Serial No.____________________

CT SYSTEMS, INC.

INSTRUCTION MANUAL

MODEL 1403/1503

SWEEP GENERATOR

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CONTENTS

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

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek Models 1403 and 1503 are all-solid-state, electronically swept and tuned Sweep Generators covering the 1 to 300 MHz and 450 to 950 MHz frequency ranges. They are designed especially for testing and aligning television tuners and receivers. The Model 1403 covers the VHF (1 to 300 MHz) range while the Model 1503 covers the UHF (450 to 950 MHz) range.

An important feature of these instruments is their ability to be remotely controlled and programmed. This enables the sweep generator to be sequenced through the test procedure with pushbutton switches or electronic sequencers, instead of manual tuning and adjustments.

The instrument's most outstanding options are those of automatic operation. Simply stated, in automatic operation, the sweep generator's frequency and RF output level are automatically adjusted to follow the variations of the tuner. This provides considerable time saving during the alignment procedure.

Included with the automatic options are scope indicators that provide both frequency and RF output indications directly on the oscilloscope tube. Additional options include up to eight crystal-controlled RF markers (either single frequency or harmonic type) and local oscillator tracking markers.

By the use of a special combining cable, Models 1403 and 1503 may be operated as a combination unit providing independent frequency and output amplitude controls with a single set of scope horizontal and vertical cables. When operated as an automatic instrument, one set of local oscillator tracking markers, automatic level, and automatic frequency options provides control of both instruments.

All optional features, as well as the circuits for the basic sweep generator, have plug-in modular construction. This allows optional features to be factory-installed at the time of purchase, or customer-installed at a later date. This concept offers protection against obsolescence, since updated and additional features can be simply and economically added as new tuner designs and test procedures dictate.

Maintenance problems can be greatly simplified by the stocking of several modules instead of hundreds of discrete parts. Servicing time of a defective instrument can be cut to a fraction of the time previously required, and can be performed by relatively inexperienced technicians.

1.2 SPECIFICATIONS

1.21 RF OUTPUT

Frequency Range –	1 to 300 MHz (Model 1403) 450 to 950 MHz (Model 1503)
Blanking –	Retrace blanking of the RF output to provide a zero level base line.
Amplitude –	Continuously adjustable from +57 to +2 dBmV (.7 VRMS to 1.26 mVRMS) 35 dB in 5 dB steps plus 20 dB vernier.
Step Attenuator Accuracy –	±0.5 dB (Model 1403) ±1 dB (Model 1503)
Flatness –	±0.25 dB (read with negative detector)
Impedance –	75 ohms standard, 50 ohms optional (Model 1403) 50 ohms standard, 75 ohms optional (Model 1503)

1.2.2 SWEEP SPECIFICATIONS

Sweep Rate –	AC line frequency (50 - 60 Hz)
Sweep Width –	5 to 300 MHz (Model 1403) 5 to 500 MHz (Model 1503)
Display Linearity –	±2%
Horizontal Output –	16 Vpp (symmetrical about ground)

1.2.3 REMOTE PROGRAMMING

The rear-panel REMOTE jack provides necessary connections for remote control of frequency, sweep width, and output level.

Frequency –	May be remotely programmed by a ±16 V signal (-16 V corresponds to low frequency band end and +16 V to high frequency band end).
Sweep Width –	May be controlled by a remote potentiometer.
Output Level –	May be remotely programmed over a 20 dB range with a 0 to -18 V signal (-18 V corresponds to maximum output).

1.2.4 MARKERS

Type –	Birdy by-pass. Provision for 8 plug-in marker modules plus rear-panel external marker input. Markers may be either single frequency or harmonic (comb) type. (See Options A-1 and A-2.)
Accuracy –	±0.005%
External Marker Input –	Rear-panel BNC connector accepts external CW signal for conversion to a birdy marker. Input level: 100 mV into 50 ohms.
Marker Size –	Adjustable from approximately 3 mVpp to 3 Vpp.
Marker Width –	Approximately 400 kHz (wide), 100 kHz (narrow).

1.2.5 GENERAL

Power Requirements	115/230 VAC ±10% (approximately 20 W) 50 - 60 Hz.
Dimensions (including screw heads, knobs, and feet)	14.3 cm (5 5/8 in.) high 34.9 cm (13 3/4 in.) deep 20.9 cm (8 1/4 in.) wide
Weight	20 lbs. net 25 lbs. shipping

1.3 OPTIONS

A-1	Single Frequency marker at any frequency within instrument range.
A-2	Harmonic Marker at 1, 10, or 50 MHz (other frequencies available on special order) intervals.
B	Local Oscillator Tracking generates two pulse markers based on the IF output frequency from a tuner. These markers indicate RF bandwidth, local oscillator frequency, and tracking (module M7E). The markers can be any two frequencies within the IF input frequency range. With the addition of a capacitor, a channel-center pulse can be added if desired.
IF Input	
Frequency	28 to 47 MHz
Minimum Level	Approximately 1 mV (0.01 mV with RB Probe) at IF IN connector (Z in = 50 ohms).
C	Automatic Level Control And Scope Indicators provides automatic adjustment of the RF output level to correct for variations in the gain of the tuner under test. Also provided are visual indications of the instrument's center frequency and RF output level (module M8E).
D	A 70 dB (10 dB/step) Step Attenuator is available to replace the standard 35 dB (5 dB/step) Step Attenuator to provide greater RF output level range (7570-01, Model 1403; 5070-01, Model 1503). NOTE: Since the Step Attenuator increment is doubled, the automatic level range of Option C may be somewhat reduced.
E	Automatic Frequency enables the instrument to track the tuner under test, maintaining the demodulated response at the center of the scope display (Module M11E). NOTE: Option B is required with Option E.

1.4 ACCESSORIES

1.4.1 FURNISHED WITH INSTRUMENT	Instruction Manual. Spare plug with pins for remote programming (mates with REMOTE jack).
1.4.2 AVAILABLE AT EXTRA COST	Wide Band Detectors: D151 (50 ohms, up to 1000 MHz) D171 (75 ohms, up to 1000 MHz)

Model RB Probe provides additional IF amplification to extend the mimimum IF input level for Option B from 1 mV to 0.01 mV.

Service Kit (K102) contains module extender and RF extension cables.

Rack Mount Kit (K103) mounts single instrument into 19 inch rack (see Section 2.2.3).

Rack Mount Kit (K104) mounts one or two instruments into 19 inch rack (see Section 2.2.4).

Additional Marker Cabinet (K105) mounts to the instrument top cover allowing up to four additional marker modules (Options A-1, A-2).

Combining Harness (K106) enables combined 1403/1503 operation.

Image Test module (M112A) enables checking the image rejection of a tuner.

SECTION 2
INSTALLATION

2.1 INTRODUCTION

This section provides installation instructions for the Wavetek Models 1403/1503. The instructions include information on mechanical installation, including rack mounting, and electrical installation.

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 carrier and either the nearest Wavetek area representative or the factory in Indiana.

Retain 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 (K103 SINGLE KIT)

CONTENTS (See Figure 2-1).

ITEM	QTY	PART NO.
A (Side)	1	B000-608
B (Side)	1	C000-691
C (Screw)	8	HS101-806

PROCEDURE

Remove the screws from one side panel. Mount item A or B against side panel of the instrument and secure with screws provided. Repeat for other side of unit. Items A and B may be interchanged to position the instrument on desired side of rack.

2.2.4 RACK MOUNTING (K104 DUAL KIT)

CONTENTS (See Figure 2-2).

ITEM	QTY	PART NO.
A (Tray)	2	C000-729
B (Side)	2	C000-730
C (Handle)	2	HH101-002
D (Screw)	12	HS106-905
E (Screw)	4	HS103-908

PROCEDURE

Install both sides (item B) to one tray (item A) using the 10-32 x 5/16 thrust head screws (item D) provided. Position the instruments on the tray so that the instrument feet extend into the holes in the tray. When the instruments are properly seated, install the top tray (other item A) and secure with the remaining thrust head screws (item D).

NOTE

If the instrument being mounted is equipped with a bail, the bail must be removed prior to installation in the K104 Rack Mount Kit.

The handles (item C) are fastened to the sides with the 10-32 x 1/2 binder head screws (item E).

Mounting holes are provided for front mounting of instrument rear-panel connectors, if desired.

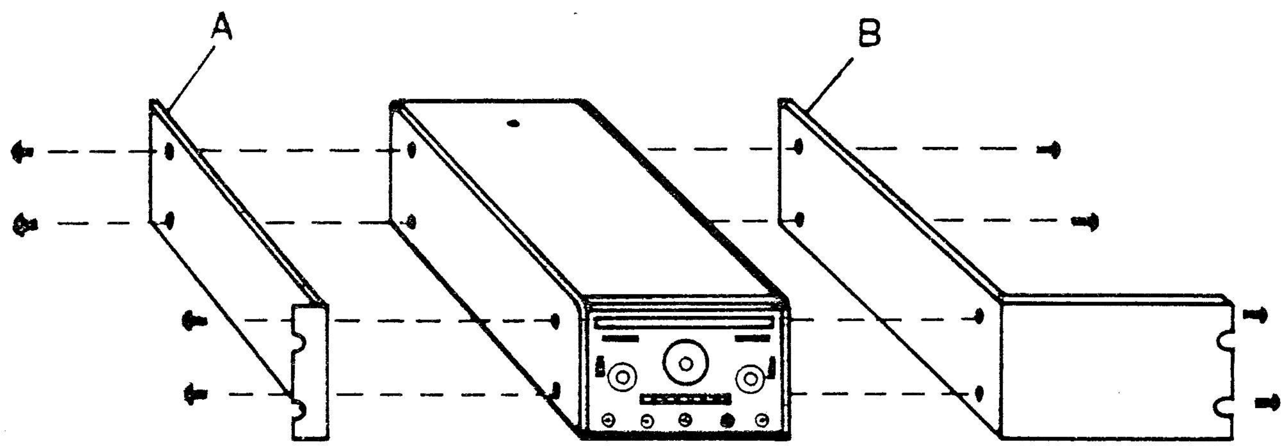


Figure 2-1. K103 Rack Mount Kit

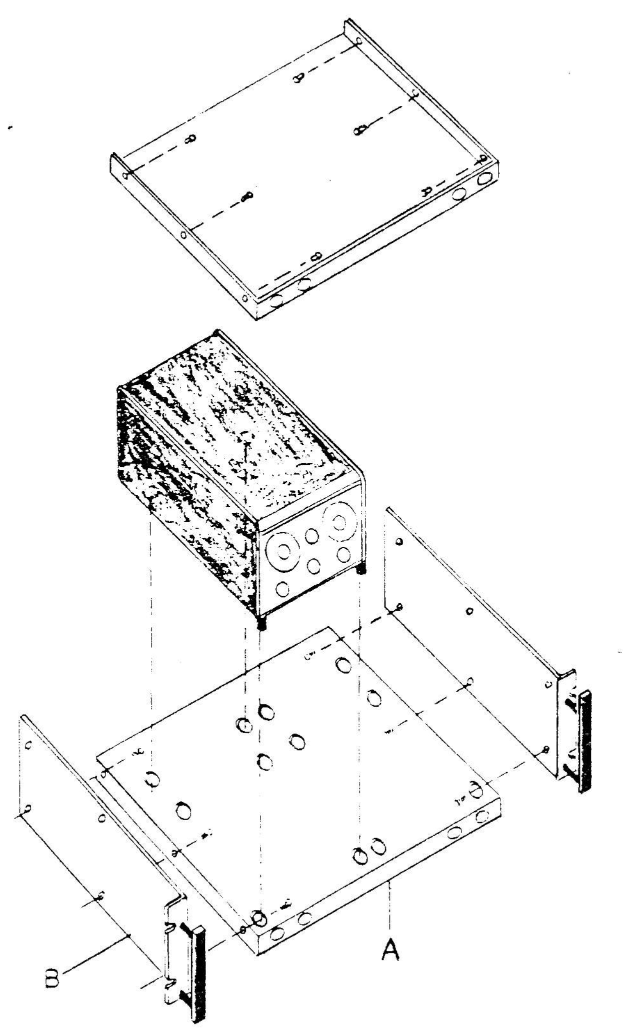


Figure 2-2. K104 Rack Mount Kit

2.3 ELECTRICAL INSTALLATION

Models 1403/1503 can operate from either 115 VAC or 230 VAC supply mains. The rear-panel AC LINE SWITCH selects which of these operating voltages is being used, and adjusts the Power Supply accordingly. The Power Supply is designed to operate at an AC supply frequency of 50 or 60 Hz.

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 AC LINE FUSE is the correct value for the supply voltage (see Section 3.3).

SECTION 3
OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section provides complete functional control description, operating instructions, and programming instructions for the Wavetek Models 1403/1503 sweep generators.

3.2 DESCRIPTION OF FRONT PANEL

(1) FREQUENCY control adjusts the center frequency when the AUTO FREQUENCY switch is down (manual operation). When this switch is up (automatic operation), this control is inactive.

(2) ATTENUATION control provides calibrated adjustment of the RF output in 5 dB increments from 0 to 35 dB.

(3) LEVEL control provides 20 dB vernier adjustment of the RF output when the AUTO LEVEL switch is down (manual operation). When this switch is up (automatic operation), this control is inactive.

(4) MARKER SIZE control adjusts the marker amplitude. When the knob is pulled out, the birdy marker width is reduced.

(5) MARKERS pushbutton switches control Option A-1 and A-2 markers (marker frequency is engraved on pushbutton).

(6) SWEEP WIDTH control adjusts the display sweep width from less than 5 MHz to the entire swept frequency range. When the knob is pulled out, the maximum sweep width is reduced to approximately 10% of the swept frequency range.

(7) POWER switch applies AC power to the Power Supply. The pilot light indicates operation.

(8) SCOPE HORIZ OUT connector (BNC) provides a 16 Vpp triangle waveform to drive the oscilloscope horizontal input.

(9) SCOPE VERT OUT connector (BNC) provides the combined demodulated RF and marker signal (and also the scope frequency and level indicators when Option C is installed) for connection to the oscilloscope vertical input.

(10) DEMOD IN connector (BNC) accepts the demodulated swept signal from the device under test so that RF markers may be added, and also adds the scope frequency and level indicators when Option C is provided. This signal is also used to control the automatic RF level circuits of Option C.

(11) PROBE POWER connector (BNC twinax) supplies ±18 V to power an external probe if needed for use with Option B or C.

(12) IF INPUT connector (BNC) accepts an IF sample from the device under test to generate IF tracking markers when Option B is installed.

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

3.3 DESCRIPTION OF REAR PANEL

(1) AC LINE SWITCH enables instrument to operate from either 115 VAC or 230 VAC supply mains.

(2) AC LINE INPUT cord provides connection to AC mains via 3 prong plug.

(3) AC LINE FUSE is time-delay; 0.5 amp for 115 VAC operation, 0.25 amp for 230 VAC operation.

(4) REMOTE jack and plug provide connections for programming of frequency and RF output level.

(5) OPTION mounting hole for BNC connector.

(6) EXT MARKER INPUT connector (BNC) accepts an external CW signal to produce a frequency marker on the display.

(7) PULSE MARKER OUTPUT connector (BNC) provides positive or negative pulse markers when Option B is installed.

(8) PULSE MARKER SIZE switch selects either negative or positive marker pulse. Control adjusts the amplitude of the pulses from 0 to more than 30 V.

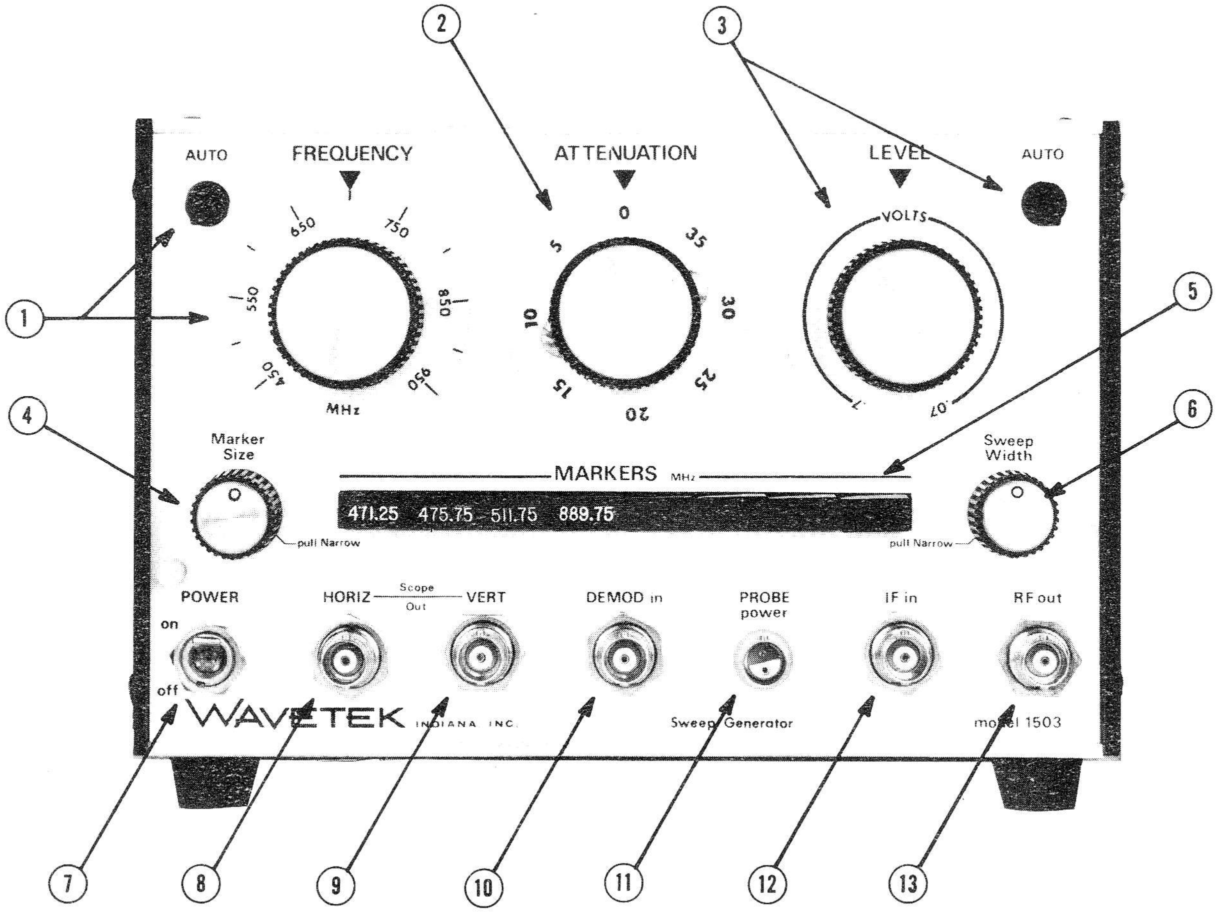


Figure 3-1. Front Panel

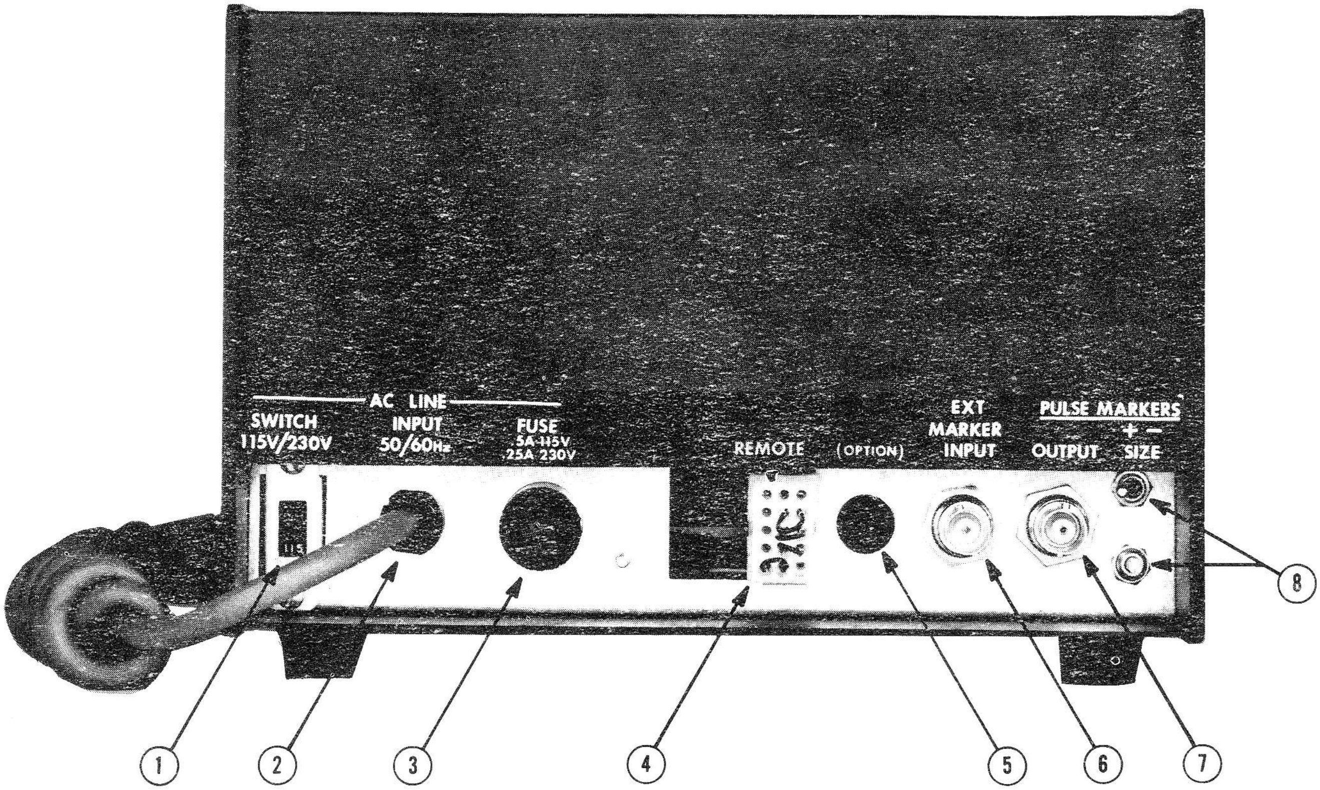


Figure 3-2. Rear Panel

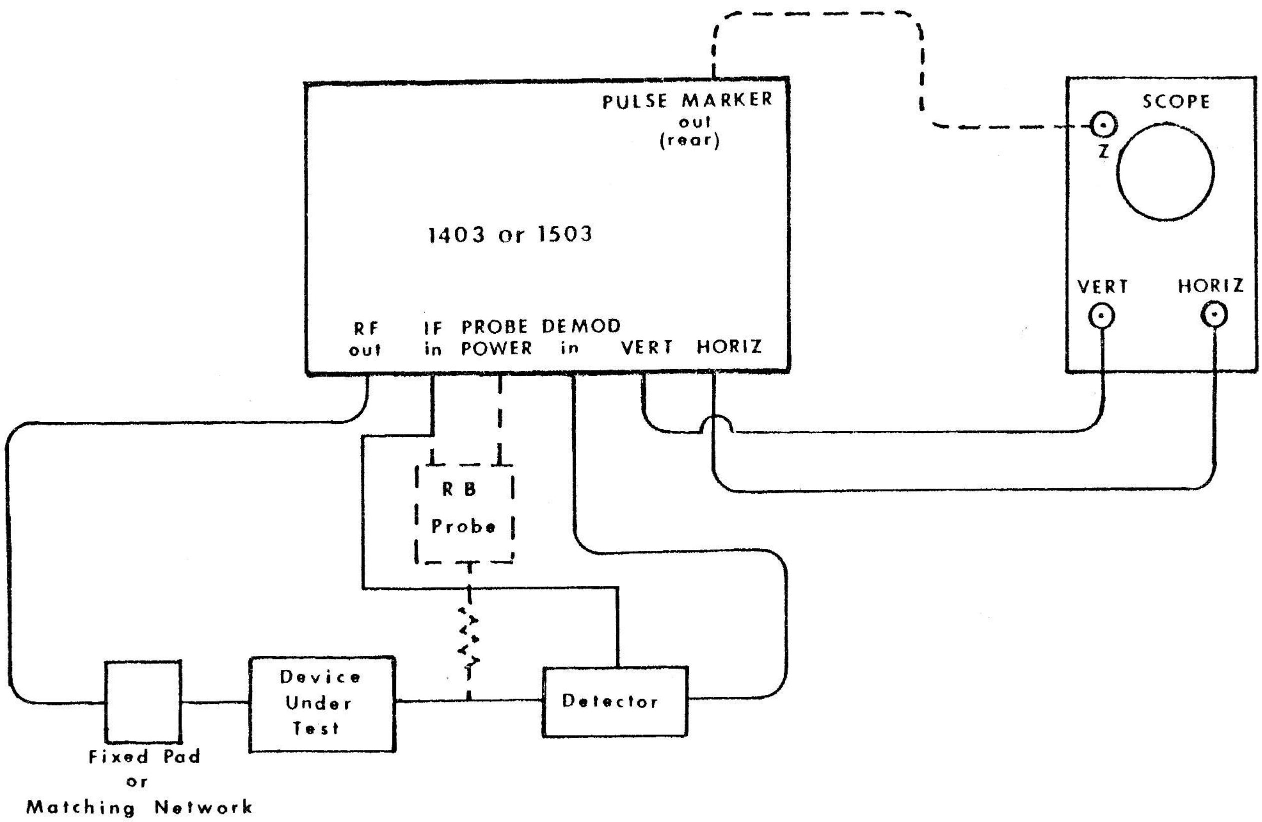


Figure 3-3. Typical Test Set-up

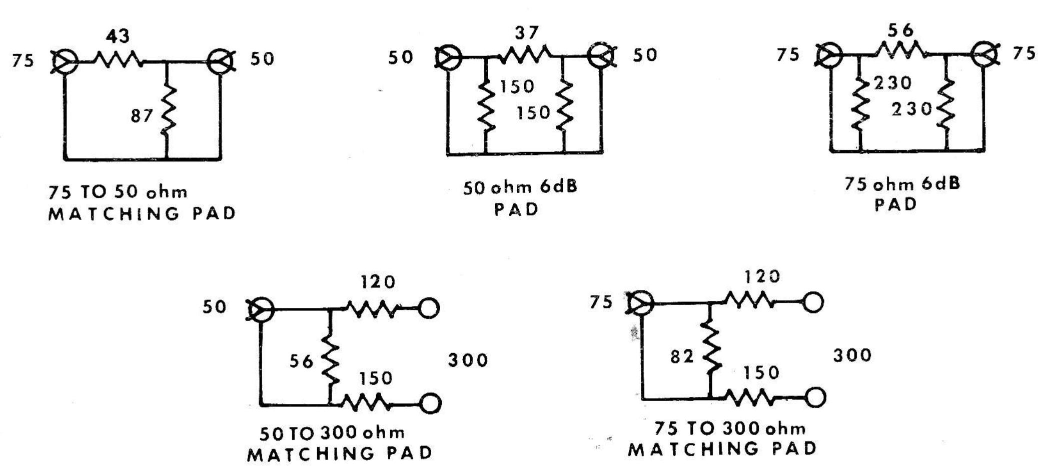


Figure 3-4. Typical Resistive Pads

3.4 TYPICAL OPERATING SET–UP

When initially setting up instrument, first check the rear-panel AC LINE SWITCH and FUSE to ensure the instrument is set for operation with the available AC mains. When Option C and/or Option E are to be used, refer to Sections 3.6 and/or 3.7 for adjustment of internal controls required for proper operation. Be sure the AUTO LEVEL and AUTO FREQUENCY switches are down before completing the set-up for manual operation.

Make connections between the sweep generator, the device under test and the oscilloscope as shown in Figure 3-3. Since hum, RF leakage, and spurious signal pickup must be kept at a minimum, it is essential that good connections and ground be maintained throughout the entire set-up. Coaxial cables with BNC connectors should be used wherever possible.

The RF output cable is especially critical. It must have a characteristic impedance identical to that of the sweep generator. The cable should be kept as short as practical (under 3 feet). This cable must also be terminated in it's characteristic impedance. This insures a constant amplitude input signal to the device under test. If the nominal input impedance of the device under test is the same as the cable impedance, but has a high VSWR, a fixed pad (normally between 6 to 10 dB) can be installed as shown in Figure 3-3 to mask this input mismatch. If the input impedance of the device under test is not the same as the cable's impedance, a matching network is used. Either a resistive pad (Figure 3-4) or a transformer matching network may be used. While the resistive pad is simple to construct, it provides more insertion loss than the balun-type transformer. The leads connecting the output of the pad to the device under test should be as short as possible (under 1 inch).

After the RF swept signal passes through the RF circuits of the device under test, it must be detected (demodulated) before being connected to the DEMOD IN connector or the scope vertical input. In the case of TV receiver alignment, the detector is already provided as a part of the receiver, while in aligning a tuner, an external detector must be used (see Figure 3-3). The detected signal is then connected to the DEMOD IN connector on the front panel.

After completing the set-up, switch the AC power on. The lamp should light, indicating an operating condition. This instrument requires no warm-up and is ready for immediate use. Turn both AUTO switches to their manual (down) positions and adjust the sweep generator controls for the required center frequency, sweep width, and output amplitude. Turn on the desired markers and adjust the marker amplitude and width as needed.

3.5 OPTION B–LOCAL OSCILLATOR TRACKING

The purpose of this option is to provide a method of precisely determining the local oscillator frequency. This is accomplished by producing markers which are related to the IF output signal. This option also provides the input signal to Option E (Automatic Frequency), and therefore must be installed when Option E is used. This option is contained entirely in plug-in module M7E, and can be either factory- or field-installed.

