# INSTRUCTION MANUAL

# MODELS 1080/1081

## SWEEP GENERATOR

WAVETEK® INDIANA, INC.
5808 CHURCHMAN, P.O. BOX 190
BEECH GROVE, INDIANA 46107
317-787-3332
(TOLL FREE OUTSIDE INDIANA)
1-800-428-4424

Serial No. ______________

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6/83

# WARRANTY

All Wavetek instruments are warranteed against defects in material and workmanship for a period of six months on field equipment or one year on laboratory equipment after date of manufacture. Wavetek agrees to repair or replace any assembly or component (except batteries) found to be defective under normal use during this period. Wavetek's obligation under this warranty is limited solely to repairing any such instrument which, in Wavetek's sole opinion, proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Wavetek.

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CHANGE INFORMATION, IF ANY, IS LOCATED AT THE REAR OF THIS MANUAL

# SECTION 1
# GENERAL INFORMATION

## 1.1 INTRODUCTION

The Wavetek Models 1080/1081 are economical, laboratory-quality, wide-band sweep generators designed to meet the needs of engineering, production, maintenance, and educational facilities.

The major features of these instruments include the wide frequency range (1 to 1000 MHz), the ability to sweep over any portion of the frequency range, digital frequency and output level readouts, and display linearity of 1%. Operating modes include CW, Δf, and FS (full sweep). A unique "auto-zero" circuit virtually eliminates annoying frequency drift normally associated with wide-band sweep generators, and provides for superior narrow-band operation and improved frequency accuracy.

A crystal-marker circuit provides markers at 1, 10, and 100 MHz harmonic intervals (with different amplitudes for positive identification of the interval points) throughout the entire frequency band. Marker width is adjustable from the front panel for optimum wide- and narrow-band operation. An external marker input is provided on the front panel. A calibrated variable "pinball" marker is also provided in the full sweep mode.

The rear-panel SLOPE control allows up to 1 dB/GHz (.1 dB/100 MHz) of slope (1 MHz pivot point) to be imposed on the output to compensate for frequency-dependent variations in the external circuitry.

The instrument's center frequency, sweep width, and output level can also be remotely controlled via a rear-panel connector. This connector also provides access to the blanking, 1 V/100 MHz, sweep ramp, pen lift, and ±18 V Power Supply output signals, as well as providing a connection for an external trigger input.

These instruments feature modular PC board plug-in construction for all non-RF circuitry. The RF circuitry is contained in its own shielded assembly. This concept offers protection against obsolesence, since updated and additional features can be simply and economically added as new requirements dictate. In addition, maintenance problems can be greatly simplified by stocking a few assemblies instead of hundreds of discrete components.

## 1.2 SPECIFICATIONS

### 1.2.1 FREQUENCY

| | |
|---|---|
| RANGE | 1 to 1000 MHz |
| INDICATOR | 3½ digit display. |
| ACCURACY | |
| CW | ± 10 MHz (see NOTE) |
| Δf | Center frequency ± 10 MHz (see NOTE)<br>Sweep width at 100 MHz intervals (VERNIER off) ± 2% (VERNIER is uncalibrated). |
| FS | Start frequency (1 MHz) ±1 MHz<br>Stop frequency (1000 MHz) ±10 MHz<br>Variable marker ±10 MHz |
| | **NOTE – Using FREQ OFFSET and crystal markers, accuracy can be improved to ± 1 MHz at specific frequencies.** |
| DISPLAY LINEARITY | ± 1% at maximum sweep width |
| DRIFT | < 200 kHz/10 minutes after 30 minute warm-up |

### 1.2.2 RF OUTPUT

| | |
|---|---|
| IMPEDANCE | 50 ohms (Model 1080); 75 ohms (Model 1081) |
| LEVEL | Continuously adjustable from +13 to -70 dBm (Model 1080) or +60 to -10 dBmV (Model 1081) in seven 10 dB steps plus vernier. |
| INDICATOR | 3 digit display. |
| ACCURACY | |
| Flatness | ±0.25 dB |
| OUTPUT Vernier | ±0.5 dB |
| Step Attenuator | ±0.3 dB + 1% of attenuation |
| Maximum Combined Error | ±1.75 dB |
| BLANKING | RF output removed during sweep retrace |
| SPECTRAL PURITY | |
| Harmonics | ⩽-15 dBc for RF output frequency of from 1 to 2 MHz<br>⩽-25 dBc for RF output frequency of from 2 to 10 MHz<br>⩽-30 dBc for RF output frequency of from 10 to 1000 MHz |
| Non-Harmonics | ⩽-50 dBc for RF output frequency of from 1 to 400 MHz<br>⩽-35 dBc for RF output frequency of from 400 to 1000 MHz |
| RESIDUAL FM | < 10 kHz peak in CW mode |

## 1.2.3 SWEEP

| | |
|---|---|
| OPERATING MODES | CW, Δf, and FS (full sweep) |
| CW | Frequency is set via the front-panel FREQUENCY control and displayed on a 3½ digit display (resolution=1 MHz). |
| Δf | Center frequency is set via the FREQUENCY control. Sweep width is set in calibrated 100 MHz steps plus a 100 MHz vernier. |
| FS (full sweep) | The entire 1 to 1000 MHz frequency range is swept. The FREQUENCY control and 3½ digit FREQUENCY display control a 1 to 1000 MHz variable ("pinball") marker. |
| SWEEP MODES | Recurring sweep, single (triggered) sweep |
| SWEEP WIDTH | 200 kHz to 1000 MHz |
| SWEEP TIME | Fast: Adjustable from 0.01 to 1 sec (typ)<br>Slow: Adjustable from 1 to 100 sec (typ)<br>Line: 1/2 of AC line period |
| HORIZONTAL OUTPUT | 0 to 10 V. In CW mode, the output voltage is proportional to the RF output frequency (1 V/100 MHz). |
| Accuracy | CW ± 1%<br>Δf ± 0.2 V<br>FS ± 0.2 V |
| Impedance | 1 kohm |

## 1.2.4 MARKERS

Birdy bypass marker system provides markers at 1, 10, and 100 MHz harmonic intervals. Front-panel switch provides selection of 100 MHz, 100 and 10 MHz, or 100, 10, and 1 MHz harmonic markers. When multiple markers are selected, amplitude differences provide identification of markers.

| | |
|---|---|
| ACCURACY | ± 0.005% |
| SIZE | Adjustable from approximately 1 mVpp to 1 Vpp |
| WIDTH | Adjustable from approximately 100 to 400 kHz in three steps |
| EXTERNAL MARKER | Front-panel connector provides a birdy marker by combining an external CW signal with a sample of the sweep oscillator signal. Input signal required is approximately 0.1 V into 50 ohms. |
| VARIABLE MARKER | This voltage-derived marker is produced only in the FS mode. A bright spot ("pinball") is produced on the display by momentarily delaying the forward sweep for approximately 2 msec. (Accuracy is as listed in Section 1.2.1.) |

## 1.2.5 INTERFACE

A rear-panel plug provides connections for remote programming and interfacing with other instruments.

| | |
|---|---|
| TRIGGER | The sweep may be externally triggered by a high-to-low transition (TTL or contact closure). |

| | |
|---|---|
| FREQUENCY | This input allows remote control of CW frequency, Δf center frequency and sweep width, and also provides external FM capability. |
| Impedance | 100 kohms |
| Tuning Sensitivity | 1 V/100 MHz (0 V=1 MHz) |
| FM Response | DC to 8 Hz (3 dB) in CW mode. |
| LEVEL | This input allows remote control of the RF output level over a > 13 dB range (Model 1080) or > 10 dB range (Model 1081). Sensitivity is 1 dB/V. This input is not recommended for external AM. |
| PEN LIFT | Provides contact closure during slow forward sweep. |
| BLANKING | Approximately −15 V during forward sweep and +15 V during retrace. |
| SWEEP | Provides connection to the 0 to 10 V sweep ramp. |
| 1 V/100 MHz | Provides a reference voltage output proportional to the instantaneous RF output frequency. |
| POWER SUPPLY | Provides connection to ± 18 V and ground. (Maximum external current draw is 10 mA for each supply.) |

1.2.6 GENERAL

| | |
|---|---|
| OPERATING TEMPERATURE | 20° to 30° C all specifications apply<br>0° to 50° C with slight degradation of specifications |
| POWER REQUIREMENTS | 100 ± 10 VAC, 115 ± 10 VAC, 200 ± 20 VAC, or 230 ± 20 VAC;<br>50 to 400 Hz; approximately 25 W |
| CONNECTORS | BNC except for INTERFACE connector which is 15-pin in-line plug. |
| DIMENSIONS | 28.6 cm wide x 13.3 cm high x 26.7 cm deep (11 1/4" x 5 1/4" x 10 1/2") |
| WEIGHT | 5 kg (11.0 lb) net; 7 kg (15.5 lb) shipping |

## 1.3 ACCESSORIES

| | |
|---|---|
| 1.3.1 FURNISHED WITH INSTRUMENT | Instruction manual<br>Mating jack for INTERFACE plug (MOL 09-50-7151 housing with 08-50-0107 contacts; W-I P/N 2112-00-0033 and 2113-07-0001).<br>Fuse for 200/230 VAC operation; ¼ A, time delay |
| 1.3.2 AVAILABLE AT EXTRA COST | Rack Mount Kit K019 for standard 19" instrument rack<br>Wide Band RF Detector Model D151 (50 ohms, up to 1000 MHz)<br>Wide Band RF Detector Model D171 (75 ohms, up to 1000 MHz) |

# SECTION 2
# OPERATION

## 2.1 INTRODUCTION

This section provides electrical and mechanical (including rack mounting) instructions, functional control descriptions, operating instructions, and programming instructions for Models 1080/1081. In addition, special operating notes cover sweep rate errors, overloading, low-level measurements, and marker generation by level modulation.

## 2.2 MECHANICAL INSTALLATION

### 2.2.1 INITIAL INSPECTION

After unpacking the instrument, visually inspect external parts for damage to knobs, connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

### 2.2.2 DAMAGE CLAIMS

If the instrument received has been damaged in transit, notify the carrier and either the nearest Wavetek area representative or the factory in Indiana.

Retain the shipping carton and packing material for the carrier's inspection.

The local representative or the factory will immediately arrange for either replacement or repair of your instrument without waiting for damage claim settlements.

### 2.2.3 RACK MOUNTING

Refer to Figure 2-1.

The K019 Rack Mount Kit enables mounting the instrument in a standard 19 inch wide rack.

CONTENTS

| ITEM | DESCRIPTION | WAVETEK P/N | TQ |
|---|---|---|---|
| A | Top Tray | 1410-00-1130 | 1 |
| B | Side | 1410-60-1660 | 2 |
| C | Bottom Tray | 1410-00-1120 | 1 |
| D | Screw, 10-32 x 1/2" | 2810-18-0208 | 4 |
| E | Screw, 6-32 x 3/8" | 2810-17-6106 | 12 |
| F | Handle | 2810-07-0001 | 2 |

PROCEDURE

Attach both sides (item B) to the bottom tray (item C) using the #6 screws (item E) provided. Position the instrument on the tray so that the feet fit into the provided holes. Attach the top tray (item A) with the remaining #6 screws (item E). Attach the handles (item F) with the #10 screws (item D) provided.

## 2.3 ELECTRICAL INSTALLATION

The instrument can operate from any of 100, 115, 200, or 230 VAC supply mains. The rear-panel LINE VOLTAGE switches select which of these operating voltages is being used and adjust the Power Supply accordingly. The Power Supply is designed to operate over a 50 to 400 Hz AC supply frequency.

Instruments are shipped from the factory set up for 115 VAC operation unless otherwise specified.

NOTE

**Before operating the instrument, check that the rear-panel FUSE is the correct value for the supply voltages (see Section 2.5).**

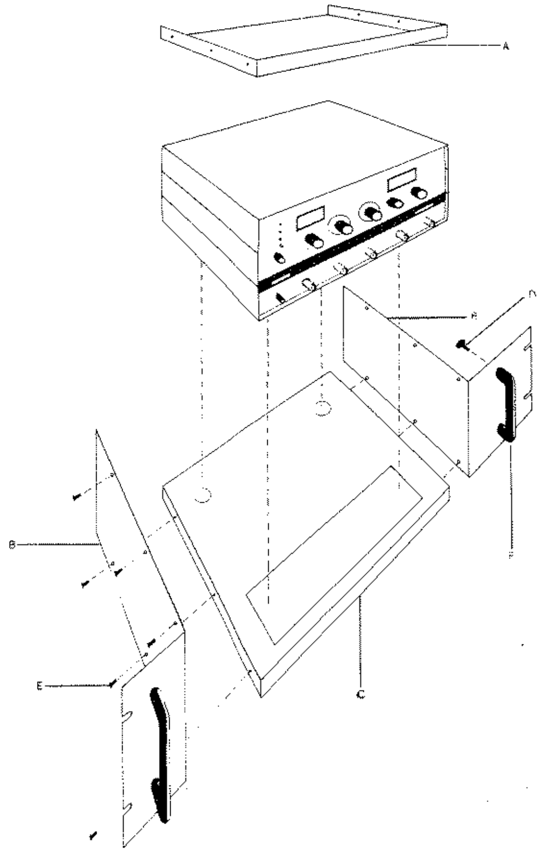



Figure 2-1. Rack Mounting

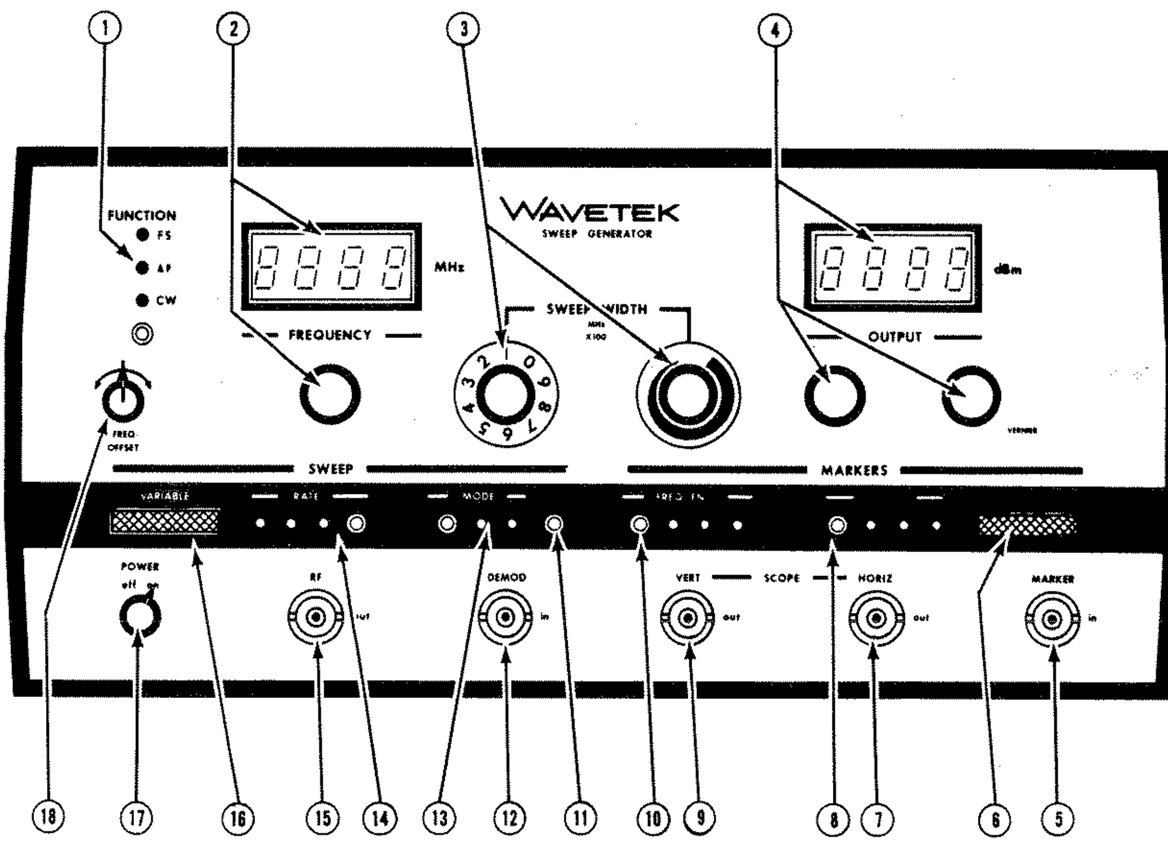



Figure 2-2. Front Panel

## 2.4 DESCRIPTION OF FRONT PANEL

Refer to Figure 2-2.

(1) FUNCTION pushbutton sequentially selects CW, Δf, or FS mode of operation. The selected mode is indicated by a lit LED.

(2) FREQUENCY control adjusts the frequency in CW mode; the center frequency in Δf mode; and the variable "pinball" marker frequency in FS mode. The 3½ digit display indicates the frequency set by the control.

(3) SWEEP WIDTH controls set the sweep width in Δf operation. The switch selects the sweep width in 100 MHz steps. The VERNIER provides continuous adjustment from 0 (full ccw) to 100 MHz (full cw). When the FUNCTION is set for CW or FS mode, the SWEEP WIDTH controls have no function.

(4) OUTPUT controls set the RF output level. The STEP control provides 0 to 70 dB of attenuation in 10 dB steps. The VERNIER provides > 13 dB of continuous attenuation when the step control is set to 0 dB (+13 to 0 dBm output, Model 1080 only), and > 10 dB of continuous attenuation at all other step control settings. The 3 digit display indicates the output level set by the controls.

(5) MARKER IN connector accepts an external CW signal to produce a birdy marker at the external frequency.

NOTE

**The external marker will not operate properly when only the 100 MHz harmonic markers are selected. When 100/10 or 100/10/1 MHz harmonic markers or no markers are selected, the external marker will function properly.**

(6) MARKERS SIZE thumbwheel control adjusts the birdy marker amplitude.

(7) SCOPE HORIZ OUT connector provides the 0 to 10 V triangle waveform to drive a display oscilloscope horizontal channel.

(8) MARKERS WIDTH pushbutton sequentially selects the birdy marker width. The selected width (wide ≅ 400 kHz, narrow ≅ 100 kHz) is indicated by a lit LED.

(9) SCOPE VERT OUT connector provides the vertical display signal (markers plus demodulated output if DEMOD IN connector is used) for a display oscilloscope.

(10) MARKERS FREQUENCY pushbutton sequentially selects 100 MHz harmonic, 100/10 MHz harmonic, or 100/10/1 MHz harmonic birdy markers. The active markers are indicated by lit LEDs.

(11) SWEEP TRIG pushbutton provides manual triggering of the sweep when the SWEEP MODE is set for single sweep.

(12) DEMOD IN connector accepts the detected swept signal from the device under test so that markers may be added. The combined signal is available at the SCOPE VERT OUT connector.

(13) SWEEP MODE pushbutton alternately selects either recurring or single sweep mode. The selected mode is indicated by a lit LED.

(14) SWEEP RATE pushbutton sequentially selects slow, fast, or line sweep rates (see Section 1.2.3). The selected rate is indicated by a lit LED.

(15) RF OUT connector provides connection for the RF output signal.

(16) SWEEP VARIABLE thumbwheel control provides continuously adjustable control of the sweep rate when the SWEEP RATE is set for either fast or slow rate. When the SWEEP RATE is set for line rate, the SWEEP VARIABLE control has no function.

(17) POWER switch applies AC power to the Power Supply.

(18) FREQ OFFSET control provides fine adjustment of the RF output frequency in CW or Δf mode independent of the FREQUENCY control or display.

## 2.5 DESCRIPTION OF REAR PANEL

Refer to Figure 2-3.

(1) SLOPE control adjusts the slope of the RF output up to ±1 dB/GHz (±0.1 dB/100 MHz) with the pivot point being 1 MHz.

(2) INTERFACE connector provides connections to internal power sources and outputs, and for external control of frequency, level, and triggering.

(3) AC line cord provides connection to AC supply mains.

(4) LINE VOLTAGE switches set the Power Supply to operate from the available AC supply mains.

(5) FUSE is time-delay; ½ amp for 100/115 VAC operation, ¼ amp for 200/230 VAC operation.

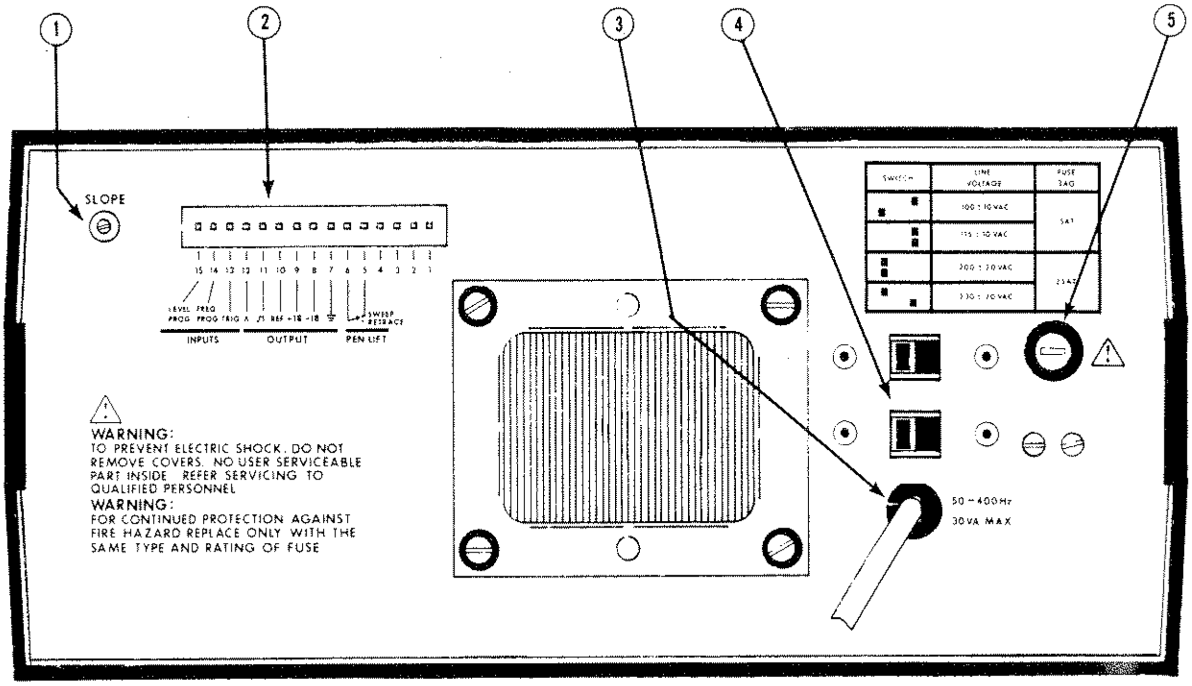



Figure 2-3. Rear Panel

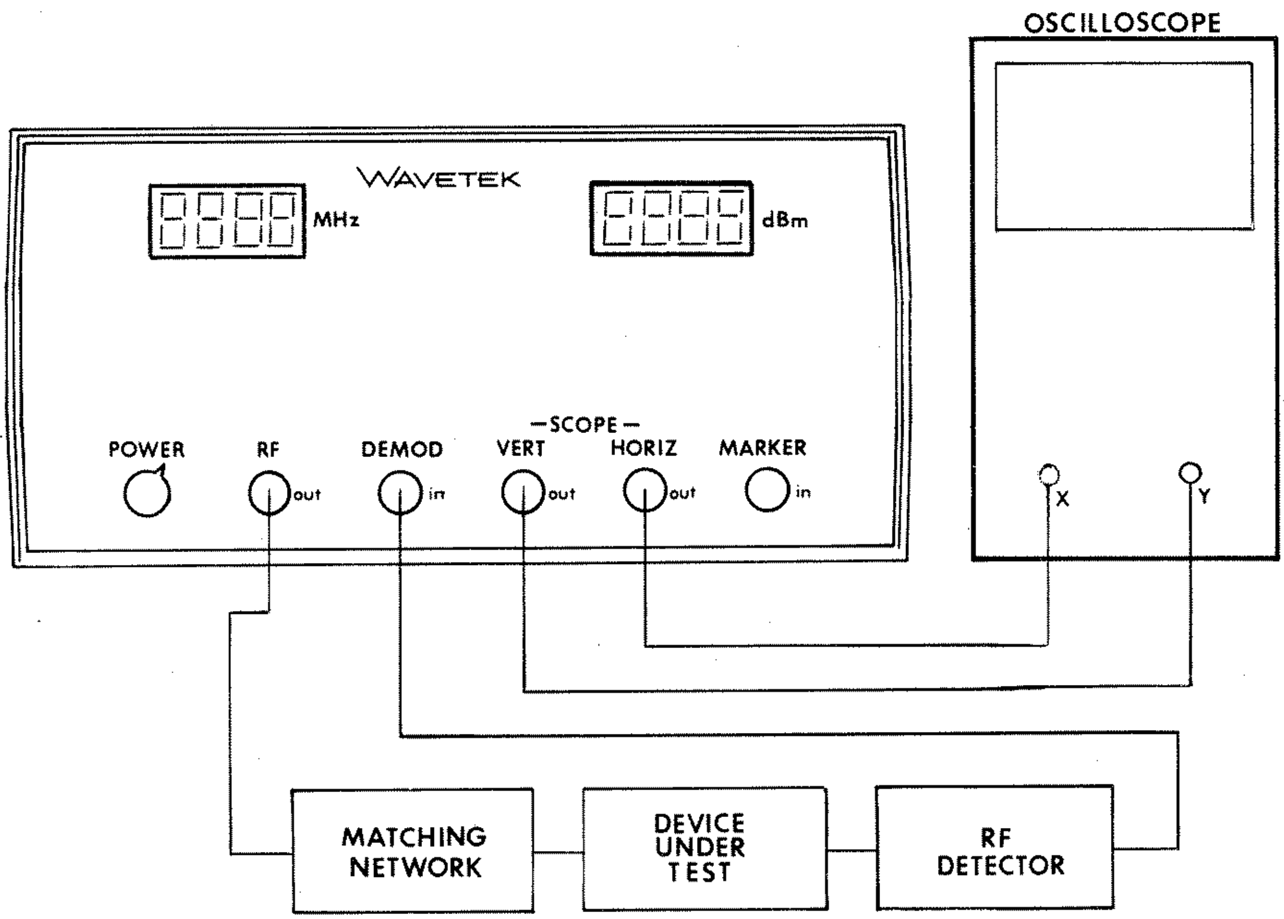



Figure 2-4. Typical Set-up

## 2.6 TYPICAL OPERATING SETUP

When initially setting up the instrument, first check the rear-panel LINE VOLTAGE switches and FUSE to ensure that the instrument is set for operation with the available AC mains.

