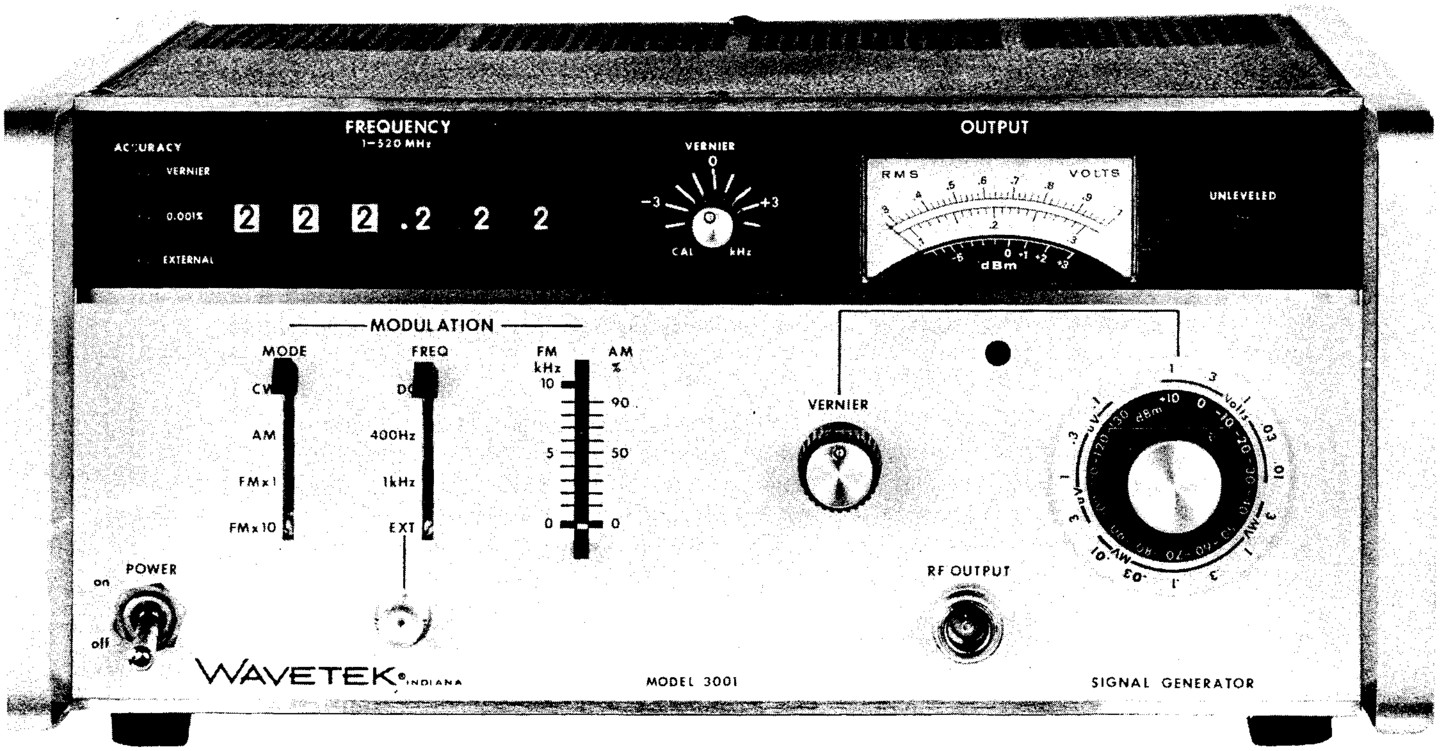
Serial No. 276879

New 3-16-78

INSTRUCTION MANUAL

MODEL 3001 OPT -3

SIGNAL GENERATOR



WAVETEK® INDIANA INC.

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317—783-3221

SCOPE OF THIS MANUAL

This manual provides descriptive material and instructions for the installation, operation, maintenance, and repair of the WAVETEK Model 3001 Signal Generator.

WARRANTY

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

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

Wavetek assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. High voltage used in some instruments may be dangerous if misused. Special disclaimers apply to these instruments. Wavetek assumes no liability for secondary charges or consequential damages and, in any event, Wavetek's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

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1st Ed. 2/77

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SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Model 3001 is a rugged, completely solid-state Signal Generator covering the frequency range of 1 to 520 MHz. The output can be amplitude or frequency modulated and the level can be set between +13 and -137 dBm.

1.1.1 Frequency Characteristics

The frequency of the unit is set via 6 front - panel lever/indicator switches which yield a resolution of 1 kHz. In addition, remote frequency programmability is standard. Series 3900 programmers are available to facilitate semi-automatic programming of both frequency and output level.

The accuracy of the instrument is based on a crystal-controlled oscillator that serves as a stable frequency reference that enables the Model 3001 to provide high stability signals to an accuracy of 0.001% over its specified 1 MHz to 520 MHz range. This accuracy includes possible errors due to short term drift, long term drift, incidental FM and variations due to line voltage changes and temperature changes. With the frequency VERNIER out of the CAL position, the frequency is accurate to 0.001% ±10 kHz.

The accuracy of the instrument can be improved by using either the optional external reference input or the optional high stability internal reference. An auxiliary RF output option is also available to drive a counter.

1.1.2 Modulation

The Model 3001 also features both internal and external amplitude and frequency modulation capabilities. Internal modulation frequencies of 400 Hz and 1 kHz are available. In the FM mode of operation, peak deviations up to 100 kHz are atainable. In the AM mode, amplitude modulation to 90% is attainable.

With the MODULATION MODE switch in the AM position and the MODULATION FREQUENCY switch in the DC position the output amplitude can be varied by the MODULATION FM/AM control. This provides a reference attenuator for variation of a signal level around a specific point of interest. This operation can also enable the user to obtain greater than 20 milliwatts of power over portions of the band. The frequency can also be continuously varied with this control over a 100 kHz range.

1.1.3 Output Level Features

The output power is indicated on a front-panel meter calibrated in both dBm and VRMS. A fifteen-position, 10 dB/step Attenuator used in conjunction with an 11 dB VERNIER control provides the user with a range of +13 dBm to -137 dBm. Two programmable attenuator options are available: 109.9 dB in 0.1 dB steps and 90 dB in 10 db steps.

The calibrated output of the Model 3001 is leveled to within ±0.75 dB across the complete frequency range of the instrument.

Reverse power protection is also available as an option.

1.2 SPECIFICATIONS

1.2.1 Frequency

RANGE	1 MHz to 520 MHz selectable in 1 kHz steps.
READOUT	6 digit lever/indicator switches
RESOLUTION	1 kHz
ACCURACY	All modes (CW, AM and FM) ±0.001% (±0.001% ±10 kHz when frequency VERNIER is not in CAL position. Frequency VERNIER range is ±5 kHz.)
STABILITY	All modes (CW, AM and FM) <0.2 ppm/hour (500 Hz per 10 min when frequency VERNIER is not in CAL position.)
PROGRAMMABILITY	Frequency is programmable via rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures (Negative true logic).

1.2.2 RF Output

POWER LEVEL RANGE	+13 dBm to -137 dBm (1 V to .03 μV)
LEVEL CONTROL	Continuously adjustable in 10 dB steps and with an 11 dB VERNIER. Output level is indicated on a front-panel meter calibrated in volts RMS and dBm.
TOTAL LEVEL ACCURACY	+13 to -7 dBm ±1.25 dB -7 to -77 dBm ±1.95 dB -77 to -137 dBm ±2.75 dB
Accuracy Breakdown	Flatness (+13 to -7 dBm) ±0.75 dB Output Meter ±0.5 dB Step Attenuator ±0.5 dB to 70 dB (±0.2 dB calibration error) ±1.0 dB to 130 dB (±0.5 dB calibration error)
IMPEDANCE	50 ohms
SWR	<1.2 at RF output levels below 0.1 V
OUTPUT CONNECTOR	Type N
LEAKAGE	<1 μV is induced in a two-turn, one-inch diameter loop which is held one inch away from any surface. Loop feeds a 50 ohm receiver.

1.2.3 Spectral Purity

HARMONIC OUTPUT
>30 dB below fundamental from 10 to 520 MHz
>20 dB below fundamental from 1 to 10 MHz

SUB-HARMONICS
None detectable

NON-HARMONICS

Fundamental (MHz)	Non-Harmonic (MHz)	Non-Harmonic Level (dB below fundamental)
1 to 3	1 to 3	>60
3 to 250	3 to 250	>65
3 to 350	3 to 350	>55
3 to 520	3 to 1000	>35

RESIDUAL AM
>55 dB below carrier in a 50 Hz to 15 kHz post-detection bandwidth.

RESIDUAL FM
<200 Hz in a 50 Hz to 15 kHz post-detection bandwidth. (Typically 100 Hz.)

1.2.4 Amplitude Modulation

NOTE: These specifications apply for a carrier level ≤+3 dBm. AM is possible above +3 dBm if the peak output does not exceed +13 dBm.

FREQUENCY
Internal: 400 Hz and 1 kHz ±5% (typically ±3%)
External: DC to 20 kHz, (3 dB bandwidth), input level required = 10 volts pp into 600 ohm to provide calibrated % modulation control.

RANGE
0 to 90%

DISTORTION
3% distortion to 70% AM (5% to 90% AM) at a frequency of 1 kHz

MODULATION CONTROL
Calibrated from 0 to 90%

ACCURACY
±(5% of reading +5%) at a frequency of 1 kHz

1.2.5 Frequency Modulation

FREQUENCY
Internal: 400 Hz and 1 kHz, ±5%
External: 50 Hz to 25 kHz, (1 dB bandwidth), input level required = 10 volts pp into 600 ohms to provide calibrated deviation control.
(DC to 25 kHz when frequency VERNIER is not in CAL position.)

DEVIATION PEAK
Two bands, 0 to 10 kHz, and 0 to 100 kHz

DEVIATION CONTROL	Calibrated from 0 to 10 kHz, x1 and x10
ACCURACY	±500 Hz on x1 range ±5 kHz on x10 range
DISTORTION	4% (3 to 100 kHz deviation) at a frequency of 1 kHz

1.2.6 General

OPERATING TEMPERATURE	25°C±5°C, all specifications apply 25 ±15°C, with slight degradation of specifications
POWER	115/230 V ±10%, 50 to 400 Hz, 40 VA
DIMENSIONS	30.3 cm wide x 13.4 cm high x 34.9 cm long (12" x 5¼" x 13 3/4").
WEIGHT	11.4 kg (25 lb) net 13.6 kg (30 lb) shipping

1.3 OPTIONS

Options 1A, 1B and 4 are factory installed; options 3, 5 and 6 are either factory or field installed. Maximum number of options per instrument is four (1A or 1B or 3) + 4 + 5 + 6. Request individual specifications for each option for a complete description of each and how it affects the instrument specifications.

1.3.1 RF Level Programming

For both options 1A and 1B the instruments are calibrated for +13 dBm at 50 MHz like a standard unit but due to greater losses in programmable attenuators, a calibrated output is only guaranteed to +12 dBm.

Option "1A" Program Level Range: 0 to 109.9 dB in .1 dB steps. 0 db reference is +13 dBm. Front-panel level range: Continuously adjustable from +13 dBm to -97 dBm in 10 dB steps and an 11 dB VERNIER. Reverse power protection is also provided by this option.

Option "1B" Program Level Range: 0 to 90 dB in 10 dB steps. 0 dB reference set by front-panel attenuators. (Remote control of CW/AM mode is also provided).
Front-panel level range: See section 1.2.2.

Reverse power protection is also provided by this option.

1.3.2 Reverse Power Protection

Option "3" prevents damage to the instrument if DC (100 V max) or RF (50 W max) voltages are accidentally applied to the RF output connector. (This option is not required when using option 1A or 1B).

1.3.3 Auxiliary RF Output

Option "4" provides a leveled (-10 dBm) signal available from a rear-panel BNC connector (normally used to drive a frequency counter).

1.3.4 External Reference

Option "5" provides a rear panel BNC input for accepting an external frequency reference. This input is used to improve the accuracy of the instrument from 10 ppm to that of the external source. The external source frequency can be 1, 2, 2.5, 5 or 10 MHz with an accuracy of 1 ppm or better with a minimum level of 50 mV into a 1 kΩ load.

1.3.5 High Stability Reference (Option 5 is necessary for driving model 3001 with Option 6.)

Option "6" provides a high stability rear panel output which can be used to drive the rear-panel input of option "5". This high stability TTL output can also be used to drive other devices which require a high stability reference input. Maximum fan-out is four.

Output Frequency	5 MHz
Accuracy after 1 hour warm-up	
Aging	.005 ppm/day
	.05 ppm/month
	.3 ppm/year
Temperature 25 $\pm$15 °C	.05 ppm

Typical overall accuracy (within 3 months of calibration) .2 ppm, 25 $\pm$15 °C.

1.4 ACCESSORIES

Furnished with instrument

Instruction Manual
Rear-panel remote plug and pins

Additional Accessories

Rack Mount Kit, K108
Programmers for single push button control of selected frequencies or output levels, Series 3900.

SECTION 2 OPERATION

2.1 INTRODUCTION

This section provides complete installation and operating instructions for the Wavetek Model 3001 signal generator. The instructions consist of mechanical installation, electrical installation, front and rear panel features, installation checks and operating procedures.

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 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 (K108)

CONTENTS (See Figure 2-1).

Item	QTY	Part No.
A (Insert)	2 ea	B001-145
B (Side)	2 ea	C001-146
C (Screw)	8 ea	HS101-808
D (Screw)	4 ea	HS101-810

PROCEDURE

Remove the screws from one side panel. Mount items A and B against side panel of the instrument and secure with screws provided. (Screws D are longer than screws C.) Repeat operation for the other side of unit.

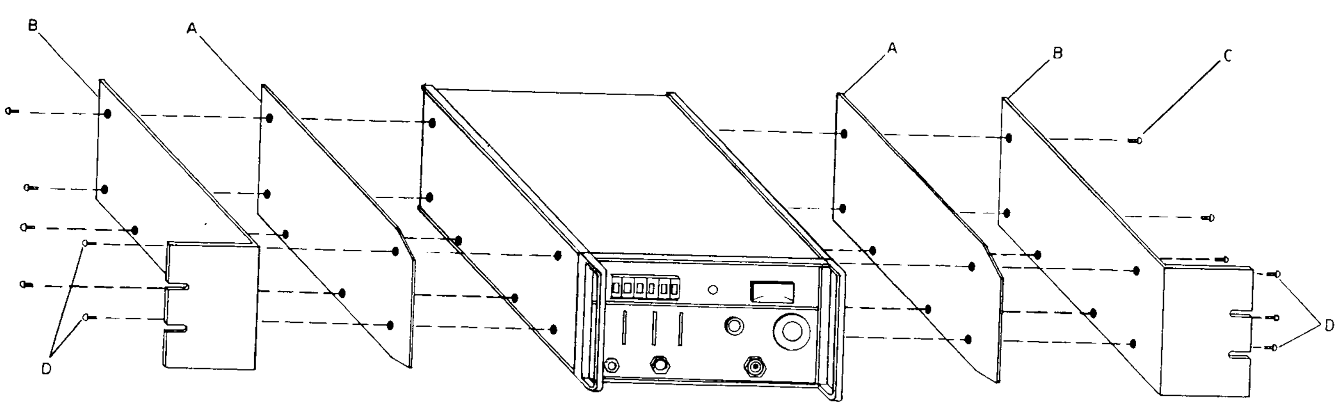


Figure 2-1. K108 Rack Mount

2.3 ELECTRICAL INSTALLATION

The instrument operates from either 115-volt or 230-volt AC supply mains as selected by a Slide Switch located on rear panel. Before operating the instrument, check that fuse mounted in the rear-panel fuseholder corresponds to correct value for selected voltage, i.e., 1.0 amp for 115 volt AC and 0.5 amp for 230 volt AC.

The power supply has been designed to operate over an AC-input range of 50 to 400 Hz.

Instruments are shipped from the factory for operation at 115-volt AC - unless specified for 230-volt AC operation.

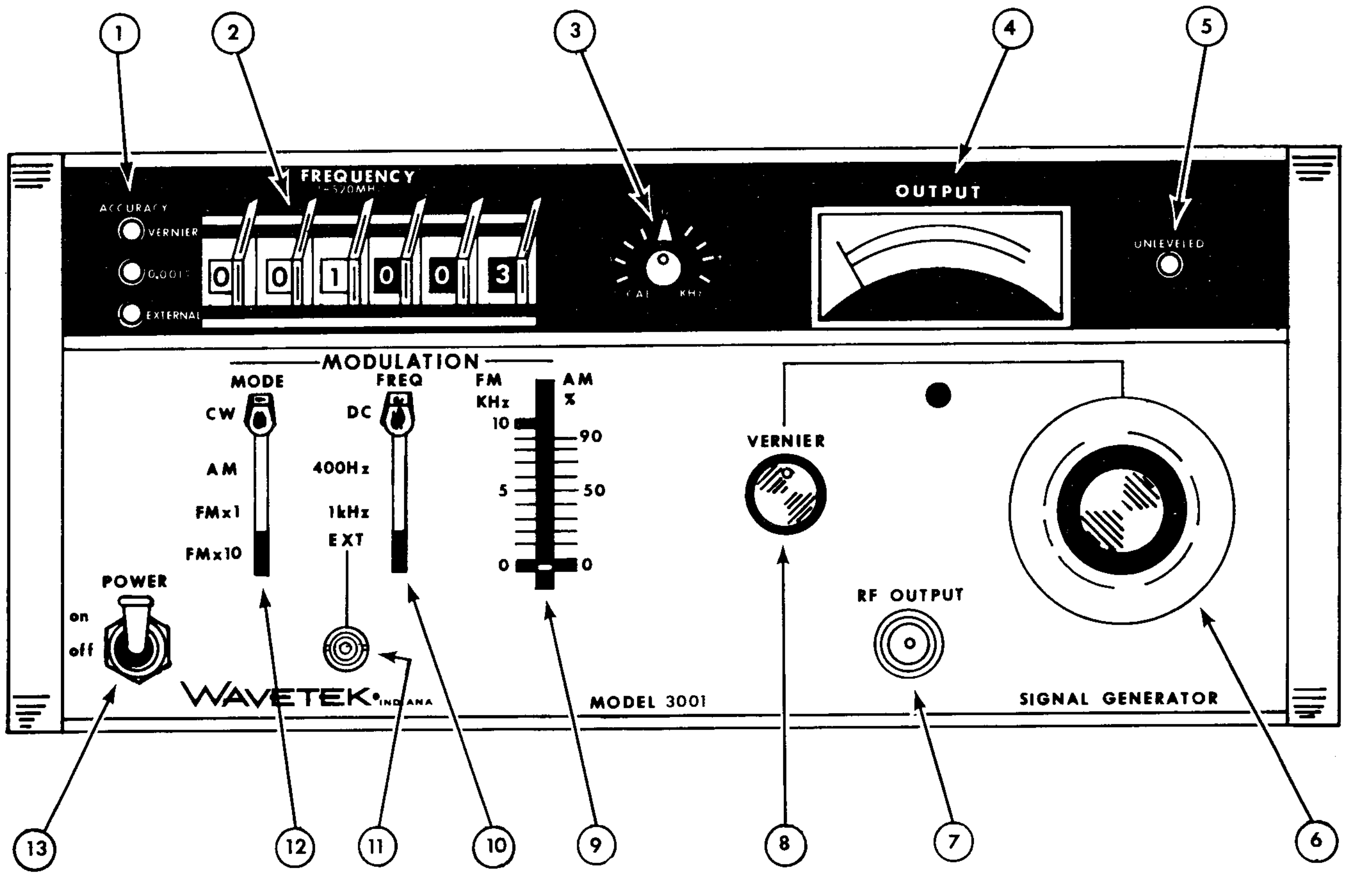


Figure 2-2. Front Panel

2.4 DESCRIPTION OF FRONT PANEL

(1) Accuracy Lamps

Indicate frequency accuracy as follows:
Vernier - lamp indicates that freq

(1) Accuracy Lamps (continued)	VERNIER is not in CAL position; accuracy is ±(0.001% +10 kHz) in all modes. 0.001% - lamp indicates that freq VERNIER is in CAL position; accuracy in all modes (CW, AM, FM) is ±0.001% External - lamp indicates that external freq reference is being used; accuracy is that of the external reference source. Typically, the lamp will flash for a few seconds after power is turned on. Normally, a steady light indicates that unit is phase - locked and frequency accuracy indication is valid; however, a continuously flashing light indicates that one or more of the phase-lock loops is open. (The open loop can be identified by removing unit top cover, and looking for the corresponding "module-fault" light.)
(2) Lever Indicator Switches	Select and indicate desired output frequency from 1 to 520 MHz with a 1 kHz resolution.
(3) Freq Vernier	In its CAL position, accuracy in all modes (CW, AM, FM) is ±0.001% as indicated by steady lighting of 0.001% Accuracy lamp. When VERNIER is out of CAL position, accuracy in all modes is ±(.001% +10 kHz) as indicated by steady lighting of "Vernier" accuracy lamp. The frequency VERNIER can shift output frequency over a 10 kHz range (-5 kHz to +5 kHz).
(4) Output Level Meter	Indicates output level over a 10 dB range in VRMS and dBm. (See section 2.7.3).
(5) Unlevel Lamp	Indicates that the output-level-meter reading is not valid when the lamp is on.
(6) Attenuator	Controls the output level over a 140 dB range from +10 to -130 dBm. The Attenuator dial is calibrated in dB and VRMS. (See section 2.7.3).
(7) RF out	Type N connector provides the RF-output signal from the instrument.
(8) Output Level Vernier	Controls the output level over an 11 dB range.

(9) Modulation FM/AM Slider

Is calibrated from 0 to 10 kHz FM peak deviation, and from 0 to 90% AM. This control permits precise AM or FM settings with mode switch in AM, FM x 1, or FM x 10 respectively and with frequency switch in 400 Hz, 1 kHz, or Ext. This control also serves as a manual amplitude control (AM mode) or manual frequency control (FM modes) with frequency switch in DC. The slider can also enable the user to obtain more than 20 milliwatts of power over portions of the band when mode switch is in AM mode; in FM modes, the frequency can be continuously varied with this control over a 10 kHz or a 100 kHz range. In CW mode, the FM/AM slider has no function.

(10) Modulation Frequency Switch

Selects DC (used for manual amplitude or frequency control), 400 Hz or 1 kHz internal modulation, or external modulation.

(11) Ext Modulation Input

BNC connector accepts external modulating signals as follows:

AM	= DC to 20 kHz
FM (Freq VERNIER in CAL)	=50 Hz to 25 kHz
FM (Freq VERNIER not in CAL)	= DC to 25 kHz

A 10 Vpp signal into 600 ohms is required for FM/AM slider calibration to be correct. A lesser input voltage will result in proportional calibration of the FM/AM slider; thus, a 1 volt pp signal into 600 ohms will result in a full-scale calibration of 1 kHz peak deviation in FM x 1, a 10 kHz peak deviation in FM x 10, or 10% amplitude modulation in AM.

(12) Mode Switch

Selects CW, AM, FMx1 or FMx10 operation.

(13) Power Switch

Provides AC power to the power supply.

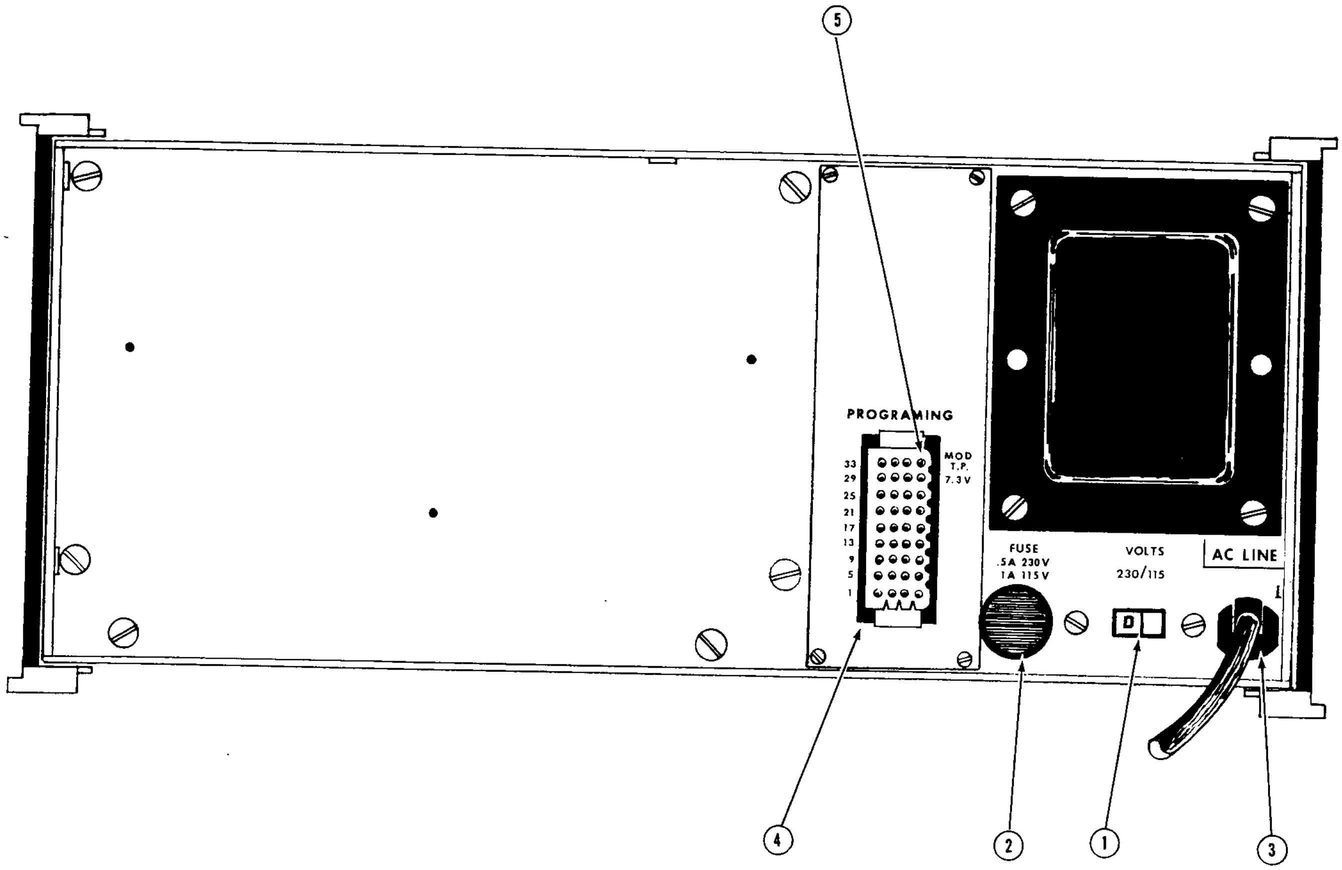


Figure 2-3. Rear Panel

2.5 DESCRIPTION OF REAR PANEL

(1)	Switch 115/230 V	Selects either 115-volt AC or 230 volt AC supply mains. Before operating instrument, check that fuse mounted in Rear-Panel Fuseholder corresponds to the correct value for selected voltage.
(2)	AC Line Fuse	1.0 amp for 115-volt AC, or 0.5 amp for 230-volt AC.
(3)	Input 50-400 Hz	3-prong AC plug provides connection to AC mains.
(4)	Programming	Provides remote connection for programming of frequency.
(5)	Modulation Test Point	Provides convenient connection for monitoring amplitude or frequency of internal or external modulating signal.

2.6 INSTALLATION CHECKS

The following procedure is used to determine that the instrument is operating properly. Performance testing and calibration procedures for the instrument are contained in other sections of this manual. If it is determined that the unit is not operating properly refer to these sections.

2.6.1 TURN ON

Verify that the power-transformer primary is matched to the line voltage available, and that the proper fuse is installed. (See Section 2.3 Electrical Installation). Turn the front-panel power switch to its "ON" position. One of the front panel accuracy lights will be illuminated indicating an operating condition. No warmup is needed for the following checks.

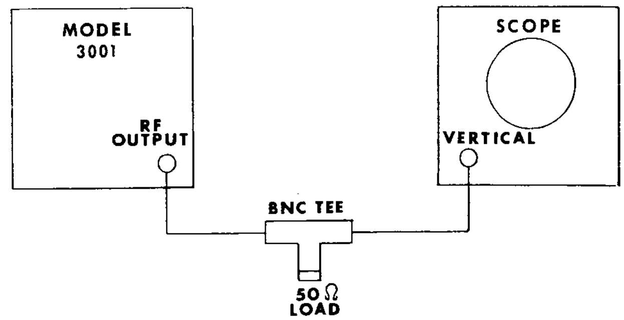
2.6.2 CONTROL ADJUSTMENT

Set the Model 3001 front-panel controls as follows:

(2)	Output Frequency	10 MHz (Lever-indicator switches to 010.000).
(3)	Freq Vernier	CAL
(12)	Mode Switch	CW
(10)	Frequency Switch	1 kHz
(9)	FM/AM Slider	0
(8)	Level Vernier	Full cw
(6)	Attenuator	+10 dBm

2.6.3 RF OUTPUT CHECK

Connect the equipment as shown in Figure 2-4. The 10 MHz signal must be at least 2.8 Vpp (a high frequency oscilloscope must be used for these checks).



NOTE: MUST BE HIGH-FREQUENCY OSCILLOSCOPE (GREATER THAN 10 MHz)

Figure 2-4. Test Setup

2.6.4 AM MODULATION CHECK (1000 Hz)

Switch the MODE switch to AM. Move FM/AM slider up to the 50% modulation point. Verify that AM envelope displayed on oscilloscope shows a peak-to-valley voltage difference of about 1.4 V and a period of 1 ms. (See Figure 2-5).

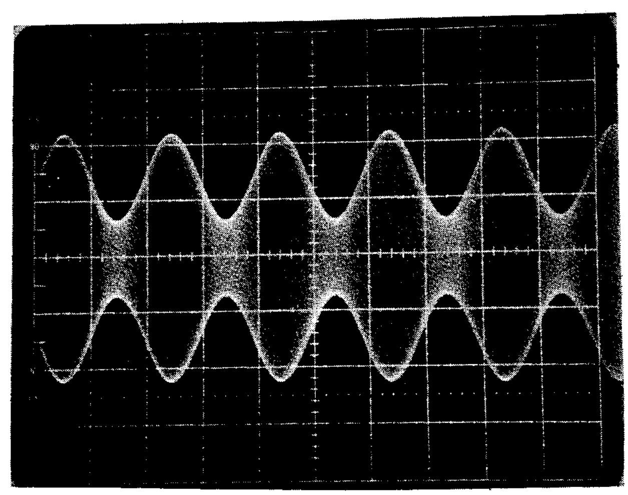


Figure 2-5. Amplitude Modulation

2.6.5 AM MODULATION CHECK (400 Hz)

Move frequency switch to its 400 Hz position. Verify that AM envelope period is 2.5 ms.

2.6.6 FMx1 CHECK

Switch the MODE switch to FMx1. Move FM/AM slider up and down. Verify that oscilloscope shows an FM display (See Figure 2-6).

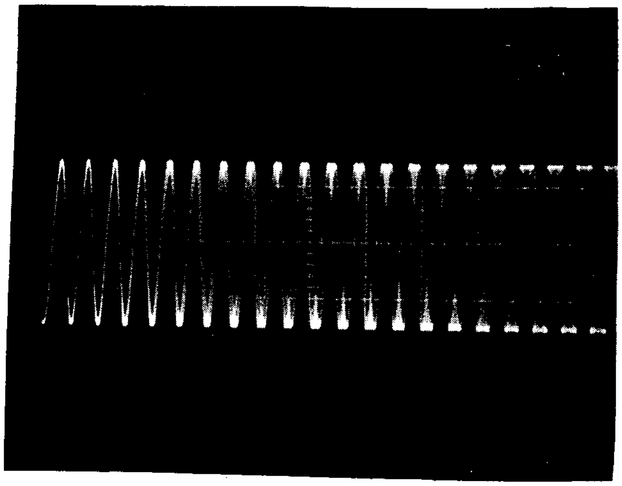


Figure 2-6. Frequency Modulation

2.6.7 FMx10 CHECK

Switch MODE switch to FMx10 and repeat above check.

2.6.8 FM/AM SLIDER CHECK (FREQ.)

Leaving MODE switch in the FMx10 position, place frequency switch in the DC position. Verify that moving FM/AM slider from 0 to 10 kHz shows an increase in frequency on the oscilloscope.

2.6.9 FM/AM SLIDER CHECK (OUTPUT)

Switch MODE switch to the AM position. Verify that moving FM/AM slider from 0 to 50 shows an increase in output amplitude. (NOTE: The unlevel light may come on during this test.)

2.6.10 ATTENUATION CHECK

Switch mode switch to CW. Verify that Output VERNIER and Attenuator controls change amplitude of signal displayed on the oscilloscope.

2.6.11 FREQ VERNIER CHECK

Switch Freq VERNIER out of CAL position. The .001% lamp should go out, and the Vernier lamp should light. Moving the VERNIER from -5 kHz to +5 kHz should show a slight change in frequency on oscilloscope. The instrument is now ready for use.

2.7 OPERATING PROCEDURE

No preparation for operation is required beyond completion of the initial installation checks contained in Section 2.6. To insure that the Model 3001 will perform as stated in the specifications, the instrument should have a two-hour warmup before using.

2.7.1 TURN ON

Turn front-panel switch "ON". One of front-panel accuracy lights will be illuminated indicating an operating condition.

NOTE

A flashing light indicates an unlocked condition. This should cease in a matter of seconds.

If the unit is not going to be used to the extreme limits of its specifications, it can be used immediately.

CAUTION

When working with active circuits, transceivers, etc., care must be used to keep DC voltage or RF power from being applied to the RF-output connector, otherwise damage may occur to the output Attenuator circuitry of the Model 3001.

2.7.2 FREQUENCY SELECTION

Select the frequency desired with the six Lever - Indicator switches on the front panel. A frequency between 1 and 520 MHz can be selected with a 1 kHz resolution.

2.7.3 OUTPUT LEVEL SELECTION

Set output Attenuator and VERNIER to the desired level. The output is continuously adjustable over a +13 to -137 dBm range. The RF output equals the level shown on the Attenuator algebraically added to the meter indication.

2.7.4 AMPLITUDE MODULATION - INTERNAL

Set MODE switch to AM and the frequency switch to either 400 or 1000 Hz modulation rate. Adjust FM/AM slider to indicate desired modulation depth.

2.7.5 AMPLITUDE MODULATION - EXTERNAL

CAUTION

Input voltages greater than ±10 VDC or 10 VRMS should not be applied to the External modulation-input connector or damage may occur to the Model 3001.

Set MODE switch to AM and the frequency switch to external. Apply a 10 Vpp signal into 600 ohms to the External modulation-input connector. This calibrates the FM/AM slide control. The desired modulation depth can then be set. The upper frequency limit of this input is 20 kHz.

NOTE

When AM modulating, care must be taken not to exceed the +13 dBm maximum level or excessive distortion and an unlevel condition can exist. In some cases, a high % of AM modulation may cause the unlevel light to come on when output VERNIER control is at minimum. This is caused by "bottoming" of the PIN diode leveler which, in turn, can cause an increase in distortion. If this is the case, add 10 dB of fixed attenuation, and turn Output VERNIER control toward maximum. The unlevel light should then go out.

2.7.6 FREQUENCY MODULATION - INTERNAL

Set MODE switch to FMx1 or FMx10 and the frequency switch to 400 or 1000 Hz. Adjust FM/AM slider to desired peak deviation.

2.7.7 FREQUENCY MODULATION - EXTERNAL

CAUTION

Input voltages greater than ±10 VDC or 10 VRMS should not be applied to the External modulation-input connector or damage may occur to the Model 3001.

Set MODE switch to FMx1 or FMx10 and the frequency switch to external. Apply a 10 Vpp signal to the External modulation-input connector (600 ohms). This calibrates the FM/AM slide control. The desired peak deviation can now be set. For FM modulation, the upper frequency limit is 25 kHz; the lower limit is 50 Hz with Freq VERNIER in CAL, or DC with Freq VERNIER not in CAL position.

2.7.8 FM/AM SLIDER - FM POSITION

Switch MODE switch to FMx1 or FMx10 position and the frequency switch to DC. Using FM/AM slide control, frequency can be increased up to 10 kHz in the x1 position or 100 kHz in the x10 position.

2.7.9 FM/AM SLIDER - AM POSITON

Switch MODE switch to AM postion and the frequency switch to DC. Using FM/AM slide control, the output amplitude can be varied. It also enables more than 20 mW of power to be obtained over portions of the band.

2.7.10 FREQ VERNIER

In the CAL position, output frequencies having an accuracy or +0.001% may be selected by the lever switches with a resolution of 1 kHz. When Freq. VERNIER is out of CAL position, the selected output frequency can be shifted ±5 kHz with Freq. VERNIER control. The output frequency at the "0" kHz position of VERNIER corresponds closely to the output frequency in CAL.

2.7.11 PROGRAMMING

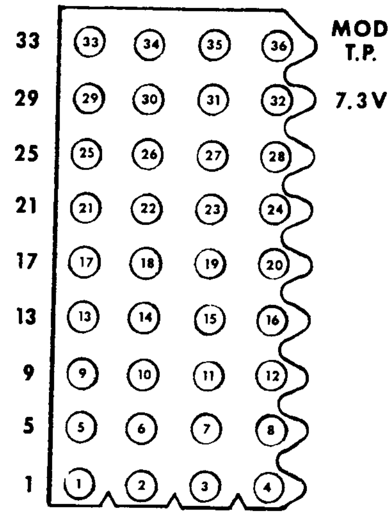
Frequency is programmable via a rear-panel input connector, using standard 8-4-2-1 BCD contact closures. The rear-panel frequency connections are in parallel with front-panel Lever-Indicator switches; thus, if rear-panel programming is used, front-panel switches must indicate all zeros. A mating rear-panel connector is supplied with each unit - see Figure 2-7 for pin location and identification. Rear - panel BCD programming can be implemented by referring to Table 2-1.

For example, to program a frequency of 130.150 MHz, the following rear-panel connector pins would be grounded:

FREQ DIGITS	CONN. PINS GROUNDED
1	4
3	7 & 8
0	none
1	16
5	18 & 20
0	none

TABLE 2-1. PROGRAMMING

	Switch	TTL
Logic "0"	Open	≥2.2V
Logic "1"	Ground	≤0.4V



PIN	CONNECTION	
1	N.C.	
2	400	100's
3	200	
4	100	
5	80	10's
6	40	
7	20	
8	10	
9	8	1's
10	4	
11	2	
12	1	
13	.8	.1's
14	.4	
15	.2	
16	.1	
17	.08	.01's
18	.04	
19	.02	
20	.01	
21	.008	.001's
22	.004	
23	.002	
24	.001	
25	ground	
26 - 31	N.C.	
32	7.3V	
33 - 35	N.C.	
36	MOD. T.P.	

Figure 2-7. Pin Identification

SECTION 3
THEORY OF OPERATION

3.1 INTRODUCTION

Section 3.2 presents a block diagram analysis to enable the reader to get a brief overall view of the operation of the entire instrument. Sections 3.3 - 3.15 contain more detailed descriptions of each subassembly.

For actual wiring of the chassis and subassemblies, refer to the schematics in Section 7 of the manual.

3.2 OVERALL BLOCK DIAGRAM

The Model 3001 is essentially a voltage controlled oscillator to which phase-locked loops and a crystal reference have been added for the high frequency resolution.

The discussion will first deal with the basic signal generator then it will describe how the phase-locked loops provide the additional accuracy.

The numbers within the block diagram symbols refer to the particular assembly in which the circuit is located.

3.2.1 BASIC SIGNAL GENERATOR

This discussion briefly describes how the RF is generated and how its frequency is controlled, also how the signal is amplified, leveled and amplitude modulated.

Refer to Figure 3-1 for a block diagram of the basic signal generator without phase locking.

RF GENERATION

The RF output frequency is generated by two UHF oscillators and a mixer. The outputs of the two oscillators are heterodyned in the mixer. The difference frequency is amplified and fed to the output amplifier.

The frequencies of these oscillators are controlled by DC voltages applied to their varactor diodes. The Narrow Oscillator yields a single frequency. The Wide Oscillator can be programmed over a range which extends from the frequency of the Narrow Oscillator to 520 MHz higher than the Narrow Oscillator frequency.

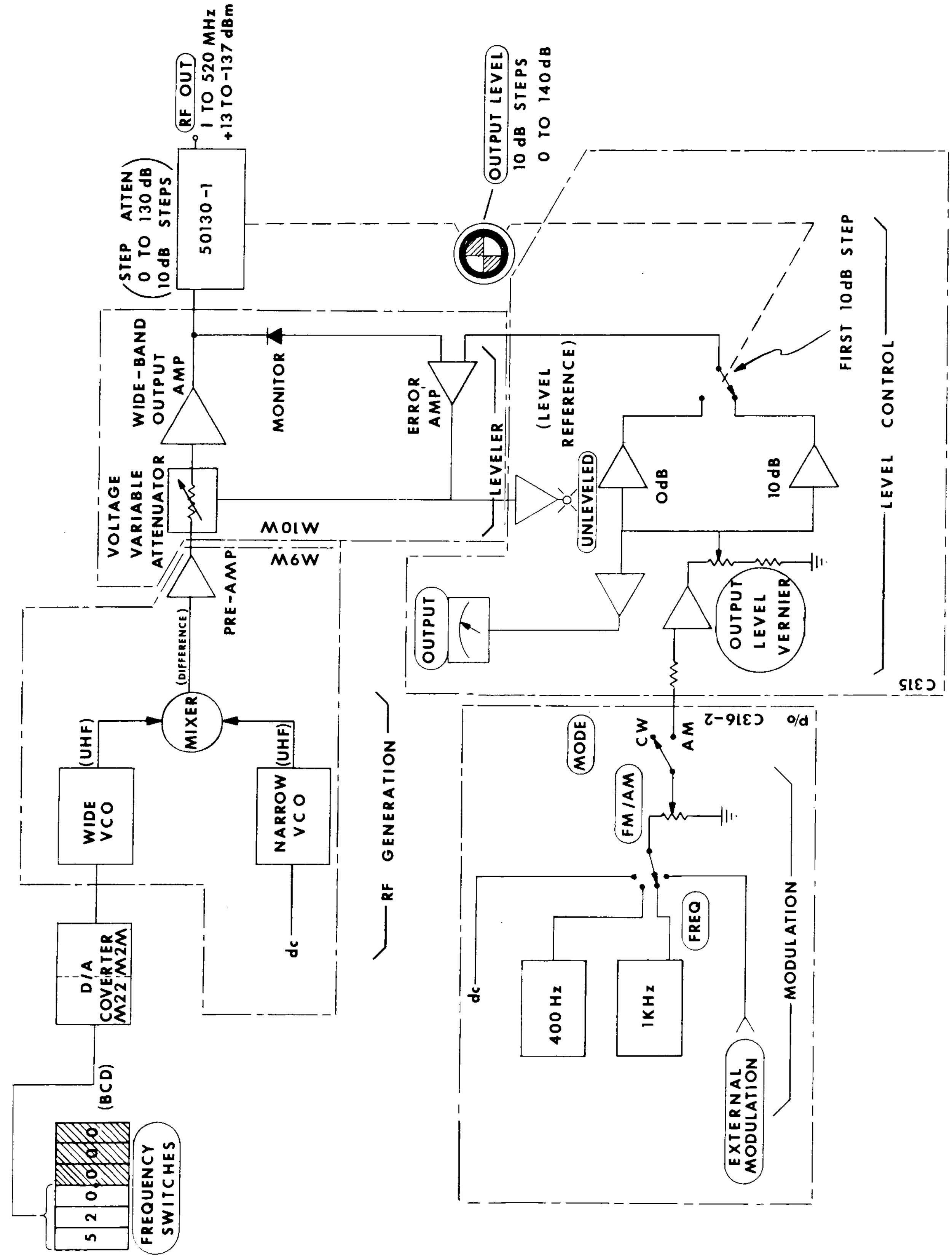
RF FREQUENCY CONTROL

The RF output frequency is determined by programming the frequency of the Wide Oscillator. The Wide Oscillator is ultimately controlled by the front-panel FREQUENCY switches. The BCD output of these switches is converted to an analog voltage which programs the oscillator in 1 MHz steps. This analog signal can provide approximately 3 MHz accuracy.

RF AMPLIFICATION AND LEVELING

The RF power is amplified by a multistage, wide-band amplifier. The flat output is maintained by a closed-loop leveling system around this Output Amplifier.

The Leveler includes a Monitor Diode, an Error Amplifier and a Voltage Variable



3-1. Basic Signal Generator

Attenuator. The Monitor detects the peak of the output of the Output Amp. This detected level is compared to a DC reference by the Error Amp. The output of the Error Amp is fed to a PIN diode (voltage variable) attenuator, which changes the input level to the Output Amp until the monitored signal produces a DC level equal to the reference level.

LEVEL CONTROL AND AM

The circuitry for controlling the RF output level is directly related to the above leveling system because changing the DC level reference changes the RF output level.

Of the 150 dB output range, 130 dB is passive attenuation. The remaining 20 dB is controlled by changing the level reference. The output level VERNIER has a 10 dB range. The remaining 10 dB is provided by switching the level reference range. This range switch is provided so that when AM is not required the output amp can provide a carrier at the highest possible power.

Since the RF level can be voltage controlled, AM can be accomplished by applying the modulating signal to the output level VERNIER. This causes the reference voltage to the Error Amp to change at the frequency of the modulating signal. The modulating signal is taken from one of two internal oscillators, a DC voltage or from an external source.

3.2.2 PHASE-LOCKED LOOPS

The basic signal generator discussed in Section 3.2.1 has a frequency range of 1 to 520 MHz, has an output voltage which is leveled and adjustable and has the ability to be amplitude modulated. With the above circuitry, however, the

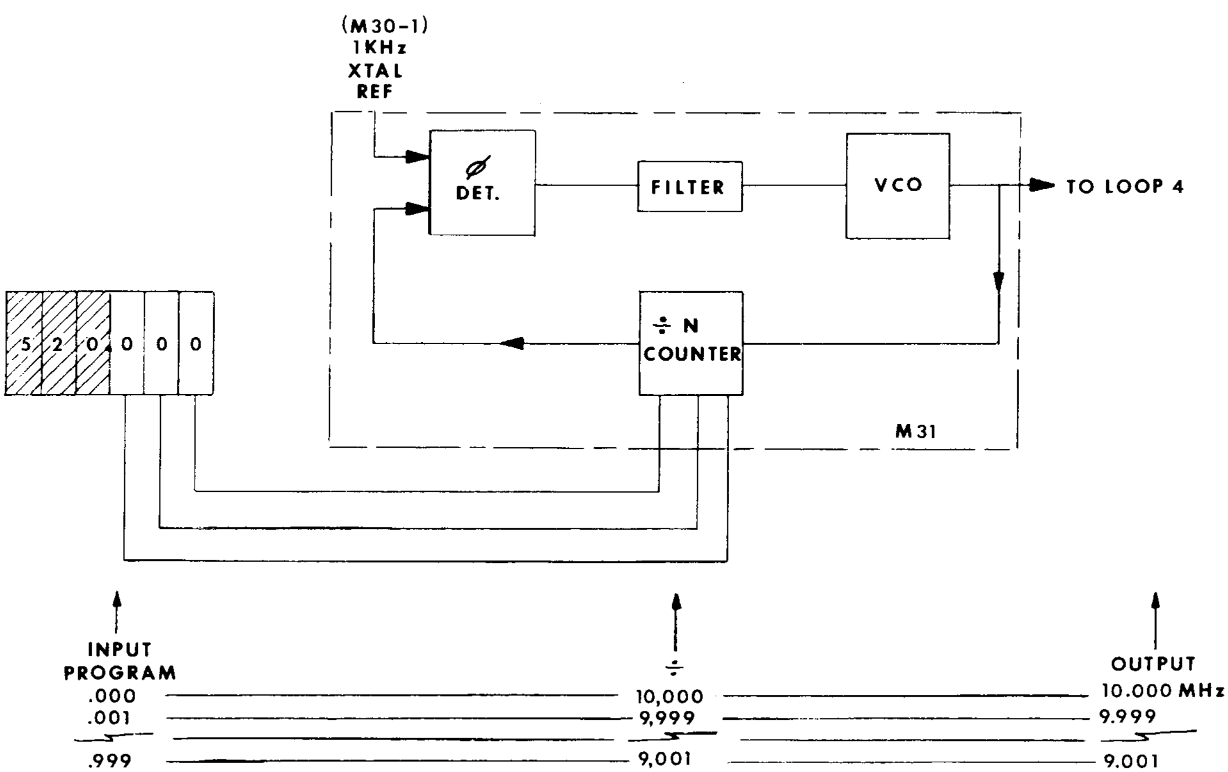


Figure 3-2. PLL #1

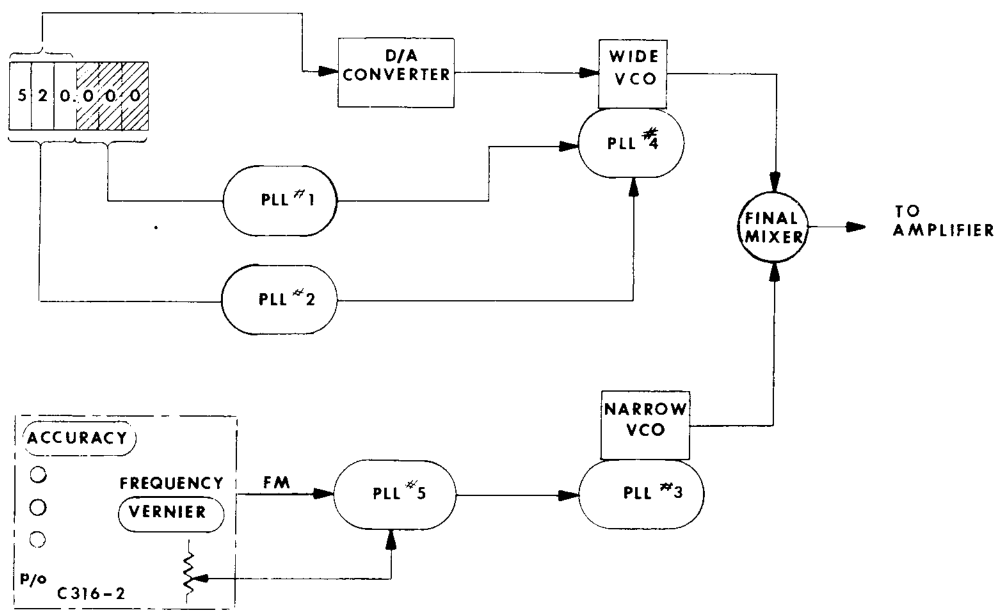


Figure 3-3. Phase Locked Loops

frequency accuracy is only 3 MHz with 1 MHz resolution. To achieve the desired 1 kHz resolution and .001% accuracy, the instrument includes five phase-locked loops.

Figure 3-3 illustrates the relationship between the five numbered loops and the "basic signal generator".

PLL #1, #2 and #4 are used to stabilize the Wide Oscillator and tune it in 1 kHz steps. The Wide VCO is part of PLL #4. PLL #1 and #2 convert the FREQUENCY switch setting to reference frequencies for PLL #4.

PLL #3 and #5 provide stabilization and allow FM operation. The Narrow VCO is part of PLL #3. PLL #5 converts a modulating signal (if present) to a reference frequency for PLL #3.

PLL #1

The purpose of PLL #1 is to generate a CW signal which changes in 1 kHz steps from 10.000 to 9.001 MHz as the front panel frequency selector is switched from .000 MHz to .999 MHz. This signal will be used as a reference signal for PLL #4.

Figure 3-2 shows a simplified block diagram of PLL #1. It includes a voltage controlled oscillator capable of frequencies from 9 to 10 MHz, a phase detector and a ÷N counter. A sample of the output signal from the VCO is fed to a programmable counter. The divisor of the counter is controlled by the three front panel kHz selector switches. The output from the counter is fed to a phase detector where it is compared to a 1 kHz crystal reference signal. If the two input signals to the phase detector are not the same frequency, an error signal is produced. This error voltage corrects the frequency of the VCO until the phase detector input from the counter is exactly 1 kHz. See section 3.12 for a more detailed explanation.

PLL #2

The purpose of PLL #2 is to generate a CW signal which changes in 1 MHz steps from 1448 to 1487 MHz when the front panel frequency selector is switched from 000. to 039. MHz. These CW steps are then repeated every 40 MHz throughout the entire 0 to 520 MHz range. Use of this signal to control the Wide Oscillator will be discussed in the description of PLL #4.

Figure 3-4 shows a simplified block diagram of PLL #2. PLL #2 operates in the same manner as PLL #1 with one exception. The circuit includes a mixer and band-pass amplifier. The purpose of this additional circuit is to offset the 1448 to 1487 MHz output from the VCO to 8 to 47 MHz. This offset is necessary in order to make the frequency compatible with the programmable counter and phase detector circuits. The other circuits in this loop operate the same as those in PLL #1. In this case the programmable counter is controlled by the three "MHz" selector switches and the loop reference frequency is 1 MHz. For a more complete description see section 3-13.

PLL #4

The purpose of PLL #4 is to adjust the Wide Oscillator in 1 kHz steps from 1198 MHz to 1718 MHz as the front-panel frequency selector is adjusted from 0 to 520.000.