SET-UP INSTRUCTIONS

For receiver applications, the IF sample is obtained from a low-impedance pick-up coil, normally 2 or 3 turns air wound on a ½ inch form. The coil is positioned with reference to the receiver's IF amplifier until sufficient signal pick-up is obtained.

For tuner applications, the IF sample is typically obtained from a high-impedance source such as the 2.2 kΩ IF sample resistor in the detector shown in Figure 3-5.

When Option B is used, an IF signal of 1 mV or more must be supplied to the front-panel IF IN connector. This IF signal can be provided directly from the IF sample output of the detector, or from the IF amplifier contained in an external probe. The probe is used only when insufficient sample is provided by the detector (see Figure 3-3). If the probe is used, the required IF input from the device under test is 10 μV instead of 1 mV. This provides for a greater operating range of the marker, and looser coupling to the device under test. If IF markers are desired at trapped frequencies, the IF pickup must occur before the frequencies are trapped out.

The IF Adj control on top of the M7E module should be set completely clockwise. Because of the large AGC range of this module, this control seldom requires further adjustment.

Connect the rear-panel PULSE MARKER OUTPUT connector to the oscilloscope Z-axis input. Adjust the PULSE MARKER SIZE controls to produce the desired intensity modulation on the oscilloscope trace.

An alternate method of displaying the L.O. Tracking markers is as differentiated vertical pulses. For this method, the connection from the rear-panel PULSE MARKER OUTPUT to the scope Z-axis (intensity) input is omitted. The front-panel MARKER SIZE control is adjusted to provide the desired RF birdy marker amplitude, and the Pulse Size control located on the M5D module (see Figure 3-6) is adjusted in a clockwise direction until the desired IF pulse marker amplitude is obtained. The front-panel MARKER SIZE control will now simultaneously adjust the amplitude of the RF birdy and the IF pulse markers.

NOTE

The M5D Pulse Size control should be turned completely counterclockwise when the intensity markers are used.

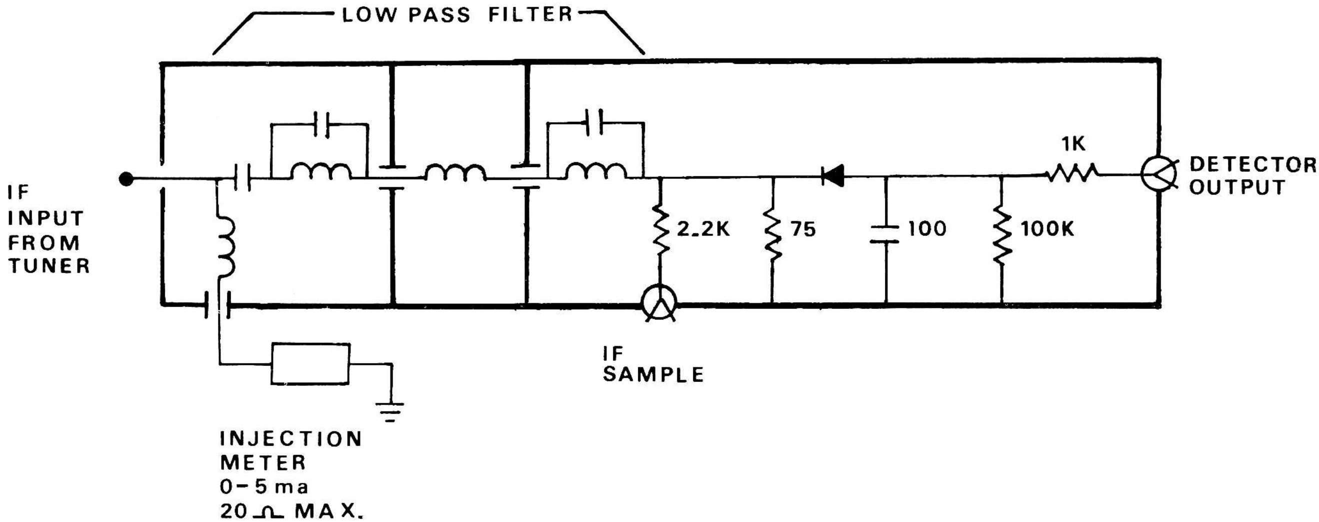


Figure 3-5. Typical Detector

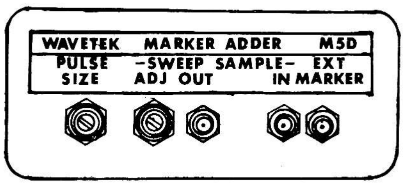


Figure 3-6. M5D Controls

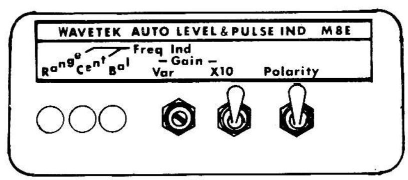


Figure 3-7. M8E Controls

3.6 OPTION C – AUTOMATIC LEVEL AND SCOPE INDICATORS

NOTE

When Option C is not provided, an M8 module base is installed to complete the marker adder circuit.

The purpose of the Automatic Level option is to maintain the scope pattern at a constant amplitude, regardless of the gain variation of the device under test. This is accomplished over a 20 dB range by controlling the 0 to 20 dB PIN diode LEVEL control in a closed-loop system. The Automatic Level option is entirely contained in plug-in module M8E, and can be either factory- or field-installed.

SET-UP INSTRUCTIONS

First, the desired operating level of the device under test must be established. This is generally determined by engineering specifications. The detected output from a typical UHF tuner without IF amplification is in the order of 10 mV, while the output from the IF second detector can be several volts. This option can accomodate detector outputs between 10 mV and 1 V of either positive or negative polarity. For detector outputs of less than 10 mV, additional gain must be added between the detected output and the instrument's DEMOD IN connector. Increasing the sensitivity of the Option C input, however, results in an increase in the noise level of the demodulated response, and also makes the test set-up more susceptible to stray signal and hum pick-up. More success in testing low-level tuners has been achieved by installing a well-designed wide band RF amplifier in the tuner test fixture between the tuner IF output and the RF detector. If the detected output is more than 1 V, a simple resistive voltage divider can be used to reduce the detected output voltage to less than the 1 V level.

Once the proper input level has been set, switch the M8E Polarity switch between positive and negative and adjust the M8E Bal control until the display base line does not shift when the Polarity switch is changed.

Temporarily connect the detector output directly to the scope vertical input and, with the instrument operating in the manual mode (both AUTO switches down), adjust the ATTENUATION and LEVEL controls to obtain the desired detector output from the device under test. Once set, do not disturb these controls until the M8E Gain controls have been adjusted. Reconnect the detector output to the DEMOD IN connector and the oscilloscope vertical input to the SCOPE VERT OUT connector. Set the oscilloscope's vertical sensitivity controls for .2 V/division (DC coupled). Set the M8E Polarity switch to obtain a positive scope pattern, and the X10 switch and the Var Gain control to obtain a pattern height of 1 V (see Figures 3-7 and 3-8). Finally, switch to automatic level operation, (front-panel AUTO LEVEL switch up) and adjust the ATTENUATION control until the output level indicator reads approximately .5 V. The LEVEL control is now inoperative.

As the gain of the device under test changes, the height of the output level indicator will vary, indicating the RF output change required to maintain the pattern at the 1 V level. The indicator is a linear indication of the RF output voltage (before the Step Attenuator) over a 20 dB range. A 0 V pedestal level indicates an RF output of .1 Vp and a 1 V level indicates an RF output of 1 Vp. The oscilloscope graticule can be calibrated in volts, dB, or indicate minimum or maximum gain points as desired.

The M8E module also provides a differentiated pulse which will change position on the base line relative to the center frequency of the instrument (see Figure 3-9). The indicator Range and Cent controls are provided to allow it to cover the entire scope horizontal scan for the frequency range being used.

Set the front-panel FREQUENCY control to the highest frequency to be used. Adjust the M8E Range control so that the indicator pulse is positioned slightly in from the right end of the display.

Set the FREQUENCY control to the lowest frequency to be used. Adjust the Cent control to position the pulse the same distance in from the left end of the display as the pulse was from the right end in the above step.

NOTE

The Cent and Range controls interact, so the above procedure must be repeated until the pulse is positioned properly on both the highest and lowest frequencies. Once calibrated, any change in the scope's horizontal position or sensitivity controls will change the calibration.

3.7 OPTION E – AUTOMATIC FREQUENCY

This option provides automatic frequency tracking of the sweep generator to the device under test for greater alignment efficiency. This is accomplished by sampling the combined frequency and sweep program voltage for the duration of an IF center frequency marker. The sampled voltage becomes the frequency program voltage for the next sweep cycle, thus keeping the response centered on the display. This feature is contained entirely in plug-in module M11E, and can be either factory- or field-installed.

SET-UP INSTRUCTIONS

First, Option B, Local Oscillator Tracking, must be installed and IF markers present on the display. Set the front-panel AUTO FREQUENCY switch to AUTO. Two adjustments

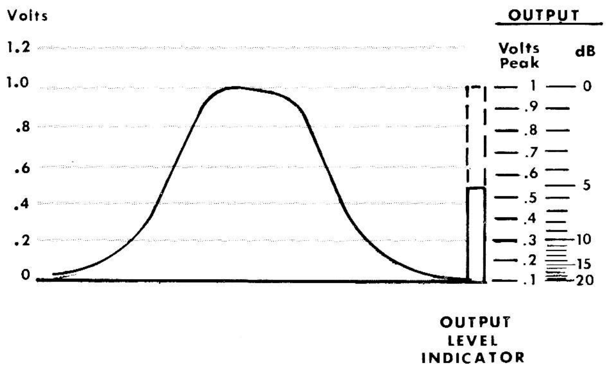


Figure 3-8. Level Indicator

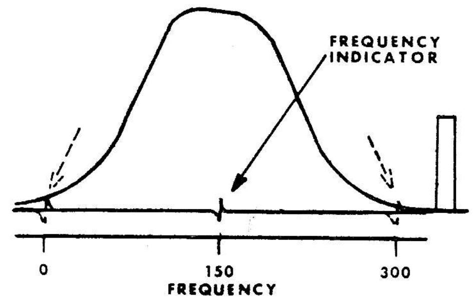


Figure 3-9. Frequency Indicato

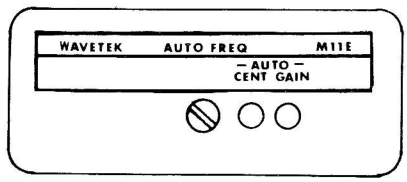
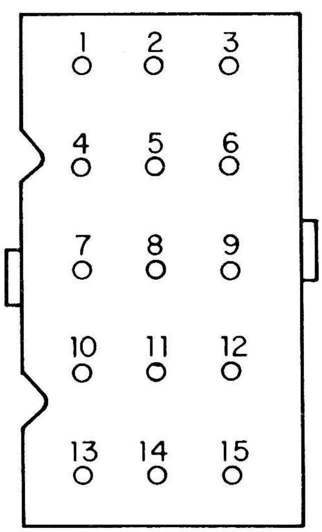


Figure 3-10. M11E Controls



VOLTAGE AND SIGNAL SOURCES

Pin 1	Ground
Pin 2	+18 V
Pin 3	-18 V
Pin 10	Sweep Ramp

CONTROL INPUTS

Pin 6	Output Level
Pin 9	Output Frequency
Pin 12	Sweep Width

INTERNAL CONTROLS

Pin 5	LEVEL
Pin 8	FREQUENCY
Pin 11	SWEEP WIDTH

Pins 13, 14, 15 are used only in
1403/1503 combined operation

Pins 4, 7 are unused.

Figure 3-11. REMOTE Jack

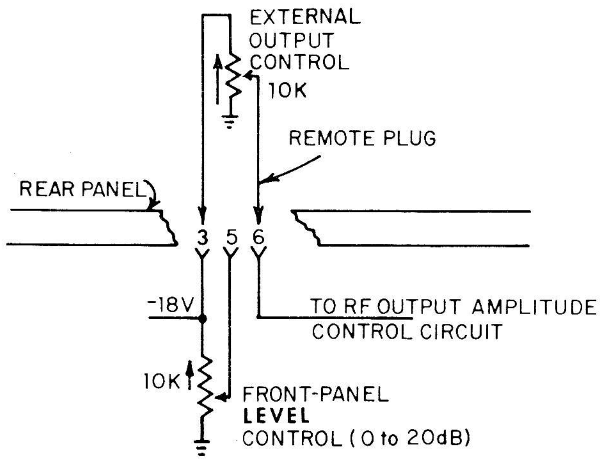


Figure 3-12. External Output Control

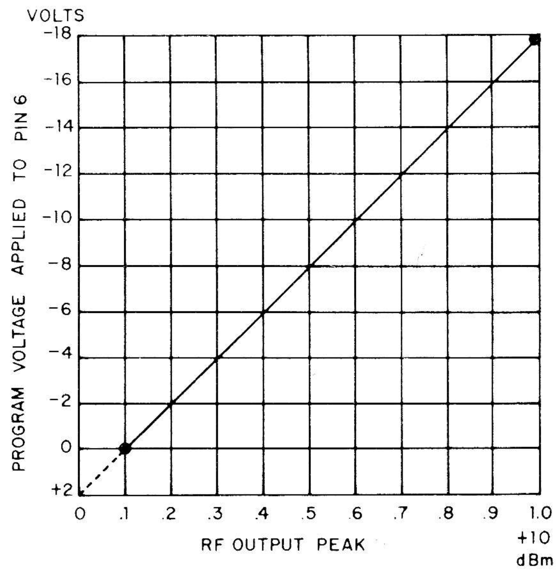


Figure 3-13. Voltage/Output

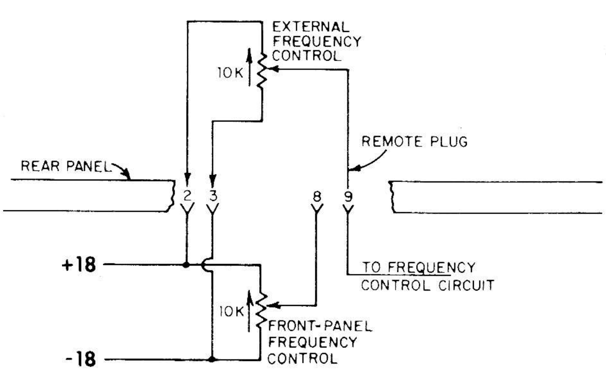


Figure 3-14. External Frequency Control

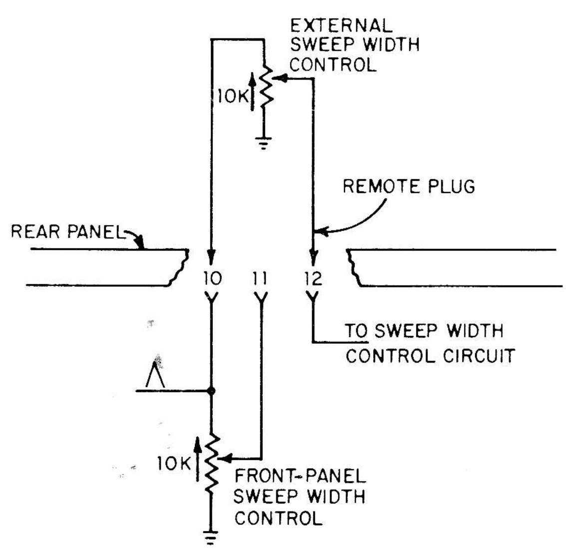


Figure 3-15. External Sweep Width Control

are provided on the M11E module (see Figure 3-10) to center the IF markers on the oscilloscope display. The Cent adjustment centers the display when the sweep generator's frequency is approximately mid-band (150 MHz, Model 1403; 700 MHz, Model 1503). The Gain adjustment centers the display when the sweep generator's frequency is at the extreme low or extreme high end of its range.

3.8 PROGRAMMING

Connections for remote control of output level, center frequency, and sweep width are provided on the rear-panel REMOTE jack. Also provided are connections for combined Model 1403/1503 operation (see Section 3-10). The REMOTE jack and its pin functions are shown in Figure 3-11.

Normal front-panel operation is provided by a REMOTE programming plug with jumpers between pins 5 and 6, 8 and 9, 11 and 12, and 13 and 14.

3.8.1 OUTPUT LEVEL CONTROL

To provide external control of the 0 to 20 dB LEVEL control, remove the jumper from pins 5 and 6 of the REMOTE plug and connect an external control as shown in Figure 3-12. The RF output is a linear function of the programming voltage as shown in Figure 3-13.

3.8.2 CENTER FREQUENCY CONTROL

To provide external control of center frequency, remove the jumper from pins 8 and 9 of the REMOTE plug and connect pin 9 to an external frequency control as shown in Figure 3-14.

3.8.3 SWEEP WIDTH CONTROL

To provide external control of sweep width, remove the jumper from pins 11 and 12 of the REMOTE plug and connect pin 12 to an external sweep width control as shown in Figure 3-15.

NOTE

The circuit as shown will control the wider sweep width range (up to 300 MHz on Model 1403 and 500 MHz on Model 1503). To externally control the narrower range (up to 30 MHz on Model 1403 and 50 MHz on Model 1503) normally activated by pulling the SWEEP WIDTH control out, a 91 kohm resistor should be connected between REMOTE plug pin 10 and the external sweep width control.

3.9 SPECIAL OPERATING NOTES

3.9.1 EFFECTS FROM OVERLOADING

The use of excessive input signals to the device under test can cause overloading. To assure that this condition is not present, and that the response is a true representation of the device under test, set the ATTENUATION and LEVEL controls for minimum output amplitude. Gradually increase the output amplitude until a response is obtained. Further increase of 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 just far enough to restore the proper configuration.

3.9.2 LOW—LEVEL MEASUREMENTS

When making measurements at low levels, radiation and ground loops become problems. Using double-shielded cables for carrying 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 scope 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.

3.10 COMBINED 1403/1503 OPERATION

Figure 3-16 shows the typical set-up to provide combined 1403/1503 operation.

The two rear-panel REMOTE plugs are removed and a special Combining Harness assembly (K106) is installed. This assembly also contains a VHF/UHF change switch. The plug adjacent to the VHF/UHF change switch is connected to the rear-panel REMOTE jack of the instrument designated as the "master". This can be either Model 1403 or 1503. The remaining plug is connected to the REMOTE jack of the "slave" instrument.

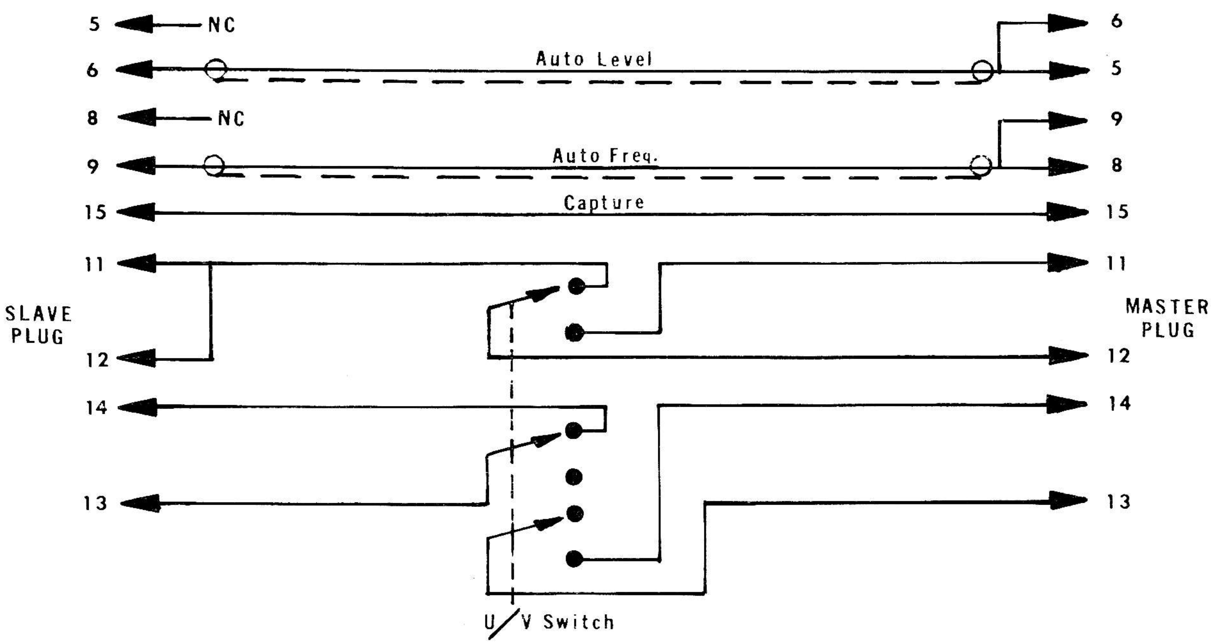
Both instruments have the desired RF marker "A" options. The "master" also has the L.O. Tracking (B) option, Automatic Level And Scope Indicators (C) option, and the Automatic Frequency (E) option, installed. For automatic operation, the slave unit cannot have Option C or E installed. The slave unit may have Option B installed, but it would not function since there is no IF input.

The AC line phase must be the same to both instruments. If it is not, reversing one of the AC plugs will correct the phase.

Set-up and operation of the instruments is identical as previously described with the exception of the additional external VHF/UHF selector switch. The AUTO switches and the FREQUENCY and LEVEL controls on the slave instrument are inoperative, but can be controlled by their counterparts on the master.

NOTE

Although the AUTO FREQUENCY switch on the slave is inoperative, it must be in the AUTO position for proper automatic operation.



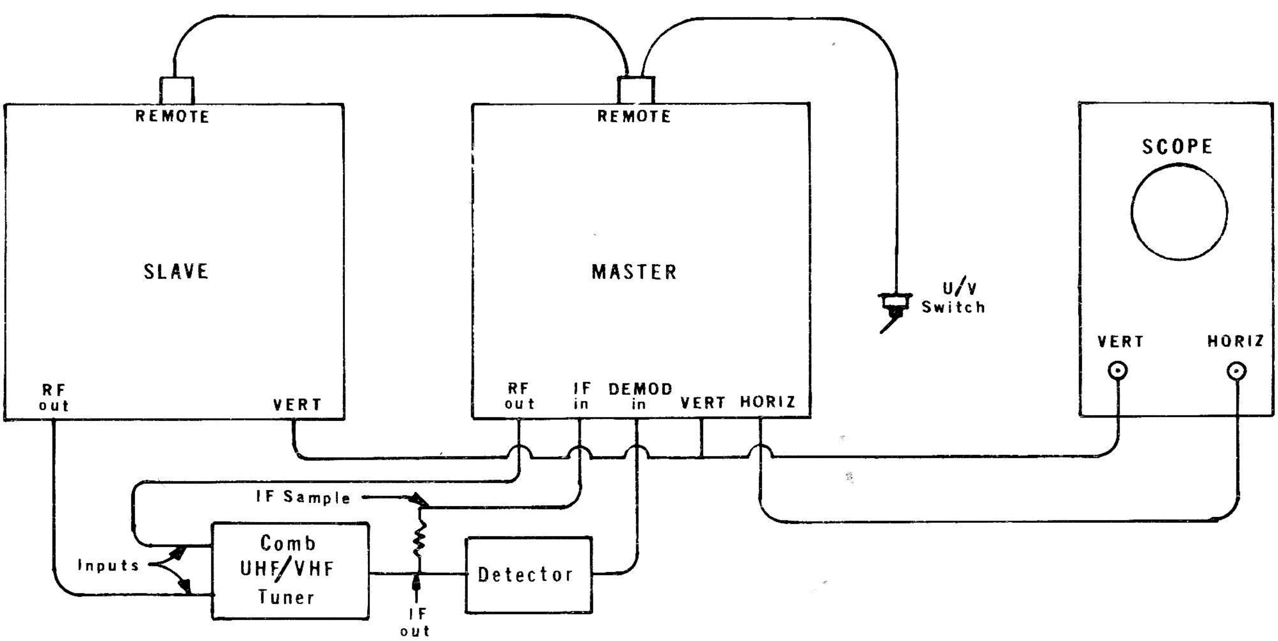


Figure 3-16. K106 Harness And 1403/1503 Combined Operation

SECTION 4
CIRCUIT DESCRIPTION

4.1 INTRODUCTION

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

Before beginning the actual circuit description it would be well to consider the mechanical arrangement of the instrument. 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. The mechanical arrangement can be seen by referring to Figure 5-15.

4.2 SIMPLIFIED BLOCK DIAGRAM

The block diagrams in Figures 4-1, 4-2, and 4-3 contain both block and module information. The blocks contained within each module are indicated by the shaded area. Figure 4-1 depicts the basic sweep generator and marker circuits in manual operation. Figure 4-2 depicts the circuits required for automatic frequency tracking operation. Figure 4-3 shows the automatic level control and scope indicator circuits.

4.2.1 MANUAL OPERATION DIAGRAM

The Power Supply provides regulated ±18 V sources, square and triangle wave generators for connection to the plug-in modules, and a pulse marker amplifier circuit.

The two power sources provide the voltage to the front-panel FREQUENCY control, while the triangle wave generator supplies the sweep ramp to the front-panel SWEEP WIDTH control. The output signal from the FREQUENCY and SWEEP WIDTH controls are then fed to the sweep drive circuits in the M2E-2 module where they are combined into a single signal which drives the frequency-determining varactor diodes in the Sweep Oscillator module. Necessary level shifting, shaping, and amplitude control are provided by the sweep drive circuitry.

The square wave generator turns the RF output and marker circuits off during retrace, and controls the timing of other circuits in the instrument.

The RF sweep generating circuits for Model 1403 are contained in the M9JA module containing a sweep oscillator, preamplifier, voltage-variable attenuator, wide band amplifier, monitor, and leveler amplifier.

The sweep signal is generated by hetrodyning a UHF sweep oscillator with a UHF CW reference oscillator in a diode mixer. The resultant difference signal is then preamplified, connected through the voltage-variable attenuator to the wide band amplifier, and sent to the monitor point.

Leveling of the RF output is accomplished by the monitor diode, which measures the RF voltage and compares it to a reference voltage supplied by the LEVEL control. Any error between the two voltages is amplified in the leveler amplifier and is fed back to the voltage-variable attenuator. This closed-loop system maintains a constant-amplitude RF signal at the monitor point, which compensates for amplitude variations in the sweep oscillator, mixer, and amplifier circuits, and also creates a zero impedance. A 75 ohm resistor is connected between the zero impedance point and the module RF Output connector to establish the source impedance of 75 ohms.

The output from the M9JA module is then connected through the Step Attenuator to the front-panel RF OUT connector.

The RF sweep generating circuits for Model 1503 are contained in the M9S-1 Sweep Oscillator module. The module contains a sweep oscillator, voltage-variable attenuator, monitor, and leveler amplifier. The output from the sweep oscillator is fed through the voltage-variable attenuator to the monitor point. Leveling of the RF output is accomplished in the same manner as previously described, and its source impedance is 50 Ω. The output from the module is then fed through the Step Attenuator to the RF OUT connector.

The marker circuit is comprised of Marker Adder module M5D, the individual Marker generators (M6), and the marker adder function of the M8/M8E module, which combines the markers with the scope vertical output. In addition to its marker adding function, the M5D module also levels the sweep sample signal in the same manner as the main RF output signal was leveled. This provides a constant-amplitude sweep signal to the individual Marker modules, which is extremely important in obtaining a "flat comb" output from the harmonic generating Marker modules. It also standardizes the sweep sample amplitude in all instruments, which insures proper operation of field-installed markers.