Make connections between the sweep generator, the device under test, and the oscilloscope as shown in Figure 2-4. Since hum, RF leakage, and spurious signal pickup must be kept to a minimum, it is essential that good connections and grounds be maintained throughout the entire setup. Use coaxial cables with the appropriate RF connectors wherever possible. The RF output cable is especially critical. It should match the output impedance of the sweep generator and should be kept as short as practical (under 3 feet). If the input impedance of the device under test is not the same as the sweep generator output impedance, a matching network should be used to ensure that a constant-amplitude input signal is sent to the device under test (see Figure 2-4). After the RF signal passes through the RF circuit of the device under test, it must be demodulated before being connected to the sweep generator DEMOD IN connector. If a demodulator is not a part of the device under test, one must be added externally (see Figure 2-4). The input impedance of the demodulator must present the proper load to the RF circuit being tested. The Wavetek Model D151 RF Detector is recommended for 50 ohm applications.

Turn the front-panel POWER switch on. Lighted front-panel LEDs should indicate operation. After completing the setup, adjust the instrument controls for the required output frequency, output amplitude, and sweep rate. Turn the desired markers on and adjust their size and width. Allow a 5 minute warmup period before using to allow the auto-zero circuitry to stabilize. If the instrument is to be used at the extreme limits of its specifications, allow a 30 minute warmup period.

**NOTE**

**When the unit is turned on or if there is an interruption of AC power, the following front-panel control settings will be automatically selected:**

| | |
|---|---|
| **FUNCTION** | **FS** |
| **SWEEP RATE** | **Fast** |
| **MODE** | **Recur** |
| **MARKERS FREQUENCY** | **100 and 10 MHz** |
| **WIDTH** | **Wide** |

**All other instrument control settings, including the RF output frequency and level, will remain as they were set prior to turn-on.**

## 2.7 SPECIAL OPERATING NOTES

### 2.7.1 ERRORS FROM SWEEP RATE EFFECTS

When sweeping RF circuits having rapid amplitude changes, errors may occur, due mainly to detector delays. Decreasing the detector output time constant will minimize this effect. Figure 2-5 illustrates sweep rate effect.

To check for sweep rate effect, first set the sweep width to its lowest practical setting, then reduce the sweep time while closely observing the swept output response. Any change in the response indicates the sweep rate is too fast for a true response. When a further reduction of sweep time does not change the response, a true response has been obtained.

### 2.7.2 EFFECT FROM OVERLOADING

The use of excessive input signals to the device under test can cause overloading, which yields a distorted response. To prevent this, first set the OUTPUT controls for minimum output amplitude. Gradually increase the output amplitude until a response is obtained. Further increasing the output amplitude should not change the configuration of the response envelope except in amplitude. If the response envelope does change (such as flattening at the top) decrease the output amplitude just enough to restore the proper configuration.

### 2.7.3 MAKING MEASUREMENTS AT LOW LEVELS

When making measurements at low levels, radiation and ground loops can become problems. Using double-shielded cables for RF signals helps minimize the radiation problem. Ground loops causing hum pick up can sometimes be eliminated by completing only one ground connection between each instrument. This applies particularly to the oscilloscope horizontal input. If the ground connection is made at the vertical input terminal, an additional ground at the horizontal input terminal will often result in hum pick-up.

### 2.7.4 MARKER GENERATION BY LEVEL MODULATION

Birdy markers may be used to modulate the RF output signal. This permits viewing the frequency markers on the detected response without having to return the detected signal to the marker adder circuitry in the sweep generator. This is useful when the detector and scope display are remote to the sweep generator.

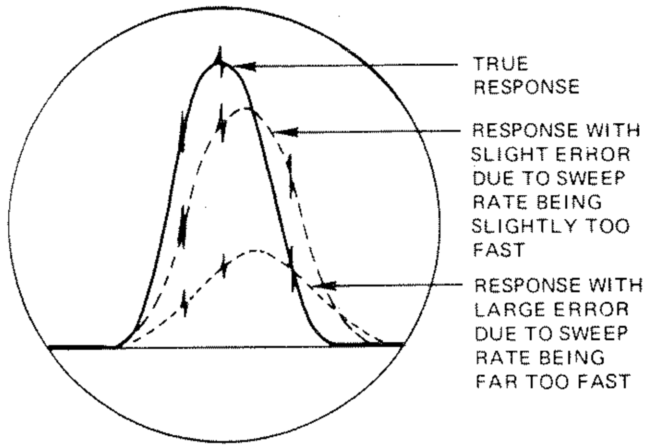



Figure 2-5. Sweep Rate Effects

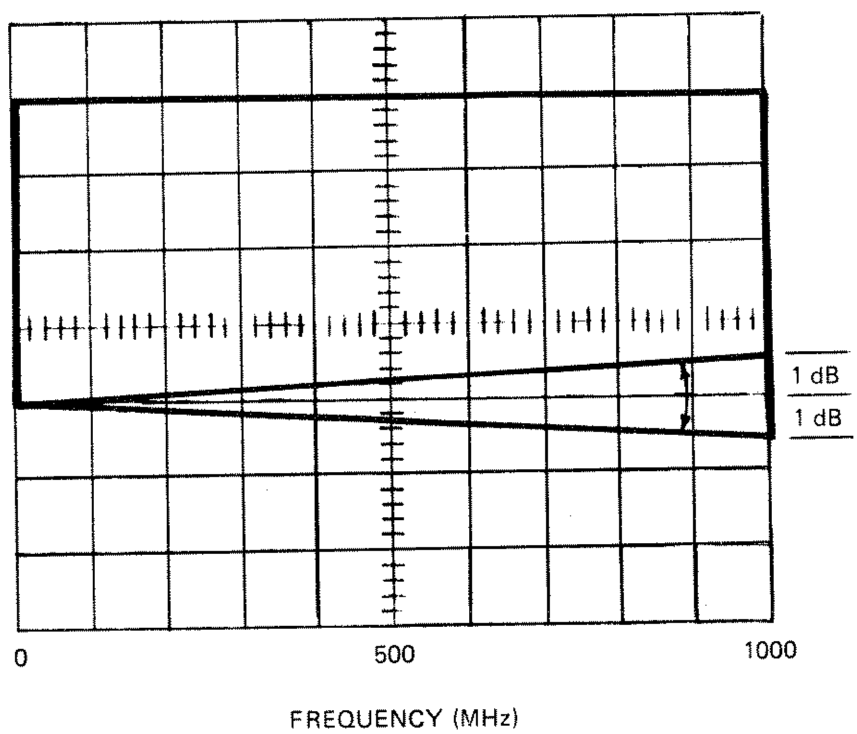



Figure 2-6. Slope

To employ this technique, connect the front-panel SCOPE VERT OUT to pin 15 of the rear-panel INTERFACE connector. The front-panel MARKERS WIDTH and SIZE controls will provide modulation adjustment.

The variable "pinball" marker in FS mode can also be generated by level modulation. It is normally an intensity marker generated by momentarily stopping the sweep ramp; however, at slow sweep rates, the momentary delay becomes indistinguishable, and level modulation is desirable. To provide level modulation with a variable marker, remove the instrument top cover (see Section 5.2) and move the jumper jack on the Variable Marker plug (see Figure 5-10) to the on position. This will produce a 1 dB reduction of the RF output coincident with the variable marker pulses.

### 2.7.5 AUTO–ZERO CIRCUIT

To minimize RF output frequency drift, an auto-zero circuit is incorporated into the RF oscillator design. At approximately 5-minute intervals, the RF output frequency is shifted to 0 MHz and a corrective signal applied to the RF oscillator. This process requires approximately 5 msec. In Δf and FS modes, this interruption occurs prior to the beginning of the forward sweep where a normal delay occurs, and is therefore not noticeable on the sweep display. In CW mode, this interruption should be negligible.

### 2.7.6 IMPROVED FREQUENCY ACCURACY

The FREQUENCY OFFSET control, which provides adjustment of the RF output frequency independent of the FREQUENCY display reading, can be adjusted to improve the accuracy of the display to ±1 MHz (instead of the normal ±10 MHz) at specific frequencies. In Δf operation, for example, with the FREQUENCY display set to a specific marker frequency, the FREQUENCY OFFSET control is adjusted until the specific marker is aligned at the center of the display at a narrow sweep width. The accuracy improvement then applies to that specific frequency and a narrow range around that frequency. In FS mode, the variable ("pinball") marker can also be aligned on a specific birdy marker using the FREQUENCY control (the FREQUENCY OFFSET control has no function in FS mode) to improve the marker frequency display accuracy. Once set, the ±1 MHz accuracy will apply at that frequency in all operating functions.

### 2.7.7 SLOPE CONTROL

This feature enables the RF output to be tilted in order to compensate for system tilt or to simulate cable losses. The amount of slope imposed is 0 to ±1 dB/GHz set via the SLOPE control, with the pivot point being 1 MHz (see Figure 2-6).

NOTE

**The front-panel OUTPUT vernier must be adjusted such that the imposed slope does not cause the vernier range to be exceeded.**

## 2.8 INTERFACE CONNECTOR

The rear-panel INTERFACE connector provides connections to instrument signal sources and enables remote programming of some instrument functions. The INTERFACE connector pin functions are:

| PIN | FUNCTION |
|---|---|
| 1 thru 4 | Unused |
| 5, 6 | Pen Lift |
| 7 | ±18 V Common |
| 8 | -18 V (10 mA) |
| 9 | +18 V (10 mA) |
| 10 | 1V/100 MHz Ref |
| 11 | Blanking |
| 12 | Sweep Ramp |
| 13 | Ext Trigger |
| 14 | Ext Frequency Program |
| 15 | Ext Level Program |

### 2.8.1 PEN LIFT

The Pen Lift feature provides a contact closure at INTERFACE plug pins 5 and 6 to operate an X-Y plotter's pen lift mechanism. The contacts are closed only during CW operation and during forward sweep when the SWEEP RATE switch is set for SLOW. At all other times, the contacts are open.

### 2.8.2 EXTERNAL TRIGGER

To trigger the sweep from an external source, set the SWEEP MODE switch for SINGLE and apply a TTL signal (or contact closure to ground) to INTERFACE plug pin 13. The sweep will be initiated by a high-to-low transition.

### 2.8.3 EXTERNAL FREQUENCY PROGRAMMING

NOTES

**External frequency programming will not be indicated on the front-panel FREQUENCY display.**

**When the sweep generator is operating in CW mode, a filter is enabled which reduces residual FM, but prevents rapid frequency changes normally required during sweep and FM operation. External sweep and FM are possible in certain cases in CW mode, but are not recommended.**

EXTERNAL CW

To remotely control the CW frequency, set the front-panel FREQUENCY control for 000 MHz and the FUNCTION switch for CW. A DC voltage (0 to +10 V) applied to INTERFACE connector pin 14 will control the CW frequency.

EXTERNAL SWEEP – CENTER FREQUENCY

To remotely control the sweep center frequency, set the FREQUENCY control for 000 MHz, the FUNCTION switch to Δf, and the SWEEP MODE switch for RECUR. An external signal applied to INTERFACE connector pin 14 will tune the center frequency (sensitivity = 100 MHz/V). The external signal may be DC, a ramp, or any other waveform between 0 and +10 V.

NOTE

**If the FREQUENCY control is not set for 000 MHz, the center frequency set via INTERFACE plug pin 14 will be offset by the FREQUENCY control setting. For example, if the FREQUENCY control is set for 100 MHz and 4 V is applied to INTERFACE plug pin 14, the sweep generator will be programmed for an output frequency of 500 MHz.**

2.8.4 EXTERNAL LEVEL PROGRAMMING

NOTE

**External level programming will not be indicated on the front-panel OUTPUT display.**

The RF output level may be remotely controlled by a DC voltage applied to INTERFACE connector pin 15 (sensitivity = 1 dB/V). The allowable input voltage range is dependent on the front-panel OUTPUT vernier setting, as follows:

**MODEL 1080**

| OUTPUT Vernier Setting | Approximate Input Voltage Range (V) | Output Level Change (dB) |
|---|---|---|
| full ccw (minimum) | 0 to +13 | 0 to +13 |
| mid-range | -6.5 to +6.5 | -6.5 to +6.5 |
| full cw (maximum) | 0 to -13 | 0 to -13 |

**MODEL 1081**

| OUTPUT Vernier Setting | Approximate Input Voltage Range (V) | Output Level Change (dB) |
|---|---|---|
| full ccw (minimum) | 0 to +10 | 0 to +10 |
| mid-range | -5 to +5 | -5 to +5 |
| full cw (maximum) | 0 to -10 | 0 to -10 |

By applying a linear voltage ramp to INTERFACE connector pin 15, a linear dB sweep RF output may be produced.

# SECTION 3
# THEORY OF OPERATION

## 3.1 INTRODUCTION

This section first presents an overall block diagram analysis followed by a more detailed description of each circuit.

Before beginning the actual circuit description, it would be well to consider the mechanical arrangement of the instrument (Figure 3-3). This will enable the following block diagram and circuit description to be associated with its physical position, thereby providing a better understanding of the overall instrument.

## 3.2 FUNCTIONAL BLOCK DIAGRAM

The block diagram in Figure 3-4 shows the overall operation of the instrument and the relationships of the individual circuits.

The Power Supply provides regulated voltage sources of ±18, ±10, and +5 volts to supply the other circuits.

The sweep rate generator produces synchronized square waves and clipped triangular waves that have a fixed amplitude and a variable rate positive-going ramp. This circuit is controlled by the front-panel SWEEP MODE, SWEEP RATE, and SWEEP VARIABLE controls. The square wave blanks the RF output during retrace. The triangular waves are used for the oscilloscope horizontal output, and are also applied to the front-panel SWEEP WIDTH controls which adjust the sweep ramp amplitude to the oscillator.

A combination of voltages from the front-panel SWEEP WIDTH and FREQUENCY controls and the auto-zero circuit is summed, amplified, and shaped by the sweep drive circuit. (Shaping is required for FREQUENCY display linearity.) The shaped voltage is then applied to varactor diodes in a VCO (voltage-controlled oscillator). The VCO output is mixed with the output from a fixed oscillator, and the difference frequency (0 to 1000 MHz) is fed to a wideband preamplifier and amplifier. The amplifier output is leveled in a control loop consisting of a monitor diode, leveler amplifier, and VVA (variable-voltage attenuator). The RF output level is controlled by the OUTPUT vernier (part of the control loop) and the 70 dB Step Attenuator.

There are two front-panel displays, one for frequency in MHz, the other for output in dBm (Model 1080) or dBmV (Model 1081). The FREQUENCY display and A/D converter comprise a digital voltmeter with suppressed decimal points. The 0 to 1000 MHz display readings are produced by 0 to 10 volt front-panel FREQUENCY control settings. The OUTPUT display reading is a combination of the front-panel OUTPUT vernier and Step Attenuator settings. The OUTPUT vernier programs the 1's and 0.1's digit of a digital voltmeter. A rotary switch on the Step Attenuator programs the 10's digit. By shaping the OUTPUT vernier voltage to the reference input of the leveler amplifier, and by programming via the Step Attenuator position, the OUTPUT display matches the RF output level of the instrument.

The auto-zero circuit acts to correct the drift of the zero beat of the RF output frequency. It has two operating modes, a search mode which requires a few milliseconds, and a hold mode (normal operation) which lasts approximately 5 minutes. In the search mode, the normal sweep drive inputs are turned off, and a digital ramp sweeping from +0.9 to -0.9 volts is applied to the sweep drive input. When the monitor diode in the RF output senses the zero beat of the VCO and the fixed oscillator, the digital ramp stops, holds its voltage, and the normal sweep inputs are turned back on. This voltage is "held" as a correction voltage until the next search.

Harmonic birdy markers at 100, 10, and 1 MHz are referenced to a 10 MHz crystal oscillator. Markers at 10 MHz intervals are produced by a step-recovery or snap diode. Markers at 1 MHz intervals are generated by a divide-by-10 circuit and a side-band marker technique. Markers at 100 MHz intervals are generated by controlling the amplitude of the appropriate 10 MHz markers. A standing wave on the sweep sample line produced by a delay line is used to generate gate pulses at 100 MHz intervals. These pulses are used to open a switch, which increases the amplitude of the 10 MHz markers at 100 MHz intervals.

During full sweep operation, an intensity ("pinball") marker is generated by delaying the ramp of the sweep rate generator.

**The following circuit descriptions are referenced to the schematics in Section 7.**

### 3.3 POWER SUPPLY

The Power Supply provides regulated outputs of ±18, ±10, and +5 volts DC, and unregulated outputs of 20 and 2 VAC.

Power transformer T1 is wound with a tapped dual primary and three center-tapped secondary windings. Nominal primary voltages are selected by two rear-panel switches, S2 and S3. The line input of 100, 115, 200, or 230 VAC is selected by parallel and series connections of the primary.

The ±18 supplies are dual regulators whose inputs are derived from the secondary of T1 via a grounded center tap and a bridge rectifier (CR101-CR104) connected in dual, full-wave configuration. Capacitor filtering (C101 and C103) is used at each regulator input. Each half of the dual regulator consists of an IC regulator (IC102 for +18 V; IC103 for -18 V). Each regulator is current and temperature limiting. Reverse-polarity protection is provided for each output (CR107 for +18 V; CR108 for -18 V).

The ±10 outputs provide the most stable regulation in the system. A +10 V monolithic voltage reference (IC105) is powered by the +18 V regulator. The +10 V output is obtained from operational amplifier follower IC106A, and -10 V output from operational amplifier inverter IC106B. The reference is adjustable at R111. The ±10 V regulators provide the reference for the ±18 V error amplifiers.

The +5 V supply consists of a separate secondary with grounded center tap, full-wave rectifier CR105 and CR106, filter capacitor C105, and series voltage regulator IC104. This IC regulator is current and temperature limiting.

The 2 VAC supply is derived from a separate grounded center-tap secondary. This output supplies the filament power for the two front-panel vacuum fluorescent displays.

The 20 VAC unregulated input to the bridge rectifier is also the line-sync input for the sweep rate generator and the timer input in the auto-zero circuit.

### 3.4 SWITCHING AND LOGIC CIRCUITS

Front-panel pushbutton switches sequentially select the operating modes of the instrument circuitry. Switching is implemented by TTL logic. Each selection is indicated by a lit LED on the front panel. The FUNCTION selector and its associated logic will be described. The logic circuits associated with the other front-panel pushbutton switches operate in a similar manner.

The FUNCTION switch logic consists of pushbutton switch S3, debouncing flip-flop IC7A/B, two D-type flip-flops with preset and clear (IC8A/B), and six NAND gates. LEDs CR7 through CR9 are lit individually when the appropriate output is low.

At turn-on, pins 4 and 13 of IC8 are at logic low by the action of initializing circuit Q1, which presets the D flip-flops. Q of IC8A will thus be high, and Q of IC8B will be low. This results in IC9 pin 11 being high, pin 6 low, and pin 8 high. With pin 6 low, CR9 will be lit, and the instrument will be in FS mode. This will always occur at turn-on.

When C3 is fully charged, the collector of Q1 will go high, causing IC8 pins 4 and 13 to go high. With the preset and clear lines of IC8A/B high, the logic states will sequence as shown in Table 3-1. Sequencing begins when S3 is depressed and a clock pulse is transmitted to pins 3 and 11 of IC8. The flip-flops are positive-edge triggered. When clocking occurs, the bit on the D (data) input will be transferred to the Q output of the flip-flop.

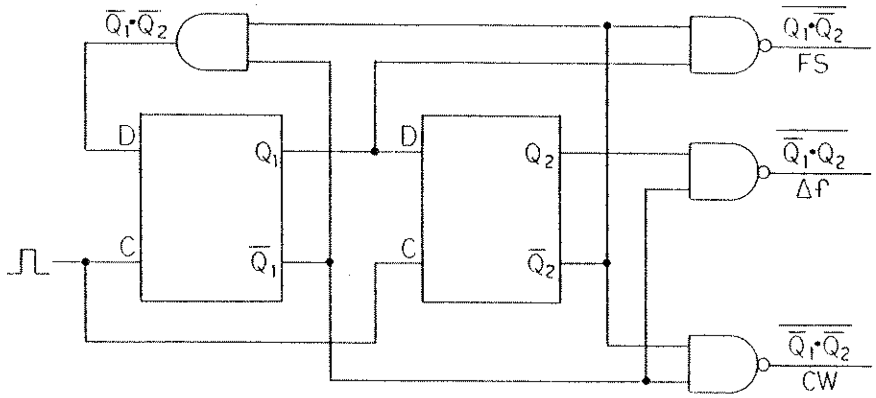
### 3.5 SWEEP RATE GENERATOR

The sweep rate generator is controlled by TTL signals from the Front-Panel Board. It is normally free-running (recur mode) but it can also be synchronized to the AC line (line rate mode), or manually triggered (single sweep mode). Except in line rate mode, it can be operated at any sweep time from 10 milliseconds to 100 seconds in two ranges (fast rate: 0.01 to 1 sec; slow rate: 1 to 100 sec). Speed within these ranges is controlled by the SWEEP VARIABLE control (R56) on the front panel. During CW operation, the sweep rate generator is disabled.

The sweep rate generator is basically a hysterisis ocsillator. It consists of a comparator (IC205A) which produces the blanking square-wave plus another square-wave which is fed back to an inverting integrator (IC204A). This integrator produces a 0 to 10 V ramp which is the input to the comparator and the scope horizontal output.

The reference (inverting input) of the comparator stays at zero volts. When the non-inverting input goes below ground, the output goes negative. When the non-inverting input rises above ground, the output goes positive. Hysterisis is provided by resistively adding a negative potential to the non-inverting input during the negative portion of the square-wave output. This is accomplished by switch Q203. This negative bias must be overcome by the positive-rising ramp acting through resistor R424. By the time the ramp reaches +10 V, the voltage at the non-inverting input of the hysterisis switch should become slightly positive, which will flip the output positive and shut off switch Q203. Since very little current is flowing

## Table 3-1. FUNCTION Switch Logic Diagram And Truth Table




| Logic State | Low = 0<br>High = 1 | Q1, Q2 | 1,0 | 0,1 | 0,0 | 1,0 |
|---|---|---|---|---|---|---|
| Output | FS | $\overline{Q1 \cdot \overline{Q2}}$ | 0 | 1 | 1 | 0 |
| | ΔF | $\overline{\overline{Q1} \cdot Q2}$ | 1 | 0 | 1 | 1 |
| | CW | $\overline{\overline{Q1} \cdot \overline{Q2}}$ | 1 | 1 | 0 | 1 |
| FF1 | D1 | $\overline{Q2} \cdot \overline{Q1}$ | 0 | 0 | 1 | 0 |
| | Q1 | ---- | 1 | 0 | 0 | 1 |
| | $\overline{Q1}$ | ---- | 0 | 1 | 1 | 0 |
| FF2 | D2 | Q1 | 1 | 0 | 0 | 1 |
| | Q2 | ---- | 0 | 1 | 0 | 0 |
| | $\overline{Q2}$ | ---- | 1 | 0 | 1 | 1 |

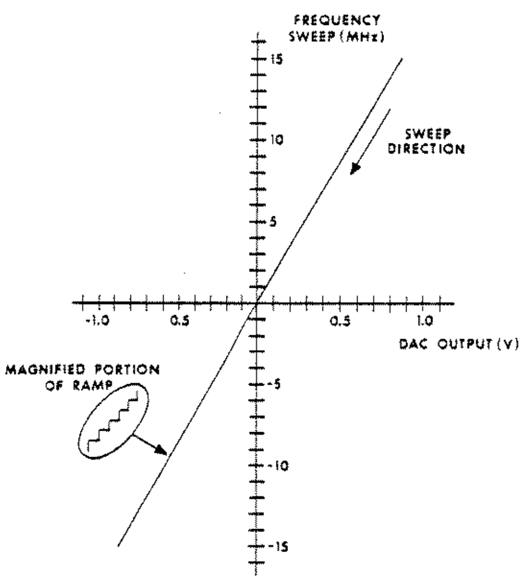



Figure 3-1. Auto Zero Digital Ramp

through R424, the voltage on the non-inverting input of the hysteresis switch will be approximately the same as the ramp voltage (+10 V); and since the input to the inverting integrator is positive, the ramp will start descending until it hits 0 V, at which time the hysteresis switch will go negative again, restarting the cycle.