The Wide Oscillator frequency is offset by Mixers #1 and #2 and compared to the

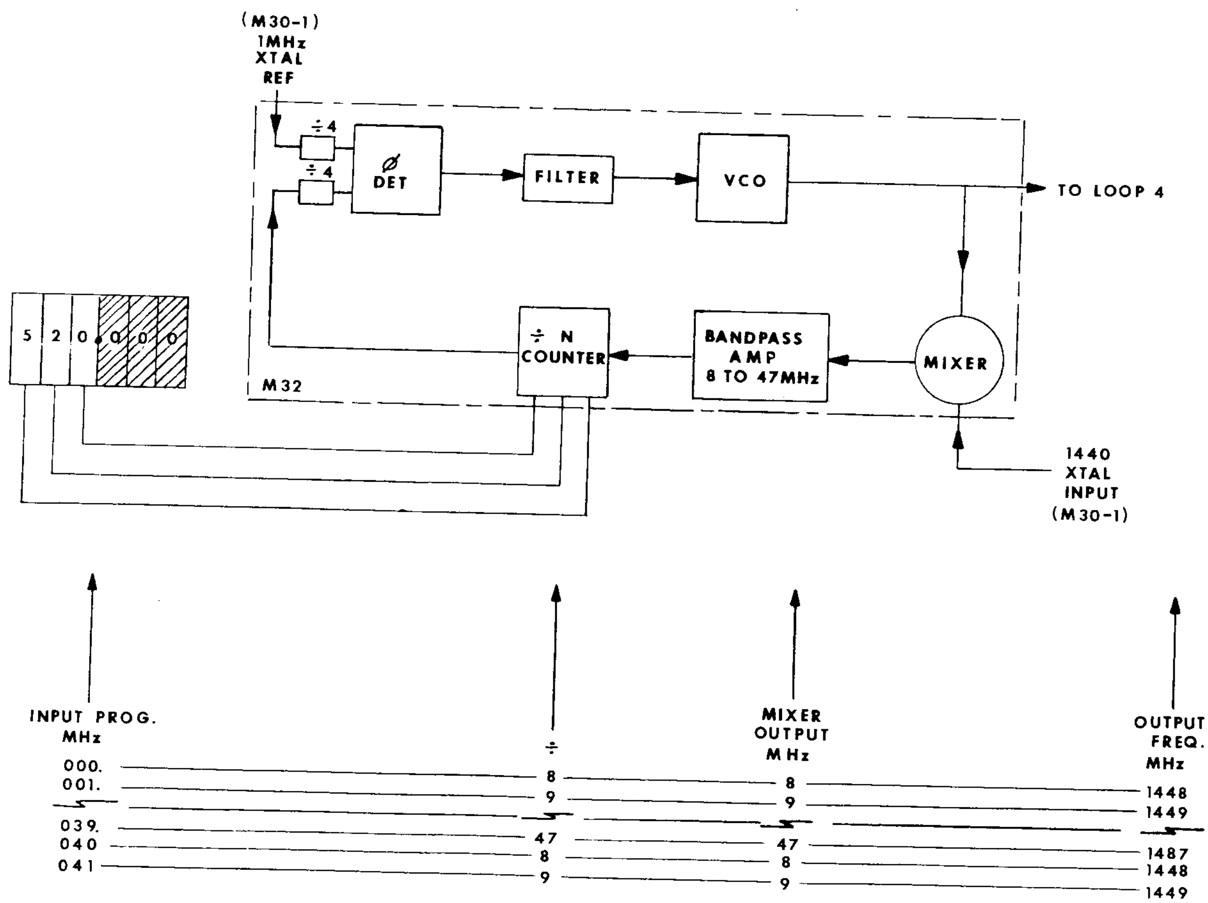


Figure 3-4. PLL #2

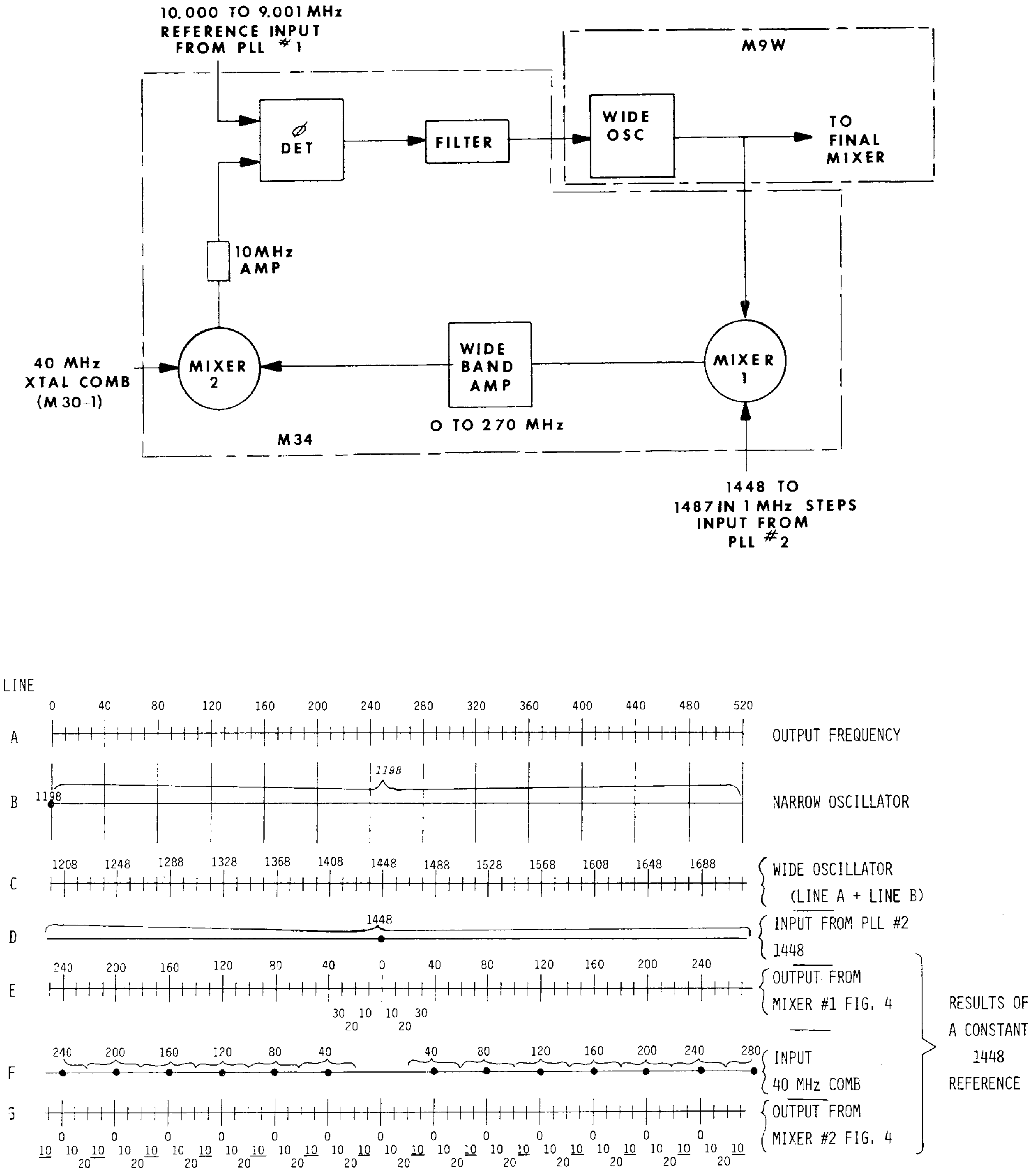


Figure 3-5. PLL #4

reference (from PLL #1) by the phase detector. A difference in phase or frequency causes an error signal to tune the Wide Oscillator until both phase detector inputs are identical. How this loop locks on a particular frequency can best be explained in three steps: 1) phase locking at 40 MHz intervals across the band, 2) phase locking at 1 MHz intervals, 3) phase locking at 1 kHz intervals. Figure 3-5 is a simplified block diagram of PLL #4.

To understand locking at 40 MHz intervals, assume temporarily that the reference frequencies from PLL #1 and PLL #2 are fixed (10 MHz and 1448 MHz respectively). Figure 3-5 shows the frequencies throughout the loop for this discussion. This step of the PLL #4 explanation can be described more clearly by considering the entire Wide Oscillator range rather than discussing single frequencies. The Wide Oscillator covers the range of 1198 to 1718 MHz as the Output frequency changes from 0 to 520 MHz. (Figure 3-5, lines A and C.)

When the Wide Oscillator range is heterodyned in Mixer #1 with 1448 MHz the difference frequency which is produced ranges from 250 to 0 to 270 MHz. (Figure 3-5, line E.) This signal is then mixed with a 40 MHz comb (all harmonics of 40 MHz) in Mixer #2. (Figure 3-5, line F.) Taking the difference between line E and F yields the repetitive frequency range from 0 to 20 to 0 MHz as shown in line G. This signal is fed to the phase detector.

The reference to the phase detector is 10 MHz but the loop will not lock on every 10 MHz output of Mixer #2. The only 10 MHz signals which will produce lock are those which would decrease in frequency if the Wide VCO tried to drift higher. Therefore at every 40 MHz interval of the output frequency an input to the phase detector would allow the loop to lock. Section 3.2.1 explains that an analog signal drives the Wide Oscillator to within three MHz of the proper frequency. Therefore, although there are 14 possible lock points on line G, the only one selected will correspond to the analog-tuned frequency of the Wide Oscillator. The unit as described so far is capable of phase locked output at 0, 40, 80. . . 520 MHz. The following is an explanation of locking at 1 MHz intervals.

To allow phase locking at 1 MHz intervals, the reference frequency to Mixer #1 is made adjustable in 1 MHz steps over a 40 MHz range (1448-1487 MHz).

If, for example, this reference frequency to Mixer #1 were 1449 MHz, the input range to the phase detector would look the same except the entire range would be shifted 1 MHz to the right. Lock points would then be possible at output frequencies of 1, 41, 81 MHz, etc.

Being able to change this reference in 1 MHz steps allows phase locking from 0 to 520 MHz in 1 MHz steps.

To provide phase locking in 1 kHz steps, the PLL #4 phase detector's reference from PLL #1 is adjustable in 1 kHz steps (10.000 to 9.001 MHz). This causes the Wide Oscillator frequency to change in 1 kHz steps in order to keep the loop locked.

PLL #3

The purpose of PLL #3 is to stabilize the Narrow Oscillator at a frequency of 1198 MHz.

Figure 3-6 shows a simplified block diagram of PLL #3. This loop operates in the same manner as PLL #1 and PLL #2 except that it does not require the use of a programmable counter. The 1198 MHz output from the Narrow Oscillator is combined in a mixer with a 1200 MHz crystal controlled signal. This produces a 2 MHz difference signal. This signal is fed to a phase detector where it is compared to a 2 MHz reference. Any difference in the input signals will produce an error voltage which is applied to the Narrow Oscillator (VCO) to correct the frequency error.

PLL #5

PLL #5 supplies the reference for PLL 3. Unlike a standard phase-locked loop the VCO can be modulated. In AM and CW the VCO is locked on 2 MHz. In the FM mode the VCO is modulated but the loop ignores modulation which is faster than 50 Hz; thus the center frequency remains locked.

The loop includes a voltage controlled oscillator, a divider for reducing the frequency from 2 MHz to 2 kHz, a phase detector and a filter for the phase detector output. If the variable input to the phase detector deviates from the reference frequency (slower than 50 Hz) the phase detector sends an error signal to the VCO to correct the frequency.

CRYSTAL REFERENCE

All the reference frequencies for the phase-locked loops are derived from a single 40 MHz crystal source by means of appropriate multiplication or division.

3.2.3 SUBASSEMBLY DESCRIPTIONS

The overall block diagram discussed in this section describes basically how the instrument functions as a unit. The unit is made up of ten module assemblies and three printed circuit card assemblies. These can be identified in Figure 5-6. Sections 3.3 thru 3.15 describe the operation of each subassembly. The name of the subassembly describes, to an extent, the primary function it performs.

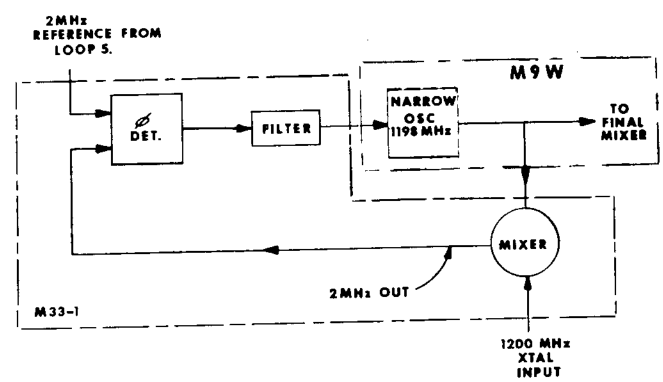


Figure 3-6. PLL #3

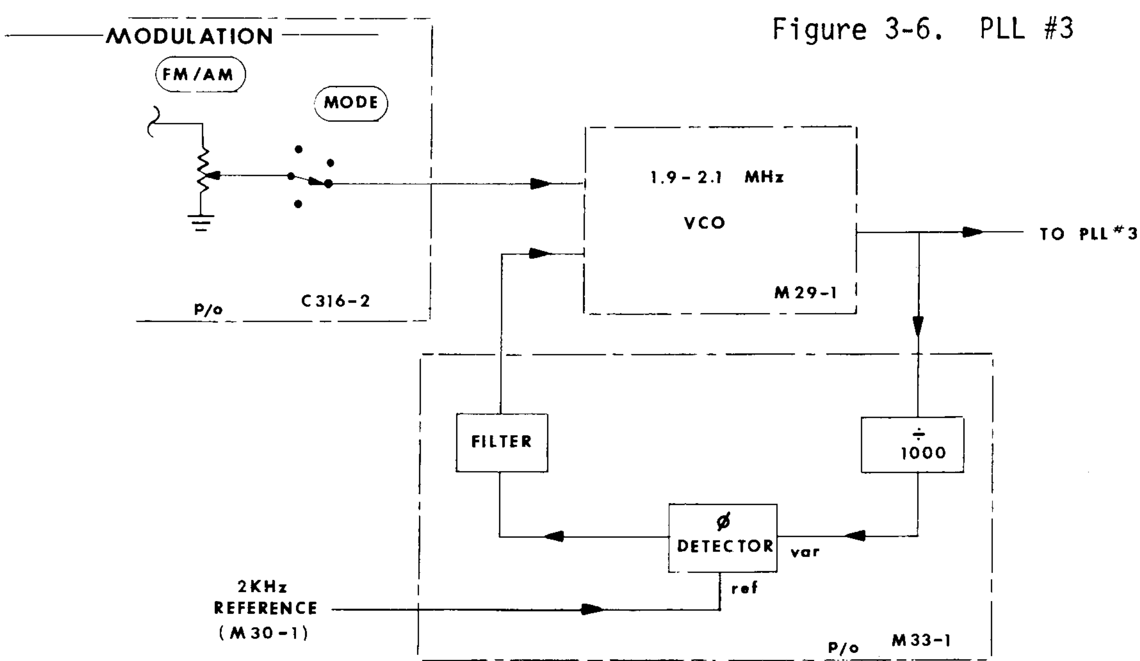


Figure 3-7. PLL #5

3.3 C315 - METER BOARD

The primary function of this assembly is to provide the program voltage to the leveler circuit for the RF amplifier. It also includes the RF output level meter which appears through the instrument front panel. See Figure 3-8.

3.3.1 LEVEL PROGRAM

During CW operation of the instrument, the level program is controlled by the VERNIER on the front panel. The output of this control goes to two range calibration circuits, "High" and "Low". The range calibration circuits convert the voltage from the VERNIER to a voltage level appropriate to drive the leveler circuit in the M10W.

The "Low" circuit provides the program for all ranges of the detented power output dial except +10 dBm. At "+10" the level program is taken from the "High" circuit. The "High" level program enables the full gain capabilities of the M10W to be used when the output is not amplitude modulated.

3.3.2 MODULATION

The modulating signal from assembly C316-2 is applied to the VERNIER which ultimately causes the RF level to change. The leveler in the M10W does not cause the RF level to respond linearly to changes in the level program voltage. To compensate for this, a stage is included in C316-2 to shape the modulation signal before being applied to the VERNIER.

3.3.3 METER

The output level meter (front panel) is controlled by the level program from the

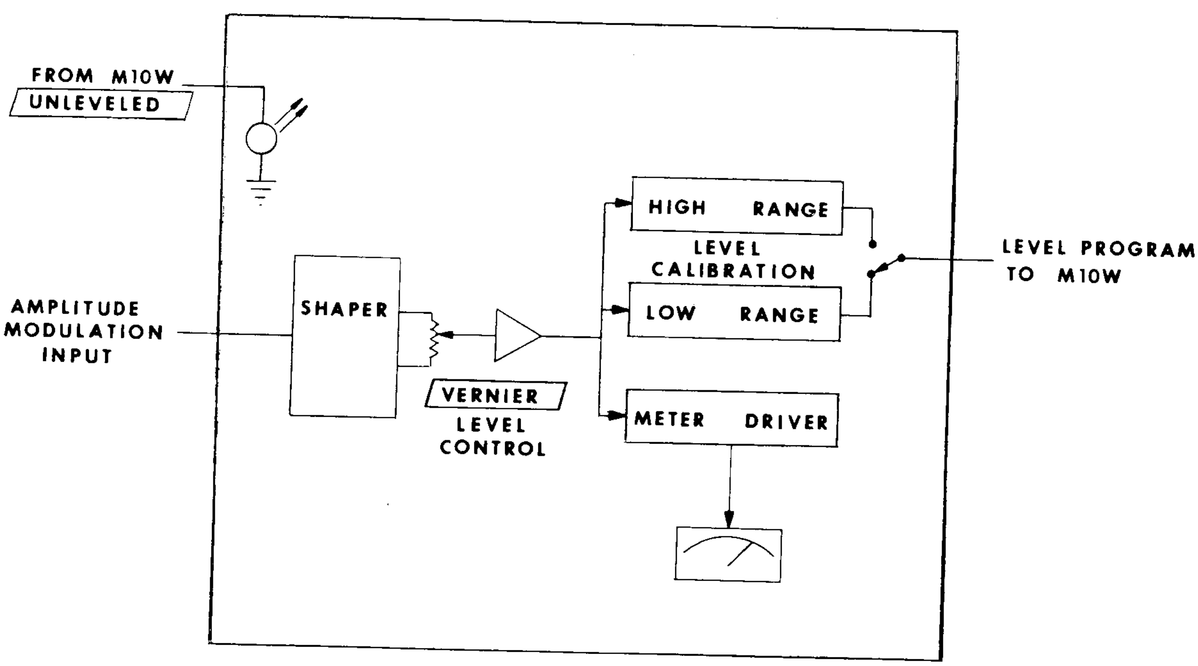


Figure 3-8. C315 - Meter Board

VERNIER. The meter and its driver circuit are designed to display a reading which corresponds to the actual RF level from the M10W.

3.3.4 "UNLEVELED" LIGHT

A light emitting diode is mounted on this assembly and appears on the front panel of the instrument. Refer to the M10W description for an explanation of the circuit driving this light.

3.4 C316-2 - MODULATION BOARD

This assembly provides the modulating signals used in the AM and FM modes. The front-panel Accuracy lights and associated circuitry are also on this assembly. See Figure 3-9.

3.4.1 MODULATING SIGNALS

The AM or FM modes are achieved by simply routing essentially the same signal to the appropriate circuitry by means of the front-panel MODE switch.

The front- panel MODULATION FREQ switch selects one of four sources of modulating frequency, one external and three internal. The internal signal can be selected from one of two CW oscillators or a manually variable DC control.

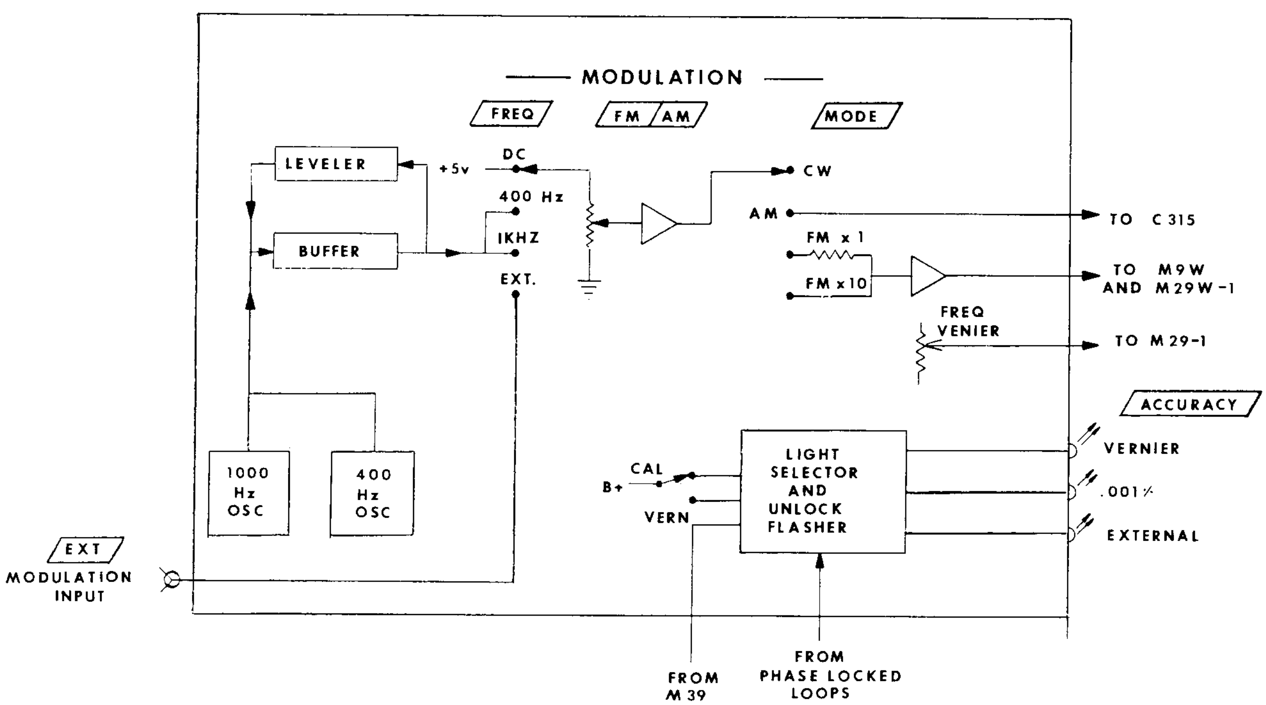


Figure 3-9. C316-2 - Modulation Board

The two internal oscillators are amplified/leveled by the same circuit for simplicity but separately energized by the FREQ switch. The oscillators are twin T oscillators, one is at 400 Hz the other is at 1 kHz.

3.4.2 ACCURACY LIGHTS

Which LED is lit is determined by the CAL switch on the frequency VERNIER or an input from an M39. If any of the phase-locked loops unlock, the energized LED is made to flash by an IC timer which is activated by a DC level from any of the five phase locked loops in the instrument.

3.5 DPS-2 - POWER SUPPLY

The DPS-2 provides DC power for the rest of the instrument. See Figure 3-10.

3.5.1 TRANSFORMER & FILTERS

The transformer steps down the line voltage to appropriate levels for the three circuits. Full wave rectifiers and filter capacitors convert this voltage to DC.

3.5.2 +18 V SUPPLY

The +18 V circuit has a zener diode pre-regulator. This feeds a high accuracy, highly stable, IC voltage regulator. The +18 V supply includes current limiting.

3.5.3 -18 V SUPPLY

This circuit compares the +18 and -18 volt outputs and holds the difference in their magnitudes to zero. A circuit is also included to limit the current output of the -18 V supply.

3.5.4 +7.3 V SUPPLY

This circuit is another comparator circuit referenced to the +18 V supply. It is a pre-regulator which supplies other voltage regulators throughout the instrument.

3.6 M2M - SWEEP DRIVE

Figure 3-11 shows the block diagram of the M2M circuit.

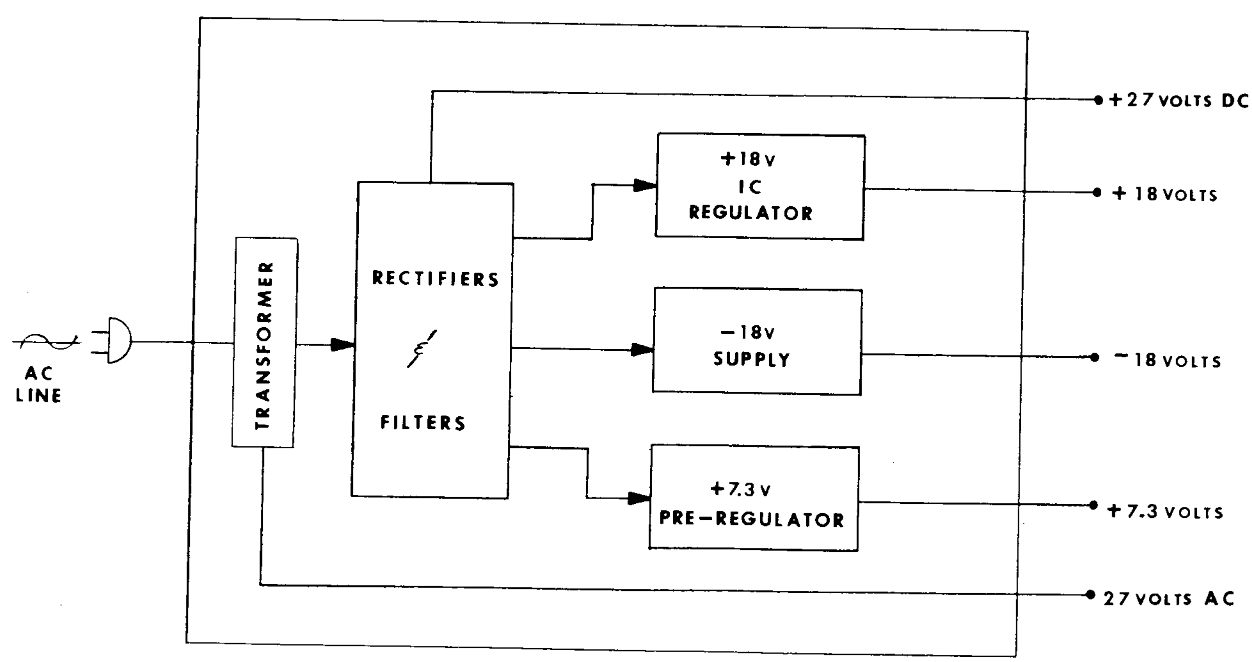


Figure 3-10. DPS-2 - Power Supply

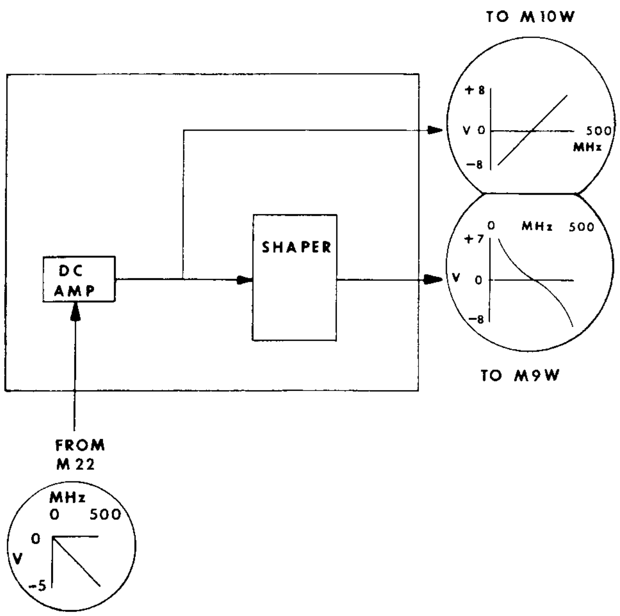


Figure 3-11. M2M - Sweep Drive

The analog tuning signal from the M22 is "shaped" before driving the M9W wide oscillator. This module also provides the varactor drive voltage to the M10W tracking filter. See section 3.8.1

3.6.1 DC AMP

This circuit inverts and slightly amplifies the input voltage for use by the M10W and the M2M shaper circuit. The graphs on the block diagram show the voltages at the input and outputs of the M2M over the range of instrument output frequencies.

3.6.2 SHAPER CIRCUIT

This is an inverting DC amplifier which amplifies the input by a smaller factor for smaller magnitude inputs.

Shaping this analog voltage compensates for the nonlinear change in capacitance of the varactor diodes in the M9W oscillator circuit.

3.7 M9W - SWEEP OSCILLATOR

The M9W is the origin of the instrument's RF output frequency. This frequency is generated by heterodyning the signals from two higher frequency voltage controlled oscillators. See Figure 3-12.

3.7.1 MIXER

The narrow oscillator applies a signal of 1198 MHz to the mixer. The wide oscillator provides between 1199 and 1718 MHz. The difference (1-520 MHz) is applied to a wide band pre-amp and then sent to the M10W.

3.7.2 WIDE OSCILLATOR

The wide range of oscillation is achieved by applying to varactor diodes in the tank circuit an analog signal which is dependent upon the setting of the frequency switches on the instrument's front panel. An additional signal is applied to this VCO from the phase detector in the M34. This is the fine tuning signal which locks the wide oscillator on the proper frequency.

3.7.3 NARROW OSCILLATOR

This oscillator also uses a varactor diode so that the frequency can be voltage controlled for phase locking and for FM operation.

The coarse modulating signal (FM) is applied to the varactor from the modulation board (C316-2). The frequency of this oscillator is further controlled by a "fine tuning" bias voltage from the M33-1 phase detector. The deviation can be controlled up to 100 kHz.

3.7.4 LEVELERS

This module contains three RF leveling circuits as shown in the diagram. These maintain a constant amplitude RF over the frequency range and with temperature variation. The output of a peak detector is compared to a constant DC level. Any error is amplified and applied to a PIN diode attenuator in series with the RF signal.

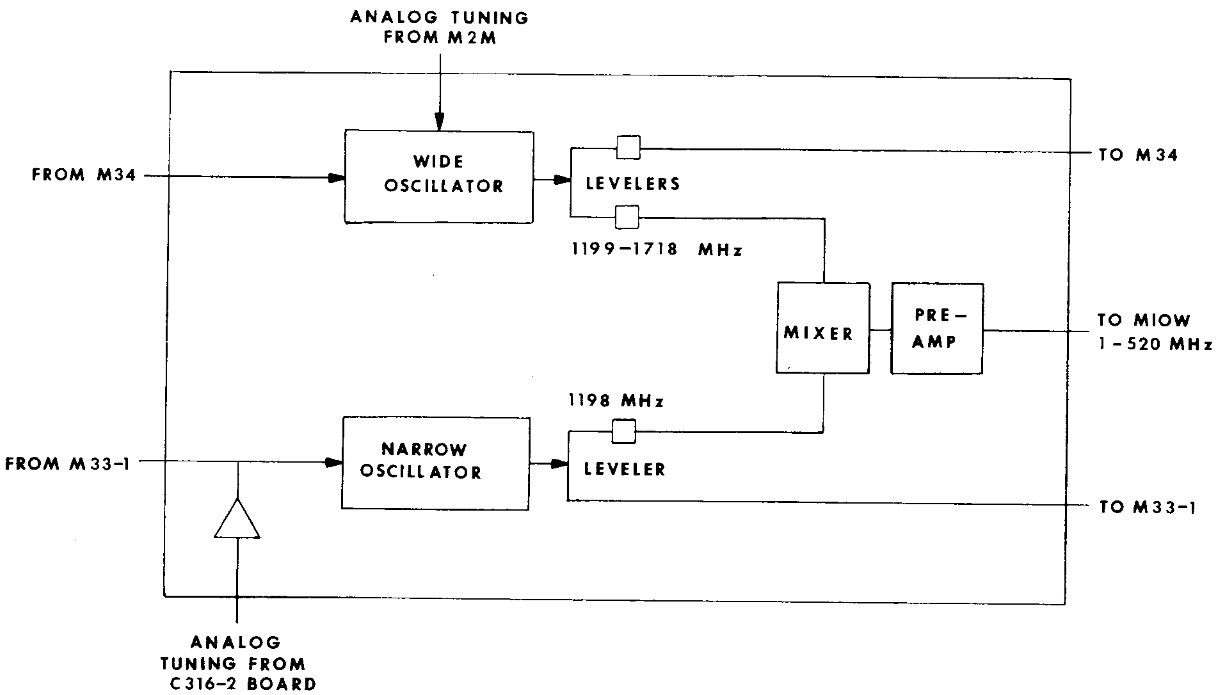


Figure 3-12. M9W Sweep Oscillator

3.8 M10W - OUTPUT AMPLIFIER

The main function of the M10W module is to amplify the RF signal from the M9W to a level programmable between -7 and +13 dBm. A leveler circuit maintains a constant amplitude output signal over the wide frequency range. The Unleveled light driver causes the front-panel light to glow when the leveler circuit exceeds its proper operating range. See Figure 3-13.

3.8.1 AMPLIFIER

This section is a six transistor, wide band amplifier which can increase the RF by about 23 dB. The analog signal from the M2M is applied to the tracking filter varactor diodes in the output of the amplifier section. This filter attenuates spurious and harmonic signals higher than the fundamental but as close to it as possible as the frequency is programmed from 1 to 520 MHz.

3.8.2 LEVELER

The leveler uses a peak detector, differential amplifier and a PIN diode attenuator. The peak detector is fed from the RF output. The resulting level is compared to a DC (or AM) reference by the differential amp which supplies the control current to the PIN diode attenuator. If the detected RF output deviates from the reference level, the signal to the PIN diode causes the input to be decreased or increased.

In addition to providing a flat frequency response, the leveler allows for electronic control of the RF output amplitude by varying the DC reference. The reference comes from the meter board (C315).

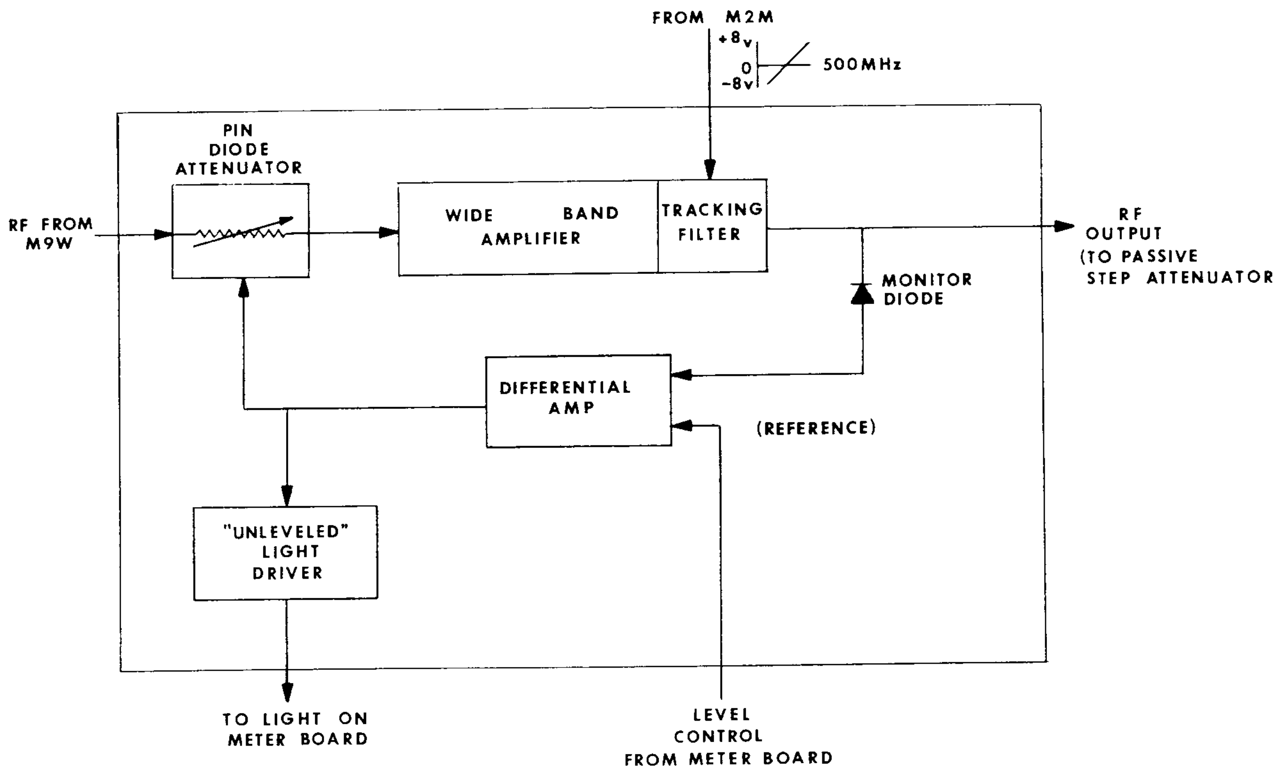


Figure 3-13. M10W - Output Amplifier

3.8.3 "UNLEVELED" LIGHT DRIVER

When the differential amp in the leveler circuit is putting out a voltage which would cause the PIN diode attenuator to be at its high or low resistance limit, the leveling circuit can no longer be effective. The above voltage levels, which are applied to the unlevel light driver, are adequate to turn on a source of current for the indicator which appears through the front panel.

3.9 M22 - DIGITAL TO ANALOG CONVERTER

This module provides two analog outputs which correspond to the frequencies selected by the "MHz" switches (left of decimal point) on the instrument's front panel. One output has a linear voltage versus frequency curve. The other output is linear from 0 to 39 MHz but repeats the analog voltages every 40 MHz. See Figure 3-14.

3.9.1 LINEAR D/A

The front-panel "MHz" switches have BCD output which indicates the desired frequency to the M22. For every logic "1" that is present a current is applied to the summing amp. The more significant the activated input, the more current results. For example, the 4's line (when activated) supplies twice the current of the activated 2's line. The eleven current sources are connected to the summing amp which produces the analog voltage which represents the sum of its "weighted" inputs.

3.9.2 REPEATING D/A

A summing amp with weighted inputs performs like the one above. The summing amp converts the weighted currents into a corresponding voltage output. The repetition of the output is achieved by using the five least significant BCD

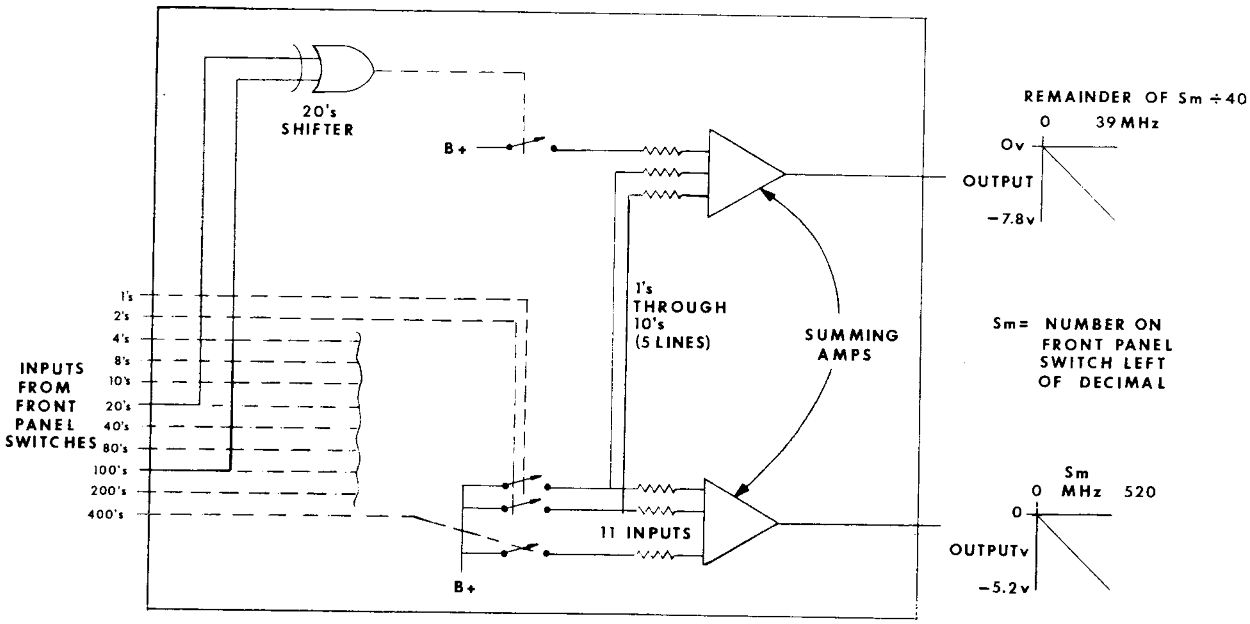


Figure 3-14. M22 - Digital to Analog Converter

lines and an artificial 20's line. These six inputs repeat themselves every 40 MHz as the front-panel switches are changed in 1 MHz steps from 1-520 MHz. A 20's line is necessary in order to represent inputs from 20 to 39, but the original 20's line doesn't repeat its sequence with every 40 MHz change in programmed frequency. See Table 3-1. The proper program for the summing amp is provided by inverting the 20's line whenever the 100's line is activated.

TABLE 3-1. 20's CONVERSION

"MHz" Switch Setting	Original 20's Line	Artificial 20's Line
0	0	0
20	1	1
40	0	0
60	1	1
80	0	0
100	0	1
120	1	0
140	0	1
160	1	0
180	0	1
200	0	0
. . .		

3.10 M29-1 - FM REFERENCE

The M29-1 is a voltage to frequency converter, the output of which is used as a phase lock reference in the M33-1. The module includes a voltage variable current source which feeds (determines the frequency of) a square wave oscillator. (See Figure 3-15.) Zero volts in yields 2 MHz out.

The M29-1 is the VCO for phase-locked loop five. The input to the M29-1 from the phase detector is essentially added to the modulation input. The Frequency VERNIER voltage is also added here. (VERNIER input becomes zero volts when VCO is locked).

3.10.1 CURRENT SOURCES

This circuit provides both a positive and a negative source of current. The

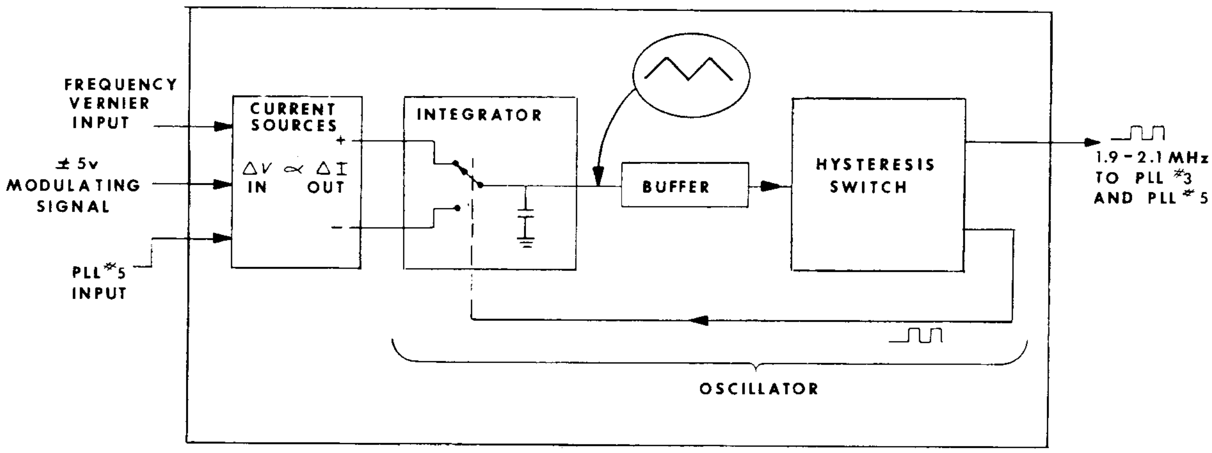


Figure 3-15. M29-1 - FM Reference

positive source is referenced to the negative source so that the instantaneous currents in both sources are equal.

The change in output current is directly proportional to the change in input voltage to the circuit. The input voltage may vary between -5 and +5 volts. The circuit is designed for a very linear graph of current-out vs. voltage in.

3.10.2 OSCILLATOR

The square wave output is produced by the combination of an integrator and a hysteresis switch. The integrator converts a square wave to a triangle wave. The triangle wave causes the hysteresis switch to produce the square wave which is fed back to the integrator.

The integrator is made up of a current switch and a capacitor. The square wave applied to the current switch causes a square current signal to be applied to the capacitor.

Positive constant current produces an increasing voltage ramp on the capacitor and negative constant current produces a decreasing voltage ramp. For a square wave input, therefore, the output is a triangle wave.

Changing the magnitude of the "currents", by changing the input voltage to the module, changes the rate at which the capacitor charges and discharges to the hysteresis points thus the frequency of oscillation changes.

3.11 M30-1 - CRYSTAL REFERENCE

This module supplies reference frequencies at 1 kHz, 2 kHz, 1 MHz, 10 MHz, 40 MHz and its harmonics, 1200 MHz (from 120 comb) and 1440 MHz to the phase locked loops in the instrument. These signals are produced by a 40 MHz crystal oscillator and a series of dividers and multipliers. See Figure 3-16.

3.11.1 40 MHz OSCILLATOR

This crystal oscillator is the heart of the accuracy of the frequency determining circuits in the instrument. It is temperature compensated for frequency stability. A varactor diode is included to enable this oscillator to be phase locked to a high stability reference. A leveler circuit causes the oscillator output level to be the same in all M30 modules.

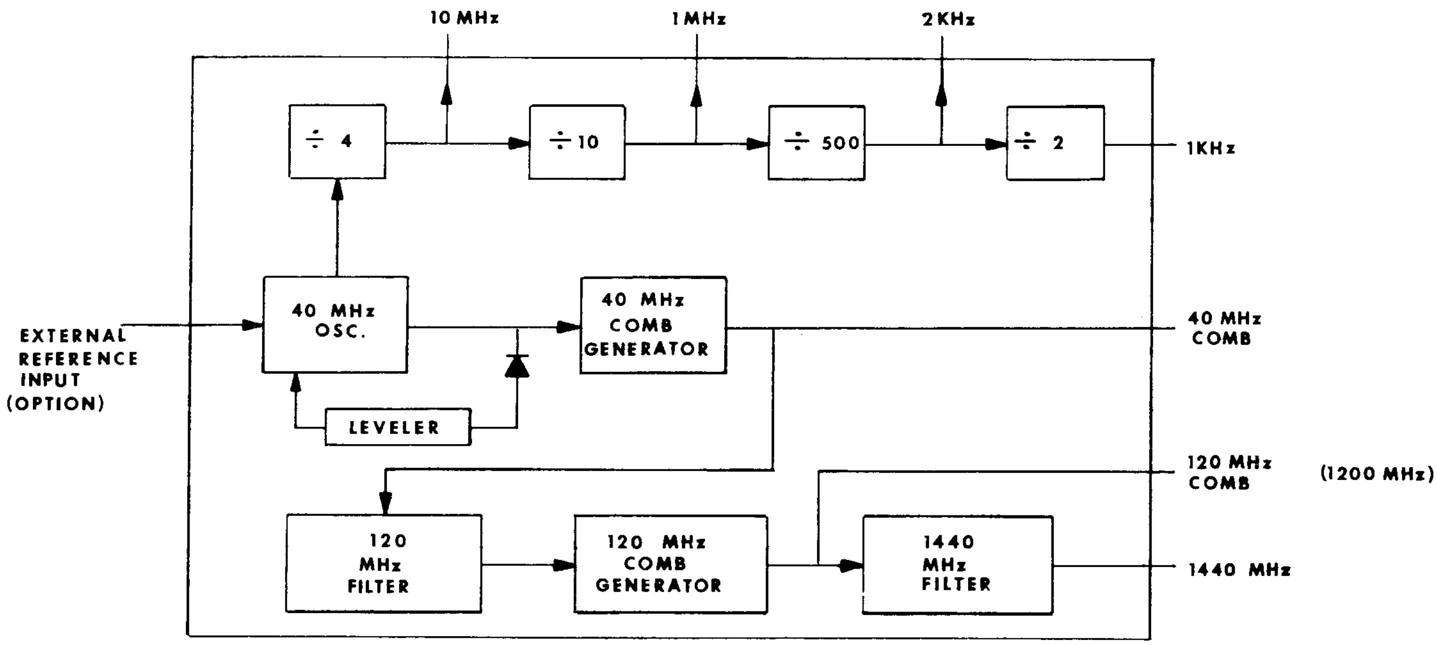


Figure 3-16. M30-1 - Crystal Reference

3.11.2 DIVIDERS

The frequencies below 40 MHz are produced by a series of TTL counters. A "divide by 4" produces the 10 MHz output for the phase-locked loop in the optional high stability reference. This frequency is further divided as shown in Figure 3-16 to provide the 1 MHz, 2 kHz and 1 kHz outputs.

3.11.3 MULTIPLIERS

The 40 MHz CW is fed to a harmonic generator which produces the "comb" output.

From the 40 MHz comb, 120 MHz is selected and applied to another harmonic generator. A sample of the 120 MHz comb output is also fed to a filter which provides the 1440 MHz output.

3.12 M31 - kHz STEPS

The input to this module is the BCD data from the front-panel "kHz" switches (to the right of the decimal point). The output frequency is (10 MHz - S_k kHz), where S_k is the number indicated by the kHz switches. If the FREQUENCY is set to 333.333 MHz, for example, the M31 output is 9.667 MHz. The block diagram of the M31 is shown in Figure 3-17.

3.12.1 VCO

The output frequency is generated by a voltage controlled oscillator which is coarsely tuned by a D/A converter and fine tuned by inclusion in a phase locked loop within the module.

3.12.2 D/A CONVERTER

The BCD information from the front-panel switches is converted to an analog signal which biases the varactor diode in the VCO.

Each BCD line corresponds to a different current source which is switched on by a logic "1" on its BCD line. The amount

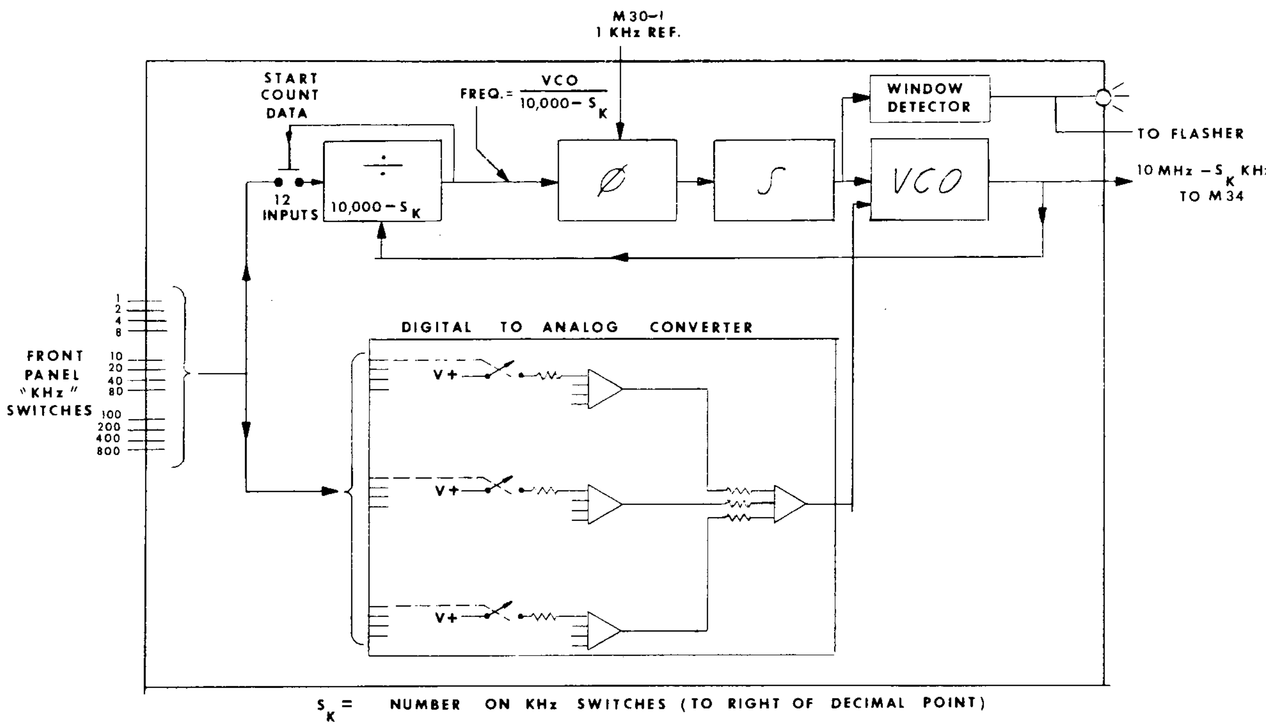


Figure 3-17. M31 - kHz Steps

of current from a source depends on the significance of its corresponding BCD line. For example, when the 4's line is activated, twice as much current is supplied as when the 2's line is activated. Summing amps add the weighted inputs and give the appropriate analog voltage output.

3.12.3 PHASE-LOCKED LOOP

Including the VCO in a phase-locked loop allows the accurate programmability. The fine tuning voltage comes from the phase detector and is filtered by an integrator stage. The M30 provides the 1 kHz reference to the phase detector. A sample of the VCO output is fed back to the programmable divider which feeds the lower frequency signal to the phase detector. When the loop is locked the divider output is 1 kHz.

In order for the M31 to perform properly, the divider is designed to divide the VCO frequency by (10,000-S_k), where S_k is the number set on the "kHz" switches. The divider counts the number of cycles at its input and puts out a pulse when the count reaches 10,000. The starting count is the number shown on the kHz switches. For example, if the instrument is set for 222.500 MHz this circuit would divide by 9,500 (count from 500 to 10,000). Therefore, the variable input to the phase detector would be correct only if the VCO put out 9.500 MHz.

3.12.4 UNLOCK INDICATOR

When the phase-locked loop is unlocked the LED on top of the module will light and the front-panel Accuracy light will flash.

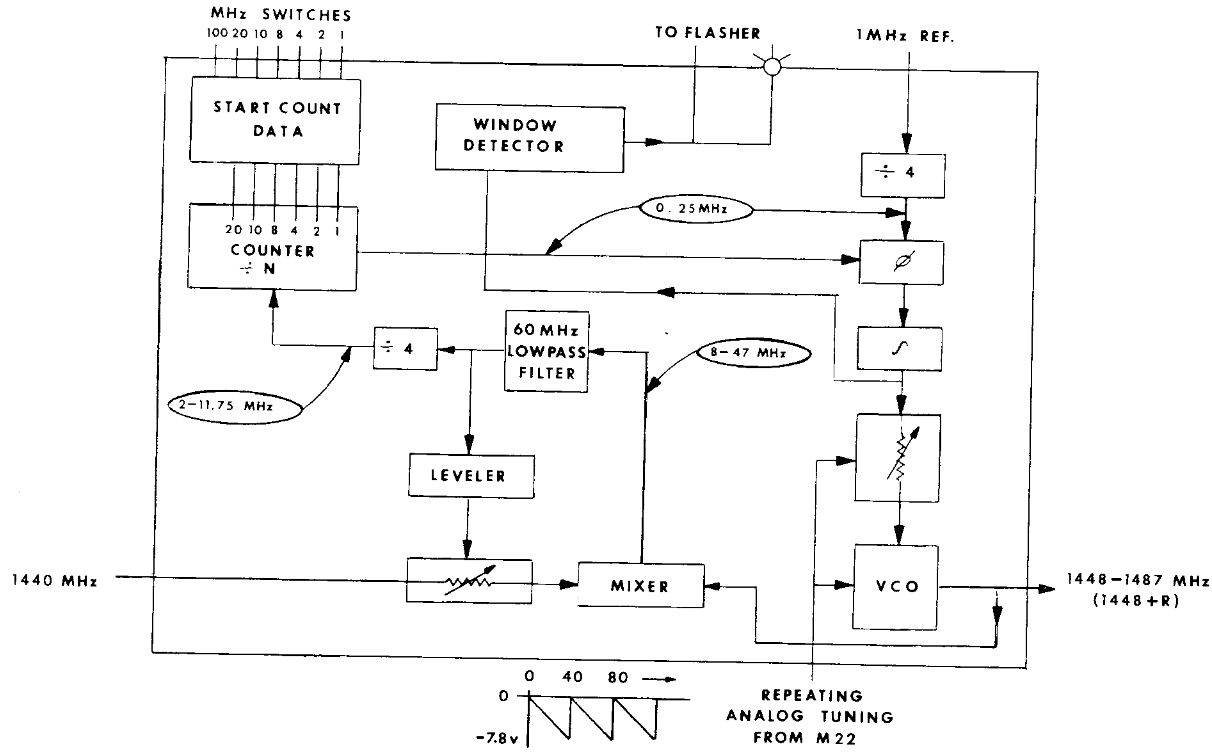


Figure 3-18. M32 - MHz Steps

A window detector monitors the voltage level which is being fed from the phase detector to the VCO. If the voltage exceeds the normal operating range, power is applied to the module light and the flasher circuit (on assembly C316-2).

3.13 M32 - MHz STEPS

The M32 provides for the M34, a reference frequency which corresponds to the setting on the "MHz" switches. See block diagram, Figure 3-18. The M32 output range is 1448 to 1487 MHz which repeats itself with every 40 MHz change of the frequency switches. Any specific M32 output relates to the "MHz" switch setting (S_m) by the equation (Output = (1448 + R) MHz), where R is the Remainder of dividing S_m by 40. If the front panel is set, for example, for 333.000, R would be 13 (333.000 ÷ 40 = 8 with a Remainder of 13). The output of the M32 would then be 1448 + 13 = 1461 MHz.

3.13.1 VCO

The output of the M32 is produced by a voltage controlled oscillator. This VCO is coarsely tuned by the repeating analog output of the M22. Fine tuning is the result of including the VCO in a phase-locked loop. In addition to the VCO the phase-locked loop includes a phase detector and programmable divider.

3.13.2 PHASE DETECTOR

The fixed reference frequency to the phase detector is 250 kHz. The variable input from the counter provides the error signal which represents the deviation of the VCO from the desired output. When both inputs to the phase detector are 250 kHz the loop is locked.

If the VCO output frequency is high, the variable phase detector input is high. This results in a positive output which causes a negative output from the integrator. More negative bias to the varactor increases the tuning capacitance thus lowering the VCO frequency.

A voltage controlled attenuator between the integrator and the VCO keeps the open loop gain of the phase-locked loop relatively constant over the programmed frequency range. This allows the loop noise to be minimized.

