>
</tr>
</tbody>
</table>

**NOTE:** Select square wave on trigger source.

| 17   | FUNCTION | PULSE | DC level (minus). |
| 18   | PULSE WIDTH | Turn cw to 100 µs 1 ms. | Pulse appears. |
| 19   | PULSE WIDTH VARIABLE | Rotate, then to 12 o'clock | CW increases pulse width; ccw decreases pulse width. |
| 20   | FUNCTION | PULSE, then PULSE. | Pulse direction reverses; dc levels remain the same values. |
| 21   | NORMAL/DIDOUBLE/Delayed Switch | DELAYED | No change. |
| 22   | PULSE DELAYED | 100 µs 1 ms | Small horizontal shift. |
| 23   | PULSE DELAYED VARIABLE | Turn knob. | Pulse moves horizontally. |
| 24   | NORMAL/DIDOUBLE/Delayed Switch | DOUBLE | No change. |
| 25   | PULSE DELAYED VARIABLE | Turn knob to resolve two pulses. | Double pulse appears. |
2.4 PREPARATION FOR SHIPMENT

If original packing material was saved, pack instrument in same manner as received. When using packing materials other than original, use the following guidelines:

1. Wrap instrument in plastic packing material.
2. Use double-wall cardboard shipping container.
3. Protect all sides with shock-absorbing material such as styrofoam dunnage to prevent instrument movement within the container.
4. Seal shipping container with approved sealing tape.
5. Mark FRAGILE on all sides, top and bottom of shipping container.

2.5 PREPARATION FOR STORAGE

This instrument should be stored in a clean, dry environment. The following limitations apply to both storage and reshipment.

1. Temperature within $-55^\circ C$ to $+75^\circ C$ range.
2. Relative humidity not to exceed 95% at $+25^\circ C$ and sea level (non-condensing).
3. Altitude from sea level to 40,000 feet.

2.6 PREPARATION FOR EXTENDED STORAGE

For extended storage greater than 6 months, pack instrument as indicated for shipment.
3.1 CONTROLS AND CONNECTIONS

The generator front panel controls and connectors are shown in figure 3-1 and keyed to the following descriptions.

1. **POWER Switch**
   
   Turns generator on and off.

2. **Frequency Dial**

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

3. **GENERATOR MODE Switch**

   Selects one of the following three modes.

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

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

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

---

Figure 3-1. Controls and Connectors
Table 3-1. Period to Frequency Conversion

<table>
<thead>
<tr>
<th>Time</th>
<th>Freq</th>
<th>Time</th>
<th>Freq</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5</td>
<td>2</td>
<td>.44</td>
<td>.1</td>
</tr>
<tr>
<td>.6</td>
<td>1.67</td>
<td>.42</td>
<td>.2</td>
</tr>
<tr>
<td>.7</td>
<td>1.43</td>
<td>.4</td>
<td>.3</td>
</tr>
<tr>
<td>.8</td>
<td>1.25</td>
<td>.39</td>
<td>.4</td>
</tr>
<tr>
<td>.9</td>
<td>1.11</td>
<td>.37</td>
<td>.5</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>.36</td>
<td>4.6</td>
</tr>
<tr>
<td>1.1</td>
<td>.91</td>
<td>.35</td>
<td>4.7</td>
</tr>
<tr>
<td>1.2</td>
<td>.83</td>
<td>.33</td>
<td>4.8</td>
</tr>
<tr>
<td>1.3</td>
<td>.77</td>
<td>.32</td>
<td>4.9</td>
</tr>
<tr>
<td>1.4</td>
<td>.71</td>
<td>.31</td>
<td>5</td>
</tr>
<tr>
<td>1.5</td>
<td>.67</td>
<td>.3</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>.63</td>
<td>.29</td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>.59</td>
<td>.29</td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>.56</td>
<td>.28</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>.53</td>
<td>.27</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.5</td>
<td>.26</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>.48</td>
<td>.26</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>.46</td>
<td>.25</td>
<td></td>
</tr>
</tbody>
</table>

Symbols

<table>
<thead>
<tr>
<th>M</th>
<th>k</th>
<th>m</th>
<th>( \mu )</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^6</td>
<td>10^3</td>
<td>10^3</td>
<td>10^{-6}</td>
<td>10^{-9}</td>
</tr>
</tbody>
</table>

To use the dial calibration marks when setting period time, the period must be converted to frequency.

Example: Set generator for a 23 \( \mu \)s pulse period.

TRIGGER LEVEL Control

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

MANUAL TRIGGER Switch

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

NOTE

Set TRIGGER LEVEL fully ccw.

PULSE DELAY Control

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

VARIABLE Control

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

NORMAL/DOUBLE/Delayed Switch

Selects the pulse parameters as follows:

NORMAL – Pulse of width and frequency set by front panel switches appears at TTL, \( ^{4} \text{TTL} \), ECL,

\[ 2.3 \times 10^{-5} \text{.} \]

4. Set the dial to the frequency equivalent of 2.3: .44.
ECL and FUNCTION OUT connectors with synchronous leading edges to the sync pulse trailing edge.

DOUBLE—As NORMAL plus an additional pulse in each pulse period delayed from the first pulse leading edge by time.

DELAYED—As NORMAL, except the pulse leading edge is delayed from the normal pulse leading edge by time.

7 PULSE WIDTH Control
Outer knob selects the range for the width of all pulses except sync. Has OFF and square wave detent. When in OFF position, the 145 has no PULSE OUT outputs. The square wave (\(\frac{t}{2}\)) detent is normally used to check the 50% period point; PULSE DELAY has no effect. For the best square wave output, set FUNCTION to \(\frac{t}{2}\).

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

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

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

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

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

10 FUNCTION Switch
Selects one of eight output signals; dc, waveforms or pulses.

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

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

TTL Connector—Same as TTL connector except active and quiescent levels are reversed.

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

ECL Connector—Furnishes an output like the ECL output, except active and quiescent levels are reversed.

13 DC OFFSET Control
Offsets the waveform or dc level at from approximately \(-15V\) to \(+15V\) (open circuit; approximately \(\pm7.5V\) into 50Ω). An OFF position ensures no offset.

14 TRIGGER START/STOP Control
Sets the start and stop point of the selected waveform (sine or triangle only) appearing at. Usually used in the trigger mode and in combination with to create desired waveforms. \(0^\circ\) CAL position ensures conventional waveforms symmetrical about 0 Vdc.

15 TRIG IN Connector
Accepts a 1 Vp-p to 10V external signal to trigger the generator. (Up to \(\pm50V\) will not damage circuitry.) Triggers on rising edge of input which crosses TRIGGER LEVEL setting from negative to positive.

16 VCG IN Connector
Accepts 0 to \(+2V\) ac or dc voltages to vary up to 1000:1 the frequency and period of the outputs.
The upper and lower limits are defined by the maximum and minimum dial settings multiplied by \( m \). VCG input will not drive the generator beyond the normal dial limits of a range.

**FREQ/PERIOD MULT Switch**

The outer knob selects one of ten frequency/period multipliers for the dial setting. Frequency, then period, are noted at each setting.

**VERNIER Control**

A fine adjustment of the frequency dial setting.

**EXT DC OFFSET IN Connector (Rear Panel)**

Applied voltage offsets the selected waveform linearly. Offset is 1V for each -1V applied with output connected into an open circuit. Maximum input is \( \pm 7.5 \text{V} \). Offset is affected by the attenuator \( A \).

**GCV OUT Connector (Rear Panel)**

This connector gives a 0 to +2V signal proportional to the frequency of the generator within any given range. The signal can be used as the X drive for X-Y recorders.

3.2 OPERATION

Perform the initial checkout in Section 2 for the feel of the instrument. Any questions concerning individual controls and connectors may be answered in paragraph 3.1.

3.2.1 Signal Termination

3.2.1.1 FUNCTION OUT Signal

Proper signal termination, or loading, of the generator connectors is necessary for its specified operation. For example, the proper termination of the main output is shown in figure 3-2. Placing the 50\( \Omega \) terminator, or 50\( \Omega \) resistance, in parallel with a higher impedance matches the receiving instrument input impedance to the generator output impedance, thereby minimizing signal reflection or power loss on the line due to phase angle mismatch.

3.2.1.2 TTL PULSE OUT Signals

The TTL and TTL PULSE OUT outputs can drive 50\( \Omega \) and higher impedance terminations.

3.2.1.3 ECL PULSE OUT Signals

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

![ECL Terminations Diagram](image)

**Figure 3-2. Signal Termination**

**Figure 3-3. ECL Terminations**

**NOTE**

All connecting cables are RG58 cables with BNC connectors.
3.2.1.4 Conversion of SYNC OUT TTL to ECL

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

3.2.2 Pulses

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

3.2.3 Waveforms

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

---

NOTES

1. Not Shown: TTL, TTL, ECL, ECL double pulse, delayed pulse and pulse.

2. Pulse period is determined by the generator frequency setting unless in trigger mode, in which case it is determined by trigger frequency.