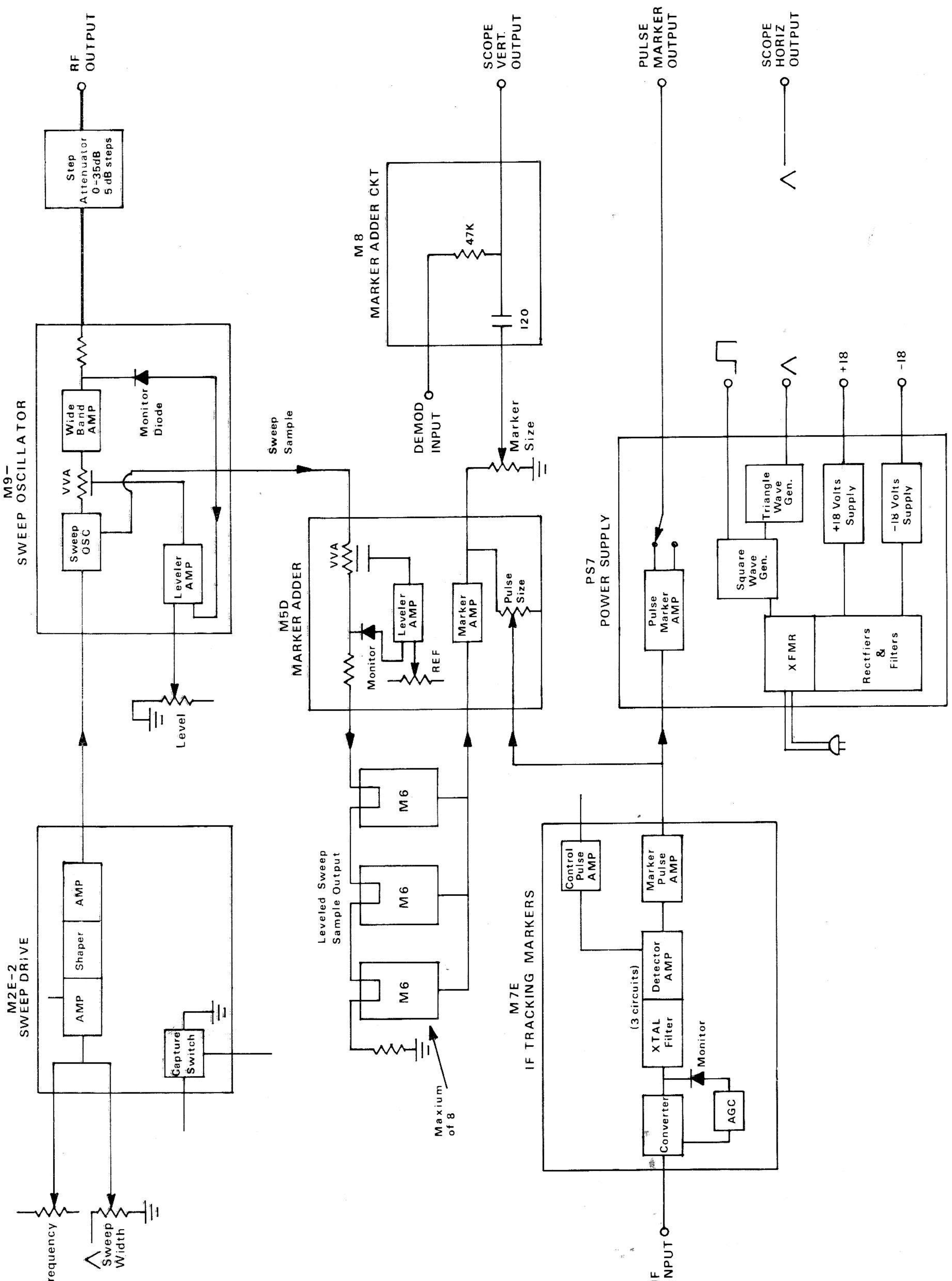


Figure 4-1. Manual Operation

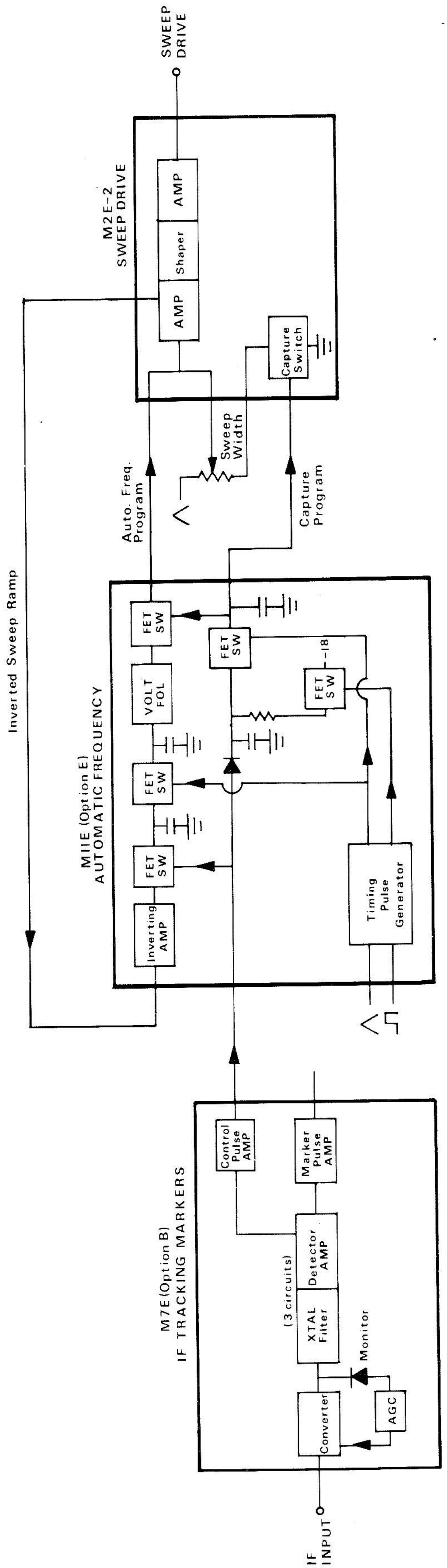


Figure 4-2. Auto Frequency Operation

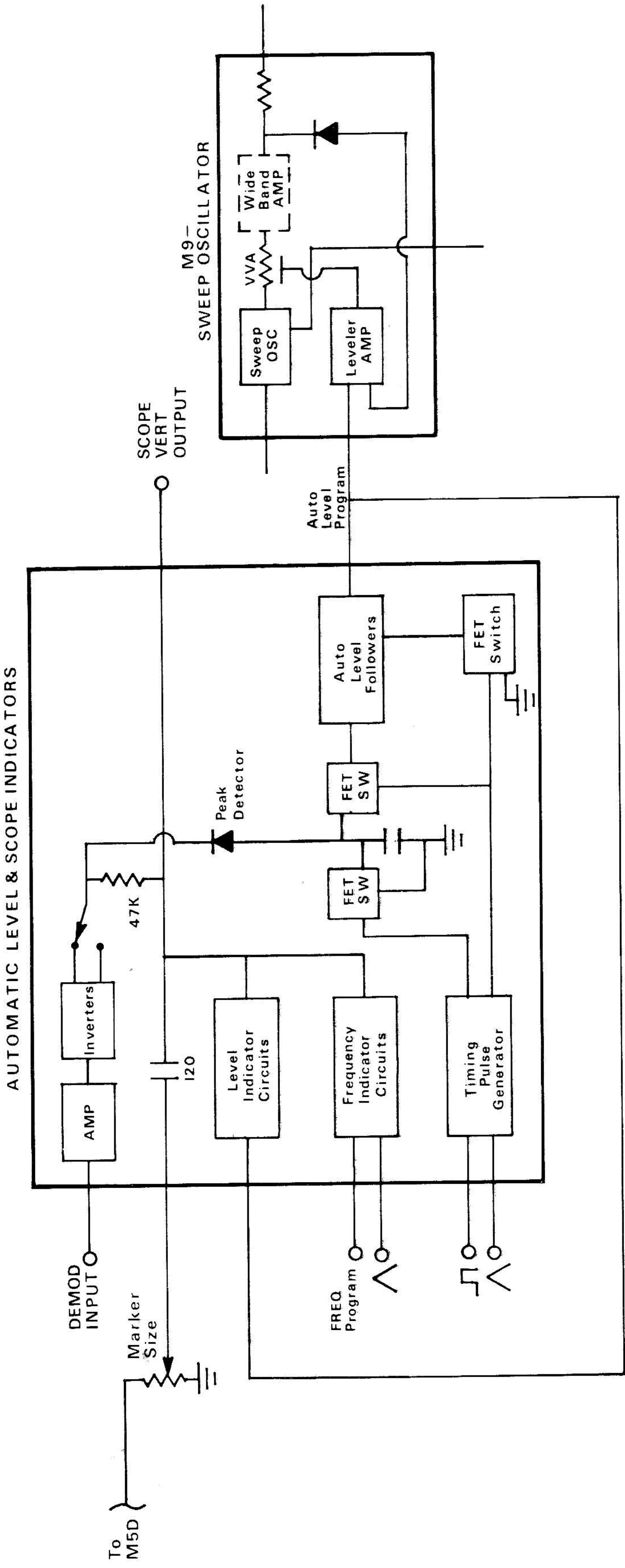


Figure 4-3. Auto Level Operation

This constant-amplitude sweep sample signal is then fed to the individual M6 Marker modules where it is combined in a mixer with a crystal-controlled CW signal. The resultant difference signal, which is the birdy marker, is then fed back to the Marker Adder module where the signals from all Marker modules are combined, amplified, and shaped into a single composite signal. This signal is then fed through the MARKER SIZE control to the marker adder circuit in the M8/M8E module where it is combined with the demodulated input signal. This combined signal is then routed to the front-panel SCOPE VERT OUT connector.

The M7E module provides pulse-type Local Oscillator Tracking Markers generated from an IF sample derived from a TV tuner or receiver. The conversion circuits, which are AGC'd to prevent loss of markers from insufficient IF sample during tuner alignment, convert the IF sample to approximately 10 MHz. (The converted signal generates RF markers in three crystal filters at equivalent converted frequencies.) The crystal filter outputs are detected and amplified in identical detector amplifier circuits, and are applied to the common marker pulse circuit which generates sharp, negative-going marker pulses.

The marker pulse circuit output is routed to the pulse marker amplifier circuit in the PS7 Power Supply, which provides either positive- or negative-going pulse markers at the rear panel.

The marker pulses are also fed through the M5D Pulse Size control to the marker adding circuit in the M8/M8E module, where they may be added to the detected response from the DEMOD IN connector.

4.2.2 AUTOMATIC FREQUENCY DIAGRAM

When Option E is provided, one crystal filter in Option B (module M7E) at the converted equivalent of the IF center frequency is used as an automatic tuning control marker, which is then fed to a separate pulse amplifier. The output of this control pulse circuit is then routed to the M11E Automatic Frequency module.

Option E provides an automatic frequency-tuning voltage to keep the tuner response curve centered on the oscilloscope display, and is dependent upon the control pulse from the M7E module. The input amplifier provides the required inversion of the signal from the M2E-2. Its output level at the duration of the control pulse is transferred to a capacitor which retains the voltage from the remainder of the sweep trace. The timing pulse generator produces a pulse occuring during the first half of the retrace which transfers this voltage to the reference input of the output amplifier. The output of this voltage follower then becomes the frequency program of the next sweep cycle.

The control pulse from the M7E also charges a capacitor to a high positive level. The first half retrace pulse transfers this voltage to the M2E-2 capture circuit, holding the FET switches on. If the control pulse did not fire, the capacitor would have a negative charge derived from a pulse occuring during the second half of the previous retrace. This negative voltage, when transferred to the M2E-2 capture circuit, would turn the FET switches off, thus opening the ground return to the SWEEP WIDTH control. The instrument would then be in the full sweep width or "capture" mode, essentially searching the full band for the presence of a control pulse.

4.2.3 AUTOMATIC LEVEL AND SCOPE INDICATORS DIAGRAM

The Option C automatic level circuit and level and frequency indicator circuits are contained in module M8E. The module also contains high-impedance, adjustable-gain scope preamplifier circuits and signal inverters to permit automatic level control with either high- or low-level tuners without using external DC amplifier probes. The level-indicator pulse and the marker signals from the front-panel MARKER SIZE control are combined with the demodulated input signal for connection to the scope vertical input.

THE FOLLOWING CIRCUIT DESCRIPTIONS ARE REFERENCED TO THE SCHEMATICS APPEARING IN SECTION 7.

4.3 POWER SUPPLY (PS7)

The PS7 Power Supply provides two regulated DC voltages, a square wave, a triangle wave, and amplified marker pulses.

AC POWER & RECTIFIER CIRCUITS

A dual-primary transformer allows operation at a line voltage of 115 or 230 VAC. AC power is supplied a 3-prong plug and is switched by the front-panel POWER switch. The transformer is located away from the Sweep Drive module to reduce magnetically-coupled line ripple.

Unregulated plus and minus voltages are supplied by two full wave rectifier circuits filtered by C1 and C7. A 12 pin plug, mounted to the printed circuit board, provides access to three unregulated voltages, the regulated ±18 V supplies, square wave, triangle wave, and an input to the marker pulse amplifier. R45 is a series voltage-dropping resistor for the power indicator, DS101.

+18 V SERIES REGULATOR

Regulation is provided by IC1 which contains its own internal reference. Resistor R9 provides an adjustment for +18.00 V. An external pass transistor, Q2, boosts the current capability, and transistor Q1 improves the current limiting characteristics of IC1 by providing amplification before limiting. The +18 V supply is protected against reverse voltage by diode CR7.

-18 V SERIES REGULATOR

The voltage reference for this supply is obtained from the +18 V supply through resistor R20. Resistor R19 provides feedback, applied to IC2, which provides high gain, forcing transistor Q5 to maintain a regulated voltage at the collector. Transistors Q3 and Q4 provide the series pass element, and are connected as a compound emitter follower so that the voltage across resistor R13 is not loaded heavily. Short-circuit protection of transistor Q4 is provided by diode CR8. Current limiting is provided by transistor Q5 when transistor Q6 conducts sufficiently to forward bias diodes CR9 and CR10. Reverse voltage protection is provided by diode CR12.

SQUARE WAVE GENERATOR

The 24 VAC from power transformer T1 is squared by comparator IC3A. Diodes CR13 and CR14 provide protection to the inverting input by limiting the voltage range to one volt. The square wave output drives the triangle generator input and is also applied to the base of Darlington emmiter follower Q7. CR15 limits the negative output to one volt. A positive 15 V, negative 1 V square wave is routed to pin 10 of P2 where it is provided to blank the RF output during retrace and to control the timing of other circuits in the instrument.

TRIANGLE WAVE GENERATOR

The symmeterical square wave output of IC3A is adjusted by R26 and is AC coupled to integrator IC3B to restore symmetery about zero. Diodes CR16 and CR17 protect the inverting input by limiting the voltage range to one volt.

Capacitor C13 in the feedback network provides the integrator configuration. This signal, applied to pin 8 of P2, provides the sweep ramp and scope horizontal drive, and controls the timing of other circuits in the instrument.

MARKER AMPLIFIER

Negative-going marker pulses from the M7E (Option B) module are routed through pin 7 of P2 and AC coupled to the base of PNP inverter Q12. The collector signal is coupled through R41 to the base of NPN inverter Q13.

Positive-going pulses are selected from the rear-panel PULSE MARKER SWITCH, S2, and coupled to the PULSE MARKER SIZE control, R44. The pulse is then applied to the PULSE MARKER OUTPUT jack, J5.

4.4 SWEEP DRIVE (M2E-2)

The M2E-2 module provides the drive voltage to the varactor diodes in the Sweep Oscillator module, and, when the Automatic Frequency option is used, provides an inverted sweep drive ramp to the M11E module. It also contains a capture circuit that causes the sweep width to increase to maximum if a command is received from the M11E when the IF input level from the tuner or receiver falls below a specific level.

OSCILLATOR DRIVE

The drive voltage to the varactor diodes is determined by the programming voltages applied to pin 5 and pin 7 by the FREQUENCY and SWEEP WIDTH controls. Resistors R3, R4, and R41 divide the frequency program so that it is equal to the sweep width program. The programs are summed to a standard voltage level in the input amplifier, IC1A, and then fed to the shaping circuit. Shaping diodes CR1 through CR5 conduct at levels determined by a resistor string driven by constant current source Q1. As each diode conducts, an additional current is fed into the summing junction of the output amplifier, IC1B. The output amplitude is set by R31, the Sweep Width control.

INVERTED SWEEP DRIVE RAMP

The output of IC1A is also fed to the M11E via pin 8 for use as a tuning reference.

CAPTURE CIRCUIT

FET transistors Q4 and Q5, in series with the SWEEP WIDTH control ground return, are normally conducting in the manual mode and in the automatic mode when an IF center frequency control pulse marker is present. (The transistors are connected in parallel to reduce the conduction resistance, which limits the minimum sweep width, to acceptable limits.)

When the tuner IF sample input falls below a level sufficient to generate markers, the automatic circuits provide a capture program at pin 10 that turns the transistors off. This produces a full-band sweep width program that overrides the front-panel SWEEP WIDTH control setting. When the IF response is restored, the capture program is removed, restoring the transistors to full conduction and the instrument to normal automatic frequency operation.

4.5 SWEEP OSCILLATOR, MODEL 1403 (M9JA)

The RF sweep signal for Model 1403 is generated by hetrodyning the output of a UHF voltage-controlled sweep oscillator with the output of a 1 GHz fixed frequency (CW) oscillator in a diode mixer. The difference frequency (1 to 300 MHz) is amplified by a wide band amplifier. A PIN diode voltage-variable attenuator, providing vernier RF level adjustment, is controlled by a leveler amplifier, which is regulated by an ALC voltage from the monitor diode.

The RF output of common base configured fixed oscillator Q1, operating at a frequency of approximately 1000 MHz, is coupled through inductors L2 and L3 to opposite terminals of the double-balanced mixer, consisting of diodes CR4, CR5, CR6, and CR7. R14 adjusts the output symmetery of this mixer bridge. Oscillator Q2 operates at a frequency of approximately 1000 MHz to 1300 MHz. The average frequency is adjusted by resistor R6 which controls the average bias on the cathodes of varactor diodes CR1, CR2, and CR3. The sweep drive voltage from pin 9 of the module is applied to the varactor diodes, decreasing their junction capacitance, thereby causing the oscillator frequency to vary from low to high. The sweep oscillator output is coupled to the other opposing terminals of the double-balanced mixer through inductor L4. The resultant difference frequency (0 to 300 MHz) is then preamplified by transistor amplifier Q4 and emitter followers Q5 and Q8. Transistor switches Q6 and Q7 provide RF blanking by shutting this preamplifier off during retrace.

Two RF outputs are provided from the preamplifier. One output is coupled via R27 and C15 to a wide band amplifier consisting of Q9, Q10, and Q11. The output of this amplifier is provided at J1 as the sweep sample signal to the marker generating circuits. The second RF output signal is coupled through R26 and C14 to the voltage-variable attenuator consisting of PIN diodes CR1, CR2, and CR3, which provides variable RF conduction proportional to the positive current supplied from the leveler amplifier.

The leveler amplifier, an operational amplifier consisting of Q13 and Q15, provides leveling of the RF output by supplying a positive current to the voltage-variable attenuator. A positively increasing output voltage from the leveler amplifier will produce an increasing RF output level.

RF blanking is effected by a positive input voltage from pin 10 to FET switch Q12, which causes the leveler output to go negative during retrace, thus shutting off the voltage-variable attenuator. (This effect is reinforced by the action of Q6 and Q7 in shutting off the preamplifier stage.)

Monitor diode CR13, near the RF Output jack, provides a negative DC voltage, related to the RF output level, to the inverting input of the leveler amplifier. Since an increasingly negative voltage at this input will reduce the positive current supplied to the voltage-variable attenuator, the RF output level is held constant, by negative feedback, at a level determined by the reference voltage at the leveler amplifier's non-inverting input. This reference voltage varies directly with the level program at pin 7. The magnitude of this negative voltage is determined by the Level Max control, which sets the maximum RF level when the program voltage is maximum. The Level Min control provides a small negative reference level when the program voltage is zero.

Three wide band amplifier stages, Q16, Q17, and Q18, amplify the signal from the voltage-variable attenuator by about 40 dB, with reduced frequency response below 1 MHz and above 300 MHz. Since the closed-loop leveling system establishes zero impedance at the monitor point, R8 sets the output impedance at 75 Ω.

4.6 SWEEP OSCILLATOR, MODEL 1503 (M9S-1)

This module contains an oscillator, a voltage-variable attenuator, a leveler amplifier and a monitor.

Transistor Q1 is a common base varactor-tuned oscillator, with biasing of the varactor diodes provided by transistors Q4 and Q5. The B- voltage for the oscillator is modulated by the blanking signal from pin 10 in transistor stages Q2 and Q3. This modulation causes the oscillator to be cut off during retrace, thereby providing a zero RF output level during retrace. The RF signal is coupled from the oscillator to a voltage-variable attenuator consisting of PIN diodes CR1, CR2, and CR3, which is controlled by the current flowing through the leveler pass transistor, Q10. This attenuator is part of the closed-loop leveling system which also includes monitor diode CR4 and leveler amplifier Q9, Q10, and Q11. CR4 provides a negative DC voltage related to the RF output level. This negative voltage is connected to one input of the leveler amplifier. The second input of the amplifier is provided by the LEVEL control. Any error between the two inputs is amplified and used to control the voltage-variable attenuator. This closed-loop system maintains a constant-amplitude signal at the monitor point, and allows adjustment of the signal over a 20 dB range. The 50 Ω output impedance is provided by resistor R8 connected between the monitor and the RF Output jack.

4.7 MARKER ADDER (M5D)

The main function of this module is adding together and amplifying the individual marker signals from the M6 Marker modules. It also contains the external marker mixer circuit and the sweep sample leveling circuit.

A low-level sweep sample signal, supplied from the Sweep Oscillator module, is connected to jack J2. This signal is then leveled in the same manner as the RF output signal. The voltage from the monitor diode, CR6, and the reference voltage from R52 is fed to the leveling amplifier consisting of transistors Q13 and Q14. Q12 provides blanking of the leveling amplifier. Any error between the two input signals is amplified and fed to PIN diode attenuator CR5. The operation of this circuit produces a constant-amplitude signal at the monitor point.

The leveled sweep sample signal is connected to the external marker mixer diode, CR1, and to the Sweep Sample Output connector, J4. R48, connected between the monitor point and J4, establishes the 50 Ω output impedance. The signal is then routed to each M6 Marker module.

The marker output signals from the individual M6 Marker modules are connected to input pins 1, 2, 3, and 4 of the M5D module. One or two M6 outputs are connected to each input. The signals are then amplified in the input stages (Q2, Q3, Q4, and Q5), and combined in the common collector load, comprised of R22 in parallel with L1. When the front-panel MARKER SIZE control is not pulled out, +18 V is applied to the gate of Q6, keeping the FET switch off. When the MARKER SIZE control is pulled out, the +18 V signal is removed. Q7 is turned on, connecting C10 from the compensated collector load to ground, thus reducing the marker bandpass and narrowing the markers.

The combined marker signals are then amplified in the operational amplifier comprised of transistors Q7, Q8, and Q9. The amplified signal is then fed to the complimentary output stage, Q10 and Q11, which is biased so that input signals of less than 0.5 V are not amplified. This eliminates most spurious markers and noise from the output.

The Pulse Size control, R40, accepts pulse markers from L.O. Tracking module M7E through pin 8. The pulse markers are combined with birdy markers at pin 7. The combined output is connected through the front-panel MARKER SIZE control to the M8/M8E module, and finally to the front-panel SCOPE VERT OUT connector.

4.8 MARKERS (M6)

Several types of marker modules are available to cover the frequency ranges of Models 1403/1503, and to produce single frequency and harmonic markers. These include:

M6S	SINGLE FREQUENCY	(Option A1)
M6H	HARMONIC	(Option A2)
M66H	DUAL HARMONIC	(Option A2)

SINGLE FREQUENCY

Single Frequency Markers produce one birdy marker at any specified frequency of the sweep generator. Each module contains a crystal oscillator, a mixer and a birdy amplifier. The various crystal oscillators employed can produce CW signals of from 1 to 55 MHz. For marker frequencies greater than 55 MHz, harmonics of the crystal frequency are used.

The output from the crystal oscillator (or harmonic generator, if used) is combined with the sweep sample in the mixer. The mixer includes a tuned circuit which selects the frequency from which the birdy is generated. A zero beat occurs when the sweep sample frequency equals that of the CW signal from the crystal oscillator (or harmonic generator). The difference frequency around the zero beat is amplified by the birdy amplifier, which has a bandwidth of less than 800 kHz, thus producing the marker.

INDIVIDUAL AND DUAL HARMONIC

Harmonic Markers produce birdy markers at evenly spaced intervals across the sweep generator frequency range. The crystal oscillator, operating between 1 and 55 MHz, sends a signal to a harmonic generator. The comb produced by the harmonic generator is combined with the instrument sweep sample in the mixer, which is untuned. This produces a series of zero beats at intervals equal to the crystal oscillator frequency. The mixer output is amplified by the birdy amplifier, which has a bandwidth of less than 800 kHz, thus producing the birdy markers.

In the Dual Harmonic Markers, the same process as above is employed to generate the birdy markers, except that a portion of the crystal oscillator output is sent to a countdown divider. The divider output is used to produce markers at 1/N the crystal frequency, where N is the divider factor. Thus, two sets of markers (in phase with each other) are produced.

For harmonic markers with a greater-than-55 MHz interval, the crystal oscillator is set up to produce a strong second harmonic of the crystal frequency. The fundamental is filtered out, and the harmonic frequency is sent to the harmonic generator.

4.9 OPTION B – L.O. TRACKING (M7E)

This option (module M7E) contains a conversion circuit consisting of a bandpass filter, RF amplifier, local oscillator, mixer, 10 to 20 MHz IF amplifier, and IF transformer. It also contains an automatic gain control (AGC) circuit, three crystal filters and their associated pulse preamplifier stages, a common marker pulse amplifier, and a reference pulse amplifier.

The input to the M7E is a sample of the swept IF signal from the tuner being tested. One output is a pair of pulses which correspond to the points in time when the tuner IF output sweeps through the video and sound frequencies. The second output is a pulse midway between the frequencies of the other two, and is primarily used as a control pulse in Option E.

CONVERSION CIRCUIT

The bandpass filter consists of the L/C tuned networks at the input to MOSFET Q1. The filter passes the frequency band from 30 to 50 MHz. Q1 is an amplifier that couples the IF frequencies to one input of mixer Q3. The other input receives the 55.75 MHz signal from crystal-controlled Colpitts oscillator Q2. The AGC voltage is also applied to the mixer at this point. The 55.75 MHz local oscillator heterodynes with the output of Q1 to provide output frequencies of approximately 8 to 21 MHz. After conversion, 10 MHz corresponds to 45.75 MHz input, 12.25 MHz corresponds to 43.5 MHz, and 14.5 MHz corresponds to 41.25 MHz.

Mixer Q3 and MOSFET amplifier Q4 drive stagger-tuned Pi-networks to provide the required flat response. Frequencies below 10 MHz are attenuated by choke L8. Frequencies above the desired band are attenuated by the low-pass filtering of the Pi-networks.

AGC CIRCUIT

A sample of the signal level is coupled from the collector of Q6 to the AGC circuit consisting of monitor diode CR2 and integrated circuit IC1.

CRYSTAL FILTERS AND PULSE PREAMPLIFIERS

The secondary of T1 is center tapped to provide two opposite-phase signals to each of the three crystal filters. The crystal filter outputs are nulled for zero output, except at resonance, by variable capacitors C30, C32, and C34. These crystal filters provide sharp bursts of energy at their series-resonant frequencies. In each case, the crystal in the filter is selected to produce a frequency equal to the difference between the M7E local oscillator (55.75 MHz) and the desired marker. (For U.S. standard sound and video, these are: 55.75 - 41.25 = 14.5 MHz, and 55.75-45.75 = 10 MHz.) The RF bursts are detected by CR3 and amplified by Q7. Emitter follower Q8 provides a low impedance to drive amplifier Q9, providing sharp pulse inputs to the common pulse marker amplifier, Q10 and Q11.

REFERENCE PULSE AMPLIFIER

The output from Q8B drives the reference pulse amplifier, producing the control pulse for Option E. The first stage, CR5 and Q12, duplicates the function of CR4 and Q9, as described above. The second stage, Q13, amplifies and inverts the pulse. The positive going pulse is then routed through pin 8 to the Automatic Frequency module, M11E. Adding a .05 μF capacitor between Q8B and CR4B allows the control pulse to also be brought out with the tracking marker pulses.

4.10 OPTION C – AUTOMATIC LEVEL AND SCOPE INDICATORS (M8E)

This option (module M8E) provides adjustable 40 dB gain to the demodulated input from the front panel, selectable polarity circuits, and an RC network for adding markers to this demodulated signal. It primarily provides an automatic RF level (attenuation) DC voltage to the Sweep Oscillator module level control input, automatically adjusting the RF output level for a constant-amplitude demodulated tuner response. The module also provides oscilloscope indications of the RF level program by means of a vertical pedestal (pulse) on the retrace base line whose amplitude varies directly with the RF level program amplitude, and of the frequency (tuning) program by means of a narrow differentiated pulse that moves across the base line in ascending frequency from left to right.

DEMODULATED INPUT AMPLIFIER, INVERTER, AND MARKER ADDER

The demodulated response of the tuner under test is fed from the DEMOD IN connector to pin 8, and is AC coupled to FET source follower Q1, then to IC1A. Diodes CR1 and CR2 and divider network R8 through R11 provide input gate protection. The Var Gain potentiometer in the feedback network adjusts the amplifier gain. The output signal is applied to the low gain (x1) contact of switch S1 and to IC1B, which is set for a ten to one voltage gain (20 dB). The 20 dB Gain adjustments are provided so that automatic RF level programming may be used with both high and low level tuners without using external active DC probes. The signal at the common contact of the Gain x 10 switch, S1, is capactively coupled to transistor Q4, then to IC2A. Q5, which saturates when the positive blanking square wave is applied to its base, is provided to restore DC level, and Bal control R14 adjusts for a zero volt baseline. The output signal is applied to the (inverted) contact of Polarity switch S2 and to the inverting input of IC2B, which is set for a gain of -1. The inverted signal is fed to the (normal) contact of the Polarity switch. A positive response pattern is selected for the proper operation of the Automatic Level circuits. (The high gain, wide range, and selectable-polarity circuits just described are provided so that responses of various DC levels may be brought within the operating range of the auto level circuitry, permitting the use of detectors of either polarity in the test set-up without requiring the use of external polarity-inverting amplifiers.)

The signal at the common contact of the Polarity switch is fed through R27 and pin 9 to the front-panel SCOPE VERT OUT connector. Markers from pin 7 are combined with the output signal through C5.

AUTOMATIC LEVEL PROGRAM CIRCUITRY

The auto level circuitry senses the demodulated peak response at each sweep cycle, compares it to a pre-set reference voltage, and regulates the program voltage to the 20 dB PIN diode attenuator in the Sweep Oscillator module so as to maintain the tuner response at a one volt level. This function is implemented by two sequential time-related pulses. The first is a sampling pulse occuring during the first half of retrace, the second is a discharge pulse which occupies the remaining half of the retrace cycle.

The peak level of the demodulated response is detected by diode CR6 and capacitor C22. The RF blanking square wave, at pin 10, is level-shifted to near-symmetry about ground through Q8. The triangle wave at pin 4 is applied to the non-inverting input of comparator IC4A, producing a positive square wave in the half cycle when the triangle wave is positive with respect to ground, i.e., the last half of the trace cycle and the first half of retrace. When both the signal at the collector of Q8 and at the output of IC4A are positive, diodes CR4 and CR5 do not conduct. The voltage at their anodes is then pulled up through R59, producing a positive pulse during the first half of retrace. This pulse, by turning FET switch Q11 on, transfers the voltage on C22 to C23, which is connected to the error amplifier consisting of Q12, Q13, and IC7A. C23 holds the voltage for the duration of the sweep cycle. The output of IC7A is connected to a follower consisting of Q16, Q17, and IC7B.