3.13.3 PROGRAMMABLE DIVIDER

In order for the proper VCO output frequency to produce 250 kHz to the phase detector it undergoes three conversions. It is first heterodyned with 1440 MHz yielding between 8 and 47 MHz. This frequency is then divided by four so that it will fall within the frequency range of the ÷N counter.

When the loop is locked the input to the ÷N counter will be N times 250 kHz. Changing N (by changing the MHz switches) ultimately causes the VCO to change in order for the loop to stay locked. "N" ranges from 8 to 47. In order for N to be between 8 and 47, the counter must count to 47 and start counting as determined by the "start count data". Data input is 39 for N=8 and 0 for N=47.

The "Start Count Data" circuit converts the BCD negative logic from the MHz switches into BCD positive logic according to the formula: "start count" = 39-R. (R is defined above.)

3.13.4 UNLOCK INDICATOR

When the phase-locked loop is unlocked the LED on top of the module will light and the front-panel Accuracy light will flash.

A window detector monitors the voltage level which is being fed from the phase detector to the VCO. If the voltage exceeds the normal operating range, power is applied to the module light and the flasher circuit (on assembly C316-2).

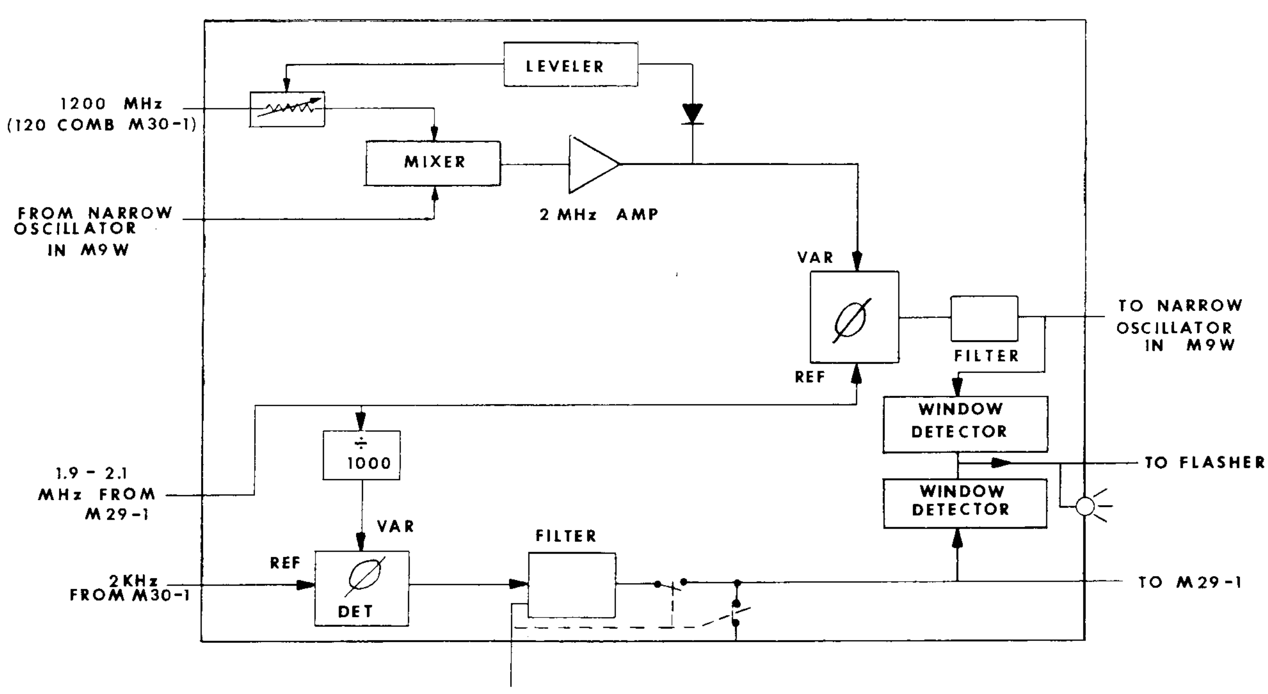


Figure 3-19. M33-1 - Narrow Oscillator Lock

3.14 M33-1 - NARROW OSCILLATOR LOCK

The M33-1 contains the circuits to phase lock the narrow oscillator in the M9W (loop 3) and the M29-1, FM reference, (loop 5). As explained in section 3.2.2 loop 5 provides the reference frequency for loop 3.

3.14.1 PHASE DETECTOR FOR LOOP #3

This circuit compares the reference frequency to the variable frequency which represents the M9W VCO output. If the VCO is too high, for example, the phase detector puts out a more positive voltage which is filtered and inverted by an integrator and applied to the VCO (narrow oscillator) to lower the frequency.

3.14.2 MIXER

The phase detector can not operate at UHF frequencies so the VCO is mixed with 1200 MHz CW. This provides an offset frequency which is the variable input to the phase detector. The deviation of this variable signal from 2 MHz is precisely the same as the deviation of the VCO from 1198 MHz.

3.14.3 PHASE DETECTOR FOR LOOP #5

This circuit compares the 2 kHz reference from the M30-1 to the variable frequency which is the M29-1 output divided by 1000. The variable frequency is divided by 1000 so that even when M29-1 is frequency modulated the variable frequency will remain in the capture range of the phase detector. Any frequency modulation (above 50 Hz) is filtered out by the integrator filter and the error voltage is fed to the M29-1.

3.14.4 UNLOCK INDICATOR

Window detectors are fed by the integrator outputs. If the integrators put out a voltage outside their normal operating range the window detectors apply voltage to the module's unlock indicator and to the flasher circuit on the Modulation board assembly.

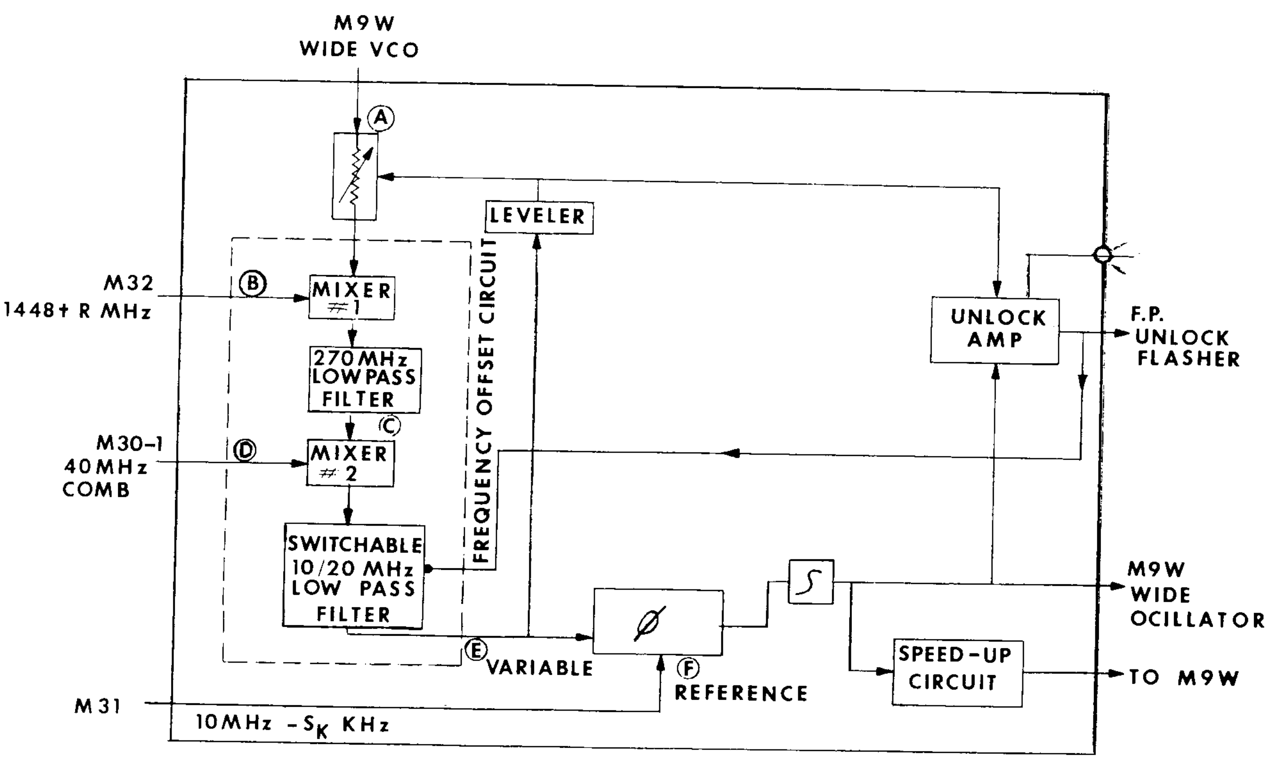


Figure 3-20. M34 - Wide Oscillator Lock

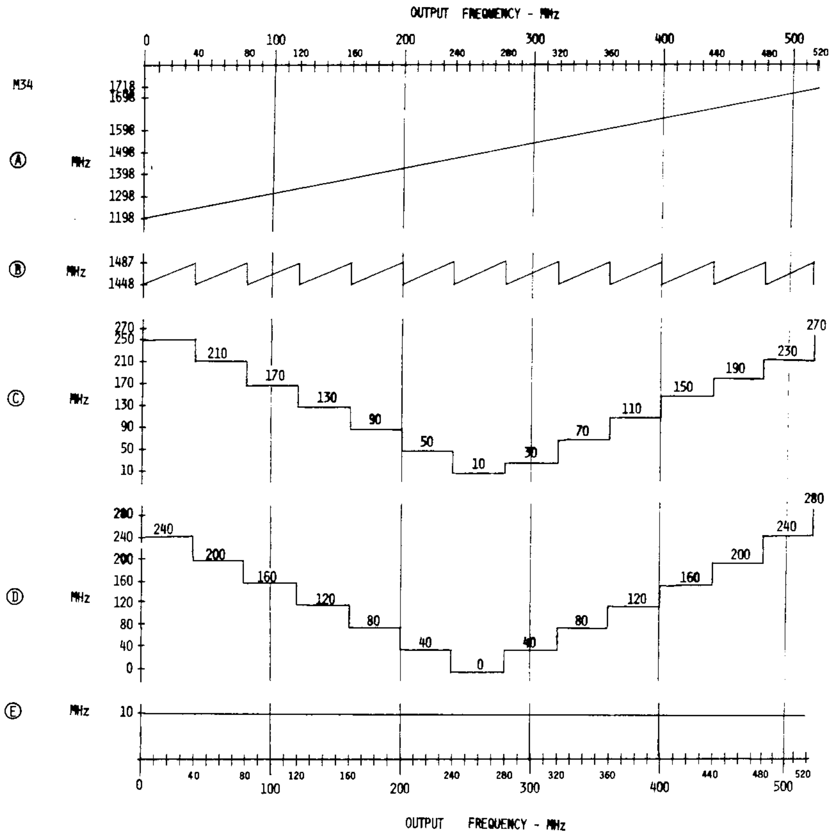


Figure 3-21. M34 Signal Frequencies

3.15 M34 - WIDE OSCILLATOR LOCK

This module provides the fine tuning program for the wide oscillator in the M9W. Figure 3-20 is the block diagram of the M34. The letters A thru F relate the signals at the associated points in the module to the graphs A thru F in Figures 3-18 and 3-19. The M34 phase locks the VCO to 1198 MHz plus the frequency indicated on all six front-panel switches. The frequency offset circuit converts the frequency of the VCO to a lower frequency which retains the frequency error information for use by the phase detector. In addition to the frequency offset circuit and the phase detector, several auxillary circuits are included.

3.15.1 PHASE DETECTOR

The phase detector compares the "offset" VCO frequency to the reference frequency from the M31. (Refer to the description of the M31 for a more detailed description of this 10.000 - 9.001 MHz reference.)

The phase detector output voltage goes positive or negative to ultimately drive the wide oscillator higher or lower in frequency until both inputs to the phase detector are the same frequency. The integrator serves as a low pass filter for the phase detector.

3.15.2 FREQUENCY OFFSET CIRCUIT

The VCO error information must be converted to a frequency useable by the phase detector. This conversion is made by mixer #1, a 270 MHz low pass filter, mixer #2 and a 10 MHz low pass filter. Refer to Figures 3-20, 3-21 and 3-22 for descriptions of signals.

Mixer #1 heterodynes the VCO frequency with the "MHz steps" reference frequency (1448 + R) MHz. The difference frequency, |1448 + R - VCO|, is below 270 MHz. This signal is sent to mixer #2 where it is heterodyned with the 40 MHz comb. For any output frequency graph D in Figure 3-21 shows only the comb frequency which will yield the desired output (below 20 MHz) of mixer #2. If the loop is locked, mixer #2 will produce a 10 MHz difference as shown in Figure 3-21 (assuming the "kHz" switches are set for 000). Figure 3-22 shows signals A thru F for a case when the kHz switches are not 000.

The filter after the mixer #2 blocks all the outputs of the mixer except the lower frequency signal containing the VCO error information. When the unit is unlocked the filter passes up to 20 MHz (to be able to capture over the 20 MHz range allowed for analog tuning). Once the loop is locked, the filter decreases to 10 MHz to further eliminate phase-locked loop related spurious signals.

3.15.3 AUXILIARY CIRCUITS

The "speed-up circuit" is activated when the phase-locked loop becomes unlocked. The output of this circuit is sent to the M9W to cause the VCO to be tuned faster by the analog voltage.

The "unlock" amp monitors both the tuning voltage from the phase detector and the leveler voltage to detect an unlocked condition of the M34. When unlock occurs, it sends a voltage to the flasher circuit.

The leveler circuit maintains a constant input amplitude to the phase detector by controlling the amplitude of the input from M9W wide oscillator. The input to the phase detector (about 10 MHz) is peak detected and compared to a DC reference in the leveler circuit. The leveler circuit controls a PIN diode attenuator which is between the VCO input and mixer #1.

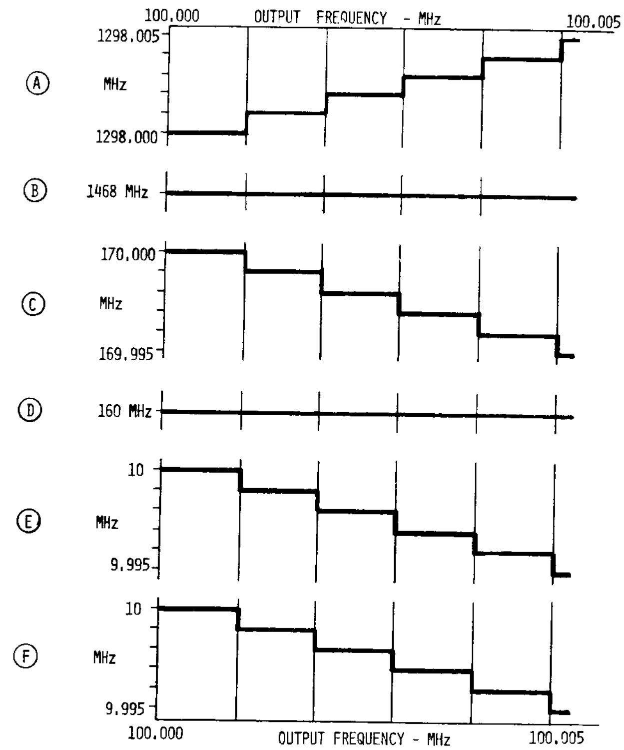


Figure 3-22. M34 - Frequencies (Expanded)

SECTION 4
PERFORMANCE TESTS

4.1 INTRODUCTION

The purpose of the performance tests in the following paragraphs is to verify that the Model 3001 Signal Generator meets its published specifications (paragraph 1.2). Individual performance tests consist of: the specification to be verified, the method of testing, a list of equipment required, and a detailed test procedure including in some cases a simplified setup drawing. If optional features are installed in the instrument refer to Section 8 for possible changes to the performance test procedure.

Critical specifications for each item of test equipment are listed in Table 4-1 of Recommended Test Equipment. Except as detailed settings of test equipment apply to performance test procedures, all other test equipment operating details are omitted.

The Signal Generator should have its top and bottom covers installed for the performance tests. All of the tests can be performed without access to the internal controls. Before applying power to the Signal Generator see Section 2 for details of electrical installation. The line voltage should be maintained at 115 or 230 volts ±10%, 50 or 60 Hz throughout the tests. The performance test procedures are begun after a two-hour minimum warmup of the Signal Generator in a +20 to +30° C ambient temperature range.

A copy of the Performance Test Record (PTR) is provided at the end of this section for convenience in recording the performance of the Model 3001 during performance tests. It can be filled out and used as a permanent record for incoming inspection or it can be used as a guide for routine performance testing. The PTR lists the paragraph, test, basic control settings and limits. All of the tests refer to this test record.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT FOR MODEL 3001 PERFORMANCE TESTS

INSTRUMENT	CRITICAL REQUIREMENT	RECOMMENDED
Digital Multimeter	10 VDC: ±(0.07%R+0.02%FS)	Dana 4300
Distortion Analyzer	Range: 5 Hz to >25 kHz	HP334A
Frequency Counter	Range: to 525 MHz	HP5300B/5303B
Function Generator	Level: 10 Vpp sine wave into 600 ohm load Range: >0.2 Hz to >25 kHz Distortion: <1%	Wavetek 130

TABLE 4-1. (Cont'd)

Power Meter	Range: 10 to >520 MHz Input Level: -7 to +13 dBm Accuracy: ±1% FS	HP435A/8481A
Modulation Meter	Range: 5 to >520 MHz Residual FM: <100 Hz (RMS) (quiet room) Residual AM: <0.1% (RMS) (in CW) AM Accuracy: ±(2%R+1%FS)	AFM2 Radiometer
Oscilloscope	Range: DC to 2 MHz Sensitivity: 2 V/cm (AC coupled)	Tektronix D10/ 5A18N/5B10N
Spectrum Analyzer	Range: 500 kHz to 1200 MHz Display: 2 dB log and 10 dB log	HP8554L/8552B/ 141T
Precision Attenuator Pads	10, 20, 30, and 40 dB	Weinschel 50-10, 50-20, 50-30, and 50-40
Wideband Amplifier	Range: 1 to 520 MHz Gain: 26 dB Impedance: 50 ohm	HP8447D
Sweep/Signal Generator	Range: 1 to 520 MHz	Wavetek 2001
VSWR Bridge	5 to 525 MHz, 50 ohm 50 dB directivity	Wiltron 60N50
Coaxial Short	Type N female	HP11511A
Coaxial Termination, 50 ohm	Type N male, 1.05 SWR	HP908A
Loop Probe	See Figure 4-9.	

4.2 FREQUENCY RANGE AND RESOLUTION TEST

SPECIFICATION RANGE — 1 MHz to 520 MHz selectable in 1 kHz steps.

READOUT — 6 digit Lever/Indicator switches

RESOLUTION — 1 kHz

METHOD — A frequency counter is used to measure the frequency range and the frequency resolution. All frequencies in CW and AM modes between 1 and 520 MHz are selected by front-panel Lever/Indicator switches. Each of the digits of the frequency selector (a total of 56) will be tested. The 0 through 9 kHz digits provide 1 kHz resolution.

EQUIPMENT

Frequency Counter HP5300B/5303B

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	050.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive in CW MODE)
MODULATION FM/AM	(Inactive in CW MODE)
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the Signal Generator RF out connector to the 50 ohm input of the frequency counter. Set the counter to read frequency to seven digits.

3. Observe the frequency counter reading. Increase the setting of the Signal Generator FREQUENCY selector in 1 kHz steps and verify that the frequency counter reading increases by 1.00 kHz ±1 count for each step increase from 1 through 9 kHz. The foregoing procedure verifies the 1 kHz resolution specification.

4. Repeat the procedure in step 3 for all other step increases indicated in the table below beginning with the 10 kHz digits. If the actual counter frequency increase per step is equal to the allowable increase per step ±1 count for each of the steps indicated in the table, place a check mark in the applicable space on line 1 of the PTR.

FREQUENCY Selector		Frequency Counter Reading	
Range (MHz)	Increase per step	No. Digits	Allowable Increase per step ±1 count
050.000-050.009	1 kHz	7	1.00 kHz
050.000-050.090	10 kHz	7	10.00 kHz
050.000-050.900	100 kHz	6	100.0 kHz
050.000-059.000	1 MHz	5	1.000 MHz
001.000-091.000	10 MHz	5	10.000 MHz
020.000-520.000	100 MHz	6	100.00 MHz

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION

ACCURACY All modes (CW, AM and FM) ±0.001% (±0.001% +10 kHz when frequency VERNIER is not in CAL position. Frequency VERNIER range is ±5 kHz.)

METHOD

A frequency counter is used to measure frequency accuracy. With the frequency VERNIER in CAL position all carrier frequencies between 1 and 520 MHz are derived from a single crystal-controlled oscillator. The Signal Generator will be tested at one CW frequency to verify that the crystal-controlled oscillator operates within specified limits.

When the frequency VERNIER is not in CAL position, all carrier frequencies are derived from a voltage-controlled oscillator in addition to the crystal-controlled oscillator. Frequency accuracy with the frequency VERNIER not in CAL position will be measured by utilizing DC modulation equal to maximum peak sinusoidal modulation in both FM modes. The frequency VERNIER range will be tested in CW mode.

EQUIPMENT

Frequency Counter HP5300B/5303B

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	040.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive in CW MODE)
MODULATION FM/AM	(Inactive in CW MODE)
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the 50 ohm input of the frequency counter to the Signal Generator RF out connector.

3. The counter should read between 39,999.59 and 40,000.41 kHz. Record the counter reading to seven places on line 2 of the PTR.

4. Set the Signal Generator controls as follows:

Frequency VERNIER	0 kHz
FREQUENCY selector	001.000 MHz
MODULATION MODE	FMx1
MODULATION FREQ	DC
MODULATION FM/AM	10 kHz

5. The frequency counter should read between 999.99 and 1,020.01 kHz. Record the counter reading to 6 places on line 3 of the PTR.

6. Set the Signal Generator MODULATION MODE to FMx10.

7. The frequency counter should read between 1,089.99 and 1,110.01 kHz. Record the counter reading to 6 places on line 4 of the PTR.

8. Set the FREQUENCY selector to 002.000 MHz.

9. Set the frequency VERNIER to +3 kHz, and make a note of the counter reading in Hz.

10. Set the frequency VERNIER to 0 kHz, and subtract the frequency counter reading in Hz from the reading in step 9. The frequency difference should be between 2500 and 3500 Hz. Record the difference on line 5 of the PTR.

11. Set the frequency VERNIER to -3 kHz, and subtract the frequency counter reading in Hz from the reading at 0 kHz in step 10. The frequency difference should be as in step 10. Record the difference in Hz on line 6 of the PTR.

4.4 FREQUENCY STABILITY TEST

STABILITY — All modes (CW, AM and FM) <0.2 ppm/hour (500 Hz per 10 min when frequency VERNIER is not in CAL position.)

METHOD — The frequency stability is measured with a frequency counter at the indicated time intervals after a 2 hour minimum warmup.

EQUIPMENT

Frequency Counter — HP5300B/5303B

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive)
MODULATION FM/AM	(Inactive)
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the 50 ohm input of the frequency counter to the Signal Generator RF out connector.

3. Allow the Signal Generator to warm up for two hours minimum. Record the frequency counter readings to nine-places at 15-minute intervals for a one-hour period. The difference between the maximum and minimum readings in the one-hour period should not exceed 104 Hz. Record the difference between the maximum and minimum readings in Hz on line 7 of the PTR.

4. Set the Signal Generator frequency VERNIER to 0 kHz, the MODULATION MODE to FMx1, and MODULATION FREQ to DC and adjust the MODULATION FM/AM control to 10 kHz.

5. After a one-minute interval record the frequency counter readings to nine-places at five-minute intervals for a ten-minute period. The difference between the maximum and minimum readings in the ten-minute period should not exceed 500 Hz. Record the difference between the maximum and minimum frequency readings in Hz on line 8 of the PTR.

4.5 OUTPUT LEVEL ACCURACY TESTS

SPECIFICATION

Power Level	+13 to -137 dBm (1 V to 0.03 μV)
Attenuator Range	Continuously adjustable in 10 dB steps and an 11 dB VERNIER. Output level is indicated on a front-panel meter calibrated in dBm and volts RMS.
Total Level Accuracy	±1.25 dB (+13 to -7 dBm) ±1.95 dB (-7 to -77 dBm) ±2.75 dB (-77 to -137 dBm)
Accuracy Breakdown	
Flatness	±0.75 dB (+13 to -7 dBm)
Output Meter	±0.5 dB
Step Attenuator	±0.5 dB to 70 dB (±0.2 dB calibration error) ±1.0 dB to 130 dB (±0.5 dB calibration error)

METHOD

The ±1.25 dB level accuracy between +13 and -7 dBm consists of the sum of the output meter error (±0.5 dB) and the flatness (±0.75 dB). Both errors are measured with a power meter.

The output meter error is measured at 50 MHz in two 10 dB output ranges (+13 to +3 dBm and +3 to -7 dBm).

The flatness is measured relative to 50 MHz in 10 MHz steps between 10 and 520 MHz at +12, +3 and -7 dBm output levels.

The level accuracy below -7 dBm depends upon the output step attenuator error in addition to the output meter error and the flatness.

The output step attenuator is a combination of pi-pad sections of 10, 20, 30, 30 and 40 dB. These five pi-pads are programmed by cams to provide 0 to 130 dB of attenuation in 10 dB steps as shown in the table below.

OUTPUT STEP ATTENUATOR POSITION	ACTIVE STEP ATTENUATOR PADS (X)				
dBm	10 dB	20 dB	30 dB	30 dB	40 dB
+ 10					
0					
- 10	x				
- 20		x			
- 30			x		
- 40	x		x		
- 50		x	x		
- 60			x	x	
- 70	x		x	x	
- 80		x	x	x	
- 90		x		x	x
-100			x	x	x
-110	x		x	x	x
-120		x	x	x	x
-130	x	x	x	x	x

Note that no step attenuator pads are active in the +10 dBm and 0 dBm positions. A leveled pin-diode attenuator reduces the output level by 10 dB in all positions of the output step attenuator below +10 dBm. The output level over the entire range of +13 dBm to -137 dBm including an 11 dB VERNIER is controlled by the pin leveler system.

The output step attenuator error is measured by an RF substitution method. Each of the five pads in the output step attenuator is measured at 520 MHz. The second 30 dB pad and the 40 dB pad are measured in combination with other pads. A reference output level is set with a power meter. A reference trace is obtained with a spectrum analyzer and a standard attenuator pad. The standard pad is removed and the output step attenuator position to be measured is substituted. The spectrum analyzer trace is returned to the reference level by resetting the Signal Generator output level. The resulting Signal Generator output level is measured and compared to the original power meter reference level. A 26 dB RF amplifier is required to boost signal levels below the -60 dBm level.

4.5.1 OUTPUT METER ACCURACY TEST

EQUIPMENT

Power Meter and Sensor	HP435A/8481A

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	050.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive in CW MODE)
MODULATION FM/AM	(Inactive in CW MODE)
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Calibrate the power meter and power sensor. Set the power meter to the +15 dBm range. Connect the power sensor to the Signal Generator RF out connector. (When reading the power meter, set the range switch so that the meter indicates between 0 and -5 dBm).

NOTE: The indicated output level of the Signal Generator is equal to the sum of the output meter reading and the step attenuator setting. The difference between the actual power meter reading and the indicated output level is the output meter error. For example, the indicated output level is +13 dBm for an output meter reading of +3 dBm and an OUTPUT step attenuator setting of +10 dBm. If the power meter reading is +13.15 dBm, the output meter error is +0.15 dB.

3. Adjust the Signal Generator OUTPUT VERNIER for a +3 dBm output meter reading. Observe the power meter reading and make a note of the output meter error to the nearest 0.05 dB (¼ division). Continue to adjust the OUTPUT VERNIER for output meter reading increments of 1 dB between +3 and -7 dBm, and note the output meter error at each reading. As the test progresses make a note of the maximum output meter error to the nearest 0.05 dB. The allowable error is ±0.5 dB. Record the maximum output meter error on line 9 of the PTR.

4. Set the Signal Generator OUTPUT step attenuator to 0 dBm and repeat step 3 above. Record the maximum output meter error on line 10 of the PTR.

4.5.2 FLATNESS TEST

EQUIPMENT

Power Meter and Sensor	HP435A/8481A

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	050.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive in CW MODE)
MODULATION FM/AM	(Inactive in CW MODE)
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Set the power meter to the +15 dBm range. Connect the power sensor to the Signal Generator RF out connector.

3. Adjust the Signal Generator OUTPUT VERNIER for a +12 dBm power meter reading.

4. Set the Signal Generator FREQUENCY selector in 10 MHz steps between 10 and 520 MHz and observe the maximum change in the power meter readings from the +12 dBm reading in step 3. The maximum allowable change is ±0.75 dB. Record the maximum change to the nearest 0.05 dB (¼ division) on line 11 of the PTR.

5. Set the Signal Generator FREQUENCY selector to 050.000 MHz and adjust the OUTPUT VERNIER for a +3 dBm power meter reading.

6. Repeat step 4 above except observe the maximum change in the power meter readings from the +3 dBm reading in step 5. Record the maximum change from the +3 dBm reading to the nearest 0.05 dB on line 12 of the PTR.

7. Set the Signal Generator FREQUENCY selector to 050.000 MHz and the OUTPUT step attenuator to 0 dBm. Adjust the OUTPUT VERNIER for a -7 dBm power meter reading.

8. Repeat step 4 above except observe the maximum change in the power meter readings from the -7 dBm reading in step 7. Record the maximum change from the -7 dBm reading to the nearest 0.05 dB on line 13 of the PTR.

4.5.3 STEP ATTENUATOR ACCURACY TEST

EQUIPMENT

Power Meter and Sensor	HP435A/8481A
Spectrum Analyzer	HP8554L/8552B/141T
10 dB Attenuator Pad	Weinschel 50-10
20 dB Attenuator Pad	Weinschel 50-20
30 dB Attenuator Pad	Weinschel 50-30
40 dB Attenuator Pad	Weinschel 50-40
Wideband Amplifier 26 dB Gain	HP8447D

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	AM
MODULATION FREQ	DC
MODULATION FM/AM	0% AM
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	0 dBm

2. Set the power meter to the +10 dBm range. Connect the power sensor to the Signal Generator RF out connector.

3. Adjust the MODULATION FM/AM control of the Signal Generator for a +7 dBm power meter reading.

NOTE: Increasing the MODULATION FM/AM control setting in the preceeding step causes the output meter needle to read off scale. This is normal.

4. Disconnect the power sensor from the Signal Generator RF out connector. Connect a standard 10 dB attenuator pad to the RF out connector. Connect the output of the attenuator pad to the spectrum analyzer as shown in Figure 4-1.

5. Set the spectrum analyzer to 520 MHz, the bandwidth to 10 kHz, the frequency span per division to 2 kHz, and the tuning stabilizer switch on. Set the video filter to 100 Hz and the vertical display to 2 dB per division.

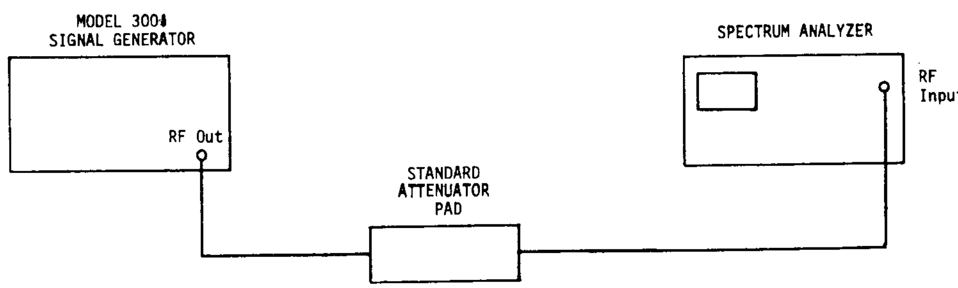


Figure 4-1. Step Attenuator Accuracy Setup

6. Use the log reference controls to obtain a peak trace one division below the log reference line of the spectrum analyzer display. Center the trace in the display with fine tuning.

7. Set the OUTPUT step attenuator of the Signal Generator to -10 dBm.

8. Disconnect the 10 dB attenuator pad from the setup and reconnect the spectrum analyzer to the RF out connector of the Signal Generator.

9. Adjust the MODULATION FM/AM control of the Signal Generator to realign the peak of the trace one division below the log reference line as in step 6.

10. Disconnect the cable to the Signal Generator RF out connector. Connect the power sensor to the Signal Generator RF out connector. Set the OUTPUT step attenuator to 0 dBm.

11. Observe the difference between the actual power meter reading and the +7 dBm reference setting in step 3. The difference or error should be ±0.7 dB maximum. Record the error on line 14 of the PTR.

12. Repeat steps 3 through 11 using the standard attenuator pads and the Signal Generator OUTPUT step attenuator settings indicated in the following table.

Steps 4 and 8 Attenuator pad dB	Step 7 OUTPUT Step Attenuator dBm setting	Step 11 Record Error on Line of PTR
10	-10	14
20	-20	15
30	-30	16
60	-60	17
90	-90	18

NOTE: To test the OUTPUT step attenuator below -60 dBm an RF amplifier (>20 dB gain) is required. Insert the 26 dB wideband amplifier between the standard attenuator pad and the spectrum analyzer (Figure 4-1). The allowable error for the -90 dBm setting (step 11) is ±1.5 dB. The OUTPUT step attenuator can be tested down to the -130 dBm position if a 40 dB RF amplifier is used and if precautions are taken to properly shield the RF output from the Signal Generator.

4.6 HARMONICS TEST

SPECIFICATION

Harmonics Outputs: >30 dB below fundamental from 10 to 520 MHz
>20 dB below fundamental from 1 to 10 MHz

METHOD: A spectrum analyzer is used to measure harmonics in the frequency range of the Signal Generator at +13 and +3 dBm output levels.

EQUIPMENT

Spectrum Analyzer HP8554L/8552B/141T

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	001.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive)
MODULATION FM/AM	(Inactive)
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the Signal Generator RF out connector to the RF input of the spectrum analyzer.

3. Set the spectrum analyzer to measure the harmonic distortion of the Signal Generator for fundamental frequencies between 1 and 10 MHz. Set the bandwidth to 100 kHz, the frequency span per division to 5 MHz, and the display to 10 dB/div. Locate the zero reference at the left edge of the graticule, and adjust the fundamental amplitude to the log reference line (0 dB) in the display.

4. Increase the setting of the Signal Generator FREQUENCY selector in 1 MHz steps between 1 and 10 MHz while observing the spectrum analyzer display. The harmonics should be >20 dB below the fundamental. Record the maximum harmonic observed in the display in dB below the fundamental on line 19 of the PTR.

5. Set the Signal Generator OUTPUT step attenuator to 0 dBm, and repeat steps 3 and 4 at the +3 dBm output level. Record the maximum harmonic observed in dB below the fundamental on line 20 of the PTR.

6. Set the Signal Generator FREQUENCY selector to 10 MHz and the OUTPUT step attenuator to +10 dBm.

7. Set the spectrum analyzer to measure harmonic distortion of the Signal Generator for fundamental frequencies between 10 and 520 MHz. Set the bandwidth to 300 kHz and the frequency span per division to 100 MHz.

8. Increase the setting of the Signal Generator FREQUENCY selector in 10 MHz steps between 10 and 520 MHz while observing the spectrum analyzer display. The harmonics should be >30 dB below the fundamental. Record the maximum harmonic observed in the display in dB below the fundamental on line 21 of the PTR.

9. Set the Signal Generator OUTPUT step attenuator to 0 dBm and repeat steps 7 and 8 at the +3 dBm output level. Record the maximum harmonic observed in dB below the fundamental on line 22 of the PTR.

4.7 NON-HARMONICS TEST

SPECIFICATION

Fundamental Range (MHz)	Non-harmonic Range (MHz)	Non-harmonic level dB below fundamental
1 to 3	1 to 3	>60
3 to 250	3 to 250	>65
3 to 350	3 to 350	>55
3 to 520	3 to 1000	>35

METHOD

A spectrum analyzer is used to measure the level of non-harmonics in the 1 to 520 MHz range at +13 dBm, the maximum specified output level of the Signal Generator.

EQUIPMENT

HP8554L/8552B/141T

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	001.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive)
MODULATION FM/AM	(Inactive)
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the Signal Generator RF out connector to the RF input of the spectrum analyzer.

3. Set the spectrum analyzer to measure the non-harmonic content of the Signal Generator output between 1 and 3 MHz. Set the bandwidth to 30 kHz, the frequency span per division to 1 MHz and the display to 10 dB/div. Locate the zero reference at the left edge of the graticule, and adjust the fundamental to the log reference line (0 dB) in the display.

4. Increase the setting of the Signal Generator FREQUENCY selector in 1 MHz steps between 1 and 3 MHz. The non-harmonics between 1 and 3 MHz should be 60 dB below the fundamental. Record the maximum non-harmonic observed in the display between 1 and 3 MHz in dB below the fundamental on line 23 of the PTR.

5. Set the spectrum analyzer to measure the non-harmonic content of the Signal Generator output between 3 and 250 MHz. Set the bandwidth to 300 kHz and the frequency span per division to 100 MHz.

6. Increase the setting of the Signal Generator FREQUENCY selector in 1 MHz steps between 3 and 10 MHz and in 10 MHz steps between 10 and 520 MHz while observing the spectrum analyzer display. Use the table below to determine the maximum non-harmonic level in each of the frequency ranges shown. Record the maximum non-harmonic level observed in each range indicated in the table on the applicable line of the PTR.

Frequency Range of Fundamental (MHz)	Non-harmonic Frequency Range (MHz)	Non-harmonic Level (dB below fundamental)	Record Max Non-harmonic (Line number in PTR)
3-250	3-250	>65	24
3-350	3-350	>55	25
3-520	3-1000	>35	26

4.8 RESIDUAL AM TEST

SPECIFICATION >55 dB below carrier in a 50 Hz to 15 kHz post-detection bandwidth.

METHOD A modulation meter operating in AM mode is used to demodulate the Signal Generator output at the minimum leveler point where AM noise is maximum. A distortion analyzer (operating in level mode) is used to increase the resolution of the demodulated output of the modulation meter. The system is calibrated at a 10% AM level. The 10% AM is removed and the residual AM is read in dB below the calibrated 10% AM level. 20 dB is added to the reading to relate the residual AM to the carrier.

EQUIPMENT

Modulation Meter Radiometer AFM2

Distortion Analyzer HP334A

PROCEDURE 1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	500.000 MHz
MODULATION MODE	AM
MODULATION FREQ	1 kHz
MODULATION FM/AM	0% AM
OUTPUT VERNIER	-7 dBm reading on output meter
OUTPUT step attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-2.

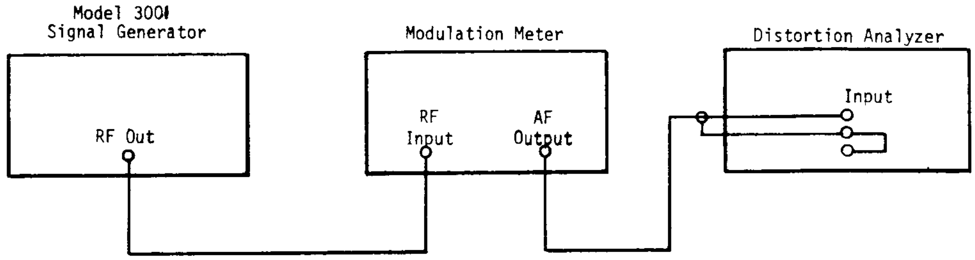


Figure 4-2. Residual AM Setup

3. Set the modulation meter to read %AM at 500 MHz. Set the RF input attenuation to 10 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +AM, the meter range switch to 10 and the filter bandwidth to 50 Hz-15 kHz.

4. Adjust the Signal Generator MODULATION FM/AM control for a modulation meter reading of 10% AM. NOTE: 10% AM is obtained at a full-scale reading of 100 with the modulation meter range switch set to 10.

5. With the distortion analyzer operating in level mode, calibrate it for a 0 dB panel-meter reading. The system is now calibrated at a reference level 20 dB below the carrier. Since the modulating signal and carrier amplitudes are equal at 100% AM, it follows that at 10% AM the modulating signal is 20 dB below the carrier.

6. Set the Signal Generator MODULATION FM/AM control to 0% AM.

7. Without disturbing the Signal Generator and modulation meter controls, set the distortion analyzer to read residual AM. Set the range switch so that the panel meter reads between 0 and -10 dB. First, read the residual AM below the 0 dB reference level in step 5. Then add 20 dB to the above reading to obtain the residual AM below the carrier. (For example, a 38 dB residual AM below the 0 dB reference +20 dB = 58 dB residual AM below the carrier.) The residual AM should be >55 dB below the carrier. Record the residual AM in dB below the carrier on line 27 of the PTR.

As many other carrier frequencies may be tested as desired.

4.9 RESIDUAL FM TEST

SPECIFICATION <200 Hz in a 50 Hz to 15 kHz post-detection bandwidth

METHOD

A modulation meter which is set to read frequency deviation is used to measure residual FM. The test is performed at maximum frequency and output level. The Signal Generator is operated in an FM mode where the residual FM is greatest.

The residual FM is measured in an environment where the noise level <60 dB relative to $2x10^{-4}$ μbar.

EQUIPMENT

Modulation Meter Radiometer AFM2

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	FMx10
MODULATION FREQ	EXT
MODULATION FM/AM	0 kHz
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the Signal Generator RF out connector to the 50 ohm RF input of the modulation meter.

3. Set the modulation meter to read FM deviation at 520 MHz. Set the meter range switch to 3, the RF input attenuation to 20 dB, the IF bandwidth to ±400 kHz, the meter response to fast and the filter bandwidth to 50 Hz-15 kHz.

4. Measure the average level of the FM deviation on the modulation meter and disregard occasional peaks. The residual FM should be <250 Hz. Read the residual FM on the panel meter with the function switch set to +FM and then -FM positions. Record the greater of the two readings in Hz on line 28 of the PTR.

As many other frequencies may be tested as desired.

4.10 INTERNAL MODULATION FREQUENCY TEST

SPECIFICATION

Amplitude & Frequency Modulation

Internal: 400 Hz and 1 kHz ±5%

METHOD

A frequency counter is used to measure modulation frequency at the rear-panel modulation test point of the Signal Generator. Since the internal 400 Hz and 1 kHz oscillators are used for both the AM and FM modes, this test will suffice for both modes.

EQUIPMENT

Frequency Counter HP5300B/5303B

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	N/A (not applicable to this test)
FREQUENCY selector	N/A
MODULATION MODE	N/A
MODULATION FREQ	400 Hz
MODULATION FM/AM	Mid-range
OUTPUT VERNIER	N/A
OUTPUT step attenuator	N/A

2. Connect the low frequency input of the frequency counter to the modulation test point (pin 36 of rear-panel jack J101) and the cable shield to ground (pin 25 of J101) of the Signal Generator. (See Figure 2-3 and Schematic 1).

3. The counter should read between 380 and 420 Hz. Record the counter reading on line 29 of the PTR.

4. Set the Signal Generator MODULATION FREQ control to 1 kHz.

5. The counter should read between 950 and 1050 Hz. Record the counter reading on line 30 of the PTR.

4.11 PERCENT AM ACCURACY TEST

SPECIFICATION

ACCURACY

$\pm$(5% of reading +5%) at a frequency of 1 kHz

This specification applies for output limits $\leq$+3 dBm. AM is possible above +3 dBm if the peak of the modulated output does not exceed +13 dBm.

METHOD

The %AM accuracy is measured with a modulation meter after the front-panel MODULATION FM/AM control error, which is $\pm$4%, is subtracted out. The FM/AM control accuracy,which consists of the control linearity and the modulation scale errors, is measured in terms of the DC voltage at the rear-panel modulation test point. The calibration of the voltage across the control at maximum position is checked initially.

The remaining %AM accuracy, which is $\pm$(5% of the reading + 1% of full scale), is measured by the modulation meter with accurately measured voltage applied to the Signal Generator modulation system. The measurement uncertainty is 2% of the reading +1% of full scale.

EQUIPMENT

Modulation Meter	Radiometer AFM2
Digital Multimeter	Dana 4300

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	CW
MODULATION FREQ	DC
MODULATION FM/AM	0% AM
OUTPUT VERNIER	-3 dBm reading on output meter
OUTPUT step attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-3. Connect the center conductor of the cable between the high terminal of the digital multimeter and the modulation test point (pin 36 of rear-panel jack J101). Connect the cable shield between the low terminal of the digital multimeter and the Signal Generator ground (pin 25 of J101).

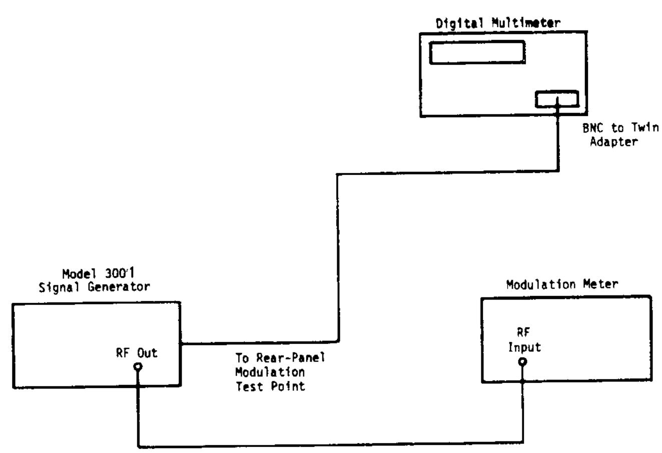


Figure 4-3. Percent AM Accuracy Setup

3. Adjust the Signal Generator MODULATION FM/AM control to its maximum up position.

4. The digital multimeter should read 5.000 ±0.020 volts DC. If the voltage is within limits, continue to step 5. If out of limits, the voltage should be recalibrated (par. 5.3.9).

5. Adjust the Signal Generator MODULATION FM/AM control to 30% AM.

6. The digital multimeter should read between 1.300 and 1.700 volts DC. Record the reading on line 31 of the PTR.

7. Set the Signal Generator MODULATION FM/AM control to 90% AM.

8. The digital multimeter should read between 4.300 and 4.700 volts DC. Record the reading on line 32 of the PTR.

9. Adjust the Signal Generator MODULATION FM/AM control to 0% AM.

NOTE: This concludes the MODULATION FM/AM control accuracy test. As many other points may be tested as desired.

10. Set the modulation meter to read %AM at 520 MHz. Set the meter range switch to 100, the RF input attenuation to 10 dB, the IF bandwidth to ±400 Hz, the meter response to fast, the function switch to +AM and the filter bandwidth to 50 Hz-15 kHz.

11. Adjust the Signal Generator MODULATION FM/AM control for a reading of 1.500 ±0.003 volts DC on the digital multimeter. Set the MODULATION FREQ switch to 1 kHz and the MODULATION MODE switch to AM.

12. Make a note of the modulation meter reading in %AM. Set the modulation meter function switch to -AM, and note the modulation meter %AM reading as before. Compute the average of the two readings. The average %AM should be between 27.5 and 32.5%. Record the average %AM to the nearest 0.5% on line 33 of the PTR.

13. Set the Signal Generator MODULATION MODE switch to CW and the MODULATION FREQ switch to DC.

14. Adjust the Signal Generator MODULATION FM/AM control for a reading of 4.500 ±0.003 volts DC on the digital multimeter. Set the MODULATION FREQ switch to 1 kHz and the MODULATION MODE switch to AM.

15. Make a note of the modulation meter reading in %AM. Set the modulation function switch to +AM and note the modulation meter %AM reading as before. Compute the average of the two readings. The average %AM should be between 84.5 and 95.5% AM. Record the average %AM to the nearest 0.5% on line 34 of the PTR.

NOTE: This concludes the modulation system accuracy test. As many other points may be tested as desired.

4.12 AM BANDWIDTH TEST

SPECIFICATION

Modulation Freq. External	DC to 20 kHz (3 dB bandwidth), input level required = 10 volts pp into 600 ohms to provide calibrated % modulation control.

METHOD

The measurement is made with a modulation meter operating in AM mode and a function generator. The function generator supplies an external sine wave to amplitude modulate the Signal Generator. The system is calibrated at -6 dB on the modulation meter dB scale (approximately 50% AM). The external modulation frequency is increased from 1 kHz to 20 kHz and the AM bandwidth is measured as the change in dB level from the calibration level.

EQUIPMENT

Modulation Meter	Radiometer AFM2
Function Generator	Wavetek 130
Oscilloscope	Tektronix D10/5A18N/5B10N

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	050.000 MHz
MODULATION MODE	AM
MODULATION FREQ	EXT
MODULATION FM/AM	0% AM
OUTPUT VERNIER	+3 dBm reading on output meter
OUTPUT step attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-4.

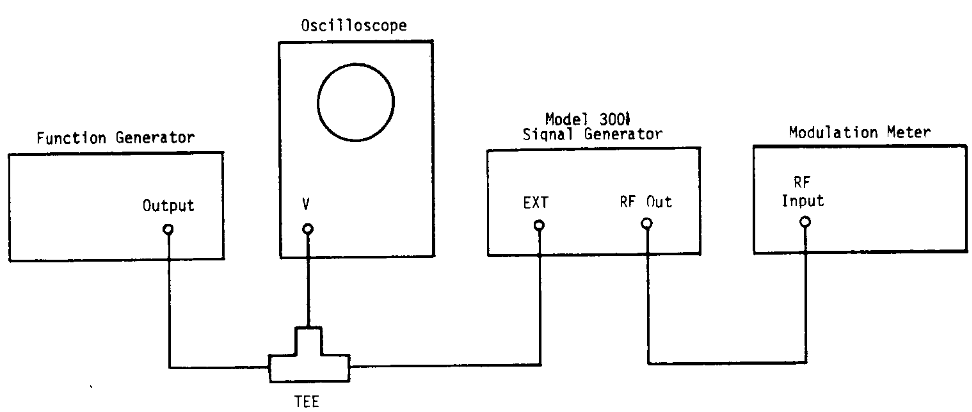


Figure 4-4. AM Bandwidth Setup

3. Set the modulation meter to read %AM at 50 MHz. Set the RF input attenuation to 20 dB, the IF bandwidth to ± 400 kHz, the meter response to fast, the function switch to +AM, the meter range switch to 100 and the filter bandwidth to 75 kHz.

4. Set the function generator for a 1 kHz sine wave output and the attenuator controls for a 10 volt pp sine wave on the oscilloscope.

5. Adjust the Signal Generator MODULATION FM/AM control for a modulation meter reading of -6 dB (approximately 50% AM).

6. Maintain the 10 volt pp output level and increase the function generator frequency from 1 to 20 kHz. Observe the modulation meter scale. It should read between -6 and -9 dB. Note the change in dB from the -6 dB calibration level.

7. Repeat steps 4 through 6 with the modulation meter function switch set to -AM. Note the change in dB from the -6 dB setting as in step 6.

8. Record the larger of the two dB changes obtained in steps 6 and 7 on line 35 of the PTR.

4.13 AM DISTORTION TEST

SPECIFICATION

Distortion

3% distortion to 70% AM (5% to 90% AM) at a frequency of 1 kHz.

This specification applies for output limits $\leq$ +3 dBm. AM is possible above +3 dBm if the peak of the modulated output does not exceed +13 dBm.

METHOD

The measurement is made with a modulation meter and a distortion analyzer, which measures the distortion of the demodulated AM from the modulation meter. The measurement is made at the minimum leveler point where the AM distortion is normally worst-case.

EQUIPMENT

Modulation Meter	Radiometer AFM2
Distortion Analyzer	HP334A

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	AM
MODULATION FREQ	1 kHz
MODULATION FM/AM	0% AM
OUTPUT VERNIER	-7 dBm reading on output meter
OUTPUT step attenuator	0 dBm

2. Connect the equipment as shown in Figure 4-5.

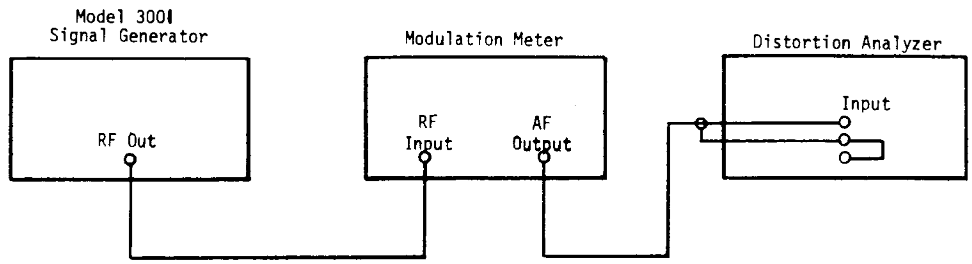


Figure 4-5. AM Distortion Setup

3. Set the modulation meter to read %AM at 520 MHz. Set the RF input attenuation to 10 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +AM, the meter range switch to 100 and the filter bandwidth to 50 Hz to 15 kHz.

4. Adjust the Signal Generator MODULATION FM/AM control for a modulation meter reading of 70% AM. Set the modulation meter function switch to -AM, and observe the modulation meter reading. Readjust the MODULATION FM/AM control until the average of the two modulation meter readings in +AM and -AM positions of the modulation meter function switch is equal to 70% AM.

5. Calibrate the distortion analyzer and measure the distortion. The distortion should be less than 3%. Record the distortion on line 36 of the PTR.

6. Adjust the Signal Generator MODULATION FM/AM control as in step 4 until the average of the modulation meter readings in +AM and -AM positions of the modulation function switch is equal to 90% AM.

7. Calibrate the distortion analyzer and measure the distortion. The distortion should be less than 5%. Record the distortion on line 37 of the PTR.

4.14 FM DEVIATION ACCURACY TEST

SPECIFICATION

Deviation Accuracy	±500 Hz on FMx1 range
	±5 kHz on FMx10 range

METHOD

The deviation is measured in both FM modes using an internal DC voltage equal to the peak of the internal sine wave voltages. A frequency counter is used to measure the maximum deviation in both FM modes.

EQUIPMENT

Frequency Counter HP5300B/5303B

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	0 kHz
FREQUENCY selector	050.000 MHz
MODULATION MODE	FMx1
MODULATION FREQ	DC
MODULATION FM/AM	5 kHz on FM scale
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the 50 ohm input of the frequency counter to the Signal Generator RF out connector.

3. Read the frequency counter and record the reading to 8 places on line 38 of the PTR.

4. Adjust the Signal Generator MODULATION FM/AM control to 0 kHz deviation on the FM scale.

5. Read the frequency counter and record the reading to 8 places on line 39 of the PTR.

6. Subtract the reading obtained in step 5 from the reading obtained in step 3. The difference between the two readings should be between 9.500 and 10.500 kHz. Record the difference in kHz on line 40 of the PTR.

7. Set the Signal Generator MODULATION MODE to FMx10 and adjust the MODULATION FM/AM control to 10 kHz deviation on the FM scale.

8. Read the frequency counter and record the reading to 6 places on line 41 of the PTR.

9. Adjust the Signal Generator MODULATION FM/AM control to 0 kHz deviation on the FM scale.

10. Read the frequency counter and record the reading to 6 places on line 42 of the PTR.

11. Subtract the reading obtained in step 10 from the reading obtained in step 8. The difference between the two readings should be between 95.0 and 105.0 kHz. Record the difference in kHz on line 43 of the PTR.

4.15 FM BANDWIDTH TEST

SPECIFICATION

External, 50 Hz to 25 kHz, (1 dB bandwidth), input level required = 10 volts pp into 600 ohms to provide calibrated deviation control.
(DC to 25 kHz when frequency VERNIER is not in CAL position.)

METHOD

The measurement is made with a modulation meter and a function generator. The function generator supplies an external sine wave to frequency modulate the Signal Generator. The system is calibrated with a 1 kHz external sine wave at an indicated deviation 1 dB below the 0 dB reference on the modulation meter dB scale (approximately 90 kHz deviation). The external modulation frequency is varied from 1 kHz to 50 Hz, and from 1 kHz to 25 kHz, and the FM bandwidth is measured as the change in dB level from the calibrated level.