The cycle can be interrupted on the rising portion of the ramp by a positive voltage applied to the gate of FET switch Q202. This interrupts the negative portion of the square wave feedback to the integrator, stopping the ramp. Four circuits can apply this interrupt voltage:

1. Front-panel selection of CW mode via the FUNCTION switch sends a TTL low signal to IC203 pin 4, producing +18 VDC at IC203 pin 2 which is applied to Q202 through CR239.

2. An open-collector TTL signal from the auto-zero circuit produces a +18 V pulse which is applied to Q202 through Q214 and CR238 to momentarily disable the sweep rate generator.

3. The start of each sweep is delayed approximately 4 msec by an interrupt pulse produced by an RC timing circuit acting on IC206B. The positive voltage is applied to Q202 through CR237.

4. The frequency program ramp is compared to the marker frequency voltage (in FS mode) by comparator IC204B which triggers a timing circuit acting on IC206B, producing an interrupt pulse. This results in an intensity marker on the display. The positive voltage is applied to Q202 through CR237.

When the sweep rate generator is operating in either of the triggered modes (line rate or single sweep), TTL lows from the front panel to the input of IC203C drive the output of that comparator to -18 V, which closes FET switch Q204 and removes the positive disarming voltage from the clamp circuitry. Switch Q204 allows a slight positive bias to be added to the positive input of the hysteresis switch (IC205A) during the descending portion of the ramp (the positive portion of the square wave), which forces the ramp to go more negative than ground before the hysteresis switch will flip and allow the circuit to run free. The ramp is prevented from reaching this more negative voltage by the action of the clamp circuitry. The ramp is monitored by Q208, and, when it reaches 0 V, Q208 is turned on and biases FET Q206, clamping the ramp off. At the same time, Q207 and Q208 are turned on, charging C205 to 18 V and arming the trigger. C205 can be suddenly discharged by either Q223 and Q212 on receipt of a trigger. This passes a negative spike through Q243, C206, and Q204 to the non-inverting input of the hysteresis switch, causing it to change states and start another sweep cycle.

The frequency of the sweep rate generator is determined by potentiometers and resistors in the square-wave feedback loop of the integrator. These resistors control the amount of current allowed to charge and discharge the integrator's capacitor.

In fast rate mode, the output of IC203B is driven negative by the action of a TTL low signal from the front-panel sweep rate circuitry. This negative voltage acts to close FET switch Q209, thus bypassing R396 and allowing the smaller resistance of R307 to control the feedback current. During retrace blanking, Q226 places R393 and R452 in parallel with R397. Since they are much larger than R397, there is very little difference in the charge and discharge times as long as front-panel SWEEP VARIABLE control R56 is fully right (maximum feedback current). When R56 is fully left, the retrace is speeded up by the current through R393 and R452.

In slow rate mode, FET switch Q209 is open, thus inserting R396 into the feedback circuit. When R56 is fully clockwise, the retrace time is less than the sweep time. When R56 is fully left, the sweep time increases to $>$ 100 sec, but the retrace time will increase only to about 2 sec.

In line rate mode, IC203A is driven positive by the action of a TTL signal from the front-panel sweep rate circuitry. This closes FET switch Q224, allowing R394 and R395 to be the main path for feedback current. The other resistors are still in the feedback loop, but their contribution to the total current is so small that the setting of R56 is negligible.

The positive output of IC203A also closes FET switch Q210, allowing the 20 VAC line-rate signal to trigger the circuit.

In CW mode, Q227 clamps the ramp at a slightly positive voltage, so the output is always enabled.

### 3.6 SWEEP DRIVE

Analog switch IC225 controls the inputs to summing amplifier IC227A. The shaper (or diode-break network) consists of diodes CR208 through CR216, potentiometers R331 through R339, biasing resistors R315 through R330, and current source Q216/IC226. This circuit shapes the linear ramp and other voltage inputs, and, after amplification by IC203A/B, provides the shaped varactor drive for the VCO to produce a linear frequency output.

During CW operation the CW line is low and the ΔF line is high. This opens the switch between pins 10 and 11 of IC225 and closes the switch between pins 14 and 15, disconnecting the SWEEP WIDTH controls which supply the ramp to the summing amp and grounding the negative side of C237.

During ΔF operation, the combined sweep and fixed inputs, including the auto zero (see Section 3.7) and FREQ OFFSET voltages, are applied to the summing amplifier input.

During FS operation, the input from the front-panel FREQUENCY control is disconnected when the switch between pins 2 and 3 of IC225 opens. The switch between pins 6 and 7 of IC225 closes so that the full sweep ramp is applied to the summing amp. The FREQUENCY control provides an intensity marker by delaying the ramp as described in Section 3.5.

## 3.7 AUTO ZERO

The purpose of this circuit is to correct for RF output frequency drift.

During normal operation (auto zero hold mode), a correction voltage is maintained at IC223 pin 4 while timer IC219 counts. When IC219 times out, the clock pulse produced transfers a logic 0 to the output of a latch (D-flip-flop IC217 pin 5) and to the input of a second latch (IC217 pin 12). The logic 0 is transferred to the output of the second latch (IC217 pin 9) by either the inverted blanking signal at the start of a sweep (ΔF or FS mode) or the clear input (IC217 pin 11) being held low (CW mode). When both latch outputs are low (logic 0), NAND gate IC222D sends a high to IC216B, which caused pin 4 of IC216 to go low. When this occurs, the auto zero circuit goes into its search mode, during which the following actions occur:

1) All analog switches in IC225 are open.

2) DAC counter IC224 is reset and oscillator IC222B is started.

3) Preset gate IC218A is enabled.

4) IC218 pins 10 and 12 (sweep stop) to high, disabling the sweep rate generator.

Since all analog switches in IC225 are open, the only input to the sweep drive circuit (IC227 pin 2) is the DAC output from IC223 pin 4. As DAC counter IC224 advances its count, the DAC output steps from ~+0.9 to ~-0.9 V. This digital ramp produces a frequency sweep of ~±15 MHz about the nominal zero beat of the sweep oscillator (see Figure 3-1).

When a zero beat of the VCO and fixed oscillator occurs, the monitor signal (from CR504) goes slightly positive and triggers comparator IC221. This causes pin 1 of IC221 to go low and pin 10 of NOR gate IC222C to go low. Since pin 9 of IC222C is also low, pin 14 of IC222C will go high. With pin 14 high, the latches in IC217 will be preset high (returning analog switch IC225 to its former state), oscillator IC222B turned off, the DAC counter stopped, and the digital ramp voltage held constant at IC223 pin 4, the DAC output. This terminates the search mode cycle. The constant voltage at the output of the DAC is applied through a voltage divider to the input of the summing amplifier. This correction voltage will be held until the next search cycle.

The search cycle requires approximately 5 milliseconds depending upon the correction voltage. The length of the hold cycle depends upon timer IC219 reaching a $2^{14}$ (16,384) count. At 60 Hz, the elapsed time is 4 minutes and 33.1 seconds.

By moving jumper J201 (see Figure 5-10) to its CAL position, the counting rate increases so that the hold mode lasts only a few seconds. The auto zero circuit may be disabled by moving jumpers J202 and J204 to their CAL positions.

## 3.8 SWEEP OSCILLATOR

The sweep oscillator is a heterodyne oscillator which tunes from 0 to 1000 MHz. It consists of a VCO (2650 to 3650 MHz), a fixed-frequency oscillator (2650 MHz) and a double-balanced mixer (MX501). The VCO includes Q506 and varactor diodes CR510 and CR511. The varactor diodes are hyperabrupt devices with relatively high Q and relatively low tuning voltage range.

The fixed oscillator is similar to the VCO with the exception of the tuning capacitor, which is fixed.

The oscillators are enclosed in separate compartments.

The oscillator outputs are mixed in MX501, and the difference frequency (0 to 1000 MHz) is applied to the wideband amplifier (see Section 3.9), producing the instrument RF output.

## 3.9 RF OUTPUT

The RF output circuits include the wideband amplifier, leveler circuits, Step Attenuator, and OUTPUT display.

The wideband amplifier consists of five stages, including a two-stage preamplifier. It includes RF integrated-circuit amplifiers IC501 through IC504, and output transistor

Q504. The final three stages are leveled by pin diodes CR502 and CR503 in a VVA. The cathode of monitor diode CR504 in the wideband amplifier output is a zero impedance point, thus R524 provides the nominal generator output impedance.

The second through fourth stages of the wideband amplifier are turned off by the blanking square wave applied to Q502. The leveler amplifier on the Main Board (IC231A) is turned off by the blanking square wave applied through CR217.

A sweep sample is taken from the second stage of the wideband amplifier and is amplified by IC506. This amplified sweep sample is then leveled by VVA CR507/CR508, monitor diode CR506, and leveler amplifier IC505. Leveler amplifier IC505 is turned off by the blanking square wave applied to Q505.

The OUTPUT vernier circuit consists of potentiometer R48, level shifting operational amplifiers IC14A/B and IC15A/B, and relay K1A/B. This circuit is located on the Front Panel Board. There are two outputs from this circuit, and two ranges. One output is measured by a DVM (1's and 0.1's digits). This DVM consists of A/D converter IC232, inverters IC213 and IC214, and front-panel display DS1. The other output is fed to shaper IC229. The vernier voltage also depends upon the Step Attenuator position. These voltage relationships are as follows:

| Step Attenuator Setting (dB) | Vernier Range (volts) | DVM Input (volts) | Shaper Input (volts) |
|---|---|---|---|
| 0 | +3 to -11 | +13 to -1 | -13 to +1 |
| 10 to 70 | 0 to -11 | 0 to -11 | -10 to +1 |

The shaper, consisting of IC229A, IC231B, and adjustable diode-break network CR219 through CR222, feeds the shaped output to the reference input of the leveler amplifier, IC231A pin 2, to control the gain of the wideband amplifier, and so the RF output level. The rotary switch mounted on the rear of the Step Attenuator selects a voltage to be added to the OUTPUT vernier voltage to drive the DVM. The reading on the OUTPUT display is thus a combination of the OUTPUT vernier and Step Attenuator settings.

### 3.10 MARKER CIRCUIT

A 10 MHz crystal oscillator (Q602/X601) provides the basic reference frequency for all internal 100, 10, and 1 MHz harmonic markers in a birdy-bypass system. At instrument turn-on, 100 and 10 MHz markers are turned on by the action of Front Panel Board initializing circuit Q1, which presets pins 4 and 13 of IC2.

When the front-panel MARKERS FREQUENCY pushbutton switch is depressed, a logic low is transmitted via TTL gates on the Front Panel Board to one or more internal marker circuits. A low at the base of Q601 on the Marker Generator Board enables the 10 MHz crystal oscillator and 100 MHz markers. A low at pin 9 of IC110 on the Power Supply/Marker Board enables the 10 MHz markers, and a low at the base of Q607 on the Marker Generator Board enables the 1 MHz markers.

#### 10 MHz MARKERS

Harmonics of the 10 MHz crystal oscillator are generated by step-recovery diode CR603 in emitter-follower amplifier Q603. The harmonics of 10 MHz are then mixed with the sweep sample in CR604. The sweep sample is filtered to limit frequencies below approximately 5.5 MHz. Wide birdies or beats are generated as the sweep sample mixes with the harmonics of 10 MHz, producing dual bands of frequencies less than and greater than the harmonic frequencies. The wide birdies are filtered to reduce bandwidth, and 10 MHz CW is trapped out. The filtered birdies are amplified by Q604 and added to a second sweep sample which is used to produce 1 MHz harmonic markers below 5 MHz. The amplified output is passed through a band-reject filter to limit 10 MHz CW.

The 10 MHz birdies and, if present, an external birdy marker from mixer CR601 are fed to a two-stage birdy amplifier, Q605/Q606. The amplified birdies are then fed to variable-bandpass amplifier Q101 on the Power Supply/Marker Board. Amplitude saturation of 10 MHz markers is determined by the setting of R116 at the input of this stage. Selectable filters are enabled by the MARKERS WIDTH pushbutton and associated TTL gates on the Front Panel Board. Open-collector hex buffers (IC107) are programmed via the TTL gates to switch in and short out filter components to provide wide (~ 400 kHz), medium, and narrow (~ 100 kHz) birdy markers.

In addition, one section of analog switch IC109 selects an additional capacitor for active filter IC108. The filtered birdies are then clamped to a ±5 volt level by complementary amplifier Q102/Q103. Low-level noise below ±0.5 volts is reduced by direct connection of the two emitters. The 10 MHz birdy markers are then summed with the 1 MHz markers, and amplified by common-base amplifier Q107. The resulting marker combinations are fed to MARKER SIZE control R6 on the Front Panel Board, and to the SCOPE VERT connector for external display.

#### 1 MHz MARKERS

1 MHz harmonic markers are produced by two related techniques. For markers from 1 to 5 MHz, 1 MHz square

pulses are generated by dividing the 10 Hz crystal oscillator frequency. IC603 is configured in the divide-by-ten mode, and a 10 MHz signal is used as a clock input to pin 8.

Square pulses at a 1 MHz rate are provided at pin 12, one for every tenth clock pulse. A logic "high" at pin 13 enables the output. The square pulses are differentiated to provide odd and even harmonics up to 5 MHz. These are mixed with the sweep sample fed through sideband amplifier Q609 and a 10 MHz CW-reject filter. The mixing that occurs in transformer T601 and diode CR605 provides birdy markers at 1 MHz intervals up to 5 MHz.

For frequencies above 5 MHz, the marker sidebands at each 10 MHz interval in the 10 to 1000 MHz range are mixed with the 1 MHz harmonics as the sidebands sweep from 5 to 0 to 5 MHz. This produces a sequence of 1 MHz birdies around each 10 MHz interval.

Once generated, the 1 MHz harmonic birdy markers are processed in a manner similar to that used for the 10 MHz harmonic markers.

100 MHz MARKERS

100 MHz harmonic markers are produced by selectively increasing the amplitude of selected 10 MHz harmonic markers. An amplified sweep sample is fed to the open end of a shorted line whose length is a half-wave length at 100 MHz. This amplified sweep sample is detected by CR602, with the detected signal being amplified and applied to pin 7 of voltage comparator IC110. The resulting signal pattern peaks at 100 MHz intervals throughout the 0 to 1000 MHz range (see Figure 3-2).

The gated pulses at the comparator output, whose width is set by the comparator reference R143, cause an analog switch section in IC109 to open only when 100 MHz markers are selected, thus increasing the marker amplitude. When the switch section is closed, R164 loads the 10 MHz harmonic signal, decreasing the marker amplitude.

When 10 MHz markers are not programmed via the front-panel, pin 14 of IC109 must be grounded. Gate pulses are routed through IC110 to ensure that the appropriate switch section of IC109 opens when 100 MHz markers are selected, and then closes to ground the 10 MHz markers.

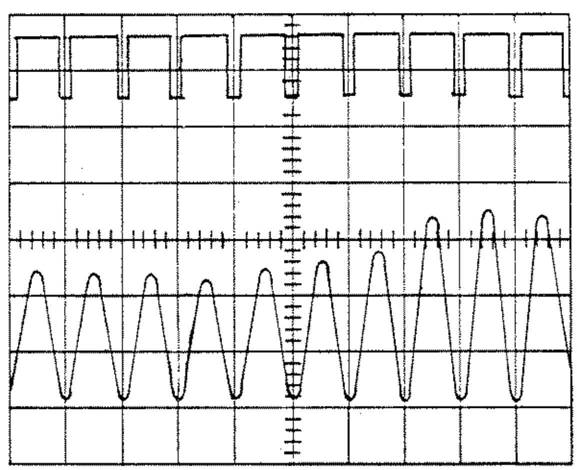


**Figure 3-2. 100 MHz Markers Sweep Sample and Gated Pulses**

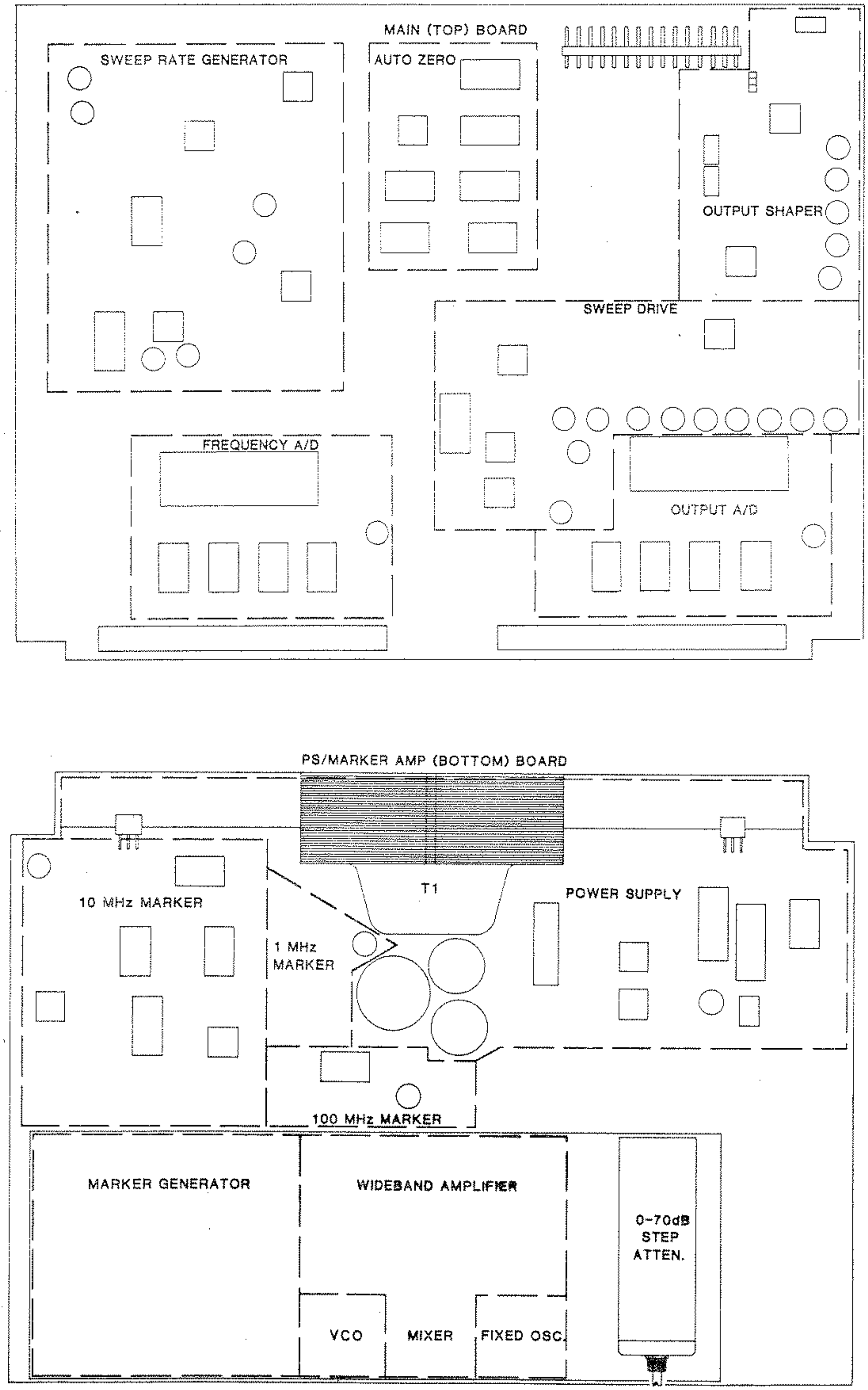



Figure 3-3. Circuit Arrangement

# SECTION 4
# PERFORMANCE TESTS

## 4.1 INTRODUCTION

The purpose of the performance tests in the following sections is to verify that the instrument meets its published specifications (Section 1.2). Critical specifications for each item of test equipment are listed in Table 4-1, Recommended Test Equipment. Except as detailed, settings of test equipment apply to performance test procedures. All other test equipment operating details are omitted.

The instrument should have its top cover removed for the performance tests. Before applying power to the instrument, see Section 2 for details of electrical installation. The line voltage should be maintained at 115 or 230 volts ±10%, 50 to 400 Hz throughout the tests. The performance test procedures are begun after a 30 minute minimum warmup of the instrument in a +20 to +30° C ambient temperature range.

If the instrument does not meet its published specifications, refer to Section 5, Maintenance, for troubleshooting and calibration information.

**TABLE 4-1. RECOMMENDED TEST EQUIPMENT**

| INSTRUMENT | CRITICAL REQUIREMENT | RECOMMENDED |
|---|---|---|
| Oscilloscope | DC coupled 1, mV/cm sensitivity | HP 1200A |
| Digital Voltmeter | .04% Accuracy | Dana Model 4200 |
| Power Meter | Frequency Range: 1 MHz to 1000 MHz | HP 435A/8482A |
| Modulation Meter | Frequency Range: 1 MHz to 1000 MHz | Wavetek 4101 |
| Spectrum Analyzer | Frequency Range: 1 MHz to 2000 MHz | HP 8555A/8552B/141T |
| Precision Attenuator Pads | 10, 20, and 40 dB | Weinchel 50-10, 50-20, 50-40 |
| CW Signal Generator | Adjustable from 1 MHz to 1000 MHz, 0.1 VRMS output, ±10 MHz Accuracy | Wavetek 3010 |
| RF Detector | Frequency Range: 1 MHz to 1000 MHz | Wavetek D152 |
| Frequency Counter | Frequency Range: to 500 MHz | HP 5300B/5303B |

## 4.2 FREQUENCY RANGE AND ACCURACY TEST

### 4.2.1 ΔF OPERATION

With the FREQUENCY control set fully ccw, the FREQUENCY display should read 0 or 1 MHz.

Connect the equipment as shown in Figure 4-1.

Set the instrument front-panel controls as follows:

| | |
|---|---|
| FUNCTION | ΔF |
| FREQUENCY control | full ccw |
| SWEEP WIDTH step | 0 MHz |
| SWEEP WIDTH vernier | mid-range |
| OUTPUT | +13 dBm (Model 1080) or +60 dBmV (Model 1081) |
| SWEEP MODE | RECUR |
| SWEEP RATE | FAST |
| SWEEP VARIABLE | full right |
| MARKERS FREQUENCY | 100/10 MHz |
| MARKERS WIDTH | WIDE |
| MARKERS SIZE | mid-range |

Set the oscilloscope for X-Y operation and adjust the oscilloscope's vertical and horizontal controls for a display pattern similar to Figure 4-2 centered on the graticule.

Adjust the FREQUENCY control and SWEEP WIDTH vernier to position the zero lock-in point at the extreme left graticule line and the 10 MHz marker at the extreme right graticule line.

Turn on the 1 MHz markers. Visually count the markers from 10 to 1 toward the zero lock-in point. The 1 MHz marker should be clearly definable on the display.

Note that the top line of the detected display is at approximately 0 volts. This is the result of blanking the RF output during retrace. (Viewing of markers may be enhanced by decreasing the SWEEP VARIABLE control setting.)

Set the MARKERS SIZE control fully left, the FREQUENCY control fully ccw, and adjust the FREQ OFFSET control to center the zero lock-in point on the display (see Figure 4-3).

Adjust the FREQUENCY control clockwise and center markers at 100 MHz intervals on the display from 100 to 1000 MHz. The FREQUENCY display should read the marker frequencies within 10 MHz at each interval.

Set the FREQUENCY display to read 700 MHz. Adjust the FREQ OFFSET control until the 700 MHz marker is centered on the scope display. Reset the FREQ OFFSET control to mid-range and center the 700 MHz marker on the display using the FREQUENCY control. Turn on the 1 MHz markers. Adjust the FREQ OFFSET from fully cw to fully ccw and observe that the displayed 700 MHz marker is shifted approximately ±10 MHz. This test may be performed at any other frequency in the 1 to 1000 MHz range.