The output of IC7B is fed through zener diode CR8 to the base of emitter follower Q18. Since this program voltage will vary between -18 and 0 V, Q18 is supplied from -30 V. R88 in series with the collector provides current overload protection.

When the demodulated output voltage exceeds 1.25 V, the response at the common of S2 causes common base transistors Q14 and Q15 to conduct, turning on FET switch Q19. This inserts R84 into the IC7B feedback loop, increasing the feedback to quickly adjust the automatic level program.

During the last half of the retrace cycle, Q9 is turned on. FET switch Q10 discharges peak-detector capacitor C22 so that the detector network is reset for the next sweep cycle.

RF LEVEL INDICATOR PULSE CIRCUITRY

The RF Level Program is fed to pin 6 and applied to the inverting input of operational amplifier IC3B, which converts the -18 to 0 V RF level program to a +1 to 0 V program when it is combined with the demodulated output signal at the junction of R27 and pin 9.

The RF-blanking square wave from pin 10 is differentiated by capacitor C8 and resistor R32, and is applied to the base of transistor Q6. Q6 inverts and amplifies the positive leading spike derived from the start of retrace. The negative-going pulse output from the collector of Q6 is differentiated by C9 and R34. The negative-going leading spike is then used to trigger the timer, IC5. This trigger sets a multivibrator which releases a short circuit around capacitor C10. C10 charges to a positive voltage at an exponential rate determined by the RC time constant of the capacitor and R35. When C10 has charged to 2/3 of the timer's B+ supply voltage, the multivibrator resets, quickly discharging the capacitor. The timer output is less than +.25 V before it is triggered, and at least +10 V during the charging time of C10. The high positive voltage overrides the negative bias on the gate of FET switch Q7, turning it on. When Q7 conducts, the converted level-program voltage at R39, described earlier, is transferred to pin 9. The result is a vertical pedestal pulse on the retrace base line located at the extreme right hand side of the scope display. The pulse amplitude indicates the RF level program.

FREQUENCY INDICATOR PULSE CIRCUITRY

The tuning program at pin 6 is inverted by operational amplifier IC3A, and the inverted program fed to the non-inverting input of comparator IC4B, where it offsets the adjusted triangle wave from pin 4. Freq Ind Range control R47 adjusts the amplitude of the triangle waveform and Freq Ind Cent control R43 adjusts the offset level at the comparison point. The comparator output is a positive pulse starting and terminating at the points in time when the adjusted offset triangle wave is greater than the zero volt reference.

The output of comparator IC4B is differentiated by C14 and R48. Diode CR3 removes the positive trace spike. The negative retrace spike triggers the timer, IC6, which functions in the same way as the level indicator pulse timer, IC5, described above. The RC time constant of C16 and R50 establishes the duration of the positive pulse output. The timer output pulse is differentiated by C18 and R52, and combined with the demodulated output through R54. Since the timer is triggered by the negative spike only, the frequency indicator appears only on the retrace base line as a narrow differentiated pulse that moves across the base line in step with the tuning program.

4.11 OPTION E – AUTOMATIC FREQUENCY (M11E)

This option (module M11E) provides two program signals. The first is an automatic frequency-tuning voltage to the M2E-2 Sweep Drive module to automatically position the demodulated tuner response in the horizontal center of the oscilloscope display. The second is a capture command program voltage to the M2E-2 to cause this module to apply a full sweep width program to the Sweep Oscillator module. This insures that, provided the tuner is functional, the IF response will appear somewhere in the band, allowing the automatic tuning function to operate. (This capture voltage appears only when the IF signal level to the M7E module falls below the level required to generate a control pulse marker.)

The two Option E signals are enabled by three sequential time-related pulses. The first of these is a control pulse, derived from module M7E, which occurs only for the duration of that pulse during forward sweep. The second is a transfer pulse, occuring throughout the first half of retrace. The third is a reset pulse, which occupies the remaining half of the retrace period.

4.11.1 AUTOMATIC FREQUENCY CIRCUITS

The Automatic Frequency circuits consist of the inverted sweep ramp amplifier, the transfer circuit, and the automatic tuning voltage follower.

INVERTED SWEEP RAMP AMPLIFIER

The inverted sweep drive ramp from the M2E-2 is connected through pin 1 to the inverting input of operational amplifier IC1A. Auto Gain control R2, which is in both the input and the feedback loop, effectively adjusts the range of the automatic frequency program. Auto Cent control R4 sets the average DC level of this input, and is effectively an automatic tuning program mid-band adjustment.

The inverted ramp is also applied to the inverting input of comparator IC2B. The Low Limit control offsets this input so as to switch the comparator output from the positive to the negative state as the tuning voltage level increases beyond the sweep oscillator low-frequency limit. The negative comparator output shuts off FET switch Q1, which is in series with the IC1A output, thereby preventing the automatic tuning program from ranging more negative. (This circuit is necessary in Model 1403 so that, when in the capture mode, the automatic circuits will not find and lock in on an "image" IF frequency beyond the hetrodyne zero beat of the sweep oscillator.)

TRANSFER CIRCUIT

The control pulse from module M7E turns FET switch Q2 on. This transfers the output voltage level of IC1A during the pulse duration to capacitor C3. C3 stores this voltage for the remainder of the forward sweep.

AUTOMATIC TUNING VOLTAGE FOLLOWER

The transfer pulse, during the first half of retrace, turns FET switch Q3 on. This transfers the voltage present on capacitor C3 to C4, which is connected to the FET input voltage follower comprised of Q4, Q5, and IC1B. Protection diodes CR1 and CR2, connected with divider networks R13/R14 and R15/R16, prevent the input voltage from exceeding ±9 V. The output voltage is sent to the M2E-2 as the frequency tuning program for the next sweep cycle.

4.11.2 CAPTURE PROGRAM CIRCUIT

The capture program circuits consist of a control pulse detector and FET capture switch circuits.

CONTROL PULSE DETECTOR

The +30 V control pulse causes diode CR3 to conduct, charging capacitor C10 to a +18 V level. This charge is retained for the remainder of the forward sweep.

CAPTURE SWITCH CIRCUITS

The transfer pulse in the first half of retrace turns FET switch Q10 on, transferring the voltage present at C10 to C11 and pin 6. This positive voltage keeps parallel FET switches in the M2E-2 module turned on, providing a path to ground for the front-panel SWEEP WIDTH control, thus maintaining the preset sweep width program. If a control pulse has not charged C10, the switches in the M2E-2 are turned off, providing full sweep width for the next sweep cycle or until the control pulse reappears. Meanwhile, FET switch Q11 is turned off, disconnecting the automatic tuning program. This causes the sweep generator center frequency to return to the center of the band when in the capture mode of operation.

4.11.3 TIMING PULSE CIRCUITS

The timing pulse circuits consist of a control pulse amplifier, located in module M7E, and transfer and reset pulse generators described below.

TRANSFER PULSE GENERATOR

The triangle wave signal at pin 4 is connected to the non-inverting input of comparator IC2A, which produces a positive rising square wave coincident with the positive rising zero voltage crossing of the triangle wave input.

The blanking square wave at pin 10 is connected to the emitter of common base configured transistor Q6, which converts it to a square wave symmetrical about ground, with collector output negative during forward sweep and positive during retrace. When the positive periods of IC2A and Q6 coincide during the first half of retrace, neither diode CR4 nor CR5 conduct. Their anode voltage rises to a positive level established by the current through R15 as supplied by +18 V, producing the positive transfer pulse during the first half of retrace.

RESET PULSE GENERATOR

Common base configured transistor, Q7, is turned off during forward sweep by the negative period of the symmetrical square wave from Q6 at its emitter. Q7 is likewise turned off during the first half of retrace by the positive transfer pulse at its base. During the second half of retrace, CR4 conducts, driving the base of Q7 negative and turning it on. The resulting positive discharge pulse is connected through FET emitter follower Q8 to the base of Q9, turning it on and discharging any positive voltage present on C10, thereby resetting this control pulse-sensing capacitor for the next sweep cycle.

SECTION 5
MAINTENANCE

5.1 INTRODUCTION

This section provides information for testing, calibrating, and troubleshooting the Wavetek Models 1403/1503. The performance test is designed for incoming inspection and periodic evaluation. If performance is not to specifications, refer to the calibration and troubleshooting sections.

5.2 SERVICE INFORMATION

5.2.1 DISASSEMBLY INFORMATION

REMOVAL OF BOTTOM COVER -- Remove the two rear feet (A) and lift cover off with a slight rearward movement.

REMOVAL OF TOP COVER – Remove the single screw (B) from the top and lift off cover with a slight rearward movement.

REMOVAL OF SIDE PANEL – Either side panel can be removed to provide better access by removing the four screws holding the side panel to the instrument. The front-panel module section can be removed from the power supply section by removing two screws holding the sections together and by disconnecting the electrical connectors between the two sections.

NOTE

Separation of the two sections performs no useful purpose during normal service procedure.

5.2.2 MODULE SERVICING

SERVICE KIT K102 – This kit contains a module extender and RF extension cables which enable the module to be electrically operated while physically located above the rest of the modules, thereby making all parts easily accessible.

REMOVAL OF MODULES – Modules may be removed by removing any cables attached to the top of the module and removing the hold-down screw (C) from the bottom.

REMOVAL OF MODULE COVER – Remove all nuts and screws from top of module and slide the cover off.

REINSTALLING MODULE – Before reinstalling the module, check the module pins for proper alignment, then carefully seat the module pins into the chassis socket and replace the hold-down screw (C) to ensure a good ground connection between module and chassis.

MODULE PIN NUMBERING SYSTEM – The module pins are numbered as shown in Figure 5-2. The index stud for each standard module is located off-center to prevent the module's being plugged in backwards. This off-center stud location also provides a method for locating pin 1.

5.3 PERFORMANCE CHECK

The following procedure is intended to ensure that the instrument meets its published specifications. The checks specified assume that the instrument is equipped with Option A-1 and A-2 markers as specified in Table 5-1. While it is possible to check the instrument's performance without the use of harmonic markers by using suitable external CW sources, a complete check by this method is impractical. The required performance is shown in Section 1.2, Specifications.

NOTE

If Option C is installed, replace module M8E with an M8 module base until the basic sweep generator performance checks are complete. Substituting this module will eliminate the need to change the automatic level setup controls to verify the performance of the instrument. If this module substitution proves inconvenient, adjust the M8E Gain controls for unity gain and the Polarity switch for negative output before proceeding. The frequency and level indicating pulses will appear on the scope pattern along with the normal demodulated display.

5.3.1 TYPICAL SET–UP

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

FREQUENCY	mid-range
SWEEP WIDTH	full cw
ATTENUATION	0
LEVEL	full cw
AUTO FREQ	down
AUTO LEVEL	down
MARKERS	30 HAR on (1403)
	50 HAR on (1503)

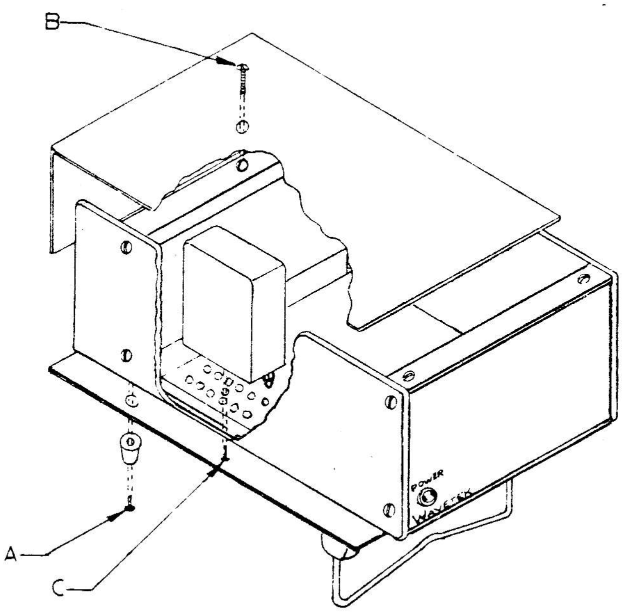


Figure 5-1. Disassembly

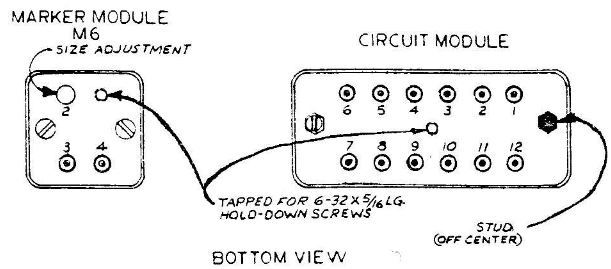


Figure 5-2. Module Pin Numbering

Table 5-1. Recommended Test Equipment

INSTRUMENT	CRITICAL REQUIREMENT	RECOMMENDED
Oscilloscope	DC Coupled; 1 mV/div Sensitivity	TEK 5110/5A18N/5B10N
Digital Voltmeter	±0.1% Accuracy	DANA 4200
RF Detector (1403)	75 ohm, 1-300 MHz	WAVETEK D171
RF Detector (1503)	50 ohm, 450-950 MHz	WAVETEK D151
Marker Generators (1503)	1, 10, 50 MHz Harmonic Markers 700 MHz Single Frequency Marker	WAVETEK M6H-1, M6H-10, M6H-50, M6S @ 700
Marker Generators (1403)	1, 10, 30 MHz Harmonic Markers 150 MHz Single Frequency Marker	WAVETEK M6H-1, M6H-10, M6H-30, M6S @ 150

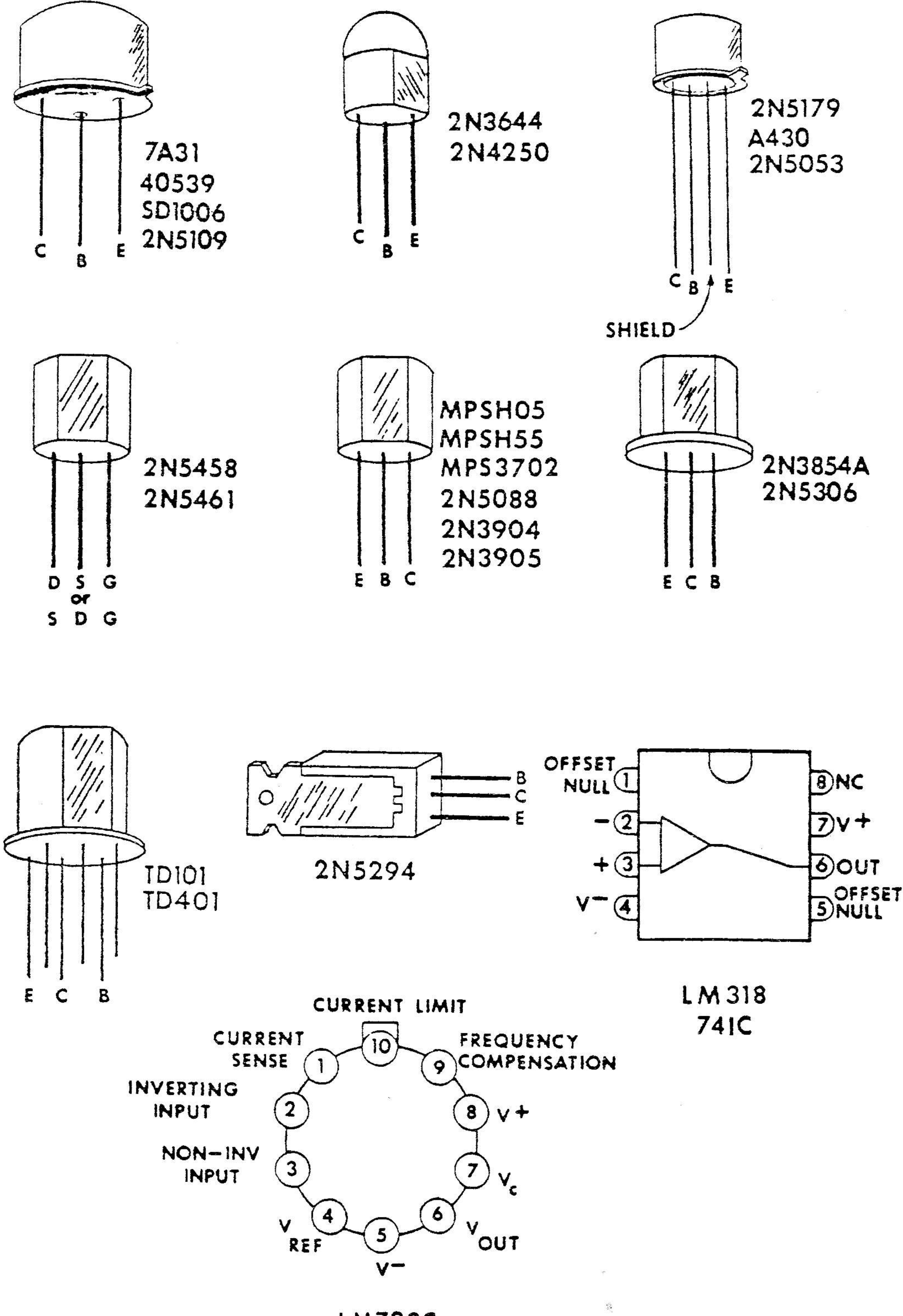


Figure 5-3. Component Lead Configuration

Adjust the scope to operate in an X-Y mode. Set the vertical sensitivity to 0.2 V/division. Adjust the scope vertical position, horizontal position, and horizontal sensitivity, and the instrument MARKER SIZE control to obtain a scope pattern as shown in Figure 5-5.

5.3.2 FREQUENCY AND SWEEP WIDTH RANGE CHECK

Turn off the harmonic markers and turn on the mid-band frequency marker (150 MHz, Model 1403; 700 MHz, Model 1503). A single marker should be present at the exact center of the display. Turn off the single frequency marker and turn on the harmonic markers. Count the markers on the scope display of Figure 5-5 to verify the frequency and sweep width range.

NOTE

The low-limit marker on the 1403 is not a marker but the zero lock-in produced by the heterodyne sweep generator technique.

5.3.3 DISPLAY LINEARITY CHECK

Display linearity is read directly from the display as shown in Figure 5-5. Each marker must fall within 0.2 divisions of its associated graticule line. This is equivalent to a display linearity of 2%.

5.3.4 TUNING RANGE CHECK

The center frequency range of the instrument can be checked by turning the FREQUENCY control to its extremes and noting the range of frequencies indicated at the exact center of the display. The low- and high-limit markers should move past the display center line by approximately 0.5 division. This represents approximately 5% overrange capacity.

5.3.5 MINIMUM SWEEP WIDTH CHECK

Pull the SWEEP WIDTH control out and turn it fully counterclockwise. With the 1 MHz harmonic markers turned on, the display will show no more than 5 markers. This is equivalent to a sweep width of less than 5 MHz.

5.3.6 MAXIMUM RF OUTPUT CHECK

Push the SWEEP WIDTH control in and turn it fully cw. A display amplitude of approximately 0.8 V indicates the proper RF output level.

5.3.7 FLATNESS CHECK

The RF flatness of ±.25 dB is read by comparing the minimum amplitude point to the maximum amplitude point. The difference between these points should be less than 6%.

5.3.8 LEVEL CONTROL CHECK

While observing the scope pattern, turn the LEVEL control from its full cw to full ccw position. The scope pattern should change smoothly from approximately 0.8 V to approximately 40 mV.

5.3.9 STEP ATTENUATOR CHECK

Turn the LEVEL control fully cw. Set the ATTENUATION control to 5. The output amplitude should decrease by approximately half. The output should continue to halve for each additional 5 dB step until approximately 20 dB. After this level, because of the square-law characteristics of the detector, each additional 5 dB step will cause the output to decrease by approximately 60 to 70%. When the ATTENUATION control is set to 35, the output level should be approximately 2 mV.

5.3.10 SCOPE HORIZONTAL CHECK

Set the scope horizontal sensitivity for 2 V/division. The display width indicates the peak-to-peak horizontal output of 16 ±.4 V.

5.3.11 MARKER SYSTEM CHECK

Readjust the scope horizontal sensitivity to obtain the pattern of Figure 5-5. The following check is for a harmonic marker. Specifications, with the exception of spurious markers, are the same for either single frequency or harmonic type markers, and the procedure for verification of performance is the same for both types.

Single frequency markers should have no spurious markers throughout the swept range. Harmonic type markers may or may not have small spurious markers at one half or one third the specified marker interval.

MARKER SIZE

Observe the markers and ensure that they are of equal amplitude throughout the range. Set the oscilloscope vertical gain to .5 V/division and turn the MARKER SIZE control fully cw. The markers should be approximately 3 Vpp in amplitude. Turn the MARKER SIZE control fully ccw. The markers should be approximately 3 mVpp in amplitude.

MARKER WIDTH

Turn on the 1 MHz harmonic markers. Adjust the FREQUENCY and SWEEP WIDTH controls and the scope's horizontal sensitivity control to calibrate the oscilloscope display for a 1 MHz display width.

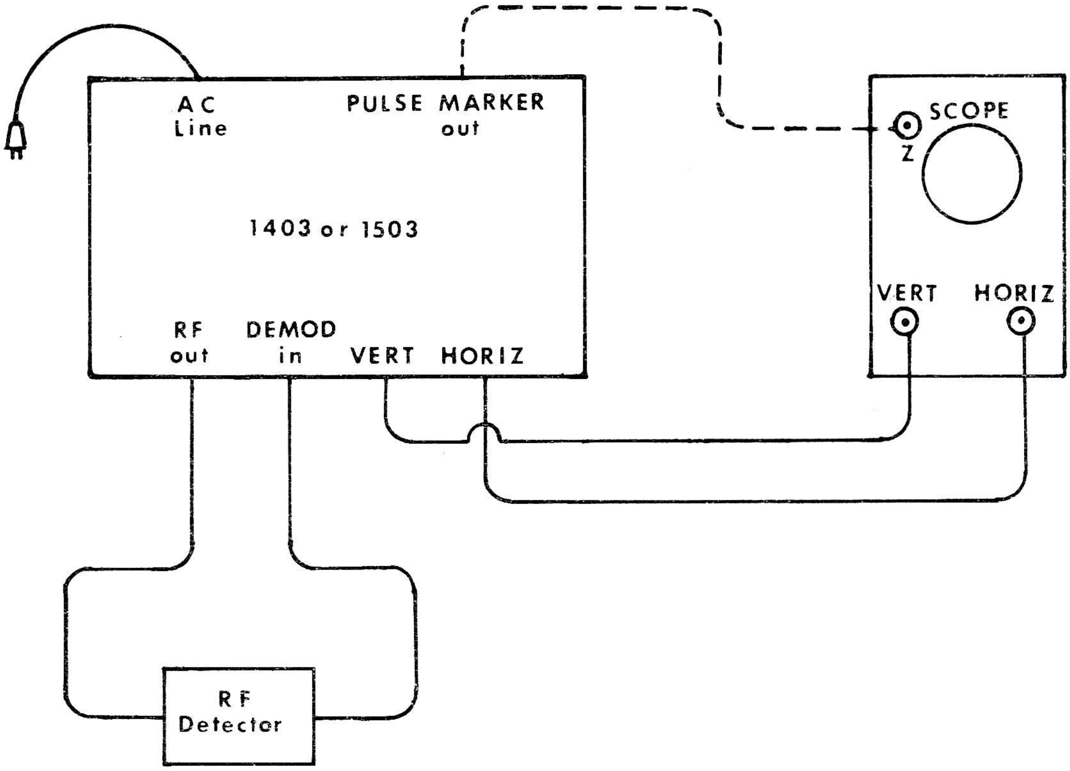


Figure 5-4. Typical Test Set-Up

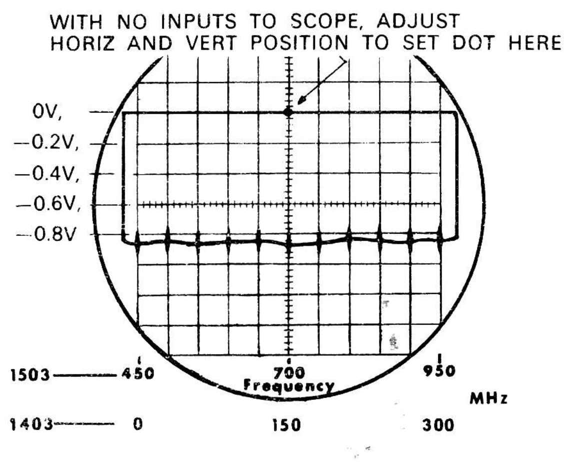


Figure 5-5. Detected RF Display

Adjust the FREQUENCY control to center a 1 MHz birdy on the display, and note that the marker is approximately 400 kHz wide. Decrease the marker width by pulling the MARKER SIZE control out. The marker width should now be approximately 100 kHz.

MARKER ACCURACY

Marker accuracy may be verified by one of several methods. One method requires a signal generator and a frequency counter covering the desired marker frequency. First, adjust the instrument's center frequency to the marker's frequency and the sweep width to approximately 2 MHz. Connect the output from the signal generator to the rear-panel MARKER IN connector, and carefully adjust the sign signal generator for a zero beat with the internally generated birdy marker. Next, connect the signal generator's output to the counter and read the signal generator frequency which is now identical to the internal marker's frequency. Allowable error is 0.005% of the marker frequency.

Another method uses the counter only, but requires the removal of the instrument and marker module covers. Probe the marker box with the input lead from the counter until sufficient signal is picked up to provide a counter reading. The highest crystal frequency used is approximately 50 MHz. Markers above this frequency use harmonics of the crystal frequency. The allowable error is 0.005% of the crystal frequency.

Test equipment for the marker accuracy check is not listed in the recommended test equipment table since the requirements vary with the method and the specific markers installed. Also, the inherent stability of the quartz crystal makes a marker accuracy check unnecessary in all but the most critical applications.

5.3.12 OPTION B CHECK

The performance of this option can be checked by using an external sweep generator. Set the external generator for a line-locked sweep with a sweep width of 50 MHz and a center frequency equal to that of the B option (43.5 MHz U.S. standards or 36.15 MHz CCIR and other standards). Set the RF output level to 1 mVRMS. Insert the signal from the external generator at the IF IN connector. Pulse markers should appear at the required marker frequencies when the M5D Pulse Size control and the front-panel MARKER SIZE control are fully clockwise. Increase the external generator output to 100 mVRMS. No spurious markers should appear.

Disconnect the cable from the SCOPE VERT OUT connector and connect it to the rear-panel PULSE MARKER OUTPUT connector. Positive or negative 35 V pulses should be present, adjustable with the rear-panel PULSE MARKER SIZE control and polarity switch.

5.3.13 OPTION C CHECK

Module M8E is factory adjusted to work in conjunction with a typical tuner test set-up. To verify the operation of this option, use a properly aligned tuner in the set-up shown in Figure 3-3.

As shipped from the factory, the M8E is set for unity gain. With the controls set as in Section 5.3.1, center the tuner response on the oscilloscope display with the FREQUENCY control. Turn the LEVEL control fully cw and set the ATTENUATION control to obtain the desired detector output as in Section 3.6. Reduce the oscilloscope vertical gain to one volt full scale. Set the M8E Polarity switch for a positive pattern on the oscilloscope display. Using the two Gain controls on the M8E (X10 and Var), adjust the display for a one volt amplitude. The display should be similar to that shown in Figure 3-9. Switch the front-panel AUTO LEVEL switch to AUTO. There should be no change in the display amplitude. Up to 20 dB of attenuation can then be removed before the display amplitude will change.

To check the operation of the frequency indicator pulse, observe the pulse while turning the FREQUENCY control from one end of its range to the other. As the control is rotated, the indicator pulse should move from one end of the display to the other.

5.3.14 OPTION E CHECK

Module M11E is factory adjusted to work in conjunction with a typical tuner test set-up. To verify the operation of this option, use a properly aligned tuner in the set-up shown in Figure 3-3.

With the AUTO FREQUENCY switch set to AUTO, the tuner should be tuned from one end of its range to the other. The tuner response should remain centered on the oscilloscope display.

5.3.15 EXTERNAL PROGRAMMING

External programming inputs are not normally checked during incoming inspection unless these special functions are to be used in a particular application. The external programming circuits are covered in Section 3.8. If it is necessary to check these functions at incoming inspection, reference can be made to that section for complete set-up instructions.

5.4 CALIBRATION PROCEDURE

Remove the instrument top cover and the M2E-2 module cover. Allow a 15 minute warm-up period before calibrating. In general, calibration must be performed in the sequence given.