EQUIPMENT

Modulation Meter	Radiometer AFM2
Function Generator	Wavetek 130
Oscilloscope	Tektronix D10/5A18N/5B10N

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	FMx10
MODULATION FREQ	EXT
MODULATION FM/AM	0 kHz
OUTPUT VERNIER	+3 dBm reading on output meter
OUTPUT step attenuator	+10 dBm

2. Connect the equipment as shown in Figure 4-6.

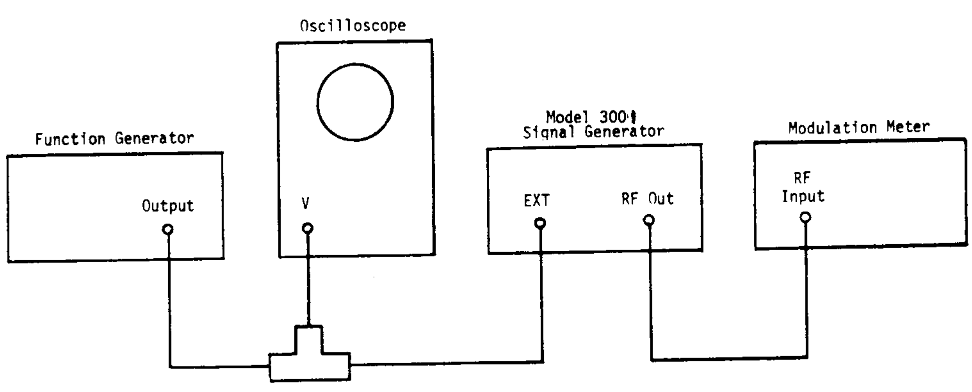


Figure 4-6. FM Bandwidth Setup

3. Set the modulation meter to read FM deviation at 520 MHz. Set the RF input attenuation to 20 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +FM, the meter range switch to 300 and the filter bandwidth to 75 kHz.

4. Set the function generator for a 1 kHz sine wave output and the attenuator controls for a 10 volt pp sine wave on the oscilloscope.

5. Adjust the Signal Generator MODULATION FM/AM control for a modulation meter reading of -1 dB (approximately 90 kHz deviation).

6. Maintain the 10 volt pp external input level during this step. Slowly decrease the function generator frequency from 1 kHz to 50 Hz, and then slowly increase the frequency to 25 kHz while observing the dB scale on the modulation meter. It should read between 0 and -2 dB. Note the maximum change from the -1 dB reference (step 5) to the nearest 0.25 dB.

7. Repeat steps 4 through 6 with the modulation meter function switch set to -FM. Note the change from -1 dB reference as in step 6. Record the larger of the two changes in dB (in this step and in step 6) on line 44 of the PTR.

4.16 FM DISTORTION TEST

SPECIFICATION

Distortion — 4% (3 to 100 kHz deviation) at a frequency of 1 kHz

METHOD

The measurement is made with a modulation meter and a distortion analyzer, which measures the distortion of the demodulated FM from the modulation meter. Distortion below 3 kHz deviation increases because of residual FM noise. The distortion at 3 kHz deviation is measured in an environment where the noise level <60 dB relative to 2×10^{-4} μbar.

EQUIPMENT

Modulation Meter	Radiometer AFM2
Distortion Analyzer	HP334A

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	FMx1
MODULATION FREQ	1 kHz
MODULATION FM/AM	3 kHz
OUTPUT VERNIER	Fully Clockwise
OUTPUT step attenuator	+10 dBm

2. Connect the equipment as shown in Figure 4-7.

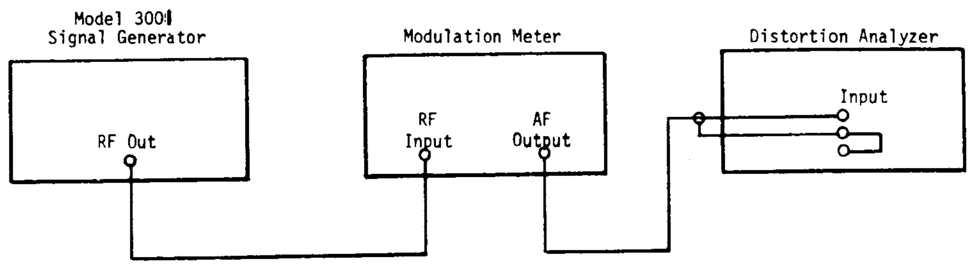


Figure 4-7. FM Distortion Setup

3. Set the modulation meter to read FM deviation at 520 MHz. Set the RF input attenuation to 20 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +FM, the meter range switch to 3 and the filter bandwidth to 50 Hz-15 kHz. The modulation meter should read approximately 3 kHz.

4. Calibrate the distortion analyzer and measure distortion. The distortion should be less than 4%. Record the distortion on line 45 of the PTR.

5. Set the meter range switch of the modulation meter to 300. Set the Signal Generator MODULATION MODE to FM x10.

6. Adjust the Signal Generator MODULATION FM/AM for a reading of 300 kHz deviation on the modulation meter.

7. Calibrate the distortion analyzer and measure the distortion. The distortion should be less than 4%. Record the distortion on line 46 of the PTR.

4.17 IMPEDANCE TEST

SPECIFICATION

Impedance — 50 ohm, VSWR 1.2 at RF output levels below 0.1 V.

METHOD

The measurement is made with a VSWR bridge and the return loss is displayed on a spectrum analyzer. An RF signal from a sweep/signal generator is fed to the input of the bridge. A reference level is established by shorting the bridge output port. The short is replaced by the RF impedance of the Signal Generator. The sweep/signal generator is tuned from 1 to 520 MHz and the return loss versus frequency is displayed.

EQUIPMENT

Spectrum Analyzer	HP8554L/8552B/141T
Sweep/Signal Generator	Wavetek 2001
VSWR Bridge	Wiltron 60N50
Coaxial Short, Type N Male	HP11512A

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	520.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive)
MODULATION FM/AM	(Inactive)
OUTPUT VERNIER	+3 dBm reading on output meter
OUTPUT step attenuator	-10 dBm

2. Use the setup in Figure 4-8. Connect the sweep/signal generator to the input port, the spectrum analyzer to the reflected output port and the coaxial short to the device-under-test port of the VSWR bridge.

3. Set the sweep/signal generator output level to -10 dBm, the mode to CW and the center frequency to 250 MHz.

4. Set the spectrum analyzer to span 0 to 500 MHz and the bandwidth to 300 kHz. Use the log reference level controls to calibrate the 250 MHz signal at the top line (0 dB reference) of the display graticule.

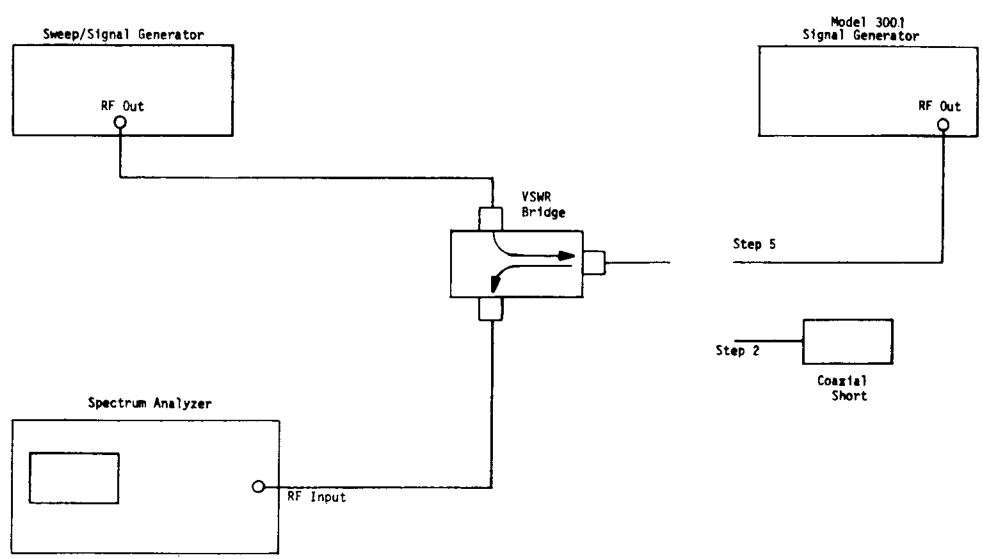


Figure 4-8. Test Setup

5. Disconnect the coaxial short and connect the device-under-test port of the VSWR bridge to the Signal Generator RF out connector. Use the sweep/signal generator center frequency control to tune from 1 to 520 MHz and verify that the signal level in the display is >21 dB below the 0 dB reference. Disregard the signal at 520 MHz. Record the reading in dB below the reference on line 47 of the PTR.

4.18 RFI TEST

SPECIFICATION

<1.0 μV is induced in a two-turn, one-inch diameter loop which is held one inch away from any surface. Loop feeds a 50 ohm receiver.

METHOD

A 50 ohm receiver consisting of a 26 dB amplifier and a spectrum analyzer are calibrated at a 1 μV level using the Signal Generator. A loop probe is then connected to the receiver and the leakage is measured at a one-inch distance from the external surfaces of the Signal Generator with the RF output terminated in 50 ohms. A screen room may be required for this measurement.

EQUIPMENT

Spectrum Analyzer	HP8554L/8552B/141T
Wideband Amplifier	HP3447D
50 ohm Load	HP11593A
Loop Probe	See Figure 4-9
Coaxial Termination (50 ohm)	HP908A

PROCEDURE

1. Set the Signal Generator controls as follows:

Frequency VERNIER	CAL
FREQUENCY selector	500.000 MHz
MODULATION MODE	CW
MODULATION FREQ	(Inactive)
MODULATION FM/AM	(Inactive)
OUTPUT VERNIER	Set to +3 dBm on output meter
OUTPUT step attenuator	-110 dBm

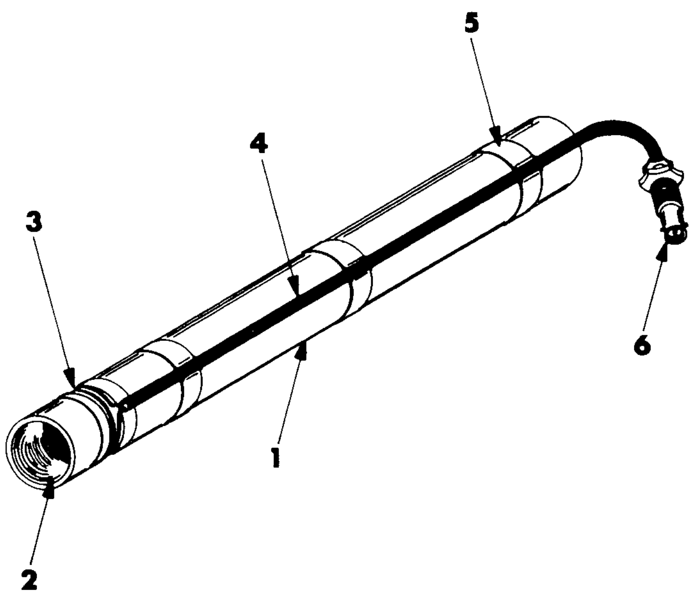
2. Connect the equipment as shown in Figure 4-10.

3. Set the spectrum analyzer bandwidth to 100 kHz, the scan width to 0.5 MHz/div, the video filter to 100 Hz, the input attenuation to 0 dB and the log reference level to -50 dBm with a 10 dB/div vertical scale. Center the signal in the display using the center frequency control. Calibrate the analyzer for the -107 dBm signal at the -31 dBm graticule using the log reference controls.

4. Disconnect the RF amplifier from the Signal Generator, and connect the 50 ohm coaxial termination to the RF out connector of the Signal Generator. Tighten the termination to minimize RF leakage.

5. Set the Signal Generator OUTPUT step attenuator to -10 dBm, and the OUTPUT VERNIER to a +3 dBm reading on the output meter.

6. Connect the loop probe to the input of the RF amplifier. Move the loop probe over the surfaces of the Signal Generator with the two-turn loop at a one-inch distance. The signal plus noise should be less than the -107 dBm reference (step 2). Record the maximum reading in dBm on line 48 of the PTR.



1. Rexolite Rod: 1.25 in. dia. by 11 in.

2. Hole: 1.00 in dia. by 0.80 in. deep.

3. Groove: 0.120 in wide by 0.125 in deep 1.00 in from end of rod.

4. Coaxial Cable: (RG-174/U) 0.110" diameter by 19" long. Strip shield for 7 in, and cut off shield to ¼ in length. Strip insulation from center conductor ¼ in. Wind 2 turns of insulated center conductor in groove of rod. Solder shield to center conductor, and insulate the solder joint.

5. Wind mylar tape around the two-turn loop, and around the rod (three places).

6. BNC male connector.

Figure 4-9. Loop Probe

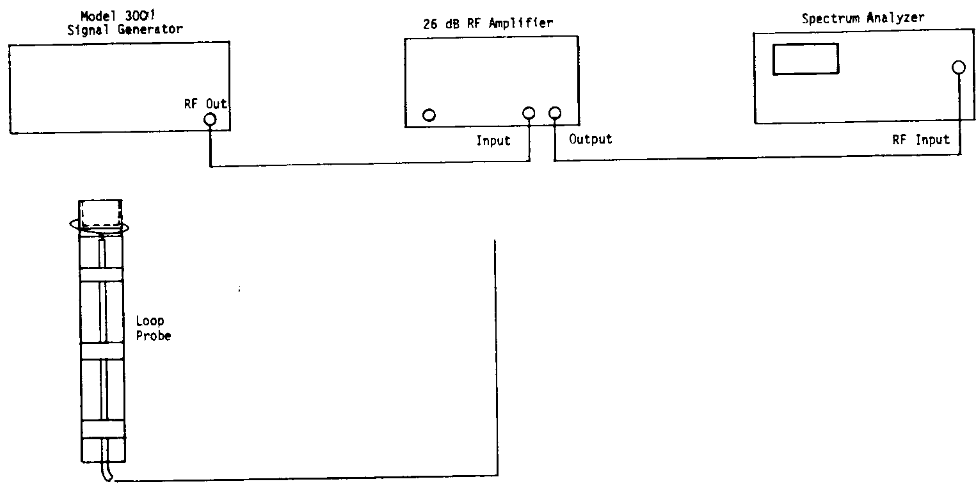


Figure 4-10. RF Leakage Setup

PERFORMANCE TEST RECORD
MODEL 3001 SIGNAL GENERATOR

S/N ____________

DATE ____________

PAR	TEST	CONTROL SETTINGS (for Reference Only) FREQUENCY MHz	FREQUENCY VERN.	MODULATION MODE	MODULATION FREQ	MODULATION FM/AM	METER dBm	ATT'N dBm	TEST RESULTS MINIMUM	TEST RESULTS MEASUREMENT	TEST RESULTS MAXIMUM	LINE
4.2	Freq Range	1-520	CAL	CW	--	--	+3	+10		( ) Check		1
4.3	Frequency Accuracy	40	CAL	CW	--	--	+3	+10	39,999.59 kHz	kHz	40,000.41 kHz	2
		1	0 kHz	FMx1	VERN	5 kHz			999.99 kHz	- Hz	1,020.01 kHz	3
				FMx10					1,089.99 kHz	- Hz	1,110.01 kHz	4
		2	+3 kHz	CW	--	--			2500 Hz	Hz	3500 Hz	5
			-3 kHz							Hz		6
4.4	Frequency Stability	520	CAL	CW	--	--	+3	+10		Hz	104 Hz	7
			0 kHz	FMx1	VERN	5 kHz				Hz	500 Hz	8
4.5.1	Meter Accuracy	50	CAL	CW	--	--	+3 to -7	+10	-0.5 dB	dB	+0.5 dB	9
								0		dB		10
4.5.2	Flatness	10-520	CAL	CW	--	--	+2	+10	-0.75 dB	dB	+0.75 dB	11
							-7	+10		dB		12
							-7	0		dB		13
4.5.3	Step Attenuator Accuracy	520	CAL	AM	VERN	Set to +7 dBm Ref on power meter	off Scale (+7)	-10	-0.7 dB	dB	+0.7 dB	14
								-20		dB		15
								-30		dB		16
								-60		dB		17
								-90	-1.5 dB	dB	+1.5 dB	18
4.6	Harmonics	1-10	CAL	CW	--	--	+3	+10	20 dB down	dB		19
								0		dB		20
		10-520						+10	30 dB down	dB		21
								0		dB		22
4.7	Non-Harmonics	1-3	CAL	CW	--	--	+3	+10	60 dB down	dB		23
		3-250							65 dB down	dB		24
		3-350							55 dB down	dB		25
		3-520							35 dB down	dB		26
4.8	Residual AM	500	CAL	AM-CW	1 kHz	10%	-7	0	55 dB down	dB		27
4.9	Residual FM	520	CAL	FMx10	EXT	Min	+3	+10		Hz	200 Hz	28
4.10	Internal Modulation Frequency	--	--	--	400 Hz	Mid-scale	--	--	380 Hz	Hz	420 Hz	29
					1 kHz				950 Hz	Hz	1050 Hz	30
4.11	FM/AM Control Accuracy	--	--	--	VERN	30%	--	--	1.300 VDC	VDC	1.700 VDC	31
						90%			4.300 VDC	VDC	4.700 VDC	32
	AM System Accuracy	520	CAL	AM	1 kHz	1.5 V pk	-3	0	27.5 %	%	32.5 %	33
						4.5 V pk			84.5 %	%	95.5 %	34
4.12	AM Bandwidth	50	CAL	AM	EXT	50%	+3	0		dB	3 dB	35
4.13	AM Distortion	520	CAL	AM	1 kHz	70%	-7	0		%	3 %	36
						90%				%	5 %	37
4.14	FM Deviation Accuracy	50	0 kHz	FMx1	DC	10 kHz	+3	+10		kHz		38
						0 kHz				kHz		39
						--			9.500 kHz	kHz	10.500 kHz	40
				FMx10		10 kHz				-- kHz		41
						0 kHz				-- kHz		42
						--			95.0 kHz	-- kHz	105.0 kHz	43
4.15	FM Bandwidth	520	CAL	FMx10	EXT	3.2 kHz	+3	+10		dB	1 dB	44
4.16	FM Distortion	520	CAL	FMx1	1 kHz	3 kHz	+3	+10		%	4 %	45
				FMx10						%		46
4.17	Impedance	520	CAL	CW	--	--	0	-10	21 dB down	dB		47
4.18	RFI	500	CAL	CW	--	--	+3	0		dB	-107 dBm	48

SECTION 5
MAINTENANCE

5.1 INTRODUCTION

This section provides information for disassembly, calibration, and trouble-shooting the Model 3001 Signal Generator.

Measurements and adjustments will be facilitated by placing instrument on its right side, as access is required to top and bottom of unit for adjustments and test points.

5.2 SERVICE INFORMATION

5.2.1 DISASSEMBLY INFORMATION

Refer to Figure 5-1. The side panels form part of the support for the top and bottom covers; therefore, these covers should be removed before removing either side panel. The covers and panels can be removed as indicated below.

NOTE

One side panel must remain on the instrument to secure front - panel assembly to chassis.

REMOVAL OF BOTTOM COVER - Remove two rear feet (A) and lift cover off with a slight rear movement. Reinstall cover by reversing the removal procedure.

REMOVAL OF TOP COVER - Remove the single screw (B) from top and lift off cover with a slight rear movement. Reinstall cover by reversing the removal procedure.

REMOVAL OF FRONT-TOP RAIL - The top rail may be removed to facilitate removal of the meter or modulation board assembly. The rail is removed by removing three screws (D) and lifting rail upward.

REMOVAL OF SIDE PANEL - Either side panel can be removed to provide better access by removing the six screws (E) holding side panel to the instrument.

CAUTION

To prevent possible damage to harness when reinstalling side panels, use only the original screws or equivalent. Longer screws in the bottom two holes can cause damage to wiring.

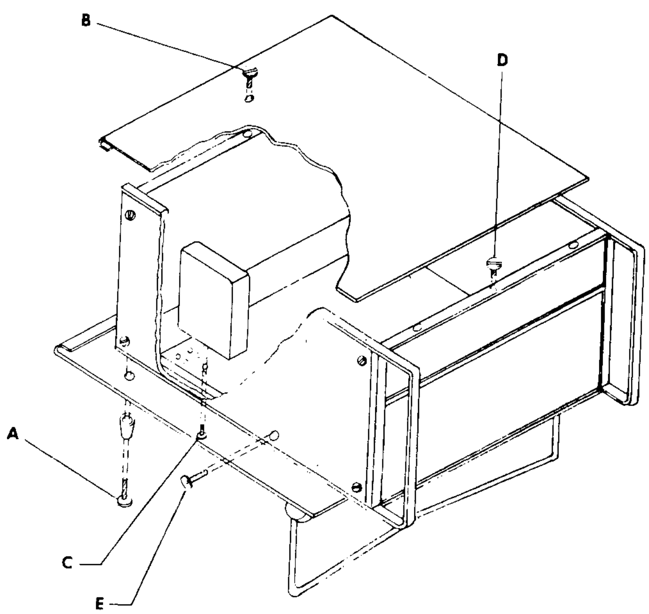


Figure 5-1. Dissassembly

5.2.2 MODULE SERVICING

REMOVAL OF MODULE - Modules may be removed by removing any cables attached to top of the module and removing hold-down screw (C) from bottom. Rock module slightly while lifting upward to free module from chassis socket.

REINSTALLING MODULE - Before installing the module, check that module pins are straight and properly aligned; then, carefully seat module pins into the chassis socket, replace module hold-down screw (C) to insure a good ground connection between module and chassis, and replace any cables attached to top of module. Module - cable connections are shown in Figure 5-6.

NOTE

If a module is replaced with a new module, it will be necessary to calibrate the phase-locked loop or other circuits involved. See Calibration Procedure in this section, Table 5-4.

MODULE-PIN NUMBERING SYSTEM - The module pins are numbered as shown in Figure 5-2. The off-center index stud prevents the module's being plugged in backward and also provides a method for locating pin #1.

NOTE

All 16 pins are not required in each module; only the pins actually used are installed, but the numbering system remains the same.

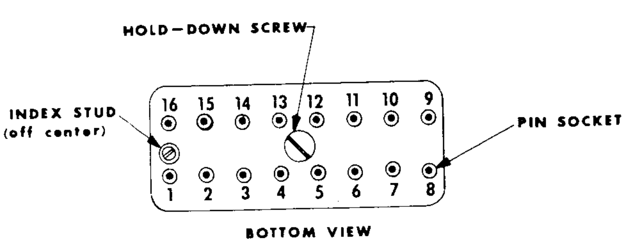


Figure 5-2. Module pin Numbering System

5.2.3 PRINTED-CIRCUIT BOARD SERVICING

PRINTED-CIRCUIT BOARD CONNECTORS - When reinstalling a cable connector on a printed-circuit board, be sure connector is properly aligned with the board connector pins and that connector faces proper direction (See Figure 5-3).

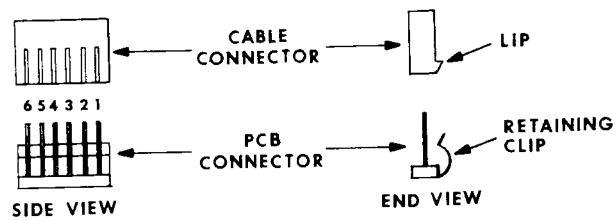


Figure 5-3. Connector Alignment

METER-BOARD (C315) REMOVAL - Removal of the meter-board assembly requires that the attenuator dial, VERNIER knob and potentiometer retaining nut and front top rail be removed. The meter board is secured to front panel by three screws - one through front panel (behind attenuator dial) and one at each top corner of meter board. Remove these three screws and disengage six-pin connector from meter board. Remove three slip-on wire connectors from attenuator switch. The meter-board assembly can then be moved toward rear until the VERNIER potentiometer shaft, UNLEVELED LED and meter case clear the front panel, then the board can be lifted from instrument.

The meter board is reinstalled by reversing the removal procedure. When installing the meter board, use care not to damage the UNLEVELED Lamp.

MODULATION BOARD (C316-2) Removal - The modulation-board assembly can be removed by the following procedure: Disengage slip-on connectors from the six BCD FREQUENCY switches; disengage twelve-pin connector from modulation board; unsolder wire from EXT modulation connector and remove retaining nut from backside of this BNC connector; remove black spring - loaded knobs from MODULATION MODE and FREQ switches; remove knob from FREQUENCY VERNIER pot shaft; remove front-top rail; then remove one screw from top-left corner of modulation board and one screw from top-left corner of C315 meter board. The modulation-board assembly can now be angled until switch levers clear the front panel. The assembly then can be lifted from instrument.

The board assembly is reinstalled by reversing the removal procedure.

NOTE

When placing connectors on FREQUENCY switches, be sure each connector is on correct switch; switch cables break out of main harness in same order that switches appear.

POWER-SUPPLY CARD (C352) REMOVAL - The power-supply card can be removed by removing four screws which secure the printed-circuit card standoffs to rear panel. The card can then be angled to allow it to clear modules, cables and side rail, and thus be lifted from instrument. The printed-circuit card can be raised far enough to permit many components to be checked without removing the three connecting cables. Disengaging the three cable connectors allows the power-supply card to be completely removed from the instrument. The power-supply card is reinstalled by reversing the removal procedure.

CAUTION

When reinstalling C352 card, use care NOT to pinch cables connected to rear-panel-mounted transistors.

5.2.4 RECOMMENDED TEST EQUIPMENT

The following test equipment, shown in Table 5-1, is recommended for servicing, troubleshooting and calibrating the Wavetek Model 3001.

TABLE 5-1. RECOMMENDED TEST EQUIPMENT

INSTRUMENT	CRITICAL REQUIREMENT	RECOMMENDED
Digital Voltmeter	.04% Accuracy	Dana Model 4200
Oscilloscope	DC and AC coupled At least 50 mV/cm sensitivity High frequency - at least 10 MHz	Tektronix 5400
Power Meter	10-520 MHz Frequency Range -10 dBm to +15 dBm Power Range	HP Model 435A with Model 8481A Power Sensor
Frequency Counter		HP Model 5303B
Spectrum Analyzer		HP Model 8558B

5.3 CALIBRATION PROCEDURE

Remove instrument top cover, bottom cover, left-side panel and M2M module cover. The M2M module can be located by reference to Figure 5-6; then remove screw from top of module and slide cover off. *Allow a two-hour warmup period before calibrating.*

In general, calibration should be performed in the sequence given. Refer to Figures 5-4, 5-5 and 5-6 for test point and adjustment locations.

NOTE

All measurements are made with reference to chassis ground.

5.3.1 +18 VOLT ADJUSTMENT

Connect digital voltmeter to orange +18 volt line on pin 3 of module M30-1; set +18 V ADJ. on power supply to produce +18.00 V. (See Figures 5-5 and 5-6).

5.3.2 -18 VOLT CHECK

Connect digital voltmeter to yellow -18 volt line on pin 4 of module M30-1. The reading must be -18 V ±40 mV.

5.3.3 +7.3 VOLT CHECK

Connect digital voltmeter to green +7.3 volt line on pin 2 of module M30-1. The reading must be +7.3 V ±150 mV.

5.3.4 CRYSTAL - FREQUENCY ADJUSTMENT MODULE M30-1

Connect frequency counter having 50-ohm input to the Model 3001 RF OUT connector. Set the signal generator FREQUENCY switches to a high frequency which is within the counter's range, such as 500.000 MHz. Set front-panel controls as follows:

MODE	CW
FREQ	EXT
MODULATION FM/AM	minimum
OUTPUT Dial	+10 dBm
OUTPUT VERNIER	Fully clockwise
FREQ VERNIER	CAL

Adjust M30-1 Frequency Adjust trimmer (Figure 5-5) for minimum-frequency indication on counter; then, carefully turn Frequency Adjust trimmer clockwise until counter indicates the frequency selected by FREQUENCY switches. Disconnect counter from RF OUT connector. A final frequency check will be covered in paragraph 5.3.11.

5.3.5 PHASE-LOCKED LOOP #1 ADJUSTMENT M31

See Figure 5-6 for location of M31 test point and adjustments. Set FREQUENCY switches to 200.000 MHz; other front-panel controls may be left as set in Section 5.3.4. Connect scope vertical input (DC, 1 V/cm) to M31 test point (D), and adjust scope horizontal controls for a smooth, continuous trace. Adjust M31 control (A) for a +1.0 V scope indication. Set frequency to 200.999 MHz and adjust M31 control (B) for a scope indication of +1.0 V.

5.3.6 PHASE-LOCKED LOOP #2 ADJUSTMENT M32

See Figure 5-5 for location of M32 test points and Figure 5-6 for adjustment controls. Set FREQUENCY to 200.000 MHz and other front-panel controls as in Section 5.3.4. Connect digital voltmeter to M32 pin 14, and carefully adjust both M30-1 trimmers (A and B) to produce a minimum reading on voltmeter. This voltage should be between +0.5 V and +3.0 VDC. Set FREQUENCY to 239.000 MHz and note that voltmeter reading is still within above limits.

Set FREQUENCY to 200.000 MHz and connect scope vertical input (DC, 1 V/cm) to M32 pin 15. Adjust M32 control (A) for a 0 V scope indication. Set FREQUENCY to 239.000 MHz, and adjust M32 control (B) to again produce a 0 V scope indication.

5.3.7 PHASE-LOCKED LOOP #3 ADJUSTMENT

P.L.L. #3 consists of two modules: The M33-1 and the M9W. The test point is on module M33-1 (Figure 5-5), while the adjustment controls are on module M9W (Figure 5-6). Set FREQUENCY to 250 MHz, and other front-panel controls as in Section 5.3.4. Connect scope vertical input (DC, 1 V/cm) to M33-1 pin 5. Adjust M9W control (D) for a 0 V scope indication.

Set front-panel controls as follows:

MODE	FM x 10
FREQ	1 kHz
MODULATION FM/AM	maximum

Set scope vertical input (on M33-1 pin 5) for AC, 50 mV/cm. Adjust M9W control (C) for minimum (null) indication of 1 kHz sine wave on scope.

5.3.8 PHASE-LOCKED LOOP #4 ADJUSTMENT

Calibration of P.L.L. #4 involves three modules: M2M, M9W and the M34. Test points are located on modules M2M and M34 (Figure 5-5), while adjustment controls are located on modules M2M and M9W (Figures 5-4 and 5-6).

Set FREQUENCY switches for 250.000 MHz and other front-panel controls as in Section 5.3.4. Connect digital voltmeter to M2M pin 8; then, adjust M2M 250 MHz control (Figure 5-4) for a 0.00 V reading on voltmeter. The voltmeter may now be disconnected.

Connect frequency counter to RF OUT connector and connect scope vertical input (DC, 1 V/cm) to M34 pin 8. Adjust M9W control (A) for 0, ±1 V, on scope. The counter should indicate a frequency of 250 MHz.

NOTE

Due to the way the M34 locks on harmonics of 40 MHz, it is possible to adjust M9W control (A) for "0 V" at multiples of 40 MHz offset from 250 MHz. If this happens, it will be necessary to readjust M9W control (A) several turns to

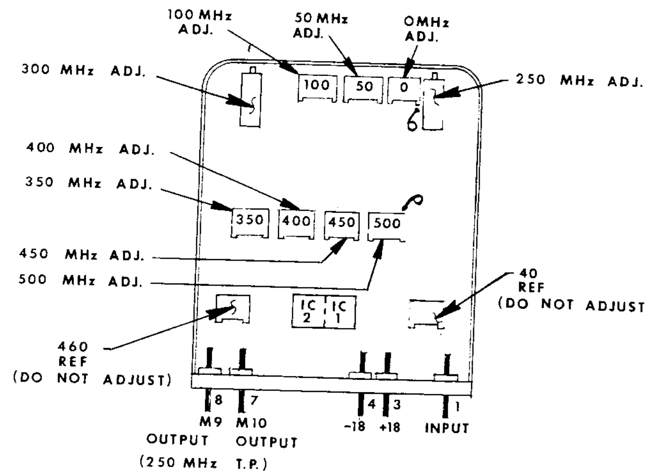


Figure 5-4. M2M Module

break lock and relock at the next multiple of 40 MHz until "0, +1 V", can be obtained with a 250 MHz counter reading.

Set FREQUENCY switches for 300 MHz and adjust M2M 300 MHz pot. for 0, ±3 V, on scope with a counter reading of 300 MHz. Repeat this step, using applicable M2M pots, for frequencies of 350, 400, and 450 MHz. Refer to Figure 5-4 for M2M pot locations.

Set FREQUENCY switches to 500 MHz. Adjust M2M 500 MHz pot for a scope reading near 0 V. Increase frequency to 520 MHz and note scope indication; then, adjust 500 MHz pot to give scope indications at 500 and 520 MHz that are symmetrical about 0 V.

Set FREQUENCY to 100 MHz and adjust M2M 100 MHz pot for 0, ±3 V, on scope and a counter reading of 100 MHz. Repeat using appropriate M2M pots, for 50 MHz and 0 MHz.

Connect digital voltmeter to M34 pin 14, Leveler TP. Step through frequency range from 1 to 520 MHz in 10 MHz steps to find frequency having highest leveler voltage; then adjust M9W control (B) for +1.0 VDC at this frequency setting.

5.3.9 PHASE-LOCKED LOOP #5 ADJUSTMENT

Adjustment controls for P.L.L. #5 are located on Modulation Board C316-2 and module M29-1 (Figure 5-6), while the MOD TP is located on underneath side of the chassis (Figure 5-5). Connect frequency counter to front-panel RF OUT connector and digital voltmeter to chassis MOD TP ; then, set other front-panel controls as follows:

FREQUENCY	2.000 MHz
Freq VERNIER	"0" kHz
MODE	FM x 10
FREQ	DC
MODULATION FM/AM	Maximum
OUTPUT VERNIER	Fully clockwise
OUTPUT Dial	+10 dBm

NOTE

Modulation Board C316-2 contains a Size Adj. pot (C) and a Balance Adj. pot (D) which are factory adjustments. DO NOT change setting of these two controls.

Refer to Figure 5-6 for control location, and adjust Modulation Board pot (A) for a +5.00 ±.01 V reading on voltmeter. Set FM/AM slider to minimum; the voltmeter should indicate 0 V ±20 mV. Disconnect voltmeter from MOD TP.

Adjust M29-1 control (B) to produce a frequency counter reading of 2.000 MHz ±100 Hz. Increase FM/AM slider to maximum and adjust M29-1 control (A) for a counter reading of 2.100 MHz ±100 Hz.

Set MODE to FM x1, and adjust Modulation Board control (B) for a counter reading of 2.010 MHz ±100 Hz.

5.3.10 METER BOARD CALIBRATION - C315

To adjust output meter, the unit must rest on its bottom surface (normal operating position). Momentarily turn OFF power to instrument and mechanically zero output meter with front-panel zero adjust screw. The meter needle should bisect dot at left end of meter scale. Restore power to instrument and allow it to stabilize.

Set the OUTPUT VERNIER fully ccw; then, adjust Meter Board pot (B) until meter needle again bisects dot at left end of meter scale. See Figure 5-6 for location of Meter Board pots. Set VERNIER completely cw and adjust Meter Board pot (A) for a +3 dBm output meter reading.

Set front-panel controls as follows:

FREQUENCY	50.000 MHz
MODE	CW
MODULATION FM/AM	minimum
OUTPUT Dial	+10 dBm
OUTPUT VERNIER	Fully clockwise
FREQ VERNIER	CAL

Calibrate power meter and its thermistor or power sensor. Set power meter to the +15 dBm range; then connect thermistor or sensor to RF OUT connector of Model 3001.

Adjust Meter Board pot (F) for a +13 dBm power meter reading. Set the OUTPUT VERNIER for -7 dBm reading on output meter and set power meter to the +5 dBm range. Adjust Meter Board pot (E) for +3 dBm power meter reading. Again set power meter to the +15 dBm range and turn front-panel VERNIER fully cw. Repeat this paragraph until +13 dBm and +3 dBm power meter readings are obtained without further adjustment of Meter Board pots (E) and (F).

Set OUTPUT dial to 0 dBm and power meter to the +5 dBm range. With VERNIER completely cw, adjust Meter Board pot (C) for a +3 dBm power meter reading. Turn VERNIER for -6 dBm reading on OUTPUT meter and set power meter to the -5 dBm range. Adjust Meter Board pot (D) for -6 dBm power meter reading. Repeat this paragraph until +3 dBm and -6 dBm power meter readings are obtained without further adjustment of Meter Board pots (C) and (D).

Set Model 3001 front-panel controls as follows:

FREQUENCY	100.000 MHz
MODE	AM
FREQ	DC
MODULATION FM/AM	Minimum
OUTPUT Dial	0 dBm

Set power meter to its 0 dBm range and adjust OUTPUT VERNIER for a -3 dBm reading on power meter. Set power meter to the +5 dBm range and place AM/FM slider to 100% AM. Adjust Meter Board pot (G) for +3 dBm reading on power meter. This 6 dB increase corresponds to 100% amplitude modulation.

5.3.11 FINAL FREQUENCY CHECK - M30-1

Connect frequency counter to signal generator RF OUT connector, and set front panel controls as specified in Section 5.3.4. Note frequency reading on counter; if it does not agree with the selected frequency within accuracy specifications, very carefully adjust M30-1 Frequency Adjust trimmer (See Figure 5-5) until desired frequency is obtained.

5.4 TROUBLESHOOTING

Effective troubleshooting requires a thorough understanding of block diagrams and circuit description located in Section 3 of this manual; then the Performance Tests in Section 4 and Calibration Procedures in Section 5 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 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 the operating instructions in Section 2 of this manual for complete explanation of each control's function along with typical operating instructions.

After verifying that trouble is not improper setting of the controls or test setup, make a thorough visual inspection of 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 Model 3001 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 3001, this provides an easy method of verifying if a suspected module is defective.

RF cables can be disconnected from the module output connectors; then a power meter or spectrum analyzer can be connected directly to the module connector for power level or frequency measurements. Fabrication of a short coax adapter cable, terminated in a mating connector for the modules on one end and a BNC connector on the other, will facilitate connection of test equipment.

The front-panel Accuracy lamps together with the four internal module "unlock indicator" lamps aid in troubleshooting phase-locked loop problems. One module in each loop contains an indicator lamp which lights to indicate when that loop is unlocked. The lamps indicate only which loops are unlocked, but not which module is at fault.

A problem in a power supply may cause many symptoms pointing to other areas and should be checked when the symptom does not clearly indicate a specific problem. Loss of the -18 V supply, for example, will cause the Accuracy lamp to flash; while loss of the +18 V supply will extinguish all lamps. The +18, -18 and +7.3 V supplies comprise the DPS-2 power supply which forms the rear panel of the instrument. Performance of these supplies is indicated in the CALIBRATION PROCEDURE.

5.4.1 TROUBLESHOOTING HINTS

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

INTERMITTENT OPERATION - Defective module-pin sockets or loose RF cables.

LOW RF OUTPUT (+10 dBm RANGE) - If power is 10 dB low on this range but is correct on the 0 dBm range, micro-switch S1 mounted on attenuator is defective, is not being actuated by attenuator shaft, or a switch wire is disconnected.

LOW OR NO RF OUTPUT (ANY RANGE) - Defective attenuator or RF cables connecting to input or output of attenuator, defective meter board, defective module M10W or M9W.

Check voltage on pin 15 of module M10W. With OUTPUT VERNIER fully clockwise, the voltage should be approximately as follows: -2.5 VDC on +10 dBm range; -0.7 VDC on 0 dBm range. These voltages indicate proper operation of the meter board; while other values, particularly positive voltages, indicate a defective IC or other problem on the meter board.

Next, check RF power directly at M10W output. If it is correct, the trouble lies in the attenuator or its RF cables. If module M10W output is low, measure module M9W RF output - this should be approximately -10 to -11 dBm. If this level is correct, module M10W is defective; while if the level is low, Sweep Oscillator M9W is defective.

OUTPUT METER DOES NOT MOVE - If meter is pegged at either end of scale, the trouble is probably a defective component on meter board C315; while if meter remains at mechanical zero, meter movement may be open or a meter board component may be defective.

UNLEVELED LAMP ON - RF OUT connector not terminated in 50-ohm load, AM percentage set so that peak of modulated output exceeds +13 dBm, defective module M10W, defective attenuator or connecting RF cables.

Connect power meter directly to M10W output. Set OUTPUT dial and VERNIER for a +13 dBm reading on power meter at 50.000 MHz. Step through frequency range from 10 to 520 MHz in 10 MHz steps. A power meter reading of +13 dBm ±0.5 dB with unleveled lamp OFF indicates proper operation of module M10W. If output is correct at M10W but the unleveled lamp is ON, the trouble is probably a defective lamp-driver circuit in module M10W. With proper operation of module M10W, connect power meter directly to attenuator output and repeat above steps. If attenuator output is correct, trouble is due to a defective RF cable or possibly a poor ground connection at RF OUT connector.

ACCURACY LAMP FLASHES CONTINUOUSLY - A steady light in CW mode but flashing in FM modes indicates a defective M29-1 or M33-1 module. If Accuracy lamp flashes in all modes, one or more of the phase-locked loops is open; see PHASE-LOCKED LOOP TROUBLES below.

NOTE

Above the normal frequency range of the instrument (in the vicinity of 560 MHz), it is normal for phase-locked loop #4 to unlock causing the Accuracy lamp to flash.

PHASE-LOCKED LOOP TROUBLES - An open or unlocked loop, indicated by a lighted module lamp, can be caused by a number of factors, including: low AC - input voltage, low DC-supply voltages, improper phase-locked loop DC voltages, an open or shorted RF cable or a defective module.

A defective RF cable or module can have a "chain-reaction" effect that causes two or more loops to unlock. For example, loss of the 1 kHz signal to module M31 will cause PLL #1 to unlock; thus, module M31 may not supply a proper signal to module M34, causing PLL #4 to unlock. Failure of the 40 MHz crystal oscillator in module M30-1 will cause all loops to unlock, since all six reference frequencies will be lost.

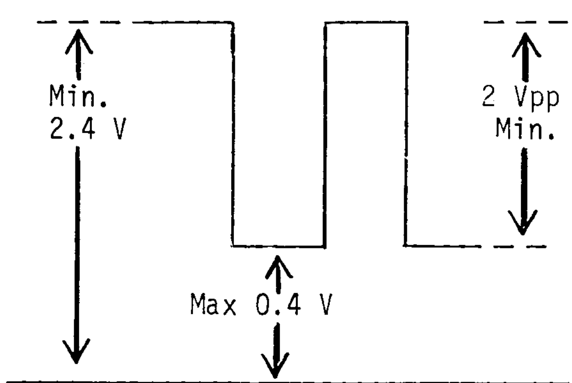
Table 5-2 lists typical RF signal-input levels for each of the phase-locked loops. Those signals having a TTL level or 1 V level may be measured with a high-frequency oscilloscope; the other signals are best measured with a spectrum analyzer (dBm), or a 50-ohm detector and calibrated scope (mV).

NOTE

The TTL waveform shown in Table 5-2 is for illustration of voltage values only, and does not necessarily represent the observed waveshape.

TABLE 5-2. PHASE-LOCKED LOOP RF-SIGNAL LEVELS

P.L.L. #	MODULE	INPUT-SIGNAL FREQUENCY	INPUT-SIGNAL LEVEL dBm (mV)	MEASURED AT
1	M31	1 kHz	TTL	M30-1 (W13)
2	M32	1 MHz	TTL	M30-1 (W12)
		1440 MHz	-12 to -15 dBm (20 mV)	M30-1 (W9)
3 & 5	M33-1	1198 MHz	-10 dBm ±3 dB (150 mV)	M9W (W5)
		1200 MHz (120 comb)	-15 dBm ±5dB (75 mV)	M30-1 (W10)
		2 kHz	TTL	M30-1 (W11)
		1.9 to 2.1 MHz	1 volt pp	M29-1 (W7)
4	M34	1198 to 1718 MHz	-10 dBm ±5 dB (25 mV)	M9W (W4)
		1448 to 1487 MHz	-2 dBm ±3 dB (200 mV)	M32 (W8)
		40 to 280 MHz (40 comb)	-10 dBm ±3 dB (1 V)	M30-1 (W6)
		10 to 9.001 MHz	TTL	M31 (W14)



TTL LOGIC LEVEL

Phase-Locked Loop #1 - Unlocking of this loop may be caused by a defective module M31, module M30-1 or RF cable connecting M30-1 to M31.

Connect digital voltmeter to M31 test point (D, Figure 5-6). Note voltmeter readings at frequencies of 200.000 and 200.999 MHz. If voltage is 12 to 16 VDC, check 1 kHz signal as listed in Table 5-2. If 1 kHz signal is correct, module M30-1 is operating properly; then, check RF cable between M30-1 and M31. If proper 1 kHz signal is being applied to M31, check for 7.3 V on pin 6, +18 V on pin 7, and -18 V on pin 8 of M31. If input signal and DC voltages are correct, module M31 is defective.

Phase-Locked Loop #2 - Unlocking of loop #2 can be caused by defective modules M22, M30-1, M32 or RF cables connecting M30-1 to M32.

Connect digital voltmeter to M32 pin 11 and observe voltmeter reading while stepping through frequency range from 200 to 239 MHz in 1 MHz steps. The voltmeter reading should change -0.2 V per MHz from 0 V at 200 MHz to -7.8 V at 239 MHz. These voltages indicate proper operation of module M22.

Module M30-1 can be checked by measuring the 1 MHz and 1440 MHz signals directly at the M30-1 - the levels specified in Table 5-2 indicate proper operation of module M30-1. Check connectors and RF cables connecting M30-1 to module M32. Check for +18 V on pin 7, -18 V on pin 8, and 7.3 V on pin 9 of M32. If all input signals and DC voltages to module M32 are normal, but the M32 LED is ON, module M32 is defective.

Phase-Locked Loops #3 and #5 - The LED indicator on module M33-1 serves both P.L.L. #3 and P.L.L. #5. If M33-1 LED is ON, determine which loop is defective by switching FREQUENCY VERNIER out of CAL position. If M33-1 LED goes OFF, trouble is in P.L.L. #5; if LED stays ON, trouble is in P.L.L. #3.

P.L.L. #3 consists of modules M33-1 and M9W. It is possible that P.L.L. #3 can be restored to operation simply by re-calibrating per paragraph 5.3.7, and this should be attempted. If adjusting M9W control (D) has no effect on M33-1 pin 5 voltage, problem is in module M33-1; however, if pin 5 voltage changes but phase lock cannot be established, or if pin 5 voltage cannot be set to within 5 volts of 0 V, trouble is in M9W. Measure M33-1 Leveler TP (pin 14): If +0.5 to 5 VDC, trouble is probably in module M33-1; however, if greater than 5 VDC, trouble is probably in module M9W or M30-1. Check M30-1 reference frequencies and M9W output level as shown in Table 5-2 to determine which module is defective.

P.L.L. #5 consists of modules M29-1 and M33-1. With Freq VERNIER in CAL position, measure P.L.L. #5 voltage on M29-1 pin 6. Adjust M29-1 control (B) for 0 V on pin 6. If, while adjusting M29-1 from 1.9 to 2.1 MHz this voltage does not move, the problem is in module M33-1. If the voltage adjusts, but will not stay locked, the trouble is in module M29-1.

Phase-Locked Loop #4 - Unlocking of loop #4 may, under certain conditions, be caused by problems originating in the other loops. Therefore, loops #1, 2, and 3 should be operating properly before troubleshooting loop #4.

Unlocking of loop #4 can be caused by defective modules M2M, M22, M9W, M30-1, M31, M32, M34 or connecting RF cables.

Connect digital voltmeter to M2M pin 1. The voltmeter reading should be 0.00 V with FREQUENCY switches set at 000 MHz, -2.5 V at 250 MHz and -5.0 V at 500 MHz. These voltages indicate proper operation of module M22. Connect voltmeter to M2M pin 8. The voltmeter reading should be +5 to +8 V at 000 MHz, 0 V at 250 MHz and -6 to -10 V at 500 MHz. If these voltages are obtained, module M2M is operating properly.

Measure the Wide Oscillator signal at module M9W. The frequency will be between 1198 MHz and 1718 MHz, depending upon the setting of the FREQUENCY switches. If the signal level is as specified in Table 5-2, module M9W is probably operating correctly.

Measure the 40 comb line at module M30-1. The 40 MHz harmonics from 40 MHz to 280 MHz should be fairly equal in amplitude and the level should be as specified in Table 5-2. This level indicates proper operation of the M30-1 module.

Measure the 1448 MHz to 1487 MHz signal at module M32. The exact frequency is dependent upon the setting of the MHz FREQUENCY switches. If the level is as specified in Table 5-2, the M32 is operating properly.

Next, measure the 10 MHz to 9.001 MHz output of the M31 module. The output will be 10.000 MHz with the kHz FREQUENCY switches set to 000 kHz, and the frequency will decrease to 9.001 MHz with the kHz switches set to 999 kHz. If the signal level is as specified in Table 5-2, module M31 is operating properly.

If output of each of the above modules is correct, check connectors and RF cables connecting M9W, M31, M32 and M30-1 to module M34. Check for +7.3 V on pin 2, +18 V on pin 3, and -18 V on pin 4 of M34. If all input signals and DC voltages to module M34 are correct, but M34 module lamp is ON, module M34 is probably defective, but trouble could be caused by M9W.

A further check of the M34 can be made by monitoring M34 pin 8 with a digital voltmeter while stepping through the frequency range from 10 MHz to 520 MHz in 10 MHz steps. The voltmeter reading should be 0 $\pm$3 V; however, a defective M34 may give a voltage reading of 12 to 16 volts.

BCD FREQUENCY SWITCHES - Troubles in the BCD switch circuits may be caused by a defective switch, loose or disengaged switch connector or a broken switch wire.

Five of the switches utilize four wires plus a ground to select decimal digits from 0 through 9. The 100's MHz switch uses three wires plus ground, since it only needs to select digits between 0 and 5. A "BCD Truth Table", applicable to each of the six switches, is given in Table 5-3.

Suspected switch problems can be checked by referring to Table 5-3 and the Model 3001 Wiring Diagram to determine which module pins are grounded for a particular frequency. For example, to select a frequency of 200.500 MHz, M22 pin 3 is grounded by selecting digit 2 on the 100's MHz switch, and M31 pins 2 and 4 are grounded by digit 5 on the 100's kHz switch.

TABLE 5-3. BCD FREQUENCY SWITCHES

Decimal Digit	BCD Wires 8 4 2 1
0	- - - -
1	- - - 0
2	- - 0 -
3	- - 0 0
4	- 0 - -
5	- 0 - 0
6	- 0 0 -
7	- 0 0 0
8	0 - - -
9	0 - - 0

NOTE: 0 = Wire Grounded by Switch.
- = Wire NOT Grounded.

MODULATION TROUBLES - The Modulation Board (C316-2) is the most common cause of modulation problems, particularly when the modulating signal is lost. Non-linear amplitude modulation, at higher-audio frequencies from an external source, may be caused by the M10W output amplifier.

Set front-panel controls as follows to determine presence of modulating signal:

MODE	AM
FREQ	400 Hz
MODULATION FM/AM	Maximum
OUTPUT Dial	0 dBm
OUTPUT VERNIER	Fully clockwise
FREQ VERNIER	CAL

Connect oscilloscope vertical input to MOD TP. The scope should display a 10 V peak-to-peak sine wave at a frequency of 400 Hz (2.5 ms period). Set FREQ switch to 1 kHz - scope display should be a 10 Vpp sine wave with a period of 1 ms. If the 10 V signals are not obtained, check for +7.3 V on pin 8, +18 V on pin 1, and -18 V on pin 2 of C316-2 Modulation Board. If DC voltages are normal, the Modulation Board is defective.

AM Troubles - Connect scope vertical input to pin 3 of C316-2 Mod. Board and check for a 10 Vpp sine wave; then, connect scope vertical input to pin 4 of Meter Board C315 and again check for a 10 V sine wave. Presence of the sine wave at this point indicates proper operation of Modulation Board and wiring.

Connect scope vertical input to pin 2 of C315 Meter Board and check for a sine wave having an approximate amplitude of 1.75 Vpp. If the 1.75 V signal is not present, check for +18 V on pin 6 and -18 V on pin 5 of Meter Board. If DC voltages are normal, Meter Board C315 is defective, or a wire is disconnected from Attenuator switch S1.

Check for 1.75 Vpp sine wave on pin 15 of module M10W. If sine wave is normal at this point, but amplitude-modulation is abnormal, amplifier M10W is defective.

FM Troubles - Set MODE to FM x 10, and check for 10 Vpp sine wave on pin 6 of Modulation Board C316-2; then, connect scope vertical input to pin 16 of module M29-1 and again check for a 10 V sine wave. A 400 Hz or 1 kHz 10 V sine wave at this point indicates proper operation of Modulation Board and wiring.

Remove RF cable W7 from top of module M29-1; then check for 1 volt peak-to-peak 1.9/2.1 MHz signal at this connector. If this signal is not present, check for +18 V on pin 3 and -18 V on pin 4 of M29-1. If DC voltages are normal, FM problems are caused by a defective module M29-1. If the 1.9/2.1 MHz signal is present at M29-1 connector, FM problems are probably caused by a defective M33-1 module.

5.4.2 PC-BOARD PARTS LOCATION DIAGRAMS

To aid in servicing or troubleshooting the Model 3001, the following printed-circuit board parts location diagrams are provided in Section 7 immediately in front of the associated schematic.

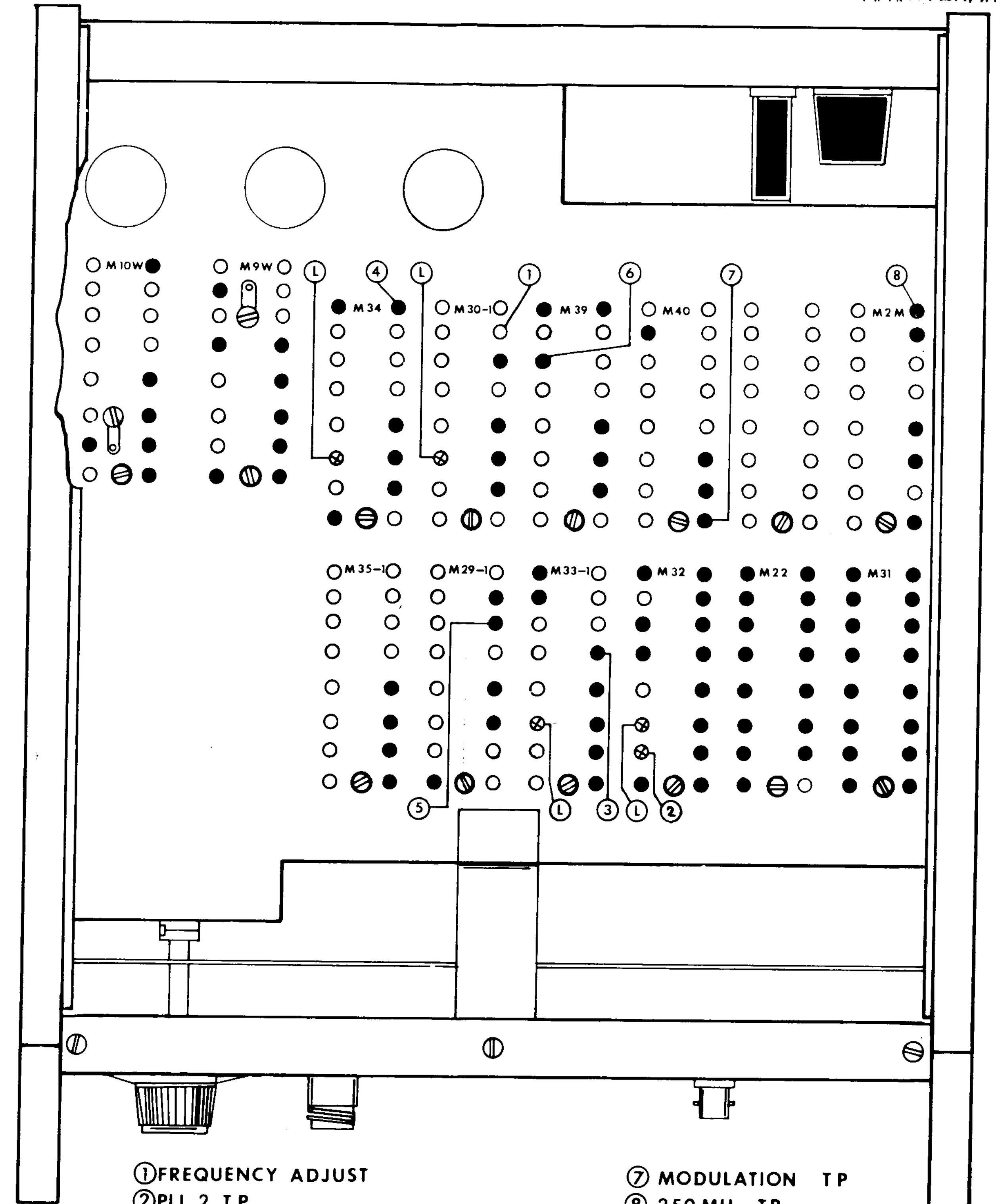
Module or Board	Schematic No.
C315	13
C316-2	4
C352 (DPS-2 PCB)	2
M2M	9
M22	8

5.4.3 MODULE REPLACEMENT

While in many cases the Model 3001 will work satisfactorily after simply replacing a defective module, to maintain the high accuracy of which the unit is capable, module replacement should be followed by calibration of the affected circuits. Table 5-4 lists each module and the adjustment needed.