The above tests for frequency range and accuracy are performed in ΔF operation at 10 MHz sweep width. Since the FREQUENCY control operates identically in CW mode, a CW test need not be performed unless desired.

### 4.2.2 FS OPERATION

Set the FUNCTION switch to FS. The zero lock-in point should be visible no more than 10 MHz in from the extreme left graticule line, and the 1000 MHz marker should be visible no more than 10 MHz in from the extreme right graticule line.

## 4.3 DISPLAY LINEARITY TEST

Display linearity is measured at maximum sweep width in ΔF mode, (In FS mode the sweep drive is the same except for centering, and when fine adjusted, the display linearity should be identical.) The horizontal linearity of the oscilloscope must be $< 0.5\%$.

Set up the equipment as shown in Figure 4-1, and set the instrument front-panel controls as follows:

| | |
|---|---|
| FUNCTION | ΔF |
| FREQUENCY | 500 MHz |
| SWEEP WIDTH step | 900 MHz |
| SWEEP WIDTH vernier | full cw |
| SWEEP RATE | LINE |
| SWEEP MODE | RECUR |
| MARKERS FREQUENCY | 100 MHz |
| MARKERS WIDTH | WIDE |
| MARKERS SIZE | mid-range |

Set the oscilloscope for X-Y operation, and adjust the horizontal and vertical sensitivity and position controls to produce a display pattern similar to Figure 4-4. Fine adjust the FREQ OFFSET control and the oscilloscope's horizontal sensitivity and position controls until all markers in the comb coincide with corresponding vertical graticule lines within 0.5 minor division. This allowable error is equivalent to 1% display linearity.

## 4.4 SWEEP WIDTH TEST

Use the equipment setup and control settings of Section 4.3. Adjust the FREQ OFFSET control to position the zero lock-in point on the extreme left graticule line. Locate the 900 MHz marker. Turn on the 10 MHz markers and count up from the 900 MHz marker. The 990 MHz marker must be visible on the display, while the 1010 MHz marker must not.

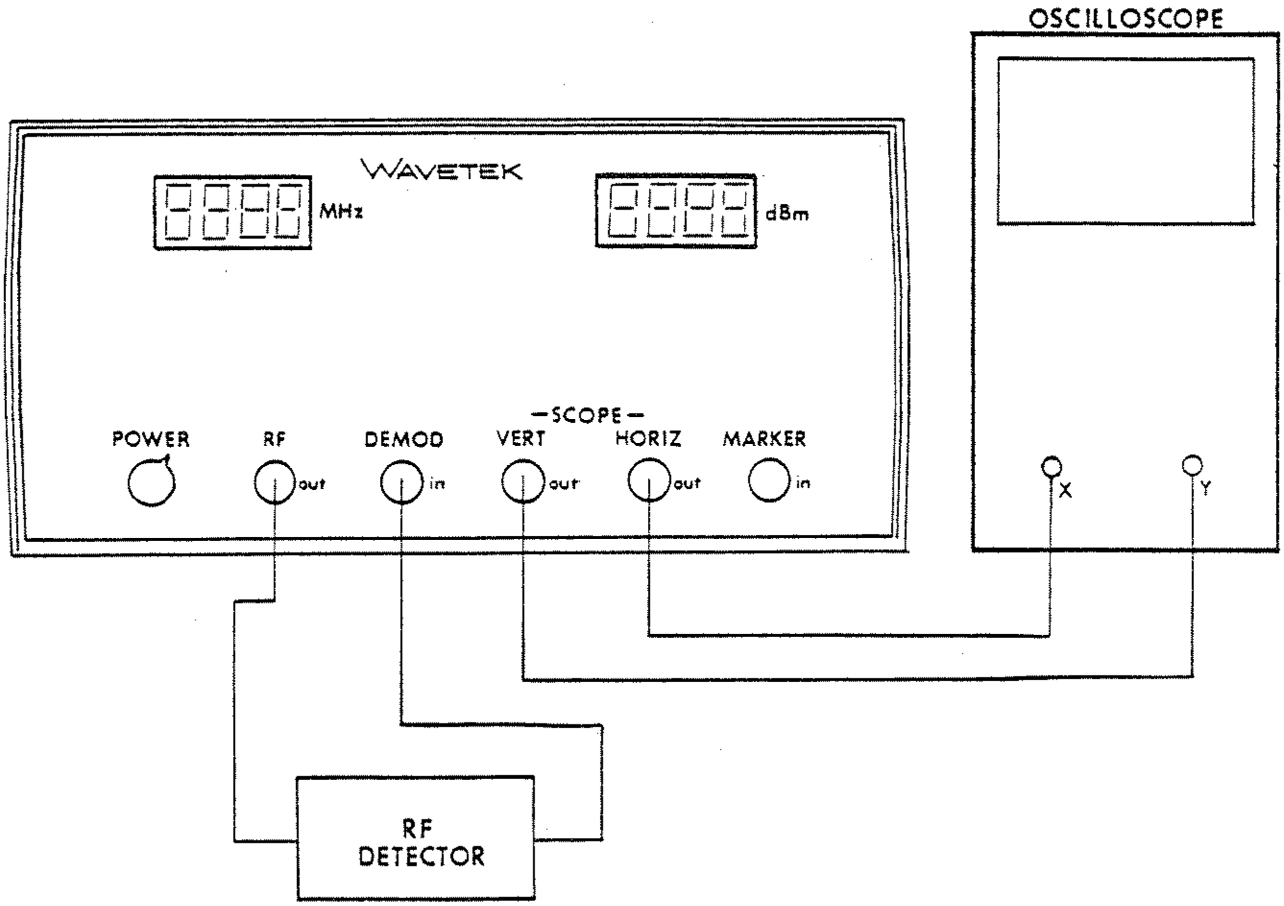



Figure 4-1. Test Set-up

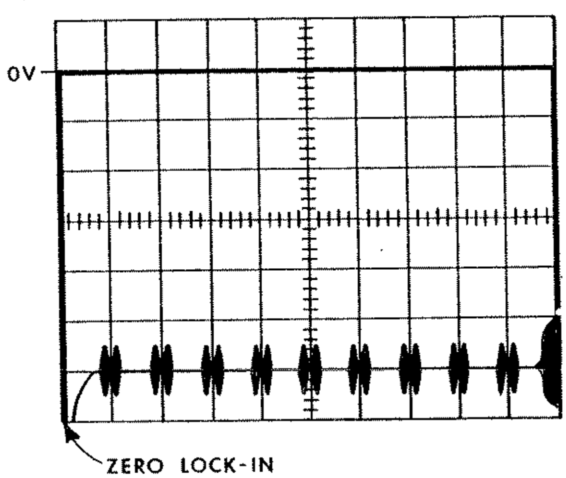



Figure 4-2. Frequency Range (Low End)

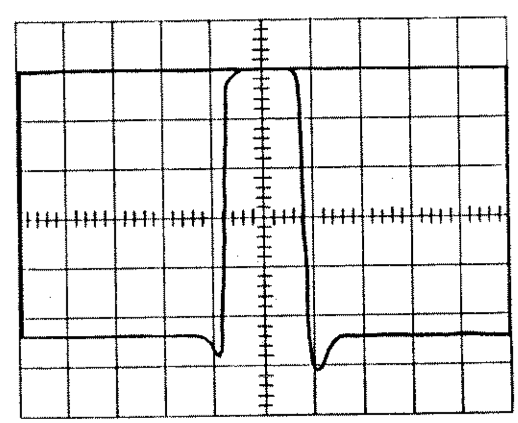


Figure 4-3. Zero Lock-in

Set the SWEEP WIDTH VERNIER fully cw. The 890 MHz marker must be visible, while the 910 MHz marker must not.

Repeat the above procedure for SWEEP WIDTH STEP control settings of 800, 700, 600, 500, 400, 300, 200, and 100 MHz. The sweep width accuracy of ±10 MHz is verified by noting the visible markers as listed below.

| SWEEP WIDTH STEP SETTING (MHz) | MARKER TO BE VISIBLE (MHz) | MARKER TO BE NOT VISIBLE (MHz) |
|---|---|---|
| 800 | 790 | 810 |
| 700 | 690 | 710 |
| 600 | 590 | 610 |
| 500 | 490 | 510 |
| 400 | 390 | 410 |
| 300 | 290 | 310 |
| 200 | 190 | 210 |
| 100 | 90 | 110 |

Turn on the 1 MHz markers and set the MARKERS WIDTH to medium. Adjust the FREQUENCY and SWEEP WIDTH controls for a sweep width of exactly 1 MHz at any frequency between 1 and 1000 MHz. Fine adjust the FREQ OFFSET to center a 1 MHz marker on the display. The marker width on the display should be approximately 200 kHz (see Figure 4-9).

Next adjust the SWEEP WIDTH vernier toward minimum. The 200 kHz wide marker should expand to fill the display. This procedure verifies minimum sweep width specifications.

## 4.5 FREQUENCY DRIFT TEST

Frequency drift may be measured at any desired frequency in the 1 to 1000 MHz range. Use the setup and control settings in Section 4.1.1, except calibrate the display's sweep width to exactly 1 MHz (use the instrument's 1 MHz harmonic markers) and center the test marker on the display with the SWEEP RATE set for LINE. Read the frequency drift directly from the scope display by noting the change in the marker's horizontal position with time. Each major division represents 100 kHz.

## 4.6 SIGNAL PURITY TEST

### 4.6.1 HARMONICS AND NON-HARMONICS

Set the FUNCTION for CW operation and turn off all markers. Connect the instrument RF output to the RF input of the spectrum analyzer.

Vary the instrument output frequency between 1 and 1000 MHz and observe the harmonics on the spectrum analyzer. When tuning from 1 to 2 MHz, the harmonics should be at least 15 dB below the fundamental. When tuning from 2 to 10 MHz, the harmonics should be at least 25 dB below the fundamental. When tuning from 10 to 1000 MHz, the harmonics should be at least 30 dB below the fundamental.

Vary the instrument output frequency between 1 and 1000 MHz and observe the non-harmonics on the spectrum analyzer. When tuning from 1 to 400 MHz, the non-harmonics should be at least 50 dB below the fundamental. When tuning from 1 to 1000 MHz, the non-harmonics should be at least 30 dB below the fundamental.

### 4.6.2 RESIDUAL FM

An automatic modulation meter is used to measure residual FM. Set the FUNCTION switch for CW, the OUTPUT controls for 0 dBm, and turn off all markers. Connect the instrument RF output to the 50 ohm input of the modulation meter. Set the modulation meter to measure residual FM in the + peak mode. Vary the instrument output frequency from 1 to 1000 MHz and note the maximum modulation meter reading.

Repeat the above procedure with the modulation meter in the – peak mode. The maximum peak residual FM in either + peak or – peak mode should be less than 10 kHz.

## 4.7 RF OUTPUT TESTS

### 4.7.1 FLATNESS TEST

Flatness is the variation in RF output level versus frequency. It is usually measured with a power meter, but it can also be measured with a broadband negative-polarity detector in a setup similar to Figure 4-1. Although the detector method takes less time to perform, the power-meter method is preferred since its flatness is better than most detectors. The power meter also registers total power rather than responding to only the negative half-cycle as with the detector.

Use the equipment set-up of Section 4.2.1. (Model 1081 requires a matching pad to match the 50 ohm input of the power meter.) Turn on the 1 MHz harmonic markers and center the 1 MHz marker on the scope display. Set the FUNCTION switch for CW and the OUTPUT controls for +13 dBm or +60 dBmV output.

Calibrate and zero the power meter and sensor and connect the sensor to the instrument RF output. Vary the output frequency from 1 to 1000 MHz and note the maximum and minimum power meter readings. The difference between the two readings divided by 2 is the flatness.

Repeat the above procedure with the OUTPUT controls set for 0.0 dBm or +50 dBmV.

NOTE

**If there is a noticeable difference between power meter readings at minimum and maximum frequencies, the rear-panel SLOPE control may require readjustment.**

Flatness may be measured at other output levels if desired.

### 4.7.2 OUTPUT VERNIER TEST

OUTPUT vernier accuracy is measured with a power meter. Model 1080 has two separate vernier ranges, 0 to +13 dB, and -10 to 0 dB. A nominal 1 dB overlap at the end of each range is not calibrated. The higher (0 to +13 dB) range operates only when the OUTPUT step control is set for 0 dB producing the 0 to +13 dBm output. The lower range operates at all other settings of the OUTPUT step control. Model 1081 has only a 0 to -10 dB range. To minimize the effect of the Step Attenuator, the OUTPUT vernier accuracy will be measured at the highest output range.

Set the FUNCTION switch for CW, the FREQUENCY control for 50 MHz, and the OUTPUT controls for +13 dBm or +60 dBmV on the display. Calibrate and zero the power meter and sensor and connect the power meter to the instrument RF OUT connector. (Use a matching pad on Model 1081.) The power meter should read +13 ±0.5 dBm on Model 1080, or the equivalent of +60 dBmV minus matching pad loss on Model 1081.

Adjust the OUTPUT vernier display readings in 1.0 dB steps (read on the OUTPUT display) and read the power meter at each step. The power meter should read within 0.5 dB of the OUTPUT display reading at each 1.0 dB step. For Model 1080, repeat the above procedure on the 0 to -10 dBm range. The ±0.5 dB accuracy applies at each dB step. (This step is not necessary on Model 1081.)

NOTE

**If the measurement error on the low range exceeds ±0.5 dB, it may be due to Step Attenuator error. The Step Attenuator test (Section 4.7.3) should be performed, and the combined OUTPUT vernier and Step Attenuator accuracies checked against the specifications in Section 1.2.2.**

### 4.7.3 STEP ATTENUATOR TEST

The accuracy of the Step Attenuator can be measured by using a suitable attenuation test set or by directly substituting precision RF attenuator pads for each 10 dB step of the Attenuator. The difference between the two outputs represents the Attenuator error. An RF detector can be used to recover the signal at levels down to approximately -40 dBm. Below this level, an RF amplifier or sensitive receiver (spectrum analyzer) must be used. This error is that produced by the Step Attenuator alone and does not include the basic flatness or OUTPUT vernier error.

To minimize the effect of the OUTPUT vernier, measurements should be referenced to the 0.0 dBm or +50 dBmV setting of the OUTPUT display (0 dB Step Attenuator setting). When the Step Attenuator is set for 10 dB or more of attenuation, fine adjust the OUTPUT vernier setting such that the least significant digit is a zero on the OUTPUT display.

## 4.8 SWEEP TESTS

### 4.8.1 SWEEP TIME (HORIZONTAL OUTPUT) IN ΔF OPERATION

FAST RATE — Connect the SCOPE HORIZ output to the oscilloscope's vertical input. Adjust the oscilloscope controls for an automatic, internally generated and triggered sweep of 1 msec/div, and a vertcal sensitivity of 2 V/div. Set the FUNCTION switch for ΔF, SWEEP MODE for RECUR, SWEEP RATE for FAST, and the SWEEP VARIABLE control fully right. Adjust the oscilloscope's position controls and trigger level for a waveform similar to Figure 4-5. The peak voltage of the waveform should be +10 ±0.2 V. The clipped (minimum) level should be 0 ±0.2 V.

The sweep time (rise time of the ramp) should be approximately 10 msec. The retrace time (fall time) should also be approximately 10 msec. Set the SWEEP VARIABLE control fully left. The sweep time should be approximately 1 second.

Set the SWEEP MODE for SINGLE, the SWEEP VARIABLE control fully right, and set the oscilloscope to trigger on an external signal. Press the TRIG pushbutton. The oscilloscope should display a single sweep trace similar to Figure 4-5, and then blank.

SLOW RATE — Set the SWEEP MODE for RECUR, the SWEEP RATE to SLOW, and SWEEP VARIABLE control fully right. Set the oscilloscope for internal triggering. The sweep time (rise time of ramp) should be approximately 1 second, but less than the slowest sweep time for fast rate. Set the SWEEP VARIABLE control fully left. Set the oscilloscope horizontal for approximately 1 msec/div so that the rising portion of the ramp appears as a rising horizontal line. The rise time of the ramp should be greater than 100 seconds.

Set the SWEEP MODE for SINGLE, and the SWEEP VARIABLE control fully right. Set the oscilloscope for external triggering. Press the TRIG pushbutton. The scope should display a single sweep trace, and then blank.

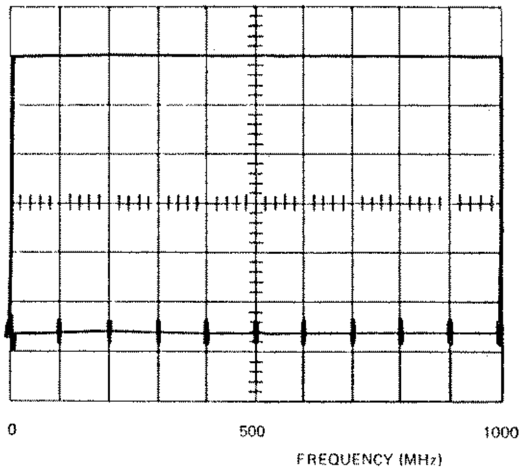



Figure 4-4. Linearity

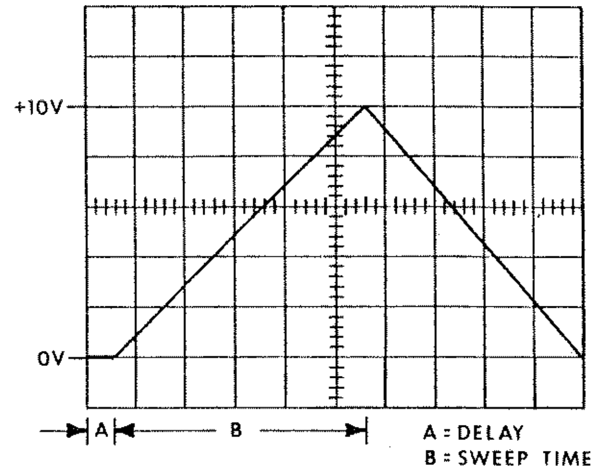



Figure 4-5. Sweep Time (Fast)

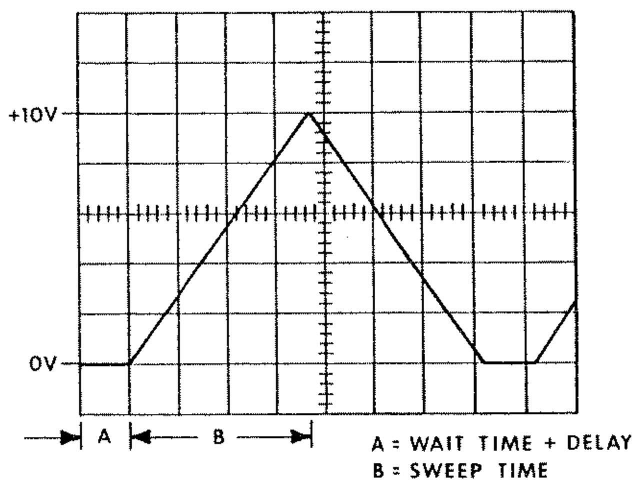



Figure 4-6. Sweep Time (Line)

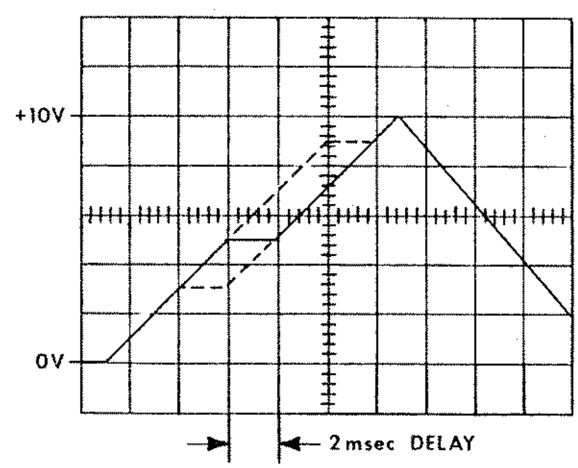



Figure 4-7. Sweep Time (FS)

LINE RATE – Set the SWEEP MODE for RECUR, the SWEEP RATE for LINE, and set the oscilloscope to trigger at line rate. The oscilloscope pattern should be similar to Figure 4-6. The sweep time should be approximately 5.3 msec at 60 Hz (7 msec at 50 Hz) line frequency.

NOTE

**Single sweep is not possible when the SWEEP RATE is set for LINE.**

4.8.2 HORIZONTAL OUTPUT IN FULL SWEEP OPERATION

Use the initial setup and control settings in Section 4.8.1 except set the FUNCTION switch to FS and the FREQUENCY control to 000 MHz. Increase the output frequency from 0 to 1000 MHz, and observe how the 2 msec delay for the FS intensity marker rises on the positive ramp from 0 to 10 volts (see Figure 4-7).

## 4.9 MARKER TESTS

### 4.9.1 MARKER ACCURACY TEST

All birdy markers are derived from a 10 MHz crystal oscilloscope whose accuracy is 0.005%. It is usually unnecessary to measure marker accuracy because of the high stability of this crystal oscillator.

Connect the equipment as shown in Figure 4-8 and set the instrument controls as follows:

| | |
|---|---|
| FUNCTION | ΔF |
| FREQUENCY | 500 MHz |
| SWEEP WIDTH step | 0 MHz |
| SWEEP WIDTH vernier | for 1 MHz |
| OUTPUT | +13 dBm or +60 dBmV |
| SWEEP MODE | RECUR |
| SWEEP RATE | LINE |
| SWEEP VARIABLE | N/A |
| MARKERS FREQUENCY | 100/10/1 MHz |
| MARKERS WIDTH | medium |
| MARKERS SIZE | mid-range |

Center the 500 MHz marker and adjust the frequency of the external CW generator until the external marker coincides with the 500 MHz marker. The frequency counter should read 500.000 ±.025 MHz.

### 4.9.2 MARKER AMPLITUDE AND WIDTH TEST

Connect the equipment as shown in Figure 4-1. Set the instrument controls as in Section 4.9.1, except set the FREQUENCY control for 900 MHz and the MARKERS SIZE fully right. Set the oscilloscope for X-Y operation and set the vertical sensitivity to 0.2 V/div. Adjust the FREQUENCY and SWEEP WIDTH controls and the oscilloscope position controls to align the 900 MHz marker with the extreme right graticule line and the 890 MHz marker with the extreme left graticule line (see Figure 4-9). The amplitude of the 900 MHz marker should be approximately 1.5 Vpp. Reduce the MARKERS SIZE control setting until the 900 MHz marker amplitude is 1.2 Vpp. The amplitude of the 890 MHz marker should be approximately 0.8 Vpp. The amplitude of the 891 through 899 MHz markers should be approximately 0.4 Vpp.

Set the MARKERS SIZE control fully left. The 900 MHz marker amplitude should be ⩽ 1 mVpp.

### 4.9.3 MARKER WIDTH TEST

Reduce the SWEEP WIDTH to 1 MHz and set the MARKER WIDTH to WIDE. Center the 891 MHz marker on the display. The marker width (measured at the half-amplitude points) should be approximately 400 kHz as shown in Figure 4-10. Reduce the MARKERS WIDTH in steps from WIDE to NARROW. The displayed marker width should decrease to approximately 200 kHz in medium and approximately 100 kHz in NARROW. Center the 890 MHz marker on the display and repeat the above procedure. Center the 900 MHz marker on the display and repeat the above procedure. The width of the 890 and 900 MHz markers should be approximately twice that of the 891 MHz marker.

### 4.9.3 EXTERNAL MARKER TEST

Use the equipment setup and control settings in Section 4.3 except turn off all instrument markers. Connect the CW output of a signal generator operating at 0.1 V level (-7 dBm) to the instrument MARKER IN connector.

Tune the signal generator from 1 to 1000 MHz and note the movement of the external birdy marker on the display. The marker should be clearly visible throughout the range. Harmonics of the external CW signal may also be visible on the display.

Turn on the 100/10/1 MHz markers and repeat the above procedure. The external marker's amplitude should be approximately equal to the 10 MHz harmonic marker's amplitude; but, within approximately 5 MHz of any 100 MHz harmonic marker, the external marker amplitude should be approximately equal to 100 MHz harmonic marker's amplitude.

## 4.10 EXTERNAL PROGRAMMING

Rear-panel outputs and external programming inputs are not normally checked at incoming inspection unless these special functions are to be used in a particular application. The program input signals, necessary external controls, and input pin connections are covered in Section 2.