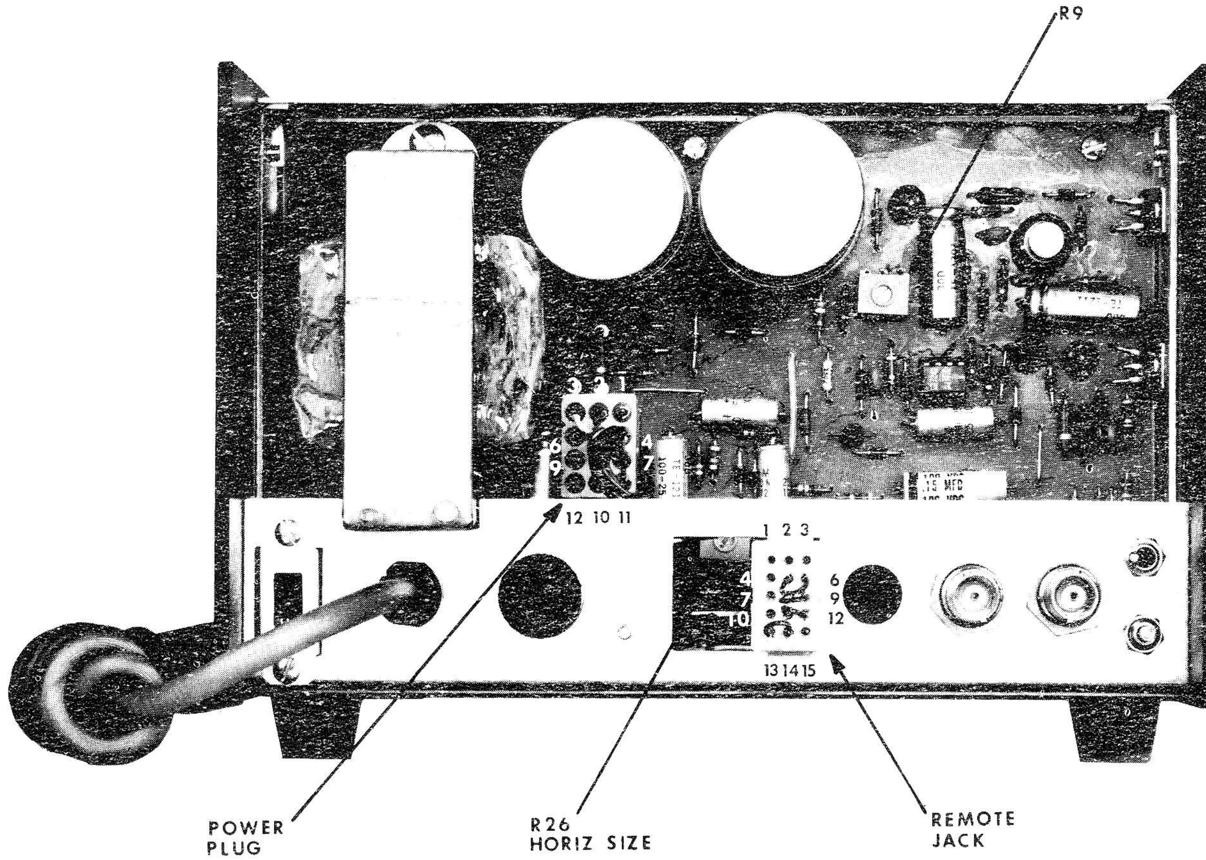


Figure 5-6. PS7 Power Supply

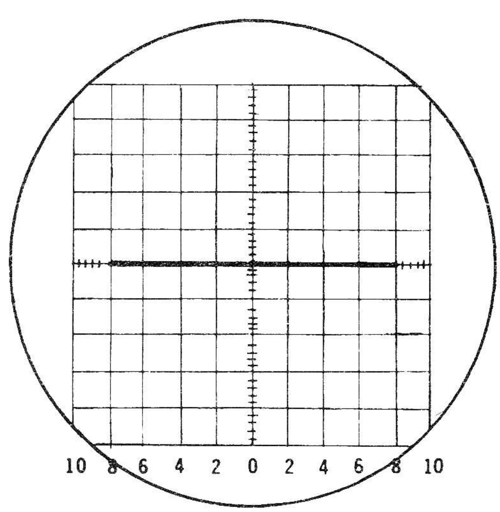


Figure 5-7. Horiz Size

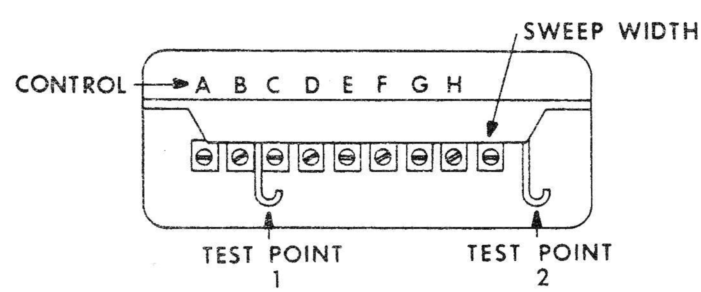


Figure 5-8. M2E-2 Controls

5.4.1 +18 VOLT ADJUSTMENT

Connect the digital voltmeter to the +18 V supply, pin 6 on the power plug, and adjust R9 (see Figure 5-6) to produce +18 V ±10 mV.

5.4.2 -18 VOLT CHECK

Connect the digital voltmeter to the -18 V supply, pin 4 on the power plug. The -18 V supply is designed to track the +18 V supply, and no independent adjustment is provided. The voltmeter should read -18 V ±50 mV.

5.4.3 HORIZ SIZE ADJUSTMENT

Adjust the scope to operate in an X-Y mode with DC coupling on both the vertical and horizontal inputs. Adjust the horizontal sensitivity to exactly 2 V/division (use the previously calibrated +18 V supply to calibrate the horizontal sensitivity). With no horizontal input to the scope, position the dot to the exact center of the display.

Connect the SCOPE HORIZ OUT connector to the oscilloscope horizontal input. Adjust R26 (see Figure 5-6) to produce a horizontal trace size on the scope display of -8 to +8 V as shown in Figure 5-7. An offset either way of .2 V is acceptable.

5.4.4 MODULE M2E-2 SIZE AND CENT ADJUSTMENT

Connect the oscilloscope vertical input to TP1 in the M2E-2 module (see Figure 5-8). Set the front-panel SWEEP WIDTH control fully cw. Set the scope vertical sensitivity to 5 V/division and adjust control A (Centering) and control B (Size) to obtain a +14 to -14 V signal centered about zero volts (see Figure 5-9).

5.4.5 SWEEP OSCILLATOR CENTERING ADJUSTMENT

Connect the instrument as shown in Figure 5-4. Set the scope vertical sensitivity to .2 V/division and the scope horizontal sensitivity for a display pattern 10 divisions wide. Set the ATTENUATION and LEVEL controls for maximum output (AUTO LEVEL switch down). Set the SWEEP WIDTH control fully cw.

Connect the digital voltmeter to the wiper arm of the FREQUENCY control pot. Set the FREQUENCY control to obtain a reading of 0 V (this should correspond to the mid-band frequency setting of the FREQUENCY control).

Turn on the mid-band frequency marker and set it to the exact center of the display with the Cent control on top of the Sweep Oscillator module (see Figures 5-10 and 5-11).

5.4.6 MODULE M2E-2 SWEEP WIDTH ADJUSTMENT

Turn on the 30 MHz (Model 1403) or 50 MHz (Model 1503) harmonic markers and adjust the M2E-2 Sweep Width control (see Figure 5-10) to place the low-limit marker (0 MHz, Model 1403; 450 MHz, Model 1503) 5% in from the extreme left scope graticule (see Figure 5-12).

5.4.7 MODULE M2E-2 LINEARITY REFERENCE

Keeping the mid-band marker in the center of the display, increase the scope horizontal sensitivity to place the low-limit marker on the extreme left scope graticule (see Figure 5-13).

Connect the oscilloscope vertical input to TP2 of the M2E-2 module (see Figure 5-10) and adjust control C (Linearity Reference) to position the knee just to the right of the 9th scope graticule (see Figure 5-13).

5.4.8 MODULE M2E-2 LINEARITY ADJUSTMENT

Reconnect the oscilloscope vertical input to the SCOPE VERT OUT connector. The sweep oscillator is inherently linear over the lower half end of the frequency range. Five adjustments are provided to improve the linearity from the mid-band frequency to the high frequency end of the band.

Turn on the 30 MHz (Model 1403) or 50 MHz (Model 1503) harmonic markers. Use M2E-2 control D (see Figure 5-10) to position the first marker to the right of the center frequency marker as shown in Figure 5-14. Use control E to position the second marker, control F to position the third marker, control G to position the fourth, and control H to position the highest frequency marker. Adjustment must be made in the sequence given.

5.4.9 SWEEP OSCILLATOR MODULE MIN AND MAX LEVEL ADJUSTMENT

Adjust the Sweep Oscillator Level Max control (see Figure 5-10) to produce a scope pattern amplitude of .8 V when the front-panel LEVEL control is fully cw (this is equivalent to an output of .7 VRMS). Next, set the LEVEL control fully ccw and adjust the Sweep Oscillator Level Min control to produce a scope pattern of 40 mV. Some interaction exists between the Level Min and Max adjustments, so repeat the adjustments until both the 40 mV and the .8 V readings are obtained.

NOTE

The accuracy of the above procedure is dependent on the RF detector, but is generally adequate. If more accuracy is required, an RF power meter can be substituted for the detector.

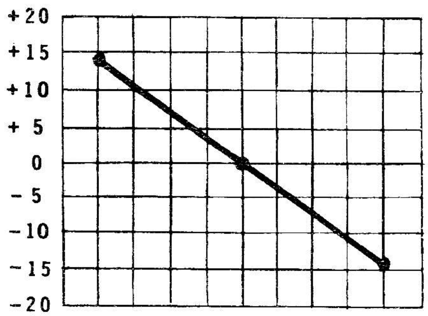


Figure 5-9. Size And Cent

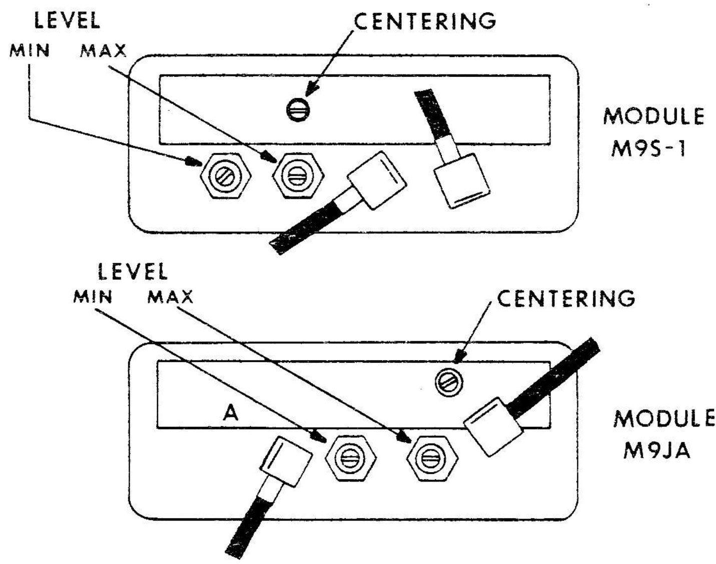


Figure 5-10. Sweep Oscillator Controls

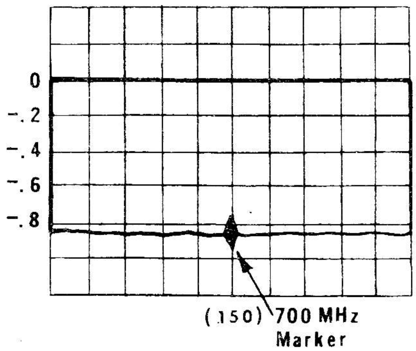


Figure 5-11. Centering

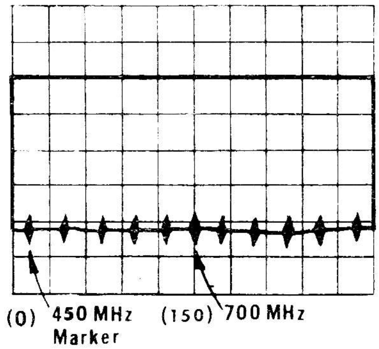


Figure 5-12. Sweep Width

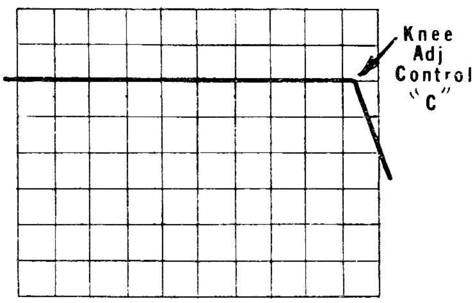


Figure 5-13. Linearity Reference

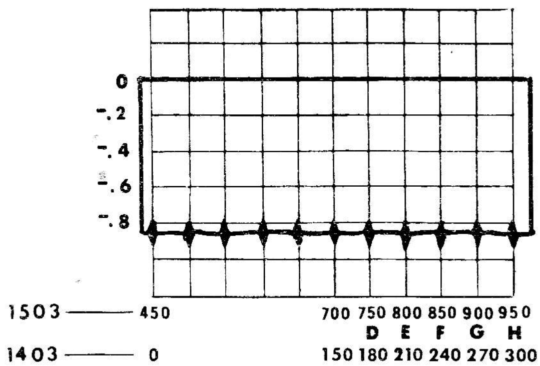


Figure 5-14. Linearity

5.4.10 MODULE M5D SWEEP SAMPLE ADJUSTMENT

Set the oscilloscope horizontal sensitivity for a display of 10 divisions and the vertical sensitivity to 5 mV/division. Connect the detector to the M5D Sweep Sample Output connector. (Use the adapter cable from the K102 Service Kit or fabricate an equivalent SMC to BNC adapter.) Adjust the M5D Sweep Sample Adj control for a detected response of approximately 30 mV. (The sweep sample is not completely leveled, but this will usually give a minimum detected response of 25 mV.) Reconnect the sweep sample output to the markers.

5.4.11 OPTIONS A-1 AND A-2 MARKER SIZE ADJUSTMENT (MODULE M6)

Each marker module has a Size control which is accessible from the under side of the sweep generator when the bottom cover is removed (see Figure 5-2). The control is adjusted until a saturated marker is obtained on the scope display when operating the instrument as shown in Figure 5-4. A saturated marker is obtained when a further increase in the marker module's Size adjustment does not increase the marker amplitude on the scope display. Increasing the Size adjustment beyond this point will result in spurious markers on the display.

5.4.12 OPTION B IF TRACKING MARKER ADJUSTMENT (MODULE M7E)

The M7E module is factory set to provide the best possible operation over a wide range of input signals. In this mode, the IF Input Adjust control on the top of the module is usually fully cw. Input signals in excess of +10 dBm can sometimes overdrive the module, causing the output markers to double trigger. In this case, the control can be turned ccw to decrease the input signal. The control can be readily returned fully cw for a different input. In some cases, an extremely weak signal (<-55 dBm) will fail to produce markers. Turning the M7E external AGC control can sometimes remedy this, but the original position of the control should be marked for later resetting.

5.4.13 OPTION C AUTOMATIC LEVEL AND SCOPE INDICATOR ADJUSTMENT (MODULE M8E)

The M8E module has three calibration adjustment controls accessable through the top of the module cover. The purpose of the Bal control is to set the baseline of the display to 0 VDC. The Cent and Range controls are used to calibrate the baseline frequency indicator to display the frequency setting directly on the scope. The procedure for setting the controls is given in Section 3.6.

5.4.14 OPTION E AUTOMATIC FREQUENCY ADJUSTMENT (MODULE M11E)

The M11E module is factory adjusted to work in conjunction with a "typical" tuner test set-up. Slight adjustments may sometimes be required for proper functioning with the individual test set-up. The module is functioning properly if the tracking markers remain centered on the display as the tuner under test is varied throughout its range while the instrument is in the auto frequency mode.

If adjustment is needed, first adjust the Gain control until the IF tracking markers remain stationary as the tuner is varied through its range, then center the markers with the Cent control.

The Low Limit control is located inside the module cover. This control should NOT be adjusted unless a mirror response is being captured (Model 1403 only) or the capture fails to work on the low end of the sweep range. To adjust, set the tuner at the low end of the range and turn the control until capture is lost, then back the control off enough to recapture the response.

5.5 TROUBLESHOOTING

Effective troubleshooting requires a thorough understanding of the block diagram and circuit descriptions located in Section 4 of this manual. The performance test and calibration procedures will aid in localizing the trouble symptom to a particular module or PC board. Once this has been accomplished, the module or board 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 module or PC board assembly.

Equipment troubles are frequently due simply to improper control settings; therefore, before engaging in a troubleshooting procedure, be sure front-panel controls are set in proper operating position. Refer to Section 3 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, defective module-pin sockets, loose RF cables, and burned or broken components.

After localizing the problem, voltage and resistance checks will help find the defective component.

For troubleshooting purposes, it is permissible to operate the instrument with any of the plug-in modules or RF cables removed; however, the instrument should be turned off when removing or installing modules. If substitute modules are available, possibly from another Model 1403 or 1503, this provides an easy method of verifying if a suspected module is defective.

RF cables can be disconnected from the module output connectors, and a power meter or spectrum analyzer can be connected directly to the module connector for power level or frequency measurements. (The SMC to BNC adapter cable in Service Kit K102 is designed for this purpose.)

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.

5.5.1 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 loose modules. If none, check for defective module pin sockets.

±18 V OUT OF CALIBRATION

If the +18 V supply measures over +25 V, change the regulator, IC1. If the ±18 V supplies measure low, disconnect the Power Supply jack and carefully check for ±28 V at plug P2. If the ±18 V supplies are now correct, low voltage was due to over-current limiting by the Power Supply. Unplug modules until the overload is found.

NO RF SWEEP

First, check pin 7 of the M2E-2 module for the presence of a 16 Vpp ramp when the SWEEP WIDTH control is fully cw. Next, check the output of the M2E-2 at pin 9. It should be similar to the input, except it will be lower in amplitude, approximately 12 Vpp, and will have an average value of 0 V when the front-panel FREQUENCY control is set to midband. If the M2E-2 output is correct, the trouble is probably in the Sweep Oscillator module.

NO RF OUTPUT

Check for a defective Attenuator or RF cables connecting to the input or output of the Attenuator.

RF OUTPUT NOT FLAT

The most common cause is the external RF detector being defective. Another is the monitor diode located in the Sweep Oscillator module. 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 approximately twice the amplitude of the external detector. For example, at an RF output of +10 dBm, an external RF detector will read approximately .8 V. The internal monitor will read approximately -1.6 V.

In replacing the monitor diode, unsolder the anode end only, and pull it out of its lead socket. Trim the leads of the replacement diode to the same dimensions, insert the cathode lead in the socket, and solder the resistor to the anode lead with the same lead dress as the original diode.

FREQUENCY UNSTABLE (JITTER)

Check all modules for loose hold-down screws, especially module M2E-2. Check the ±18 V supplies for excessive ripple. 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 60 Hz hum modulation.

MARKER PROBLEMS

To isolate the cause of a marker problem when the symptom does not clearly indicate a specific circuit or component, first check the sweep sample output at the M5D Sweep Sample Output connector. It should be a detected signal of between 30 and 50 mV. If the proper sweep sample signal is not present, it indicates that the trouble is in the M5D, the Sweep Oscillator module, or connecting sweep sample cables.

Next, connect the detector in place of the Terminator plug. A signal at this point indicates all jumper cables and RF jacks on the M6 modules are intact. Then check for the birdy output at pin 3 of each Marker module. A 10 to 15 mVpp birdy is sufficient to drive the M5D module, and indicates the Marker module is operating properly. With the 10 mVpp birdy present at the input of the M5D (pins 1, 2, 3, and 4), a 32 Vpp signal will be produced at the output (pin 7). This indicates proper operation of the M5D. The signal is now routed through the front-panel MARKER SIZE control and the M8/M8E module to the rear-panel SCOPE VERT OUT connector. A 3 Vpp signal is normally at this point when the front-panel MARKER SIZE control is set to maximum. A common marker problem occurs when one of the interconnecting cables between the M6 modules is loose. This causes a notch in the sweep sample input to the module, causing uneven harmonics or weak output.

LOCAL OSCILLATOR TRACKING PROBLEMS

Loss of the L.O. tracking markers indicates either that the IF input signal is too weak or the M7E module is defective.

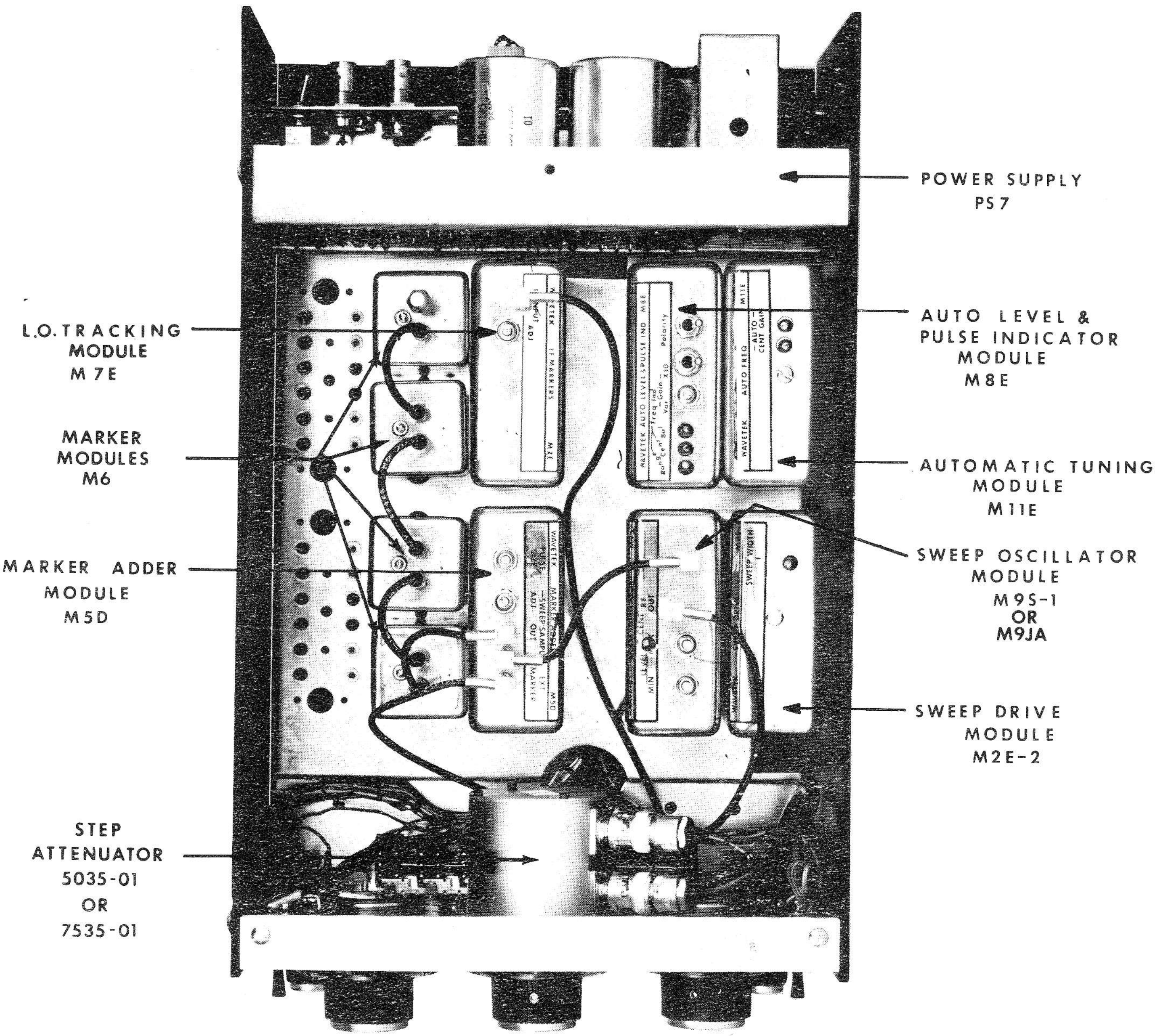
AUTOMATIC LEVEL PROBLEMS

If the instrument fails to maintain a 1 V detected response when the LEVEL control is varied and the AUTO LEVEL switch is set to AUTO, or if the scope indicators are missing or operating improperly in either automatic or manual mode, the problem is most likely in the M8E module.

AUTOMATIC FREQUENCY PROBLEMS

If the instrument operates properly when the AUTO FREQUENCY switch is down, but not when the switch is set to AUTO, the problem may be a defective M11E module.

Another automatic frequency problem is the loss of the control pulse from the M7E module. Check for the L.O. tracking markers to be sure the IF input is sufficient, then, with the AUTO FREQUENCY switch down, set the SWEEP WIDTH control fully cw. Connect the oscilloscope vertical input to pin 8 of the M7E and check for the presence of the control pulse.



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
1010-00-0056	1403
1010-00-0057	1503
1111-00-0027	CHASSIS
1219-00-0050	HARNESS
1118-00-0001	REMOTE PLUG
1112-00-0002	POWER SWITCH
1115-00-0005	PS7
1218-00-0013	PC - PS7
1114-00-0061	M2E-2
1114-00-0082	M5D
1114-00-0197	M7E
1114-00-0122	M8
1114-00-0128	M8E
1114-00-0074	M9JA
1114-00-0085	M9S-1
1114-00-0133	M11E
1114-00-0050	M6H-1
1114-00-0099	M6H-10
1114-00-0100	M6H-50
1114-00-0045	M6S-3
1219-00-0115	RB PROBE

6.2 MANUFACTURERS CODE

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

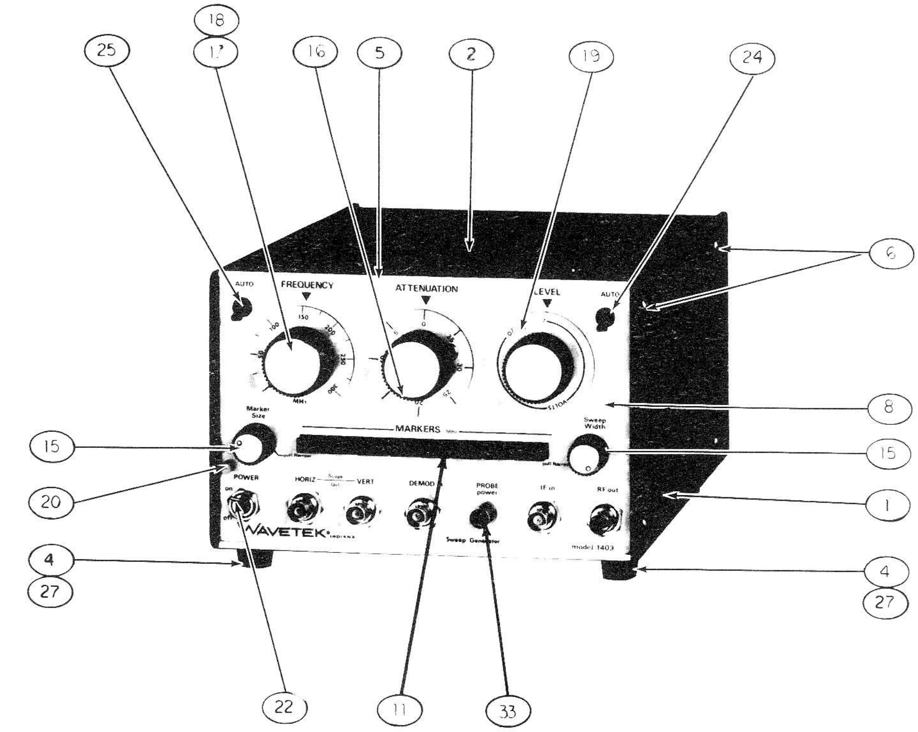
ABBRV	NAME..........................	CITY................	ST
A-B	ALLEN-BRADLEY	MILWAUKEE	WI
A-D	ANALOG DEVICES	CAMBRIDGE	MA
A-H	ARROW HART, INC.	KETTERING	OH
A-I	ALAN INDUSTRIES	COLUMBUS	IN
A-M	AMERICAN MAGNETICS	CARTERVILLE	IL
A-P	AMERICAN PLASTICRAFT CO.	CHICAGO	IL
ABAC	ABACUS PACKAGING CO.	CHICAGO	IL
ACI	ADVANCE COMPONENTS, INC.	CENTERBROOK	CT
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
AMD	ADVANCED MICRO DEVICES, INC.	SUNNYVALE	CA
AMP	AMP, INC.	HARRISBURG	PA
APL	AMPHENOL CONNECTOR SYSTEMS	BROADVIEW	IL
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
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
AVT	AVANTEK, INC.	SANTA CLARA	CA
AWC	ALPHA WIRE	ELIZABETH	NJ
B-T	BEK-TEK, INC.	READING	PA
BEK	BECKMAN INSTRUMENTS, INC.	FULLERTON	CA
BEL	BELDEN CORP.	GENEVA	IL
BER	BERG ELECTRONICS	NEW CUMBERLAND	PA
BGH	BEECH GROVE HARDWARE	BEECH GROVE	IN
BOU	BOURNS, INC.	RIVERSIDE	CA
BREZ	BREEZE CORPORATIONS, INC.	UNION	NJ
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-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