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

  $DC \text{ offset} + \text{pulse peak voltage} > 7.5V$ causes pulse clipping.

---

Figure 3-4. Pulse Characteristics
3.2.4 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. Set the frequency dial to 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 dial at desired center frequency. Do not exceed the maximum dial range of the selected frequency range.

NOTES

1. Period is controlled by the generator frequency setting.
2. In trigger mode, just one period is generated for each trigger pulse.
3. DC offset plus peak waveform voltage > 7.5V causes waveform clipping.

Figure 3-5. Waveform Characteristics
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 0.02, excursions between 0V and +2V at VCG IN provide the up to 1000:1 sweep within the set frequency range.

### 3.2.5 Delay of Triggered Pulse

Additional pulse delay is available in triggered mode. Note that only the PULSE DELAY is usable, but the % cycle delay between trigger acceptance and sync pulse shown in figure 3-7 can also be variable delay.

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

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

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

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

---

**NOTE**

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

Nonlinear operation results when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range setting (2 times the multiplier setting) or in the other direction, 1/1000th of the range setting.
Figure 4-1. Overall Block Diagram
4.1 BASIC WAVEFORM DEVELOPMENT

The heart of the generator (the bold path in figure 4-1) is a triangle and square wave generator. The triangle waves are developed by capacitor charging ramps that are alternately reversed in polarity. The polarity reversal is caused by a flip-flop circuit, or hysteresis switch, that in turn produces the square waves. The flip-flop changes states upon detecting amplitude limits of the charging ramps through the triangle amplifier.

As shown in figure 4-1, the VCG dial buffer sums the currents from the frequency dial, frequency vernier and VCG in connector. The VCG dial buffer is an inverting amplifier whose output voltage is used to control a positive current source and a negative current source. For symmetrical output waveforms, the currents from the two current sources are equal and directly proportional to the voltage of the VCG dial buffer output. The diode gate, which is controlled by the hysteresis switch, is used to switch the positive or the negative current to the integrating capacitor selected by the frequency multiplier. If the positive current is switched into the integrating capacitor, the voltage across the capacitor will rise linearly to generate the triangle rise transition. If the current is negative, the voltage across the integrating capacitor will fall linearly to produce the fall transition.

The triangle amplifier is a unity gain amplifier whose output is fed to the hysteresis switch. The hysteresis switch has two voltage limit points (+1.25 and −1.25V) at its input.

During the time the output voltage of the triangle amplifier is rising, the output voltage of the hysteresis switch is positive, but when the output voltage of the triangle reaches +1.25V, it triggers the hysteresis switch causing the output to switch 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, so that the voltage across the capacitor will reverse, starting a linear decrease of the waveform. 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 a triangle wave at the same frequency.

The output frequency is determined by the magnitude of the capacitor selected by the frequency multiplier and the magnitude of the positive and negative current sources. Since the current sources are linearly proportional to the control voltage of the VCG circuit, the output frequency will also be linearly proportional to the control voltage.

The output of the hysteresis switch is fed to the sync amplifier and also the square wave shaper. The square wave shaper consists of a shaping circuit which limits the square wave output swing to ±1.25V. For positive pulse outputs, it limits the output voltage swing from −1.25 to 0V; and for negative pulse outputs, it limits the output voltage swing from 0 to +1.25V. The PULSE or PULSE from the auxiliary board are bipolar and processed as the square wave.

The triangle wave from the triangle amplifier is coupled through a buffer amplifier and made available to the function selector switch. The buffer amplifier provides a low impedance to drive the sine converter circuit. The sine converter, using the nonlinear characteristics of its diodes, converts the triangle wave into a sine wave.

The square wave from the sync amplifier, processed through a one-shot and the sync out buffer, is externally available at the sync out connector. The sync pulse, then, is a TTL level pulse output of the generator frequency.
4.2 AMPLITUDE OFFSET AND ATTENUATION

The selected waveform is inverted and amplified in the preamplifier. The preamplified waveform is sent to the output amplifier.

The output amplifier is an inverting amplifier with a current limiting output stage for short circuit protection. The dc offset control provides the offset to the selected waveforms center reference. The dc offset can be set by voltage at the external dc offset connector. The output amplifier establishes the generator 0 dB attenuation reference. An output attenuator decreases this reference amplitude in operator selected 20 dB steps. The attenuator consists of three voltage dividers. Attenuation between the steps is provided by the attenuation vernier.

4.3 TRIGGER AND GATE CONTROL

Generator operation is controlled by allowing or preventing the timing capacitor to charge. Figure 4-3 shows in detail this portion of the circuit. For continuous operation, the trigger amplifier maintains a positive level above the positive peak developed by the charging capacitors. This reverse biases (turns off) the start/stop diode, and the trigger amplifier does not interfere with continuous operation.

When the trigger amplifier outputs some level below the positive peak charging level, the diode is forward biased (turned on) to sink the integrating current from the current source, preventing the capacitors from charging to the positive peak. This stops waveform generation and holds the triangle output at some dc level called the trigger baseline. The trigger baseline is the level where a triangle waveform cycle starts and where it stops. This baseline is directly applicable to the triangle waveform and thus affects the sine wave. The square wave levels, output via the hysteresis switch, are not affected by the triangle baseline levels.

The normal trigger baseline is zero volts, analogous to 0° phase of a sine or triangle waveform. The trigger start/stop control offsets the trigger amplifier output and can change the baseline for starting and stopping a sine or triangle waveform from its negative peak (−90°) to its positive peak (+90°) range. At the extreme positive peak level setting though, the diode is again reverse biased and generator operation goes continuous.

When charging level is being held, the positive current generator still varies its output with corresponding frequency control inputs. These varying currents must be sunk through the diode to keep the timing capacitors from varying their charge, and thus varying the trigger baseline. The baseline compensation circuit monitors the output from the positive current generator to control the trigger amplifier and thus control the necessary compensating current through the diode.

The trigger control logic determines that after a waveform starts, it always stops at a complete cycle and at the same phase at which it started. The trigger control logic latches the trigger amplifier for an enabling output from the time the cycle starts to when the negative peak of the last cycle is reached (just one cycle in the trigger mode). Upon reaching the negative peak, the timing capacitor continues charging positive again, but stops upon reaching the trigger baseline. A square wave from the hysteresis switch synchronizes the last negative peak time for unlatching the trigger amplifier for its trigger baseline output.

The generator mode control circuitry (not shown) determines whether the trigger control logic is to be fired for just one cycle, or is to be held on for the duration of the trigger input. When in gate mode, the trigger is directly coupled for controlling the trigger control logic. In the trigger mode, the squaring circuit output is converted by a one-shot to a narrow pulse which fires the trigger control logic.

The squaring circuit is a level detector that generates a square pulse for the duration of a trigger signal above the set trigger level. The pulse is also generated for the duration the manual trigger switch is held down in gate mode, and fires one cycle in triggered mode.

4.4 PULSE OUTPUTS

The pulse outputs are based on the square wave from the basic generator circuit (see figure 4-1); the pulse frequency is controlled by the frequency dial, frequency vernier and VCG voltage in the same manner as the waveforms. The square wave is first modified to the sync pulse by a one-shot circuit; then the normal/delayed/delayed pulse selector switch sets or inhibits AND gates to distribute the sync pulse to the delay one-shot and the width one-shot circuits. When the switch is in normal position, the sync pulse is gated to the width one-shot; the delay one-shot is bypassed. When the switch is in delayed position, the sync pulse is gated to the delay one-shot only. With the switch in the double position, the sync pulse is gated to both the delay and width one-shots.

Pulse width of the width and delay one-shot pulses can be varied by the front panel width and delay controls, respectively. The resulting pulse is gated by the selection of a pulse width value rather than the square wave (\( \tau \)) detent on the pulse width switch. The pulse or the basic generator square wave, as selected by the pulse width control, is sent to a buffer circuit and output as TTL, ECL and ECL pulses. The pulse or square wave is also routed to another buffer which is set by the selection of PULSE, PULSE or a
waveform with the front panel function switch. This output, a normal pulse or a complemented pulse, is routed to the square wave shaper and output, if selected, through the output amplifier as a variable amplitude pulse. The pulse modes of normal, delayed and double are shown as timing diagrams in figures 4-4, 4-5 and 4-6.

4.5 WIDTH AND DELAY ONE-SHOTS

The pulse width and delay one-shots feature front panel adjustable current sources to regulate the capacitor charge time and as a result, the one-shot pulse width. The steady state condition of the one-shot circuit is as shown in figure 4-7: Upon triggering, Q goes low, the switch transistor switches off and the capacitor begins to charge. When the voltage across the capacitor is sufficient, the level detector senses the set level, the flip-flop is cleared and the circuit reverts to its steady state condition. The duty cycle of the one-shots is limited by the capacitor discharge time when returning to steady state conditions.