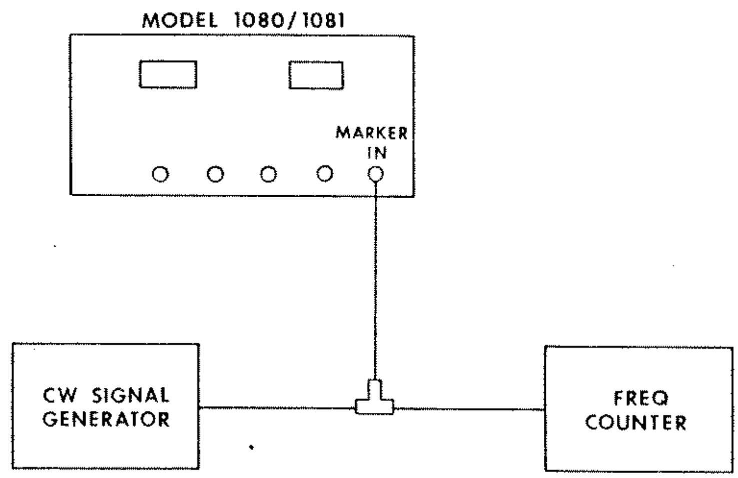



Figure 4-8. Marker Accuracy Set-up

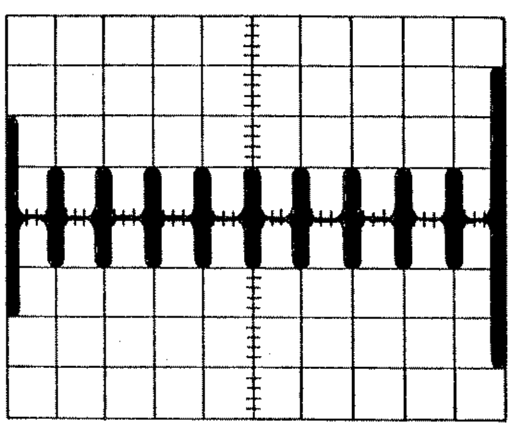


Figure 4-9. Marker Amplitude

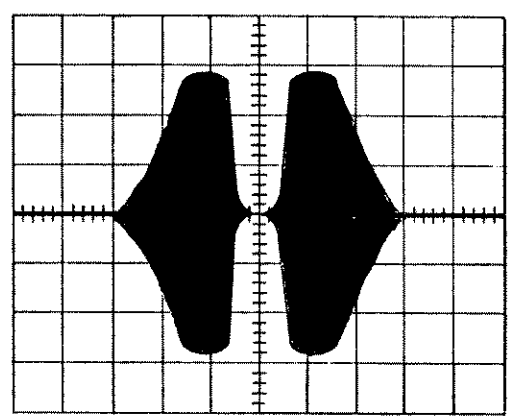


Figure 4-10. Marker Width

# SECTION 5
# MAINTENANCE

## 5.1 INTRODUCTION

This section provides information for servicing, calibrating, and troubleshooting the Wavetek Model 1080/1081 Sweep/ Signal Generators.

## 5.2 SERVICE INFORMATION

**NOTE**

**The DIP ribbon jumpers and coaxial RF cables (except W4) are long enough to allow separation of the instrument's internal assemblies for testing and servicing. If the RF assembly is removed, W4 should be replaced with a longer, flexible coaxial cable. The DIP ribbon jumpers and coaxial RF cables may be disconnected if required, but must be reconnected as shown in Figure 5-10.**

### TOP COVER REMOVAL

Disconnect the line cord from the AC mains. Turn the instrument upside down and remove the four screws in the bottom of the unit. Hold both top and bottom covers and turn the unit right side up. Lift off the top cover. Internal assemblies are shown in Figure 5-1. Calibration can be performed without further disassembly.

### BOTTOM COVER REMOVAL

Remove the two screws in the front corners of the Power Supply/Marker (bottom) Board which secure the board to the bottom cover. Holding both front and rear panels, lift the unit from the bottom cover and place the unit in an upright position.

### FRONT-PANEL AND MAIN BOARD ASSEMBLY REMOVAL

Remove the two screws from the rear edge of the Main (top) Board which secure it to the rear panel. Pry off the knob caps and unscrew and remove the knobs from the front-panel POWER switch and OUTPUT STEP control. Lift the Front-Panel and Main Board assemblies forward to clear the POWER switch and Step Attenuator shafts.

The Main Board can be disconnected from the Front-Panel assembly by removing the screw between the two 36-pin connector sections which form J101 and unplugging J101 from the Front-Panel assembly.

### RF ASSEMBLY REMOVAL

Remove the four screws securing the RF assembly as shown in Figure 5-10. The RF assembly covers can be removed for access to the RF circuits.

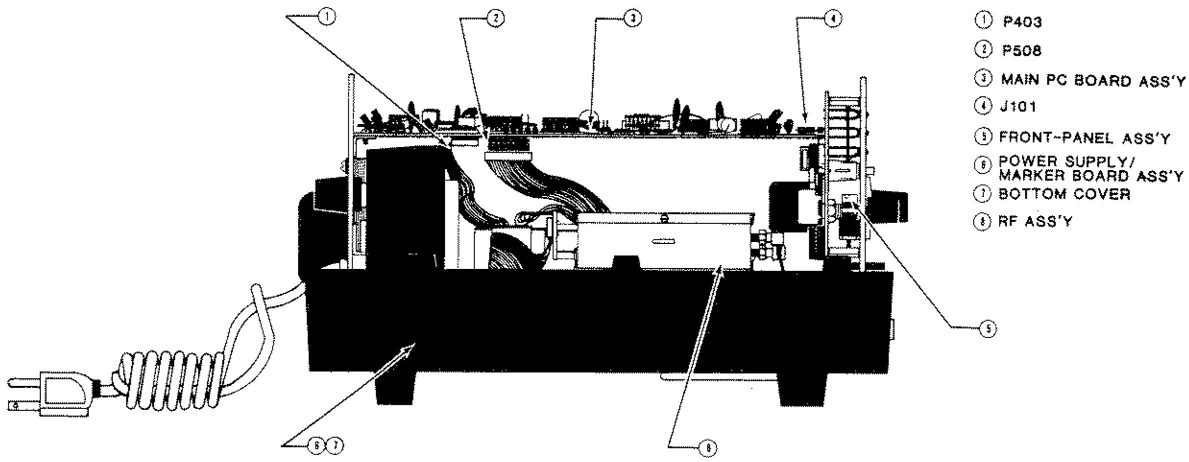



Figure 5-1. Side View

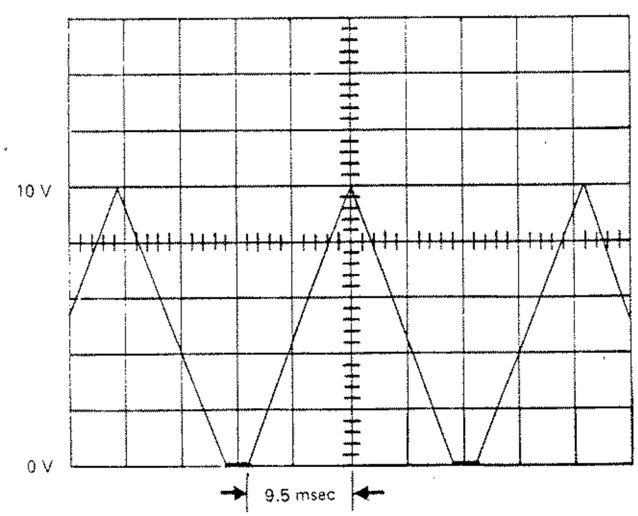



Figure 5-2. Sweep Rate

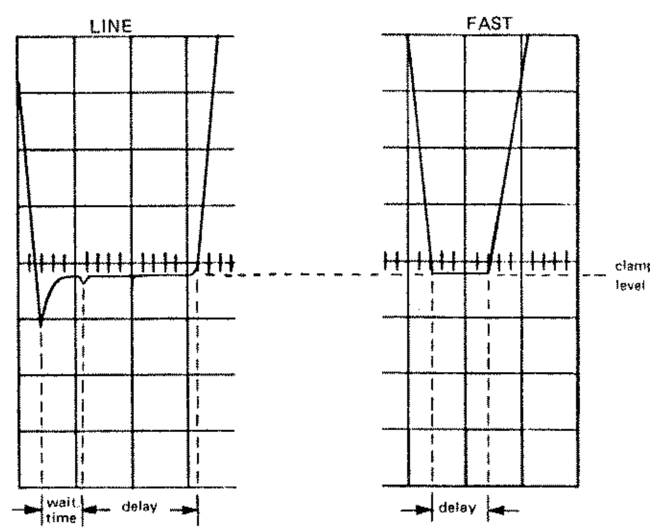



Figure 5-3. Wait Time/Delay/Clamp Level

## 5.3 CALIBRATION PROCEDURE

NOTE

**Refer to Figure 5-10 for control and test point location. Test points and controls are designated by the following symbols which identify the circuit to be calibrated.**

- **♦ → Power Supply**
- **♣ → Sweep Rate**
- **▲ → Frequency**
- **● → Output Level**
- **★ → Markers**

Remove the instrument top cover per Section 5.2. This permits access to test points and adjustments on the Main Board assembly. With power applied to the instrument, allow a 30-minute warmup. For recommended test equipment, refer to Table 4-1. Calibration should be performed in the sequence given.

### 5.3.1 POWER SUPPLY

CALIBRATE +10 V SUPPLY

Connect the DVM volts input to TP ♦A and the common to TP ♦a. Adjust the +10 V control ♦1 to produce a DVM reading of +10.00 V.

CHECK -10 V SUPPLY

Connect the DVM volts input to TP ♦B and the common to TP ♦b. The DVM should read -10 ±0.01 V.

CHECK +18 V SUPPLY

Connect the DVM volts input to TP ♦C and the common to TP ♦c. The DVM should read +18 ±0.15 V.

CHECK -18 V SUPPLY

Connect the DVM volts input to TP ♦D and the common to TP ♦d. The DVM should read -18 ±0.15 V.

CHECK +5 V SUPPLY

Connect the DVM volts input to TP ♦E and the common to TP ♦e. The DVM should read +5 ±0.25 V.

With nominal AC line input, the unregulated input to the ±18 volt regulator is typically ±25 V with 1 Vpp ripple. The unregulated input to the 5 V regulator is 8.5 V with 1 Vpp ripple. Regulator ripple is typically < 1 mV on the ±10 and ±18 V supplies, and < 3 mV on the 5 V supply (in CW mode).

### 5.3.2 SWEEP RATE (PART 1)

Set Auto Zero jumper jacks A and C to calibrate position, and jumper jack B to operate position (see Figure 5-10a).

RAMP SIZE

Connect the front-panel SCOPE HORIZ output to the oscilloscope horizontal input.

Set the instrument front-panel controls as follows:

| | |
|---|---|
| FUNCTION | Δf |
| FREQUENCY | 500 MHz |
| SWEEP WIDTH step | 100 MHz |
| SWEEP WIDTH vernier | full ccw |
| SWEEP VARIABLE | full right |
| SWEEP RATE | FAST |
| SWEEP MODE | RECUR |

Set the oscilloscope vertical sensitivity to 2 V/div (DC coupled), and position the trace (0 V input) on the bottom graticule line. Set the oscilloscope horizontal time base to 5 msec/div (internally triggered). Connect the SCOPE VERT output to TP ♣A, and the common to TP ♣B. The display should be similar to Figure 5-2.

Use the Size control ♣1 to adjust the 10 V peak level. Required accuracy is ±0.2 V at the 0 and 10 V levels.

FREQUENCY

Use the Frequency control ♣2 to set the rise time of the ramp to ~9.8 msec (see Figure 5-2).

LINE

Set the FUNCTION switch to FS and the SWEEP RATE to LINE. Set the oscilloscope vertical sensitivity to 0.2 V/div and the oscilloscope horizontal time base to 2 msec/div. Use the oscilloscope's vertical position control to align a 0 V trace on the center graticule on the display. Preset the Wait control ♣4 fully cw. Set the front-panel SWEEP RATE switch for LINE, and adjust the oscilloscope sync for negative triggering. The oscilloscope display should be similar to Figure 5-3. Adjust the Clamp control ♣3 to vertically position the clamp level to the identical level as when set for FAST rate. Check the level while alternating between LINE and FAST rates to ensure proper adjustment. Adjust the Wait control ♣4 until wait time = 1 msec.

NOTE

**Wait time will be ~3 msec in Δf mode.**

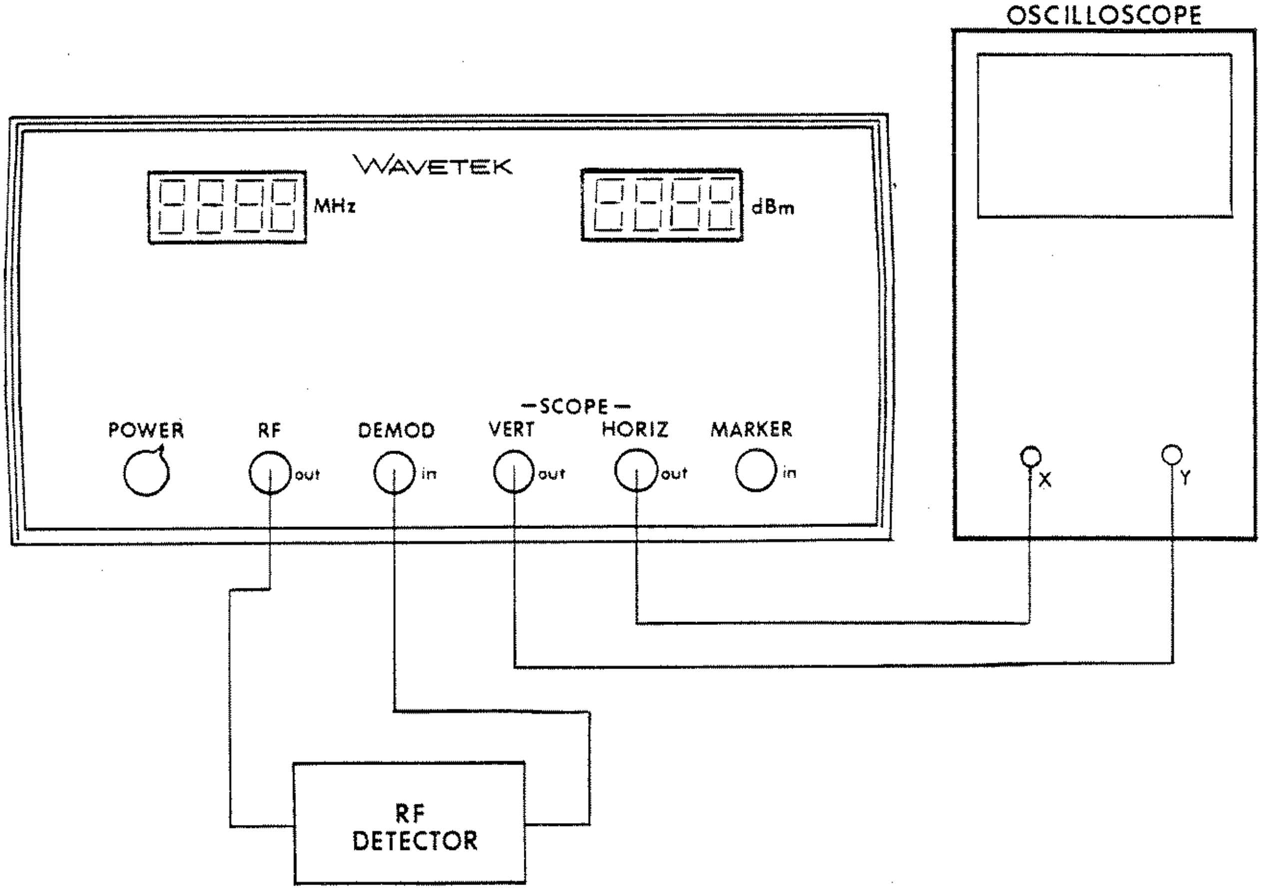



Figure 5-4. Test Set-up

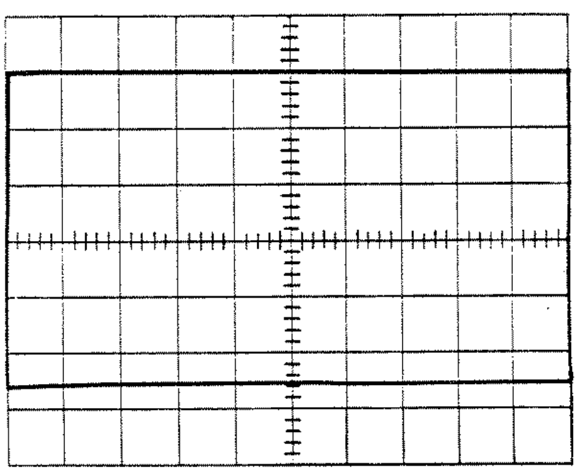


Figure 5-5. Typical Detected Output

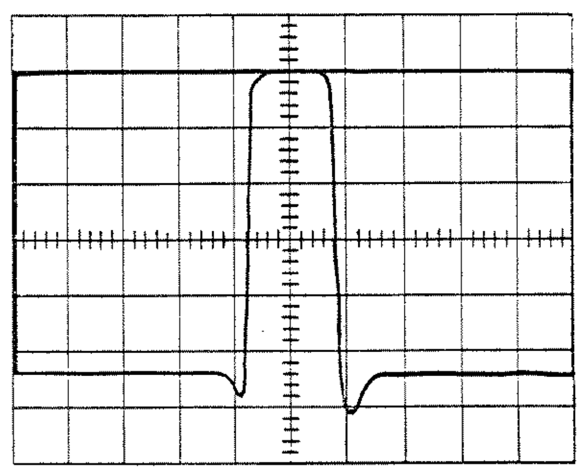


Figure 5-6. Zero Lock-in Point

### 5.3.3 FREQUENCY

FRONT-PANEL FREQUENCY DISPLAY

Set the front-panel FREQUENCY control fully ccw. The FREQUENCY display must read 000 or 001 MHz. Connect the DVM volts input to TP ▲A and the common to TP ▲B. Adjust the FREQUENCY control until the DVM reads +10.000 V. Adjust the Cal control ▲1 until the FREQUENCY display reads 1000 MHz.

REF ADJUST

Set the front-panel FREQ OFFSET control to mid-range and the FUNCTION switch for CW. Connect the DVM volts input to TP ▲C, and the common to TP ▲B. Set the FREQUENCY control to read 910 MHz on the FREQUENCY display. Adjust the Ref control ▲2 until the DVM reads -0.1 ±0.05 V.

OUTPUT FREQUENCY

Connect the equipment as shown in Figure 5-4. Set the instrument controls as follows:

| | |
|---|---|
| FUNCTION | Δf |
| SWEEP WIDTH step | 0 MHz |
| OUTPUT | +13 dBm |
| FREQ OFFSET | mid-range |
| SWEEP RATE | LINE |
| SWEEP MODE | RECUR |
| MARKERS FREQUENCY | 100/10 MHz |
| MARKERS SIZE | full left |

Set the oscilloscope for X-Y mode and adjust the vertical and horizontal controls to produce a scope pattern similar to Figure 5-5.

Set the MARKERS WIDTH and SIZE switches to produce an easily read display. Adjust the SWEEP WIDTH vernier to produce a display approximately 10 MHz wide. Turn on the 100 MHz harmonic markers.

Set the front-panel FREQUENCY control to read 000 MHz on the display. Adjust ▲3 until the zero lock-in point is centered on the scope display as shown in Figure 5-6. Move Auto Zero jumper jack B to the calibrate (speed up) position, and jumper jacks A and C to the operate position. If the zero lock-in point shifts slightly, move jumper jack A back to the calibrate position and readjust ▲3 until any shift caused by changing jumper jack A from the calibrate to operate position is negligible. Leave jumper jack A in the operate position.

Set the FREQUENCY control to read 100 MHz on the display. Adjust control ▲4 to center the 100 MHz marker on the oscilloscope display.

Adjust the FREQUENCY control in 100 MHz increments and adjust controls ▲5 through ▲13 in the same manner as control ▲4. The final adjustment (control ▲13) will center the 1000 MHz marker on the oscilloscope display.

### 5.3.4 SWEEP RATE (PART 2)

Connect the equipment as shown in Figure 5-4. Set the instrument controls as follows:

| | |
|---|---|
| FUNCTION | FS |
| FREQUENCY | any |
| SWEEP WIDTH | N/A |
| OUTPUT | +13 dBm |
| SWEEP RATE | LINE |
| SWEEP MODE | RECUR |
| MARKERS FREQUENCY | 100 MHz |

Adjust MARKERS SIZE and WIDTH to produce an easily readable display. Adjust the Bal control ♠5 until the zero lock-in point is just visible at extreme left edge of the display, and adjust the Size control ♠6 until the 1000 MHz marker is just visible at the extreme right edge of the display.

Set the FUNCTION switch for Δf and adjust the FREQUENCY control for 500 MHz. Set the SWEEP WIDTH controls for maximum sweep width and adjust the Bal control ♠7 to align the 100 MHz harmonic markers with the graticule lines on the display, as shown in Figure 5-7.

### 5.3.5 OUTPUT LEVEL

SLOPE

Set the rear-panel SLOPE control to mid-range and adjust the Slope control on the Main Board (R449) to produce a flat oscilloscope display trace.

OUTPUT DISPLAY (MODEL 1080)

Set the front-panel OUTPUT controls for maximum output Connect the DVM volts input to TP ●A and the common to TP ●B. The DVM should read -13 ±0.02 V. Adjust the Cal control ●1 such that the OUTPUT display reads +13.0 dBm. Set the OUTPUT step control fully ccw (70 dB of attenuation). Adjust the Cal control ●9 such that the OUTPUT display reads -60 dBm. Verify that each step of the OUTPUT step control changes the OUTPUT display reading by 10.0 dB except for the most cw step, which should change the display reading by 13.0 dB.

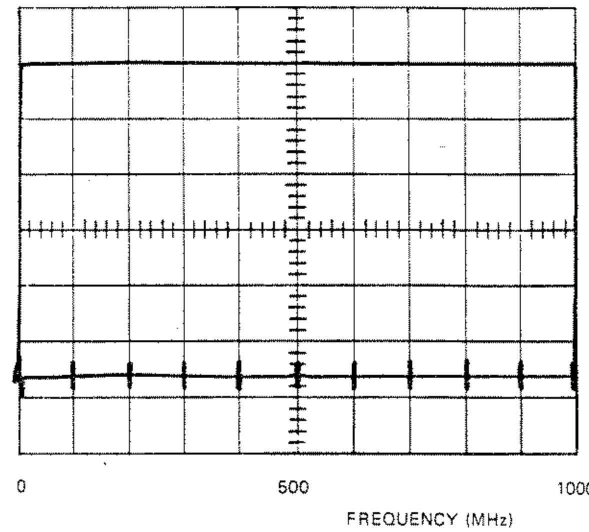



Figure 5-7. Sweep Linearity

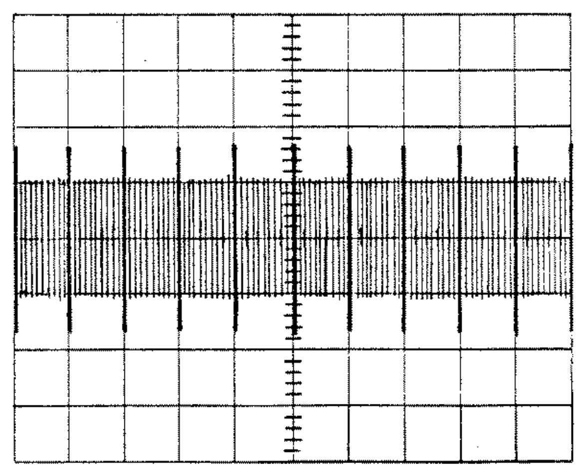


Figure 5-8. Marker Amplitude

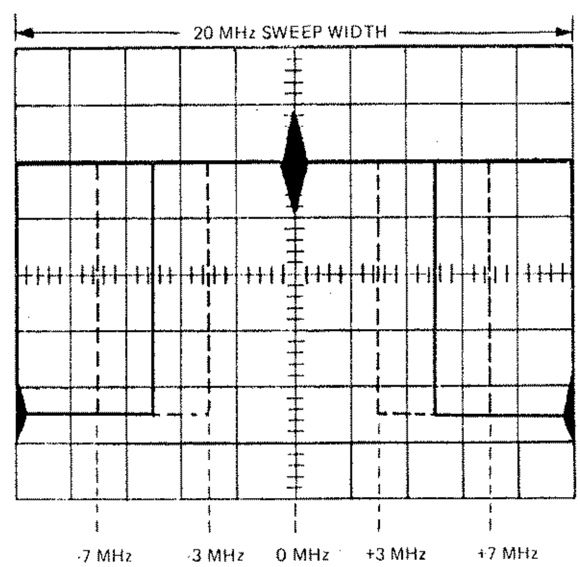



Figure 5-9. Gate Pulse

OUTPUT DISPLAY (MODEL 1081)

Set the OUTPUT vernier fully cw and the step control two steps cw from its fully ccw position (50 dB of attenuation). Connect the DVM volts input to TP •A and the common to TP •B. The DVM should read -10 ±0.02 V. Adjust the Cal control •1 such that the OUTPUT display reads +10.0 dBmV. Set the OUTPUT step control fully ccw and adjust Cal control •9 such that the OUTPUT display reads -10.0 dBmV. Set the OUTPUT step control fully cw and adjust the Cal control •10 such that the OUTPUT display reads +60.0 dBmV. Verify that each step of the OUTPUT step control changes the OUTPUT display reading by 10.0 dB.