ABBRV	NAME.........................	CITY.................	ST
CECO	CENTRAL COIL CO.	BRAZIL	IN
CGW	CORNING GLASS WORKS	CORNING	NY
CHE	CHERRY ELECTRICAL PRODUCTS	WAUKEGAN	IL
CHOM	CHOMERICS INC.	WOBURN	MA
CIMCO	CIMCO WIRE AND CABLE INC.	ALLENDALE	NJ
CKI	CTS KNIGHTS, INC.	SANDWICH	IL
CLA	CLAIREX CORP.	MT. VERNON	NY
CLAR	CLAROSTAT MFG. CO	DOVER	NH
CLFX	COLE-FLEX CORP.	BABYLON	NY
CPKG	CREATIVE PACKAGING DIV.	INDIANAPOLIS	IN
CTS	CHICAGO TELEPHONE SYSTEMS	CHICAGO	IL
CTS-E	CTS OF ELKHART	ELKHART	IN
CTSBR	CTS OF BERNE	BERNE	IN
CTSBV	CTS OF BROWNSVILLE	BROWNSVILLE	TX
DAL	DALE TECHNOLOGY CORP.	HARTSDALE	NY
DAV	HARRY DAVIES MOLDING CO.	CHICAGO	IL
DEL	DELEVAN DIV.	EAST AURORA	NY
DEN	DENNISON MFG. CO.	FRAMINGHAM	MA
DEW	DEWIRE FABRICATING CORP.	LOWELL	MA
DIO	DIODES, INC.	CHATSWORTH	CA
DRA	DRAKE MANUFACTURING CO.	HARWOOD HEIGHTS	IL
E-C	ELECTRONIC CRYSTALS	KANSAS CITY	MO
E-M	ELECTRA/MIDLAND CORP.	MINERAL WELLS	TX
ECMC	ELECTRI-CORD MFG. CO. INC.	WESTFIELD	PA
ELCO	ELCO INDUSTRIES	ROCKFORD	IL
ELFX	ELECTRO-FLEX HEAT INC.	BLOOMFIELD	CT
EPITK	EPITEK ELECTRONICS	KANATA, ONT., CAN.	**
ETP	ERIE TECHNOLOGICAL PRODUCTS	ERIE	PA
EXAR	EXAR INTEGRATED SYSTEMS	SUNNYVALE	CA
F-K	THERMWELL PRODUCTS, INC.	FRAMINGHAM	MA
F-S	FEDERAL SCREW	CHICAGO	IL
FAN	FANCOURT & CO.	GREENSBORO	NC
FCD	FAIRCHILD	MOUNTAIN VIEW	CA
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
GAL	GALILEO ELECTRO-OPTICS	CARMEL	IN
GATES	GATES ENERGY PROD.	DENVER	CO
GBN	GILBERT ENGINEERING CO. INC.	PHOENIX	AZ
GOU	GOULD, INC.	ST. PAUL	MN
GRIES	GRIES REPRODUCER	NEW ROCHELLE	NY
GRIP	GRIPMASTER CO.	MARLBORO	NJ
GUDL	GUDEBROD BROS. SILK CO.	CHICAGO	IL
H-P	HEWLETT-PACKARD	INDIANAPOLIS	IN
HEL	HELIPOT	ANAHEIM	CA
HEY	HEYMAN MFG. CO.	WAUKESHA	WI
HHS	HERMAN H. SMITH, INC.	BROOKLYN	NY
HIT	HITACHI AMERICA, LTD.	SAN FRANCISCO	CA
HOLUB	HOLUB DISTRIBUTING CO.	NEWPORT	KY
HUD	HUDSON TOOL & DIE CO.	NEWARK	NJ
HY/PL	HYDRO PLASTICS INC.	GEORGETOWN	KY
HYT	HYTRONICS	PINELLAS PARK	FL
ICI	ILLINOIS CAPACITOR INC.	MORTON GROVE	IL

ABBRV	NAME........................	CITY................	ST
IERC	INT'L ELEC. RESEARCH CORP.	BURBANK	CA
INT	INTERSIL, INC.	CUPERTINO	CA
IRC	INTERNATIONAL RESISTANCE CO.	PHILADELPHIA	PA
ITT	INT'L TELEPHONE & TELEGRAPH	W. PALM BEACH	FL
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
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
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
KSTR	KESTER SOLDER DIV.	CHICAGO	IL
KSW	KSW ELECTRONICS	INDIANAPOLIS	IN
KUL	KULKA ELECTRIC CORP.	MT. VERNON	NY
LEYSE	LEYSE ALUMINUM CO.	KEWANEE	WI
LIT	LITTELFUSE, INC.	DES PLAINES	IL
LRC	LRC ELECTRONICS, INC.	HORNELL	NY
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.	**
MDC	MAIDA DEVELOPMENT CO.	HAMPTON	VA
MILN	MILLEN MFG. CO.	NEW YORK	NY
MILSP	MILITARY SPECIFICATION	WASHINGTON	DC
MINOR	MINOR RUBBER CO.	BLOOMFIELD	NJ
MMM	3M COMPANY	ST. PAUL	MN
MNO	MONSANTO COMM. PROD. DIV.	PALO ALTO	CA
MOL	MOLEX PRODUCTS	LISLE	IL
MOT	MOTOROLA SEMI. PROD. DIV.	INDIANAPOLIS	IN
MRO	MICRO SWITCH DIV.	FREEPORT	IL
MSN	MICROSONICS DIV.	WEYMOUTH	MA
MSP	MICRO SEMICONDUCTOR CORP.	SANTA ANA	CA
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
NEC	NIPPON ELECTRIC CO.	TOKYO, JAPAN	**
NEL	NATIONAL ENGINEERING LABS	INDIANAPOLIS	IN
NEW	NEWARK ELECTRONICS	INDIANAPOLIS	IN
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

ABBRV	NAME..........................	CITY................	ST
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
PAM	PAMOTOR DIV.	BURLINGAME	CA
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
PHC	PHILADELPHIA HANDLE CO.	CAMDEN	NJ
PIC	PIHER INTERNATIONAL CORP.	ARLINGTON HEIGHTS	IL
PLSSY	PLESSEY ENG.	SCHILLER PARK	IL
PMCL	PERMACEL DIV.	NEW BRUNSWICK	NJ
PMI	PRECISION MONOLITHICS INC.	SANTA CLARA	CA
POM	POMONA ELECTRONICS CO., INC.	POMONA	CA
PRMD	PYRAMID INDUSTRIES, INC.	PHOENIX	AZ
PRSN	PRECISION TUBE CO., INC	NORTH WALES	PA
PTN	PENN TRAN CORP.	BELLEFONT	PA
PYRO	PYROFILM CORP.	WHIPPANY	NY
PYTT	PYTTRONICS INDUSTRIES, INC.	MONTGOMERYVILLE	PA
Q-C	QUALITY COMPONENTS	ST. MARYS	PA
RAY	RAYTHEON	INDIANAPOLIS	IN
RCA	RCA	CAMDEN	NJ
REL	RELIANCE MICA CO.	BROOKLYN	NY
RGR	ROGERS CORP.	CHANDLER	AZ
RICH	RICHCO PLASTIC CO.	CHICAGO	IL
RMC	RADIO MATERIALS CORP.	CHICAGO	IL
RMF	RMF PRODUCTS INC.	BATAVIA	IL
ROGAN	ROGAN CORP.	NORTHBROOK	IL
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
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
SEL	SEALECTRO CORP.	MAMARONECK	NY
SEM	SEMTECH	NEWBURY PARK	CA
SGM	SIGMA INSTRUMENTS	BRAINTREE	MA
SHAM	SHAMROCK PLASTICS & RUBBER CO.	INDIANAPOLIS	IN
SIEM	SIEMENS	ISELIN	NJ
SIG	SIGNETICS CORPORATION	SUNNYVALE	CA
SLT	SOLITRON/MICROWAVE DIV.	PORT SALERNO	FL
SOUTH	SOUTHCO FASTENERS	LESTER	PA
SPE	SPECTROL	DAYTON	OH
SPEC	SPECTRUM CONTROL. INC.	FAIRVIEW	PA
SPR	SPRAGUE ELECTRIC CO.	INDIANAPOLIS	IN
SPST	SPECTRA-STRIP	GARDEN GROVE	CA
SSS	SOLID STATE SCIENTIFIC	MONTGOMERYVILLE	PA
STR	STETTNER TRUSH CO.	CAZENOVIA	NY
STSA	STEEL SALES	INDIANAPOLIS	IN

ABBRV	NAME........................	CITY................	ST
SYL	GTE SYLVANIA	WALTHAM	MA
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
TELE	TELETYPE CORP.	ELK GROVE VILLAGE	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
TORCO	TOR CORP.	VAN NUYS	CA
TRU	WALDES TRUARC	LONG ISLAND CITY	NY
TRW	TRW CAPACITOR DIV.	OGALLALA	NB
U-C	UNIVERSAL COMPONENTS	LOS ANGELES	CA
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
VLIER	VLIER ENGINEERING CORP.	BURBANK	CA
VONGT	VONNEGUT HARDWARE	INDIANAPOLIS	IN
VRN	VERNITRON CORP.	GREAT NECK	NY
VRN	VERNITRON CORP.	GREAT NECK	NY
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
WKFLD	WAKEFIELD ENGINEERING	WAKEFIELD	MA
WNSL	WEINSCHEL ENGINEERING	GAITHERSBURG	MD
WSD	WAVETEK	SAN DIEGO	CA
WSR	WAVETEK	SANTA ROSA	CA
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



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LEVEL
MARKERS
Marker Size
Sweep Width
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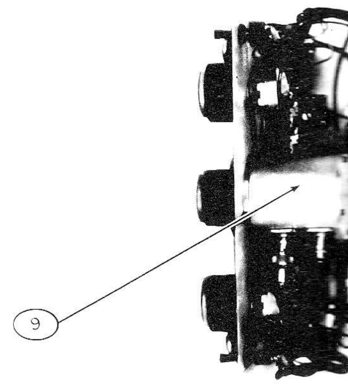
DEMOD
PROBE power
IF in
RF out
WAVETEK
Sweep Generator
model 1403



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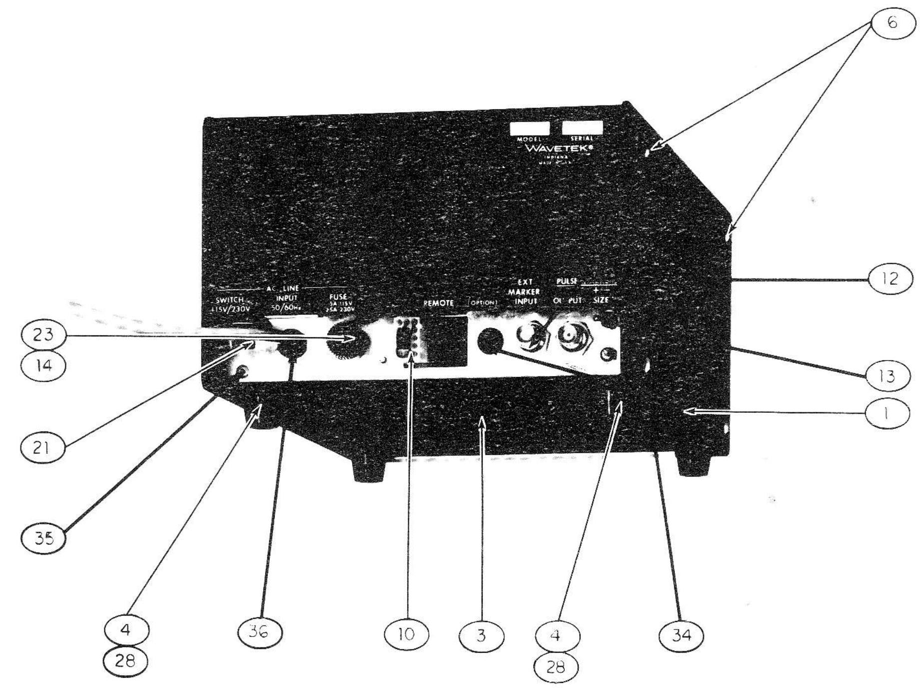

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MODEL
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SWITCH 115V/230V
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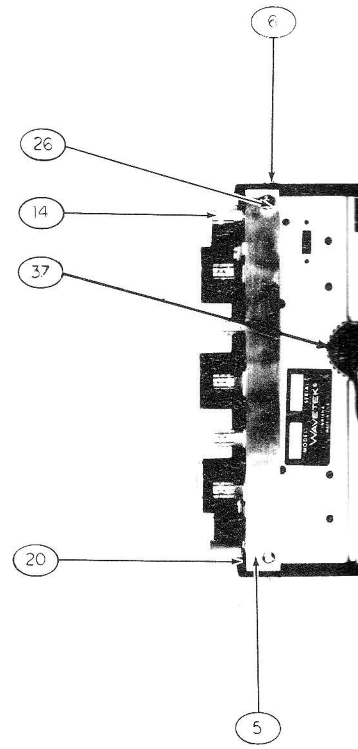
REMOTE
OPTION
EXT MARKER INPUT
PULSE OUTPUT
SIZE



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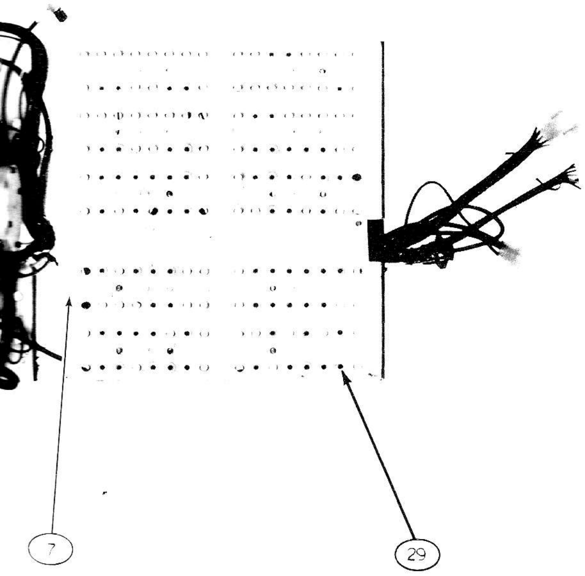

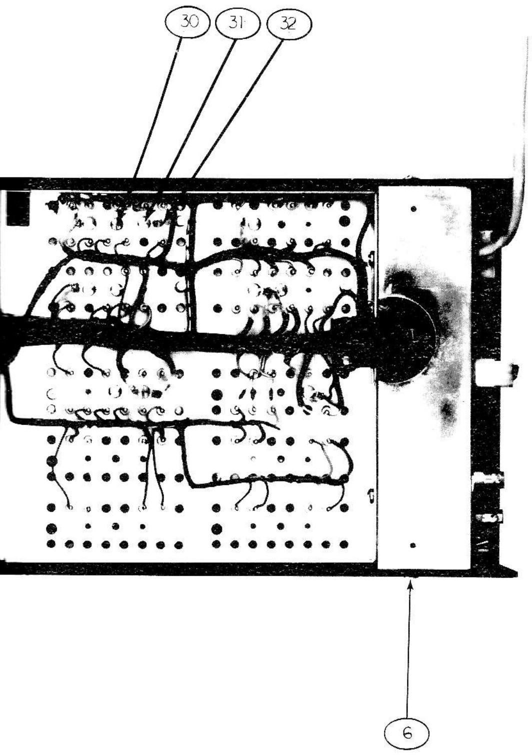

ITEM	DESCRIPTION	PART NUMBER	T. Q.
37	GROMMET 1-9/16	2810-10-0003	2
36	STRAIN REL.	2810-10-0001	1
35	RIVET 1/8X5/16	2810-30-0007	2
34	PLUG	2113-04-0001	1
33	CONN	2110-01-2001	1
32	GROUND LUG #6	2112-03-0003	7
31	SCREW 6-32X3/16	2810-17-6103	6
30	SCREW 6-32X5/16	2810-17-6105	15
29	PIN SOCKET	2112-00-0002	68
28	SCREW, 6-32X3/8	2810-17-6106	2
27	SCREW, 6-32X 1/2, BH	2810-17-6108	2
26	SCREW, 6-32X3/8, OH	2810-21-6106	2
25	SWITCH, TOGGLE	5106-00-0012	1
24	SWITCH, TOG, BLK.	5106-00-0009	1
23	FUSE, S.B., 1/4 AMP	2410-05-0002	1
22	POWER SWITCH ASSY.	1112-00-0002	1
21	SWITCH, SLIDE	5105-00-0011	1
20	INDICATOR LIGHT	2410-02-0003	1
19	KNOB, LEVEL, SCRN	2410-01-1003	1
18	KNOB, FREQ, 1403	2410-01-1004	1
17	KNOB, FREQ. 1503	2410-01-1002	1
16	KNOB, ATTEN	2410-01-1001	1
15	KNOB KK000 016	2410-01-0005	2
14	FUSE CARRIER	3010-10-0002	1
13	SWITCH	5110 00 0007	1
12	CABLE ASSY. 19-1/4 IN	1217-80-0003	1
11	BUTTON, SW	5110-04-0001	8
10	REMOTE JUMPER PLUG	1118-00-0001	1
9	ATTEN, 7535-01	1113-20-0026	1
8	FRONT PANEL	1410-00-5090	1
7	CHASSIS, 1403	1111-00-0082	1
6	SCREW 8-32X3/16, TH	2810 20-8103	9
5	SUPPORT RAIL	1410-00-1550	2
4	FEET, HH 102-002	2810-08-0003	4
3	BOTTOM COVER	1410-00-4450	1
2	TOP COVER	1410-00-4270	1
1	SIDE PANEL	1410-00-4260	2

TOLERANCE:
DECIMAL DIM. ± .005
FRACTIONAL DIM. ± 1/64
ANGLES ± 30'
UNLESS OTHERWISE SPECIFIED

NO	DESCRIPTION	BY
	REVISION	

MATERIAL:

FINISH:

ARTWORK #

WAVETEK INDIANA

1403 — 1503
MECHANICAL

DRAWN BY: BOB NAYLOR
SCALE:
DATE: JAN. 4 1980
CHK'D:
DATE:
RELEASED BY:
DATE:
DRAWING NO. DD-32

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY
11	CABINET, P-CHAS-1	A500-228-1	W-I	1111-00-0010	1
1	CHASSIS, 1403	A500-274-1	W-I	1111-00-0082	1
4	ATTEN, 7535-01	7535-01	W-I	1113-20-0026	1
10	POWER SUPPLY, PS7	PS7	W-I	1115-00-0005	1
3	POWER SWITCH ASSY	A500-247	W-I	1112-00-0002	1
8	SWP DRIVE, M2E-2	M2E-2	W-I	1114-00-0061	1
6	MKR ADDER, M5D	M5D	W-I	1114-00-0082	1
12	VERT/MKR ADDER, M8	M8	W-I	1114-00-0122	1
7	SWP OSC, M9JA	M9JA	W-I	1114-00-0074	1
A3	CABLE ASSY, 2-3/4 IN	WX2000-A2	W-I	1217-00-0026	1
A6	CABLE ASSY, 2-3/4 IN	WX2001-A7	W-I	1217-02-0026	1
A1	CABLE ASSY, 5 IN	WX1801A-A3	W-I	1217-70-0001	1
A2	CABLE ASSY, 7-3/4 IN	WX1402A-A3	W-I	1217-70-0004	1
A5	CABLE ASSY, 19-1/4 IN	WX200-A8	W-I	1217-80-0003	1
A4	CABLE ASSY, 12-1/2 IN	WX1402A-A4	W-I	1217-80-0013	1
9	HARNESS ASSY	WY1403	W-I	1219-00-0050	1
2	REMOTE JUMPER PLUG	A500-233	W-I	1118-00-0001	1
5	SMC TERM, 50 A500-267	A500-267	W-I	1118-00-0007	1

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	SWP GEN, 1403	1010-00-0056 PAGE: 1	J

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
11	CABINET, P-CHAS-1	A500-228-1	W-I	1111-00-0010	1
1	CHASSIS, 1503	A500-274	W-I	1111-00-0027	1
4	ATTEN, 5035-01	5035-1	W-I	1113-30-0019	1
10	POWER SUPPLY, PS7	PS7	W-I	1115-00-0005	1
3	POWER SWITCH ASSY	A500-247	W-I	1112-00-0002	1
8	SWP DRIVE, M2E-2	M2E-2	W-I	1114-00-0061	1
6	MKR ADDER, M5D	M5D	W-I	1114-00-0082	1
12	VERT/MKR ADDER, M8	M8	W-I	1114-00-0122	1
7	SWP OSC, M9S-1	M9S-1	W-I	1114-00-0085	1
A3	CABLE ASSY, 2-3/4 IN	WX2000-A2	W-I	1217-00-0026	1
A6	CABLE ASSY, 2-3/4 IN	WX2-01-A7	W-I	1217-02-0026	1
A1	CABLE ASSY, 5 IN	WX1801A-A3	W-I	1217-70-0001	1
A2	CABLE ASSY, 7-3/4 IN	WX1402A-A3	W-I	1217-70-0004	1
A5	CABLE ASSY, 19-1/4 IN	WX2000-A8	W-I	1217-80-0003	1
A4	CABLE ASSY, 12-1/2 IN	WX1402A-A4	W-I	1217-80-0013	1
9	HARNESS ASSY	WY1403	W-I	1219-00-0050	1
2	REMOTE JUMPER PLUG	A500-233	W-I	1118-00-0001	1
5	SMC TERM, 50 A500-267	A500-267	W-I	1118-00-0007	1

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	SWP GEN, 1503	1010-00-0057 PAGE: 1	I

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
DS101	INDICATOR LT MB000-003	99-33080-5P47TL-018	M-O	2410-02-0003	1
L101 L102 L103	CHOKE, 10.0MH, 10% LA005-010	08N100K	ASE	1810-03-0100	3
R102 R105	POT, 10K, RP134-310	RK45	CTS	4610-30-2103	2
R103 R104	POT, 10K RP118-310	JAIN056S103MA	A-B	4610-10-5103	2
R101	RES, C, 1/4W, 5%, 91K RC103-391	CF1/4-91K	ASE	4700-15-9102	1
S104	SWITCH, TOG, BLK ANOD. ST001-006	7101PN	C-K	5106-00-0009	1
S103	SWITCH, TOGGLE ST003-006	7201PN-BLK	C-K	5106-00-0012	1
S106	SWITCH, PB, SZ001-011	PB15	C-L	5110-00-0007	1
J4 J5 J104	CONN, BNC, UG911A/U	KC79-146	KIN	2110-01-1013	3
J105	CONN, BNC, TWINAX	21JR101-2	S-C	2110-01-2001	1

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	CHASSIS ASSY	1111-00-0027 ALSO 0082 PAGE: 1	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
J2	RECEPTACLE, MC000-030	03-09-1121	MOL	2113-08-0001	1
2	TERM, MALE MC000-033	02-09-2143	MOL	2113-09-0002	1
3	TERMINAL, FEMALE MC000-032	02-09-1143	MOL	2113-09-0001	6
J101	RECEPTACLE, MC000-016	03-06-1151	MOL	2113-03-0001	1
5	TERMINAL, FEMALE MC000-018	02-06-1131	MOL	2113-05-0001	13
J102 J103	CONN, JB000-003	KC19-175	KIN	2110-01-1012	2

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	HARNESS ASSY	1219-00-0050 PAGE: 1	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
J101	PLUG, MC000-017	03-06-2151	MOL	2113-04-0001	1
2	TERMINAL, MALE MC000-019	1854	MOL	2113-05-0002	8

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	REMOTE JUMPER PLUG A500-223	1118-00-0001 PAGE: 1	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
3	CONTACT, MC000-041	02-06-2103	MOL	2113-05-0003	3
S101	SWITCH, TOG	ST000-007	W-I	5106-00-0005	1
P1	PLUG, 4-PIN	03-06-2042	MOL	2113-04-0002	1

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	POWER SWITCH ASSY A500-247	1112-00-0002 PAGE: 1	A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C7	CAP, CER, .1MF, 50V CD103-410	TGP-10	SPR	1510-10-2104	1
F1	FUSE, S.B., .5 AMP MF000-007	MDL 1/2	BUS	2410-05-0004	1
J1	RECEPTACLE MC000-034	03-06-1041	MOL	2113-03-0002	1
12	TERMINAL, FEMALE MC000-018	02-06-1131	MOL	2113-05-0001	4
J5	CONN, UG911A/U JB109-111	KC79-146	KIN	2110-01-1013	1
P3	CORD SET, 18/3SVT, 6FT GRY, MLD. CAP, UL-APPRV	17237SVT	BEL	6011-80-0001	1
Q2 Q3	TRANS QA052-940	2N5294	RCA	4901-05-2940	2
R44	POT, 20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	1
S1	SWITCH, SLIDE, DPDT	EPSI-SLI	S-I	5105-00-0011	1
S2	SWITCH, TOGGLE ST000-003	MTA106D	ALC	5106-00-0002	1
T1	XFMR, PWR, TT000-022	TT000-022	W-I	5610-00-0006	1
14	POWER SUPPLY BOARD	PS7 CARD	W-I	1218-00-0013	1

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	POWER SUPPLY, PS7	1115-00-0005 PAGE: 1	G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C01 C07	CAP, ELECT, 1250MF, 50V CE114-212	1510-20-7122	MAL	1510-20-7122	2
C02	CAP, ELECT, 50MF, 50V CE107-050	TE1307	SPR	1510-20-5500	1
C03 C06 C11	CAP, ELECT, 100MF, 25V CE105-110	TE1211	SPR	1510-20-4101	3
C04 C09	CAP, CER, 100PF, 1KV CD102-110	60U101M	MDC	1510-10-1101	2
C05	CAP, CER, .005MF, 100V	TG-D50	SPR	1510-10-2502	1
C08	CAP, CER, 120PF, 1KV CD102-112	60U121M	MDC	1510-10-1121	1
C10 C12 C14	CAP, TANT, 10MF, 25V CE120-010	162D106X0025DD2	SPR	1510-21-7100	3
C13	CAP, MYLAR, .15MF, 100V CP103-415	WMF1P15	C-D	1510-60-2154	1
C16	CAP, CER, .05MF, 100V CD103-350	TG-S50	SPR	1510-10-2503	1
CR01 CR02 CR03 CR04 CR05 CR06 CR07 CR08 CR09 CR10 CR11 CR12 CR13 CR14 CR15 CR16 CR17	DIODE DR000-001	1N4004	P-C	4806-01-4004	17
IC1	IC, IC000-001	LM723CH	NAT	7000-17-2300	1

WAVETEK PARTS LIST

TITLE POWER SUPPLY BOARD

ASSEMBLY NO. 1218-00-0013

PAGE: 1

REV E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC2	IC, IC000-002	N5741CV	SIG	7000-57-4100	1
IC3	IC, IC000-005	RC4558DN	RAY	7000-14-5800	1
P2	WAFERCON, MC000-031	1840-12-2	MOL	2112-09-0001	1
Q01 Q04 Q05	TRANS QA036-440	2N3644	FCD	4901-03-6440	3
Q06 Q13	TRANS QA038-541	2N3854A	G-E	4901-03-8541	2
Q07	TRANS QA053-060	2N5306	G-E	4901-05-3060	1
Q12	TRANS QB000-009	MPS3702	MOT	4902-03-7020	1
R01	RES, C, 1/4W, 5%, 270 RC103-127	CF1/4-270	ASE	4700-15-2700	1
R02	RES, C, 1/4W, 5%, 1.8K RC103-218	CF1/4-1.8K	ASE	4700-15-1801	1
R03 R11 R21 R46	RES, 1/2W, 1%, 5 RD01R-050	K20-5	KID	4701-23-0050	4
R04 R14	RES, MF, 1/8W, 1%, 1K RF212-100	MF55K-1K	ASE	4701-03-1001	2
R05	RES, MF, 1/8W, 1%, 12.1K RF213-121	MF55K-12.1K	ASE	4701-03-1212	1
R06	RES, C, 1/4W, 5%, 1.5K RC103-215	CF1/4-1.5K	ASE	4700-15-1501	1
R07	RES, C, 1/4W, 5%, 220 RC103-122	CF1/4-220	ASE	4700-15-2200	1

WAVETEK PARTS LIST

TITLE POWER SUPPLY BOARD

ASSEMBLY NO. 1218-00-0013

PAGE: 2

REV E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R08	RES, C, 1/4W, 5%, 3.9K RC103-239	CF1/43.9K	ASE	4700-15-3901	1
R09	POT, 1K, RP131-210	360T102B	CTS	4610-00-3102	1
R10	RES, C, 1/4W, 5%, 2.7K RC103-227	CF1/4-2.7K	ASE	4700-15-2701	1
R12	RES, C, 1/4W, 5%, 470 RC103-147	CF1/4-470	ASE	4700-15-4700	1
R13	RES, C, 1/2W, 5%, 2.7K RC105-227	CF1/2-2.7K	ASE	4700-25-2701	1
R15	RES, MF, 1/8W, 1%, 15K RF213-150	MF55K-15K	ASE	4701-03-1502	1
R16 R17	RES, C, 1/4W, 5%, 1K RC103-210	CF1/4-1K	ASE	4700-15-1001	2
R18	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	1
R19 R20	RES, SET, 2-10K, 1/8W QTY: 2: 4701-03-1002	RX000-003	W-I	4789-00-0004	1
R22 R29 R30 R38 R42	RES, C, 1/4W, 5%, 10K RC103-310	CF1/4-10K	ASE	4700-15-1002	5
R23 R28 R39 R41	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	4

WAVETEK
PARTS LIST

TITLE
POWER SUPPLY BOARD

ASSEMBLY NO.
1218-00-0013

PAGE: 3

REV
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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R24	RES, C, 1/4W, 5%, 100 RC103-110	CF1/4-100	ASE	4700-15-1000	1
R25	RES, C, 1/4W, 5%, 15K RC103-315	CF1/4-15K	ASE	4700-15-1502	1
R26 R44	POT, 20K, RP131-320	360T203B	CTS	4610-00-3203	2
R27	RES, C, 1/4W, 5%, 220K RC103-422	CF1/4220K	ASE	4700-15-2203	1
R31	RES, C, 1/4W, 5%, 47 RC103-047	CF1/4-47	ASE	4700-15-4709	1
R40	RES, C, 1/4W, 5%, 22K RC103-322	CF1/422K	ASE	4700-15-2202	1
R43	RES, C, 1/4W, 5%, 18K RC103-318	CF1/4-18K	ASE	4700-15-1802	1
R45	RES, C, 1/2W, 5%, 220 RC105-122	CF1/2-220	ASE	4700-25-2200	1

WAVETEK
PARTS LIST

TITLE
POWER SUPPLY BOARD

ASSEMBLY NO.
1218-00-0013

PAGE: 4

REV
E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1 C10 C15 C16 C2 C5 C6 C9	CAP, F.T., 6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	8
C3 C4	CAP, Q.C., 3.9PF CG101-239	QC-3.9PF	Q-C	1510-40-0399	2
C7 C8	CAP, Q-C, 2.4PF, 10% CG101-224	QC-2.4PF	Q-C	1510-40-0249	2
C13 C14	CAP, F.T., 470PF CF101-147	FA5C-4712	A-B	1510-30-0471	2
CR1 CR2 CR3 CR4 CR5	DIODE DR000-001	1N4004	P-C	4806-01-4004	5
IC1	IC, IC000-005	RC4558DN	RAY	7000-14-5800	1
Q1	TRANS-QA042-500	2N4250	FCD	4901-04-2500	1
Q4 Q5	TRANS QA054-580	2N5458	MOT	4901-05-4580	2
R1 R2 R42	RES, SET, 3-178K, 1/8W QTY: 3: 4701-03-1783	RX000-002	W-I	4789-00-0001	1
R3 R4	RES, MF, 1/8W, 1%, 10K RF213-100	MF55K10K	ASE	4701-03-1002	2
R15 R31 R5 R8	POT, 20K, RP130-320	89PR20K	BEK	4610-00-2203	4
R6	RES, C, 1/4W, 5%, 470K RC103-447	CF1/4-470K	ASE	4700-15-4703	1
R7	RES, C, 1/4W, 5%, 150K RC103-415	CF1/4-150K	ASE	4700-15-1503	1