---

**Figure 4-3. Trigger Circuit and Timing**
Figure 4-4. Normal Mode Timing

Figure 4-5. Delayed Mode Timing
Figure 4-6. Double Mode Timing

Figure 4-7. Width and Delay One-Shots
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 INSPECTION AND PERFORMANCE VERIFICATION

Inspect and verify instrument performance every six months or at a frequency determined from actual instrument usage. Inspect the exterior for damage, cleanliness and loose knobs. Use a soft cloth dampened with commercial window cleaner to clean the exterior. When calibrating or repairing the instrument, inspect the instrument interior for heat damage and loose wires. This instrument requires no lubrication. Verify performance by performing the calibration procedures.

5.3 REQUIRED TEST EQUIPMENT

Refer to table 1-1 for equipment required to perform the calibration procedures.

5.4 REMOVING GENERATOR COVERS

WARNING

With covers removed, several dangerous voltage points may be exposed. Contact with these points could cause serious injury or death.

1. Invert the instrument; remove the four screws in the cover.
2. Turn the instrument upright; remove the top cover; and remove the four screws securing the bottom cover.
3. Replace the top cover.

NOTE

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

5.5 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. See figures 5-1 and 5-2 for calibration point location.

1. Unless otherwise noted, all measurements made at the 50Ω OUT connector should be terminated into a 50Ω (±0.1%) load.
2. Allow the unit to warm up at least 30 minutes for final calibration. Keep the instrument covers on to maintain heat. Remove covers only to make adjustments or measurements.
3. Verify operation in TRIG and GATE modes by connecting an external generator to the TRIG IN BNC and observing proper operation of TRIGGER LEVEL and TRIGGER START/STOP controls (paragraph 3.1).
4. Verify SYNC OUT is an approximate 30 ns positive pulse into 50Ω and that GCV OUT is a voltage proportional to dial position with a 2V max (open circuit).
5. Properly terminate the TTL, TTL, ECL and ECL outputs (paragraph 3.2.1) and verify proper operation (paragraph 3.1)
6. After starting the calibration by connecting the unit to an ac source and setting the front panel switches as follows; invert the instrument.

Dial .................................................. 02
FREQ MULT ........................................ 100K
FREQ VERNIER .................................. Full ccw
GENERATOR MODE ............................ CONT
TRIGGER LEVEL ............................... Full ccw
TRIGGER START/STOP ....................... 0° CAL
PULSE DELAY ................................. 50 ns ± 100 ns
PULSE DELAY VARIABLE .................... cw
Pulse Mode ..................................... DOUBLE
PULSE WIDTH ................................... OFF
PULSE WIDTH VARIABLE .................... 12 o'clock
DC OFFSET .................................... OFF
FUNCTION ..................................... DC
ATTENUATION ................................. 20 db
ATTENUATION VERNIER ..................... Full ccw
POWER ......................................... ON
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>C112</td>
<td></td>
<td></td>
<td>+15 ±0.05 Vdc</td>
<td>If voltage is incorrect, proceed to step 3.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>C111</td>
<td></td>
<td></td>
<td>−15 ±0.05 Vdc</td>
<td>If voltage is correct, proceed to step 9.</td>
</tr>
</tbody>
</table>

Steps 3 - 8 are on the trig/pulse board. Place the cover on the generator and turn it upright. Remove the top cover for access to the trig/pulse board.

<table>
<thead>
<tr>
<th>Step</th>
<th>Check</th>
<th>Tester</th>
<th>TP1 (COM)</th>
<th>TP2 (±15 Vdc)</th>
<th>R27</th>
<th>+15 ±0.02 Vdc</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Power Supply</td>
<td>DVM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>TP3</td>
<td></td>
<td></td>
<td>−15 ±0.05 Vdc</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>TP4</td>
<td></td>
<td></td>
<td>+24 ±1 Vdc</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>TP5</td>
<td></td>
<td></td>
<td>−24 ±1 Vdc</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>TP6</td>
<td></td>
<td></td>
<td>+5 ±0.2 Vdc</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>TP7</td>
<td></td>
<td>R18</td>
<td>−5.2 ±0.01 Vdc</td>
<td></td>
</tr>
</tbody>
</table>

If steps 3 - 8 were performed, place the cover on, invert the generator and warm up the generator for ½ hour. Remove the uppermost cover for generator board access when necessary.

<table>
<thead>
<tr>
<th>Step</th>
<th>Check</th>
<th>Tester</th>
<th>TP5 (COM)</th>
<th>TP1</th>
<th>R55</th>
<th>&lt; 5 mV</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Cap Mult Balance</td>
<td>DVM (DCV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Power Ampl Balance</td>
<td></td>
<td>FUNCTION OUT</td>
<td></td>
<td>R181</td>
<td>0 ±0.01 Vdc</td>
<td>Terminate with 50Ω load.</td>
</tr>
<tr>
<td>11</td>
<td>Preamp Balance</td>
<td></td>
<td>ATTENUATION VERNIER: full cw</td>
<td></td>
<td>R252</td>
<td>0 ±0.01 Vdc</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>VCG Null</td>
<td>Scope</td>
<td>FUNCTION: function</td>
<td></td>
<td>R12</td>
<td>Minimum frequency shift</td>
<td>Observe one cycle at 50μs/div. Alternately short and open VCG IN BNC while adjusting R12.</td>
</tr>
<tr>
<td>13</td>
<td>1000:1 Freq</td>
<td></td>
<td>FREQ VERNIER: full ccw</td>
<td></td>
<td>R13</td>
<td>&lt; 1 cycle (&lt; 200 Hz)</td>
<td>Scope on .5 ms/div.</td>
</tr>
<tr>
<td>Step</td>
<td>Check</td>
<td>Tester</td>
<td>Cal Points</td>
<td>Control Settings</td>
<td>Adjust</td>
<td>Desired Results</td>
<td>Remarks</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>-------------</td>
<td>--------------</td>
<td>------------------</td>
<td>---------</td>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14</td>
<td>1000:1 Symmetry</td>
<td>Scope</td>
<td>FUNC:TION OUT</td>
<td>R16 BOD Sym</td>
<td></td>
<td>Symmetrical waveform</td>
<td>NOTE: Steps 13 and 14 are interactive.</td>
</tr>
<tr>
<td>15</td>
<td>Main Symmetry</td>
<td></td>
<td></td>
<td>R35 TOD Sym</td>
<td></td>
<td>Symmetrical waveform</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Sine Distortion</td>
<td>Distortion</td>
<td></td>
<td>FUNCTION: ∨</td>
<td>R120</td>
<td>Symmetrical residue</td>
<td>Connect FUNCTION OUT to distortion analyzer and distortion analyzer output to scope. Set scope to .1V/div. Sync scope to SYNC OUT BNC loaded into 50Ω.</td>
</tr>
<tr>
<td></td>
<td>Analyzer, Scope</td>
<td>Scope</td>
<td></td>
<td>Triangle Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td>R93, R107</td>
<td></td>
<td>Minimum sine distortion</td>
<td>If either adjustment is going near a stop, re-center both pots and return to step 15.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency Counter/Timer</td>
<td>FUNCTION: ▼</td>
<td>R4 TOD Freq Adj</td>
<td></td>
<td>2000 ±10 Hz</td>
<td>Remove SYNC OUT cable.</td>
</tr>
<tr>
<td>19</td>
<td>Cap Mult Freq</td>
<td></td>
<td></td>
<td>FREQ MULT: 10</td>
<td>R48</td>
<td>20 ±0.1 Hz</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>X 10M Freq</td>
<td></td>
<td></td>
<td>FREQ MULT: 10M</td>
<td>C40</td>
<td>Best frequency tracking over X 10M range</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dial: Vary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>X 1M Freq</td>
<td></td>
<td></td>
<td>FREQ MULT: 1M</td>
<td>C34</td>
<td>Best frequency tracking over X 1M range</td>
<td>This adjustment must be made each time step 20 is done.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dial: Vary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Trigger Baseline</td>
<td>Scope</td>
<td></td>
<td>FUNCTION: ∨</td>
<td>R162</td>
<td>Minimum shift of baseline around 0 Vdc</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 CHARTS

Troubleshooting charts are given in figures 6-1 thru 6-9. The charts do not cover every possible trouble, but will be an aid in systematically isolating faulty components.

Figure 6-1. Initial Checks, Generator Board
Figure 6-2. Generator Loop Checks, Generator Board
Figure 6-3. VCG Checks, Generator Board
Figure 6-4. Generator Output Checks
Figure 6-5. Trigger and Gate Mode Checks, Trig/Pulse Board
Figure 6-6. Power Supply Checks, Trig/Pulse Board
Figure 6-7. Generator Input and Output Checks
Figure 6-8. Pulse Mode Checks, Trig/Pulse Board
Figure 6-9. Pulse Generator Checks, Trig/Pulse Board

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 across base-emitter junction.

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., 741, 1458)

1. The "+" and "-" inputs of an operational amplifier will have less than 15 mV voltage difference when operating under normal conditions.