REF ADJ

Set the FUNCTION switch for CW, the FREQUENCY control for 50 MHz, and the OUTPUT controls for +10.5 dBm (Model 1080) or +57.5 dBmV (Model 1081). Connect the DVM volts input to TP •C (Model 1080) or the cathode of CR221 (Model 1081), and the common to TP •B. Adjust the Ref control •2 such that the DVM reads 0.1 V.

OUTPUT LEVEL

Set the OUTPUT controls for maximum output. Connect a power meter to the front-panel RF output. (Ensure the power meter is properly warmed up, calibrated, and zeroed. Adjust power meter ranges as necessary.) Adjust the OUTPUT vernier until the OUTPUT display reads 00.0 dBm (Model 1080) or +50 dBmV (Model 1081). Adjust control •3 such that the power meter reading matches the OUTPUT display reading. Repeat the above procedure for the following output levels.

| MODEL 1080 OUTPUT LEVEL (dBm) | MODEL 1081 OUTPUT LEVEL (dBmV) | CONTROL |
|---|---|---|
| +1.0 | +51.0 | •4 |
| +4.0 | +54.0 | •5 |
| +7.0 | +57.0 | •6 |
| +10.0 | +60.0 | •7 |
| +13.0 | — — — | •8 |

5.3.6 MARKER CALIBRATION

Connect the equipment as shown in Figure 5-4, except disconnect the RF detector from the DEMOD IN connector. Set the oscilloscope for X-Y mode with vertical and horizontal sensitivities of 1 V/div.

Set the instrument controls as follows:

| | |
|---|---|
| FUNCTION | Δf |
| FREQUENCY | 500 MHz |
| SWEEP WIDTH step | 900 MHz |
| SWEEP WIDTH vernier | full cw |
| OUTPUT | any |
| SWEEP RATE | FAST |
| SWEEP VARIABLE | for slight flicker on scope |
| MARKERS FREQUENCY | 10 MHz |
| MARKERS WIDTH | WIDE |
| MARKERS SIZE | full right |

10 MHz ADJUSTMENT

Adjust the 10 MHz saturation control ★1 until all 10 MHz markers are of constant amplitude. This is accomplished by first adjusting the control clockwise until amplitude differences are visible, then ccw just enough to produce a constant amplitude across the entire band (see Figure 5-8). Adjusting the control further ccw will cause over-saturation, a condition which can produce a distorted, overly wide marker when viewed at a narrow sweep width, and also spurious markers at incorrect frequencies. When properly set, the 10 MHz marker amplitude should be ~100 mVpp at the wiper and ~200 mVpp at the top of control ★1.

1 MHz ADJUSTMENT

Turn on the 1 MHz harmonic MARKERS. Reduce the sweep width to ~100 MHz. Adjust the 1 MHz saturation control ★2 in the same manner as the 10 MHz adjustment above. Tune the front-panel FREQUENCY control throughout the entire 0 to 1000 MHz range to ensure the 1 MHz markers are saturated at all frequencies. When properly set, the 1 MHz marker amplitude should be ~ 200 mVpp at the wiper and ~ 400 mVpp at the top of control ★2.

100 MHz ADJUSTMENT

Connect the front-panel DEMOD IN input to TP ★C and the common to TP ★B.

Set the instrument controls as follows:

| | |
|---|---|
| FUNCTION | Δf |
| FREQUENCY | 1000 MHz |
| SWEEP WIDTH step | 0 MHz |
| SWEEP WIDTH vernier | 20 MHz |
| SWEEP RATE | LINE |
| MARKERS FREQUENCY | 10 MHz |
| MARKERS WIDTH | WIDE |
| MARKERS SIZE | full right |

Center the 1000 MHz marker on scope display with the FREQUENCY control. Adjust the 1000 MHz comparator ★3 to produce a gate pulse 10 MHz wide. The ideal gate pulse and maximum limits (dashed) are shown in Figure 5-9. Check each 100 MHz point (1000 to 0 MHz) to ensure each gate pulse meets specifications. Reset the 1000 MHz comparator if necessary. (Centering of the pulses to their 100 MHz points is accomplished by varying the length of the delay line, and should not require readjustment.)

VARIABLE MARKER AT 10 MHz

Connect the equipment as shown in Figure 5-4. Set the instrument controls as follows:

| | |
|---|---|
| FUNCTION | FS |
| FREQUENCY | 10 MHz |
| FREQUENCY OFFSET | mid-range |
| SWEEP WIDTH | N/A |
| OUTPUT | +13 dBm |
| SWEEP RATE | LINE |
| SWEEP MODE | RECUR |
| MARKERS FREQUENCY | 100/10 MHz |
| MARKERS WIDTH | WIDE |

Adjust the 10 MHz FS control ★4 on the Main Board until the variable marker (bright spot) or "pinball" coincides with the 10 MHz birdy marker.

VARIABLE MARKER AT 900 MHz

Use the previous setup except set the instrument controls as follows:

| | |
|---|---|
| FREQUENCY | 900 MHz |
| MARKERS FREQUENCY | 100 MHz |

Adjust the 900 MHz FS control ★5 until the variable marker coincides with the 900 MHz birdy marker.

Return all Auto Zero jacks to operate position. Calibration is complete.

## 5.4 TROUBLESHOOTING

Effective troubleshooting requires a thorough understanding of the block diagram and circuit descriptions located in Section 3 of this manual. The performance test and calibration procedures will then aid in localizing the trouble symptom to a particular assembly. Once this has been accomplished, the assembly can be replaced or repaired with the aid of the proper schematic and parts layout diagram. In general, it is preferable to replace a defective assembly.

Equipment troubles are frequently due simply to improper control settings; therefore, before engaging in a troubleshooting procedure, be sure front- and rear-panel controls are set in proper operating position. Refer to Section 2 of this manual for complete explanation of each control's function along with typical operating instructions.

After verifying that the trouble is not improper setting of the controls or test set-up, make a thorough visual inspection of the instrument for such obvious defects as loose or missing screws, broken wires, loose RF cables, and burned or broken components.

After localizing the problem, voltage and resistance checks will help find any defective components. If substitute assemblies are available, this provides an easy method of verifying if a suspected assembly is defective.

A problem in a power supply may cause many symptoms pointing to other areas, and should be checked when the symptom does not indicate a specific problem. Performance of the power supplies is indicated in the calibration procedure.

**NOTE**

**For troubleshooting purposes, it is permissible to operate the instrument in a semi-disassembled state. Refer to Section 5.2 for service and disassembly information.**

### 5.4.1 TROUBLESHOOTING HINTS

Following is a list of several typical symptoms, accompanied by the possible cause(s) or a troubleshooting procedure. It is assumed the instrument has been properly calibrated previously, and that a warmup period will precede troubleshooting.

INTERMITTENT OPERATION

Check for loose RF cables or DIP ribbon jumpers. If none, check for broken feed-thru capacitors on the RF assembly.

FREQUENCY UNSTABLE (JITTER)

Check for loose screws causing bad ground, especially on the RF assembly. Check for excessive ripple on power supplies.

Operating the instrument in a strong magnetic field, such as sitting on top of, or adjacent to, another instrument containing a large power transformer can produce line-rate hum modulation.

NO RF OUTPUT

Defective Step Attenuator or cable between the RF Assembly and the Step Attenuator, or between the Step Attenuator and the front panel. Check also for a broken feed-thru capacitor on the RF Assembly.

RF OUTPUT NOT FLAT

The most common cause is the external RF detector being defective. Another cause is a defective monitor diode (CR504 on the Sweep Oscillator Board). This is a point contact diode and can be damaged if the RF output is momentarily connected to a B+ voltage. A good monitor diode will produce a negative detected voltage (at Sweep Oscillator feed-thru capacitor A) approximately twice the amplitude of the external detector. For example, at an RF output of +10 dBm, an external RF detector will read approximately 0.8 V. The internal monitor will read approximately -1.6 V.

INCORRECT HORIZONTAL OUTPUT OR SWEEP RATE

The probable cause is a defective component in the sweep rate generator section of the Main Board or defective wiring to the front-panel SWEEP controls.

NO RF SWEEP

Check both Δf and FS modes. If only one mode is inoperative, the problem is probably in the wiring to the front-panel MODE switch or a switching circuit on the Main Board. If both modes are inoperative, check the sweep drive signal at J504 of the RF Assembly. If this signal is correct (~+3 to +13 V in FS mode), the problem in on the Sweep Oscillator Board in the RF Assembly. If the voltage is not correct at J504, check it at J404 of the Main Board. If it is correct at J404, but not at J504, cable W4 is defective or loose. If the sweep drive signal is not correct at J404, the problem is probably a defective component in the sweep drive circuitry on the Main Board.

MARKER PROBLEMS

To isolate the cause of a marker problem when the symptom does not clearly indicate a specific circuit or component, first, turn on the 100/10/1 MHz harmonic markers. The birdy outputs at Marker Generator feed-thru capacitors B and C should be at least .5 Vpp. If they are, the Marker Generator Board is operating properly, and the trouble is either on the Power Supply/Marker Amp Board or in connecting wiring.

If the birdy outputs are not present, check for the proper power supply voltages at Marker Generator feed-thru capacitors D, E, and F.

If the supply voltages are correct, check the output signal at Marker Generator feed-thru capacitor A. If the instrument is sweeping, a scalloped pattern (~15 Vp, one scallop per 100 MHz) should be present. If it is, the sweep sample circuitry is working properly. If the scalloped pattern is not present, check for the sweep sample at IC505 pin 3 on the Sweep Oscillator Board (~40 mV detected signal). If the detected sweep sample is correct, but the scalloped pattern is not present, the problem is a defective component in the vicinity of IC602 on the Marker Generator Board. (Be sure shorted line W601 is tightly secured to J601.)

If the scalloped pattern is present at Marker Generator feed-thru capacitor A, but the 10 and 1 MHz harmonic marker birdy outputs at feed-thru capacitors B and C are not present, check the markers disable signal at feed-thru capacitor G. If this signal is less than 0.5 V, check IC603 pin 8 for a 10 MHz signal to verify that the oscillator is working. If the 10 MHz oscillator is working, but the birdy output is not present at feed-thru capacitor C, the problem is a defective component between Q603 and feed-thru capacitor C.

If the 10 MHz harmonic markers work but the 1 MHz harmonic markers do not work, check the 1 MHz marker disable signal at Marker Generator feed-thru capacitor H. If this signal is less than 0.5 V, the problem is a defective component between Q608 and feed-thru capacitor B.

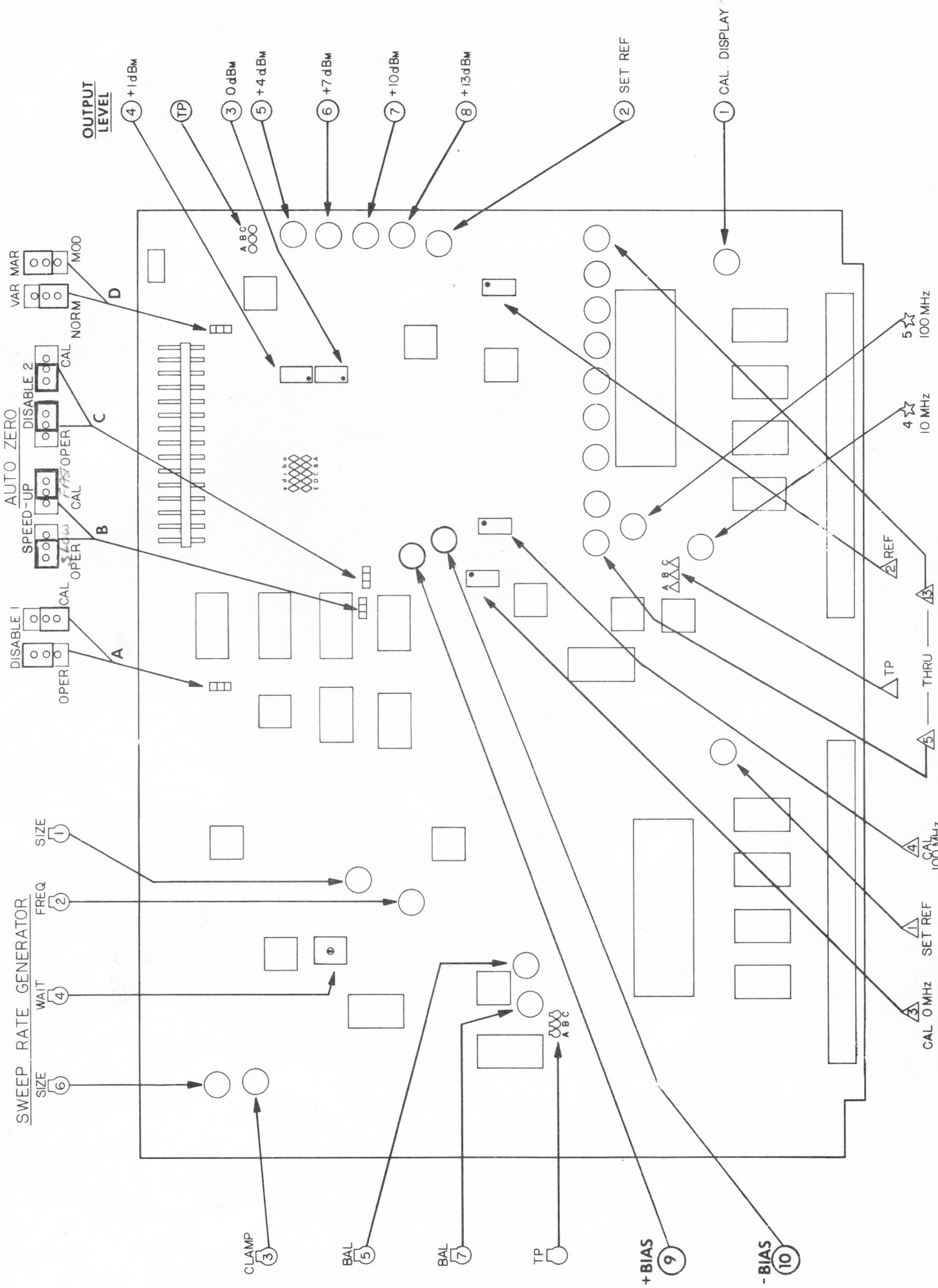



Figure 5-10a. Test Points And Controls (Main Bd.)

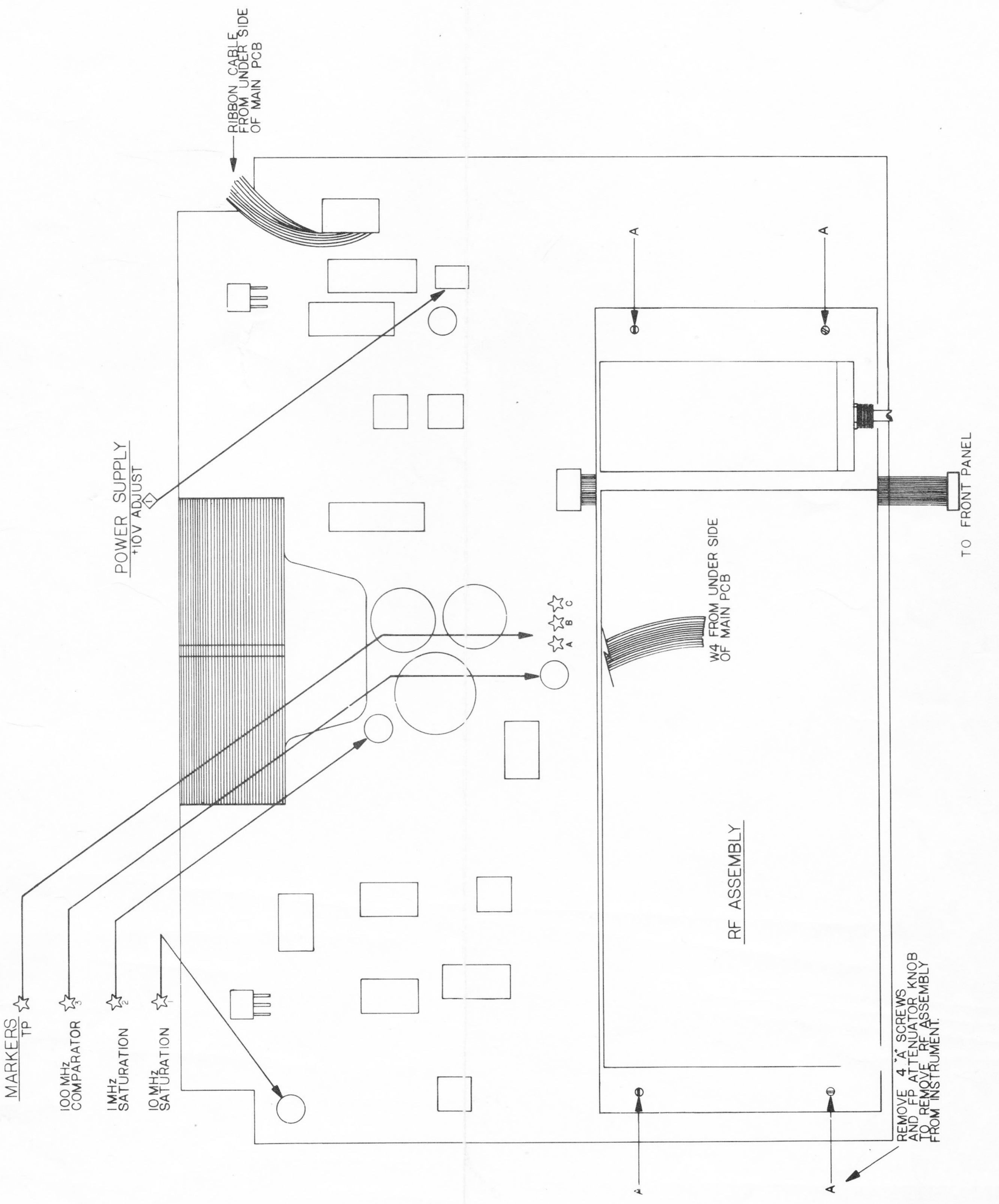



Figure 5-10b. Test Points And Controls (PS Mkr. Gen. Bd.)

# SECTION 6
# REPLACEABLE PARTS

## 6.1 INTRODUCTION

This section contains lists of all replaceable parts for the instrument.

For an assembly containing one or more subassemblies, the assembly list appears first, and is followed by the subassembly lists.

The lists appear in the following order.

| PARTS LIST | ASSEMBLY |
|---|---|
| 1010-00-0160 | 1080 |
| 1010-00-0205 | 1081 |
| 1118-00-0051 | REAR-PANEL ASSY |
| 1219-00-0194 | POWER XFMR ASSY |
| 1111-00-0097 | CABINET ASSY |
| 1118-00-0050 | FRONT-PANEL ASSY |
| 1110-00-1301 | FRONT-PANEL BD |
| 1110-00-1310 | MAIN BD |
| 1115-00-0023 | POWER SUPPLY/MARKER BD |
| 1118-00-0052 | RF ASSY – 1080 |
| 1118-00-0053 | MA175 |
| 1118-00-0094 | RF ASSY – 1081 |
| 1118-00-0095 | MA175-1 |
| 1218-00-1210 | ADAPTER BD |
| 1219-00-0193 | HARNESS – 1080-ATT |
| 1219-00-0263 | HARNESS – 1081-ATT |
| 1218-00-1200 | SWEEP OSCILLATOR BD |
| 1218-00-1190 | MARKER GENERATOR BD |
| 1113-30-0048 | 5070-11 ATTENUATOR |
| 1113-20-0049 | 7570-04 ATTENUATOR |

## 6.2 MANUFACTURERS CODE

The following code is used on the parts lists to identify the manufacturer.

| ABBRV | NAME........................ | CITY................. | ST |
|---|---|---|---|
| A-B | ALLEN-BRADLEY | MILWAUKEE | WI |
| A-D | ANALOG DEVICES | CAMBRIDGE | MA |
| A-H | ARROW HART, INC. | KETTERING | OH |
| A-I | ALAN INDUSTRIES | COLUMBUS | IN |
| A-M | AMERICAN MAGNETICS | CARTERVILLE | IL |
| A-P | AMERICAN PLASTICRAFT CO. | CHICAGO | IL |
| ABAC | ABACUS PACKAGING CO. | CHICAGO | IL |
| ACEIN | ACE INDUSTRIAL HDWR. | CAMDEN | NJ |
| ACI | ADVANCE COMPONENTS, INC. | CENTERBROOK | CT |
| AEG-T | AEG-TELEFUREN CORP. | SOMERVILLE | NJ |
| AER | AVX CERAMICS | MYRTLE BEACH | SC |
| AERTK | AERTECH INDUSTRIES | SUNNYVALE | CA |
| AHAM | AHAM COMPANY | AZUSA | CA |
| AIN | ALPHA INDUSTRIES, INC. | WOBURN | MA |
| ALC | ALCO ELECTRONICS PRODUCTS | NORTH ANDOVER | ME |
| ALLPL | ALL PLASTICS, INC. | INDIANAPOLIS | IN |
| AMD | ADVANCED MICRO DEVICES INC. | SUNNYVALE | CA |
| AMELC | AMERICAN ELECTRIC CORDSETS | BENSENVILLE | IL |
| AMP | AMP, INC. | HARRISBURG | PA |
| ANZAC | ADAMS-RUSSELL, ANZAC DIV | BURLINGTON | MA |
| APL | AMPHENOL CONNECTOR SYSTEMS | BROADVIEW | IL |
| APP | A-P PRODUCTS | PAINESVILLE | OH |
| APX | AMPEREX ELECTRONIC CORP. | SLATERSVILLE | RI |
| ARC | ARCO ELECTRIC PRODUCTS | SHELBYVILLE | IN |
| ARN | ARNOLD ENGINEERING CO. | MARENGO | IL |
| ARW-M | ARROW-M CORP. | CARSON | CA |
| ASC | ASSOCIATED SPRING | BRISTOL | CT |
| ASE | AIRCO SPEER ELECTRONICS | ST. MARYS | PA |
| ASTID | ASTRO INDUSTRIES | DAYTON | OH |
| AT/IN | ATLANTIC INDIA RUBBER COMPANY | CHICAGO | IL |
| ATC | AMERICAN TECHNICAL CERAMICS | HUNTINGTON STATION | NY |
| ATR | ATR COIL CO. | BLOOMINGTON | IN |
| AUGAT | AUGAT, INC. | ATTLEBORO | MA |
| AULT | AULT INC. | MINNEAPOLIS | MN |
| AUTCP | AUTOMATION CORP. | PECKVILLE | PA |
| AVDEL | AVDEL FASTENER SYS. | PARSIPPANY | NJ |
| AVT | AVANTEK, INC. | SANTA CLARA | CA |
| AWC | ALPHA WIRE | ELIZABETH | NJ |
| B-T | BEK-TEK, INC. | READING | PA |
| BEARI | BEARINGS, INC. | CLEVELAND | OH |
| BEK | BECKMAN INSTRUMENTS, INC. | FULLERTON | CA |
| BEL | BELDEN CORP. | GENEVA | IL |
| BER | BERG ELECTRONICS | NEW CUMBERLAND | PA |
| BGH | BEECH GROVE HARDWARE | BEECH GROVE | IN |
| BORDN | BORDEN INC. | COLUMBUS | OH |
| BOU | BOURNS, INC. | RIVERSIDE | CA |
| BREZ | BREEZE CORPORATIONS, INC. | UNION | NJ |
| BSCAN | B-SCAN, INC. | PHILADELPHIA | PA |
| BUCK | BUCKEYE STAMPING CO. | COLUMBUS | OH |
| BUD | BUD RADIO, INC. | WILLOUGHBY | OH |
| BURND | BURNDY CORP. | NORWALK | CT |
| BUS | BUSSMAN MFG. | ST. LOUIS | MO |
| BWC | BARON WIRE AND CABLE CORP. | NILES | IL |
| C-D | CORNELL DUBILIER ELECT. DIV. | NEWARK | NJ |
| C-E | CLINTON ELECTRONICS | ROCKFORD | IL |
| C-H | CUTLER-HAMMER, INC. | MILWAUKEE | WI |
| C-I | COMPONENTS, INC. | BIDDEFORD | ME |
| C-J | TRW/CINCH | ELK GROVE VILLAGE | IL |
| C-K | C & K COMPONENTS, INC. | WATERTOWN | MA |
| C-L | CENTRALAB DIV. | MILWAUKEE | WI |
| C-M | C-M | | |
| C W | C-W INDUSTRIES | WARMINSTER | PA |
| CAI | CUSTOM ACCESSORIES, INC. | SKOKIE | IL |
| CAM | CAMBION | CAMBRIDGE | MA |
| CAR | CARLING ELECTRIC, INC. | WEST HARTFORD | CT |
| CCM | CORCOM, INC. | CHICAGO | IL |
| CDC | COMPONENT DEVELOPMENT CORP. | CARSON | CA |
| CECO | CENTRAL COIL CO. | BRAZIL | IN |
| CFI | CIRCUIT FUNCTIONS INC. | NEWBURY PK | CA |
| CGW | CORNING GLASS WORKS | CORNING | NY |
| CHE | CHERRY ELECTRICAL PRODUCTS | WAUKEGAN | IL |
| CHEMP | CHEMPLAST, INC. | WAYNE | NJ |
| CHLAR | CHARLES LARSON CO. | STERLING | IL |
| CHOM | CHOMERICS INC. | WOBURN | MA |
| CHRY | CHRYSLER CORP. | DETROIT | MI |
| CIMCO | CIMCO WIRE AND CABLE INC. | ALLENDALE | NJ |