TABLE 5-4. REPLACEMENT MODULE CALIBRATION

MODULE REPLACED	ADJUSTMENT REQUIRED (See indicated paragraphs in Calibration Procedure)
M2M Sweep Drive	Reset Phase-Locked Loop #4 (Section 5.3.8)
M9W Sweep Oscillator	Reset Phase-Locked Loops #3 and #4 (Sections 5.3.7 and 5.3.8)
M10W Output Amplifier	Recalibrate C315 Meter Board (Section 5.3.10)
M22 DAC	None required
M29-1 FM Reference	Reset Phase-Locked Loop #5 (Section 5.3.9)
M30-1 Crystal Reference	Adjust Crystal Frequency (Section 5.3.4 and 5.3.11)
M31 kHz Steps	Set Phase-Locked Loop #1 (Section 5.3.5)
M32 MHz Steps	Adjust Phase-Locked Loop #2 (Section 5.3.6)
M33-1 Narrow Osc. Lock	Adjust Phase-Locked Loop #3 (Section 5.3.7)
M34 Wide Osc. Lock	Set M34 pin 14 for +1.0 VDC (last para. Section 5.3.8)
C315 Meter Board	Adjust Meter Board Calibration (Section 5.3.10)
C316-2 Modulation Board	Adjust Phase-Locked Loop #5 (Section 5.3.9)
DPS-2 Power Supply	Adjust +18 V; check -18 V and 7.3 V (Sections 5.3.1 through 5.3.3).



①FREQUENCY ADJUST
②PLL 2 TP
③PLL 3 TP
④PLL 4 TP
⑤PLL 5 TP
⑥PLL 6 TP
(PLL 1 TP TOP OF M 31)

⑦ MODULATION TP
⑧ 250 MHz TP
Ⓛ LEVELER TP

WIRE COLOR CODE
GREEN +7.3V
ORANGE +18V
YELLOW -18V
(OTHERS UNASSIGNED)

Figure 5-5. Test Points, Chassis Bottom View

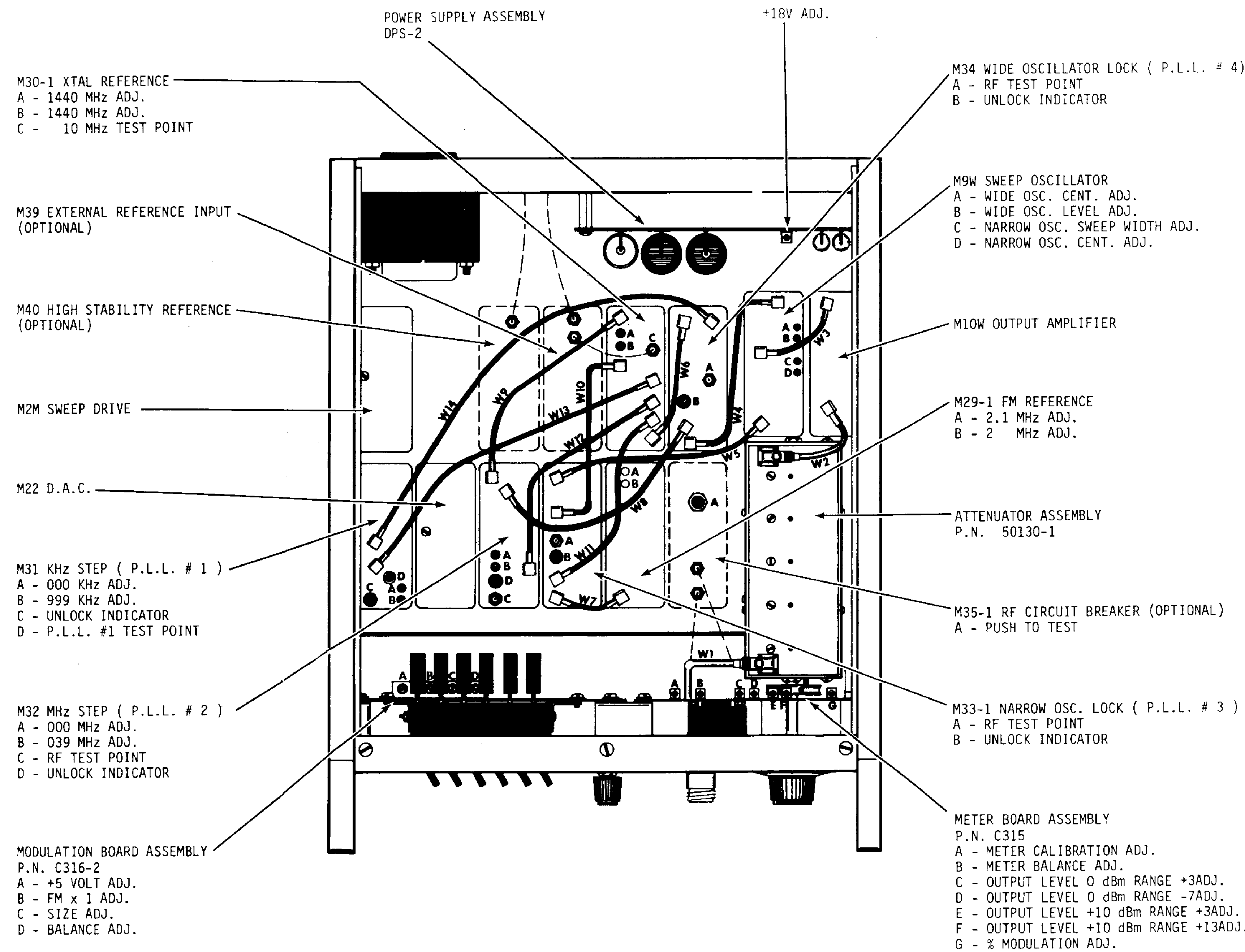


Figure 5-6. Adjustment Controls and Cable Connections

SECTION 6
REPLACEABLE PARTS

6.1 INTRODUCTION

This section contains a list of all replaceable electronic parts for the instrument.

In an assembly containing one or more subassemblies, the assembly parts list is divided to separate the subassemblies. The subassembly three-digit circuit reference on the schematic is represented in the REFERENCE SYMBOL column by the last one or two digits. The first digit represents the subassembly on which the part is located. The subassembly (100, 200. . .) is indicated next to the reference symbol heading. The first parts list corresponds to the Wiring Diagram in Section 7. The assembly parts lists follow in alpha-numerical order.

6.2 MANUFACTURERS CODE

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

A-B	Allen-Bradley	Milwaukee, Wisconsin
ACI	Advance Components, Inc.	Centerbrook, Connecticut
A-D	Analog Devices	Norwood, Massachusetts
AER	AVX	Myrtle Beach, South Carolina
A-I	Alan Industries	Columbus, Indiana
AIN	Alpha Industries, Inc.	Woburn, Massachusetts
ALC	Alco Electronics Products, Inc.	Lawrence, Massachusetts
AMP	AMP, Inc.	Harrisburg, Pennsylvania
APL	Amphenol	Danbury, Connecticut
A-P	American Plasticraft (APCO)	Chicago, Illinois
APX	Amperex	Slatersville, Rhode Island
ARC	ARCO Electronics	Great Neck, New York
ASE	Airco Speer Electronics	Nogales, Arizona
AVT	Avantek	Santa Clara, California
BEK	Beckman Instruments, Inc.	Fullerton, California
BEL	Belden	Chicago, Illinois
BER	Berg Electronics	New Cumberland, Pennsylvania
BOU	Bourns	Riverside, California
BUS	Bussman	St. Louis, Missouri
CAM	Cambion	Cambridge, Massachusetts
CAR	Carling Electric, Inc.	West Hartford, Connecticut
C-D	Cornell Dubilier	Newark, New Jersey
C-E	Clinton Electronics	Rockford, Illinois
CGW	Corning Glass Works	Corning, New York
CHE	Cherry Electrical Products, Prod.	Waukegan, Illinois
C-H	Cutler-Hammer	Milwaukee, Wisconsin
C-I	Components Incorporated	Biddeford, Maine
C-J	Cinch Jones	Elk Grove Village, Illinois
C-K	C & K Components	Watertown, Massachusetts
CKI	CTS Knight, Inc.	Sandwich, Illinois
C-L	Centralab	Milwaukee, Wisconsin
CLA	Clairex Electronics	Mount Vernon, New York
CTS	Chicago Telephone Systems	Elkhart, Indiana
C-W	C-W Industries	Philadelphia, Pennsylvania
DAL	Dale Technology Corp.	Hartsdale, New York
DEL	Delevan	East Aurora, New York
DIO	Diodes, Inc.	Chatsworth, California
DRA	Drake Mfg, Company	Harwood Heights, Illinois
ETP	Erie Technological Prod., Inc.	Erie, Pennsylvania
FCD	Fairchild	Mountain View, California

G-E	General Electric	Syracuse, New York
G-H	Grayhill	La Grange, Illinois
G-I	General Instrument Semi., Comp,	Hicksville, New York
HEL	Helipot	Anaheim, California
HEY	Heyman Mfg. Company	Kenilworth, New Jersey
HHS	Herman H. Smith, Inc.	Brooklyn, New York
HIT	Hitachi America Ltd.	Chicago, Illinois
H-P	Hewlett-Packard	Palo Alto, California
INT	Intersil, Inc.	St. Palos Heights, Illinois
IRC	International Resistance Co.	Philadelphia, Pennsylvania
ITT	International Telephone and Telegraph	West Palm Beach, Florida
JEF	Jeffers	Dubois, Pennsylvania
JEW	Jewell Electrical Instruments	Manchester, New Hampshire
JON	E.F. Johnson Company	Waseca, Minnesota
KEM	Kemtron Electron Products, Inc.	Newburyport, Massachusetts
KID	Kidco, Inc.	Medford, New Jersey
KIN	Kings	Tuckahoe, New York
KSW	KSW Electronics	Burlington, Massachusetts
LIT	Littelfuse	Des Plaines, Illinois
M-A	Microwave Associates	Burlington, Massachusetts
MAL	Mallory	Indianapolis, Indiana
MDC	Maida Development Co.	Hampton, Virginia
M-E	Mepco/Electra	Mineral Wells, Texas
M-O	Marko-Oak	Anaheim, California
MOL	Molex	Downers Grove, Illinois
MOT	Motorola	Phoenix, Arizona
NAT	National Semiconductor Corp.	Santa Clara, California
NEC	Nippon Electric Company, Limited	Burlingame, California
N-T	National Teltronics	Laredo, Texas
OHM	Ohmite Mfg. Company	Skokie, Illinois
O-S	Omni Spectra, Inc.	Farmington, Michigan
P-B	Potter and Brumfield	Princeton, Indiana
POM	Pomona Electronics Co., Inc.	Pomona, California
Q-C	Quality Components	St. Marys, Pennsylvania
RAY	Raytheon	Burlington, Massachusetts
RCA	RCA	Harrison, New Jersey
RMC	Radio Material Company	Chicago, Illinois
S-C	Specialty Connector	Indianapolis, Indiana
SCC	Stackpole Carbon Co.	St. Marys, Pennsylvania
SEL	Sealectro	Mamaroneck, New York
SEM	Semtech	Newbury Park, California
S-G	Standard Grigsby	Aurora, Illinois
SGM	Sigma	Braintree, Massachusetts
S-I	Switchcraft, Inc.	Chicago, Illinois
SIG	Signetics Corporation	Sunnyvale, California
SPE	Spetrol	City of Industry, California
SPR	Sprague	North Adams, Massachusetts
SSS	Solid State Scientific	Montgomeryville, Pennsylvania
S-T	Sarkes Tarzian	Bloomington, Indiana
STR	Stettner Trush	Cazenovia, New York
SYL	Sylvania	Woburn, Massachusetts
SYS	Syscon International	South Bend, Indiana
THR	Thermalloy, Co.	Dallas, Texas
T-I	Texas Instruments	Dallas, Texas
TRW	TRW Capacitor Division	Ogallala, Nebraska
VAC	VACTEC	Maryland Heights, Missouri
VAR	Varadyne Capacitor Div.	Santa Monica, California
W-E	Wells Electronics	South Bend, Indiana
W-I	Wavetek Indiana, Inc.	Beech Grove, Indiana
WSD	Wavetek, San Diego	San Diego, California
WSR	Wavetek, Santa Rosa	Santa Rosa, California

PARTS LIST

MODEL 3001 CHASSIS

REV

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	MODULES AND CARDS				
C315	Meter Board	A500-315	W-I	A500-315	1
C316-2	Modulation Board	A500-316-2	W-I	A500-316-2	1
DPS-2	Power Supply	A500-351	W-I	A500-351	1
M2M	Sweep Drive	C510-M2M	W-I	C510-M2M	1
M9W	Sweep Oscillator	C510-M9W	W-I	C510-M9W	1
M10W	Output Amplifier	C510-M10W	W-I	C510-M10W	1
M22	DAC	C510-M22	W-I	C510-M22	1
M29-1	FM Reference	C510-M29-1	W-I	C510-M29-1	1
M30-1	Crystal Reference	C510-M30-1	W-I	C510-M30-1	1
M31	kHz Steps	C510-M31	W-I	C510-M31	1
M32	MHz Steps	C510-M32	W-I	C510-M32	1
M33-1	Narrow Oscillator Lock	C510-M33-1	W-I	C510-M33-1	1
M34	Wide Oscillator Lock	C510-M34	W-I	C510-M34	1
	ASSEMBLIES				
W1 thru W14	Cable Assemblies	WX3001	W-I	WX3001	14
50130-1	Step Attenuator, 50 ohm	50130-1	W-I	50130-1	1
"J 100"	CONNECTORS (JACKS)				
1	Jack, 36 pin	MC000-054	MOL	1772-36R	-
2	Jack, 9 pin	MC000-067	MOL	09-50-3091	-
3,4,5,6,7,8	Jack, 5 pin	MC000-065	AMP	583369-1	-
9	Jack, 6 pin	MC000-076	MOL	09-50-3061	-
10	Jack, 12 pin	MC000-107	MOL	09-50-3121	-
12	BNC receptacle	JB110-941	APL	31-2221	1
"P 100"	CONNECTORS (PLUGS)				
1	AC Plug/Cord Assembly	WL002-088	BEL	17237	-
	Remote Programming Plug	MC000-055	MOL	1772-36-P1	-
	Contacts for above	MC000-019	MOL	1854	-
"S 100"	SWITCHES				
1,2,3,4,5,6	10 position, BCD output see assembly C316-2 parts list	--------	---	-----	-

PARTS LIST METER BOARD

C315
C315-1 REV G

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"C "	CAPACITORS				
1	Electrolytic, .47 uF 50 V	CE113-447	TRW	935	1
"CR "	DIODES				
1	Red light emitting diode	DL000-001	NAT	NS102	-
2,3	Silicon Junction, 100 PIV 750 mA	DR000-001	ITT	1N4004	2
"IC "	INTEGRATED CIRCUITS				
1,2,3	Dual Operational Amplifier	IC000-005	MOT	MC1458PI	3
"M "	METERS				
1	3 - scale volt/dBm meter	MI000-004	W-I	MI000-004	1
"P "	CONNECTORS (PLUGS)				
1	6 pin locking plug	MC000-075	MOL	09-65-1061	1
"R "	RESISTORS				
1,22	Variable, 2 Kilohm	RP130-220	BOU	89PR2K	2
2	Fixed Comp., 8.2 Kilohm ±5% ¼ W	RC103-282	A-B	CB8225	1
3	Fixed Metal Film, 36.5 Kilohm ±1%	RF213-365	CGW	RN55D	1
4,28	Fixed Comp., 33 Kilohm ±10% ¼ W	RC104-333	A-B	CB3331	2
5,6	Fixed Metal Film, 10 Kilohm ±1%	RF213-100	CGW	RN55D	2
7,23	Fixed Comp., 20 Kilohm ±5% ¼ W	RC103-320	A-B	CB2035	2
8	Fixed Metal Film, 2.74 Kilohm ±1%	RF212-274	CGW	RN55D	1
9	Fixed Metal Film, 11.3 Kilohm ±1%	RF213-113	CGW	RN55D	1
10	Fixed Metal Film, 3.92 Kilohm ±1%	RF212-392	CGW	RN55D	1
11	Variable, 10 Kilohm	RP140-310	A-B	70A1N044S 103U	1
12,15,17,18, 26	Variable, 20 Kilohm	RP130-320	BOU	89PR20K	5
13	Fixed Comp., 5.6 Kilohm ±10% ¼ W	RC104-256	A-B	CB5621	1
14	Fixed Comp., 220 Kilohm ±10% ¼ W	RC104-422	A-B	CB2241	1
16,20	Fixed Comp., 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	2
19	Fixed Comp., 1 Megohm ±10% ¼ W	RC104-510	A-B	CB1051	1
21	Fixed Metal Film, 15.8 Kilohm ±1%	RF213-158	CGW	RN55D	1
24	Fixed Comp., 68 Kilohm ±10% ¼ W	RC104-368	A-B	CB6831	1
25	Fixed Comp., 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	1
27	Fixed Comp., 15 Kilohm ±10% ¼ W	RC104-315	A-B	CB1531	1
"S "	SWITCHES				
1	SPDT Limit Switch	SM000-006	CHE	E6300H	-
	For C315-1 Delete the following from C315 parts list:				
R2	Fixed comp., 8.2 Kilohm ±5%, ¼ W	RC103-282	A-B	CB8225	1
R7	Fixed,comp., 20 Kilohm ±5%, ¼ W	RC103-320	A-B	CB2035	1
	For C315-1 Add the following:				
R2	Comp, 2.0 Kilohm ±5%, ¼ W	RC103-220	A-B	CB2025	1
R7	Met flm, 19.1 Kilohm, ±1%, 1/8 W	RF213-191	CGW	RN55D	1

PARTS LIST

MODULATION BOARD

C316-2
and C316-3 REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	The following is a list for C316-2; see sheet 2 for C316-3 differences				
"C "	CAPACITORS				
1,6,12,13	Ta, 0.47 µF ±10%, 50 V	CE113-447	TRW	Type 935	4
2,3,7,8	Sil mica, 470 pF ±5%, 500 V	CM101-147	ARC	DM15-471J	4
4,9,10	Sil mica, 1000 pF ±5%, 500 V	CM101-210	ARC	DM19-102J	3
5	Cer disc, 330 pF ±5%, 1 kV	CD104-133	SPR	10TCU-T33	1
11	Cer disc, .001 µF ±20%, 1 kV	CD102-210	SPR	5GA-010	1
14	Cer disc, .05 µF ±20%, 100 V	CD103-350	SPR	TG-S50	1
15	Cer disc, .01 µF ±20%, 100 V	CD103-310	SPR	TG-S10	1
16	Ta, 10 µF ±20%, 20 V	CE120-010	ACI	100DE106M 20C2	1
17,18	Elect, 10 µF +150%-10%, 12 V	CE105-010	SPR	TE-1204	2
"CR "	DIODES				
1,2,3,4,7	Si, Junction, 100 PIV	DR000-001	DIO	1N4004	5
5,6,8	Red LED with mounting Kit	DL000-001	NAT	NSL5046	3
"IC "	INTEGRATED CIRCUITS				
1,2	Dual Op. Amp. RC4558DN RAY only	IC000-027	W-I	IC000-027	2
3	Dual Operational Amplifier, 8 pin, DIP	IC000-005	MOT	MC1458P1	1
4	Timer, 8 pin, DIP	IC000-006	MOT	MC1455P1	1
"OC "	OPTO-COUPLERS				
1	LED/Photocell	MP000-002	VAC	VTL5C3	1
"P "	CONNECTORS (PLUGS)				
1	12 pin locking plug	MC000-106	MOL	09-65-1121	1
"Q "	TRANSISTORS				
1,2	N-channel, JFET	QA054-580	MOT	2N5458	2
3,4	NPN, Si	QA038-541	G-E	2N3854A	2
5	PNP, Si	QB000-009	MOT	MPS3702	1
"R "	RESISTORS				
1*,17,30	Comp, 270 kΩ ±10%, ¼ W	RC104-427	A-B	CB2741	3
2,5,16,37	Comp, 10 MΩ ±10%, ¼ W	RC104-610	A-B	CB1061	4
3,12,26,54	Comp, 100 kΩ ±10%, ¼ W	RC104-410	A-B	CB1041	4
4*,18*	Comp, 5.6 MΩ ±10%, ¼ W	RC104-556	A-B	CB5651	2
6*,21*	Comp, 4.7 MΩ ±10%, ¼ W	RC104-547	A-B	CB4751	2
7*,34,35	Comp, 1 MΩ ±10%, ¼ W	RC104-510	A-B	CB1051	3
8,60	Met flm, 178 kΩ ±1%, 1/8 W	RF214-178	CGW	RN55D	2
9,10	Met flm, 340 kΩ ±1%, 1/8 W	RF214-340	CGW	RN55D	2
11,13,25,27, 57,58,59	Comp, 10 kΩ ±10%, ¼ W	RC104-310	A-B	CB1031	7

PARTS LIST

MODULATION BOARD C316-2 and C316-3 REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R"	RESISTORS - Cont'd				
14,28	Comp, 470 kΩ ±10%, ¼ W	RC104-447	A-B	CB4741	2
15*	Comp, 390 kΩ ±10%, ¼ W	RC104-439	A-B	CB3941	1
19,20*,53	Comp, 22 MΩ ±10%, ¼ W	RC104-622	A-B	CB2261	3
22	Met flm, 464 kΩ ±1%, 1/8 W	RF214-464	CGW	RN55D	1
23,24	Met flm, 845 kΩ ±1%, 1/8 W	RF214-845	CGW	RN55D	2
29	Comp, 7.5 kΩ ±5%, ¼ W	RC103-275	A-B	CB7525	1
31	Met flm, 4.87 kΩ ±1%, 1/8 W	RF212-487	CGW	RN55D	1
32,42,47	Var cermet, 1 kΩ	RP129-210	CTS	360S102B	3
33	Met flm, 12.1 kΩ ±1%, 1/8 W	RF213-121	CGW	RN55D	1
36	Var cermet, 20 kΩ	RP129-320	CTS	360S203B	1
38	Comp, 47 kΩ ±10%, ¼ W	RC104-347	A-B	CB4731	1
39	Comp, 18 kΩ ±10%, ¼ W	RC104-318	A-B	CB1831	1
40*	Comp, 620 kΩ ±10%, ¼ W	RC104-462	A-B	CB6241	
41	Met flm, 2.74 kΩ ±1%, 1/8 W	RF212-274	CGW	RN55D	1
43	Met flm, 5.11 kΩ ±1%, 1/8 W	RF212-511	CGW	RN55D	1
44	Var comp, 10 kΩ	RP137-310	W-I	RP137-310	1
45	Comp, 33 Ω ±10%, ¼ W	RC104-033	A-B	CB3301	1
46	Met flm, 16.5 kΩ ±1%, 1/8 W	RF213-165	CGW	RN55D	1
48	Met flm, 1.5 kΩ ±1%, 1/8 W	RF212-150	CGW	RN55D	1
49	Comp, 1 kΩ ±10%, ¼ W	RC104-210	A-B	CB1021	1
50	Comp, 200 Ω ±5%, ¼ W	RC103-120	A-B	CB2015	1
51	Comp, 4.7 kΩ ±10%, ¼ W	RC104-247	A-B	CB4721	1
52	Comp, 330 Ω ±10%, ¼ W	RC104-133	A-B	CB3311	1
55	Comp, 47 MΩ ±10%, ¼ W	RC104-647	A-B	CB4761	1
56	Comp, 620 Ω ±5%, ¼ W	RC103-162	A-B	CB6215	1
61	Met flm, 44.2 kΩ ±1%	RF213-442	CGW	RN55D	1
62	Var comp, 10 kΩ, w/SPDT switch	RP150-310	A-B	70K1G040-R103U(1001)	1
"S"	SWITCHES				
1,2	Lever, 4 position, 2 pole	SL000-003	S-G	42125	2
3	Part of R62	---------	---	-----	-
See Model 3001 Wiring Diagram	Lever, 6 position, w/stop (White Dial)	SL000-002	CHE	L20-35AD	1
	Lever, 10 position, (White Dial)	SL001-002	CHE	L20-36AD	2
	Lever, 10 position w/decimal point (Black Dial)	SL002-002	CHE	L20-37AD	1
	Lever, 10 position std. (Black Dial)	SL003-002	CHE	L20-02A	2
	For assy C316-3 delete the following items from C316-2				
CR8	Red LED with mounting Kit	DL000-001	NAT	NSL5046	1
Q4	NPN, Si	QA038-541	G-E	2N3854A	1
Q5	PNP, Si	QB000-009	MOT	MPS3702	1
R57,58,59	Comp, 10 kΩ ±10%, ¼ W	RC104-310	A-B	CB1031	3

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	--------PARTS MOUNTED ON P.C. CARD C352--				
"C "	CAPACITORS				
1,10	Electrolytic, 1500 µF 50 V	CE102-215	C-D	WBR1500-50	2
2,5,7,8	Electrolytic, 100 µF 25 V	CE105-110	SPR	TE-1211	4
3	Ceramic Disc, .005 µF ±20% 100 V	CD103-250	SPR	TG-D50	1
4,12	Ceramic Disc. 100 pF ±20% 1 kV	CD102-110	SPR	5GA-T10	2
6	Tantalum, 10 µF ±20%, 25 V	CE120-010	SPR	162D106X0-025DD0	1
9	Electrolytic, 10,000 µF +75%-10%, 16 V	CD122-310	SPR	D76381	1
11	Electrolytic, 10 µF 25 V	CD105-010	SPR	TE-1204	1
13	Ceramic Disc, 120 µF ±20%, 1 kV	CD102-112	SPR	5GA-T12	1
"CR "	DIODES				
1,2,3,4,5,6	Silicon, Junction 200 PIV	DR000-008	G-E	1N5059	6
7	Zener, 4.7 V	DB000-010	MOT	1N4732A	1
8,10,11,12, 13,15,16, 17,18,19	Silicon, Junction 100 PIV	DR000-001	DIO	1N4004	10
9	Zener, 12 V	DB000-003	C-L	HW12B	1
14	Hot Carrier	DG000-009	H-P	5082-2835	1
"F "	FUSES				
1	Fuse, 2 A, Slo-blow	MF000-002	BUS	MDL2	1
"IC "	INTEGRATED CIRCUITS				
1	Voltage Regulator, 10-pin TO-5	IC000-001	FCD	U5R7723393	1
2	Dual Operational Amplifier, 8 pin DIP	IC000-005	MOT	MC1458P1	1
"P "	CONNECTORS (PLUGS)				
1	6 pin male	MC000-075	MOL	09-65-1061	1
2,3	9 pin male	MC000-071	MOL	09-65-1091	2
"Q "	TRANSISTORS				
1,4,5,8,9	NPN, Silicon	QA038-541	G-E	2N3854A	5
2,6	PNP, Silicon	QA036-440	FCD	2N3644	2
3	PNP, Silicon	QB000-009	MOT	MPS3702	1
7	PNP, Silicon	QB000-031	RCA	40537	1
"R "	RESISTORS				
1,2	Composition, 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	2
3	Metal Film, 499 ohm ±1%	RF211-499	CGW	RN55D	1
4*	Metal Film, 21.5 Kilohm ±1%	RF213-215	CGW	RN55D	1
5	Metal Film, 3.92 Kilohm ±1%	RF212-392	CGW	RN55D	1
6	Variable Cermet, 2 Kilohm ±20%	RP130-220	BEK	89PR2K	1
7, 26	Metal Film, 5.11 Kilohm ±1%	RF212-511	CGW	RN55D	2
9	Composition, 100 Kilohm ±10%, ¼ W	RC104-410	A-B	CB1041	1
10	Metal Film, 2.49 Kilohm ±1%	RF212-249	CGW	RN55D	1
11	Composition, 10 Kilohm ±10%, ¼ W	RC104-310	A-B	CB1031	1

PARTS LIST POWER SUPPLY

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R "	RESISTORS (Cont'd)				
12	Composition, 3.3 Kilohm ±10% ¼ W	RC104-233	A-B	CB3321	1
13	Composition, 27 Kilohm ±10% ¼ W	RC104-327	A-B	CB2731	1
14	Metal Film, 10 Kilohm ±1%	RF213-100	CGW	RN55D	1
15,28	Metal Film, 1 Kilohm ±1%	RF212-100	CGW	RN55D	2
16,17,18,33, 34,35	Metal Film, 5 ohm ±1%	RD01R-050	KID	K-C¼	6
19	Composition, 220 ohm ±10% ¼ W	RC104-122	A-B	CB2211	1
20,21	Metal Film, 10 Kilohm ±1% matched to ±.1%	RX000-003	W-I	RX000-003	1
22,27,30	Composition, 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	3
23	Metal Film, 11.3 Kilohm ±1%	RF213-113	CGW	RN60D	1
24	Metal Film, 8.06 Kilohm ±1%	RF212-806	CGW	RN55D	1
25	Wire Wound, 41 Turns of 28 gage wire .2" dia	RX000-009	W-I	RX000-009	1
29	Metal Film, 16.5 Kilohm ±1%	RF213-165	CGW	RN55D	1
31	Composition, 2.7 Kilohm ±10% ½ W	RC106-227	A-B	EB2721	1
32	Composition, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	1
	For C352-1 ADD the following to above assembly				
R 8	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	1
	PARTS MOUNTED ON CHASSIS				
"F 100"	FUSES				
1	Fuse, 1 amp 115 volt	MF000-010	BUS	MDL1	-
	Fuse, .5 amp 230 volt	MF000-007	BUS	MDV½	-
"J 100"	CONNECTORS (JACKS)				
1	6 pin, female	MC000-076	MOL	09-50-3061	-
2	9 pin, female	MC000-067	MOL	09-50-3091	-
"P 100"	CONNECTOR (PLUG)				
1	AC Plug/Cord Assembly	WL002-088	BEL	17237	-
"Q 100"	TRANSISTORS				
1,2	NPN, Silicon	QA060-990	RCA	2N6099	2
3	NPN, Silicon	QA052-940	RCA	2N5294	1

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	---Parts Mounted on Chassis cont'd.---				
"S 100"	SWITCHES				
1	Power Switch, SPST	ST001-007	W-I	ST001-007	-
2	Switch, DPDT, Slide	SS000-003	S-I	46256LFE	-
"T 100"	TRANSFORMER				
1	Transformer, w/cover	TT000-025	W-I	TT000-025	-
	MISCELLANEOUS				
	Bushing Strain Relief	HB104-002	HEY	SR5P-4	-
	Fuse Holder	MF000-001	BUS	HMM	-
	Transistor Mounting Insulator	HQ101-003	W-I	HQ101-003	3
	Shoulder Washer, Nylon #4	HW110-400	RCA	DF137A	3

PARTS LIST SWEEP DRIVE MODULE M2M REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"C "	CAPACITORS				
1,2,3	Ceramic Feedthru, 120 pF ±10% 500 V	CF102-112	A-B	FA5C	3
4,5	Ceramic Disc, .05 µF +80 -20% 100 V	CD103-350	SPR	TG-S50	2
6,7	Ceramic Feedthru, 1000 pF ±20% 500 v	CF112-210	A-B	FA5C	2
"CR "	DIODES				
1,2,3,4,5,6, ,7,8	Silicon, Junction 100 PIV 750 mA	DR000-001	ITT	1N4004	8
"IC "	INTEGRATED CIRCUITS				
1,2	Dual Operational Amplifier, 8 pin, DIP	IC000-005	MOT	MC1458PI	2
"L "	INDUCTORS				
1,2	10 Turn Toroid	LA006-010	W-I	LA006-010	2
"Q "	TRANSISTORS				
1	PNP, Silicon	QA042-500	FCD	2N4250	1
2	NPN, Silicon	QA050-880	MOT	2N5088	1
"R "	RESISTORS				
1,39	Fixed Metal Film, 56.2 Kilohm ±1%	RF213-562	CGW	RN55D	2
2,38	Variable Cermet, 20 Kilohm	RP131-320	CTS	360T203B	2
3,15,26,32	Fixed Metal Film, 100 Kilohm ±1%	RF214-100	CGW	RN55D	4
4,40	Fixed Metal Film, 4.02 Kilohm ±1%	RF212-402	CGW	RN55D	2
5	Fixed Comp., 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	1
6,11,12,25	Fixed Comp., 330 Kilohm ±10% ¼ W	RC104-433	A-B	CB3341	4
7,10,13,24, 30,34,37	Variable Cermet, 100 Kilohm	RP131-410	CTS	360T104B	7
8,18,23,31, 33	Fixed Metal Film, 1 Kilohm ±1%	RF212-100	CGW	RN55D	5
9	Fixed Metal Film, 3.01 Kilohm ±1%	RF212-301	CGW	RN55D	1
14	Fixed Metal Film, 5.11 Kilohm ±1%	RF212-511	CGW	RN55D	1
16	Fixed Comp., 910 Kilohm ±5% ¼ W	RC103-491	A-B	CB9145	1
17	Fixed Comp., 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	1
19	Fixed Metal Film, 16.5 Kilohm ±1%	RF213-165	CGW	RN55D	1
20	Fixed Metal Film, 40.2 Kilohm ±1%	RF213-402	CGW	RN55D	1
21	Fixed Comp., 270 Kilohm ±10% ¼ W	RC104-427	A-B	CB2741	1
22,28	Variable Cermet, 20 Kilohm	RP130-320	HEL	89PR20K	2
27	Fixed Comp., 75 Kilohm ±5% ¼ W	RC103-375	A-B	CB7535	1
29,35	Fixed Comp., 220 Kilohm ±10% ¼ W	RC104-422	A-B	CB2241	2
36	Fixed Comp., 120 Kilohm ±10% ¼ W	RC104-412	A-B	CB1241	1

PARTS LIST SWEEP OSCILLATOR MODULE M9W M9W-1 REV F

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"C "	CAPACITORS				
1,4,22,23	Ceramic Feedthru, 6.8 pF ±10% 500 V	CF102-R68	A-B	FA5C	4
2	Ceramic Feedthru, 470 pF ±10% 500 V	CF101-147	A-B	FA5C	1
3	Ceramic Feedthru, 120 pF ±10% 500 V	CF102-112	A-B	FA5C	1
5	Composition, 2.0 pF ±10% 500 V	CG101-220	Q-C	QC2.0	1
6,7,8,9,24, 38,40,41, 42	Tantalum, .47 µF 50 V	CE113-447	TRW	Type 935	9
10,11,12,13, 20,21,26, 28,36,43	Ceramic Feedthru, 100 pF ±20% 250 V	CF104-110	AER	EF4	10
14,15,16,17, 32,33,34	Composition, 10 pF ±10% 500 V	CG101-310	Q-C	QC10	7
18,35	Ceramic Disc, 120 pF ±20% 1 kV	CD102-112	SPR	5GA-T12	2
19	Ceramic Disc, .02 µF ±20% 100 V	CD103-320	SPR	TG-S20	1
25	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF4	1
27	Composition, 1 pF ±10% 500 V	CG101-210	Q-C	QC1.0	1
29	Composition, .75 ±10% 500 V	CG101-175	Q-C	QC.75	1
30	Ceramic Chip, 1 pF ±.25 pF 100 V	CC101-R10	VAR	3BN100S1ROC	1
31	Composition, 3 pF ±10% 500 V	CG101-230	Q-C	QC3.0	1
37,39	Ceramic Feedthru, 1000 pF GMV 500 V	CF112-210	A-B	FA5C	2
44	Ceramic disc, 100 pF ±20%, 1 kV	CD102-110	SPR	5GA-T10	1
"IC "	DIODES				
1,2,3,4,9	Varactor	DC000-008	W-I	DC000-008	5
5,7,10	Silicon, PIN	DP000-040	M-A	MA47047	3
6,8,11	Silicon, Point Contact	DG100-821	G-L	1N82AS	3
"IC "	INTEGRATED CIRCUITS				
1,2,3,4	Operational Amplifier, 8 pin, TO-5	IC000-004	SIG	N5741T	4
"J "	CONNECTORS (JACKS)				
1,2	Jack, 50 ohm, subminiature	JF000-005	APL	27-9	2
"L "	INDUCTORS				
1,2,21,22	10 Turn Toroid	LA006-010	W-I	LA006-010	4
3,4,7,8,11, 12,14,15, 16,17,20	Fixed,	Not assign	W-I	------	11
5,9,10,13, 18,19	Fixed, .22 µH	LA005-R02	ASE	08NR47K	6
6	Fixed, .22 µH	LA008-R02	SYS	506	1
23	4 Turn Toroid	LA006-004	W-I	LA006-004	1
"Q "	TRANSISTORS				
1	N-channel, JFET	QA054-580	MOT	5458	1
2	NPN Silicon, Wideband Amp	QB000-013	APX	A430	1
3,4,6,7	NPN, Silicon	QA050-530	APX	2N5053	4
5	NPN, Silicon	QA051-090	RCA	2N5109	1
"R "	RESISTORS				
1,14	Composition, 12 Kilohm ±10% ¼ W	RC104-312	A-B	CB1231	2
2,38	Variable, 5 Kilohm	RP130-250	BEK	89PR5K	2
3	Composition, 100 ohm ±10% ¼ W	RC104-110	A-B	CB1011	1

PARTS LIST SWEEP OSCILLATOR MODULE M9W M9W-1 REV F

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R "	RESISTORS (Cont'd)				
4,27,29,42, 60	Composition, 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	5
5	Composition, 330 ohm ±10% ¼ W	RC104-133	A-B	CB3311	1
6	Composition, 47 Kilohm ±10% ¼ W	RC104-347	A-B	CB4731	1
7	Composition, 10 Megohm ±10% ¼ W	RC104-610	A-B	CB1061	1
8	Composition, 33 Kilohm ±10% ¼ W	RC104-333	A-B	CB3331	1
9	Composition, 10 ohm ±10% ¼ W	RC104-010	A-B	CB1001	1
10	Composition, 680 ohm ±10% ¼ W	RC104-168	A-B	CB6811	1
11,15	Composition, 8.2 Kilohm ±10% ¼ W	RC104-282	A-B	CB8221	2
12,13	Composition, 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	2
16,22,28,32, 33,34,50, 54,59,61	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	10
17,20,23,37, 39,48,51, 55	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	8
18,24,52,56	Composition, 560 ohm ±10% ¼ W	RC104-156	A-B	CB5611	4
19,21,49,53	Composition, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	4
25,46	Variable, 20 Kilohm	RP130-320	BEK	89PR20K	2
26,31	Composition, 470 Kilohm ±10% ¼ W	RC104-447	A-B	CB4741	2
30,57	Variable, 20 Kilohm	RP129-320	CTS	360S203B	2
35,62	Composition, 47 ohm ±5% ½ W	RC105-047	A-B	EB4705	2
36,63	Composition, 47 ohm ±10% ¼ W	RC104-047	A-B	CB4701	2
40	Composition, 51 Kilohm ±5% ¼ W	RC103-351	A-B	CB5135	1
41,58	Composition, 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	2
43	Composition, 5.6 Kilohm ±10% ¼ W	RC104-256	A-B	CB5621	1
44	Composition, 150 ohm ±10% ½ W	RC106-115	A-B	EB1511	1
45	Composition, 3.9 Kilohm ±10% ¼ W	RC104-239	A-B	CB3921	1
47	Composition, 1.2 Kilohm ±10% ¼ W	RC104-212	A-B	CB1221	1
64	Composition, 270 ohm ±10% ¼ W	RC104-127	A-B	CB2711	1
65	Comp, 1.2 Kilohm ±10% (A-B only) ¼ W	RC104-212	A-B	CB1221	1
66	Comp, 6.2 Kilohm ±10% (A-B only) ¼ W	RC104-262	A-B	CB6221	1
	MIXER P.C. BOARD				
"C 100"	CAPACITORS				
1	Composition, 2.4 pF ±10% 500 V	CG101-224	Q-C	QC2.4	-
"CR 100"	DIODES				
1,2,3,4	Hot Carrier	DG000-009	H-P	5082-283 5	-
"T 100"	TRANSFORMERS				
1	RF Transformer	TR001-003	W-I	TR001-003	-
2	RF Transformer	TR002-001	W-I	TR002-001	-
	PRE-AMP ASSEMBLY				
"C 200"	CAPACITORS				
1,5	Tantalum, .47 µF 50 V	CE113-447	TRW	Type 935	-
2	Tantalum, 1 µF 25 V	CE120-001	C-I	CCT025-105	-
3,4	Ceramic Feedthru, 500 pF	CF104-150	AER	EF4	-
6	Composition, 2 pF ±10% 500 V	CG101-220	Q-C	QC2.0	-

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	---Pre Amp Assembly cont'd.---				
"CR 200"	DIODES				
1	Zener, 6.8 V, 1 W, 10%	DB000-001	C-L	ZD6.8A	-
"J 200"	CONNECTORS (JACKS)				
1	Jack, 50 ohm, subminiature	JF000-005	APL	27-9	-
"L 200"	INDUCTORS				
1,3	Fixed	Not assign	W-I	------	-
2	Fixed, .22 µH	LA005-R02	ASE	08NR47K	-
4	10 Turn Toroid	LA006-010	W-I	LA006-010	-
"Q 200"	TRANSISTORS				
1,2	NPN, Silicon	QA050-530	AMP	2N5053	-
3	NPN, Silicon	QA051-790	RCA	2N5179	-
"R 200"	RESISTORS				
1	Composition, 100 ohm ±10% ¼ W	RC104-110	A-B	CB1011	-
2	Composition, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	-
3	Composition, 330 ohm ±10% ¼ W	RC104-133	A-B	CB3311	-
4	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	-
5,6	Composition, 47 ohm ±10% ¼ W	RC104-047	A-B	CB4701	-
7	Composition, 270 ohm ±10% ¼ W	RC104-127	A-B	CB2711	-
	PARTS ADDED FOR M9W-1				
"C "	CAPACITORS				
43	Cer Miniature, .01 µF ±20%, 50 V	CD113-310	C-L	CY15C103M	1
"J "	CONNECTORS (JACKS)				
3	Jack, 50 ohm, subminiature	JF000-005	APL	27-9	1
"R "	RESISTORS				
65	Comp, 180 ohm ±10%, ¼ W	RC104-118	A-B	CB1811	1

PARTS LIST OUTPUT AMPLIFIER MODULE M10W M10W-1 REV K

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	Following parts are for M10W; see sheet 2 for M10W-1 differences				
"C "	CAPACITORS				
1	Ceramic Feedthru, 6.8 pF ±10%, 500 V	CF102-R68	A-B	FA5C	1
2*,8	Ceramic Disc, 120 pF ±20%, 1 kV	CD102-112	SPR	5GA-T12	2
3,4,6	Ceramic Disc, 200 pF ±20%, 1 kV	CD102-120	SPR	5GA-T20	3
5,13,14,29	Electrolytic, .47 μF 50 V	CE113-447	TRW	935	4
7	Ceramic Disc, 47 pF ±5% 1 kV	CD104-047	SPR	10TCU-Q47	1
9	Ceramic Disc, .005 μF ±20% 100 V	CD103-250	SPR	TG-D50	1
10,11,30	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF4	3
12,17,19,21	Ceramic Disc, .01 μF ±20% 100 V	CD103-310	SPR	TG-S10	4
15,24,25,32	Electrolytic, 10 μF 25 V	CE105-010	SPR	TE1204	4
16	Ceramic Disc, 15 pF ±5% 1 kV	CD101-015	SPR	10TCC-Q15	1
18,20,27,31	Ceramic Feedthru, 1000 pF ±20% 500 V	CF112-210	A-B	FA5C	4
22	Ceramic Disc, 4.7 pF ±5% 1 kV	CD101-R47	SPR	10TCC-V47	1
23	Ceramic Disc, 10 pF ±5% 1 kV	CD101-010	SPR	10TCC-Q10	1
28	Ceramic Feedthru, 100 pF ±20% 250 V	CF104-110	AER	EF4	1
33	Ceramic Disc, 470 pF ±20% 1 kV	CD102-147	SPR	5GA-T47	1
34	Comp, .10 pF ±10%, 500 V	CG101-110	Q-C	QC.1	1
"CR "	DIODES				
1,3,4	Silicon, PIN	DP000-050	W-I	DP000-050	3
2,12,13	Silicon, Hot Carrier	DG000-007	W-I	DG000-007	3
5,6,7	Silicon Junction, 100 PIV 750 mA	DR000-001	ITT	1N4002	3
8,9	Varactor	DC000-008	W-I	DC000-008	2
10,11	Varactor	DC000-005	W-I	DC000-005	2
"J "	CONNECTORS (JACKS)				
1,2	Jack, receptacle, 50 ohm subminiature	JF000-005	APL	27-9	2
"L "	INDUCTORS				
1,2,6	Fixed	Not assign	W-I	------	-
3,4,8,9,10, 11	Fixed	LA006-010	W-I	LA006-010	6
5,7,12,13,15	Fixed	LA006-004	W-I	LA006-004	5
14	Fixed, 10 mH	LA004-310	ASE	15S103K	1
"Q "	TRANSISTORS				
1	NPN, Silicon, Dual	QB000-010	SPR	TD101	1
2,3	NPN, Silicon	QA050-530	APX	2N5053	2
4,5	PNP, Silicon	QB000-009	MOT	MPS3702	2
6,10,11	NPN, Silicon	QB000-018	SSS	SD1006	3
7	NPN, Silicon	QB000-013	AER	A430	1
8,9	NPN, Silicon	QA038-541	G-E	2N3854A	2

PARTS LIST OUTPUT AMPLIFIER MODULE M10W M10W-1 REV K

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R "	RESISTORS				
1,8,45,51	Composition, 47 ohm ±10% ¼ W	RC104-047	A-B	CB4701	4
2,6,12,47	Compositon, 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	4
3,20,37	Composition, 47 Kilohm ±10% ¼ W	RC104-347	A-B	CB4731	3
4,19	Composition, 560 Kilohm ±10% ¼ W	RC104-456	A-B	CB5641	2
5,10,38,40	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	4
7	Composition, 330 ohm ±10% ¼ W	RC104-133	A-B	CB3311	1
9	Composition, 1.2 Kilohm ±10% ¼ W	RC104-212	A-B	CB1221	1
11,21	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	2
13	Composition, 150 ohm ±10% ¼ W	RC104-115	A-B	CB1511	1
14,26,31,36, 41	Composition, 10 ohm ±5% ¼ W	RC103-010	A-B	CB1005	5
15,53	Composition, 100 ohm ±10% ¼ W	RC104-110	A-B	CB1011	2
16	Composition, 820 ohm ±10% ¼ W	RC104-182	A-B	CB8211	1
17	Composition, 56 ohm ±10% ¼ W	RC104-056	A-B	CB5601	1
18,24,25	Composition, 220 ohm ±10% ¼ W	RC104-122	A-B	CB2211	3
22	Composition, 560 ohm ±10% ¼ W	RC104-156	A-B	CB5611	1
23,33	Composition, 27 ohm ±10% ¼ W	RC104-027	A-B	CB2701	2
27	Composition, 470 ohm ±5% ¼ W	RC103-147	A-B	CB4715	1
28,32,35,52*	Composition, 82 ohm ±5% ¼ W	RC103-082	A-B	CB8205	4
29	Composition, 360 ohm ±5% ½ W A-B only	RC105-136	A-B	EB3615	1
30	Composition, 1.5 Kilohm ±5% ¼ W	RC103-215	A-B	CB1525	1
34	Composition, 22 ohm ±10% ¼ W	RC104-022	A-B	CB2201	1
39	Composition, 7.5 Kilohm ±5% ¼ W	RC103-275	A-B	CB7525	1
42	Composition, 150 ohm ±5% 1 W	RC107-115	A-B	GB1515	1
43*,50	Composition, 33 Kilohm ±10% ¼ W	RC104-333	A-B	CB3331	2
44*	Composition, 39 Kilohm ±10% ¼ W	RC104-339	A-B	CB3931	1
46	Composition, 100 ohm ±5% 1 W	RC107-110	A-B	GB1015	1
48	Composition, 620 ohm, ±5%, ¼ W	RC103-162	A-B	CB6215	1
49*	Composition, 18 Kilohm ±10%, ¼ W	RC104-318	A-B	CB1831	-
54	Composition, 15 Kilohm ±10%, ¼ W	RC104-315	A-B	CB1531	1
	For module M10W-1 ADD the following parts to M10W				
C35	Ceramic disc, .05 µF +20%, 100V	CD103-350	SPR	TG-550	1
C36	Ceramic mono, .01 µF ±20%, 50 V	CD113-310	C-L	CY15C103M	1
C37	Ta, 10 µF ±20%, 20V	CE120-010	SPR	162D106XO-K25A2	1
C38	Cer ft, 1000 pF GMV, 500 V	CF112-210	A-B	FA5C	1
CR14	Silicon, PIN	DP000-040	M-A	MA47980	1
J3	Jack, receptacle. 50 ohm subminiature	JF000-005	APL	27-9	1
L16	4 Turn Toroid	LA006-004	W-I	LA006-004	1
L17	10 Turn Toroid	LA006-010	W-I	LA006-010	1
R55	Composition, 4.3 kΩ ±5%, ¼ W	RC103-243	A-B	CB4325	1
R56	Composition, 15 kΩ ±10%, ¼ W	RC104-315	A-B	CB1531	1

PARTS LIST D.A.C. MODULE M22 REV C

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"C "	CAPACITORS				
1 thru 13	Ceramic Feedthru, 1000 pF GMV 500 V	CF112-210	A-B	FA5C	13
14,15	Ceramic Feedthru, 6.8 pF ±10% 500 V	CF102-R68	A-B	FA5C	2
"IC "	INTEGRATED CIRCUITS				
1	Dual Operational Amplifier, 8 pin	IC000-005	MOT	MC1458PI	1
"Q "	TRANSISTORS				
1	NPN, Silicon	QA053-060	G-E	2N5306	1
2 thru 12, 24,25	NPN, Silicon	QA038-541	G-E	2N3854A	13
13 thru 23, 26	PNP, Silicon	QB000-009	MOT	MPS3702	12
"R "	RESISTORS				
1	Fixed Comp., 15 Kilohm ±5% ¼ W	RC103-315	A-B	CB1535	1
2,40	Fixed Comp., 3.3 Kilohm ±5% ¼ W	RC103-233	A-B	CB3325	2
3	Fixed Comp., 220 ohm ±10% ¼ W	RC104-122	A-B	CB2211	1
4,8,12	Fixed Comp., 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	3
5,6,7,9,10, 11,13,14, 15	Fixed Comp., 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	9
16 thru 26	Fixed Comp., 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	11
27 thru 37,	Fixed Comp., 22 Kilohm ±10% ¼ W	RC104-322	A-B	CB2231	11
38, 39	Fixed Comp., 270 Kilohm ±10% ¼ W	RC104-427	A-B	CB2741	2
41	Fixed Comp., 20 Kilohm ±10% ¼ W	RC103-320	A-B	CB2031	1
42	Fixed Metal Film, 17.8 Kilohm ±1%	RF213-178	CGW	RN55D	1
43	Fixed Metal Film, 4.02 Kilohm ±1%	RF212-402	CGW	RN55D	1
44	Fixed Metal Film, 2.74 Kilohm ±1%	RF212-274	CGW	RN55D	1
45	Fixed Metal Film, 8.06 Kilohm ±1%	RF212-806	CGW	RN55D	1
46	Fixed Metal Film, 16.9 Kilohm ±1%	RF213-169	CGW	RN55D	1
47	Fixed Metal Film, 34.0 Kilohm ±1%	RF213-340	CGW	RN55D	1
48	Fixed Metal Film, 42.2 Kilohm ±1%	RF213-422	CGW	RN55D	1
49	Fixed Metal Film, 86.6 Kilohm ±1%	RF213-866	CGW	RN55D	1
50,51	Variable Cermet, 2 Kilohm	RP130-220	HEL	89PR2K	2
52,53,54	Variable Cermet, 5 Kilohm	RP130-250	HEL	89PR5K	3
55,62	Fixed Metal Film, 178 Kilohm ±1%	RF214-178	CGW	RN55D	2
56,61	Fixed Metal Film, 357 Kilohm ±1%	RF214-357	CGW	RN55D	2
57	Fixed Metal Film, 442 Kilohm ±1%	RF214-442	CGW	RN55D	1
58	Fixed Metal Film, 887 Kilohm ±1%	RF214-887	CGW	RN55D	1
59	Fixed Metal Film, 1.78 Megohm ±1%	RF215-178	CGW	RN55D	1
60	Fixed Metal Film, 3.57 Megohm ±1%	RF215-357	CGW	RN55D	1
63	Fixed Metal Film, 88.7 Kilohm ±1%	RF213-887	CGW	RN55D	1
64	Fixed Metal Film, 44.2 Kilohm ±1%	RF213-442	CGW	RN55D	1
65	Fixed Metal Film, 35.7 Kilohm ±1%	RF213-357	CGW	RN55D	1
66	Variable Cermet, 100 Kilohm	RP130-410	HEL	89PR100K	1
67	Fixed Metal Film, 2.43 Megohm ±1%	RF215-243	COR	RN55D	1
68,69	Fixed Metal Film, 2.43 Kilohm ±1%	RF212-243	CGW	RN55D	2
70	Fixed Metal Film, 8.25 Kilohm ±1%	RF212-825	CGW	RN55D	1
71	Variable Cermet, 20 Kilohm	RP130-320	HEL	89PR20K	1
72	Fixed Comp., 330 Kilohm ±5% ¼ W	RC103-433	A-B	CB3345	1