2. When the output of the amplifier is connected to the "-" input (voltage follower connection), the output should be the same voltage as the "+" input voltage; otherwise, the operational amplifier is defective.

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.

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

1. The device is operating correctly if the output high state is > +2.4V and low state is < +0.5V.

2. The input must show the same two levels as in step 1. If the levels are between +0.8V and +2.0V, the connection to the driving circuit output is open.
6.4 DISASSEMBLY/REASSEMBLY INSTRUCTIONS
(For the Bench Instrument)

6.4.1 Disassembly

WARNING
With covers removed, several dangerous voltage points may be exposed. Contact with these points could cause serious injury or death.

Review the following procedure and identify components using chassis assembly drawing 0102-00-0575 (refer to Section 7).

1. Disconnect the power plug from the line receptacle.

2. Invert the instrument and remove four screws fastening the bottom cover to the top cover.

3. Turn the instrument upright and remove the top cover.

4. Remove the four screws fastening the lower board to the bottom cover standoffs.

5. Remove the instrument from the bottom cover and invert the instrument.

6. Unsolder the No. 18 black wire at the solder lug of FUNCTION OUT BNC.

7. Disconnect the following wires from the generator board locations:
   - E28 (coax) and E29 (shield) function output;
   - E26 (yellow) and E27 (white-black) Ext DC;
   - E6 (green) and E7 (white-black), GCV;
   - E1 (brown) and E2 (white-black), VCG;
   - E4 (red), E5 (brown) and E3 (orange) dial pot.

8. Remove all knobs except the dial knob.

9. Remove four screws fastening the generator board (upper board in this inverted position) to standoffs between the boards.

10. Tilt the front panel forward and slide it forward enough to clear the detents of the generator board and lift the generator board free. Slide the front panel back over the detents of the remaining board.

11. For troubleshooting, set the generator board component side up on the working surface alongside the rest of the instrument. Ensure that the generator board is lying on a nonconductive surface and it is not making physical contact with the rest of the instrument. A jumper wire may be attached between E3 and E4 of the generator board to simulate a top-of-dial frequency voltage. It may be necessary to replace some of the knobs to set up various test conditions.

At this point, the entire instrument is accessible for troubleshooting. To reassemble, perform steps 6 through 16, paragraph 6.4.2.

12. To completely remove the generator board, disconnect the following wires from the generator board:
   - E21 pulse disable;
   - E23 pulse select;
   - E24 pulse coax;
   - E25 pulse coax shield.

   Disconnect the Molex connector. To reassemble, perform steps 1 through 16, paragraph 6.4.2.

13. To remove the trigger/pulse board, remove the two screws connecting the power switch to the trigger/pulse board.

14. Unsolder the following wires from the trigger/pulse board:
   - E1 (blue);
   - E2 (white-blue);
   - E3 (blue);
   - E4 (red);
   - E5 (white-red);
   - E6 (red);
   - E7 (green);
   - E8 (green);
   - E9 (blue);
   - E10 (red);
   - E11 (violet);
   - E12 (white);
   - E13 (white);
   - E14 (white);
   - E15 (gray);
   - E16 (orange);
   - E17 (red);
   - E18 (white-black);
   - E19 (yellow);
   - E22 (brown);
   - E48 (green);
   - E30 (coax, center conductor);
   - E31 (coax, shield);
   - J6 (TTL BNC), E40 and E41;
   - J5 (TTL BNC), E42 and E43;
   - J4 (ECL BNC), E44 and E47;
   - J3 (ECL BNC), E45 and E46.

15. Unsolder the green-yellow wire connecting the front and rear panels.

16. Slide out the trigger/pulse board.
6.4.2 Reassembly

Refer to the chassis assembly drawing 0102-00-0575 (refer to Section 7) for correct positioning of the reassembled components.

1. Turn the unit upside down (bottom of unit up).

2. Insert the trigger/pulse board (component side up).

3. Solder the following wires to the board:
   
   E1 (blue);
   E2 (white-blue);
   E3 (blue);
   E4 (red);
   E5 (white-red);
   E6 (red);
   E7 (green);
   E8 (green);
   E30 (coax-center conductor);
   E31 (coax-shield);
   J6 (TTL BNC), E40 and E41;
   J5 (TTL BNC), E42 and E43;
   J4 (ECL BNC), E44 and E47;
   J3 (ECL BNC), E45 and E46;
   E9 (blue);
   E10 (red);
   E11 (violet);
   E12 (white);
   E13 (white);
   E14 (white);
   E15 (gray);
   E16 (orange);
   E17 (red);
   E18 (white-black);
   E19 (yellow);
   E22 (brown);
   E48 (green).

4. Secure the power switch to the trigger/pulse board.

5. Solder the green-yellow wire connecting the front and rear panels.

6. Slide in the generator board (component side up).

7. Secure the four screws attaching the generator and trigger/pulse boards together.

8. Install the two screws securing the generator to the left side panel mounting brackets.

9. Push the front panel back over the board detents.

10. Connect the following wires to the generator board:
    
    E4 (red), E5 (brown) and E3 (orange) dial pot;
    E1 (brown) and E2 (white-black) VCG;
    E6 (green) and E7 (white-black) GCV;
    E28 (coax, center conductor) and E29 (coax shield);
    E26 (yellow) and E27 (white-black) Ext DC;
    E23 from E34 of trigger/pulse board;
    E21 from E39 of trigger/pulse board;
    E24 from E37 of trigger/pulse board;
    E25 from E38 of trigger/pulse board.

    Connect the Molex connector.

11. Solder the large No. 18 ground wire to the output BNC.

12. Turn the instrument upright and slide front and rear panels into the bottom cover. This spaces them correctly for proper knob alignment.

13. Install all knobs. Align them so that they match the front panel graphics and are spaced approximately 1/16th of an inch away from the surface the front panel.

14. Install four screws to secure the lower board to the bottom cover standoffs

15. Replace the top cover and invert the instrument.

16. Secure the top cover with four screws into bottom cover.

6.5 DISASSEMBLY/REASSEMBLY INSTRUCTIONS (For the Rack Mounted Instrument)

6.5.1 Disassembly

Review the following procedure and identify components using drawings 0102-00-0621 and 0102-00-0575 (refer to Section 7).

1. Disconnect the power plug from the line receptacle.

2. Turn the unit top side up.

3. Remove the four top cover screws and cover.
4. Invert the unit (bottom side up).
5. Remove the four bottom cover screws and cover.
6. Remove all front panel knobs except the frequency dial knob.
7. Position the unit upside down (bottom of unit) with the front panel away from you.
8. Remove the three screws holding the heat sinks of the trigger/pulse board to the rear panel.
9. Remove the two screws attaching the front panel to the right side panel (labeled “R.H.” in drawing 0102-00-0621).
10. Remove the two screws securing the rear panel to the left side panel.
11. Remove the two screws securing the generator board to the left side panel mounting brackets.
12. Unsolder the large No. 18 (black) ground on the function output BNC.
13. To remove the generator board, disconnect the following wires from the generator board locations:

   E28 (coax) and E29 (shield), function output;
   E26 (yellow) and E27 (white-black), Ext DC;
   E6 (green) and E7 (white-black), GCV;
   E1 (brown) and E2 (white-black), VCG;
   E4 (red), E5 (brown) and E3 (orange), dial pot;
   E23 (pulse select);
   E21 (pulse disable);
   E24 (pulse coax);
   E25 (pulse coax shield).

   Disconnect the Molex connector.
14. Slide the rear panel to the right and backwards. Notice that the wires for the power supply are connected to the rear panel.
15. Remove the two screws attaching the generator board to the mounting brackets on the right side panel.
16. Remove the four screws securing the generator and trigger/pulse boards together.
17. Remove the main board back and upwards.
18. For troubleshooting the generator and trigger/pulse boards, turn the instrument around with the front panel facing you (keep the unit inverted). Place the generator board (component side up) on a working surface with the board on the right side of the unit. Ensure the generator board is lying on a nonconductive surface and not making physical contact with the rest of the unit. Jumper E3 and E4 simulate the top of dial frequency voltage. Pull J1 (Molex connector) from the instrument and plug into position on the generator board. Add the following jumpers between the generator and trigger/pulse board:

   **Trigger/Pulse**

<table>
<thead>
<tr>
<th>Trigger/Pulse</th>
<th>Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>E34 (pulse select)</td>
<td>E23</td>
</tr>
<tr>
<td>E39 (pulse disable)</td>
<td>E21</td>
</tr>
<tr>
<td>E37 (pulse coax, center)</td>
<td>E24</td>
</tr>
<tr>
<td>E38 (pulse coax, shield)</td>
<td>E25</td>
</tr>
</tbody>
</table>

   It may be necessary to replace some of the knobs to set up various test conditions.