WAVETEK PARTS LIST | TITLE SWP DRIVE, M2E-2 | ASSEMBLY NO. 1114-00-0061 | PAGE: 1 | REV B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R9	RES, C, 1/4W, 5%, 10K RC103-310	CF1/4-10K	ASE	4700-15-1002	1
R10	RES, C, 1/4W, 5%, 470 RC103-147	CF1/4-470	ASE	4700-15-4700	1
R11 R12 R13 R14	RES, C, 1/4W, 5%, 2.2K RC103-222	CF1/4-2.2K	ASE	4700-15-2201	4
R16 R17 R18 R32	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	4
R19 R27	RES, C, 1/4W, 5%, 100K RC103-410	CF1/4-100K	ASE	4700-15-1003	2
R20 R22 R24 R26 R28	POT, 100K, RP130-410	89PR100K	BEK	4610-00-2104	5
R21 R23 R25	RES, C, 1/4W, 5%, 220K RC103-422	CF1/4220K	ASE	4700-15-2203	3
R29	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R30	RES, C, 1/4W, 5%, 18K RC103-318	CF1/4-18K	ASE	4700-15-1802	1
R40	RES, C, 1/4W, 10%, 22M RC104-622	CB2261	A-B	4700-16-2205	1
R41	RES, C, 1/4W, 5%, 51K RC103-351	CF1/4-51K	ASE	4700-15-5102	1

WAVETEK PARTS LIST | TITLE SWP DRIVE, M2E-2 | ASSEMBLY NO. 1114-00-0061 | PAGE: 2 | REV B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1 C19 C20	CAP, FT, 500PF, 20%250V CF104-150	4420-500PF	AER	1510-30-3501	3
C2	CAP, CER, .025MF, 50V CD103-325	TG-S25	SPR	1510-10-2253	1
C14 C15 C25 C3 C4 C5 C6	CAP, F.T., 6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	7
C7	CAP, TANT, 10MF, 25V CE120-010	162D106X0025DD2	SPR	1510-21-7100	1
C23 C24 C26 C28 C8	CAP, F.T., 470PF CF101-147	FA5C-4712	A-B	1510-30-0471	5
C9	CAP, CER, 200PF, 1KV CD102-120	5GA-T20	SPR	1510-10-1201	1
C10	CAP, CER, 3000PF, 1KV CD102-230	5GA-D30	SPR	1510-10-1302	1
C11 C12 C13 C17	CAP, CER, .05MF, 100V CD103-350	TG-S50	SPR	1510-10-2503	4
C18	CAP, CER, .005MF, 100V	TG-D50	SPR	1510-10-2502	1
C21	CAP, CER, 470PF, 1KV CD102-147	60U471M	MDC	1510-10-1471	1
C22	CAP, CER, 120PF, 1KV CD102-112	60U121M	MDC	1510-10-1121	1
C27 C29	CAP, ELECT, 100MF, 25V CE105-110	TE1211	SPR	1510-20-4101	2

WAVETEK
PARTS LIST

TITLE
MKR ADDER, M5D

ASSEMBLY NO.
1114-00-0082

PAGE: 1

REV
E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
CR1 CR6	DIODE DG100-821	1N82AG	G-I	4807-01-0082	2
CR2	DIODE DR000-001	1N4004	P-C	4806-01-4004	1
CR5	DIODE DP000-040	MA47980	M-A	4805-02-0001	1
J1 J2 J4	CONN JF000-005	37JR116-1	S-C	2110-03-0002	3
L1	CHOKE, 10MILH, 10% LA004-310	15S103K	ASE	1810-02-1001	1
L2	CHOKE .22MH 10% LA005-R02	08NR22K	ASE	1810-03-0228	1
L03	TORRID, 10 TURN	LA009-010-1	HYT	1810-05-0004	1
Q1 Q2 Q3 Q4 Q5	TRANS QA050-880	2N5088	MOT	4901-05-0880	5
Q6	TRANS QA054-610	2N5461	MOT	4901-05-4610	1
Q13 Q7	TRANS QB000-010	TD101	SPR	4902-00-1010	2
Q10 Q14 Q8 Q9	TRANS QB000-009	MPS3702	MOT	4902-03-7020	4
Q11	TRANS QA038-541	2N3854A	G-E	4901-03-8541	1
Q12	TRANS QA054-580	2N5458	MOT	4901-05-4580	1
R1 R36 R37	RES, C, 1/4W, 5%, 680 RC103-168	CF1/4-680	ASE	4700-15-6800	3
R2 R3	RES, C, 1/4W, 5%, 56 RC103-056	CF1/4-56	ASE	4700-15-5609	2

WAVETEK
PARTS LIST

TITLE
MKR ADDER, M5D

ASSEMBLY NO.
1114-00-0082

PAGE: 2

REV
E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R26 R4 R60 R61	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	4
R12 R15 R18 R38 R39 R5 R7 R9	RES, C, 1/4W, 5%, 22K RC103-322	CF1/422K	ASE	4700-15-2202	8
R10 R13 R16 R19 R6	RES, C, 1/4W, 5%, 270 RC103-127	CF1/4-270	ASE	4700-15-2700	5
R11 R14 R17 R8	RES, C, 1/4W, 5%, 5.6K RC103-256	CF1/4-5.6K	ASE	4700-15-5601	4
R20 R50	RES, C, 1/4W, 5%, 1M RC103-510	CF1/4-1M	ASE	4700-15-1004	2
R21	RES, C, 1/4W, 5%, 10M RC103-610	CB1065	A-B	4700-15-1005	1
R22 R30	RES, C, 1/4W, 5%, 3.3K RC103-233	CF1/4-3.3K	ASE	4700-15-3301	2
R23 R24 R29 R32 R35 R57 R58	RES, C, 1/4W, 5%, 10K RC103-310	CF1/4-10K	ASE	4700-15-1002	7
R25 R56	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	2
R27 R46	RES, C, 1/4W, 5%, 2.2K RC103-222	CF1/4-2.2K	ASE	4700-15-2201	2
R28	RES, C, 1/4W, 5%, 220K RC103-422	CF1/4220K	ASE	4700-15-2203	1

WAVETEK PARTS LIST

TITLE: MKR ADDER, M5D

ASSEMBLY NO. 1114-00-0082

REV E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R31	RES, C, 1/4W, 5%, 1.8K RC103-218	CF1/4-1.8K	ASE	4700-15-1801	1
R33 R34 R54	RES, C, 1/4W, 5%, 1K RC103-210	CF1/4-1K	ASE	4700-15-1001	3
R40 R52	POT, 20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	2
R45 R55	RES, C, 1/4W, 5%, 2.7K RC103-227	CF1/4-2.7K	ASE	4700-15-2701	2
R47	RES, C, 1/4W, 5%, 100 RC103-110	CF1/4-100	ASE	4700-15-1000	1
R48	RES, C, 1/2W, 5%, 47 RC105-047	EB4705	A-B	4705-25-4709	1
R49	RES, C, 1/4W, 5%, 47 RC103-047	CF1/4-47	ASE	4700-15-4709	1
R51	RES, C, 1/4W, 10%, 2.2M RC104-522AB	CB2251	A-B	4705-16-2204	1
R53	RES, C, 1/4W, 5%, 470K RC103-447	CF1/4-470K	ASE	4700-15-4703	1
R59	RES, C, 1/4W, 5%, 220 RC103-122	CF1/4-220	ASE	4700-15-2200	1

WAVETEK PARTS LIST

TITLE: MKR ADDER, M5D

ASSEMBLY NO. 1114-00-0082

REV E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C01 C02	CAP, CER, 33PF, 1KV CD101-033	10TCC-Q33	SPR	1510-10-0330	2
C03	CAP, CER, 100PF, 1KV CD102-110	60U101M	MDC	1510-10-1101	1
C04 C15	CAP, CER, 10PF, 1KV CD101-010	10TCC-Q10	SPR	1510-10-0100	2
C05 C21 C37A C37B C37C C38A C38B C38C C42 C55*	CAP, CER, .05MF, 100V CD103-350	TG-S50	SPR	1510-10-2503	10
C06 C07 C16 C17 C22 C44	CAP, CER, .01MF, 100V CD103-310	68U103M	MDC	1510-10-2103	6
C08 C09 C23 C28 C50	CAP, CER, .025MF, 50V CD103-325	TG-S25	SPR	1510-10-2253	5
C10 C20 C27 C29 C46	CAP, CER, .001MFD, 1KV CD102-210	5GAD10	SPR	1510-10-1102	5
C11 C24 C25	CAP, CER, 47PF, 1KV CD104-047	60U2J470J	MDC	1510-10-3470	3
C12 C19	CAP, CER, 20PF, 1KV CD101-020	60C0G200J	MDC	1510-10-0200	2
C13 C40 C41	CAP, CER, 120PF, 1KV CD104-112	10TCU-T12	SPR	1510-10-3121	3
C14	CAP, FT, 500PF, 20%250V CF104-150	4420-500PF	AER	1510-30-3501	1

WAVETEK PARTS LIST

TITLE: IF MKR, M7E

ASSEMBLY NO. 1114-00-0197

REV B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C18	CAP, CER, 68PF, 1KV CD104-068	68U2J680J	MDC	1510-10-3680	1
C26	CAP, CER, 25PF, 1KV CD101-025	60C0G250J	MDC	1510-10-0250	1
C30 C32 C34	CAP, VAR, 3.5-13PF250V CV101-013	7S-TRIKO-02-3.5-13PF	STR	1510-70-0130	3
C36A C36B C36C C39A C39B C39C	CAP, CER, 200PF, 1KV CD102-120	5GA-T20	SPR	1510-10-1201	6
C43 C47 C55	CAP, F.T., 6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	3
C45	CAP, CER, .02UF, 50V	TG-S20	SPR	1510-10-2203	1
C48* C49	CAP, TANT, .47MF, 50V CE113-447	935	TRW	1510-21-9470	2
C51 C53	CAP, TANT, 10MF, 25V CE120-010	162D106X0025DD2	SPR	1510-21-7100	2
C52 C54	CAP, F.T., 470PF CF101-147	FA5C-4712	A-B	1510-30-0471	2
CR01 CR06	DIODE DR000-001	1N4004	P-C	4806-01-4004	2
CR02 CR03A CR03B CR03C CR04A CR04B CR04C CR05	DIODE DG100-341	1N34A	HIT	4807-01-0034	8

WAVETEK PARTS LIST

TITLE: IF MKR, M7E

ASSEMBLY NO. 1114-00-0197

REV B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
IC01	IC, IC000-002	N5741CV	SIG	7000-57-4100	1
J01	CONN JF000-005	37JR116-1	S-C	2110-03-0002	1
L01 L02 L03	CHOKE .22MH 10% LA005-R02	08NR22K	ASE	1810-03-0228	3
L04 L05 L07 L09	RF CHOKE	CHOKE	W-I	1819-99-9999	4
L06	TORRID, 4 TURN	LA009-004-1	HYT	1810-05-0003	1
L08	CHOKE, 2.2MH, 10% LA005-R22	08N2R2K	ASE	1810-03-0229	1
Q01 Q03 Q04	TRANS QB000-020	40841	RCA	4902-40-8410	3
Q02 Q07A Q07B Q07C Q08A Q08B Q08C Q09A Q09B Q09C Q11 Q12	TRANS QA038-541	2N3854A	G-E	4901-03-8541	12
Q05 Q06	TRANS QA051-790	2N5179	RCA	4901-05-1790	2
Q10 Q13	TRANS QB000-009	MPS3702	MOT	4902-03-7020	2
R01 R02	RES, C, 1/4W, 5%, 56 RC103-056	CF1/4-56	ASE	4700-15-5609	2
R03	POT, 1K RP124-210	WA2G032S-102MA	A-B	4610-10-7102	1
R04 R11 R16	RES, C, 1/4W, 10%, 22M RC104-622	CB2261	A-B	4700-16-2205	3

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	IF MKR, M7E	1114-00-0197	B
		PAGE: 3	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R05 R13 R17	RES, C, 1/4W, 5%, 220 RC103-122	CF1/4-220	ASE	4700-15-2200	3
R06 R23	RES, C, 1/4W, 5%, 47 RC103-047	CF1/4-47	ASE	4700-15-4709	2
R07 R14 R19	RES, C, 1/4W, 5%, 1K RC103-210	CF1/4-1K	ASE	4700-15-1001	3
R08 R31A R31B R31C R35A R35B R35C R43 R44	RES, C, 1/4W, 5%, 27K RC103-327	CF1/4-27K	ASE	4700-15-2702	9
R09	RES, C, 1/4W, 5%, 68 RC103-068	CF1/4-68	ASE	4700-15-6809	1
R10	RES, C, 1/4W, 5%, 56K RC103-356	CF1/4-56K	ASE	4700-15-5602	1
R12 R21 R22 R40 R46	RES, C, 1/4W, 5%, 22K RC103-322	CF1/422K	ASE	4700-15-2202	5
R15 R20	RES, C, 1/4W, 5%, 10 RC103-010	CF1/4-10	ASE	4700-15-1009	2
R18 R26 R27 R28A R28B R28C R32A R32B R32C R54	RES, C, 1/4W, 5%, 2.2K RC103-222	CF1/4-2.2K	ASE	4700-15-2201	10
R24	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	1
R25	RES, C, 1/4W, 5%, 68K RC103-368	CF1/4-68K	ASE	4700-15-6802	1

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	IF MKR, M7E	1114-00-0197	B
		PAGE: 4	

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R29A R29B R29C R34A R34B R34C R39 R42	RES, C, 1/4W, 5%, 10K RC103-310	CF1/4-10K	ASE	4700-15-1002	8
R30A R30B R30C	RES, C, 1/4W, 5%, 1.8M RC103-518	CF1/4-1.8M	ASE	4700-15-1804	3
R33A R33B R33C R41	RES, C, 1/4W, 5%, 1M RC103-510	CF1/4-1M	ASE	4700-15-1004	4
R36 R37 R45	RES, C, 1/4W, 5%, 18K RC103-318	CF1/4-18K	ASE	4700-15-1802	3
R38	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R47	RES, C, 1/4W, 5%, 1.5M RC103-515	CF1/4-1.5M	ASE	4700-15-1504	1
R48	RES, C, 1/4W, 5%, 470K RC103-447	CF1/4-470K	ASE	4700-15-4703	1
R49 R50	RES, C, 1/4W, 5%, 100K RC103-410	CF1/4-100K	ASE	4700-15-1003	2
R51	POT, 20K, RP129-320	360S203B	CTS	4610-00-1203	1
R52	RES, C, 1/4W, 5%, 3.9K RC103-239	CF1/43.9K	ASE	4700-15-3901	1

WAVETEK PARTS LIST | TITLE: IF MKR, M7E | ASSEMBLY NO. 1114-00-0197 | REV B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R55 R56	RES, C, 1/4W, 5%, 22 RC103-022	CF1/4-22	ASE	4700-15-2209	2
R57*	RES, C, 1/4W, 5%, 3.9M RC103-539	CB3955	A-B	4700-15-3904	1
T01	RF XFMR FROM: 1813-00-0002	1210-44-0001	W-I	1210-44-0001	1
X01	CRYSTAL, XX000-331	X33W-00.00000	W-I	2310-00-0331	1
X02 X03 X04	CRYSTAL, XX000-391	X39W-00.00000	W-I	2310-00-0391	3

WAVETEK PARTS LIST | TITLE: IF MKR, M7E | ASSEMBLY NO. 1114-00-0197 | REV B

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
2	CAP, F.T., 6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	3
3	CAP, CER, 120PF, 1KV CD102-112	60U121M	MDC	1510-10-1121	1
4	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1

WAVETEK PARTS LIST	TITLE VERT/MKR ADDER, M8	ASSEMBLY NO. 1114-00-0122 PAGE: 1	REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1 C13 C20 C21 C25 C4 C6 C7	CAP,F.T.,6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	8
C2	CAP,MYLAR,.1MF,200V CP101-410	WMF2P1	C-D	1510-60-0104	1
C23 C3	CAP,MYLAR,.047MF100V CP103-347	WMF1S47	C-D	1510-60-2473	2
C05 C12	CAP,CER,120PF,1KV CD102-112	60U121M	MDC	1510-10-1121	2
C10 C14 C15 C16 C17 C18 C19 C29 C8 C9	CAP,CER,.001MFD,1KV CD102-210	5GAD10	SPR	1510-10-1102	10
C11	CAP,CER,270PF,1KV CD102-127	60U271M	MDC	1510-10-1271	1
C22 C24	CAP,MYLAR,.15MF,100V CP103-415	WMF1P15	C-D	1510-60-2154	2
C30	CAP,CER,.05MF,100V CD103-350	TG-S50	SPR	1510-10-2503	1
CR3 CR4 CR5 CR6 CR7 CR9	DIODE DR000-001	1N4004	P-C	4806-01-4004	6
CR8	DIODE DB000-001	HW6.8B	MSP	4801-02-0001	1
IC1 IC2 IC3 IC4 IC7	IC,IC000-005	RC4558DN	RAY	7000-14-5800	5
IC5 IC6	IC IC000-006	MC1455P1	MOT	7000-14-5500	2

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	AUTO LEVEL,MBE	1114-00-0128 PAGE: 1	K

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
Q1 Q12 Q13 Q16 Q17 Q2 Q3 Q4	TRANS,M/PR,2N5458 QTY:2:4901-05-4580	QB000-017	W-I	4998-00-0003	4
Q5 Q6	TRANS QA038-541	2N3854A	G-E	4901-03-8541	2
Q10 Q11 Q19 Q20 Q7	TRANS QA054-580	2N5458	MOT	4901-05-4580	5
Q14 Q15 Q8 Q9	TRANS QB000-009	MPS3702	MOT	4902-03-7020	4
Q18	TRANS QA036-440	2N3644	FCD	4901-03-6440	1
R1	RES,C,1/4W,5%,2.2M RC103-522	CF1/4-2.2M	ASE	4700-15-2204	1
R16 R2 R65 R77 R87	RES,C,1/4W,5%,4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	5
R17 R18 R19 R24 R27 R28 R3 R32 R4 R52 R58 R64 R69 R70 R79 R80	RES,C,1/4W,5%,47K RC103-347	CF1/4-47K	ASE	4700-15-4702	16
R22 R23 R5 R55 R57 R76 R85	RES,C,1/4W,5%,10K RC103-310	CF1/4-10K	ASE	4700-15-1002	7
R6	RES,C,1/4W,5%,91K RC103-391	CF1/4-91K	ASE	4700-15-9102	1
R7	POT,20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	1
R12 R73 R84 R88	RES,C,1/4W,5%,1K RC103-210	CF1/4-1K	ASE	4700-15-1001	4

WAVETEK PARTS LIST	TITLE	ASSEMBLY NO.	REV
	AUTO LEVEL,MBE	1114-00-0128 PAGE: 2	K

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R13	RES,C,1/4W,5%,9.1K RC103-291	CF1/4-9.1K	ASE	4700-15-9101	1
R14 R43 R47	POT,20K,RP130-320	89PR20K	BEK	4610-00-2203	3
R15 R54 R78	RES,C,1/4W,5%,1M RC103-510	CF1/4-1M	ASE	4700-15-1004	3
R20 R21 R42 R46 R53 R61 R66* R68 R74 R75	RES,C,1/4W,5%,100K RC103-410	CF1/4-100K	ASE	4700-15-1003	10
R25 R44 R45 R59 R67	RES,C,1/4W,5%,470K RC103-447	CF1/4-470K	ASE	4700-15-4703	5
R26 R37	RES,C,1/4W,10%,22M RC104-622	CB2261	A-B	4700-16-2205	2
R29	RES,C,1/4W,5%,120K RC103-412	CF1/4-120K	ASE	4700-15-1203	1
R30 R56 R82	RES,C,1/4W,5%,18K RC103-318	CF1/4-18K	ASE	4700-15-1802	3
R31 R49 R83	RES,C,1/4W,5%,22K RC103-322	CF1/422K	ASE	4700-15-2202	3
R33	RES,C,1/4W,5%,33K RC103-333	CF1/4-33K	ASE	4700-15-3302	1
R34 R50	RES,C,1/4W,5%,56K RC103-356	CF1/4-56K	ASE	4700-15-5602	2
R35	RES,C,1/4W,5%,270K RC103-427	CF1/4-270K	ASE	4700-15-2703	1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R36 R51	RES,C,1/4W,5%,1.8K RC103-218	CF1/4-1.8K	ASE	4700-15-1801	2
R38 R81	RES,C,1/4W,10%,10M RC104-610	CB1061	A-B	4700-16-1005	2
R39	RES,C,1/4W,5%,39K RC103-339	CF1/4-39K	ASE	4700-15-3902	1
R40 R41	RES,C,1/4W,5%,180K RC103-418	CF1/4-180K	ASE	4700-15-1803	2
R48	RES,C,1/4W,5%,150K RC103-415	CF1/4-150K	ASE	4700-15-1503	1
R60	RES,C,1/4W,5%,220K RC103-422	CF1/4220K	ASE	4700-15-2203	1
R62 R63 R86	RES,C,1/4W,10%,100M RC104-710	CB1071	A-B	4700-16-1006	3
R71	RES,C,1/4W,5%,24K RC103-324	CF1/4-24K	ASE	4700-15-2402	1
R72	RES,C,1/4W,5%,2.7K RC103-227	CF1/4-2.7K	ASE	4700-15-2701	1
S1 S2	SWITCH,TOGGLE ST000-003	MTA106D	ALC	5106-00-0002	2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1	CAP, Q.C., .47PF CG101-147	QC-.47PF	Q-C	1510-40-0478	1
C11 C13 C16 C17 C2 C25 C28 C32 C36 C4 C40	CAP, FT, 500PF, 20%250V CF104-150	4420-500PF	AER	1510-30-3501	11
C3	CAP, CER, 100PF, 1KV CD108-110	CN1500	RMC	1510-10-5101	1
C5 C6 C7	CAP, FT, CER, 100PF, 20% CF104-110	4420-100PF	AER	1510-30-3101	3
C43 C45 C8	CAP, F.T., 470PF CF101-147	FA5C-4712	A-B	1510-30-0471	3
C12 C14 C24 C30 C31 C33 C34 C35 C38 C39 C44 C9	CAP, TANT, .47MF, 50V CE113-447	935	TRW	1510-21-9470	12
C10 C23	CAP, M.C., 3.9PF CG102-239	MC-3.9PF	Q-C	1510-40-1399	2
C15 C18	CAP, CER, .01MF, 100V CD103-310	68U103M	MDC	1510-10-2103	2
C19 C42	CAP, F.T., 6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	2
C20	CAP, CER, 270PF, 1KV CD102-127	60U271M	MDC	1510-10-1271	1
C21	CAP, CER, 120PF, 1KV CD102-112	60U121M	MDC	1510-10-1121	1

WAVETEK
PARTS LIST

TITLE
SWP OSC, M9JA

ASSEMBLY NO.
1114-00-0074

PAGE: 1

REV
G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C22	CAP, M-C, 4.7PF, 10% CG102-247	QC-4.7PF	Q-C	1510-40-1479	1
C26	CAP, CER, .025MF, 50V CD103-325	TG-S25	SPR	1510-10-2253	1
C27	CAP, Q.C., 2.7PF CG101-227	QC-2.7PF	Q-C	1510-40-0279	1
C29	CAP, CER, 10PF, 1KV CD101-010	10TCC-Q10	SPR	1510-10-0100	1
C37	CAP, CER, 15PF, 1KV CD101-015	10TCC-Q15	SPR	1510-10-0150	1
C41	CAP, CER, .001MFD, 1KV CD102-210	5GAD10	SPR	1510-10-1102	1
C46	CAP, TANT, 10MF, 25V CE120-010	162D106X0025DD2	SPR	1510-21-7100	1
CR1 CR2 CR3	DIODE DC000-005	BB141A	ITT	4889-00-0001	3
CR4 CR5 CR6 CR7	DIODE DG100-822	1N82A-K102	KEM	4807-03-0001	4
CR8 CR9	DIODE DB000-001	HW6.8B	MSP	4801-02-0001	2
CR10	DIODE DR000-001	1N4004	P-C	4806-01-4004	1
CR11 CR12	DIODE DP000-050	5082-3080	H-P	4805-02-0002	2
CR13	DIODE DG100-821	1N82AG	G-I	4807-01-0082	1

WAVETEK
PARTS LIST

TITLE
SWP OSC, M9JA

ASSEMBLY NO.
1114-00-0074

PAGE: 2

REV
G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
J1 J3	CONN JF000-005	37JR116-1	S-C	2110-03-0002	2
J2	CONN JF000-004	27-21	APL	2110-03-0001	1
L1 L15 L17 L2 L20 L3 L4 L5	RF CHOKE	CHOKE	W-I	1819-99-9999	8
L13 L6 L7	CHOKE .22MH 10% LA005-R02	08NR22K	ASE	1810-03-0228	3
L09 L10	TORRID, 4 TURN	LA009-004-1	HYT	1810-05-0003	2
L11 L12 L14 L16 L18 L19 L22	TORRID, 10 TURN	LA009-010-1	HYT	1810-05-0004	7
L21	CHOKE, 4.7MH, 10% LA005-R47	08N4R7K	ASE	1810-03-0479	1
Q08 Q1 Q10 Q11 Q2 Q4 Q9	TRANS QA051-790	2N5179	RCA	4901-05-1790	7
Q14 Q15 Q3 Q7	TRANS QB000-009	MPS3702	MOT	4902-03-7020	4
Q05	TRANS QA050-530	2N5053	APX	4901-05-0530	1
Q6	TRANS QA038-541	2N3854A	G-E	4901-03-8541	1
Q12	TRANS QA054-580	2N5458	MOT	4901-05-4580	1
Q13	TRANS QB000-010	TD101	SPR	4902-00-1010	1
Q16 Q17	TRANS QB000-018	SD1006	SSS	4902-01-0060	2

WAVETEK
PARTS LIST

TITLE
SWP OSC, M9JA

ASSEMBLY NO.
1114-00-0074

REV
G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
Q18	TRANS QB000-019	SD1005	SSS	4902-01-0050	1
R1 R10 R58 R64	RES, C, 1/4W, 5%, 680 RC103-168	CF1/4-680	ASE	4700-15-6800	4
R11 R12 R2 R24 R3 R31 R46 R51	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	8
R23 R33 R4 R70	RES, C, 1/4W, 5%, 47 RC103-047	CF1/4-47	ASE	4700-15-4709	4
R05	RES, C, 1/4W, 5%, 5.6K RC103-256	CF1/4-5.6K	ASE	4700-15-5601	1
R6	POT, CONT, 10K RV102-310	3067P-10K	BOU	4610-20-0103	1
R07 R55	RES, C, 1/4W, 5%, 2.2K RC103-222	CF1/4-2.2K	ASE	4700-15-2201	2
R21 R47 R48 R8	RES, C, 1/4W, 5%, 10K RC103-310	CF1/4-10K	ASE	4700-15-1002	4
R9	RES, C, 1/4W, 5%, 10 RC103-010	CF1/4-10	ASE	4700-15-1009	1
R13 R14	RES, C, 1/4W, 5%, 120 RC103-112	CF1/4-120	ASE	4700-15-1200	2
R15	POT, 1K, RP129-210	360S102B	CTS	4610-00-1102	1
R16 R26	RES, C, 1/4W, 5%, 33 RC103-033	CF1/4-33	ASE	4700-15-3309	2