PARTS LIST FM REFERENCE MODULE

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
	Following is parts list for M29-1; see sheet 2 for M29-2 differences				
"C"	CAPACITORS				
1,29,30	Ceramic Feedthru, 6.8 pF ±10% 500 V	CF102-R68	A-B	FA5C	3
2	Ceramic Disc, 75 pF N750 ±5% 1 kV	CD104-075	SPR	10TCU-Q75	1
3,5,8,9,19, 24,25,26,27	Ceramic Disc, .01 μF ±20% 100 V	CD103-310	SPR	TG-S10	9
4,10	Ceramic Disc, 150 pF ±20% 1 kV	CD102-115	SPR	5GA-T15	2
6	Ceramic Disc, .003 μF ±20% 1 kV	CD102-230	SPR	5GA-D30	1
7	Ceramic Disc, 68 pF N750 ±5% 1 kV	CD104-068	SPR	10TCU-068	1
11	Ceramic Trimmer, 7 to 35 pF	CV101-035	STR	7S-TRIKO-02	1
12*	Duramica, 68 pF ±5% 500 V	CM101-068	ARC	DM-15-680J	1
13	Duramica, 470 pF ±5% 500 V	CM101-147	ARC	DM-15-471J	1
15,18	Electrolytic, 10 uF 25 V	CE105-010	SPR	TE-1204	2
16,17	Ceramic Feedthru, 1000 pF ±20% 500 V	CF112-210	A-B	FA5C	2
20	Ceramic Disc, .001 uF ±20% 1 kV	CD102-210	SPR	5GA-010	1
21	Duramica, 100 pF ±5% 500 V	CM101-110	A-E	DM-15-101J	1
23,28	Ceramic Disc, 20 pF NPO ±5% 1 kV	CD101-020	SPR	10TCC-020	2
"CR"	DIODES				
1,10,11	Silicon junction	DR000-001	ITT	1N4004	3
2,7,8,9	Silicon epitaxial planar	DG000-011	FCD	FD6666	4
3,4,5,6	Silicon epitaxial planar	DG000-010	FCD	FD777	4
"IC"	INTEGRATED CIRCUITS				
1,2	Op Amp	IC000-008	NAT	LM301AN	2
3	Dual Independent Differential AMP	IC000-010	RCA	CA3049T	1
"J"	CONNECTORS				
1	Jack Receptacle, 50 ohm subminiature	JF000-005	APL	27-9	1
"L"	INDUCTORS				
1,2	Fixed	LA006-010	W-I	LA006-010	2
"Q"	TRANSISTORS				
1	PNP, Silicon, Dual	QB000-011	SPR	TD401	1
2	PNP, Silicon	QB000-009	MOT	MPS3702	1
3	NPN, Silicon, Dual	QB000-010	SPR	TD101	1
4	NPN, Silicon	QA038-541	G-E	2N3854A	1
5,7,10	PNP, Silicon	QA051-390	NAT	2N5139	3
6	N-Channel JFET, Dual	QB000-026	A-D	AD3958	1
8,9	PNP, Silicon	QA036-400	NAT	2N3640	2
"R"	RESISTORS				
1	Variable Cermet, 2 Kilohm ±10%	RP130-220	BEK	89PR2K	1
2,17,29,56, 57	Fixed Metal Film, 5.11 Kilohm ±1%	RF212-511	CGW	RN55D	5
3,5,10,16, 19,22,25	Fixed Metal Film, 1.0 Kilohm ±1%	RF212-100	CGW	RN55D	7
4,7,38,40,	Fixed Metal Film, 2.0 Kilohm ±1%	RF212-200	CGW	RN55D	4

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R "	RESISTORS (Cont'd)				
6,12,15	Fixed Metal Film, 110 Kilohm ±1%	RF214-110	CGW	RN55D	3
8,21	Fixed Metal Film, 249 ohm ±1%	RF211-249	CGW	RN55D	2
9,14,30,32, 33,44	Fixed Metal Film, 499 ohm ±1%	RF211-499	CGW	RN55D	6
13	Fixed Comp., 150 Kilohm ±10% ¼ W	RC104-415	A-B	CB1541	1
18	Variable Cermet, 20 Kilohm ±10%	RP130-320	BEK	89PR20K	1
20,23,58	Fixed Metal Film, 4.02 Kilohm ±1%	RF212-402	CGW	RN55D	3
26	Fixed Metal Film, 33.2 ohm ±1%	RF21R-332	CGW	RN55D	1
28,39,41,42, 46	Fixed Metal Film, 100 ohm ±1%	RF211-100	CGW	RN55D	5
34	Fixed Metal Film, 845 ohm ±1%	RF211-845	CGW	RN55D	1
35,50	Fixed Metal Film, 1.1 Kilohm ±1%	RF212-110	CGW	RN55D	2
36,37,51	Fixed Metal Film, 1.5 Kilohm ±1%	RF212-150	CGW	RN55D	3
43,54	Fixed Metal Film, 15 Kilohm ±1%	RF213-150	CGW	RN55D	2
45	Fixed Metal Film, 174 ohm ±1%	RF211-174	CGW	RN55D	1
47,49	Fixed Metal Film, 357 ohm ±1%	RF211-357	CGW	RN55D	2
48	Fixed Metal Film, 2.1 Kilohm ±1%	RF212-210	CGW	RN55D	1
55	Fixed Metal Film, 2.49 Kilohm ±1%	RF212-249	CGW	RN55D	1
59	Fixed Metal Film, 1 Megohm ±1%	RF215-100	CGW	RN55D	1
60	Fixed Metal Film, 48.7 Kilohm ±1%	RF213-487	CGW	RN55D	1
	For M29-2 ADD following parts to M29-1				
C31	Ceramic Feedthru, 6.8 pF ±10%, 500 V	CF102-R68	A-B	FA5C	1
R61	Fixed Metal Film, 10.0 Kilohm ±1%	RF213-100	CGW	RN55D	1

PARTS LIST CRYSTAL REFERENCE MODULE M30-1 M30-2 REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	Following is a parts list for M30-1; see sheet 4 for M30-2 differences				
"C "	CAPACITORS				
1,2,3,18,57, 58	Cer ft, 1000 pF GMV, 500 V	CF112-210	A-B	FA5C	6
4,5,6,7,8	Ta, 1.0 µF ±10%, 25 V	CE120-001	ACI	100DE105-K25A2	5
9	Elect, 100 µF, +100%-10%, 12 V	CE119-110	ARC	ME4D100	1
10	Elect, 100 µF, 6 V	CE118-110	ARC	ME3B100	1
13	Cer disc, 47 pF ±5%, 1 kV	CD101-047	SPR	10TCC-Q47	1
14	Small capacitance may be added in calibration				
15	Cer disc, 470 pF ±20%, 1 kV	CD102-147	SPR	TGA-T47	1
16	Cer disc, 25 pF ±5%, 1 kV	CD101-025	SPR	10TCC-Q25	1
17	Var Air, 1.4-9.2 pF	CV107-001	JON	189-0563-001	1
19,40,50	Cer disc, .005 µF +80%-20%, 100 V	CD103-250	SPR	TG-D50	3
20	Sil mica, 180 pF ±5%, 500 V	CM101-118	ARC	DM15-181J	1
21	Cer ft, 500 pF ±20%, 250 V	CF104-150	AER	EF4	1
22	Cer disc, 20 pF ±5%, 1 kV	CD101-020	SPR	10TCC-Q20	1
23	Cer disc, 100 pF ±20%, 250 V	CF104-110	AER	EF4	1
24,25,28,40, 45	Cer ft, 2200 pF GMV, 500 V	CF115-222	AER	4420	5
26,34,36,39, 42,47,57	Var, cer, 3.5-13 pF, disc	CV101-013	STR	7S-TRIKO-02	7
27*	Cer disc, 4.7 pF ±5%, 1 kV	CD101-R47	SPR	10TCC-V47	1
29	Cer disc, 200 pF ±20%, 1 kV	CD102-120	SPR	5GA-T20	1
30	Cer disc, 15 pF ±5%, 1 kV	CD101-015	SPR	10TCC-Q15	1
31	Comp, 2.0 pF ±10%, 500 V	CG101-220	Q-C	QC2.0	1
32	Comp, 4.7 pF ±10%, 500 V	CG102-247	Q-C	MC4.7	1
33,38	Comp, 1.1 pF ±10%, 500 V	CG102-211	Q-C	MC1.1	2
35,37	Comp, .47 pF ±10%, 500 V	CG102-147	Q-C	MC.47	2
41,46	Cer ft, 500 pF ±20%, 250 V	CF104-150	AER	EF4	2
43	Cer ft, 27 pF ±5%, 500 V	CF114-027	AER	4420	1
44,49,51,52	Cer disc, 10 pF ±5%, 1 kV	CD101-010	SPR	10TCC-Q10	4
48	Cer ft, 100 pF ±20%, 250 V	CF104-110	AER	EF4	1
53,55	Var, cer, .5-3 pF	CV102-R30	STR	R-TRIKO-104	2
54	Comp, .1 pF ±10%, 500 V	CG101-110	Q-C	QC.10	1
56	Comp, .75 pF ±10%, 500 V	CG102-175	Q-C	MC.75	1
59	Comp, 10 pF ±10%, 500 V	CG101-310	Q-C	QC10	1
"CR "	DIODES				
1,2,4	Si, Junction, 100 PIV	DR000-001	DIO	1N4004	3
3	Si, PIN	DP000-040	M-A	MA47047	1
5	Germanium, Point Contact	DG100-341	HIT	1N34AS	1
6,7	Step Recovery	DG000-012	H-P	5082-0180	2
8	Varactor	DC000-005	W-I	DC000-005	1

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"IC "	INTEGRATED CIRCUITS				
1	Voltage Regulator, 5 V	IC000-011	FCD	μA78M05UC	1
2	Operational Amplifier, 8 pin, DIP	IC000-002	SIG	N5741V	1
"J "	CONNECTORS (JACKS)				
1,2,3,4,5, 6,7	Jack, 50 Ω, subminiature	JF000-005	APL	27-9	7
"L "	INDUCTORS				
1,2,3,27	10 Turn Toroid	LA006-010	W-I	LA006-010	4
7	Fxd, .47 μH, conformal coated	LA005-R04	ASE	08NR47K	1
8,9,16,17	4 Turn Toroid	LA006-004	W-I	LA006-004	4
10,11,21,23, 24,25	Fxd, -----	not assigned	W-I	-----	–
12,13,14,15, 19	Fxd, .22 μH, conformal coated	LA005-R02	ASE	08NR22K	5
18	Fxd, .10 μH, conformal coated	LA005-R01	ASE	08NR10K	1
20	Fxd, 1 μH, conformal coated	LA005-R10	ASE	08N1R0K	1
26	Lug, #6	HG102-600	W-I	HG102-600	1
"Q "	TRANSISTORS				
1,2,6,7,8 9,10	NPN, Si	QA050-530	AMP	2N5053	7
3	NPN, Si	QA051-790	RCA	2N5179	1
4,5	NPN, Si	QA038-541	G-E	2N3854A	2
"R "	RESISTORS				
4	Met flm, 5.11 kΩ ±1%, 1/8 W	RF212-511	CGW	RN55D	1
5,50	Met flm, 10 kΩ ±1%, 1/8 W	RF213-100	CGW	RN55D	2
6,18,19	Met flm, 2 kΩ ±1%, 1/8 W	RF212-200	CGW	RN55D	3
7,14,23,41	Comp, 100 Ω ±10%, ¼ W	RC104-110	A-B	CB1011	4
8,29	Comp, 2.2 kΩ ±10%, ¼ W	RC104-222	A-B	CB2221	2
9,11,22	Comp, 1 kΩ ±10%, ¼ W	RC104-210	A-B	CB1021	3
10	Comp, 100 kΩ ±10%, ¼ W	RC104-410	A-B	CB1041	1
12	Comp, 4.7 kΩ ±10%, ¼ W	RC104-247	A-B	CB4721	1
13	Comp, 470 kΩ ±10%, ¼ W	RC104-447	A-B	CB4741	1
15	Met flm, 40.2 kΩ ±1%, 1/8 W	RF213-402	CGW	RN55D	1
16	Met flm, 15 kΩ ±1%, 1/8 W	RF213-150	CGW	RN55D	1
17	Comp, 1.5 kΩ ±5%, ¼ W	RC103-215	A-B	CB1525	1
20	Comp, 1.8 kΩ ±5%, ¼ W	RC103-218	A-B	CB1825	1

PARTS LIST CRYSTAL REFERENCE

MODULE M30-1 M30-2 REV A

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R "	RESISTORS				
21	Comp, 220 Ω ±10%, ¼ W	RC104-122	A-B	CB2211	1
24	Comp, 10 Ω ±5%, 1/8 W	RC101-010	A-B	BB1005	1
25,26	Comp, 100 Ω ±5%, 1/8 W	RC101-110	A-B	BB1015	2
27	Comp, 47 kΩ ±10%, ¼ W	RC104-347	A-B	CB4731	1
28	Comp, 22 kΩ ±10%, ¼ W	RC104-322	A-B	CB2231	1
30,36,43	Comp, 33 kΩ ±10%, ¼ W	RC104-333	A-B	CB3331	3
31,35,42	Comp, 10 kΩ ±10%, ¼ W	RC104-310	A-B	CB1031	3
32,38,44,45	Comp, 47 Ω ±5%, 1/8 W	RC101-047	A-B	BB4705	4
33,39,49	Comp, 470 Ω ±10%, ¼ W	RC104-147	A-B	CB4711	3
34,37	Comp, 22 Ω ±5%, 1/8 W	RC101-022	A-B	BB2205	2
40	Comp, 82 Ω ±10%, ¼ W	RC104-082	A-B	CB8201	1
46,47	Comp, 270 Ω ±5%, 1/8 W	RC101-127	A-B	CB2715	2
48	Comp, 10 Ω ±10%, ¼ W	RC104-010	A-B	CB1001	1
51	Met flm, 34 kΩ ±1%, 1/8 W	RF213-340	CGW	RN55D	1
52	Met flm, 13 kΩ ±1%, 1/8 W	RF213-130	CGW	RN55D	1
"T "	TRANSFORMERS				
1	RF Transformer	TR004-001	W-I	TR004-001	1
"X "	CRYSTALS				
1	X40W, 40.00000 MHz	XX000-040	W-I	XX000-040	1
	MISCELLANEOUS				
	IC Socket, 8 pin, DIP	MC000-040	T-I	C930802	1
	--------DIVIDER SUB-ASSEMBLY--------				
"C 100"	CAPACITORS				
1,3,4,5,6,7	Ta, 1.0 μF ±10%, 25 V	CE120-001	ACI	100DE105-K25A2	6
2	Cer disc, .01 μF ±20%, 100 V	CD103-310	SPR	TG-S10	1
"IC 100"	INTEGRATED CIRCUITS				
1	Flip-Flop, Dual D Type, Schottky	IC000-015	T-I	SN74S74N	1
2	Decade Counter, 14 pin, DIP	IC000-016	SIG	N8290A	1
3,4,5	Decade Counter, 14 pin, DIP	IC000-003	SIG	N8292A	3

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	---DIVIDER SUB-ASSEMBLY (CONTINUED)------				
"L 100"	INDUCTORS				
1,3,4,5,6,7	10 Turn Toroid	LA006-010	W-I	LA006-010	6
2	4 Turn Toroid	LA006-004	W-I	LA006-004	1
"R 100"	RESISTORS				
1	Comp, 390 ±10%, ¼ W	RC104-139	A-B	CB3911	1
2	Comp, 100 ±10%, ¼ W	RC104-110	A-B	CB1011	1
3	Comp, 1.8 k ±10%, ¼ W	RC104-218	A-B	CB1821	1
	MISCELLANEOUS				
	IC Socket, 14 pin, DIP	MC000-073	T-I	C931402	5
	For M30-2 change the M30-1 as follows				
	ADD				
C16	Cer disc, 33 pF ±5%, 1 kV	CD101-033	SPR	10TCC-Q33	1
	DELETE				
C16	Cer disc, 25 pF ±5%, 1 kV	CD101-025	SPR	10TCC-Q25	1
C57,58	Cer ft, 1000 pF GMV, 500 V	CF112-210	A-B	FA5C	2
C59	Comp, 10 pF ±10%, 500 V	CG101-310	Q-C	QC10	1
CR8	Varactor	DC000-005	W-I	DC000-005	1
L27	10 Turn Toroid	LA006-010	W-I	LA006-010	1
R50	Met flm, 10 kΩ ±1%, 1/8 W	RF213-100	CGW	RN55D	1
R51	Met flm, 34 kΩ ±1%, 1/8 W	RF213-340	CGW	RN55D	1
R52	Met flm, 13 kΩ ±1%, 1/8 W	RF213-130	CGW	RN55D	1

PARTS LIST kHz STEPS

MODULE M31 REV E

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	-------MAIN P.C. BOARD (Z261) PARTS-------				
"C "	CAPACITORS				
1 thru 12, 14,19,20	Ceramic Feedthru, 1000 pF ±20% 500 V	CF112-210	A-B	FA5C-1000	15
13,32	Ceramic Disc, .05 µF ±20% 100 V	CD103-350	SPR	TG-S50	2
15	Electrolytic, 100 µF 12 V	CE119-110	ARC	ME4D100	1
16	Electrolytic, 100 µF 6 V	CE118-110	ARC	ME3B100	1
17,22	Ceramic Disc, .01 µF ±20% 100 V	CD103-310	SPR	TG-S10	2
18,21	Electrolytic, 1 µF 25 V	CE120-001	C-I	CCT025-105	2
23	Ceramic Feedthru, 6.8 pF ±10% 500 V	CF102-R68	A-B	FA5C	1
24,25	Ceramic Disc, .001 µF ±20% 1 kV	CD102-210	SPR	5GA-D10	2
26,27	Duramica, 180 pF ±5% 500 V	CM101-118	ARC	DM15-181J	2
28,33	Electrolytic, .47 µF 50 V	CE113-447	TRW	Type 935	2
29	Ceramic Disc, 10 pF ±5% 1 kV	CD101-010	SPR	10TCC-Q10	1
30	Duramica, 68 pF ±5% 500 V	CM101-068	ARC	DM15-680J	1
31	Duramica, .002 µF ±5% 500 V	CM101-220	ARC	DM19-202J	1
"CR "	DIODES				
1,2	Silicon Junction, "FCD" only	DR001-001	W-I	DR001-001	2
3,4,5	Silicon Junction, 100 PIV	DR000-001	ITT	1N4004	3
5	Red LED with mounting kit	DL000-001	FCD	FLV102	1
6	Varactor Diode	DC000-007	W-I	DC000-007	1
"IC "	INTEGRATED CIRCUITS				
1,2,12	Hex Inverter	IC000-012	T-I	SN7404N	3
3,4,6	Decade Counter	IC000-016	SIG	N8290A	3
5	Decade Counter	IC000-017	SIG	N82S90A	1
7	AND Gate, Triple 3-Input	IC000-018	SIG	N74H11A	1
8	Flip-Flop, J-K with AND inputs	IC000-019	T-I	SN74H102N	1
9	Phase-Frequency Detector	IC000-029	FCD	11C44	1
10	Dual Operational Amplifier	IC000-005	MOT	MC1458PI	1
11	Voltage regulator, 5 V	IC000-011	FCD	MA78M05UC	1
"J "	CONNECTORS (JACKS)				
1,2	Jack Receptacle, 50 ohm	JF000-005	APL	27-9	2
"L "	INDUCTORS				
1 thru 16	10 Turn Toroid	LA006-010	W-I	LA006-010	16
17	Fixed, 2.2 µH ±10%	LA005-R22	ASE	08N2R2	1
18	13 Turn (32 AWG) on 2.2 Megohm resistor	not assign	W-I	not assign	1
19	Fixed, .22 µH ±20%	LA005-R02	ASE	08NR22K	1
"Q "	TRANSISTORS				
1,4	NPN, Silicon	QA038-541	G-E	2N3854A	2
2	N-channel, JFET	QA054-580	MOT	2N5458	1
3	NPN, Silicon, Darlington	QA053-060	G-E	2N5306	1

PARTS LIST kHz STEPS — MODULE M31 REV E

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	---Main P.C. Board Parts cont'd.---				
"R "	RESISTORS				
1,2	Composition, 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	2
3	Composition, 33 Kilohm ±10% ¼ W	RC104-333	A-B	CB3331	1
4	Composition, 27 Kilohm ±5% ¼ W	RC103-327	A-B	CB2735	1
5	Composition, 12 Kilohm ±5% ¼ W	RC103-312	A-B	CB1235	1
6	Composition, 1 Megohm ±10% ¼ W	RC104-510	A-B	CB1051	1
7,13,27	Composition, 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	3
8,9	Composition, 100 Kilohm ±5% 1/8 W	RC101-410	A-B	BB1045	2
10,11	Composition, 220 Kilohm ±5% 1/8 W	RC101-422	A-B	BB2245	2
12,19	Composition, 1.8 Kilohm ±10% ¼ W	RC104-218	A-B	CB1821	2
14	Composition, 15 Kilohm ±10% ¼ W	RC104-315	A-B	CB1531	1
15	Compositoin, 220 Kilohm ±10% ¼ W	RC104-422	A-B	CB2241	1
16,18	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	2
17	Composition, 2.7 Kilohm ±10% ¼ W	RC104-227	A-B	CB2721	1
20	Metal Film, 2.1 Kilohm ±1% 1/8 W	RF212-210	CGW	RN55D	1
21,22	Metal Film, 19.6 Kilohm ±1% 1/8 W	RF213-196	CGW	RN55D	2
23	Metal Film, 4.32 Kilohm ±1% 1/8 W	RF212-432	CGW	RN55D	1
24	Metal Film, 30.1 Kilohm ±1% 1/8 W	RF213-301	CGW	RN55D	1
25	Composition, 3.3 Megohm ±10% ¼ W	RC104-533	A-B	CB3351	1
26	Metal Film, 100 Kilohm ±1% 1/8 W	RF214-100	CGW	RN55D	1
28	Composition, 390 Kilohm ±10% ¼ W	RC104-439	A-B	CB3941	1
29	Metal Film, 12.1 Kilohm ±1% 1/8 W	RF213-121	CGW	RN55D	1
30	Metal Film, 36.5 Kilohm ±1% 1/8 W	RF213-365	CGW	RN55D	1
31	Metal Film, 12.1 Kilohm ±1% 1/8 W	RF213-121	CGW	RN55D	1
32	Variable Cermet, 20 Kilohm ±20%	RP130-320	CGW	89PR20K	1
33	Variable Cermet, 2.0 Kilohm ±20%	RP130-220	BEK	89PR2K	1
34	Composition, 2.0 Kilohm ±5%, ¼ W	RC103-220	A-B	CB2025	1
	MISCELLANEOUS				
	Male Pole Contact	MC000-057	AMP	85891-6	17
	Component Socket	MC000-072	MOL	02-04-1875	2
	-------DAC - P.C. BOARD PARTS-------				
"IC 100"	INTEGRATED CIRCUITS				
1,2	Dual Operational Amplifier	IC000-005	MOT	MC1458PI	2
"Q 100"	TRANSISTORS				
1A thru L	PNP, Silicon	QB000-009	MOT	MPS3702	12
2A thru L	NPN, Silicon	QA038-541	G-E	2N3854A	12
"R 100"	RESISTORS				
1,7,11,15	Metal Film, 10 Kilohm ±1% 1/8 W	RF213-100	CGW	RN55D	4
2	Metal Film, 100 Kilohm ±1% 1/8 W	RF214-100	CGW	RN55D	1
3	Composition, 1 Megohm ±10% ¼ W	RC104-510	A-B	CB1051	1
4,5,6	Metal Film, 4.32 Kilohm ±1% 1/8 W	RF212-432	CGW	RN55D	3
8,12,16	Metal Film, 20 Kilohm ±1% 1/8 W	RF213-200	CGW	RN55D	3

PARTS LIST kHz STEPS MODULE M31 REV E

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	-----------DAC cont'd.-----------				
"R 100"	RESISTORS (Cont'd)				
9,13,17	Metal Film, 40.2 Kilohm ±1% 1/8 W	RF213-402	CGW	RN55D	3
10,14,18	Metal Film, 80.6 Kilohm ±1% 1/8 W	RF213-806	CGW	RN55D	3
19A thru L	Composition, 22 Kilohm ±10% ¼ W	RC104-322	A-B	CB2231	12
20A thru L	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	12
21,25,29	Composition, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	3
22,23,24,26, 27,28,30, 31,32	Composition, 1 Kilohm ±10% ¼ W	RC104-210	a-B	CB1021	9
33	Composition, 6.8 Kilohm ±5% ¼ W	RC103-268	A-B	CB6825	1
34	Composition, 820 ohm ±5% ¼ W	RC103-182	A-B	CB8215	1
	MISCELLANEOUS				
	10 Contact Receptacle	MC000-051	AMP	6-38095-0	1
	5 Contact Receptacle	MC000-052	AMP	5-380950-5	1
	2 Contact Receptacle	MC000-077	W-I	MC000-077	1

PARTS LIST MHz STEPS MODULE M32 REV E

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	MAIN CHASSIS (S-1)				
"C"	CAPACITORS				
1,29,30	Ceramic Feedthru, 470 pF ±20% 500 V	CF101-147	A-B	FA5C4711	3
4,15,16,18, 19,39,40,	Tantalum, 1 μF 25 V	CE120-001	C-I	CCT025-105-20	7
5,17,20,21, 22,23,24, 25,26,27	Ceramic Feedthru, Module Base Type, 1000pF	CF112-210	A-B	FA5C-1000pF	10
9	Electrolytic, 100 μF 12 V	CE119-110	A-E	ME4D100	1
12,28,35,41, 44	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF-4	5
13,42	Composition, 3.9 pF ±10% 500 V	CG101-239	Q-C	QC3.9	2
14	Electrolytic, 100 μF 6 V	CE118-110	A-E	ME3B100	1
31,38	Ceramic Feedthru, 100 pF ±10%	CF104-110	AER	EF-4	2
32	Composition, 0.75 pF	CG102-175	Q-C	MC.75	1
33	Fixed	not assign	W-I	------	–
34,37	Composition, 0.62 pF	CG102-162	Q-C	MC.62	2
36	Ceramic Disc, Solder-in 22 pF ±10%	CD108-022	RMC	C,N220	1
43	Ceramic Feedthru, 120 pF ±10% 500 V	CF102-112	A-B	FA5C-120	1
"CR"	DIODES				
5	Silicon, Hot Carrier	DG000-009	H-P	5082-2835	1
6	Silicon, Varicap	DC000-005	W-I	DC000-005	1
7	Red LED and mounting kit	DL000-001	NAT	NSL102	1
"IC"	INTEGRATED CIRCUITS				
2	5 V Regulator	IC000-011	NAT	NA78M05UC	1
"J"	CONNECTORS (JACKS)				
1,2,3,4,5	Jack, 50 ohm subminiature	JF000-005	AMP	27-9	5
"L"	INDUCTORS				
1,3,5,6,7,8, 9,10,11, 12,13,14, 15,22,23,	10 Turn Toroid	LA006-010	W-I	LA006-010	15
16	Fixed, .22 μH ±10%	LA005-R02	ASE	08NR22K	1
17,18,19,20	Fixed	not assign	W-I	------	–
24	4 Turn Toroid	LA006-004	W-I	LA006-004	1
"OC"	OPTO-COUPLER				
1	LED/Photocell	MP000-002	VAC	VTL5C3	1
"Q"	TRANSISTORS				
1	NPN, Silicon	QB000-013	APX	A430	1
2,3	NPN, Silicon	QA050-530	APX	2N5053	2

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R "	RESISTORS				
2	Composition, 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	1
8	Composition, 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	1
9	Metal Film, 499 ohm ±1% ¼ W	RF211-499	CGW	RN55D	1
18	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	1
11,17,19	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	3
12	Composition, 2.7 ohm ±5% ¼ W	RC103-R27	A-B	CB27G5	1
13	Composition, 820 ohm ±5% 1/8 W	RC101-182	A-B	BB8215	1
14	Composition, 2.7 Kilohm ±10% ¼ W	RC104-227	A-B	CB2721	1
15	Composition, 18 Kilohm ±5% 1/8 W	RC101-318	A-B	BB1835	1
16,21	Composition, 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	2
10,20	Composition, 4.7 Kilohm ±5% 1/8 W	RC101-247	A-B	BB4725	2
24	Composition, 1.2 Kilohm ±5% 1/8 W	RC101-212	A-B	BB1225	1
22	Composition, 68 ohm ±5% 1/8 W	RC101-068	A-B	BB6805	1
23	Composition, 15 Kilohm ±10% ¼ W	RC104-315	A-B	CB1531	1
25	Composition, 33 ohm ±10% ¼ W	RC104-033	A-B	CB3301	1
	---VIDEO AMP. ASSEMBLY (S-2)---				
"C 100"	CAPACITORS				
1,8	Ceramic Miniature, .01 μF ±20% 50 V	CD113-310	C-L	CY15C103	2
3,4,6,10, 12,14	Tantalum, 1 μF 25 V	CE120-001	ACI	100DE105	6
2,5,7	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF-4	3
9	Ceramic Disc, 120 pF ±20% 1 kV	CD102-112	SPR	5GA-T12	1
11,13	Ceramic Feedthru, 68 pF ±10%	CF120-068	AER	4420	2
"L 100"	INDUCTORS				
1,7	Fixed, 0.22 μH ±10%	LA005-R02	ASE	08NR22K	2
2	Fixed, 1.0 μH ±10%	LA005-R10	ASE	08N1R0K	1
3	10 Turn Toroid	LA006-010	W-I	LA006-010	1
4	4 Turn Toroid	LA006-004	W-I	LA006-004	1
5,6	Fixed, .1 μH ±10%	LA005-R01	ASE	08NR10K	2
"Q 100"	TRANSISTORS				
1,2,3,4,5	NPN, Silicon	QA050-530	APX	2N5053	5

PARTS LIST MHz STEPS   MODULE M32 REV E

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"R 100"	RESISTORS				
1	Fixed Comp., 82 ohm ±10% ¼ W	RC104-082	A-B	CB8201	1
2,7	Fixed Comp., 560 ohm ±10% ¼ W	RC104-156	A-B	CB5611	2
3,6	Fixed Comp., 820 ohm ±5% 1/8 W	RC101-182	A-B	BB8215	2
4	Fixed Comp., 47 ohm ±5% 1/8 W	RC101-047	A-B	BB4705	1
5	Fixed Comp., 68 ohm ±5% 1/8 W	RC101-068	A-B	BB6805	1
8	Fixed Comp., 100 ohm ±5% 1/8 W	RC101-110	A-B	BB1015	1
9	Fixed Metal Film, 374 ohm ±1% 1/8 W	RF211-374	CGW	RN55D	1
10	Fixed Comp., 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	1
11	Fixed Comp., 15 Kilohm ±10% ¼ W	RC104-315	A-B	CB1531	1
12	Fixed Comp., 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	1
	--PROGRAMMABLE DIVIDER ASSEMBLY (S-3)--				
"IC 200"	INTEGRATED CIRCUITS				
1	Flip-Flop,Dual D Type, Schottky	IC000-015	T-I	SN74S74N	1
2	Counter Presettable Decade, Schottky	IC000-017	SIG	N82S90A	1
3	Flip-Flop, J-K Edge Triggered w/AND inputs	IC000-019	T-I	SN74H102N	1
4	Flip-Flop, Dual "D" Type	IC000-021	FCD	7474PC	1
5	Counter Presettable Decade	IC000-016	SIG	N8290A	1
6	Phase-Frequency Detector	IC000-013	MOT	MC4044P	1
"R 200"	RESISTORS				
1	Fixed Comp., 1.2 Kilohm ±10% ¼ W	RC104-212	A-B	CB1221	1
2,3	Fixed Comp., 8.2 Kilohm ±10% ¼ W	RC104-282	A-B	CB8221	2
	-----OSC. DRIVE ASSEMBLY (S-4)-----				
"C 300"	CAPACITORS				
1	Tantalum, 1 uF 25 V	CE120-001	C-I	CCT-025-105	1
2	Ceramic Disc, .05 uF ±20% 50 V	CD103-350	SPR	TG-S50	1
3	Mylar, .1 μF ±10% 200 V	CP101-410	C-D	WMF-2PI	1
4	Electrolytic, 10 μF 25 V	CE105-010	SPR	TE-1204	1
"CR 300"	DIODES				
1,2,3,4,5, 6,7,8	Silicon, General Purpose 100 PIV, 750 mA	DR000-001	ITT	1N4004	8
"IC 300"	INTEGRATED CIRCUITS				
1	Transistor Array, NPN 16 pin DIP	IC000-020	RCA	CA3083	1
2,3	Dual Op. Amp. RC4558DN RAY only	IC000-027	W-I	IC000-027	2

PARTS LIST MHz STEPS MODULE M32 REV E

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"Q 300"	TRANSISTORS				
1	Silicon, NPN	QA038-541	G-E	2N3854A	1
"R 300"	RESISTORS				
1,8,11,12, 19	Fixed Comp., 5.6 Kilohm ±10% ¼ W	RC104-256	A-B	CB5621	5
2,10,18,34	Fixed Comp., 47 Kilohm ±10% ¼ W	RC104-347	A-B	CB4731	4
3,9	Fixed Comp., 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	2
4	Fixed Comp., 8.2 Kilohm ±10% ¼ W	RC104-282	A-B	CB8221	1
5,6	Fixed Comp., 120 Kilohm ±10% ¼ W	RC104-412	A-B	CB1241	2
7	Fixed Comp., 33 Kilohm ±10% ¼ W	RC104-333	A-B	CB3331	1
13	Fixed Comp., 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	1
14	Fixed Comp., 27 Kilohm ±5% ¼ W	RC103-327	A-B	CB2735	1
15,26,27	Fixed Comp., 12 Kilohm ±5% ¼ W	RC103-312	A-B	CB1235	3
16	Fixed Comp., 3.3 Kilohm ±10% ¼ W	RC104-233	A-B	CB3321	1
17,29,30	Fixed Comp., 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	3
20,28	Variable Cermet, 20 Kilohm ±10% 3/4 W	RP130-320	BEK	89PR20K	2
21,35,36	Fixed Comp., 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	3
24,25	Fixed Comp., 22 Kilohm ±10% ¼ W	RC104-322	A-B	CB2231	2
31,32	Fixed Comp., 220 Kilohm ±10% ¼ W	RC104-422	A-B	CB2241	2
33	Fixed Comp., 1.8 Kilohm ±10% ¼ W	RC104-218	A-B	CB1821	1
22	Fixed Comp., 20 Kilohm ±5% ¼ W	RC103-320	A-B	CB2035	1
37	Variable Cermet, 50 Kilohm	RP129-350	CTS	360S503B	1
38	Fixed Comp., 2.2 Megohm ±10% ¼ W	RC104-522	A-B	CB2251	1
39	Fixed Comp., 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	1
40	Fixed Comp., 22 Kilohm ±10% ¼ W	RC104-322	A-B	CB2231	1
41	Fixed Comp., 18 Kilohm ±10% ¼ W	RC104-318	A-B	CB1831	1
42	Fixed Comp., 150 Kilohm ±10% ¼ W	RC104-415	A-B	CB1541	1
	LEVELER ASSEMBLY (S-5)				
"C 400"	CAPACITORS				
1	Ceramic Disc, .001 µF ±20% 1 kV	CD102-210	SPR	5GA-D10	1
2	Ceramic Disc, .005 µF ±20% 100 V	CD103-250	SPR	TG-D50	1
"IC 400"	INTEGRATED CIRCUITS				
1	Operational Amplifier	IC000-002	SIG	N5741V	1
"R 400"	RESISTORS				
1	Composition, 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	1
2	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	1
3	Composition, 15 Kilohm ±10% ¼ W	RC104-315	A-B	CB1531	1
4	Composition, 560 Kilohm ±10% ¼ W	RC104-456	A-B	CB5641	1
5	Composition, 150 Kilohm ±10% ¼ W	RC104-415	A-B	CB1541	1
	MIXER ASSEMBLY (S-6)				
"C 500"	CAPACITORS				
1,2,3	Ceramic Miniature, .001 µF ±20%	CD112-210	ETP	8101-050	3
4,5	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	FF-4	2
6	Composition, 1.1 pF ±10% 500 V	CG102-211	Q-C	MC1.1	1

PARTS LIST MHz STEPS — MODULE M32 REV E

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"CR 500"	DIODES				
1,2	Silicon, PIN	DP000-040	W-I	DP000-040	2
3,4	Silicon, Hot Carrier	DG000-009	W-I	DG000-009	2
"L 500"	INDUCTORS				
1	Fixed	LA007-001	W-I	LA007-001	1
2	Fixed	Not assign	W-I	-----	1
"R 500"	RESISTORS				
1,2	Composition, 47 Kilohm ±5% 1/8 W	RC101-347	A-B	BB4735	2
3	Composition, 390 ohm ±5% 1/8 W	RC101-139	A-B	BB3915	1
"T 500"	TRANSFORMERS				
1	RF Transformer	TR001-001	W-I	TR001-001	1

PARTS LIST NARROW OSCILLATOR LOCK — MODULE M33-1 M33-2 REV B

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	Following is parts list for M33-1; see sheet 2 for M33-2 differences				
"C "	CAPACITORS				
1,20,21	Cer ft, 6.8 pF ±10%, 500 V	CF102-R68	A-B	FA5C	3
2	Comp, 10 pF ±10%, 500 V	CG101-310	Q-C	QC10	1
3,7,13,24,31	Cer disc, .005 µF ±20%, 100 V	CD103-250	SPR	TG-D50	5
4,10	Cer ft, 150 pF ±10%, 500 V	CF116-115	AER	4420	2
5,6,8,9,11, 15,26,27, 30,32	Ta, 1.0 µF ±10%, 25 V	CE120-001	ACI	100DE105-K25A2	10
12	Cer disc, 470 pF ±20%, 1 kV	CD102-147	SPR	5GA-T47	1
14,18,19,37	Cer disc, .001 µF ±20%, 1 kV	CD102-210	SPR	5GA-D10	4
16,42	Cer disc, .05 µF ±20%, 100 V	CD103-350	SPR	TG-S50	2
17,35,36	Cer disc, .002 µF ±20%, 1 kV	CD102-220	SPR	5GA-D20	3
22	Elect, 100 µF, +100%-10%, 12 V	CE119-110	ARC	ME4D100	1
23,28,29,34	Cer ft, 1000 pF GMV, 500 V	CF112-210	A-B	FA5C	4
25	Elect, 100 µF, +100%-10%, 6 V	CE118-110	ARC	ME3B100	1
38,39	Cer mono, 1 µF +80%-20%, 50 V	CD114-510	AER	3420050	2
40	Cer disc, .1 µF ±20%, 100 V	CD103-410	SPR	TG-P10	1
41	Cer ft, 120 pF ±10%, 500 V	CF102-112	A-B	FA5C	1
"CR "	DIODES				
1,2	Si, PIN	DP000-040	M-A	MA47980	2
3	Schottky	DG000-009	H-P	5082-2835	1
4	Si, Hot Carrier	DG000-007	H-P	5082-2800	1
5,6,7,8,11, 12,13,14, 15	Si, Junction, 100 PIV	DR000-001	DIO	1N4004	9
9	Red LED with mounting Kit	DL000-001	NAT	NSL5046	1
10	Zener, 4.7 V ±10%, 1 W	DB000-010	MOT	1N4732	1
"IC "	INTEGRATED CIRCUITS				
1	Operational Amplifier, 8 pin, DIP	IC000-002	SIG	N5741V	1
2,3,9	Dual Operational Amplifier, 8 pin, DIP	IC000-005	MOT	MC1458P1	3
4	Voltage Regulator, 5 V	IC000-011	FCD	µA78M05UC	1
5	3 digit BCD counter	ID001-001	MOT	MC14553CL	1
6	Hex Inverter open collector	IC000-023	T-I	SN7405	1
7,8	Phase/Frequency Detector	IC000-013	MOT	MC4044P	2
"J "	CONNECTORS (JACKS)				
1,2,3,4,5	Jack, 50 Ω, subminiature	JF000-005	APL	27-9	5
"L "	INDUCTORS				
1,2,5,6	Fxd, 3.3 µH, conformal coated	LA005-R33	ASE	08N3R3	4
3,4,8,9,10, 11,12,13	10 Turn Toroid	LA006-010	W-I	LA006-010	8
7	4 Turn Toroid	LA006-004	W-I	LA006-004	1

PARTS LIST NARROW OSCILLATOR LOCK MODULE M33-2 REV B

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"Q "	TRANSISTORS				
1,2	NPN, Si	QA038-541	G-E	2N3854A	2
3	NPN, Si	QA050-530	AMP	2N5053	1
4	P-channel, JFET	QA054-610	MOT	2N5461	1
5	N-channel, JFET	QA054-580	MOT	2N5458	1
"R "	RESISTORS				
1,2,5	Comp, 56 Ω ±10%, ¼ W	RC104-056	A-B	CB5601	3
3,41,43,44, 45,46	Comp, 1 kΩ ±10%, ¼ W	RC104-210	A-B	CB1021	6
4,10,13,25, 55	Comp, 2.2 kΩ ±10%, ¼ W	RC104-222	A-B	CB2221	5
6	Comp, 47 kΩ ±10%, ¼ W	RC104-347	A-B	CB4731	1
7,8	Comp, 470 Ω ±10%, ¼ W	RC104-147	A-B	CB4711	2
9,14	Comp, 22 kΩ ±10%, ¼ W	RC104-322	A-B	CB2231	2
11,12	Comp, 390 Ω ±10%, ¼ W	RC104-139	A-B	CB3911	2
15	Comp, 47 Ω ±10%, ¼ W	RC104-047	A-B	CB4701	1
16*	Comp, 100 Ω ±10%, ¼ W	RC104-110	A-B	CB1011	1
17	Comp, 1.2 kΩ ±10%, ¼ W	RC104-212	A-B	CB1221	1
18	Met flm, 619 Ω ±1%, 1/8 W	RF211-619	CGW	RN55D	1
19	Met flm, 2.74 kΩ ±1%, 1/8 W	RF212-274	CGW	RN55D	1
20,30,32,49, 61,62	Comp, 100 kΩ ±10%, ¼ W	RC104-410	A-B	CB1041	6
21	Comp, 15 kΩ ±10%, ¼ W	RC104-315	A-B	CB1531	1
22,28,29,48, 50	Comp, 10 kΩ ±10%, ¼ W	RC104-310	A-B	CB1031	5
23	Var cermet, 100 kΩ	RP144-410	HEL	91AR100K	1
24	Comp, 2.2 MΩ ±10%, ¼ W	RC104-522	A-B	CB2251	1
26	Comp, 2.7 kΩ ±10%, ¼ W	RC104-227	A-B	CB2721	1
27,34,38,66	Comp, 1.8 kΩ ±10%, ¼ W	RC104-218	A-B	CB1821	4
31,33,63,64	Comp, 180 kΩ ±10%, ¼ W	RC104-418	A-B	CB1841	4
35	Comp, 820 Ω ±10%, ¼ W	RC104-182	A-B	CB8211	1
37,67	Comp, 39 kΩ ±10%, ¼ W	RC104-339	A-B	CB3931	2
39,42,51, 52,53,54	Comp, 27 kΩ ±10%, ¼ W	RC104-327	A-B	CB2731	6
40	Comp, 270 Ω ±5%, ¼ W	RC103-127	A-B	CB2715	1
56,57	Comp, 12 kΩ ±5%, ¼ W	RC103-312	A-B	CB1235	2
58	Comp, 3.3 kΩ ±5%, ¼ W	RC103-233	A-B	CB3325	1
59,60	Comp, 470 kΩ ±5%, ¼ W	RC103-447	A-B	CB4745	2
65	Comp, 6.8 kΩ ±5%, ¼ W	RC103-268	A-B	CB6825	1
	For M33-2 add following parts to M33-1				
C33	Cer ft, 1000 pF GMV, 500 V	CF112-210	A-B	FA5C	1
R47	Comp, 33 kΩ ±5%, ¼ W	RC103-339	A-B	CB3335	1
R67	Comp, 27 kΩ ±10%, ¼ W	RC104-327	A-B	CB2731	1
	For M33-2 Delete following parts from M33-1				
R67	Comp, 39 kΩ ±10%, ¼ W	RC104-339	A-B	CB3931	1

PARTS LIST WIDE OSCILLATOR LOCK MODULE M34 REV F

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	---MAIN CHASSIS (S-1)---				
"C "	CAPACITORS				
1	Electrolytic, 100 µF 12 V	CE119-110	ARC	ME4D100	1
2,6,9	Ceramic Feedthru, 1000 pF GMV 500 V	CF112-210	A-B	FA5C	3
3	Electrolytic, 100 µF 6 V	CE118-110	ARC	ME3B100	1
4,5,7,8	Ceramic Disc, .01 µF +80 -20% 100 V	CD103-310	SPR	TG-S10	4
10,11,12	Tantalum, 1 µF ±10% 25 V	CE120-001	ACI	100DE105	3
13	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF-4	1
14,15,16,17, 20	Ceramic Feedthru, 6.8 pF ±10% 500 V	CF102-R68	A-B	FA5C6895	5
18,19	Ceramic Feedthru, 120 pF ±10% 500 V	CF102-112	A-B	FA5C	2
"CR "	DIODES				
1	Schottky	DG000-009	H-P	5082-2835	1
2	Red LED with mounting kit	DL000-001	FCD	FLV102	1
"IC "	INTEGRATED CIRCUITS				
1	Voltage Regulator, 5 V	IC000-011	FCD	µA78M05UC	1
2	Phase-Frequency Detector	IC000-029	FCD	11C44	1
"J "	CONNECTORS (JACKS)				
1,2,3,4,5	Jack, 50 ohm subminiature	JF000-005	APL	27-9	5
"L "	INDUCTORS				
1	1 Turn Toroid	LA007-001	W-I	LA007-001	1
2,3,4,5,6,7, 8,9,10,11, 12	10 Turn Toroid	LA006-010	W-I	LA006-010	11
"R "	RESISTORS				
1	Composition, 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	1
2*,7*	Composition, 100 ohm ±10% ¼ W	RC104-110	A-B	CB1011	2
3,8*	Composition, 47 ohm ±10% ¼ W	RC104-047	A-B	CB4701	2
4*	Composition, 47 ohm ±5% 1/8 W	RC101-047	A-B	BB4705	1
5*	Composition, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	1
6	Composition, 1.2 Kilohm ±10% ¼ W	RC104-212	A-B	CB1221	1
	---WIDE BAND MIXER ASSEMBLY (S-2)---				
"C 100"	CAPACITORS				
1,4	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF-4	2
2,3	Ceramic Disc, .001 µF ±20% 50 V	CD112-210	ETP	8101-050-651-102M	2
5*	Composition, 1.5 pF ±10% 500 V	CG101-215	Q-C	QC1.5	1

PARTS LIST WIDE OSCILLATOR LOCK MODULE M34 REV F

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"CR 100"	DIODES				
1,2	Silicon, PIN	DP000-040	M-A	MA47047	2
3,4	Schottky	DG000-009	H-P	5082-2835	2
"L 100"	INDUCTORS				
1	1 Turn Toroid	LA007-001	W-I	LA007-001	1
2	10 Turn Toroid	LA006-010	W-I	LA006-010	1
"R 100"	RESISTORS				
1,2	Composition, 47 Kilohm ±5% 1/8 W	RC101-347	A-B	BB4735	2
3	Composition, 27 ohm ±10% ¼ W	RC104-027	A-B	CB2701	1
"T 100	TRANSFORMER				
1	RF Transformer	TR001-001	W-I	TR001-001	1
	---WIDE BAND AMPLIFIER ASSEMBLY (S-3)---				
"C 200"	CAPACITORS				
1,4	Ceramic Disc, .005 F +80 -20% 100 V	CD103-250	SPR	TG-D50	2
2*,7,10	Ceramic Disc, 6.8 pF ±5% 1 kV	CD101-R68	SPR	10TCC-V68	2
3	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF-4	1
5*	Composition, 2.7 pF ±10% 500 V	CG101-227	Q-C	QC2.7	1
6	Composition, 4.7 pF ±10% 500 V	CG102-247	Q-C	MC4.7	1
8,9	Ceramic Disc, 15 pF ±5% 1 kV	CD101-015	SPR	10TCC-Q15	2
"L 200"	INDUCTORS				
1	4 Turn	not assign	W-I	-------	-
2,3	6 Turn	not assign	W-I	-------	-
4	5 Turn	not assign	W-I	-------	-
"Q 200"	TRANSISTORS				
1,2	NPN, Silicon	QA050-530	AMP	2N5053	2
"R 200"	RESISTORS				
1	Composition, 820 ohm ±10% ¼ W	RC104-182	A-B	CB8211	1
2	Composition, 560 ohm ±10% ¼ W	RC104-156	A-B	CB5611	1
3	Composition, 68 ohm ±10% ¼ W	RC104-068	A-B	CB6801	1
4	Composition, 47 ohm ±10% ¼ W	RC104-047	A-B	CB4701	1
5	Composition, 100 ohm ±10% ¼ W	RC104-110	A-B	CB1011	1

PARTS LIST WIDE OSCILLATOR LOCK MODULE M34 REV F

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
	VIDEO AMPLIFIER ASSEMBLY (S-4)				
"C 300"	CAPACITORS				
1	Ceramic Feedthru, 39 pF ±5% 500 V	CF114-039	AER	4420	1
2	Ceramic Feedthru, 27 pF ±5% 500 V	CF114-027	AER	4420	1
3,6,8,20	Ceramic Miniature, .01 µF ±20% 50 V	CD113-310	C-L	CY15C103	4
4,5,7,9,10, 12	Ceramic Feedthru, 2200 pF GMV 500 V	CF115-222	AER	4420	6
11,21,22	Tantalum, 1 µF ±10% 25 V	CE120-001	ACI	100DE105	3
13,15	Ceramic Feedthru, 120 pF ±10% 500 V	CF116-112	AER	4420	2
14	Ceramic Feedthru, 150 pF ±10% 500 V	CF116-115	AER	4420	1
16,17,18	Ceramic Feedthru, 360 pF ±10% 500 V	CF116-136	AER	4420	3
19	Ceramic Disc, 100 pF ±5% 1 kV	CD104-110	SPR	10TCU-T10	1
"CR 300"	DIODES				
1,2,3	Silicon, Hot Carrier	DG000-013	H-P	5082-3188	3
"L 300"	INDUCTORS				
1,2	Fixed, 4.7 µH ±10%	LA005-R47	ASE	08N4R7K	2
3	4 Turn Toroid	LA006-004	W-I	LA006-004	1
4	Fixed, .47 µH	LA005-R04	ASE	08NR47K	1
5,6,7	Fixed, 1 µH	LA005-R10	ASE	08N1R0K	3
8	10 Turn Toroid	LA006-010	W-I	LA006-010	1
"Q 300"	TRANSISTORS				
1,2,3,4	NPN, Silicon	QA050-530	APX	2N5053	4
"R 300"	RESISTORS				
1,8,10	Composition, 22 Kilohm ±5% 1/8 W	RC101-322	A-B	BB2235	3
2,7,9,13	Composition, 47 ohm ±5% 1/8 W	RC101-047	A-B	BB4705	4
3,5,11	Composition, 2.2 Kilohm ±5% 1/8 W	RC101-222	A-B	BB2225	3
4,6,12	Composition, 390 ohm ±5% 1/8 W	RC101-139	A-B	BB3915	3
14,15,16	Composition, 2 Kilohm ±5% 1/8 W	RC101-220	A-B	BB2025	3
17	Metal Film, 15 Kilohm ±1% ¼ W	RF213-150	CGW	RN55D	1
18	Metal Film, 1 Kilohm ±1% ¼ W	RF212-100	CGW	RN55D	1
19	Metal Film, 499 ohm ±1% ¼ W	RF211-499	CGW	RN55D	1
20	Metal Film, 2.43 Kilohm ±1% ¼ W	RF212-243	CGW	RN55D	1
	LEVELER ASSEMBLY (S-5)				
"C 400"	CAPACITORS				
1,4	Tantalum, 1 µF ±10% 25 V	CE120-001	ACI	100DE105	2
2	Ceramic Disc, .005 µF +80 -20% 100 V	CD103-250	SPR	TG-D50	1
3	Ceramic Disc, .001 µF ±20% 1 kV	CD102-210	SPR	5GA-D10	1

PARTS LIST WIDE OSCILLATOR LOCK MODULE M34 REV F

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"CR 400"	DIODES				
1,2,3,4,5,6, 7,8	Silicon, Junction 100 PIV	DR000-001	DIO	1N4004	8
"IC 400"	INTEGRATED CIRCUITS				
1	Dual Op. Amp. RC4558DN, RAY only	IC000-027	W-I	IC000-027	1
"Q "	TRANSISTORS				
1,2,3,5	NPN, Silicon	QA038-541	G-E	2N3854A	4
4	PNP, Silicon	QB000-009	MOT	MPS3702	1
"R 400"	RESISTORS				
1,3	Composition, 15 Kilohm ±10% ¼ W	RC104-315	A-B	CB1531	2
2,10,17	Composition, 47 Kilohm ±10% ¼ W	RC104-347	A-B	CB4731	3
4,5	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	2
6	Composition, 1 Kilohm ±10% ¼ W	RC104-210	A-B	CB1021	1
7	Composition, 33 Kilohm ±10% ¼ W	RC104-333	A-B	CB3331	1
8,9	Composition, 7.5 Kilohm ±5% ¼ W	RC103-275	A-B	CB7525	2
11	Composition, 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	1
12	Composition, 1 Megohm ±10% ¼ W	RC104-510	A-B	CB1051	1
13	Composition, 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	1
14	Composition, 330 Kilohm ±10% ¼ W	RC104-433	A-B	CB3341	1
15	Composition, 2.2 Megohm ±10% ¼ W	RC104-522	A-B	CB2251	1
16	Composition, 470 Kilohm ±10% ¼ W	RC104-447	A-B	CB4741	1
18	Composition, 22 Kilohm ±10% ¼ W	RC104-322	A-B	CB2231	1
19	Composition, 1.8 Kilohm ±10% ¼ W	RC104-218	A-B	CB1821	1
	--------PHASE LOCK ASSEMBLY (S-6)--------				
"C 500"	CAPACITORS				
1	Ceramic Disc, 25 pF ±5% 1 kV	CD101-025	SPR	10TCC-025	1
2	Mylar, .022 µF ±10% 200 V	CP101-322	CDE	WMF-2S22	1
3	Tantalum, 1 µF ±10% 25 V	CE120-001	ACI	100DE105	1
4,7	Ceramic Disc, .05 µF +80 -20% 100 V	CD103-350	SPR	TG-S50	2
5	Ceramic Disc, 150 pF ±20% 1 kV	CD102-115	SPR	5GA-T15	1
6	Ceramic Disc, 470 pF ±20% 1 kV	CD102-147	SPR	5GA-T47	1
8	Ceramic Disc, .005 µF +80 -20% 100 V	CD103-250	SPR	TG-D50	1
9	Ceramic Disc, .001 µF ±20% 1 kV	CD102-210	SPR	5GA-D10	1
"CR 500"	DIODES				
1,2,3,4,5,6	Silicon, Junction 100 PIV	DR000-001	DIO	1N4004	6
"IC 500"	INTEGRATED CIRCUITS				
1,2	Dual Op. Amp. RC4558DN RAY only	IC000-027	W-I	IC000-027	2

PARTS LIST WIDE OSCILLATOR LOCK MODULE M34 REV F

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	TQ
"Q 500"	TRANSISTORS				
1	N-channel, JFET	QA054-580	MOT	2N5458	1
2	P-channel, JFET	QA054-610	MOT	2N5461	1
"R 500"	RESISTORS				
1	Composition, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	1
2	Composition, 82 Kilohm ±10% ¼ W	RC104-382	A-B	CB8231	1
3	Composition, 1.2 Kilohm ±10% ¼ W	RC104-212	A-B	CB1221	1
4,10	Composition, 3.3 Kilohm ±10% ¼ W	RC104-233	A-B	CB3321	2
5	Composition, 27 Kilohm ±5% ¼ W	RC103-327	A-B	CB2735	1
6	Composition, 12 Kilohm ±5% ¼ W	RC103-312	A-B	CB1235	1
7,8	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	2
9	Composition, 2.2 Megohm ±10% ¼ W	RC104-522	A-B	CB2251	1
11	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	1
12,14	Composition, 470 Kilohm ±10% ¼ W	RC104-447	A-B	CB4741	2
13,15	Composition, 10 Megohm ±10% ¼ W	RC104-610	A-B	CB1061	2
16,19,21	Composition, 33 Kilohm ±10% ¼ W	RC104-333	A-B	CB3331	3
17,18	Composition, 680 Kilohm ±10% ¼ W	RC104-468	A-B	CB6841	2
20,22	Composition, 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	2
	---VIDEO MIXER ASSEMBLY (S-7)---				
"C 600"	CAPACITORS				
1	Ceramic Feedthru, 18 pF ±5% 500 V	CF113-018	AER	4420	1
2	Ceramic Feedthru, 39 pF ±5% 500 V	CF114-039	AER	4420	1
"CR 600"	DIODES				
1,2	Schottky	DG000-009	H-P	5082-2835	2
"L 600"	INDUCTORS				
1	Fixed, 4.7 H ±10%	LA005-R47	ASE	08N4R7K	1
"R 600"	RESISTORS				
1	Composition, 47 ohm ±5% 1/8 W	RC101-047	A-B	BB4705	1
2	Composition, 470 ohm ±10% ¼ W	RC104-147	A-B	CB4711	1
"T 600"	TRANSFORMERS				
1	RF Transformer	TR001-002	W-I	TR001-002	1

SECTION 7
SCHEMATICS

7.1 INTRODUCTION

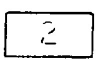
This section contains all schematics for the instrument. A schematic index is given in paragraph 7.4.