   At this point, the entire instrument is accessible for troubleshooting. To reassemble, perform steps 6 through 19, paragraph 6.5.2.
19. To remove the trigger/pulse board, remove the two screws connecting the power switch to the trigger/pulse board.
20. Unsolder the following wires from the trigger/pulse board:

   E1 (blue);
   E2 (white-blue);
   E3 (blue);
   E4 (red);
   E5 (white-red);
   E6 (red);
   E7 (green);
   E8 (green);
   E9 (blue);
   E10 (red);
   E11 (violet);
   E12 (white);
   E13 (white);
   E14 (white);
   E15 (gray);
   E16 (orange);
   E17 (red);
   E18 (white-black);
   E19 (yellow);
E22 (brown);
E48 (green);
E30 (coax, center conductor);
E31 (coax, shield);
J6 (TTL BNC), E40 and E41;
J5 (TTL BNC), E42 and E43;
J4 (ECL BNC), E44 and E47;
J3 (ECL BNC), E45 and E46.

21. Unsolder the green-yellow wire connecting the front and rear panels.

22. Slide out the trigger/pulse board.

6.5.2 Reassembly

Review the following procedure and identify components using drawings 0102-00-0621 and 0102-00-0575 (refer to Section 7).

1. Turn the unit upside down (bottom of unit up).

2. Insert the trigger/pulse board (component side up).

3. Solder the following wires to the board:

4. Secure the power switch to the trigger/pulse board.

   E1 (blue);
   E2 (white-blue);
   E3 (blue);
   E4 (red);
   E5 (white-red);
   E6 (red);
   E7 (green);
   E8 (green);
   E30 (coax-center conductor);
   E31 (coax-shield);
   J6 (TTL BNC), E40 and E41;
   J5 (TTL BNC), E42 and E43;
   J4 (ECL BNC), E44 and E47;
   J3 (ECL BNC), E45 and E46;
   E9 (blue);
   E10 (red);
   E11 (violet);
   E12 (white);
   E13 (white);
   E14 (white);
   E15 (gray);
   E16 (orange);
   E17 (red);
   E18 (white-black);
   E19 (yellow);
   E22 (brown);
   E48 (green).

5. Solder the green-yellow wire connecting the front and rear panels.

6. Slide in the generator board (component side up).

7. Secure the four screws attaching the generator and trigger/pulse boards together.

8. Install the two screws securing the generator to the left side panel mounting brackets.

9. Attach all knobs to the front panel.

10. Slide the rear panel and right side panel into position. Align the wires with notched locations on the generator board.

11. Install the two screws securing the rear and left side panel.

12. Secure the front and right side panels with two screws.

13. Install the two screws securing the generator to the right side panel mounting brackets.

14. Secure the heat sink to the rear panel using three screws.

15. Connect the following wires to the generator board:

   E4 (red), E5 (brown) and E3 (orange) dial pot;
   E1 (brown) and E2 (white-black) VCG;
   E6 (green) and E7 (white-black) GCV;
   E28 (coax, center conductor) and E29 (coax shield);
   E26 (yellow) and E27 (white-black) Ext DC;
   E23 from E34 of trigger/pulse board;
   E21 from E39 of trigger/pulse board;
   E24 from E37 of trigger/pulse board;
   E25 from E38 of trigger/pulse board;

   Connect the Molex connector.

16. Solder the large No. 18 ground wire to the output BNC.

17. Visually inspect the instrument for missing hardware and disconnected wires.

18. Attach top and bottom covers with four screws for each cover.

19. Check the unit for proper operation.
FUNCTION OUT IS BAD

PLACE ALL CONTROLS TO INITIAL* POSITIONS

STILL BAD?

NO

TRY EACH CONTROL IN OTHER POSITIONS, RETURNING TO INITIAL POSITION. IDENTIFICATION OF MALFUNCTION INDICATES WHICH CHART TO USE

YES

WAVEFORMS BAD OR MISSING?

NO

FREQUENCY BAD?

YES

↑ GOOD

▾ BAD

↑ GOOD

▾ OR ↑ BAD**

NO

YES

Δ GOOD & ▲ BAD

NO

PROBLEM IN BOTTOM FOUR FREQUENCY RANGES ONLY

NO

PROBLEM IN TRIG & GATE MODES

YES

↑ GOOD

▾ BAD

NO

YES

CHECK CAPACITANCE MULTIPLIER IC7 & IC8

±1.25V TRIANGLE AT TP2?

NO

YES

CHECK SINE CONVERTER CIRCUIT OR SW4-C

CHECK CR28 - 31, Q17, SW4-C, SW4-D & SW4-E

CHECK TRIANGLE BUFFER CIRCUIT

*NORMAL/D Double/Delay Switch to Normal, Freq Vernier to Cal, Dial to 2.0, All Others to 12 O'Clock

**Symmetrical Square or Offset Squares

Figure 6-1. Initial Checks, Generator Board
Figure 6-2. Generator Loop Checks, Generator Board
*NORMAL/DDELAY SWITCH TO NORMAL, FREQ VERNIER TO CAL,
DIAL TO 2.0, ALL OTHERS TO 12 O’CLOCK
**USE SCOPE AND HIGH IMPEDANCE PROBE FOR THIS AND SUBSEQUENT
VCG MEASUREMENTS

Figure 6-3. VCG Checks, Generator Board
Figure 6-4. Generator Output Checks, Generator Board
**Figure 6-5. Trigger and Gate Mode Checks, Trig/Pulse Board (Page 1 of 2)**

*NORMAL/DOUBLE/Delay Switch to Normal, Freq Vernier to Cal, Dial to 2.0, All Others to 12 O’Clock

*RETURN TRIG LEVEL CCW TO OPERATE MANUAL TRIGGER
**Figure 6-5. Trigger and Gate Mode Checks, Trig/Pulse Board (Page 2 of 2)**

*MATCHED DIODE PAIR*
Figure 6-6. Power supply checks, Trig/Pulse Board (Page 1 of 2)
Figure 6-6. Power Supply Checks, Trig/Pulse Board (Page 2 of 2)
Figure 6-7. Generator Input and Output Checks (Page 1 of 2)
Figure 6-7. Generator Input and Output Checks (Page 2 of 2)
PULSE MODE INITIAL CHECKS

PLACE ALL CONTROLS IN INITIAL POSITIONS*

YES
1 kHz SQUARE A'T FUNCTION OUT?

NO
RETURN TO GENERATOR MODE INITIAL CHECKS, FIGURE 6-1

SET FUNCTION TO PULSE

YES
POS PULSE (APPROX 10 µs) AT TTL?

NO
COAX E40 & E41 TO J6 OK?

YES
8

NEG PULSE AT TTL?

NO
CHECK COAX E42 & E43 TO J5, IC7 & IC9

YES
POS PULSE AT ECL?

NO
CHECK COAX E44 & E47 TO J4, IC8 & -5.2V SUPPLY

YES
NEG PULSE AT ECL?

NO
CHECK COAX E45 & E46 TO J3 & IC8

YES
POS PULSE AT FUNCTION OUT?

NO
NEG PULSE?

YES
E21 ON GENERATOR HIGH?

NO
12

PULSE SELECT STAYS HIGH CHECK IC9, R44, SW4-8 ON GENERATOR & WIRING FROM E23 ON GENERATOR TO E34 ON TRIG/PULSE

*NORMAL/DOUBLE/Delay SWITCH TO NORMAL, FREQ VERNIER TO CAL, DIAL TO 2.0, ALL OTHERS TO 12 O'CLOCK

Figure 6-8. Pulse Mode Checks, Trig/Pulse board (Page 1 of 2)
Figure 6-8. Pulse Mode Checks, Trig/Pulse Board (Page 2 of 2)

Table 6-1. Pulse Ranges

<table>
<thead>
<tr>
<th>Pulse Width</th>
<th>Ranging Components</th>
<th>Pulse Delay</th>
<th>Ranging Components</th>
<th>Pulse Period</th>
<th>Scope Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>IC5, SW3-A</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>25 ns</td>
<td>C55, Q19, Q20, SW3-B</td>
<td>50 ns - 100 ns</td>
<td>C40, Q16, Q17, SW2-B</td>
<td>&gt; 0.5 μs</td>
<td>0.05 μs/div</td>
</tr>
<tr>
<td>100 ns</td>
<td>C56, CR29, CR30</td>
<td>100 ns - 1 μs</td>
<td>C41, CR19, CR20</td>
<td>&gt; 5 μs</td>
<td>0.5 μs/div</td>
</tr>
<tr>
<td>1 μs</td>
<td>C57, CR31, CR32</td>
<td>1 μs - 10 μs</td>
<td>C42, CR21, CR22</td>
<td>&gt; 50 μs</td>
<td>5 μs/div</td>
</tr>
<tr>
<td>10 μs</td>
<td>C58, CR33, CR34</td>
<td>10 μs - 100 μs</td>
<td>C43, CR23, CR24</td>
<td>&gt; 0.5 ms</td>
<td>50 μs/div</td>
</tr>
<tr>
<td>100 μs</td>
<td>C59, CR35, CR36</td>
<td>100 μs - 1 ms</td>
<td>C44, CR25, CR26</td>
<td>&gt; 5 ms</td>
<td>0.5 ms/div</td>
</tr>
<tr>
<td>100 μs</td>
<td>C59, CR35, CR36</td>
<td>1 ms - 10 ms</td>
<td>C45, CR27, CR28</td>
<td>&gt; 5 ms</td>
<td>0.5 ms/div</td>
</tr>
</tbody>
</table>

1 Rotate PULSE DELAY VERNIER ccw for proper display

6-17
PLACE ALL CONTROLS IN INITIAL POSITIONS, EXCEPT PERIOD AT 0.5 X 1 μs, PULSE WIDTH AT 25 ns to 100 ns, PULSE WIDTH VARIABLE AT 12 O'CLOCK, PULSE MODE AT DOUBLE, PULSE DELAY AT 50 ns to 100 ns, VARIABLE AT CW*

CONNECT SYNC OUT TO FAST SCOPE; USE HIGH IMPEDANCE X 10 PROBE TO CHECK WAVEFORMS, SYNC SCOPE ON NEGATIVE (TRAILING) EDGE

**TTL SQUARE AT IC4-12?**

**POS PULSE AT IC4-8?**

**POS PULSE AT IC4-3?**

NEG PULSE WITH APPROX 110 ns DELAY FROM SYNC AT IC11-8?