WAVETEK
PARTS LIST

TITLE
SWP OSC, M9JA

ASSEMBLY NO.
1114-00-0074

REV
G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R17 R25 R28 R32 R54 R73	RES, C, 1/4W, 5%, 100 RC103-110	CF1/4-100	ASE	4700-15-1000	6
R18	RES, C, 1/4W, 5%, 390 RC103-139	CF1/4-390	ASE	4700-15-3900	1
R19 R29 R53 R56 R68	RES, C, 1/4W, 5%, 470 RC103-147	CF1/4-470	ASE	4700-15-4700	5
R20	RES, C, 1/4W, 5%, 1.5K RC103-215	CF1/4-1.5K	ASE	4700-15-1501	1
R22	RES, C, 1/4W, 5%, 27K RC103-327	CF1/4-27K	ASE	4700-15-2702	1
R27	RES, C, 1/4W, 5%, 56 RC103-056	CF1/4-56	ASE	4700-15-5609	1
R30	RES, C, 1/4W, 5%, 330 RC103-133	CF1/4-330	ASE	4700-15-3300	1
R34	RES, C, 1/4W, 5%, 150 RC103-115	CF1/4-150	ASE	4700-15-1500	1
R35	RES, C, 1/4W, 5%, 22 RC103-022	CF1/4-22	ASE	4700-15-2209	1
R36	RES, C, 1/4W, 5%, 1M RC103-510	CF1/4-1M	ASE	4700-15-1004	1
R37	RES, C, 1/4W, 5%, 2.2M RC103-522	CF1/4-2.2M	ASE	4700-15-2204	1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R38 R39	POT, 20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	2
R40	RES, C, 1/4W, 5%, 15K RC103-315	CF1/4-15K	ASE	4700-15-1502	1
R41	RES, C, 1/4W, 5%, 470K RC103-447	CF1/4-470K	ASE	4700-15-4703	1
R42 R71	RES, C, 1/4W, 5%, 1K RC103-210	CF1/4-1K	ASE	4700-15-1001	2
R43	RES, C, 1/4W, 5%, 1.2K RC103-212	CF1/4-1.2K	ASE	4700-15-1201	1
R44 R49	RES, C, 1/4W, 5%, 1.2M RC103-512	CF1/4-1.2M	ASE	4700-15-1204	2
R45	RES, C, 1/4W, 5%, 2.7K RC103-227	CF1/4-2.7K	ASE	4700-15-2701	1
R50	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R52	RES, C, 1/4W, 5%, 220 RC103-122	CF1/4-220	ASE	4700-15-2200	1
R57 R62 R63 R67	RES, C, 1/4W, 5%, 1.8K RC103-218	CF1/4-1.8K	ASE	4700-15-1801	4
R59	RES, C, 1/4W, 5%, 180 RC103-118	CF1/4-180	ASE	4700-15-1800	1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R60	RES, C, 1/2W, 5%, 150 RC105-115	CF1/2-150	ASE	4700-25-1500	1
R61 R66	RES, C, 1/4W, 5%, 4.7 RC103-R47	CF1/4-4.7	ASE	4700-15-4708	2
R65	RES, C, 1/2W, 5%, 100 RC105-110	CF1/2-100	ASE	4700-25-1000	1
R69	RES, C, 1/2W, 5%, 68 RC105-068	CF1/2-68	ASE	4700-25-6809	1
R74	RES, L-A, 1/4W, 1%, 75 RF407-500	MF5C-75	M-E	4741-75-0007	1
26	RES, C, 1/4W, 10%, 4.7K RC104-247AB	CB4721	A-B	4705-16-4701	1
NONE	RES, C, 1/4W, 5%, 82 RC103-082	CF1/4-82	ASE	4700-15-8209	1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1 C19 C20	CAP, F.T., 470PF CF101-147	FA5C-4712	A-B	1510-30-0471	3
C11 C2 C7 C8	CAP, FT, CER, 100PF, 20% CF104-110	4420-100PF	AER	1510-30-3101	4
C12 C13 C14 C3 C4 C5 C9	CAP, FT, 500PF, 20%250V CF104-150	4420-500PF	AER	1510-30-3501	7
C6	CAP, Q.C., .75PF CG101-175	QC-.75PF	Q-C	1510-40-0758	1
C10	CAP, Q-C, 2.0PF, 10% CG101-220	QC-2.0PF	Q-C	1510-40-0020	1
C17 C18	CAP, F.T., 6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	2
C21	CAP, CER, 120PF, 1KV CD102-112	60U121M	MDC	1510-10-1121	1
C22	CAP, CER, 270PF, 1KV CD102-127	60U271M	MDC	1510-10-1271	1
CR1 CR2 CR3	DIODE DP000-040	MA47980	M-A	4805-02-0001	3
CR4	DIODE DG100-821	1N82AG	G-I	4807-01-0082	1
CR5 CR6 CR7 CR8	DIODE DC000-008	BB205	APX	4803-02-0004	4
CR9	DIODE DR000-001	1N4004	P-C	4806-01-4004	1
J1 J2	CONN JF000-005	37JR116-1	S-C	2110-03-0002	2

WAVETEK PARTS LIST	TITLE SWP OSC, M9S-1	ASSEMBLY NO. 1114-00-0085 PAGE: 1	REV A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
L01 L02 L10 L11	TORRID, 4 TURN	LA009-004-1	HYT	1810-05-0003	4
L12 L3 L8	CHOKE .22MH 10% LA005-R02	08NR22K	ASE	1810-03-0228	3
L4 L5 L6 L7 L9	RF CHOKE	CHOKE	W-I	1819-99-9999	5
Q1	TRANS QA051-090	2N5109	SSS	4901-05-1090	1
Q10 Q11 Q2 Q4	TRANS QB000-009	MPS3702	MOT	4902-03-7020	4
Q3 Q5	TRANS QA038-541	2N3854A	G-E	4901-03-8541	2
Q8	TRANS QA054-580	2N5458	MOT	4901-05-4580	1
Q9	TRANS QB000-010	TD101	SPR	4902-00-1010	1
R1 R12	RES, C, 1/4W, 5%, 22K RC103-322	CF1/422K	ASE	4700-15-2202	2
R11 R2	RES, C, 1/4W, 5%, 68K RC103-368	CF1/4-68K	ASE	4700-15-6802	2
R14 R3 R9	RES, C, 1/4W, 5%, 2.2K RC103-222	CF1/4-2.2K	ASE	4700-15-2201	3
R4	RES, C, 1/4W, 5%, 100K RC103-410	CF1/4-100K	ASE	4700-15-1003	1
R5 R6*	RES, C, 1/2W, 5%, 220 RC105-122	CF1/2-220	ASE	4700-25-2200	2
R7	RES, C, 1/4W, 5%, 390 RC103-139	CF1/4-390	ASE	4700-15-3900	1

WAVETEK PARTS LIST	TITLE SWP OSC, M9S-1	ASSEMBLY NO. 1114-00-0085 PAGE: 2	REV A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R8	RES,L-A,1/4W,1%,49.9 RF404-990	SPS-N-347-49.9	IRC	4741-49-9007	1
R10	RES,C,1/4W,5%,47 RC103-047	CF1/4-47	ASE	4700-15-4709	1
R13	RES,C,1/4W,5%,100 RC103-110	CF1/4-100	ASE	4700-15-1000	1
R15	POT,CONT,10K RV102-310	3067P-10K	BOU	4610-20-0103	1
R16	RES,C,1/4W,5%,3.9K RC103-239	CF1/43.9K	ASE	4700-15-3901	1
R17	RES,C,1/4W,5%,7.5K RC103-275	CF1/4-7.5K	ASE	4700-15-7501	1
R18 R26 R35	RES,C,1/4W,5%,4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	3
R19	RES,C,1/4W,5%,470 RC103-147	CF1/4-470	ASE	4700-15-4700	1
R20 R22	POT,20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	2
R21	RES,C,1/4W,5%,15K RC103-315	CF1/4-15K	ASE	4700-15-1502	1
R23	RES,C,1/4W,5%,470K RC103-447	CF1/4-470K	ASE	4700-15-4703	1

WAVETEK
PARTS LIST

TITLE
SWP OSC,M9S-1

ASSEMBLY NO.
1114-00-0085

REV
A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R24 R37	RES,C,1/4W,5%,1.2M RC103-512	CF1/4-1.2M	ASE	4700-15-1204	2
R25	RES,C,1/4W,5%,2.7K RC103-227	CF1/4-2.7K	ASE	4700-15-2701	1
R27 R28	RES,C,1/4W,5%,10K RC103-310	CF1/4-10K	ASE	4700-15-1002	2
R29 R36	RES,C,1/4W,5%,220 RC103-122	CF1/4-220	ASE	4700-15-2200	2
R30	RES,C,1/4W,5%,1.2K RC103-212	CF1/4-1.2K	ASE	4700-15-1201	1
R31	RES,C,1/4W,5%,1M RC103-510	CF1/4-1M	ASE	4700-15-1004	1
R32	RES,C,1/4W,5%,2.2M RC103-522	CF1/4-2.2M	ASE	4700-15-2204	1
R33	RES,C,1/4W,5%,1K RC103-210	CF1/4-1K	ASE	4700-15-1001	1
R34	RES,C,1/4W,5%,47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R38*	RES,C,1/4W,5%,68 RC103-068	CF1/4-68	ASE	4700-15-6809	1

WAVETEK
PARTS LIST

TITLE
SWP OSC,M9S-1

ASSEMBLY NO.
1114-00-0085

REV
A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1 C12 C5 C6 C7 C8	CAP, F.T., 6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	6
C2	CAP, CER, 200PF, 1KV CD102-120	5GA-T20	SPR	1510-10-1201	1
C11 C3	CAP, MYLAR, .022MF200V CP101-322	WMF2S22	C-D	1510-60-0223	2
C4	CAP, MYLAR, 2200PF, 10% CP101-222	WMF2D22	C-D	1510-60-0222	1
C9	CAP, CER, .01MF, 100V CD103-310	68U103M	MDC	1510-10-2103	1
C10	CAP, MYLAR, .047MF100V CP103-347	WMF1S47	C-D	1510-60-2473	1
C13 C14	CAP, F.T., 470PF CF101-147	FA5C-4712	A-B	1510-30-0471	2
C15 C16	CAP, TANT, 10MF, 25V CE120-010	162D106X0025DD2	SPR	1510-21-7100	2
CR1 CR2 CR3 CR4 CR5	DIODE DR000-001	1N4004	P-C	4806-01-4004	5
IC1 IC2	IC, IC000-005	RC4558DN	RAY	7000-14-5800	2
Q1 Q10 Q11 Q2 Q3 Q8	TRANS QA054-580	2N5458	MOT	4901-05-4580	6
Q4 Q5	TRANS, M/PR, 2N5458 QTY: 2: 4901-05-4580	QB000-017	W-I	4998-00-0003	1

WAVETEK PARTS LIST

TITLE: AUTO FREQ, M11E

ASSEMBLY NO. 1114-00-0133

REV G

PAGE: 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
Q6 Q7	TRANS QB000-009	MPS3702	MOT	4902-03-7020	2
Q9	TRANS QA038-541	2N3854A	G-E	4901-03-8541	1
R1 R21 R22	RES, C, 1/4W, 5%, 10K RC103-310	CF1/4-10K	ASE	4700-15-1002	3
R2 R4 R9	POT, 20K, RP130-320	89PR20K	BEK	4610-00-2203	3
R25 R3	RES, C, 1/4W, 5%, 470K RC103-447	CF1/4-470K	ASE	4700-15-4703	2
R17 R5	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	2
R6	RES, C, 1/4W, 5%, 20K RC103-320	CF1/4-20K	ASE	4700-15-2002	1
R7	RES, C, 1/4W, 5%, 33K RC103-333	CF1/4-33K	ASE	4700-15-3302	1
R13 R14 R15 R16 R20 R27 R8	RES, C, 1/4W, 5%, 100K RC103-410	CF1/4-100K	ASE	4700-15-1003	7
R10 R28	RES, C, 1/4W, 10%, 10M RC104-610	CB1061	A-B	4700-16-1005	2
R11 R12 R32	RES, C, 1/4W, 10%, 100M RC104-710	CB1071	A-B	4700-16-1006	3
R18 R19 R24 R29 R30	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	5

WAVETEK PARTS LIST

TITLE: AUTO FREQ, M11E

ASSEMBLY NO. 1114-00-0133

REV G

PAGE: 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R23	RES, C, 1/4W, 5%, 18K RC103-318	CF1/4-18K	ASE	4700-15-1802	1
R26	RES, C, 1/4W, 5%, 220K RC103-422	CF1/4220K	ASE	4700-15-2203	1
R31	RES, C, 1/4W, 5%, 120K RC103-412	CF1/4-120K	ASE	4700-15-1203	1
R33	RES, C, 1/4W, 10%, 22M RC104-622	CB2261	A-B	4700-16-2205	1
R34	RES, C, 1/4W, 5%, 22 RC103-022	CF1/4-22	ASE	4700-15-2209	1
R35	RES, C, 1/4, 5%, 27 RC103-027	CF1/4-27	ASE	4700-15-2709	1

WAVETEK PARTS LIST	TITLE AUTO FREQ, M11E	ASSEMBLY NO. 1114-00-0133 PAGE: 3	REV G

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C01	CAP,VALUE DETERMINED IN CALIBRATION	CAP,TRIM	W-I	1519-99-9999	1
C02	CAP,CER,33PF,1KV CD104-033	10TU-Q33	SPR	1510-10-3330	1
C03 C14	CAP,CER,.01MF,100V CD103-310	68U103M	MDC	1510-10-2103	2
C04	CAP,CER,.025MF,50V CD103-325	TG-S25	SPR	1510-10-2253	1
C05	CAP,CER,68PF,1KV CD104-068	68U2J680J	MDC	1510-10-3680	1
C06	CAP,CER,100PF,1KV CD104-110	10TCU-T10	SPR	1510-10-3101	1
C07	CAP,VAR,3.5-13PF250V CV101-013	7S-TRIKO-02-3.5-13PF	STR	1510-70-0130	1
C08	CAP,CER,15PF,1KV CD101-015	10TCC-Q15	SPR	1510-10-0150	1
C09	CAP,CER,47PF,1KV CD104-047	60U2J470J	MDC	1510-10-3470	1
C10 C13	CAP,CER,.001MFD,1KV CD102-210	5GAD10	SPR	1510-10-1102	2
C11	CAP,TANT,.47MF,50V CE113-447	935	TRW	1510-21-9470	1
C12	CAP,CER,470PF,1KV CD102-147	60U471M	MDC	1510-10-1471	1

WAVETEK PARTS LIST

TITLE: 1 MHZ HARMONIC MARKER, M6H-1

ASSEMBLY NO. 1114-00-0050

REV E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C15	CAP,FT,500PF,20%250V CF104-150	4420-500PF	AER	1510-30-3501	1
C16	CAP,F.T.,6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	1
C17	CAP,F.T.,470PF CF101-147	FA5C-4712	A-B	1510-30-0471	1
C18	CAP,TANT,10MF,25V CE120-010	162D106X0025DD2	SPR	1510-21-7100	1
CR1 CR2	DIODE DG100-821	1N82AG	G-I	4807-01-0082	2
J1 J2	CONN JF000-005	37JR116-1	S-C	2110-03-0002	2
L1 L2 L3	RF CHOKE	CHOKE	W-I	1819-99-9999	3
L4	FERRITE CHOKE LA009-004	T1255-1	HYT	1810-05-0001	1
Q1 Q3	TRANS QB000-009	MPS3702	MOT	4902-03-7020	2
Q2	TRANS QA038-541	2N3854A	G-E	4901-03-8541	1
Q4	TRANS QA051-790	2N5179	RCA	4901-05-1790	1
Q5	TRANS QB000-013	A430	APX	4902-00-4300	1
Q6	TRANS QA054-580	2N5458	MOT	4901-05-4580	1
Q7	TRANS QA050-880	2N5088	MOT	4901-05-0880	1
R01 R16	RES,C,1/4W,5%,1K RC103-210	CF1/4-1K	ASE	4700-15-1001	2

WAVETEK PARTS LIST

TITLE: 1 MHZ HARMONIC MARKER, M6H-1

ASSEMBLY NO. 1114-00-0050

REV E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R02 R05 R12	RES,C,1/4W,5%,3.9K RC103-239	CF1/43.9K	ASE	4700-15-3901	3
R03 R04	RES,C,1/4W,5%,2.2K RC103-222	CF1/4-2.2K	ASE	4700-15-2201	2
R06	RES,C,1/4W,5%,27K RC103-327	CF1/4-27K	ASE	4700-15-2702	1
R07 R09 R13	RES,C,1/4W,5%,470 RC103-147	CF1/4-470	ASE	4700-15-4700	3
R08 R20	RES,C,1/4W,5%,10K RC103-310	CF1/4-10K	ASE	4700-15-1002	2
R10 R24	RES,C,1/4W,5%,100 RC103-110	CF1/4-100	ASE	4700-15-1000	2
R11	RES,C,1/4W,5%,75 RC103-075	CR1/4-75	ASE	4700-15-7509	1
R14	RES,C,1/4W,5%,33K RC103-333	CF1/4-33K	ASE	4700-15-3302	1
R15	RES,C,1/4W,5%,1M RC103-510	CF1/4-1M	ASE	4700-15-1004	1
R17	RES,C,1/4W,5%,8.2K RC103-282	CF1/4-8.2K	ASE	4700-15-8201	1
R18	RES,C,1/4W,5%,15K RC103-315	CF1/4-15K	ASE	4700-15-1502	1
R19	RES,C,1/4W,5%,1.5M RC103-515	CF1/4-1.5M	ASE	4700-15-1504	1

WAVETEK PARTS LIST

TITLE
1 MHZ HARMONIC
MARKER, M6H-1

ASSEMBLY NO.
1114-00-0050

PAGE: 3

REV
E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R21	POT,20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	1
R22 R23	RES,C,1/4W,5%,4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	2
X1	CRYSTAL X25W XX000-251	X25W-00.00000	W-I	2310-00-0251	1

WAVETEK PARTS LIST

TITLE
1 MHZ HARMONIC
MARKER, M6H-1

ASSEMBLY NO.
1114-00-0050

PAGE: 4

REV
E

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C01 C07	CAP,CER,47PF,1KV CD104-047	60U2J470J	MDC	1510-10-3470	2
C02	CAP,CER,330PF,1KV CD104-133	10TCU-T33	SPR	1510-10-3331	1
C03	CAP,CER,120PF,1KV CD104-112	10TCU-T12	SPR	1510-10-3121	1
C04	CAP,FT,500PF,20%250V CF104-150	4420-500PF	AER	1510-30-3501	1
C05	CAP,VAR,3.5-13PF250V CV101-013	7S-TRIKO-02-3.5-13PF	STR	1510-70-0130	1
C06	CAP,CER,15PF,1KV CD101-015	10TCC-Q15	SPR	1510-10-0150	1
C08 C09	CAP,CER,.001MFD,1KV CD102-210	5GAD10	SPR	1510-10-1102	2
C10	CAP,CER,.01MF,100V CD103-310	68U103M	MDC	1510-10-2103	1
C11	CAP,F.T.,6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	1
C12	CAP,F.T.,470PF CF101-147	FA5C-4712	A-B	1510-30-0471	1
C13	CAP,TANT,10MF,25V CE120-010	162D106X0025D02	SPR	1510-21-7100	1
CR1	DIODE DG100-821	1N82AG	G-I	4807-01-0082	1

WAVETEK PARTS LIST

TITLE: 10 MHZ HARMONIC MARKER, M6H-10

ASSEMBLY NO. 1114-00-0099 — REV C

PAGE: 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
J1 J2	CONN JF000-005	37JR116-1	S-C	2110-03-0002	2
L1 L3	RF CHOKE	CHOKE	W-I	1819-99-9999	2
L2	FERRITE CHOKE LA009-010	T1255-2	HYT	1810-05-0002	1
L4	FERRITE CHOKE LA009-004	T1255-1	HYT	1810-05-0001	1
Q1	TRANS QA038-541	2N3854A	G-E	4901-03-8541	1
Q2	TRANS QB000-013	A430	APX	4902-00-4300	1
Q3	TRANS QA054-580	2N5458	MOT	4901-05-4580	1
Q4	TRANS QA050-880	2N5088	MOT	4901-05-0880	1
R01	RES,C,1/4W,5%,47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R02	RES,C,1/4W,5%,56 RC103-056	CF1/4-56	ASE	4700-15-5609	1
R03	RES,C,1/4W,5%,1.5K RC103-215	CF1/4-1.5K	ASE	4700-15-1501	1
R04 R17	RES,C,1/4W,5%,100 RC103-110	CF1/4-100	ASE	4700-15-1000	2
R05	RES,C,1/4W,5%,75 RC103-075	CR1/4-75	ASE	4700-15-7509	1
R06	RES,C,1/4W,5%,3.9K RC103-239	CF1/43.9K	ASE	4700-15-3901	1

WAVETEK PARTS LIST

TITLE: 10 MHZ HARMONIC MARKER, M6H-10

ASSEMBLY NO. 1114-00-0099 — REV C

PAGE: 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R07	RES,C,1/4W,5%,470 RC103-147	CF1/4-470	ASE	4700-15-4700	1
R08	RES,C,1/4W,5%,33K RC103-333	CF1/4-33K	ASE	4700-15-3302	1
R09	RES,C,1/4W,5%,1M RC103-510	CF1/4-1M	ASE	4700-15-1004	1
R10	RES,C,1/4W,5%,1K RC103-210	CF1/4-1K	ASE	4700-15-1001	1
R11	RES,C,1/4W,5%,8.2K RC103-282	CF1/4-8.2K	ASE	4700-15-8201	1
R12	RES,C,1/4W,5%,15K RC103-315	CF1/4-15K	ASE	4700-15-1502	1
R13	RES,C,1/4W,5%,1.5M RC103-515	CF1/4-1.5M	ASE	4700-15-1504	1
R14	RES,C,1/4W,5%,10K RC103-310	CF1/4-10K	ASE	4700-15-1002	1
R15	POT,20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	1
R16	RES,C,1/4W,5%,100K RC103-410	CF1/4-100K	ASE	4700-15-1003	1
X1	CRYSTAL,XX000-321	X32W-00.00000	W-I	2310-00-0321	1

WAVETEK
PARTS LIST

TITLE
10 MHZ HARMONIC
MARKER, M6H-10

ASSEMBLY NO.
1114-00-0099

PAGE: 3

REV
C

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C01	CAP,CER,20PF,1KV CD101-020	60C0G200J	MDC	1510-10-0200	1
C02	CAP,CER,120PF,1KV CD104-112	10TCU-T12	SPR	1510-10-3121	1
C03 C07	CAP,CER,47PF,1KV CD104-047	60U2J470J	MDC	1510-10-3470	2
C04	CAP,FT,500PF,20%250V CF104-150	4420-500PF	AER	1510-30-3501	1
C05	CAP,VAR,3.5-13PF250V CV101-013	7S-TRIKO-02-3.5-13PF	STR	1510-70-0130	1
C06	CAP,CER,15PF,1KV CD101-015	10TCC-Q15	SPR	1510-10-0150	1
C08 C09	CAP,CER,.001MFD,1KV CD102-210	5GAD10	SPR	1510-10-1102	2
C10	CAP,CER,.01MF,100V CD103-310	68U103M	MDC	1510-10-2103	1
C11	CAP,F.T.,6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	1
C12	CAP,F.T.,470PF CF101-147	FA5C-4712	A-B	1510-30-0471	1
C13	CAP,TANT,10MF,25V CE120-010	162D106X0025DD2	SPR	1510-21-7100	1
CR1	DIODE DG100-821	1N82AG	G-I	4807-01-0082	1

WAVETEK
PARTS LIST

TITLE
50 MHZ HARMONIC
MARKER, M6H-50

ASSEMBLY NO.
1114-00-0100

PAGE: 1

REV
C

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
J1 J2	CONN JF000-005	37JR116-1	S-C	2110-03-0002	2
L1 L3	RF CHOKE	CHOKE	W-I	1819-99-9999	2
L2	FERRITE CHOKE LA009-010	T1255-2	HYT	1810-05-0002	1
L4	FERRITE CHOKE LA009-004	T1255-1	HYT	1810-05-0001	1
R01	RES,C,1/4W,5%,47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R02	RES,C,1/4W,5%,56 RC103-056	CF1/4-56	ASE	4700-15-5609	1
R03	RES,C,1/4W,5%,1.5K RC103-215	CF1/4-1.5K	ASE	4700-15-1501	1
R04 R17	RES,C,1/4W,5%,100 RC103-110	CF1/4-100	ASE	4700-15-1000	2
R05	RES,C,1/4W,5%,75 RC103-075	CR1/4-75	ASE	4700-15-7509	1
R06	RES,C,1/4W,5%,3.9K RC103-239	CF1/43.9K	ASE	4700-15-3901	1
R07	RES,C,1/4W,5%,470 RC103-147	CF1/4-470	ASE	4700-15-4700	1
R08	RES,C,1/4W,5%,33K RC103-333	CF1/4-33K	ASE	4700-15-3302	1

WAVETEK PARTS LIST

TITLE
50 MHZ HARMONIC
MARKER, M6H-50

ASSEMBLY NO.
1114-00-0100

PAGE: 2

REV
C

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R09	RES,C,1/4W,5%,1M RC103-510	CF1/4-1M	ASE	4700-15-1004	1
R10	RES,C,1/4W,5%,1K RC103-210	CF1/4-1K	ASE	4700-15-1001	1
R11	RES,C,1/4W,5%,8.2K RC103-282	CF1/4-8.2K	ASE	4700-15-8201	1
R12	RES,C,1/4W,5%,15K RC103-315	CF1/4-15K	ASE	4700-15-1502	1
R13	RES,C,1/4W,5%,1.5M RC103-515	CF1/4-1.5M	ASE	4700-15-1504	1
R14	RES,C,1/4W,5%,10K RC103-310	CF1/4-10K	ASE	4700-15-1002	1
R15	POT,20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	1
R16	RES,C,1/4W,5%,100K RC103-410	CF1/4-100K	ASE	4700-15-1003	1
X1	CRYSTAL,XX000-331	X33W-00.00000	W-I	2310-00-0331	1

WAVETEK PARTS LIST

TITLE
50 MHZ HARMONIC
MARKER, M6H-50

ASSEMBLY NO.
1114-00-0100

PAGE: 3

REV
C

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C01	CAP,CER,47PF,1KV CD104-047	60U2J470J	MDC	1510-10-3470	1
C02	CAP,CER,20PF,1KV CD101-020	60C0G200J	MDC	1510-10-0200	1
C03	CAP,CER,120PF,1KV CD104-112	10TCU-T12	SPR	1510-10-3121	1
C04 C09	CAP,FT,500PF,20%250V CF104-150	4420-500PF	AER	1510-30-3501	2
C05	CAP,F.T.,470PF CF101-147	FA5C-4712	A-B	1510-30-0471	1
C08	CAP,VALUE DETERMINED IN CALIBRATION	CAP,TRIM	W-I	1519-99-9999	1
C10	CAP,CER,.01MF,100V CD103-310	68U103M	MDC	1510-10-2103	1
C11	CAP,CER,.05MF,100V CD103-350	TG-S50	SPR	1510-10-2503	1
C12	CAP,F.T.,6.8PF CF102-R68	FA5C-6892	A-B	1510-30-1689	1
CR1A	DIODE DG000-007	5082-2800	H-P	4809-02-0001	1
CR2	DIODE DG100-821	1N82AG	G-I	4807-01-0082	1
J1 J2	CONN JF000-005	37JR116-1	S-C	2110-03-0002	2
L2	CHOKE,2.2MH,10% LA005-R22	08N2R2K	ASE	1810-03-0229	1

WAVETEK
PARTS LIST

TITLE
SING FREQ MKR M6S-3

ASSEMBLY NO.
1114-00-0045

PAGE: 1

REV
A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
Q1 Q2	TRANS QA038-541	2N3854A	G-E	4901-03-8541	2
R1	RES,C,1/4W,5%,47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R2	RES,C,1/4W,5%,56 RC103-056	CF1/4-56	ASE	4700-15-5609	1
R3 R4	RES,C,1/4W,5%,1.5K RC103-215	CF1/4-1.5K	ASE	4700-15-1501	2
R5	RES,C,1/4W,5%,180K RC103-418	CF1/4-180K	ASE	4700-15-1803	1
R6	RES,C,1/4W,5%,470K RC103-447	CF1/4-470K	ASE	4700-15-4703	1
R7 R9	RES,C,1/4W,5%,10K RC103-310	CF1/4-10K	ASE	4700-15-1002	2
R8	POT,20K RP124-320	WA2G032S-203MA	A-B	4610-10-7203	1
X1	CRYSTAL,XX000-331	X33W-00.00000	W-I	2310-00-0331	1

WAVETEK
PARTS LIST

TITLE
SING FREQ MKR M6S-3

ASSEMBLY NO.
1114-00-0045

PAGE: 2

REV
A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C1	CAP, CER, 47PF, 1KV CD104-047	60U2J470J	MDC	1510-10-3470	1
C2	CAP, CER, .025MF, 50V CD103-325	TG-S25	SPR	1510-10-2253	1
C3 C5	CAP, CER, .01MF, 100V CD103-310	68U103M	MDC	1510-10-2103	2
C4	CAP, CER, 15PF, 1KV CD101-015	10TCC-Q15	SPR	1510-10-0150	1
C6	CAP, CER, 68PF, 1KV CD104-068	68U2J680J	MDC	1510-10-3680	1
C7	CAP, TANT, .47MF, 50V CE113-447	935	TRW	1510-21-9470	1
J1	CONN, UG911A/U JB109-111	KC79-146	KIN	2110-01-1013	1
L1 L2	CHOKE, 2.2MH, 10% LA005-R22	08N2R2K	ASE	1810-03-0229	2
L3 L4	CHOKE .22MH 10% LA005-R02	08NR22K	ASE	1810-03-0228	2
P1	CONN, UG88C/U JB100-883	31-202	APL	2110-01-0003	1
P2	CONN, TWINAX JB000-016	31-224	APL	2110-01-2002	1

WAVETEK PARTS LIST	TITLE RB PROBE	ASSEMBLY NO. 1219-00-0115 PAGE: 1	REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
Q1	TRANS QB000-020 STATIC SENSITIVE	40841	RCA	4902-40-8410	1
Q2	TRANS QA051-790	2N5179	RCA	4901-05-1790	1
R1	RES, C, 1/4W, 5%, 150 RC103-115	CF1/4-150	ASE	4700-15-1500	1
R2	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R3	RES, C, 1/4W, 5%, 2.7K RC103-227	CF1/4-2.7K	ASE	4700-15-2701	1
R4	RES, C, 1/4W, 5%, 22K RC103-322	CF1/422K	ASE	4700-15-2202	1
R5	RES, C, 1/4W, 5%, 1K RC103-210	CF1/4-1K	ASE	4700-15-1001	1
R6 R7	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	2
R8 R9	RES, C, 1/4W, 5%, 18K RC103-318	CF1/4-18K	ASE	4700-15-1802	2
R10	RES, C, 1/4W, 5%, 680 RC103-168	CF1/4-680	ASE	4700-15-6800	1
R11	RES, C, 1/4W, 5%, 100 RC103-110	CF1/4-100	ASE	4700-15-1000	1
1	CONN JZ000-007	MX1684/U	S-C	2110-07-0001	1

WAVETEK PARTS LIST	TITLE RB PROBE	ASSEMBLY NO. 1219-00-0115 PAGE: 2	REV