7.2 SCHEMATIC NOTES

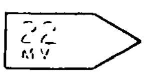
The following notes and abbreviations pertain to all schematics. Additional notes pertaining to specific schematics are included on each schematic if required.

All values are shown in the following units unless otherwise specified.

Components	Units
Resistor	ohms
Capacitor	picofarads
Inductor	microhenries



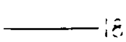
Denotes DC voltage reading in volts unless otherwise specified.

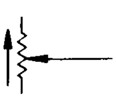


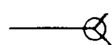
Denotes high impedance crystal detector reading in volts unless otherwise specified.

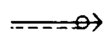
Denotes 50 ohm crystal detector reading in volts unless otherwise specified.

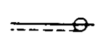

Signal or voltage source.


Connects to indicated signal or voltage source.

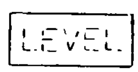

Arrow indicates clockwise rotation of wiper.


Coaxial jack


Coaxial plug

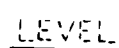

Coaxial cable


Factory adjusted part.

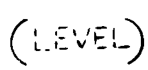


Denotes a front-panel device.

Denotes a rear-panel device.



Denotes a PC board adjustment or accessible module adjustment.



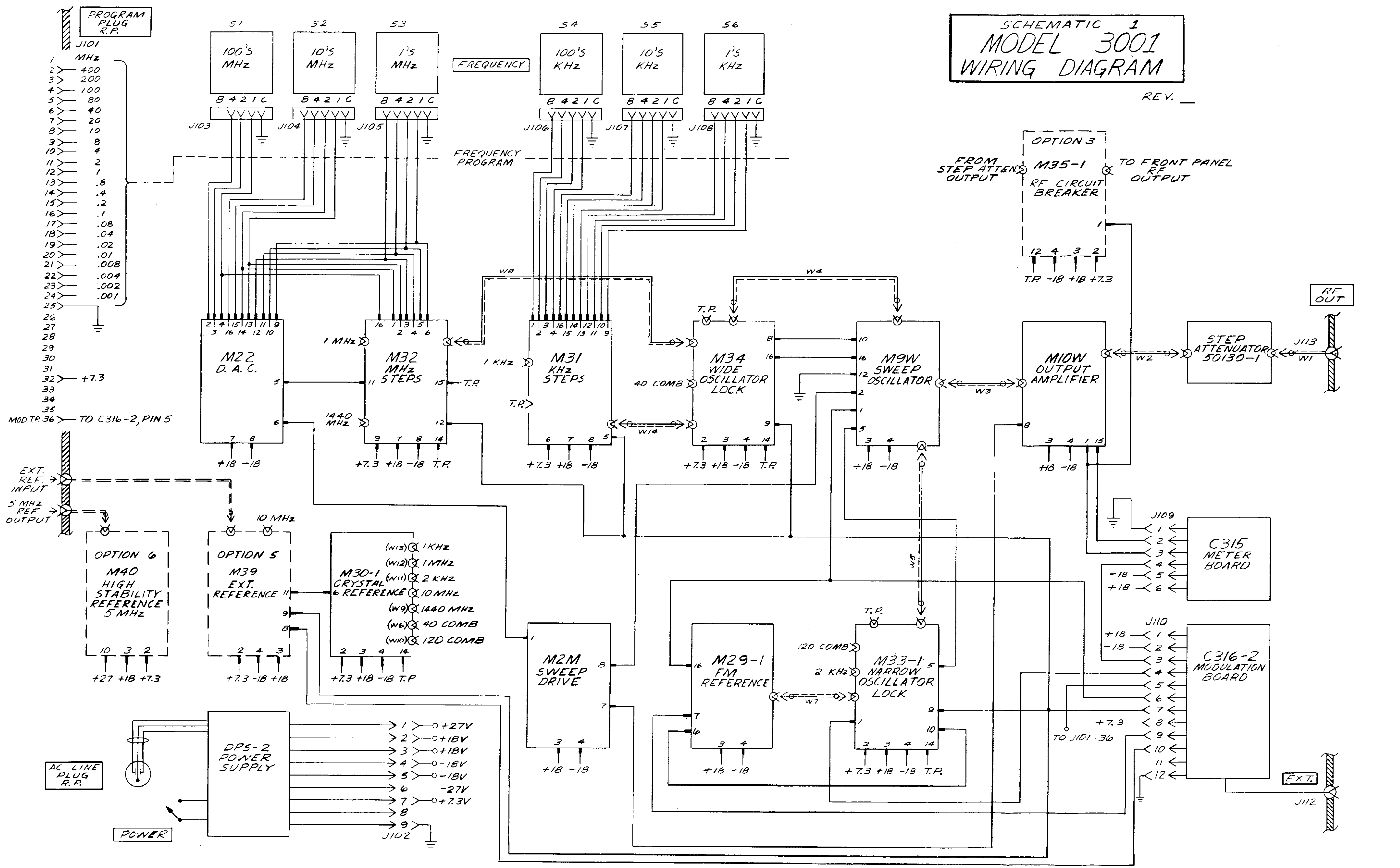
Denotes an internal module adjustment not accessible without removing module cover.

7.3 ABBREVIATION CODE

A	Assembly	IF	intermediate frequency	Ω	ohm
A	ampere	J	jack	OC	opto coupler
AC	alternating current	K	relay	P	plug
C	capacitor	kHz	kilohertz	pp	peak-to-peak
CR	diode	kΩ	kilohm	pF	picofarad
CW	continuous wave	kV	kilovolt	Q	transistor
cw	clockwise	kW	kilowatt	R	resistor
dB	decibel	L	inductor	RF	radio frequency
dBm	decibel referred to 1 mW	MHz	megahertz	RMS	root-mean-square
dBmV	decibel referred to 1 mV	MΩ	megohm	R.P.	rear panel
DC	direct current	μF	microfarad	S	switch
DS	indicating device, lamp	μA	microampere	T	transformer
F	farad	μH	microhenry	TP	test point
F.P.	front panel	M	meter	V	volt
H	henry	mA	milliampere	VA	voltampere
Har	harmonic	mH	millihenry	W	watt
Hz	hertz	mV	millivolt	X	crystal
IC	integrated circuit	mW	milliwatt		

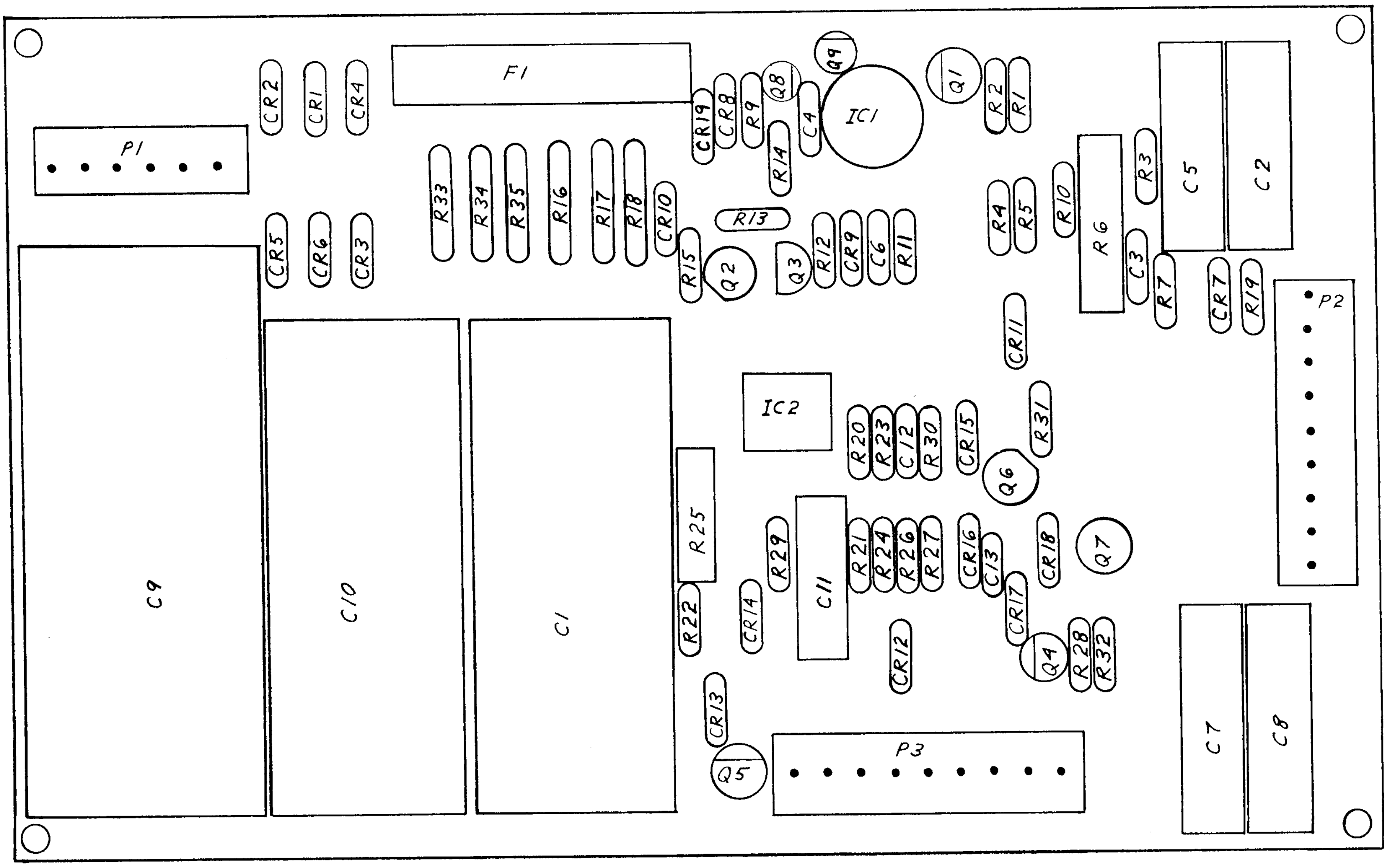
7.4 SCHEMATIC INDEX

ASSEMBLY	NAME	SCHEMATIC NO.	PARTS LIST: PAGE
C315	Meter Board	13	6-4
C316-2	Modulation Board	4	6-5
DPS-2	Power Supply	2	6-7
M2M	Sweep Drive	9	6-10
M9W	Sweep Oscillator	12	6-11
M10W	Output Amplifier	14	6-14
M22	DAC	8	6-16
M29-1	FM Reference	5	6-17
M30-1	Crystal Reference	3	6-19
M31	kHz Steps	6	6-23
M32	MHz Steps	10	6-26
M33-1	Narrow Oscillator Lock	7	6-31
M34	Wide Oscillator Lock	11	6-33
Model 3001	Wiring Diagram	1	6-3

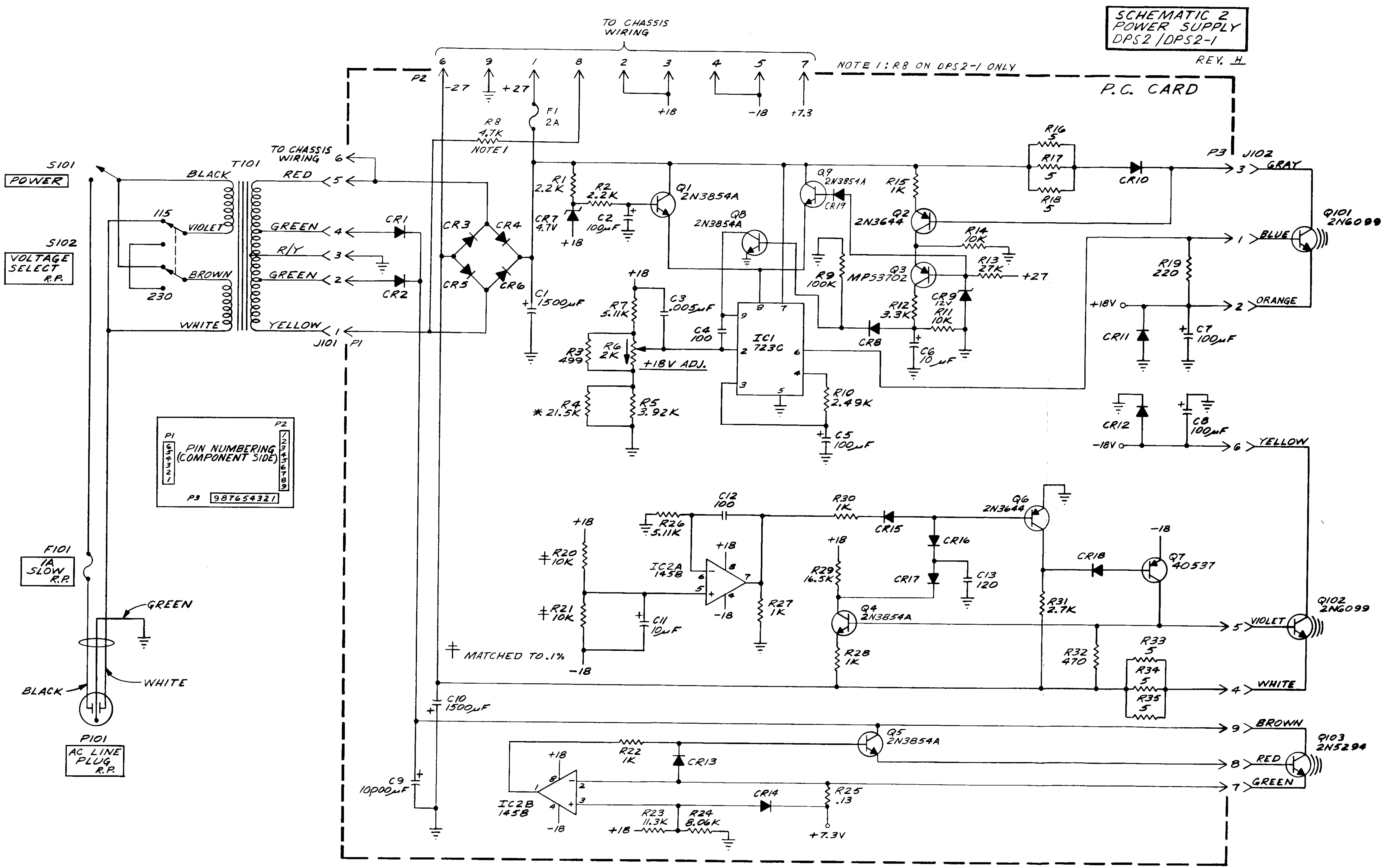


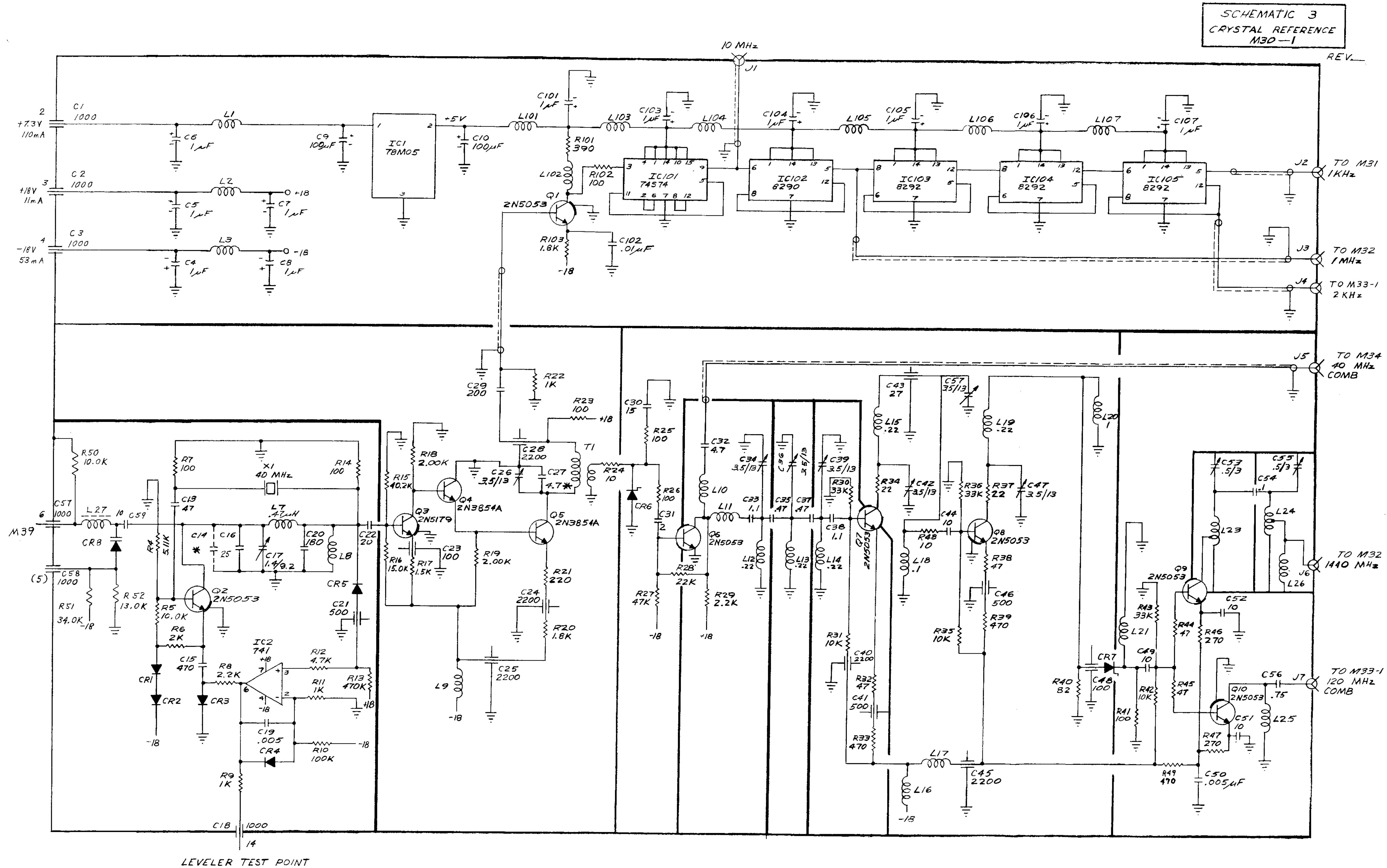
SCHEMATIC 1
MODEL 3001
WIRING DIAGRAM
REV. __
PROGRAM PLUG R.P.
J101
MHz
400
200
100
80
40
20
10
8
4
2
1
.8
.4
.2
.1
.08
.04
.02
.01
.008
.004
.002
.001
+7.3
MOD T.P. 36 TO C316-2, PIN 5
S1
100'S MHz
S2
10'S MHz
S3
1'S MHz
FREQUENCY
S4
100'S KHz
S5
10'S KHz
S6
1'S KHz
8 4 2 1 C
J103
J104
J105
J106
J107
J108
FREQUENCY PROGRAM
OPTION 3
M35-1
RF CIRCUIT BREAKER
FROM STEP ATTEN OUTPUT
TO FRONT PANEL RF OUTPUT
T.P. -18 +18 +7.3
RF OUT
M22
D. A. C.
+18 -18
M32
MHz STEPS
1 MHz
1440 MHz
+7.3 +18 -18 T.P.
W8
M31
KHz STEPS
1 KHz
T.P.
+7.3 +18 -18
W14
M34
WIDE OSCILLATOR LOCK
40 COMB
T.P.
+7.3 +18 -18 T.P.
W4
M9W
SWEEP OSCILLATOR
+18 -18
W3
M10W
OUTPUT AMPLIFIER
+18 -18
W2
STEP ATTENUATOR 50130-1
W1
J113
EXT. REF. INPUT
5 MHz REF OUTPUT
OPTION 6
M40
HIGH STABILITY REFERENCE 5 MHz
+27 +18 +7.3
OPTION 5
M39
EXT. REFERENCE
10 MHz
+7.3 -18 +18
M30-1
CRYSTAL REFERENCE
(W13) 1 KHz
(W12) 1 MHz
(W11) 2 KHz
10 MHz
(W9) 1440 MHz
(W6) 40 COMB
(W10) 120 COMB
+7.3 +18 -18 T.P
M2M
SWEEP DRIVE
+18 -18
M29-1
FM REFERENCE
+18 -18
W7
W5
M33-1
NARROW OSCILLATOR LOCK
120 COMB
2 KHz
T.P.
+7.3 +18 -18 T.P.
J109
C315
METER BOARD
-18
+18
J110
C316-2
MODULATION BOARD
+18
-18
+7.3
TO J101-36
EXT.
J112
DPS-2
POWER SUPPLY
AC LINE PLUG R.P.
POWER
+27V
+18V
+18V
-18V
-18V
-27V
+7.3V
J102

C352

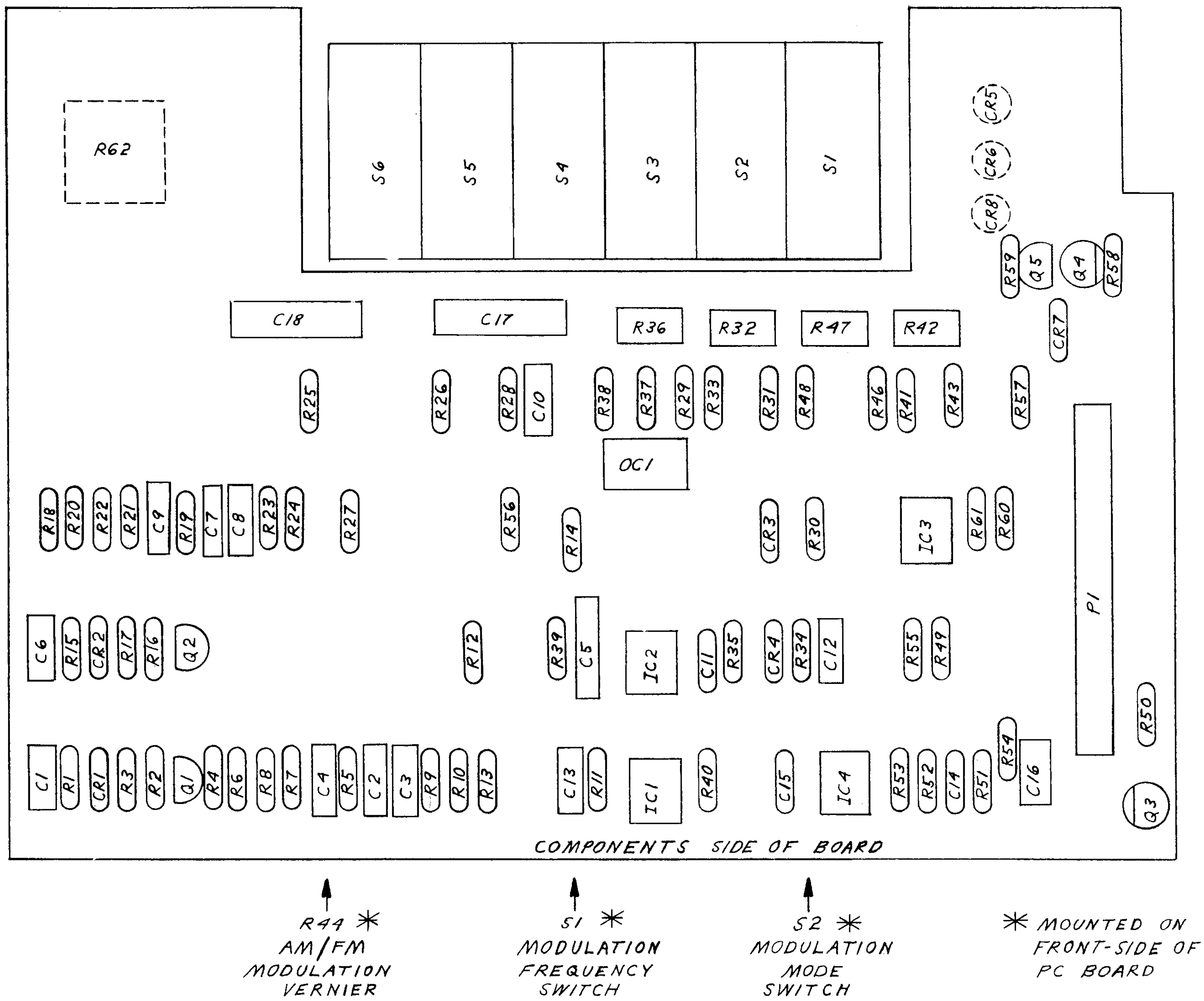


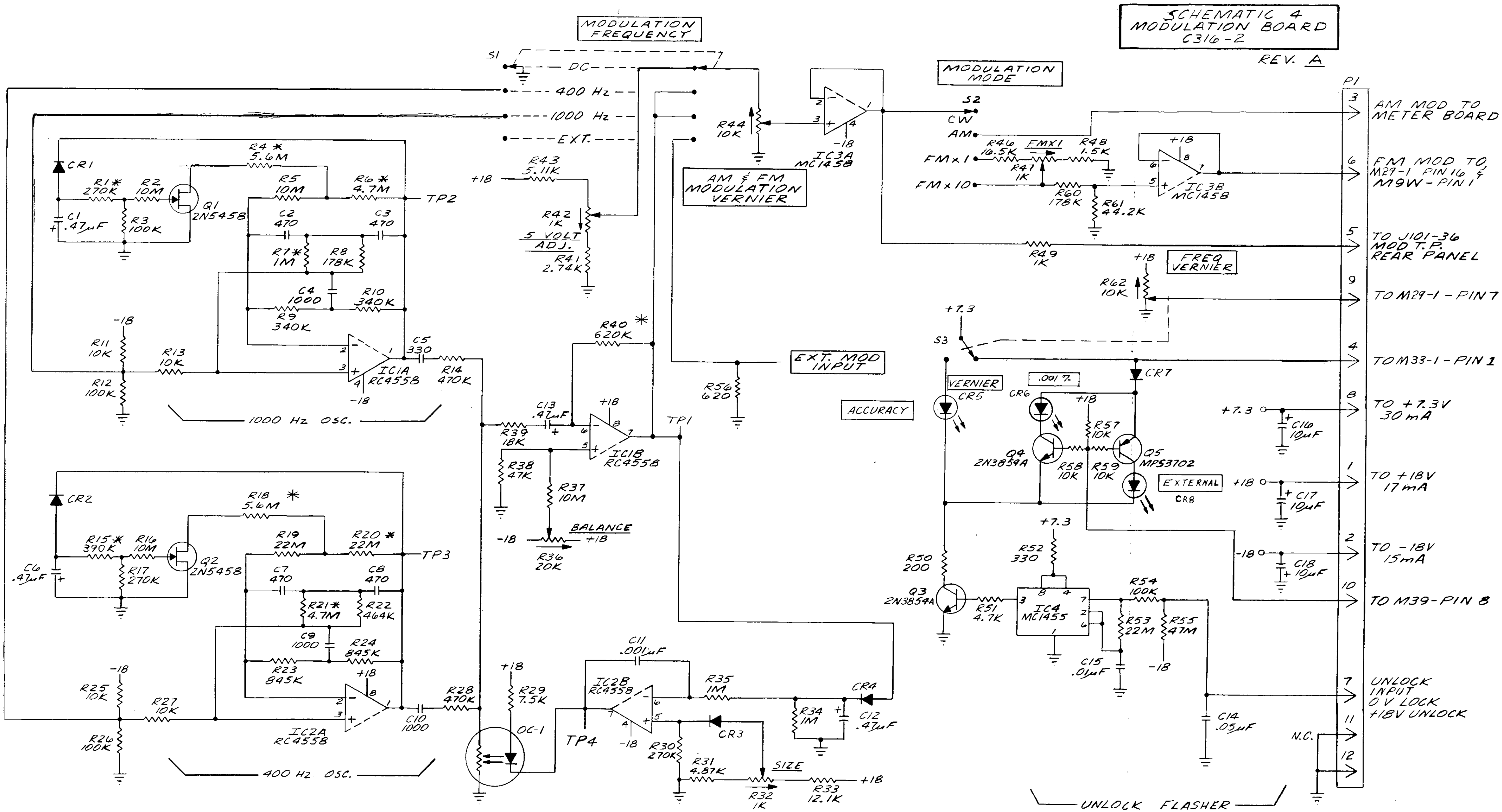
COMPONENT SIDE OF BOARD


SCHEMATIC 2
POWER SUPPLY
DPS2 / DPS2-1
REV. H
P.C. CARD
TO CHASSIS WIRING
NOTE 1: R8 ON DPS2-1 ONLY
S101 POWER
S102 VOLTAGE SELECT R.P.
115
230
T101
BLACK
VIOLET
BROWN
WHITE
RED
GREEN
R/Y
YELLOW
J101 P1
P2
P3 J102
F1 2A
R8 4.7K NOTE 1
CR1
CR2
CR3
CR4
CR5
CR6
C1 1500µF
R1 2.2K
R2 2.2K
CR7 4.7V
C2 100µF
Q1 2N3854A
Q8 2N3854A
Q9 2N3854A
CR19
Q2 2N3644
Q3 MPS3702
R15 1K
R14 10K
R13 27K
R9 100K
CR9 12V
R12 3.3K
R11 10K
CR8
C6 10µF
R16 5
R17 5
R18 5
CR10
Q101 2N6099
GRAY
BLUE
ORANGE
R19 220
+18V
CR11
C7 100µF
CR12
C8 100µF
-18V
R7 5.11K
C3 .005µF
C4 100
R3 499
R6 2K
+18V ADJ.
R4 * 21.5K
R5 3.92K
IC1 723C
R10 2.49K
C5 100µF
PIN NUMBERING (COMPONENT SIDE)
987654321
F101 1A SLOW R.P.
GREEN
WHITE
BLACK
P101 AC LINE PLUG R.P.
C12 100
R26 5.11K
R30 1K
CR15
CR16
CR17
C13 120
Q6 2N3644
R20 10K
R21 10K
IC2A 1458
C11 10µF
R27 1K
R29 16.5K
Q4 2N3854A
R28 1K
CR18
Q7 40537
R31 2.7K
R32 470
R33 5
R34 5
R35 5
Q102 2N6099
YELLOW
VIOLET
WHITE
MATCHED TO .1%
C10 1500µF
C9 10000µF
Q5 2N3854A
R22 1K
CR13
IC2B 1458
CR14
R25 .13
R23 11.3K
R24 8.06K
+7.3V
BROWN
RED
GREEN
Q103 2N5294


SCHEMATIC 3
CRYSTAL REFERENCE
M30—1
REV
10 MHz
J1
IC1 78M05
IC101 74S74
IC102 8290
IC103 8292
IC104 8292
IC105 8292
+7.3V 110mA
+18V 11mA
-18V 53mA
M39
TO M31 1KHz
TO M32 1MHz
TO M33-1 2KHz
TO M34 40 MHz COMB
TO M32 1440 MHz
TO M33-1 120 MHz COMB
X1 40 MHz
IC2 741
2N5053
2N5179
2N3854A
LEVELER TEST POINT

C316-2

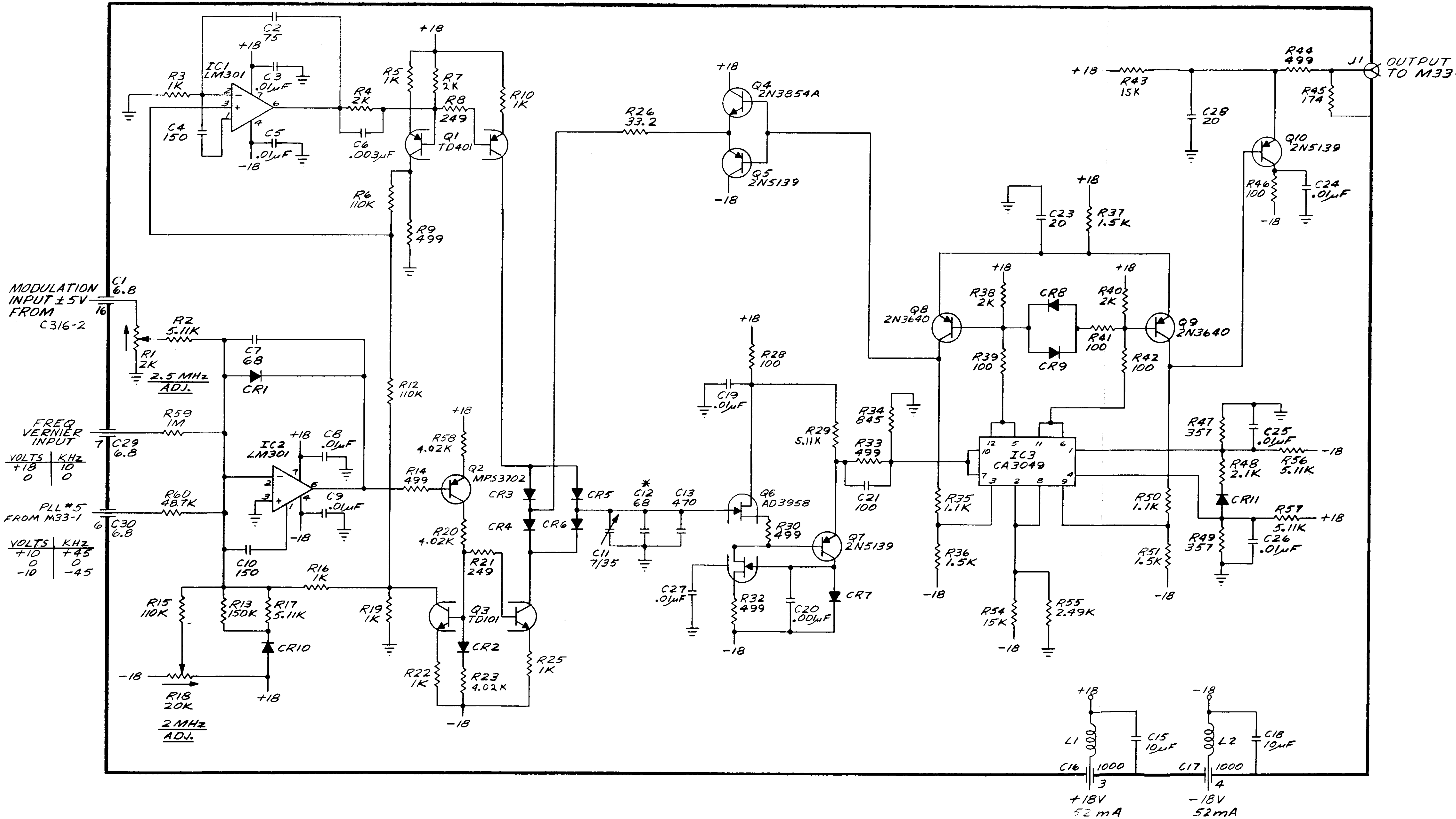

R62
S6
S5
S4
S3
S2
S1
CR5
CR6
CR8
R59
Q5
Q4
R58
CR7
C18
C17
R36
R32
R47
R42
R25
R26
R28
C10
R38
R37
R29
R33
R31
R48
R46
R41
R43
R57
OC1
R18
R20
R22
R21
C9
R19
C7
C8
R23
R24
R27
R56
R14
CR3
R30
IC3
R61
R60
P1
C6
R15
CR2
R17
R16
Q2
R12
R39
C5
IC2
C11
R35
CR4
R34
C12
R55
R49
R50
R54
C16
C1
R1
CR1
R3
R2
Q1
R4
R6
R8
R7
C4
R5
C2
C3
R9
R10
R13
C13
R11
IC1
R40
C15
IC4
R53
R52
C14
R51
Q3
COMPONENTS SIDE OF BOARD
R44 ✳
AM/FM
MODULATION
VERNIER
S1 ✳
MODULATION
FREQUENCY
SWITCH
S2 ✳
MODULATION
MODE
SWITCH
✳ MOUNTED ON
FRONT-SIDE OF
PC BOARD



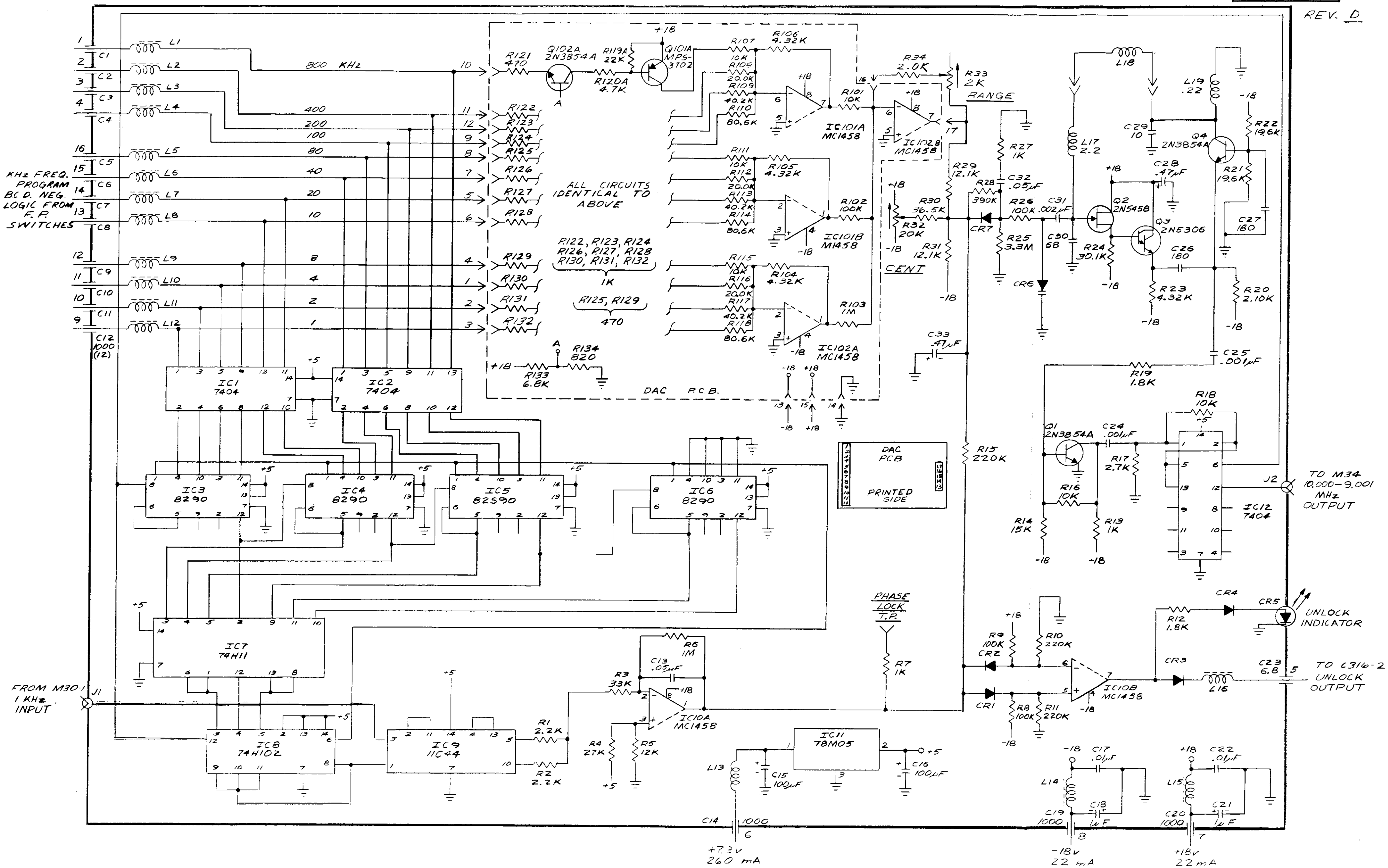
SCHEMATIC 4
MODULATION BOARD
C316-2
REV. A
MODULATION FREQUENCY
S1
DC
400 Hz
1000 Hz
EXT.
MODULATION MODE
S2
CW
AM
AM & FM MODULATION VERNIER
R44 10K
IC3A MC1458
FM x 1
FM x 10
R46 16.5K
FMX1
R47 1K
R48 1.5K
R60 178K
R61 44.2K
IC3B MC1458
R49 1K
FREQ VERNIER
R62 10K
S3
+7.3
VERNIER
CR5
ACCURACY
.001 %
CR6
CR7
Q4 2N3859A
Q5 MPS3702
R57 10K
R58 10K
R59 10K
EXTERNAL
CR8
R50 200
Q3 2N3854A
R51 4.7K
R52 330
IC4 MC1455
R54 100K
R53 22M
R55 47M
C15 .01µF
C14 .05µF
UNLOCK FLASHER
P1
AM MOD TO METER BOARD
FM MOD TO M29-1 PIN 16 & M9W - PIN 1
TO J101-36 MOD T.P. REAR PANEL
TO M29-1 - PIN 7
TO M33-1 - PIN 1
TO +7.3V 30mA
TO +18V 17mA
TO -18V 15mA
TO M39 - PIN 8
UNLOCK INPUT 0 V LOCK +18V UNLOCK
N.C.
C16 10µF
C17 10µF
C18 10µF
R43 5.11K
R42 1K
5 VOLT ADJ.
R41 2.74K
EXT. MOD INPUT
R56 620
R40 620K
C13 .47µF
R39 18K
R38 47K
R37 10M
IC1B RC4558
TP1
BALANCE
R36 20K
CR1
R1* 270K
R2 10M
C1 .47µF
R3 100K
Q1 2N5458
R4* 5.6M
R5 10M
R6* 4.7M
TP2
C2 470
C3 470
R7* 1M
R8 178K
C4 1000
R10 340K
R9 340K
R11 10K
R12 100K
R13 10K
IC1A RC4558
C5 330
R14 470K
1000 Hz OSC.
CR2
R15* 390K
R16 10M
C6 .47µF
R17 270K
Q2 2N5458
R18 5.6M
R19 22M
R20* 22M
TP3
C7 470
C8 470
R21* 4.7M
R22 464K
C9 1000
R24 845K
R23 845K
R25 10K
R26 100K
R27 10K
IC2A RC4558
C10 1000
R28 470K
400 Hz OSC.
R29 7.5K
OC-1
TP4
C11 .001µF
IC2B RC4558
R35 1M
CR4
R34 1M
C12 .47µF
CR3
R30 270K
R31 4.87K
R32 1K
SIZE
R33 12.1K

SCHEMATIC 5
M29-1
FM REFERENCE

REV.___

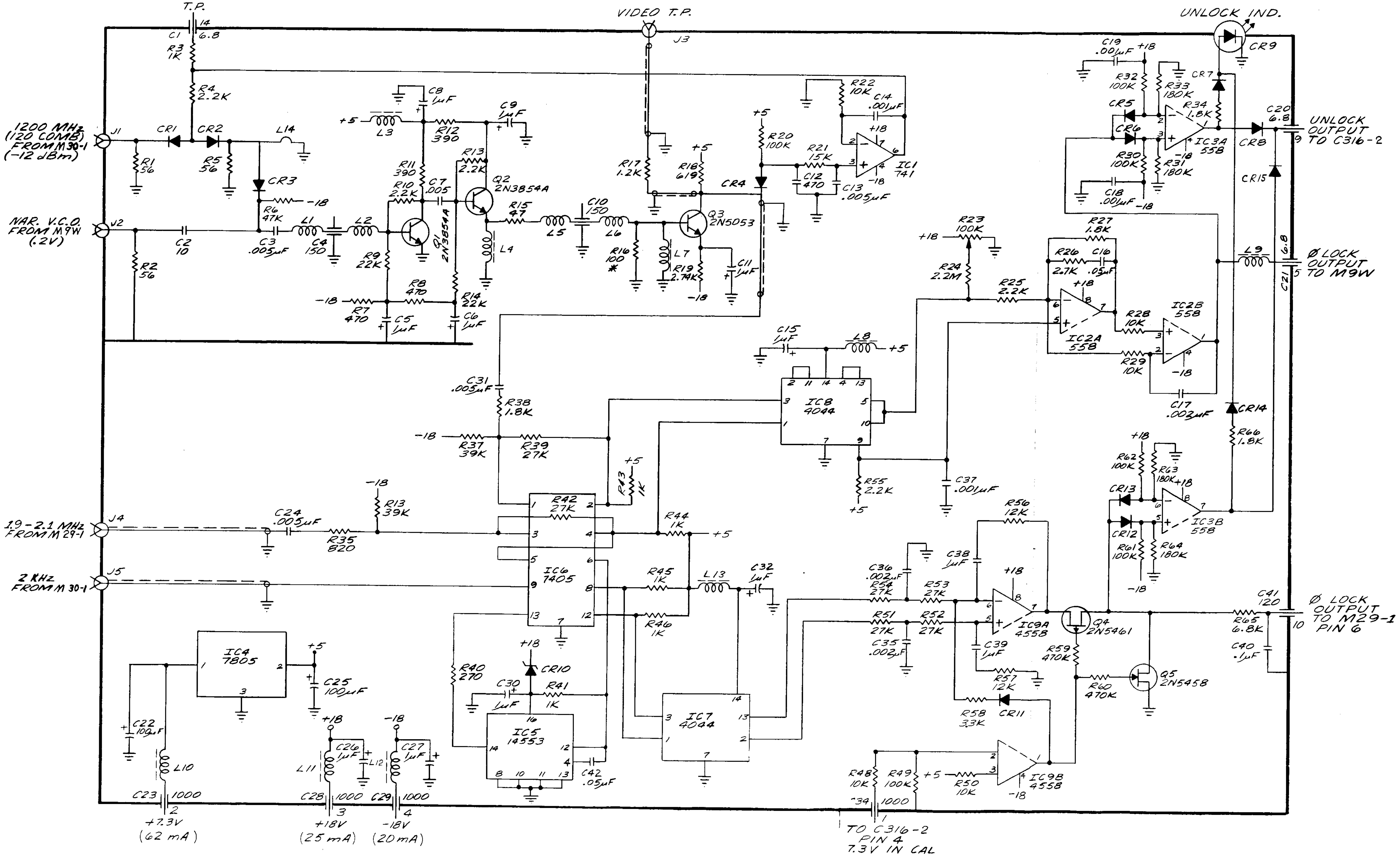


SCHEMATIC 6
KHz STEP
M31

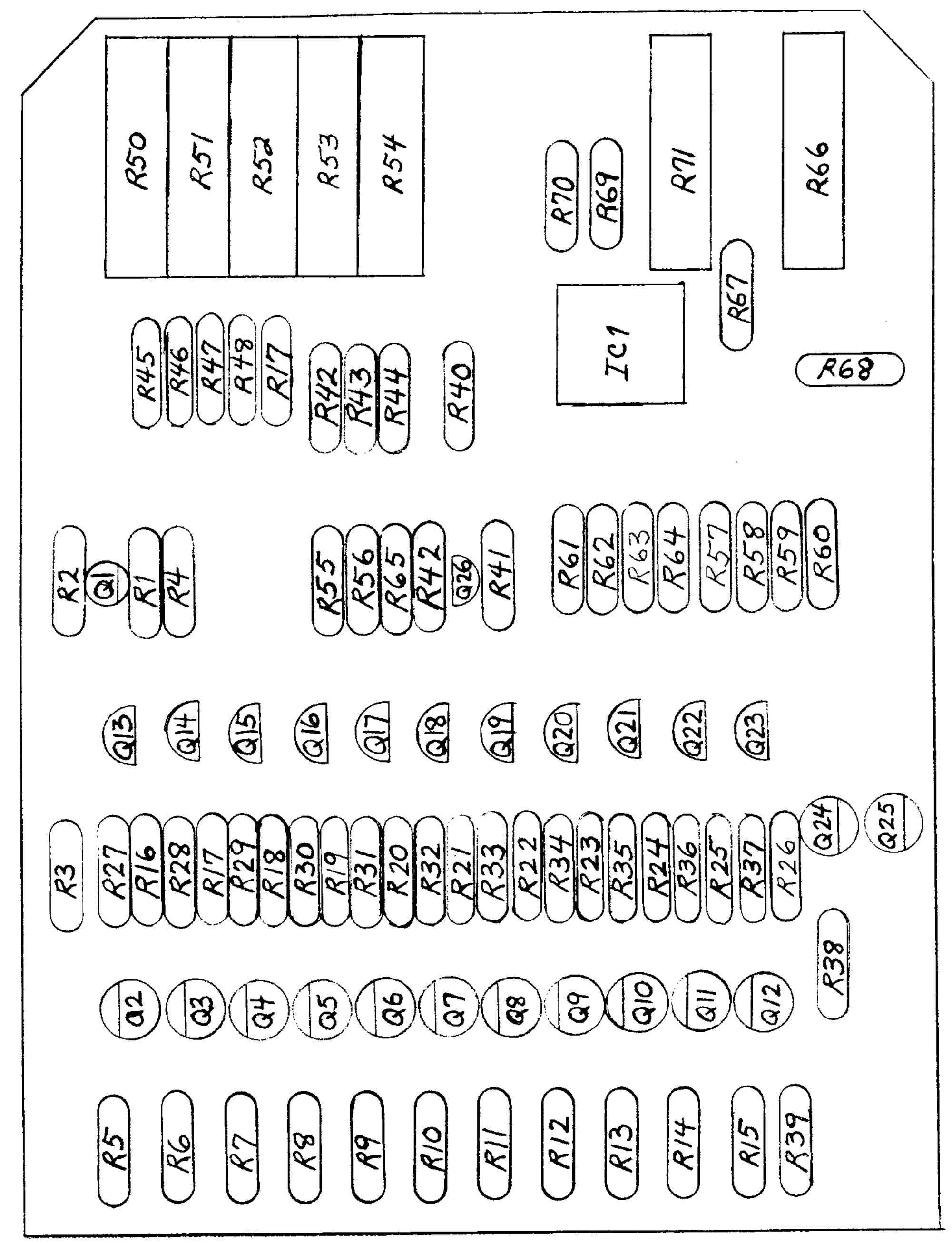


SCHEMATIC 7
NARROW OSCILLATOR LOCK
M33-1

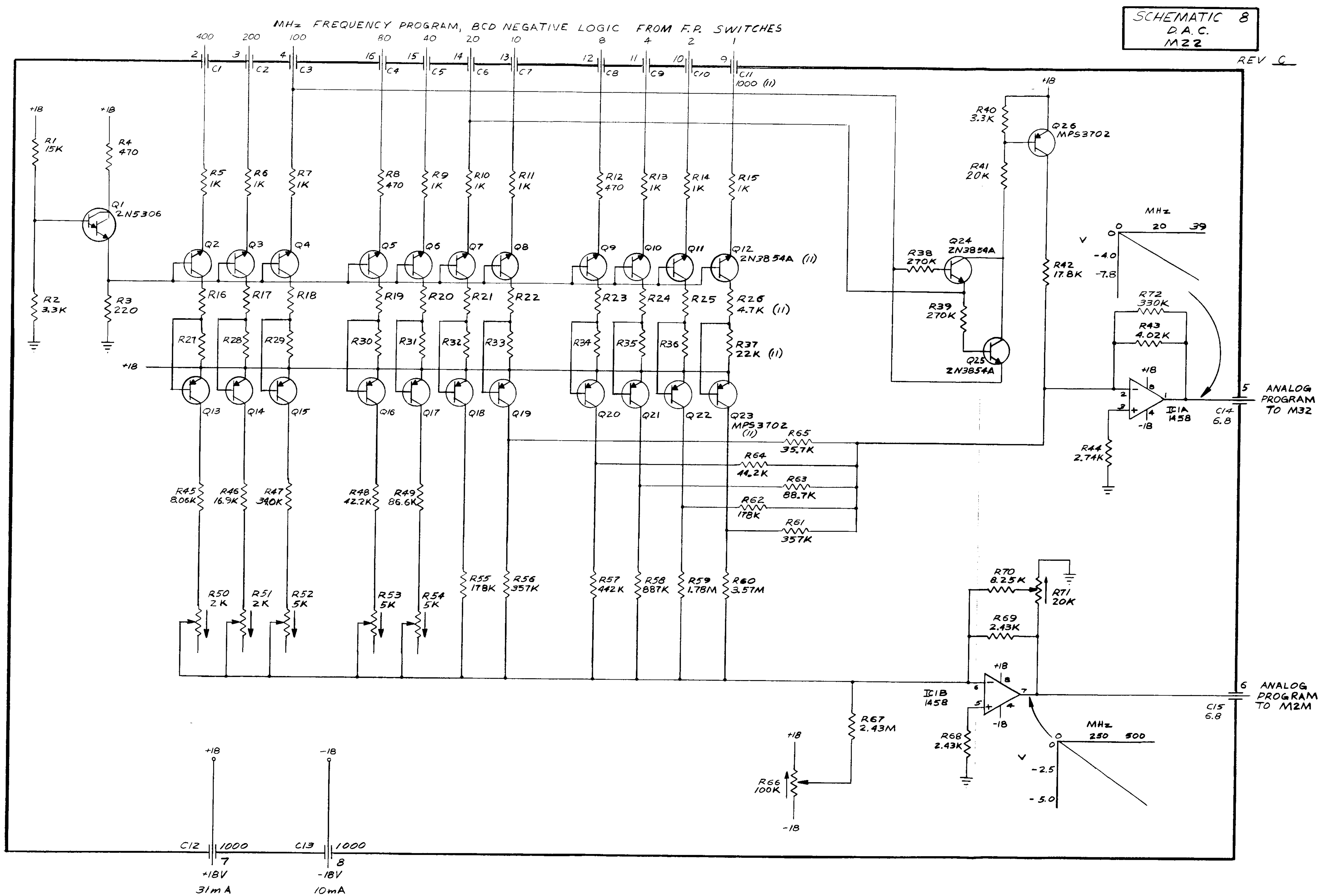
REV. A



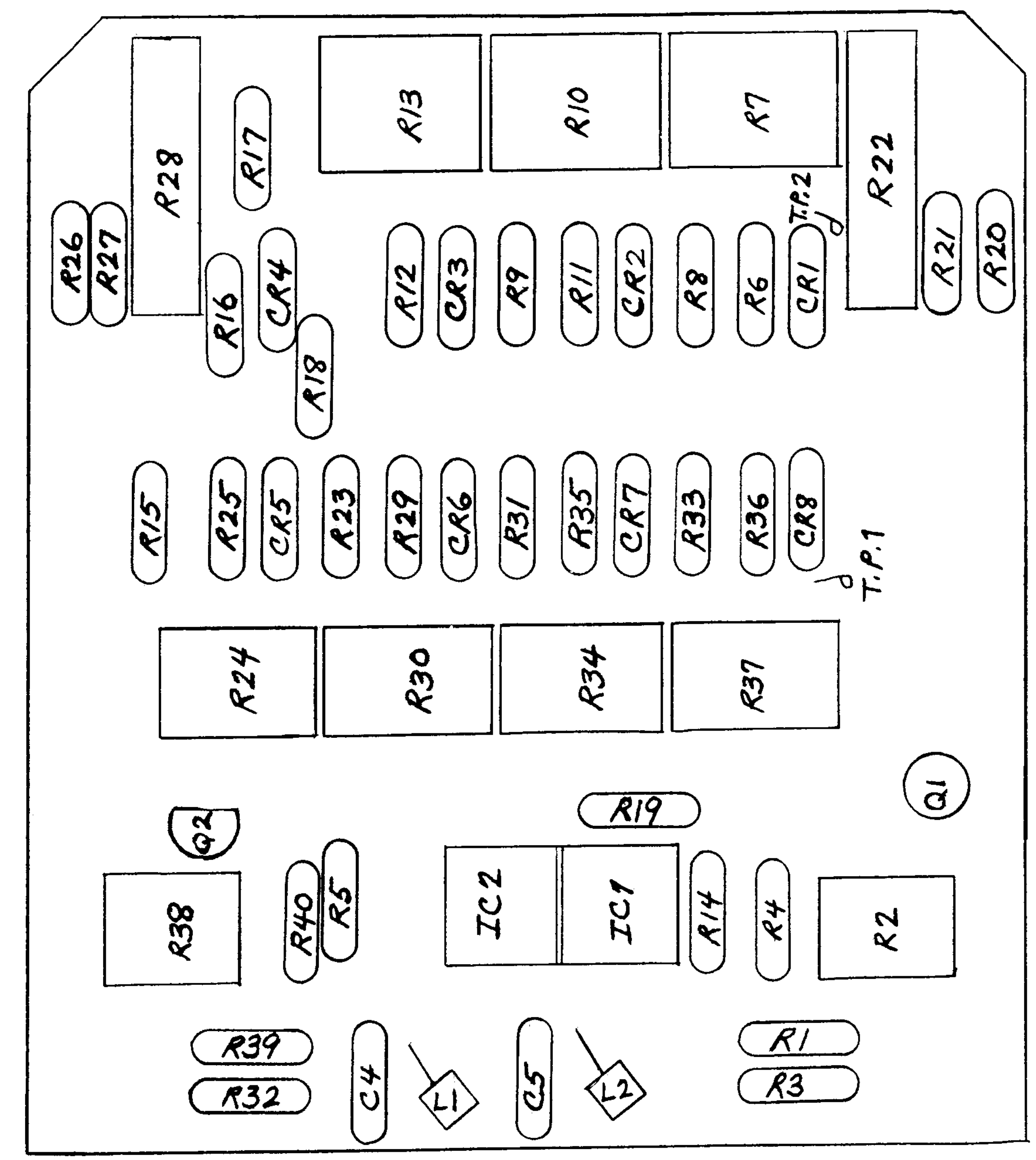
M22



COMPONENT SIDE OF PC BOARD


SCHEMATIC 8
D.A.C.
M22
REV C
MHz FREQUENCY PROGRAM, BCD NEGATIVE LOGIC FROM F.P. SWITCHES
400 200 100 80 40 20 10 8 4 2 1
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11
1000 (11)
R1 15K
R2 3.3K
R4 470
R3 220
Q1 2N5306
R5 1K
R6 1K
R7 1K
R8 470
R9 1K
R10 1K
R11 1K
R12 470
R13 1K
R14 1K
R15 1K
Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11
Q12 2N3854A (11)
R16 R17 R18 R19 R20 R21 R22 R23 R24 R25
R26 4.7K (11)
R27 R28 R29 R30 R31 R32 R33 R34 R35 R36
R37 22K (11)
Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22
Q23 MPS3702 (11)
R40 3.3K
Q26 MPS3702
R41 20K
Q24 2N3854A
R38 270K
R39 270K
Q25 2N3854A
R42 17.8K
R65 35.7K
R64 44.2K
R63 88.7K
R62 178K
R61 357K
R45 8.06K
R46 16.9K
R47 34.0K
R48 42.2K
R49 86.6K
R55 178K
R56 357K
R57 442K
R58 887K
R59 1.78M
R60 3.57M
R50 2K
R51 2K
R52 5K
R53 5K
R54 5K
MHz
0 20 39
V
-4.0
-7.8
R72 330K
R43 4.02K
IC1A 1458
R44 2.74K
C14 6.8
5 ANALOG PROGRAM TO M32
R70 8.25K
R71 20K
R69 2.43K
IC1B 1458
R68 2.43K
R67 2.43M
R66 100K
MHz
0 250 500
-2.5
-5.0
C15 6.8
6 ANALOG PROGRAM TO M2M
C12 1000
7 +18V 31mA
C13 1000
8 -18V 10mA