**NEG PULSE AT IC13-5?**

DOUBLE POS PULSES AT IC13-6?

CHECK GENERATOR OR EXT SOURCE, P1-1 WIRING

CHECK IC3, IC4 & +5V SUPPLY

CHECK IC4, IC5, R1 (SIP), SW3-A & SW5

CHECK PULSE DELAY ONE-SHOT IC10, IC11 & Q16 - Q18

CHECK IC4 & IC10

CHECK IC5, IC13, R1, SW3-A & SW5

CHECK IC12 & IC13

*IF GENERATOR BOARD IS REMOVED, APPROX 1 MHz TTL MAY BE CONNECTED FROM AN EXTERNAL SOURCE TO P1-1 (SYNC) AND P1-2 (COM)
10

SET GENERATOR MODE TO NORMAL

DELAYED PULSE GOES AWAY?

NO → CHECK IC4 & SW5

YES → SET GENERATOR MODE TO DELAYED

NORMAL PULSE GOES AWAY; DELAYED PULSE COMES BACK?

NO → CHECK IC13 & SW5

YES → SET GENERATOR MODE TO DOUBLE

NEG PULSES ≈ 50 ns WIDE; SECOND DELAYED ≈ 110 ns FROM SYNC AT IC13-8?

NO → CHECK IC12, IC13, & Q19-Q21 PULSE WIDTH ONE-SHOT

YES → POS PULSES IC14-8 & NEG PULSES IC7-6?

NO → CHECK IC6, IC7, IC9, IC14 & SHORTED COAX

YES → GO THRU FIGURE 6-8 TO VERIFY ALL PULSE FUNCTIONS

Figure 6-9. Pulse Generator Checks, Trig/Pulse Board (Page 2 of 2)
7.1 DRAWINGS

The following assembly drawings, schematics and parts lists are in the arrangement shown below.

<table>
<thead>
<tr>
<th>Drawings</th>
<th>Drawing No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument Assy &amp; Parts List</td>
<td>0102-00-0101</td>
</tr>
<tr>
<td>Instrument Schematic</td>
<td>0004-00-0101</td>
</tr>
<tr>
<td>Chassis Assy</td>
<td>0102-00-0575</td>
</tr>
<tr>
<td>Chassis Assy Parts List</td>
<td>1101-00-0575</td>
</tr>
<tr>
<td>Generator Board Schematic</td>
<td>0103-00-0556</td>
</tr>
<tr>
<td>Generator Board Parts Locator</td>
<td>1100-00-0556</td>
</tr>
<tr>
<td>Generator Board Assy (sheets 2 &amp; 3)</td>
<td>0101-00-0556</td>
</tr>
<tr>
<td>Generator Board Parts List</td>
<td>1100-00-0556</td>
</tr>
<tr>
<td>Current Limiter Assy &amp; Parts List</td>
<td>0101-00-1008</td>
</tr>
<tr>
<td>Trigger/Pulse Board Schematic</td>
<td>0103-00-0565</td>
</tr>
<tr>
<td>Trigger/Pulse Board Parts Locator</td>
<td>1100-00-0565</td>
</tr>
<tr>
<td>Trigger/Pulse Board Assy (sheet 2)</td>
<td>0101-00-0565</td>
</tr>
<tr>
<td>Trigger/Pulse Board Parts List</td>
<td>1100-00-0565</td>
</tr>
<tr>
<td>Rack Mount Assy &amp; Parts List</td>
<td>0102-00-0621</td>
</tr>
<tr>
<td>Chassis Assembly</td>
<td>1101-00-3243</td>
</tr>
<tr>
<td>Chassis Parts List</td>
<td>1100-00-3243</td>
</tr>
<tr>
<td>Generator Board Schematic</td>
<td>1104-00-3245</td>
</tr>
<tr>
<td>Generator Board Assembly</td>
<td>1101-00-3245</td>
</tr>
<tr>
<td>Generator Board Parts List</td>
<td>1100-00-3245</td>
</tr>
<tr>
<td>Option 001 Timer Assy &amp; Parts List</td>
<td>0102-00-0221</td>
</tr>
<tr>
<td>Option 003 Timer Assy</td>
<td>0102-00-0442</td>
</tr>
<tr>
<td>Option 003 Timer Parts List</td>
<td>1000-00-0442</td>
</tr>
</tbody>
</table>

7.2 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, next higher assembly and serial number of the unit.

7.3 ERRATA

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, errata pages are prepared to summarize the changes made and are inserted inside the shipping carton with the instrument. If no such pages exist, the manual is correct as printed.

7.4 INDEX OF FEDERAL SUPPLY CODES

The following table gives the Federal Supply Code for Manufacturers (FSCM) for manufacturers cited in the parts lists.

<table>
<thead>
<tr>
<th>MFGR Code</th>
<th>Manufacturer</th>
<th>FSCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMP</td>
<td>AMP Inc.</td>
<td>00779</td>
</tr>
<tr>
<td></td>
<td>P.O. Box 3608</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harrisburg, PA 17105</td>
<td></td>
</tr>
<tr>
<td>ANDEV</td>
<td>Analog Devices Inc.</td>
<td>24355</td>
</tr>
<tr>
<td></td>
<td>221 Fifth Street</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cambridge, MA 02142</td>
<td></td>
</tr>
<tr>
<td>ARCO</td>
<td>Arco Electronics Inc.</td>
<td>84171</td>
</tr>
<tr>
<td></td>
<td>Community Drive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Great Neck, NY 11022</td>
<td></td>
</tr>
<tr>
<td>BECK</td>
<td>Beckman Instrument Inc.</td>
<td>71738</td>
</tr>
<tr>
<td></td>
<td>2500 Harbor Blvd.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fullerton, CA 92634</td>
<td></td>
</tr>
<tr>
<td>BOURN</td>
<td>Bourns Inc.</td>
<td>32997</td>
</tr>
<tr>
<td></td>
<td>1200 Columbia Ave.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Riverside, CA 92507</td>
<td></td>
</tr>
<tr>
<td>C&amp;K</td>
<td>C&amp;K Components Inc.</td>
<td>09353</td>
</tr>
<tr>
<td></td>
<td>103 Morse Street</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Newton, MA 02158</td>
<td></td>
</tr>
<tr>
<td>CRL</td>
<td>Centralab-Division</td>
<td>71590</td>
</tr>
<tr>
<td></td>
<td>of Globe Union</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milwaukee, WI 53201</td>
<td></td>
</tr>
<tr>
<td>CHIM</td>
<td>Chicago Miniature Lamp Works</td>
<td>71744</td>
</tr>
<tr>
<td></td>
<td>4433 Ravenwoods Ave.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chicago, IL 60640</td>
<td></td>
</tr>
<tr>
<td>CINCH</td>
<td>Cinch Manufacturing Co.</td>
<td>71785</td>
</tr>
<tr>
<td></td>
<td>1026 S. Homan Street</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chicago, IL 60624</td>
<td></td>
</tr>
<tr>
<td>CRL</td>
<td>Centralab-Division</td>
<td>71590</td>
</tr>
<tr>
<td></td>
<td>of Globe Union</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P.O. Box 591</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milwaukee, WI 53201</td>
<td></td>
</tr>
</tbody>
</table>