| ABBRV | NAME......................... | CITY................ | ST |
|---|---|---|---|
| CKI | CTS KNIGHTS, INC. | SANDWICH | IL |
| CLA | CLAIREX CORP. | MT. VERNON | NY |
| CLAR | CLAROSTAT MFG. CO | DOVER | NH |
| CLFRM | COILFORM | GENEVA | IL |
| CLFX | COLE-FLEX CORP. | BABYLON | NY |
| CNCRD | CONCORD ELEX | NEW YORK | NY |
| CPKG | CREATIVE PACKAGING DIV. | INDIANAPOLIS | IN |
| CPLRD | COMPLETE READING | | |
| CRTR | CORE-TRONICS | ORANGE | NJ |
| CTS | CHICAGO TELEPHONE SYSTEMS | CHICAGO | IL |
| CTS-E | CTS OF ELKHART | ELKHART | IN |
| CTS-F | C.T.S. OF FAIRBERRY | FAIRBERRY | IL |
| CTS-K | CTS OF KEENE | PASO ROBLES | CA |
| CTSBR | CTS OF BERNE | BERNE | IN |
| CTSBV | CTS OF BROWNSVILLE | BROWNSVILLE | TX |
| CW/AL | C.W./ALPHA | SOUTHAMPTON | PA |
| DAL | DALE TECHNOLOGY CORP. | HARTSDALE | NY |
| DATEL | DATEL SYSTEMS, INC. | MANSFIELD | MA |
| DAV | HARRY DAVIES MOLDING CO. | CHICAGO | IL |
| DAYTN | DAYTON ELECTRIC CO. | CHICAGO | IL |
| DEL | DELEVAN DIV. | EAST AURORA | NY |
| DEN | DENNISON MFG. CO. | FRAMINGHAM | MA |
| DEW | DEWIRE FABRICATING CORP. | LOWELL | MA |
| DILEC | DILECTRON | MONROVIA | CA |
| DIO | DIODES, INC. | CHATSWORTH | CA |
| DK-WR | DAKO-WARE | CHICAGO | IL |
| DLGHT | DIALIGHT | BROOKLYN | NY |
| DNTCH | DONTECH, INC. | | |
| DRA | DRAKE MANUFACTURING CO. | HARWOOD HEIGHTS | IL |
| DRMYR | DORMEYER | ROCKVILLE | IN |
| DYNR | DYNEER CORP. | CHATSWORTH | CA |
| E-C | ELECTRONIC CRYSTALS | KANSAS CITY | MO |
| E-I | ELECTRICAL INDUSTRIES, INC. | MURRAY HILL | NJ |
| E-M | ELECTRA/MIDLAND CORP. | MINERAL WELLS | TX |
| EBY | EBY COMPANY | PHILADELPHIA | PA |
| ECKDT | ECKARDT LABORATORIES | ORANGE | CA |
| ECMC | ELECTRI-CORD MFG. CO. INC. | WESTFIELD | PA |
| ELC-I | ELECTRA | CUMBERLAND | IN |
| ELCO | ELCO INDUSTRIES | ROCKFORD | IL |
| ELEXP | ELECT EXPEDITERS | MILWAUKEE | WI |
| ELFX | ELECTRO-FLEX HEAT INC. | BLOOMFIELD | CT |
| ELHDW | ELECTRONIC HARD | FARMINGDALE | NY |
| ELNA | ELNA | CARSON | CA |
| EMRON | | | S |
| EPITK | EPITEK ELECTRONICS | KANATA, ONT., CAN. | ** |
| EPOXT | EPOXY TECHNOLOGY, INC. | BILLERICA | MA |
| ETC | ELECTRONIC TRANSISTOR CORP. | FLUSHING | NY |
| ETP | ERIE TECHNOLOGICAL PRODUCTS | ERIE | PA |
| EVRDY | EVEREADY | NEW YORK | NY |
| EXAR | EXAR INTEGRATED SYSTEMS | SUNNYVALE | CA |
| EZLOK | E-Z LOK | GARDENIA | CA |
| F-K | THERMWELL PRODUCTS, INC. | FRAMINGHAM | MA |
| F-S | FEDERAL SCREW | CHICAGO | IL |
| FAN | FANCOURT & CO. | GREENSBORO | NC |
| FASTX | FASTEX DIV., ILL. TOOL WORKS | DES PLAINES | IL |
| FCD | FAIRCHILD | MOUNTAIN VIEW | CA |
| FNWL | FENWAL | FRAMINGHAM | MA |
| FRK | FRAKO | FRANKFORT, GER. | ** |
| FRTE | FAIR RITE PRODUCTS CORP. | WALLKILL | NY |
| FRXC | FERROXCUBE DIVISION | SAUGERTIES | NY |
| G-E | GENERAL ELECTRIC | INDIANAPOLIS | IN |
| G-H | GRAYHILL, INC. | LA GRANGE | IL |
| G-I | GEN'L INSTRUMENT SEMICONDUCTOR | HICKSVILLE | NY |
| G-T | GRAND TRANSFORMERS | GRAND HAVEN | MI |
| GAL | GALILEO ELECTRO-OPTICS | CARMEL | IN |
| GATES | GATES ENERGY PROD. | DENVER | CO |
| GBN | GILBERT ENGINEERING CO. INC. | PHOENIX | AZ |
| GCE | GC ELECTRONICS | ROCKFORD | IL |
| GHZ | GHZ DEVICES, INC. | CHELMSFORD | MA |
| GLOBE | GLOBE | MILWAUKEE | WI |
| GNATR | GENERAL ATRONICS CORP. | PHILADELPHIA | PA |
| GOU | GOULD, INC. | ST. PAUL | MN |
| GRIES | GRIES REPRODUCER | NEW ROCHELLE | NY |
| GRIP | GRIPMASTER CO. | MARLBORO | NJ |
| GRVCO | GROVE COMPANY | DAYTON | OH |
| GUDL | GUDEBROD BROS. SILK CO. | CHICAGO | IL |

| ABBRV | NAME....................... | CITY................. | ST |
|---|---|---|---|
| H-P | HEWLETT-PACKARD | INDIANAPOLIS | IN |
| HARTW | HARTWELL CORP. | PLACENTIA | CA |
| HEL | HELIPOT | ANAHEIM | CA |
| HEY | HEYMAN MFG. CO. | WAUKESHA | WI |
| HHS | HERMAN H. SMITH, INC. | BROOKLYN | NY |
| HI-G | HI-G INC. | WINDSOR LOCKS | CT |
| HI-G | HI-G INC | WINDSOR LOCKS | CT |
| HIT | HITACHI AMERICA, LTD. | SAN FRANCISCO | CA |
| HMLN | HAMLIN | LAKE MILLS | WI |
| HOLGW | HOLLINGSWORTH SLDRLS TERM. | POTTSTOWN | PA |
| HOLUB | HOLUB DISTRIBUTING CO. | NEWPORT | KY |
| HSD | HARRIS CORP. SEMICDR. DIV. | MELBOURNE | FL |
| HUD | HUDSON TOOL & DIE CO. | NEWARK | NJ |
| HY/PL | HYDRO PLASTICS INC. | GEORGETOWN | KY |
| HYSYS | HYBRID SYSTEMS | BEDFORD | MA |
| HYT | HYTRONICS | PINELLAS PARK | FL |
| ICI | ILLINOIS CAPACITOR INC. | MORTON GROVE | IL |
| ICO-R | ICO-RALLY | PALO ALTO | CA |
| IERC | INT'L ELEC. RESEARCH CORP. | BURBANK | CA |
| INDCP | INDUCTIVE COMPONENTS | HAUPPAUGE | NY |
| INDEC | INDUSTRIAL ELECTRONIC HDWR. | NEW YORK | NY |
| INLOK | INTERLOK/WM J PURDY CO. | BURLINGAME | CA |
| INT | INTERSIL, INC. | CUPERTINO | CA |
| INWEB | INTERNATIONAL WEBBING | WHITEHALL | PA |
| IRC | INTERNATIONAL RESISTANCE CO. | PHILADELPHIA | PA |
| IREC | INT'L RECTIFIER CORP. | LOS ANGELES | CA |
| ITRON | ISE ELECTRONICS | ISE, JAPAN | ** |
| ITT | INT'L TELEPHONE & TELEGRAPH | W. PALM BEACH | FL |
| JAMES | JAMES ELECTRONICS | CHICAGO | IL |
| JAN | JAN HARDWARE MFG. CO. | LONG ISLAND CITY | NY |
| JEF | JEFFERS | DUBOIS | PA |
| JEFWC | JEFFERSON WIRE AND CABLE | WORCHESTER | MA |
| JEW | JEWELL ELECTRICAL INSTRUMENTS | MANCHESTER | NH |
| JFD | JFD ELECTRONICS | BROOKLYN | NY |
| JFW | JFW INDUSTRIES | BEECH GROVE | IN |
| JHSN | JOHANSON MFG. CORP. | BOONTON | NJ |
| JON | E.F. JOHNSON CO. | WASECA | MN |
| JUDD | JUDD WIRE DIV. ECC | TURNERS FALLS | MA |
| K-L | KERRIGAN LEWIS MFG. | CHICAGO | IL |
| K-S | K & S ENGINEERING CO. | CHICAGO | IL |
| KDI-P | KDI-PYROFILM CORP. | WHIPPANY | NJ |
| KEENE | KEENE CORP. | NEWARK | DE |
| KEM | KEMTRON ELECTRON PRODUCTS | NEWBURYPORT | MA |
| KEY | KEYSTONE ELECTRONIC CORP. | NEW YORK | NY |
| KID | KIDCO, INC. | MEDFORD | NJ |
| KIN | KINGS ELECTRONICS | TUCKAHOE | NY |
| KMYO | KAMAYA OHM | JAPAN | ** |
| KRYST | KRYSTINEL | PATERSON | NJ |
| KSTR | KESTER SOLDER DIV. | CHICAGO | IL |
| KSW | KSW ELECTRONICS | BURLINGTON | MA |
| KSW | KSW ELECTRONICS | BURLINGTON | MA |
| KUL | KULKA ELECTRIC CORP. | MT. VERNON | NY |
| LAURN | LAUREN MFG CO. | NEW PHILADELPHIA | OH |
| LEYSE | LEYSE ALUMINUM CO. | KEWANEE | WI |
| LIT | LITTELFUSE, INC. | DES PLAINES | IL |
| LNMST | LINEMASTER SWITCH CORP. | WOODSTOCK | CT |
| LOCTT | LOCTITE CORP. | NEWINGTON | CT |
| LRC | LRC ELECTRONICS, INC. | HORNELL | NY |
| LTRNX | LITRONIX | CUPERTINO | CA |
| M-A | MICROWAVE ASSOCIATES | BURLINGTON | MA |
| M-D | MILLER DIAL & NAMEPLATE CO. | EL MONTE | CA |
| M-E | MEPCO ELECTRA, INC. | MORRISTOWN | NJ |
| M-O | ILLUMINATED PRODUCTS INC. | SANTA ANA | CA |
| M-P | MICRO PLASTICS INC. | CHATSWORTH | CA |
| MAL | MALLORY CONTROLS CO. | FRANKFORT | IN |
| MAND | MANDEX | CHICAGO | IL |
| MARQ | J. & J. MARQUARDT | TUTTLINGEN, GER. | ** |
| MCREL | MICRO ELEX LTD | HONG KONG | ** |
| MD-AM | MID AMERICA | CHICAGO | IL |
| MDC | MAIDA DEVELOPMENT CO. | HAMPTON | VA |
| MDLRS | MIDLAND ROSS | CINCINNATI | OH |
| MDTC | MODUTEC | NORWALK | CT |
| MILN | MILLEN MFG. CO. | NEW YORK | NY |
| MILSP | MILITARY SPECIFICATION | WASHINGTON | DC |
| MIN-C | MINI-CIRCUITS | BROOKLYN | NY |
| MINIS | MINI SYSTEMS | NORTH ATTLEBORO | MA |

| ABBRV | NAME....................... | CITY................. | ST |
|---|---|---|---|
| MINOR | MINOR RUBBER CO. | BLOOMFIELD | NJ |
| MITEK | MITEK | LEXINGTON | MA |
| MLRJW | J.W. MILLER | COMPTON | CA |
| MMM | 3M COMPANY | ST. PAUL | MN |
| MNO | MONSANTO COMM. PROD. DIV. | PALO ALTO | CA |
| MOL | MOLEX PRODUCTS | LISLE | IL |
| MORAD | MORGAN ADHESIVES | STOW | OH |
| MOSTK | MOSTK CORP. | CARROLLTON | TX |
| MOT | MOTOROLA SEMI. PROD. DIV. | INDIANAPOLIS | IN |
| MRM | M. ROSS MASON | INDIANAPOLIS | IN |
| MRO | MICRO SWITCH DIV. | FREEPORT | IL |
| MRRUB | MARION RUBBER PROD. | INDIANAPOLIS | IN |
| MSN | MICROSONICS DIV. | WEYMOUTH | MA |
| MSP | MICRO SEMICONDUCTOR CORP. | SANTA ANA | CA |
| MULSO | MULTICORE SOLDERS LTD. | WESTBURY | NY |
| MURA | MURA | | |
| MURA | MURA | WESTBURY | NY |
| MURGA | MURATA-GEORGIA | MARIETTA | GA |
| MWS | MAGNET WIRE SUPPLY CO. | CHATSWORTH | CA |
| MYERS | MYERS SPRING CO. | LOGANSPORT | IN |
| N-T | NATIONAL TEL-TRONICS | LAREDO | TX |
| NAT | NATIONAL SEMICONDUCTOR CORP. | SANTA CLARA | CA |
| NCC | NATIONAL CERAMIC CO | TRENTON | NJ |
| NCSVC | NATL COM SERV. | WILLOW GROVE | PA |
| NEC | NIPPON ELECTRIC CO. | TOKYO, JAPAN | ** |
| NEL | NATIONAL ENGINEERING LABS | INDIANAPOLIS | IN |
| NEW | NEWARK ELECTRONICS | INDIANAPOLIS | IN |
| NHWC | NEW HAVEN WIRE & CABLE | NEW HAVEN | IN |
| NICHN | NICHICON (AMERICA) CORP. | SCHAUMBURG | IL |
| NMB | NMB CORP. | ARLINGTON HEIGHTS | IL |
| NMC | MAGNUM MICROWAVE CORP. | SUNNYVALE | CA |
| NPC | NUCLEONIC PRODUCTS CO. | CANOGA PARK | CA |
| NYLO | NYLOMATIC | MORRISVILLE | PA |
| O-G | OPTI-GAGE INC. | DAYTON | OH |
| O-S | OMNI SPECTRA INC. | FARMINGTON | MI |
| OAK | OAK INDUSTRIES INC. | CRYSTAL LAKE | IL |
| OHM | OHMITE MFG. CO. | SKOKIE | IL |
| OMEGA | OMEGA WIRE & CABLE | HARLEYSVILLE | PA |
| OPTRN | OPTRON INC. | CARROLLTON | TX |
| P-B | POTTER AND BRUMFIELD | PRINCETON | IN |
| P-C | POWER COMPONENTS | WOODLAND HILLS | CA |
| P-K | PARKER KALON CORP. | CLIFTON | NJ |
| P-T | PENN TUBE PLASTICS CO. | CLIFTON HEIGHTS | PA |
| P-U | PROJECTS UNLIMITED INC. | DAYTON | OH |
| POLPH | POLYPHASE INSTR. CO. | BRIDGEPORT | PA |
| PACTC | PACTEC DIV. | PHILADELPHIA | PA |
| PAM | PAMOTOR DIV. | BURLINGAME | CA |
| PAND | PANDUIT CORP. | TINLEY PARK | IL |
| PARA | PARAMETRIC INDUSTRIES | NORTHFIELD | IL |
| PCC | PANEL COMPONENTS CORP. | BERKELEY | CA |
| PEC | PACIFIC ELECTRICORD CO. | GARDENA | CA |
| PEM | PENN ENGRG & MANUF CO. | DANBORO | PA |
| PFZR | PFIZER, NC. | | |
| PHC | PHILADELPHIA HANDLE CO. | CAMDEN | NJ |
| PHILP | PHILPOTT RUBBER CO. | CLEVELAND | OH |
| PIC | PIHER INTERNATIONAL CORP. | ARLINGTON HEIGHTS | IL |
| PLI | PRECISION LAMP, INC. | MT. VIEW | CA |
| PLSSY | PLESSEY ENG. | SCHILLER PARK | IL |
| PLSTI | PLASTIC TECHNIQUES, INC | NEW BOSTON | NH |
| PLYCL | POLYCLAD LAMINATES | SOUTHFIELD | MI |
| PMCL | PERMACEL DIV. | NEW BRUNSWICK | NJ |
| PMI | PRECISION MONOLITHICS INC. | SANTA CLARA | CA |
| PNSNC | PANASONIC | | |
| POM | POMONA ELECTRONICS CO., INC. | POMONA | CA |
| PREH | PREH VERT, MBH | GERMANY | ** |
| PRMD | PYRAMID INDUSTRIES, INC. | PHOENIX | AZ |
| PRSLK | PRESTO-LOCK | | |
| PRSN | PRECISION TUBE CO., INC | GARFIELD | NJ |
| PTN | PENN TRAN CORP. | NORTH WALES | PA |
| PWRMT | POWER-MATE CORP. | BELLEFONT | PA |
| PYRO | PYROFILM CORP. | HACKENSACK | NJ |
| PYTT | PYTTRONICS INDUSTRIES, INC. | WHIPPANY | NY |
| Q-C | QUALITY COMPONENTS | MONTGOMERYVILLE | PA |
| R-N | ROBINSON-NUGENT | ST. MARYS | PA |
| R-OHM | R-OHM | NEW ALBANY | IN |
| RAWST | RAW STOCK | IRVINE | CA |
| | | ***** | ** |

| ABBRV | NAME...................... | CITY................. | ST |
|---|---|---|---|
| RAY | RAYTHEON | INDIANAPOLIS | IN |
| RCA | RCA | CAMDEN | NJ |
| REL | RELIANCE MICA CO. | BROOKLYN | NY |
| RGNCY | REGENCY ELECTRONICS, INC. | INDPLS. | IN |
| RGR | ROGERS CORP. | CHANDLER | AZ |
| RICH | RICHCO PLASTIC CO. | CHICAGO | IL |
| RICHM | RICHARDS METAL PRODUCTS | WOLCOTT | CT |
| RMC | RADIO MATERIALS CORP. | CHICAGO | IL |
| RMF | RMF PRODUCTS INC. | BATAVIA | IL |
| ROCKW | ROCKWELL INTL. | ANAHEIM | CA |
| ROGAN | ROGAN CORP. | NORTHBROOK | IL |
| ROTRN | ROTRON INC. | WOODSTOCK | NY |
| RPBLC | REPUBLIC ELECTRONICS CORP | PATTERSON | NJ |
| RSSLL | RUSSELL | OCEANSIDE | NY |
| S-C | SPECIALTY CONNECTOR | INDIANAPOLIS | IN |
| S-G | STANDARD GRIGSBY | AURORA | IL |
| S-I | SWITCHCRAFT, INC. | CHICAGO | IL |
| S-S | SERVICE SUPPLY | INDIANAPOLIS | IN |
| S-T | SARKES TARZIAN | BLOOMINGTON | IN |
| SAGE | SAGE LABORATORIES, INC. | NATIC | MA |
| SAYRO | SAYROSA ENGINEERS LTD. | ALTON, HANTS, U.K. | ** |
| SCBE | SCANBE DIVISION | EL MONTE | CA |
| SCC | STACKPOLE CARBON CO. | ST. MARYS | PA |
| SCX | SILICONIX INC. | SANTA CLARA | CA |
| SEAST | SEASTROM MFG. CO. | GLENDALE | CA |
| SECR | SECOR INC. | WESTWOOD | NJ |
| SEL | SEALECTRO CORP. | MAMARONECK | NY |
| SEM | SEMTECH | NEWBURY PARK | CA |
| SEMTX | SEMTEX | DAYTON | OH |
| SGM | SIGMA INSTRUMENTS | BRAINTREE | MA |
| SGS-A | SGS-ATES COMP ELET SPA | AGRATE BRIANZE, ITALY | ** |
| SHAM | SHAMROCK PLASTICS & RUBBER CO. | INDIANAPOLIS | IN |
| SHDW | I.E.E. SCHADOW | EDEN PRAIRIE | MN |
| SHKMN | SHACKMAN INSTRUMENTS | CHESHAM, ENGLAND | ** |
| SIEM | SIEMENS | ISELIN | NJ |
| SIG | SIGNETICS CORPORATION | SUNNYVALE | CA |
| SIGPT | SIGMA PLASTRONICS | DEARBORN | MI |
| SINCR | SINCLAIR & RUSH, INC. | ST. LOUIS | MO |
| SKDRV | STOCK DRIVE PROD. DIV. | NEW HYDE PARK | NY |
| SLT | SOLITRON/MICROWAVE DIV. | PORT SALERNO | FL |
| SMTC | SAMTEC INC. | NEW ALBANY | IN |
| SOUTH | SOUTHCO FASTENERS | LESTER | PA |
| SPE | SPECTROL | DAYTON | OH |
| SPEC | SPECTRUM CONTROL. INC. | FAIRVIEW | PA |
| SPR | SPRAGUE ELECTRIC CO. | INDIANAPOLIS | IN |
| SPRTX | SUPERTEX INC. | CUPERTINO | CA |
| SPST | SPECTRA-STRIP | GARDEN GROVE | CA |
| SSS | SOLID STATE SCIENTIFIC | MONTGOMERYVILLE | PA |
| STDPS | STANDARD PRESSED STEEL | JENKINTOWN | PA |
| STKFS | STAKE FASTENERS | SOUTH EL MONTE | CA |
| STR | STETTNER TRUSH CO. | CAZENOVIA | NY |
| STSA | STEEL SALES | INDIANAPOLIS | IN |
| SYL | GTE SYLVANIA | WALTHAM | MA |
| SYNTC | SYNTAC CORP. | CLEVELAND | OH |
| SYNTK | SYNERTEK | ** | * |
| SYS | SYSCON INTERNATIONAL, INC. | SOUTH BEND | IN |
| T-I | TEXAS INSTRUMENTS | DALLAS | TX |
| TCPL | TACONIC PLASTIC | PETERSBURG | NY |
| TEK | TEKTRONIX | INDIANAPOLIS | IN |
| TEKA | TEKA PRODUCTS INC. | COLLEGE POINT | NY |
| TEKNT | TECKNIT | CRANFORD | NJ |
| TELE | TELETYPE CORP. | ELK GROVE VILLAGE | IL |
| TELRY | TELEDYNE RELAYS | HAWTHORNE | CA |
| TFI | T&F INDUSTRIES DIV. | ROLLING MEADOWS | IL |
| THR | THERMALLOY CO. | DALLAS | TX |
| TIMES | TIMES WIRE AND CABLE | CINCINNAI | OH |
| TIN | TINNERMAN PRODUCTS, INC. | CLEVELAND | OH |
| TKN | TECHNICAL WIRE | CRAWFORD | NJ |
| TLNC | TELONIC ALTAIR | LAGUNA BEACH | CA |
| TOKO | TOKO AMERICA | SKOKIE | IL |
| TOKO | TOKO AMERICA | SKOKIE | IL |
| TORCO | TOR CORP. | VAN NUYS | CA |
| TR-UT | TRIAD-UTRAD DIV. | HUNTINGTON | IN |
| TRIYX | TRIONYX INDUSTRIES | INDIANAPOLIS | IN |
| TRU | WALDES TRUARC | LONG ISLAND CITY | NY |

| ABBRV | NAME........................... | CITY................. | ST |
|---|---|---|---|
| TRW | TRW CAPACITOR DIV. | OGALLALA | NB |
| TSHBA | TOSHIBA | ** | * |
| TVL | TEL-VISION LABS | WAUCONDA | IL |
| TWAY | TWAY COMPANY | INDIANAPOLIS | IN |
| TYTON | TYTON CORP. | MILWAUKEE | WI |
| U-C | UNIVERSAL COMPONENTS | LOS ANGELES | CA |
| ULSP | UNDERWRITERS LAB. SPEC. | CHICAGO | IL |
| UNCAR | UNION CARBIDE COMPONENTS | GREENVILLE | SC |
| UNIC | UNICORP | ORANGE | NJ |
| UNIT | UNITRODE CORP. | WATERTOWN | MA |
| USECO | USECO DIV. | VAN NUYS | CA |
| UTK | UNITRACK DIV. | UPPER DARBY | PA |
| VAC | VACTEC INC. | MARYLAND HEIGHTS | MO |
| VACO | VACO PRODUCTS CO. | NORTHBROOK | IL |
| VAR | VARADYNE CAPACITOR DIV. | SANTA MONICA | CA |
| VARIL | VARI-L CO. | DENVER | CO |
| VELCR | VELCRO USA INC | NEW YORK | NY |
| VISCM | VISUAL COMM | | |
| VLIER | VLIER ENGINEERING CORP. | BURBANK | CA |
| VONGT | VONNEGUT HARDWARE | INDIANAPOLIS | IN |
| VRN | VERNITRON CORP. | GREAT NECK | NY |
| VTRMN | VITRAMON, INC. | BRIDGEPORT | CT |
| W-E | WELLS ELECTRONICS | SOUTH BEND | IN |
| W-I | WAVETEK INDIANA, INC. | BEECH GROVE | IN |
| WAG | WAGNER ELECTRIC CORP. | ST. LOUIS | MO |
| WECK | WECKESSER CO., INC. | CHICAGO | IL |
| WHTMN | WHITMAN | CINCINNATI | OH |
| WKFLD | WAKEFIELD ENGINEERING | WAKEFIELD | MA |
| WLDM | WALDOM | CHICAGO | IL |
| WMBG | W.M. BERG | ROCKAWAY | NY |
| WNSL | WEINSCHEL ENGINEERING | GAITHERSBURG | MD |
| WNZLR | WINZLER MFG | CHICAGO | IL |
| WSD | WAVETEK | SAN DIEGO | CA |
| WSTN | WESTON COMPONENTS | ARCHBALD | PA |
| ZEN | ZENITH RADIO CORP. | CHICAGO | IL |
| ZERO | ZERO MANUFACTURING CO. | BURBANK | CA |
| ZIE | ZIERICK MFG. CORP. | MOUNT KISCO | NY |
| ZPT | ZIPPERTUBING, CO. | LOS ANGELES | CA |