7-1
<table>
<thead>
<tr>
<th>MFGR Code</th>
<th>Manufacturer</th>
<th>FSCM</th>
<th>MFGR Code</th>
<th>Manufacturer</th>
<th>FSCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORCM</td>
<td>Corman Inc.</td>
<td>05245</td>
<td>MOT</td>
<td>Motorola Inc.</td>
<td>04713</td>
</tr>
<tr>
<td></td>
<td>2635 N. Kildars Ave.</td>
<td></td>
<td>Semiconductor Production Div</td>
<td>5005 East McDowell Rd.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chicago, IL 60639</td>
<td></td>
<td></td>
<td>Phoenix, AZ 85008</td>
<td></td>
</tr>
<tr>
<td>CTS</td>
<td>CTS Corporation</td>
<td>71450</td>
<td>PACRD</td>
<td>Packard Electric Division</td>
<td>77060</td>
</tr>
<tr>
<td></td>
<td>Elkhart, IN 46514</td>
<td></td>
<td></td>
<td>408 Dana Street N.E.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Warren, OH 44481</td>
<td></td>
</tr>
<tr>
<td>FAIR</td>
<td>Fairchild Semiconductor Division</td>
<td>07263</td>
<td>RCA</td>
<td>RCA</td>
<td>86684</td>
</tr>
<tr>
<td></td>
<td>313 Frontage Road</td>
<td></td>
<td></td>
<td>Harrison, NJ 07029</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mountain View, CA 94043</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FERRX</td>
<td>Ferroxcube Corporation of America</td>
<td>02114</td>
<td>ROGAN</td>
<td>Rogan Bros., Inc.</td>
<td>86797</td>
</tr>
<tr>
<td></td>
<td>Mount Marion Road</td>
<td></td>
<td></td>
<td>8031 N. Monticello St.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saugerties, NY 12477</td>
<td></td>
<td></td>
<td>Skokie, IL 60076</td>
<td></td>
</tr>
<tr>
<td>GAVTT</td>
<td>Gavitt Wire &amp; Cable</td>
<td>23499</td>
<td>SEMTEC</td>
<td>Semitech Corporation</td>
<td>14099</td>
</tr>
<tr>
<td></td>
<td>455 N. Quince Street</td>
<td></td>
<td></td>
<td>652 Mitchell Road</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Escondido, CA 92025</td>
<td></td>
<td></td>
<td>Newbury Park, CA 91320</td>
<td></td>
</tr>
<tr>
<td>IMB</td>
<td>IMB</td>
<td>27556</td>
<td>SMITH</td>
<td>Herman H. Smith</td>
<td>83330</td>
</tr>
<tr>
<td></td>
<td>15401 S. Carments Rd.</td>
<td></td>
<td></td>
<td>812 Snediker Avenue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Santa Fe Springs, CA 90670</td>
<td></td>
<td></td>
<td>Brooklyn, NY 11207</td>
<td></td>
</tr>
<tr>
<td>KING</td>
<td>Kings Electronics Co. Inc.</td>
<td>91836</td>
<td>SPRAG</td>
<td>Sprage Electric Co.</td>
<td>56289</td>
</tr>
<tr>
<td></td>
<td>40 Marbledale Road</td>
<td></td>
<td></td>
<td>North Adams, MA 01247</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tuckahoe, NY 11223</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LITFU</td>
<td>Littelfuse Inc.</td>
<td>79515</td>
<td>THOMN</td>
<td>Thompson Industries Inc.</td>
<td>96881</td>
</tr>
<tr>
<td></td>
<td>800 E. Northwest Highway</td>
<td></td>
<td></td>
<td>1029 Plandome Road</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Des Plaines, IL 60016</td>
<td></td>
<td></td>
<td>Manhasset, NY 11030</td>
<td></td>
</tr>
<tr>
<td>MAL</td>
<td>Mallory Capacitor Co.</td>
<td>90201</td>
<td>TI</td>
<td>Texas Instruments</td>
<td>01295</td>
</tr>
<tr>
<td></td>
<td>3029 E. Washington St.</td>
<td></td>
<td></td>
<td>North Central Expwy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P.O. Box 372</td>
<td></td>
<td></td>
<td>Dallas, TX 75231</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indianapolis, IN 46206</td>
<td></td>
<td>TRIKO</td>
<td>Trico Products Corp.</td>
<td>75915</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>817 Washington Street</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Buffalo, NY 14203</td>
<td></td>
</tr>
<tr>
<td>METRS</td>
<td>Milton Ross Company</td>
<td>07047</td>
<td>TRW</td>
<td>TRW Electronic Components Division</td>
<td>18486</td>
</tr>
<tr>
<td></td>
<td>511 Second St. Pike</td>
<td></td>
<td></td>
<td>666 Garland Place</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Southampton, PA 18966</td>
<td></td>
<td></td>
<td>Des Plaines, IL 60016</td>
<td></td>
</tr>
<tr>
<td>MICRO</td>
<td>Micro Semiconductor Corporation</td>
<td>14552</td>
<td>UNICP</td>
<td>Unicorp</td>
<td>44729</td>
</tr>
<tr>
<td></td>
<td>11250 Playa Court</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Culver City, CA 90230</td>
<td></td>
<td>USECO</td>
<td>USECO Inc.</td>
<td>15849</td>
</tr>
<tr>
<td>MOLEX</td>
<td>Molex Products Co.</td>
<td>27264</td>
<td>WVTK</td>
<td>Wavetek</td>
<td>23338</td>
</tr>
<tr>
<td></td>
<td>5224 Katrine Avenue</td>
<td></td>
<td></td>
<td>9045 Balboa Avenue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Docuners Grove, IL 60515</td>
<td></td>
<td></td>
<td>San Diego, CA 92123</td>
<td></td>
</tr>
</tbody>
</table>
7.5 CAPACITOR VARIANCE

Because of changes in part suppliers, certain capacitor values in your instrument may differ from those called out in the schematics and parts lists. These value variations are well within tolerable limits for correct circuit performance.

The following capacitor variations may occur in your instruments:

<table>
<thead>
<tr>
<th>Assembly</th>
<th>Part</th>
<th>Ref Designation</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100-00-0565</td>
<td>1500-35-0003</td>
<td>C-14, C-16</td>
<td>50 μF, 50V or 47 μF, 50V</td>
</tr>
<tr>
<td>1100-00-0565</td>
<td>1500-35-0103</td>
<td>C-6, C-8</td>
<td>500 μF, 50V or 470 μF, 50V</td>
</tr>
<tr>
<td>1100-00-0556</td>
<td>1500-72-7602</td>
<td>C-95, C-98</td>
<td>27 μF, 35V or 33 μF, 35V</td>
</tr>
</tbody>
</table>
### Reference Designators and Part Descriptions

<table>
<thead>
<tr>
<th>Reference Designators</th>
<th>Part Description</th>
<th>DRK6-068 (Part No)</th>
<th>NSN</th>
<th>Part No.</th>
<th>Qty/Pt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>613 621 622 625 627 628 629</td>
<td>TRANS, 21-1200x3</td>
<td>506302</td>
<td>4961-00-1706</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>614 621 622 625 627 628 629</td>
<td>TRANS, 21-1200x4</td>
<td>506303</td>
<td>4961-00-1706</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>630</td>
<td>TRANS, 21-1200x10</td>
<td>506304</td>
<td>4961-00-1706</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>TRANS, P-CHANNEL</td>
<td>506305</td>
<td>4961-00-1706</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>TRANS, N-CHANNEL</td>
<td>506306</td>
<td>4961-00-1706</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>TRANS, P-CHANNEL</td>
<td>506307</td>
<td>4961-00-1706</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>TRANS, N-CHANNEL</td>
<td>506308</td>
<td>4961-00-1706</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>TRANS, P-CHANNEL</td>
<td>506309</td>
<td>4961-00-1706</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>TRANS, N-CHANNEL</td>
<td>506310</td>
<td>4961-00-1706</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

#### WaveTek Parts List

**Title:** Kit, Pre-Wave Load 145-056

**Assembly No.:** 2333-00-1756-01

**Qty.:** 1

---

**Title:** Super Kit

**Assembly No.:** 2333-00-1418-01

**Qty.:** 1
<table>
<thead>
<tr>
<th>REFERENCE DESIGNATIONS</th>
<th>PART DESCRIPTION</th>
<th>ORI-FOR-PART-NUM</th>
<th>NFDR</th>
<th>WAVEKET NO.</th>
<th>STYL/PRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5</td>
<td>TRANS. DUAL IMP.</td>
<td>X4704</td>
<td>TI</td>
<td>5000-74-7461</td>
<td>1</td>
</tr>
<tr>
<td>Q6</td>
<td>TRANS. DUAL IMP.</td>
<td>X4707</td>
<td>TI</td>
<td>5000-74-7461</td>
<td>1</td>
</tr>
<tr>
<td>109</td>
<td>BUS IN IMP. 2-IMP.</td>
<td>X4711</td>
<td>TI</td>
<td>5000-74-6661</td>
<td>1</td>
</tr>
<tr>
<td>1011 1018</td>
<td>BUS IMP. 3-IMP.</td>
<td>X4712</td>
<td>TI</td>
<td>5000-74-6661</td>
<td>1</td>
</tr>
</tbody>
</table>

**REFERENCE DESIGNATIONS**

<table>
<thead>
<tr>
<th>PART DESCRIPTION</th>
<th>ORI-FOR-PART-NUM</th>
<th>NFDR</th>
<th>WAVEKET NO.</th>
<th>STYL/PRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5</td>
<td>TRANS. DUAL IMP.</td>
<td>X4704</td>
<td>TI</td>
<td>5000-74-7461</td>
</tr>
<tr>
<td>Q6</td>
<td>TRANS. DUAL IMP.</td>
<td>X4707</td>
<td>TI</td>
<td>5000-74-7461</td>
</tr>
<tr>
<td>109</td>
<td>BUS IN IMP. 2-IMP.</td>
<td>X4711</td>
<td>TI</td>
<td>5000-74-6661</td>
</tr>
<tr>
<td>1011 1018</td>
<td>BUS IMP. 3-IMP.</td>
<td>X4712</td>
<td>TI</td>
<td>5000-74-6661</td>
</tr>
</tbody>
</table>

**REFERENCE DESIGNATIONS**

<table>
<thead>
<tr>
<th>PART DESCRIPTION</th>
<th>ORI-FOR-PART-NUM</th>
<th>NFDR</th>
<th>WAVEKET NO.</th>
<th>STYL/PRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5</td>
<td>TRANS. DUAL IMP.</td>
<td>X4704</td>
<td>TI</td>
<td>5000-74-7461</td>
</tr>
<tr>
<td>Q6</td>
<td>TRANS. DUAL IMP.</td>
<td>X4707</td>
<td>TI</td>
<td>5000-74-7461</td>
</tr>
<tr>
<td>109</td>
<td>BUS IN IMP. 2-IMP.</td>
<td>X4711</td>
<td>TI</td>
<td>5000-74-6661</td>
</tr>
<tr>
<td>1011 1018</td>
<td>BUS IMP. 3-IMP.</td>
<td>X4712</td>
<td>TI</td>
<td>5000-74-6661</td>
</tr>
<tr>
<td>REFERENCE DESIGNATIONS</td>
<td>PART DESCRIPTION</td>
<td>ORIG-PART-NUM</td>
<td>P/N</td>
<td>MANUFACT. NUM.</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------</td>
<td>--------------</td>
<td>-----</td>
<td>---------------</td>
</tr>
<tr>
<td>629</td>
<td>TRANS</td>
<td>240600</td>
<td>MEC</td>
<td>9901-03-6969</td>
</tr>
<tr>
<td>629</td>
<td>TRANS SPACER</td>
<td>240900</td>
<td>MEC</td>
<td>9901-03-9830</td>
</tr>
<tr>
<td>629</td>
<td>TRANS CONNECTOR</td>
<td>240950</td>
<td>ITT</td>
<td>9901-03-9500</td>
</tr>
<tr>
<td>630</td>
<td>TRANS</td>
<td>240950-10</td>
<td>MEC</td>
<td>9901-03-6969</td>
</tr>
<tr>
<td>630</td>
<td>TRANS</td>
<td>240940</td>
<td>MEC</td>
<td>9901-03-6969</td>
</tr>
<tr>
<td>630</td>
<td>TRANS</td>
<td>240940</td>
<td>MEC</td>
<td>9901-03-6969</td>
</tr>
<tr>
<td>630</td>
<td>TRANS</td>
<td>240950</td>
<td>ITT</td>
<td>9901-03-9500</td>
</tr>
<tr>
<td>618 20</td>
<td>TRANS KIT INSERT</td>
<td>47900-00-0004</td>
<td>ALS</td>
<td>9900-00-9999</td>
</tr>
<tr>
<td>60 07</td>
<td>TRANS KIT INSERT</td>
<td>47900-00-0008</td>
<td>ALS</td>
<td>9900-00-9999</td>
</tr>
<tr>
<td>60 07</td>
<td>TRANS KIT INSERT</td>
<td>47900-00-0008</td>
<td>ALS</td>
<td>9900-00-9999</td>
</tr>
<tr>
<td>60 07</td>
<td>TRANS KIT INSERT</td>
<td>47900-00-0008</td>
<td>ALS</td>
<td>9900-00-9999</td>
</tr>
<tr>
<td>304 185</td>
<td>DP APH, SMP, APH</td>
<td>7000-04-1120</td>
<td>MEC</td>
<td>9900-00-9999</td>
</tr>
<tr>
<td>304 185</td>
<td>DP APH, SMP, APH</td>
<td>7000-04-1120</td>
<td>MEC</td>
<td>9900-00-9999</td>
</tr>
</tbody>
</table>

**Note:** Parts list page 5.
MARK LABEL FOR OPTION 001.

1. FOR PARTS LIST SEE 1100-00-0221.

NOTE: MARK MODEL NO. "145-S-STD."

WIRE TO XMI AND 23-GA.
TWISTED WIRE, COLORS:
RED AND BLACK.

CABLE ASSEMBLY

SEE DETAIL A.
ITEM 4 (INSTALLATION)

1100-00-0556
(GENERATOR SG)

MODEL 145-STD

BOTTOM VIEW
(with cover removed)

MARK MODEL NO. "145-S-STD."

REFERENCE DESIGNATION PART DESCRIPTION O/R/OPTION-PART-NR. MANUFACTURER NO. REV/REV

NONE

1 MODEL, 145-001 OPTION 5000 HOUR TIMER

WAVETEK PARTS LIST

TITLE: MODEL 145-001 OPTION 5000 HOUR TIMER

PAGE 2

WAVETEK

1100-00-0221

REV: 0
<table>
<thead>
<tr>
<th>Reference Designator</th>
<th>Part Description</th>
<th>P/N (W/088-PART-N)</th>
<th>MFR</th>
<th>WAVTEK #</th>
<th>QTY/Flt</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOME</td>
<td>SCHEMATIC INSTRUMENT</td>
<td>00456-00-0001</td>
<td>WTX</td>
<td>00456-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>NOME</td>
<td>ASSY DRAWN. MODEL 14S</td>
<td>0020-00-0442</td>
<td>WTX</td>
<td>0020-00-0442</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>MODEL 14S B,D,F H-MICROFUSION SENSOR</td>
<td>149</td>
<td>WTX</td>
<td>1490-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>NOME</td>
<td>CARTER FOR MODEL 14S AND OPTIONS</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>LABEL, OPTIONAL, MODEL 14S</td>
<td>1490-00-0001</td>
<td>WTX</td>
<td>1490-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>SCL PANEL</td>
<td>1490-00-1490</td>
<td>WTX</td>
<td>1490-00-1490</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>LABEL, 56-760-10-014</td>
<td>1490-00-1490</td>
<td>WTX</td>
<td>1490-00-1490</td>
<td>1</td>
</tr>
<tr>
<td>CA 17</td>
<td>CAP INFER PHIND H-MICROFUSION SENSOR</td>
<td>1490-00-1490</td>
<td>WTX</td>
<td>1490-00-1490</td>
<td>1</td>
</tr>
<tr>
<td>J2</td>
<td>CONN-HEADER, 5 PIN, 100 PCB</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>J0</td>
<td>CONN-HEADER, 5 PIN</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>JACK STK</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>DISCONNECTER, CLOSED TIME (6000 HRS)</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
</tbody>
</table>

**PARTS LIST**

**MODEL 14S WITH SPECIAL OPTION B-20821**

**ASSEMBLY** 1000-00-0042

**PAGE 1**

---

<table>
<thead>
<tr>
<th>Reference Designator</th>
<th>Part Description</th>
<th>P/N (W/088-PART-N)</th>
<th>MFR</th>
<th>WAVTEK #</th>
<th>QTY/Flt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HELPER, TYPEN</td>
<td>1-1000</td>
<td>WTX</td>
<td>1-1000</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>NUT, PANEL, PANEL W1/2, 5/16, AF, 1/2</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>MOUNT, INTERNAL TEST, 3/8, AF</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>100</td>
<td>CONTROL, SHAFT, HELPER, W/088-PART-N</td>
<td>0020-00-0001</td>
<td>WTX</td>
<td>0020-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>R20</td>
<td>RES-MF, 1/4MA (1.3K)</td>
<td>1000-00-0001</td>
<td>WTX</td>
<td>1000-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>R20</td>
<td>RES-MF, 1/4MA (1.3K)</td>
<td>1000-00-0001</td>
<td>WTX</td>
<td>1000-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>R20</td>
<td>RES-MF, 1/4MA (1.3K)</td>
<td>1000-00-0001</td>
<td>WTX</td>
<td>1000-00-0001</td>
<td>1</td>
</tr>
<tr>
<td>103</td>
<td>BOP,内部测试, 1.3K</td>
<td>1000-00-0001</td>
<td>WTX</td>
<td>1000-00-0001</td>
<td>1</td>
</tr>
</tbody>
</table>

**PARTS LIST**

**MODEL 14S WITH SPECIAL OPTION B-20821**

**ASSEMBLY** 1000-00-0042

**PAGE 2**