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| ZA1 | PCB ASSY 1080 | 1110-00-1310 | W-I | 1110-00-1310 | 1 |
| ZA2 | PWR SUPPLY/MARKER PCB ASSY, 1080 | 1115-00-0023 | W-I | 1115-00-0023 | 1 |
| ZA3 | F.P. ASSY 1080 | 1118-00-0050 | W-I | 1118-00-0050 | 1 |
| ZA4 | R.P. ASSY 1080 | 1118-00-0051 | W-I | 1118-00-0051 | 1 |
| ZA5 | RF ASSY 1080 | 1118-00-0052 | W-I | 1118-00-0052 | 1 |
| ZA6 | CABINET, 1080 | 1111-00-0097 | W-I | 1111-00-0097 | 1 |
| 1 | HOUSING, CRIMP TERM. 15 CKT | 09-50-7151 | MOL | 2113-06-0012 | 1 |
| 2 | CONTACT MC000-068 | 08-50-0107 | MOL | 2113-07-0001 | 15 |

WAVETEK PARTS LIST | TITLE: SWP GEN, 1080 | ASSEMBLY NO. 1010-00-0160 | PAGE: 1 | REV 3

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| ZA1 | PCB ASSY, 1080 | 1110-00-1310 | W-I | 1110-00-1310 | 1 |
| ZA2 | PWR SUPPLY/MARKER PCB ASSY, 1080 | 1115-00-0023 | W-I | 1115-00-0023 | 1 |
| ZA3 | FP ASSY 1081 | 1118-00-0096 | W-I | 1118-00-0096 | 1 |
| ZA4 | R.P. ASSY 1080 | 1118-00-0051 | W-I | 1118-00-0051 | 1 |
| ZA5 | RF ASSY 1081 | 1118-00-0094 | W-I | 1118-00-0094 | 1 |
| ZA6 | CABINET, 1080 | 1111-00-0097 | W-I | 1111-00-0097 | 1 |
| 1 | HOUSING, CRIMP TERM, 15 CKT | 09-50-7151 | MOL | 2113-06-0012 | 1 |
| 2 | CONTACT MC000-068 | 08-50-0107 | MOL | 2113-07-0001 | 15 |

$ 1134.30

WAVETEK PARTS LIST | TITLE: SWP GEN, 1081 (U) | ASSEMBLY NO. 1010-00-0205 | PAGE: 1 | REV B

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| F01 | FUSE, S.B., .5 AMP MF000-007 | MDL 1/2 | BUS | 2410-05-0004 | 1 |
| P15 | CORD SET, 18/3SVT, 6FT BK, MLD. CAP, UL-APPRV | 17237SVT | BEL | 6011-80-0001 | 1 |
| S01 | SWITCH, TOGGLE DPDT | 9201P3HZQ | C-K | 5106-00-0016 | 1 |
| S02 S03 | SWITCH, SLIDE, DPDT | 4021.0521 | MARQ | 5105-00-0012 | 2 |
| ZA1 | XFMR ASSY, 1080 | 1219-00-0194 | W-I | 1219-00-0194 | 1 |

**WAVETEK PARTS LIST**

TITLE: R.P. ASSY 1080

ASSEMBLY NO. 1118-00-0051

PAGE: 1

REV

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| J11 | 7-PIN JACK | 09-50-3071 | MOL | 2113-06-0009 | 1 |
| NONE | CONTACT, MC000-131 | 08-50-0106 | MOL | 2113-07-0002 | 7 |
| T1 | XRMR, PWR, 40/15/2 VCT | 9348 | A-M | 5610-00-0035 | 1 |

**WAVETEK PARTS LIST**

TITLE: XFMR ASSY, 1080

ASSEMBLY NO. 1219-00-0194

PAGE: 1

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| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| IC102 | IC, IC000-026 | MC7818CD | MOT | 7000-78-1800 | 1 |
| IC103 | IC, IL002-001 | MC7918CP | MOT | 7000-79-1800 | 1 |
| IC104 | IC, IC000-011 | 78M05U1C | FCD | 7000-78-0500 | 1 |
| J404 | CONN., RECEPT., P.C., STRAIGHT | 50-051-0000 | SEL | 2110-03-0004 | 1 |
| J408 | IC SKT, PC, 14 PIN MC000-073 | C931402 | T-I | 2112-00-0011 | 1 |
| K201 | RELAY, SPST, REED | JRM1000 | P-B | 4510-00-0011 | 1 |
| P403 | DIP RIBBON JUMPER, 14 W/STRAIN RELIEF PER B/P | 6011-60-0008 | W-I | 6011-60-0008 | 1 |
| W4 | CABLE ASSY, 9-7/8 IN | WX1080-W4 | W-I | 1217-90-0058 | 1 |

**WAVETEK PARTS LIST**

TITLE: CABINET, 1080

ASSEMBLY NO. 1111-00-0097

PAGE: 1

REV: A

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| C01 | CAP, CER, 120PF, 1KV CD102-112 | 60U121M | MDC | 1510-10-1121 | 1 |
| CR01 CR02 CR03 CR04 CR05 CR06 CR07 CR08 CR09 CR10 CR11 CR12 CR13 CR14 | LED, RED, T-1, 1.4 MCD | 5082-4494 | H-P | 4810-02-0006 | 14 |
| DS01 DS02 | DISPLAY, 4 DIGIT, VACUUM FLOURESCENT | FG410E2 | ITRON | 2410-03-0005 | 2 |
| J12 J13 J14 | CONN, BNC, JB000-023 | KC79-167 | KIN | 2110-01-1009 | 3 |
| K01 | RELAY, DPDT, DIP | HB2-DC 12V | ARW-M | 4510-00-0010 | 1 |
| P02 | DIP RIBBON JUMPER, 14 W/STRAIN RELIEF PER B/P | 6011-60-0009 | W-I | 6011-60-0009 | 1 |
| R05 | RES, C, 1/4W, 5%, 47K RC103-347 | CF1/4-47K | ASE | 4700-15-4702 | 1 |
| R06 R56 | POT, CERMET, LIN, 10K | 388, B-24-5, 10K | CLAR | 4610-01-3103 | 2 |
| R28 R48 | POT, 10K1 15/16 SHFT FROM: 4610-13-6103 | 4610-14-2103 | W-I | 4610-14-2103 | 2 |
| R29 | POT, 10K, 10T | 534-130 | SPE | 4610-20-4103 | 1 |
| R41 | POT, 10K, 1-1/16 SHAFT FROM: 4610-13-6103 | 4610-14-1103 | W-I | 4610-14-1103 | 1 |
| S01 S02 S04 S05 S06 | SWITCH, SPDT, MOM, VERT MOUNT, WHITE CAP | 8125-V3 W/7089 WH | C-K | 5111-00-0008 | 5 |

WAVETEK PARTS LIST

TITLE F.P. ASSY 1080

ASSEMBLY NO. 1118-00-0050

PAGE: 1

REV B

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| S03 | SWITCH, SPDT, MOM, VERT MOUNT, BLACK CAP | 8125-V3 W/7089 BK | C-K | 5111-00-0009 | 1 |
| S07 | SWITCH, POT, 1 POLE, 10 POS, PER B/P | 1210SM | S-G | 5104-00-0231 | 1 |
| W05 | CABLE ASSY, 14-1/2 IN | WX3000-200-W8 | W-I | 1217-80-0004 | 1 |
| W06 | CABLE ASSY, 14-1/2 IN | WX1080-W6 | W-I | 1217-80-0051 | 1 |
| ZA1 | PC BD ASSY, F.P. 1080 | 1110-00-1301 | W-I | 1110-00-1301 | 1 |
| ZA2 | FP SUBASSY, 1080 | 1216-00-0024 | W-I | 1216-00-0024 | 1 |

WAVETEK PARTS LIST

TITLE F.P. ASSY 1080

ASSEMBLY NO. 1118-00-0050

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REV B

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| C02 | CAP, ELECT, 1MF, 25V CE120-001 | 162D105X9025BC2 | SPR | 1510-21-7010 | 1 |
| C03 | CAP, CER, .15MF, 100V CD113-415 | CY20A154M | C-L | 1510-11-1154 | 1 |
| C04 C05 | CAP, CER, .05MF, 100V CD103-350 | TG-S50 | SPR | 1510-10-2503 | 2 |
| CR15 | DIODE DR000-001 | 1N4004 | P-C | 4806-01-4004 | 1 |
| IC01 IC04 IC07 IC10 | QUAD POS NAND | SN74LS00N | T-I | 8000-74-0010 | 4 |
| IC02 IC05 IC08 IC11 IC13 | DUAL D-FLIP FLOP | SN74LS74AN | T-I | 8000-74-7411 | 5 |
| IC03 IC06 IC09 IC12 | QUAD POS NAND BUF | SN7438N | T-I | 8000-74-3800 | 4 |
| IC14 | DUAL OP AMP, RAYTHEON IC000-027 | RC4558DN | RAY | 7000-45-5801 | 1 |
| IC15 | DUAL OP AMP | TL082CP | T-I | 7000-00-8200 | 1 |
| P1A P1B | HEADER, 36 PIN, STRT | 65646-436 | BER | 2112-07-0023 | 2 |
| Q01 | TRANS | 2N3904 | NAT | 4901-03-9040 | 1 |
| R01 R02 R03 R04 R13 R14 R15 R16 R17 R18 R57 | RES, C, 1/4W, 5%, 2K RC103-220 | CF1/4-2K | ASE | 4700-15-2001 | 11 |
| R07 R08 R09 R10 R11 R12 R19 R20 R21 R23 R24 R25 R26 R27 | RES, C, 1/4W, 5%, 360 RC103-136 | CF1/4-360 | ASE | 4700-15-3600 | 14 |

WAVETEK
**PARTS LIST**

TITLE: PC BD ASSY, F.P. 1080

ASSEMBLY NO. 1110-00-1301

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| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| R22 R58 R60 | RES, C, 1/4W, 5%, 1K RC103-210 | CF1/4-1K | ASE | 4700-15-1001 | 3 |
| R30 R50 | RES, MF, 1/8W, 1%, 10K RF213-100 | MF55K10K | ASE | 4701-03-1002 | 2 |
| R31 | RES, MF, 1/8W, 1%, 3.65K | MF55K-3.65K | ASE | 4701-03-3651 | 1 |
| R32 R33 R34 R35 R36 R37 R38 R39 R40 R46 R61 | RES, MF, 1/8W, 1%, 1K RF212-100 | MF55K-1K | ASE | 4701-03-1001 | 11 |
| R42 R45 R52 | RES, C, 1/4W, 5%, 100 RC103-110 | CF1/4-100 | ASE | 4700-15-1000 | 3 |
| R47 | RES, MF, 1/8W, 1%, 9.09K RF212-909 | MF55K-9.09K | ASE | 4701-03-9091 | 1 |
| R49 | RES, MF, 1/8W, 1%, 4.99K | MF55K-4.99K | ASE | 4701-03-4991 | 1 |
| R51 | RES, MF, 1/8W, 1%, 3.01K RF212-301 | MF55K-3.01K | ASE | 4701-03-3011 | 1 |
| R54 | RES, C, 1/2W, 5%, 200 RC105-120 | CF1/2-200 | ASE | 4700-25-2000 | 1 |
| R55 | RES, C, 1/4W, 5%, 75 RC103-075 | CR1/4-75 | ASE | 4700-15-7509 | 1 |
| R59 | RES, C, 1/4W, 5%, 100K RC103-410 | CF1/4-100K | ASE | 4700-15-1003 | 1 |

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**PARTS LIST**

TITLE: PC BD ASSY, F.P. 1080

ASSEMBLY NO. 1110-00-1301

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| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| C200 C210 | CAP, CER, 5%, .022MF | C331C223J1G5CA | UNCAR | 1510-12-7223 | 2 |
| C201 | CAP, CER, .002MF, 1KV CD102-220 | 5GAD20 | SPR | 1510-10-1202 | 1 |
| C202 | CAP, FILM, .15MF, 100V | 60C154K100 | PLSSY | 1510-60-7154 | 1 |
| C203 C209 | CAP, CER, 10PF, 1KV CD101-010 | 10TCC-Q10 | SPR | 1510-10-0100 | 2 |
| C204 C212 C217 C226 C228 | CAP, CER, .01MF, 100V CD103-310 | 68U103M | MDC | 1510-10-2103 | 5 |
| C205 C224 | CAP, CER, .02MF, 500V CD106-320 | 5HK-S20 | SPR | 1510-10-4203 | 2 |
| C206 | CAP, CER, .02UF, 50V | TG-S20 | SPR | 1510-10-2203 | 1 |
| C207 C223 | CAP, CER, .005MF, 1KV CD102-250 | 5GA-D50 | SPR | 1510-10-1502 | 2 |
| C208 | CAP, CER, 47PF, 1KV CD101-047 | 10TCC-Q47 | SPR | 1510-10-0470 | 1 |
| C211 C216 C222 C231 C233 | CAP, CER, .05MF, 100V CD103-350 | TG-S50 | SPR | 1510-10-2503 | 5 |
| C213 C219 | CAP, MYLAR, .22MF, 200V CP101-422 | WMF2P22 | C-D | 1510-60-0224 | 2 |
| C214 C220 | CAP, FILM, .047MF, 250V 5% | B32547-.047-5%-250V | SIEM | 1510-60-9473 | 2 |

WAVETEK PARTS LIST

TITLE: PCB ASSY, 1080

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| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| C215 C221 | CAP, MICA, 110PF, 500V | DM15-111J | ARC | 1510-50-0111 | 2 |
| C218 C236 | CAP, CER, .1MF, 50V CD103-410 | TGP-10 | SPR | 1510-10-2104 | 2 |
| C225 C227 | CAP, CER, .001MFD, 1KV CD102-210 | 5GAD10 | SPR | 1510-10-1102 | 2 |
| C229 C237 | CAP, TANT, 10MF, 25V CE108-010 | TIM106K025P0V | MAL | 1510-21-6100 | 2 |
| C230 | CAP, CER, 15PF, 1KV CD101-015 | 10TCC-Q15 | SPR | 1510-10-0150 | 1 |
| C234 | CAP, CER, 470PF, 1KV CD102-147 | 60U471M | MDC | 1510-10-1471 | 1 |
| C235 | CAP, CER, 120PF, 1KV CD102-112 | 60U121M | MDC | 1510-10-1121 | 1 |
| CR201 CR202 CR203 CR204 CR205 CR206 CR207 CR217 CR223 CR224 CR227 CR228 CR232 CR233 CR234 CR235 CR236 CR237 CR238 CR239 CR240 CR241 CR242 CR246 CR247 CR248 CR250 | DIODE DG109-140 | 1N4148 | T-I | 4807-01-0914 | 27 |
| CR208 CR209 CR210 CR211 CR212 CR213 CR214 CR215 CR216 CR218 CR219 CR220 | DIODE DR000-001 | 1N4004 | P-C | 4806-01-4004 | 15 |

WAVETEK PARTS LIST

TITLE: PCB ASSY, 1080

ASSEMBLY NO.: 1110-00-1310

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| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| CR221 CR222 CR245 | | | | | |
| IC201 IC225 | SWITCH, QUAD SPST, JFET, 2 NO/2 NC | LF13333N | NAT | 7001-33-3300 | 2 |
| IC202 IC204 IC205 IC206 | DUAL OP AMP | TL082CP | T-I | 7000-00-8200 | 4 |
| IC203 | IC, IL004-001 | LM339N | NAT | 7000-03-3900 | 1 |
| IC207 IC208 IC209 IC210 IC212 IC213 IC214 IC215 | HEX INVERTER 7406 | SN7406 | T-I | 8000-74-0600 | 8 |
| IC211 IC232 | A/D CONV. 3-1/2 DIGIT STATIC SENSITIVE | ICL7107CPL | INT | 7000-71-0700 | 2 |
| IC217 | DUAL D-FLIP FLOP | SN74LS74AN | T-I | 8000-74-7411 | 1 |
| IC218 | IC, IC000-023 | SN7405N | T-I | 8000-74-0500 | 1 |
| IC219 | COUNTER, 14 STAGE BIN STATIC SENSITIVE | CD4020BE | RCA | 8000-40-2002 | 1 |
| IC220 IC226 IC227 IC230 | IC, IC000-005 | RC4558NB | RAY | 7000-14-5800 | 4 |
| IC221 | DUAL OP AMP, JFET | LF353AN | NAT | 7000-03-5301 | 1 |
| IC222 | IC, ID002-001 | N8T380A | SIG | 8000-83-8000 | 1 |
| IC223 | DAC, 8-BIT | DAC-08EQ | AMD | 8000-00-0800 | 1 |

**WAVETEK PARTS LIST** — TITLE: PCB ASSY, 1080 — ASSEMBLY NO. 1110-00-1310 — PAGE: 3 — REV H

| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| IC224 | BINARY CTR/DVDR STATIC SENSITIVE | CD4040BE | RCA | 8000-40-4012 | 1 |
| IC229 IC231 | DUAL OP AMP, RAYTHEON IC000-027 | RC4558DN | RAY | 7000-45-5801 | 2 |
| J401A J401B | CONN, PV CARD, 36 CKT | 65001-236 | BER | 2112-10-0003 | 2 |
| P416 | HEADER, R/A, 15 CKT, POLARIZING WALL | 09-88-2151 | MOL | 2112-08-0019 | 1 |
| Q201 Q207 Q211 Q212 Q213 Q215 Q217 Q219 Q223 Q225 | TRANS QA039-040 | 2N3904 | NAT | 4901-03-9040 | 10 |
| Q202 Q203 Q204 Q209 | TRANS QA054-610 | 2N5461 | MOT | 4901-05-4610 | 4 |
| Q205 Q208 Q214 | TRANS QB000-009 | MPS3702 | NAT | 4902-03-7020 | 3 |
| Q206 Q210 Q224 Q226 Q227 | TRANS QA054-580 | 2N5458 | MOT | 4901-05-4580 | 5 |
| Q216 | TRANS-QA042-500 | 2N4250 | FCD | 4901-04-2500 | 1 |
| Q218 | TRANS QA050-880 | 2N5088 | MOT | 4901-05-0880 | 1 |
| R200 R201 R202 R203 R204 R208 | RES, NTWRK, 10-PIN, 5%, 10K-OHM | 1009-103J | EPITK | 4770-00-0012 | 6 |
| R205 R441 R451 | RES, C, 1/4W, 5%, 100 RC103-110 | CF1/4-100 | ASE | 4700-15-1000 | 3 |
| R206 R256 R367 | RES, C, 1/4W, 5%, 2.4K | CF1/4-2.4K | ASE | 4700-15-2401 | 3 |

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| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| R207 R299 R350 R387 | RES, C, 1/4W, 5%, 15K RC103-315 | CF1/4-15K | ASE | 4700-15-1502 | 4 |
| R209 R243 R244* R443 | RES, MF, 1/8W, 1%, 100K RF214-100 | MF55K-100K | ASE | 4701-03-1003 | 4 |
| R210 | RES., M.F., 1/8W, 1%, 10.5K-OHM | MF55K-10.5K | ASE | 4701-03-1052 | 1 |
| R211 R213 R279 | POT, 1K | 91AR1K | BEK | 4610-00-7102 | 3 |
| R212 | RES, MF, 1/8W, 1%, 12.4K | MF55K-12.4K | ASE | 4701-03-1242 | 1 |
| R214 R282 R311 R424 | RES, MF, 1/8W, 1%, 10K RF213-100 | MF55K10K | ASE | 4701-03-1002 | 4 |
| R215 R242 R251 R253 R280 R289 R301 R368 R374 R395 R405 R413 R416 R422 R428 R432 R435 R455 | RES, C, 1/4W, 5%, 10K RC103-310 | CF1/4-10K | ASE | 4700-15-1002 | 18 |
| R216 R224 R231 R239 R241 R262 R263 R272 R294 R322 R323 R351 R352 R354 R355 R356 R382 R383 R384 R385 R386 R410 R430 R444 R450 | RES, C, 1/4W, 5%, 100K RC103-410 | CF1/4-100K | ASE | 4700-15-1003 | 25 |
| R217 R238 R276 R277 R315 R316 R317 R318 R319 R320 R321 | RES, C, 1/4W, 5%, 470K RC103-447 | CF1/4-470K | ASE | 4700-15-4703 | 11 |



| REFERENCE DESIGNATORS | PART DESCRIPTION | ORIG-MFGR-PART-NO | MFGR | WAVETEK NO. | QTY |
|---|---|---|---|---|---|
| R218 R234 | RES, MF, 1/8W, 1%, 16.9K RF213-169 | MF55K-16.9K | ASE | 4701-03-1692 | 2 |
| R219 R233 | RES, C, 1/4W, 5%, 820K RC103-482 | CF1/4-820K | ASE | 4700-15-8203 | 2 |
| R220 R236 R402 R437 | RES, C, 1/4W, 5%, 33K RC103-333 | CF1/4-33K | ASE | 4700-15-3302 | 4 |
| R221 R235 R258 R286 R288 R291 R295 R300 R304 R307 R310 R314 R380 R388 R439 | RES, C, 1/4W, 5%, 1K RC103-210 | CF1/4-1K | ASE | 4700-15-1001 | 15 |
| R222 R237 R264 R266 R268 R270 R331 R332 R333 R334 R335 R336 R337 R338 R339 R417 | POT, 100K | 91AR-100K | BEK | 4610-00-7104 | 16 |
| R223 R230 R245 R433 R453 | RES, C, 1/4W, 5%, 1M RC103-510 | CF1/4-1M | ASE | 4700-15-1004 | 5 |
| R225 R232 | RES, MF, 1/8W, 1%, 909K RF214-909 | MF55K-909K | ASE | 4701-03-9093 | 2 |
| R226 R229 R271 R274 R293 R296 R379 | RES, C, 1/4W, 5%, 4.7K RC103-247 | CF1/4-4.7K | ASE | 4700-15-4701 | 7 |
| R227 R228 R292 R381 R390 R391 R392 | RES, C, 1/4W, 5%, 6.8K RC103-268 | CF1/4-6.8K | ASE | 4700-15-6801 | 7 |
| R240 R365 | RES, C, 1/4W, 10%, 18M RC104-618 | CB1861 | A-B | 4700-16-1805 | 2 |