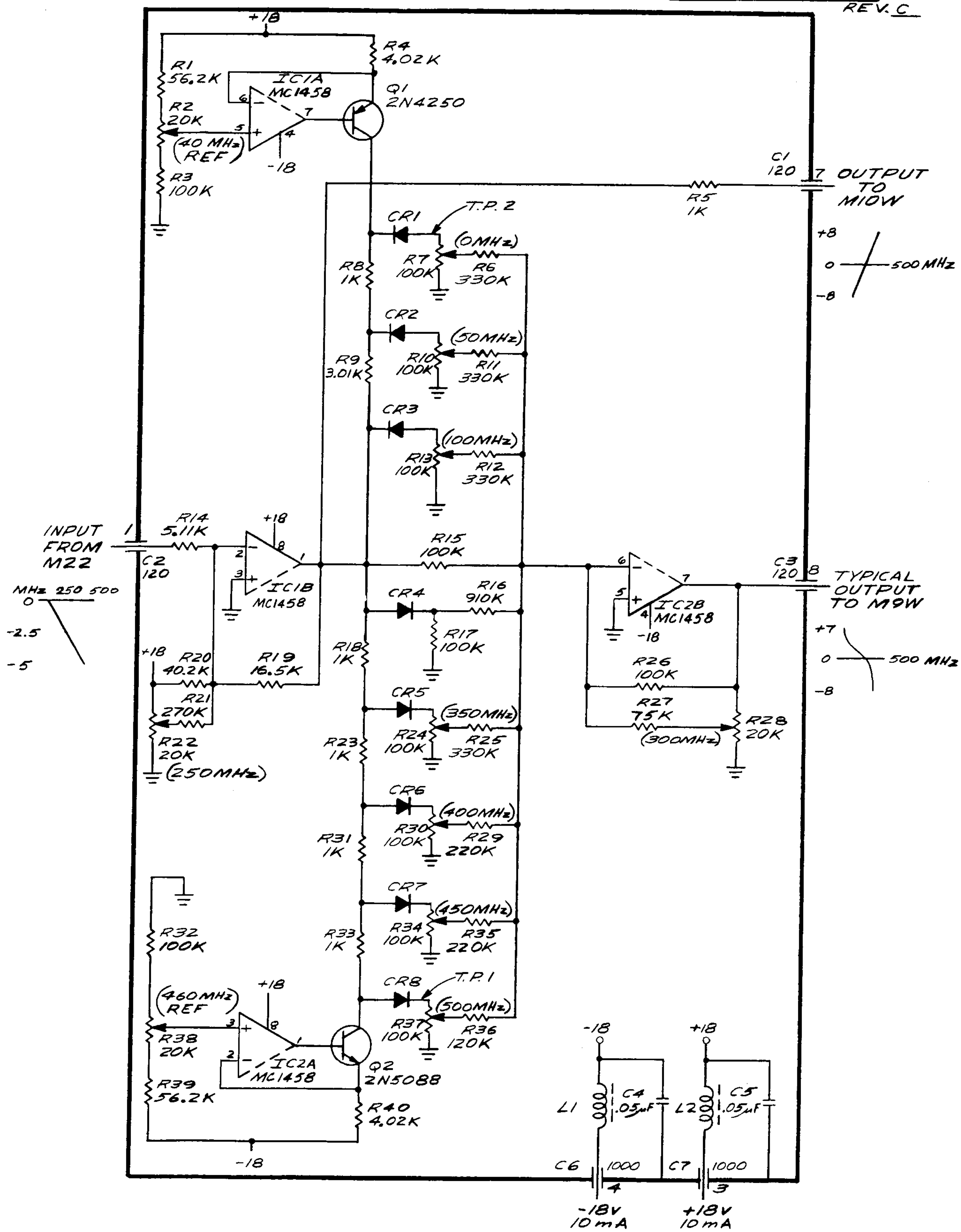
M2M

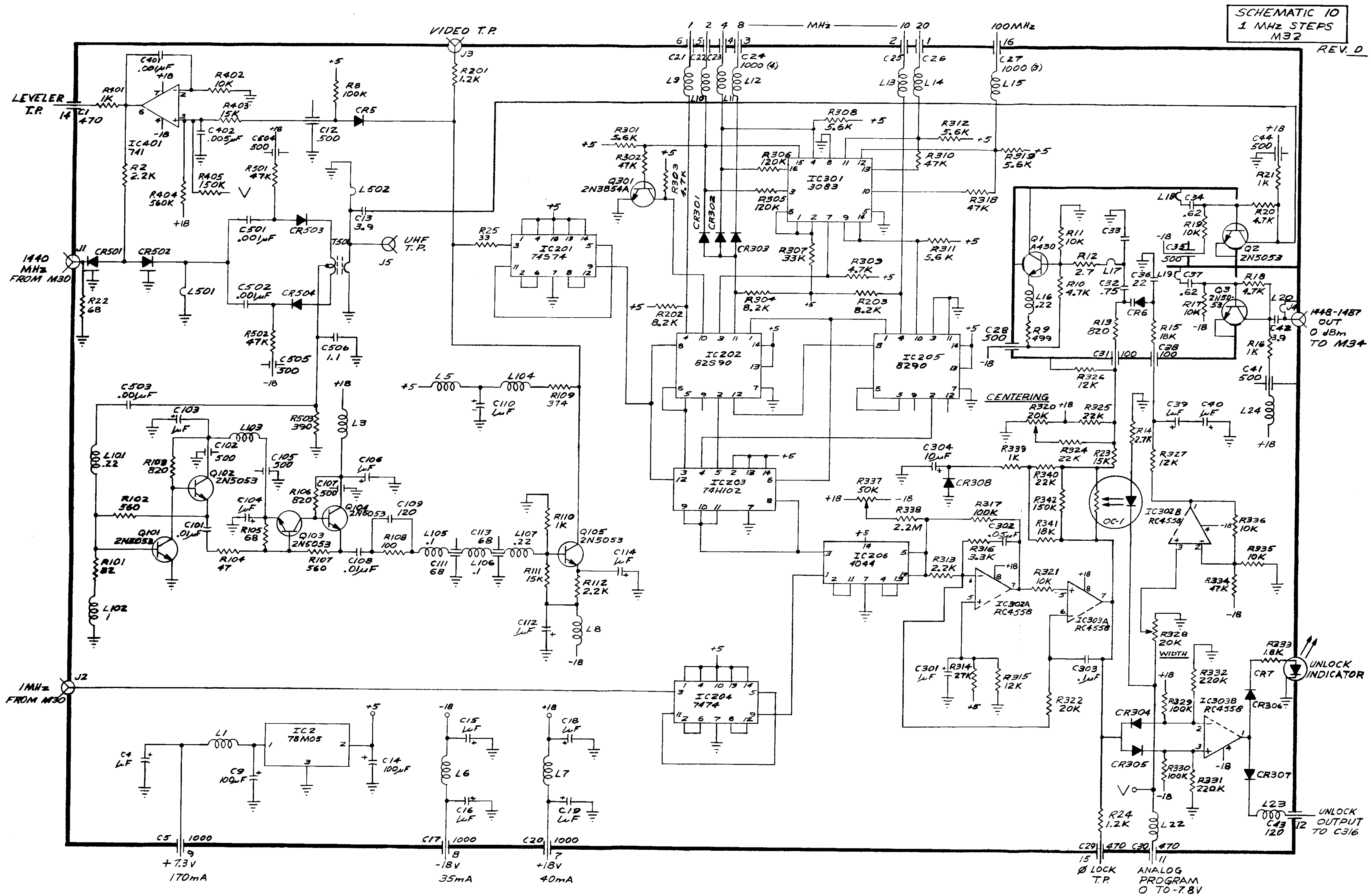


COMPONENT SIDE OF PC BOARD

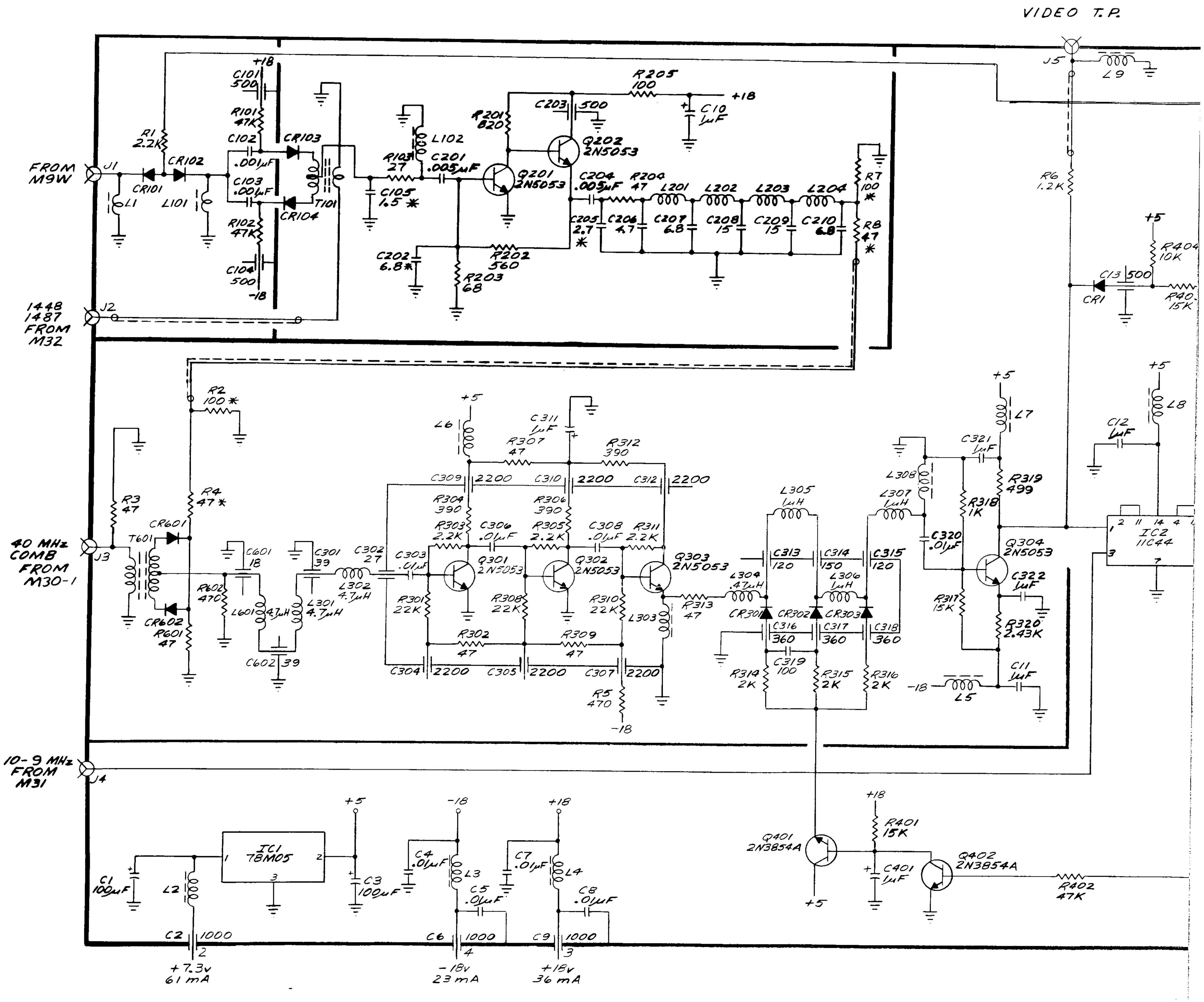
SCHEMATIC 9
SWEEP DRIVE
M2M

REV. C





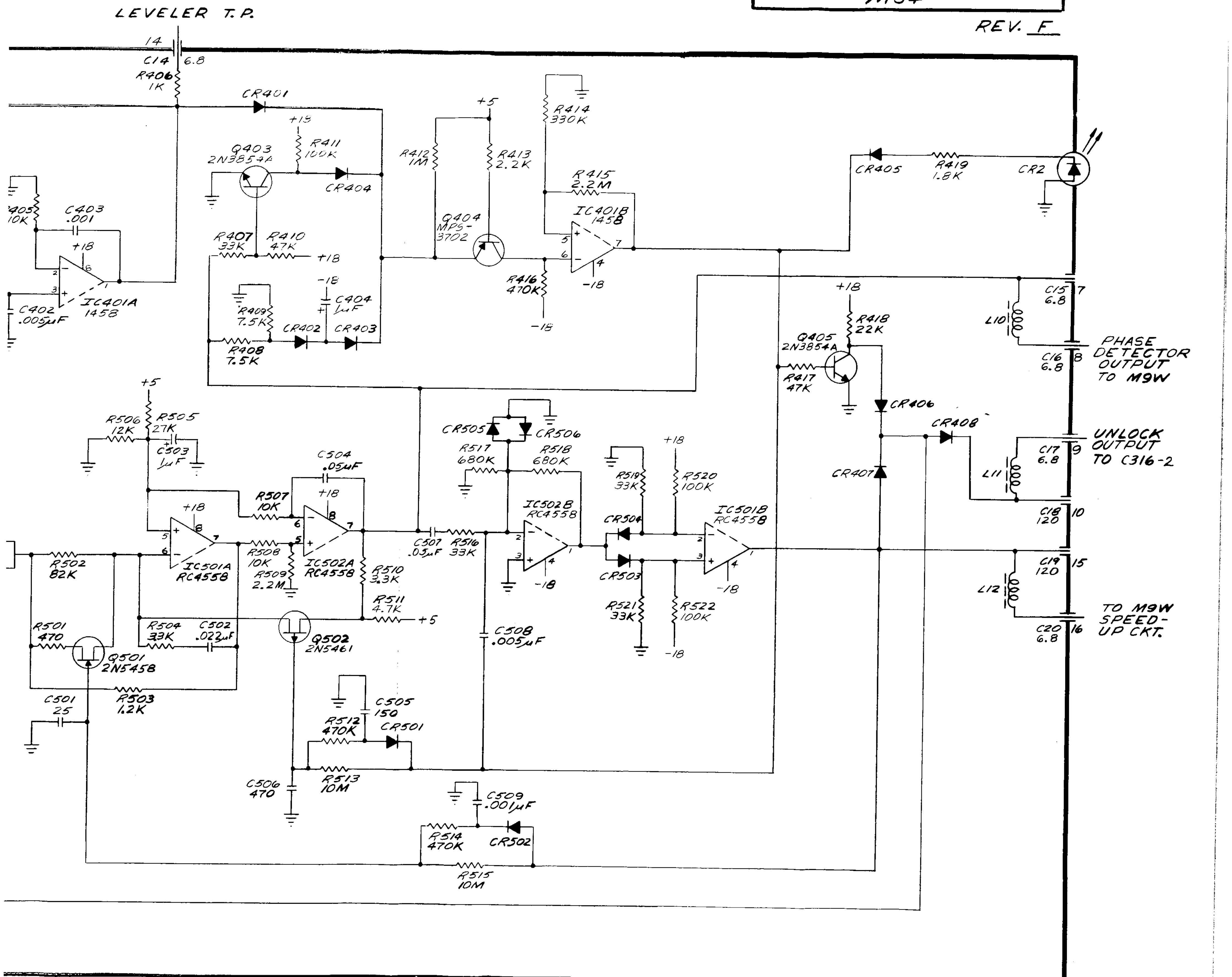
SCHEMATIC 10
1 MHz STEPS
M32
REV. D
VIDEO T.P.
LEVELER T.P.
1440 MHz FROM M30
UHF T.P.
1MHz FROM M30
1448-1487 OUT 0 dBm TO M34
UNLOCK INDICATOR
UNLOCK OUTPUT TO C316
Ø LOCK T.P.
ANALOG PROGRAM 0 TO -7.8V
+7.3V 170mA
-18V 35mA
+18V 40mA
MHz
100MHz
CENTERING
WIDTH
IC401 741
IC201 74S74
IC202 82S90
IC205 8290
IC203 74H102
IC204 7474
IC206 4044
IC301 3083
IC302A RC4558
IC302B RC4558
IC303A RC4558
IC303B RC4558
IC2 78M05
OC-1



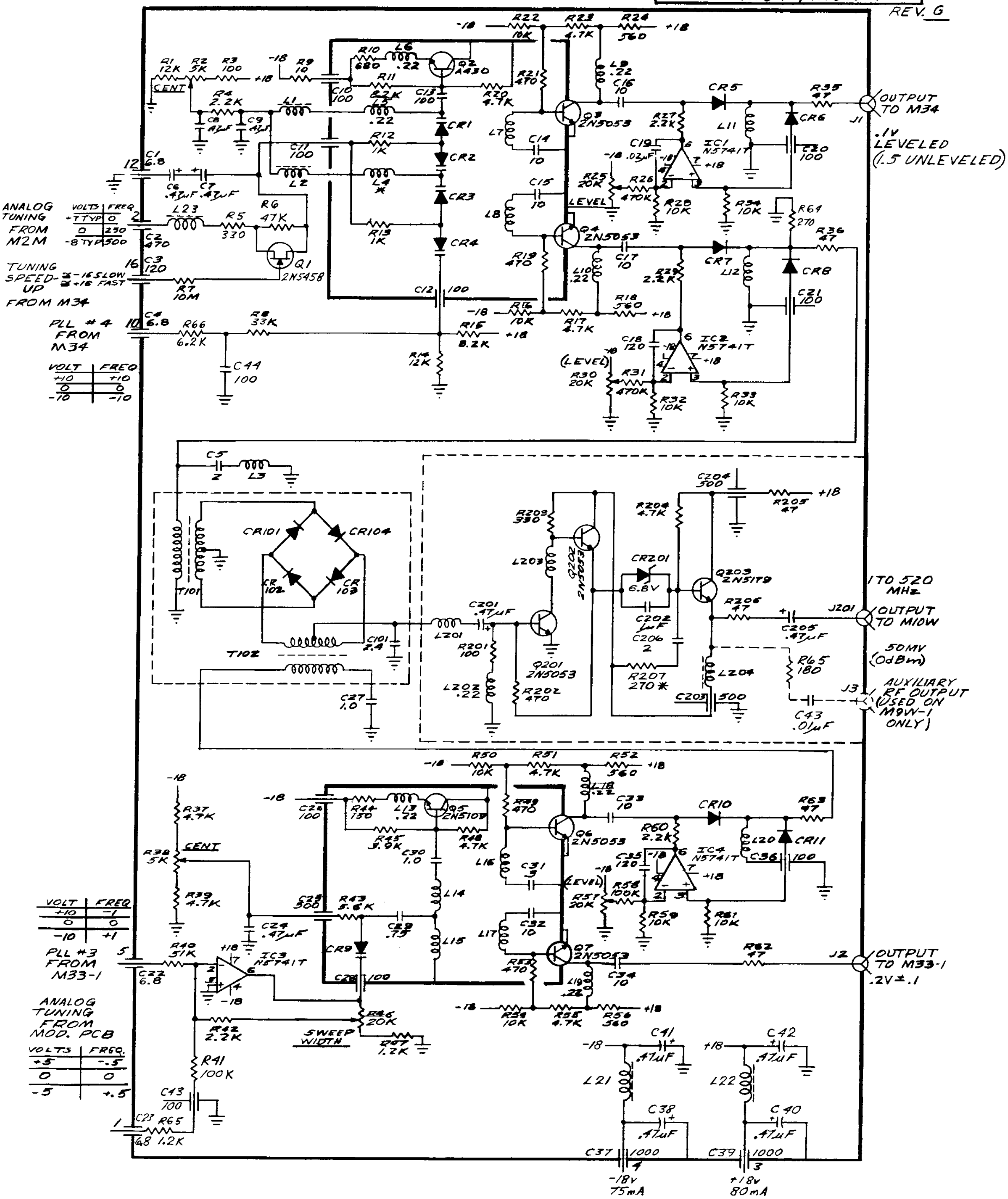
VIDEO T.P.
FROM M9W
1448 1487 FROM M32
40 MHz COMB FROM M30-1
10-9 MHz FROM M31
J1
J2
J3
J4
J5
R205 100
+18
C10 1μF
C203 500
R201 820
Q202 2N5053
Q201 2N5053
L102
R103 27
C201 .005μF
C105 1.5 *
C204 .005μF
R204 47
L201
L202
L203
L204
C205 2.7 *
C206 4.7
C207 6.8
C208 15
C209 15
C210 6.8
R7 100 *
R8 47 *
C202 6.8 *
R202 560
R203 68
C101 500
R101 47K
C102 .001μF
C103 .001μF
CR103
CR104
T101
R102 47K
C104 500
-18
R1 2.2K
CR101
CR102
L1
L101
R6 1.2K
L9
+5
R404 10K
C13 500
CR1
R405 15K
R2 100 *
R3 47
R4 47 *
CR601
T601
CR602
R601 47
R602 470
C601 18
L601 .47μH
C602 39
C301 39
L301 4.7μH
L302 4.7μH
C302 27
C303 .01μF
L6
C311 1μF
R307 47
R312 390
C309 2200
C310 2200
C312 2200
R304 390
R306 390
R303 2.2K
C306 .01μF
R305 2.2K
C308 .01μF
R311 2.2K
Q301 2N5053
Q302 2N5053
Q303 2N5053
R301 22K
R308 22K
R310 22K
R302 47
R309 47
L303
R313 47
C304 2200
C305 2200
C307 2200
R5 470
L305 1μH
L307 1μH
L308
C313 120
C314 150
C315 120
L304 .47μH
L306 1μH
CR301
CR302
CR303
C316 360
C317 360
C318 360
C319 100
R314 2K
R315 2K
R316 2K
L7
C321 1μF
R319 499
R318 1K
C320 .01μF
Q304 2N5053
C322 1μF
R317 15K
R320 2.43K
C11 1μF
L5
L8
C12 1μF
IC2 11C44
Q401 2N3854A
R401 15K
C401 1μF
Q402 2N3854A
R402 47K
IC1 78M05
C1 100μF
L2
C3 100μF
C2 1000
C4 .01μF
L3
C5 .01μF
C6 1000
C7 .01μF
L4
C8 .01μF
C9 1000
+7.3v 61 mA
-18v 23 mA
+18v 36 mA

SCHEMATIC 11
WIDE OSCILLATOR LOCK
M34

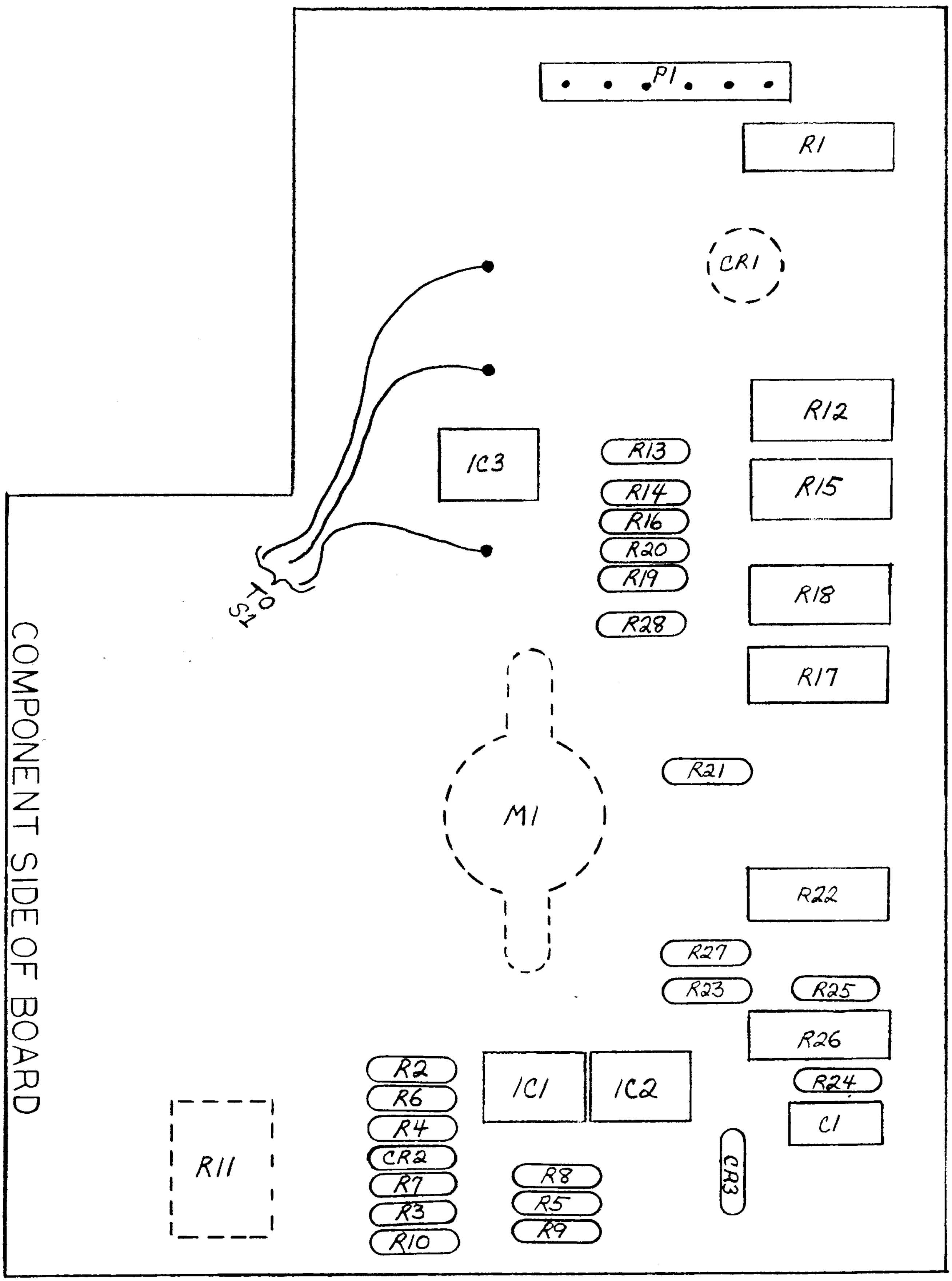
REV. F

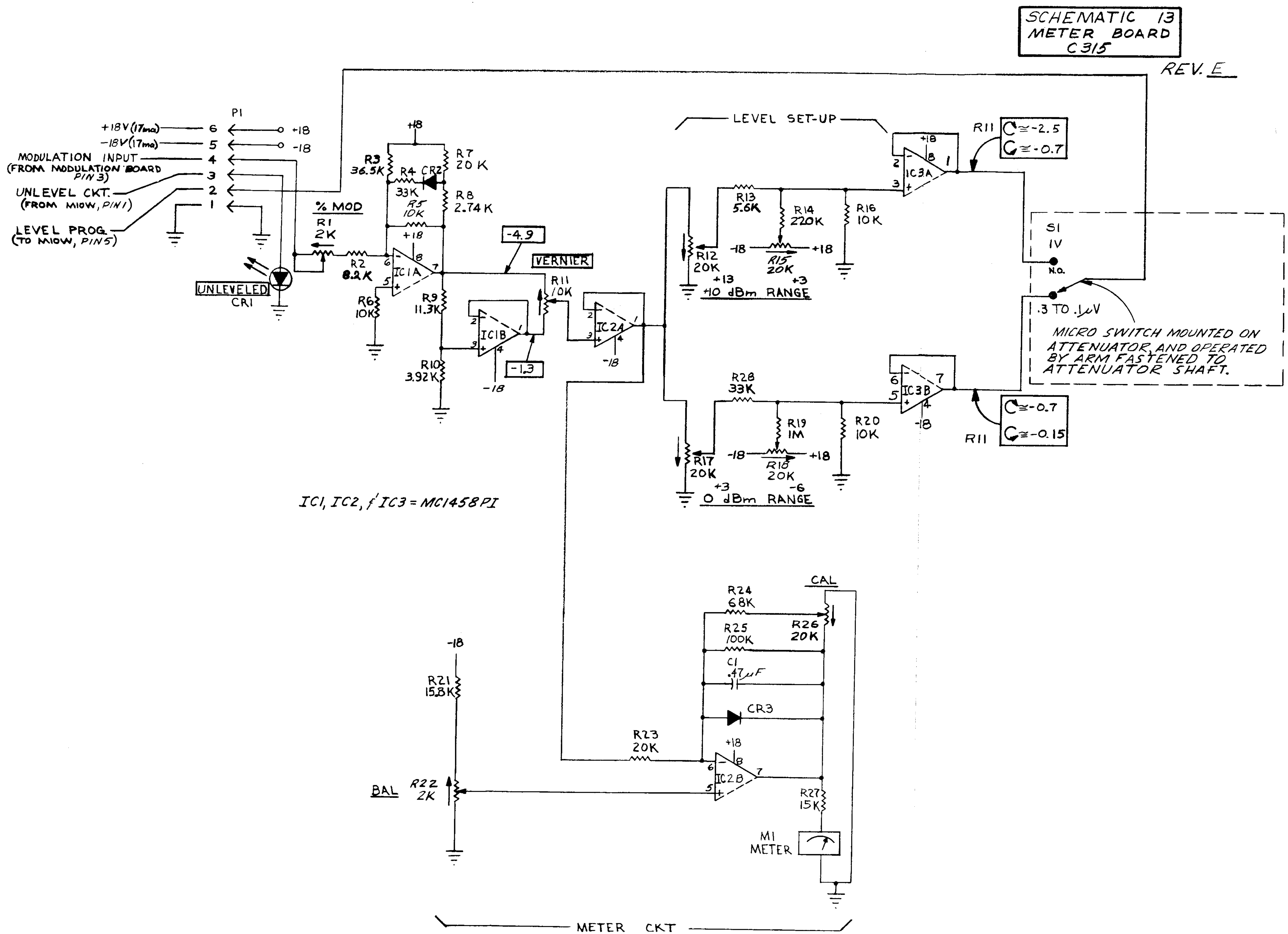


SCHEMATIC 12
WIDE SWEEP OSCILLATOR
1198 TO 1718 MHz
M9W/M9W-1



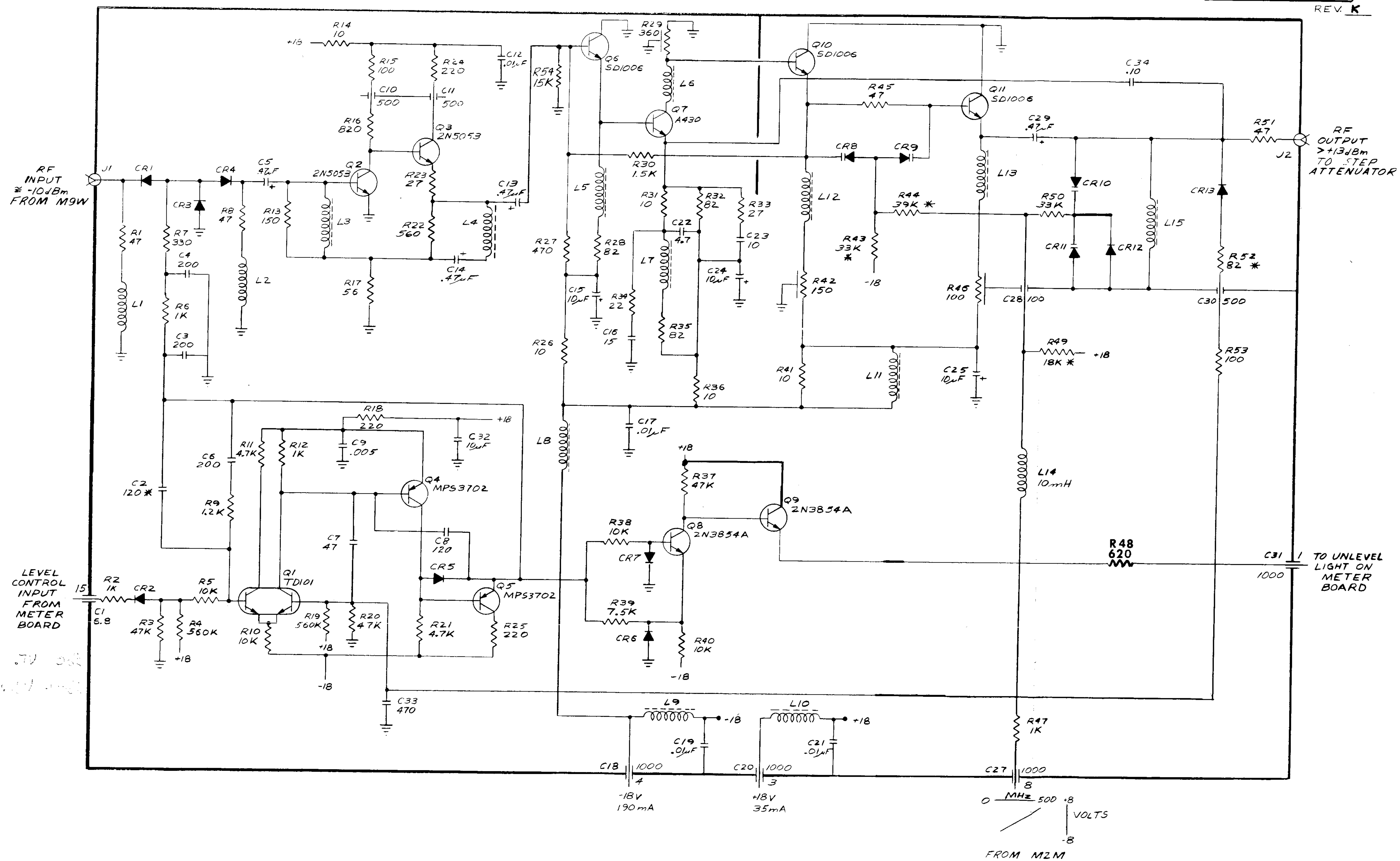
C315


P1
R1
CR1
R12
R13
IC3
R14
R15
R16
R20
R19
R18
TO S1
R28
R17
R21
M1
R22
R27
R23
R25
R26
R2
IC1
IC2
R24
R6
C1
R4
R11
CR2
CR3
R7
R8
R5
R3
R9
R10
COMPONENT SIDE OF BOARD


SCHEMATIC 13
METER BOARD
C315
REV. E
P1
+18V (17ma) 6 +18
-18V (17ma) 5 -18
MODULATION INPUT 4
(FROM MODULATION BOARD PIN 3)
3
UNLEVEL CKT. 2
(FROM MIOW, PIN 1)
1
LEVEL PROG.
(TO MIOW, PIN 5)
UNLEVELED
CR1
% MOD
R1 2K
R2 8.2K
R3 36.5K
R4 33K
CR2
R5 10K
R6 10K
R7 20K
R8 2.74K
R9 11.3K
R10 3.92K
IC1A
IC1B
-4.9
-1.3
VERNIER
R11 10K
IC2A
LEVEL SET-UP
R12 20K
R13 5.6K
R14 220K
R15 20K
R16 10K
+13 +3
+10 dBm RANGE
IC3A
R11
≅-2.5
≅-0.7
S1
1V
N.O.
.3 TO .1μV
MICRO SWITCH MOUNTED ON ATTENUATOR, AND OPERATED BY ARM FASTENED TO ATTENUATOR SHAFT.
R28 33K
R19 1M
R18 20K
R20 10K
R17 20K
+3 -6
0 dBm RANGE
IC3B
≅-0.7
≅-0.15
IC1, IC2, & IC3 = MC1458P1
CAL
R24 68K
R25 100K
R26 20K
C1 .47μF
CR3
R23 20K
IC2B
R21 15.8K
BAL
R22 2K
R27 15K
M1 METER
METER CKT

SCHEMATIC 14
OUTPUT AMPLIFIER
M10W

REV. K



SECTION 8
MANUAL CHANGES & OPTIONS

8.1 INTRODUCTION

This section contains descriptions of engineering updates as well as corrections to any errors in the manual. Also in this section is the necessary information to document the options which have been ordered with this instrument.

8.2 MANUAL CHANGES

WAVETEK'S product improvement program incorporates the latest electronic developments into these instruments as rapidly as development and testing permit. Due to the time required to document and print these instruction manuals, it is not always possible to include the change information in the current printing. The following changes should be made to this manual:

MODEL 3001
CHANGES

OPTION 7 (Low RF Leakage) is now available.
M31A replaces M31 (see attached addendum).

PAGE	
4-19	Section 4.12 - Specification should read "DC to 20 kHz (±3 dB bandwidth)".
4-21	Section 4.12 - 6. - Third sentence should read, "It should read between -3 and -9 dB."
4-25	Section 4.15 - 3. - Second sentence should read, "the meter range switch to 100".
DPS2 PL	**The Wavetek part numbers for C9 and C11 should read:** **C9**——CE122-310 **C11**——CE105-010
M22 LAYOUT	Q24 and Q25 are reversed.
M9W PL/SCH	"Parts added for M9W-1" - C43 should be C45, R65 should be R67.
M30-1 PL/SCH	There are 2 capacitors referenced "C40" and 2 capacitors referenced "C57". Therefore change: C57....Var cer, 3.5-13pF....CV101-013 to C60 and delete: C40....Cer disc, .005uF....DE103-250
M32 PL/SCH	R112 is now 1.5 kΩ, and should read: R112....Fixed comp, 1.5 kΩ, ±10%....RC104-215....A-B....CB1521 Also R404 and R405 are now * values.

M9W SCH	J201, - Output level should read "50 mV (-10 dBm)." Also, "PPL #3 VOLT/FREQ" table at the lower left should read

VOLT	FREQ
+10	-2
0	0
-10	+2

8.3 OPTIONS

Refer to Section 1.3 for a list of the options available with this instrument. The option documentation includes the operation, theory of operation, maintenence, list of replaceable parts, and schematics.

M31A SUBSTITUTION

In this instrument, module M31 has been replaced by module M31A. The M31A is a pin-for-pin replacement for the M31, but is an improvement on it. The changes caused by this substitution are detailed below.

All references to M31 are now to M31A.

Section 3.12.1 VCO

The output frequency is generated by a Voltage Controlled Oscillator which is phase locked within the module.

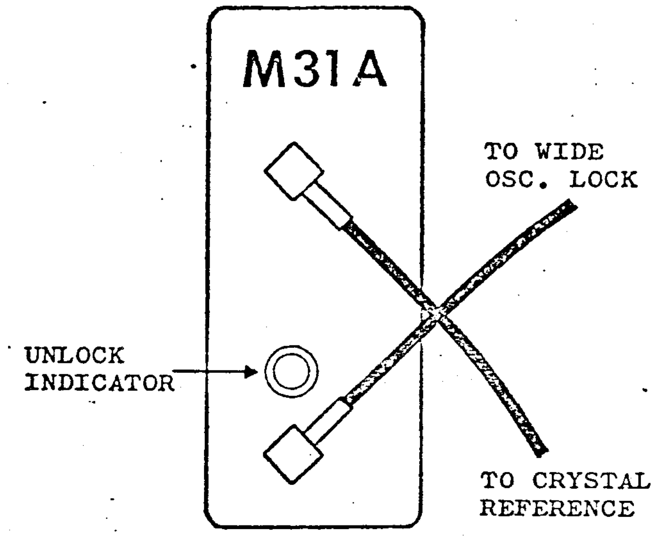
Section 3.12.2 D/A CONVERTER

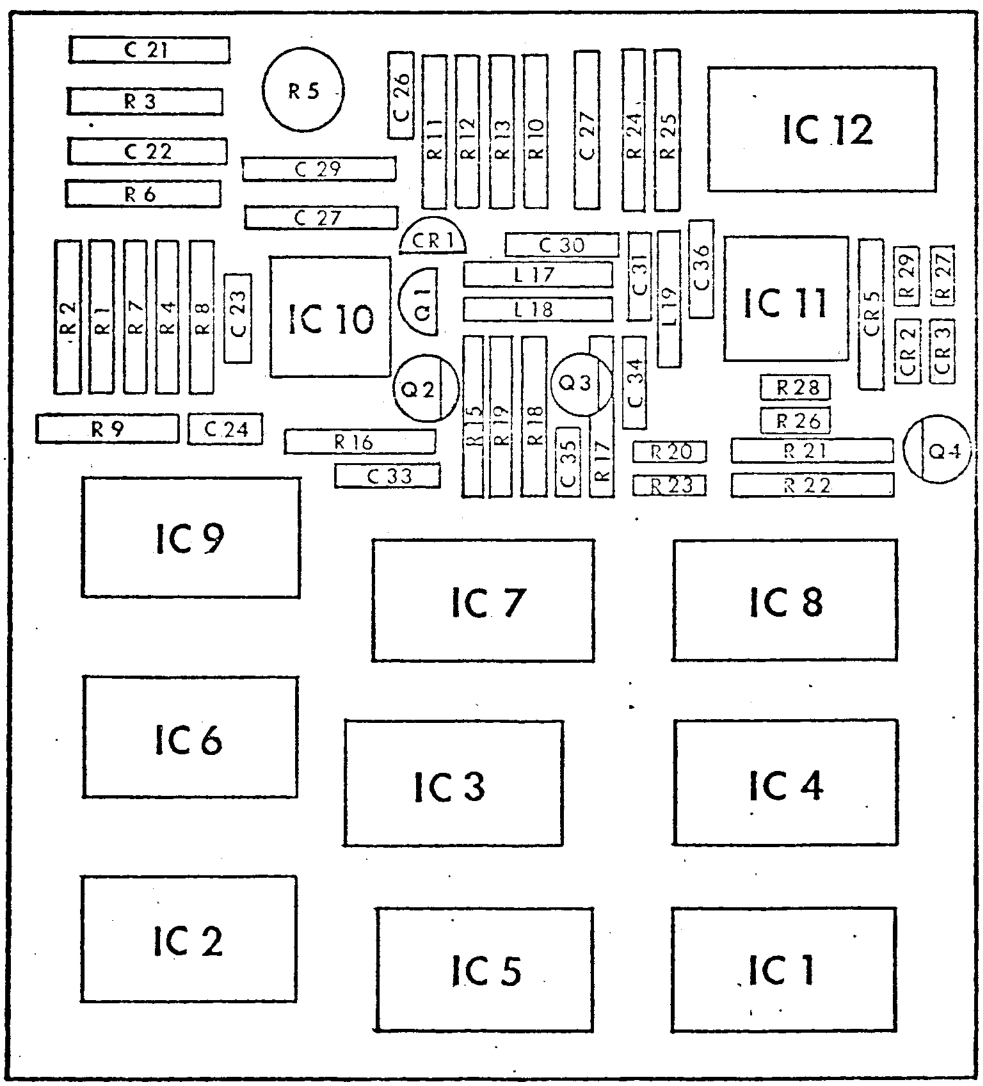
This section is deleted.

Section 5.3.5 PLL #1 Adjustment M31A

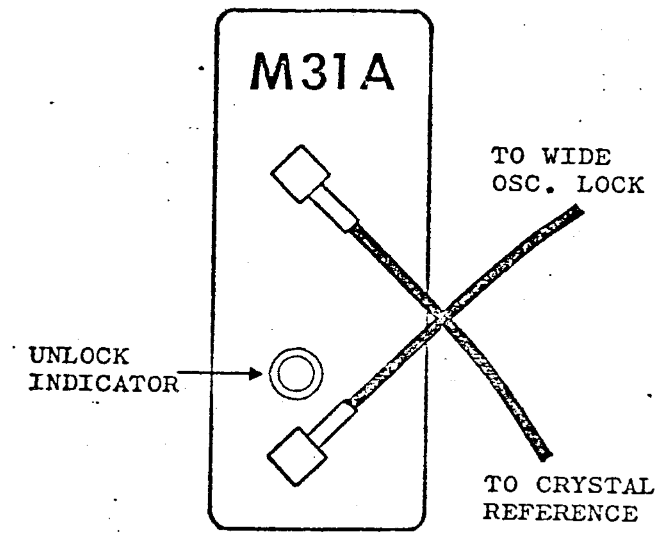
No adjustment of module M31 is necessary.

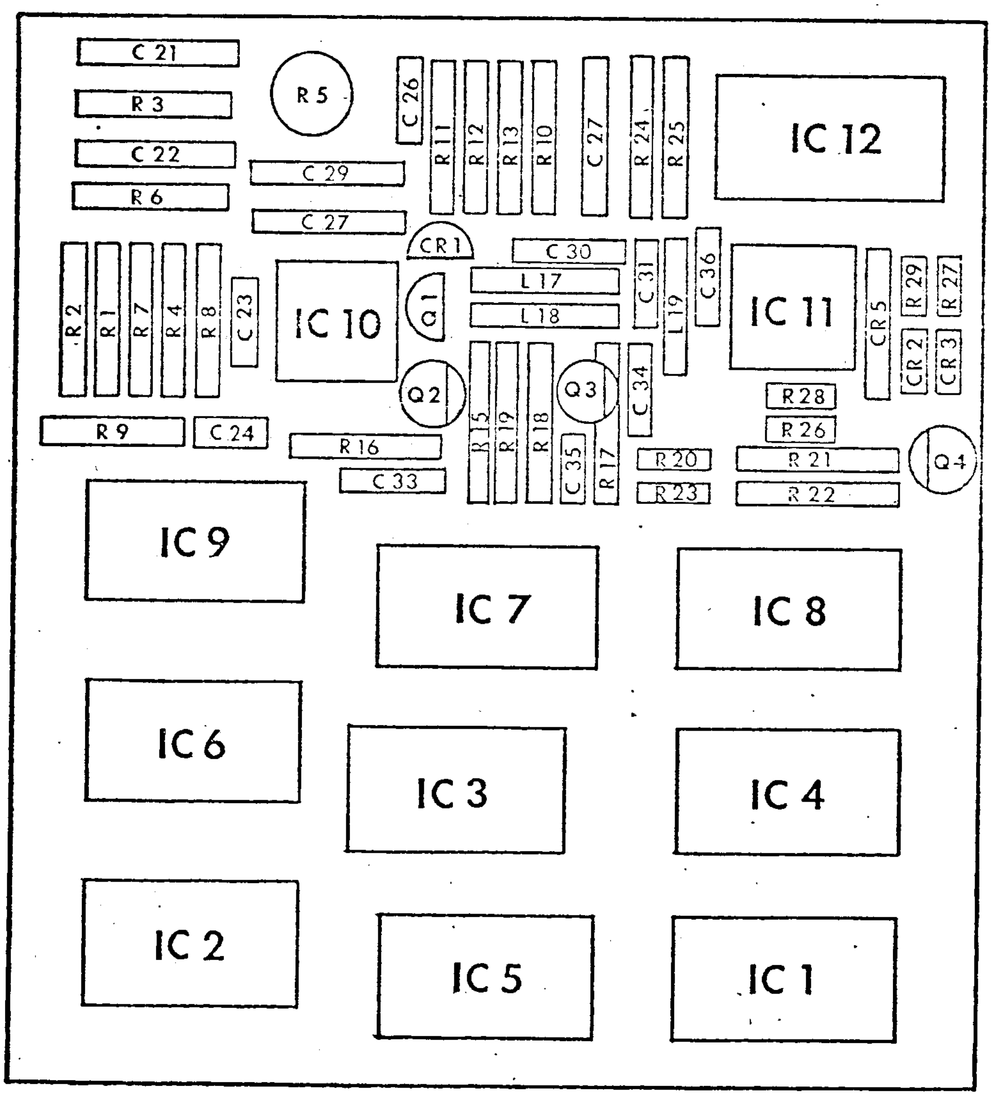
Following are the Top View, Component Layout, Parts List, and Schematic for module M31A.





M31A Top View And Component Layout





M31A Top View And Component Layout

M31A SUBSTITUTION

In this instrument, module M31 has been replaced by module M31A. The M31A is a pin-for-pin replacement for the M31, but is an improvement on it. The changes caused by this substitution are detailed below.

All references to M31 are now to M31A.

Section 3.12.1 VCO

The output frequency is generated by a Voltage Controlled Oscillator which is phase locked within the module.

Section 3.12.2 D/A CONVERTER

This section is deleted.

Section 5.3.5 PLL #1 Adjustment M31A

No adjustment of module M31 is necessary.

Following are the Top View, Component Layout, Parts List, and Schematic for module M31A.

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C01 C02 C03 C04 C05 C06 C07 C08 C09 C10 C11 C12 C13 C14 C15 C16	CAP,CER,F.T. 1000PF CF112-210	54-794-010-102P	SPEC	1510-30-8102	16
C17	CAP,ELECT,100MF,12V CE119-110	500D107G012CC7	SPR	1510-21-2101	1
C18	CAP,ELECT,100MF,6V CE118-110	500D107G006CC7	SPR	1510-21-1101	1
C19 C20 C25 C28 C32 C37	CAP,TANT,10MF,25V	162D106X0025D02	SPR	1510-21-7100	6
C21 C22 C29	CAP.FILM,.12MF,250V 5%	60E124J250	PLSSY	1510-60-8124	3
C23 C24 C26	CAP,CER,1MF,50V,MONO TYPE 3400 CD114-510	3430-050-E105Z	AVX	1510-10-9105	3
C30	CAP,MICA,1000PF,500V CM101-210	DM15-102J	ARC	1510-50-0102	1
C31	CAP,CER,10PF,1KV CD101-010	10TCC-Q10	SPR	1510-10-0100	1
C33 C34	CAP,MICA,180PF,500V CM101-118	DM15-181J	ARCO	1510-50-0181	2
C35 C36	CAP,CER,.001MFD,1KV CD102-210	5GAD10	SPR	1510-10-1102	2
CR01	MOT MV2301 TUNER DIODE	MV2301	MOT	4803-02-0008	1

WAVETEK PARTS LIST

TITLE KHZ STEPS MODULE M31A

ASSEMBLY NO. 1114-00-0143

PAGE: 1

REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
CR02 CR03 CR05	DIODE,DG109-140	1N4148	FCD	4807-01-0914	3
CR04	LED DL000-001	NSL5046	NAT	4810-02-0001	1
IC01 IC02 IC12	IC,IC000-012	SN7404N	T-I	8000-74-0400	3
IC03 IC05 IC06	IC,IC000-016	N8290A	SIG	8000-82-9000	3
IC04	IC,IC000-017	N82S90A	SIG	8000-82-9001	1
IC07	IC,IC000-019	SN74H102N	T-I	8007-41-0200	1
IC08	IC,IC000-018	N74H11A	SIG	8000-74-1100	1
IC09	IC,IC000-029	11C44DC ONLY	FCD	8000-11-4400	1
IC10	IC,IC000-005	RC4558DN	RAY	7000-14-5800	1
IC11	IC,IC000-002	N5741CV	SIG	7000-57-4100	1
IC13	IC,IC000-011	78M05UC	FCD	7000-78-0500	1
J01 J02	CONN JF000-005	37JR116-1	S-C	2110-03-0002	2
L01 L02 L03 L04 L05 L06 L07 L08 L09 L10 L11 L12 L13 L14 L15 L16	FERRITE CHOKE LA009-010	T1255-2	HYT	1810-05-0002	16
L17	CHOKE,2.2MH,10% LA005-R22	08N2R2K	ASE	1810-03-0229	1
L18	CHOKE .47MH 10% LA005-R04	08NR47K	ASE	1810-03-0478	1

WAVETEK PARTS LIST

TITLE KHZ STEPS MODULE M31A

ASSEMBLY NO. 1114-00-0143

PAGE: 2

REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
L19	CHOKE .22MH 10% LA005-R02	08NR22K	ASE	1810-03-0228	1
Q01	TRANS QA054-580	2N5458	MOT	4901-05-4580	1
Q02	TRANS QA053-060	2N5306	GE	4901-05-3060	1
Q03 Q04	TRANS QA038-541	2N3854A	G-E	4901-03-8541	2
R01 R02	RES,C,1/4W,5%,4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	2
R03 R04 R06 R07 R26	RES,C,1/4W,5%,30K RC103-330	CF1/4-30K	ASE	4700-15-3002	5
R05	POT,2K,RP144-220	91AR2K	BEK	4610-00-4202	1
R08 R27	RES,C,1/4W,5%,47K RC103-347	CF1/4-47K	ASE	4700-15-4702	2
R09	RES,C,1/4W,5%,68K RC103-368	CF1/4-68K	ASE	4700-15-6802	1
R10 R11 R14	RES,C,1/4W,5%,6.8K RC103-268	CF1/4-6.8K	ASE	4700-15-6801	3
R12	RES,C,1/4W,5%,3.3K RC103-233	CF1/4-3.3K	ASE	4700-15-3301	1
R13 R22 R25	RES,C,1/4W,5%,10K RC103-310	CF1/4-10K	ASE	4700-15-1002	3
R15	RES,MF,1/8W,1%,30.1K RF213-301	MF55K-30.1K	ASE	4701-03-3012	1

WAVETEK PARTS LIST	TITLE KHZ STEPS MODULE M31A	ASSEMBLY NO. 1114-00-0143 PAGE: 3	REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R16	RES,MF,1/8W,1%,4.32K RF212-432	MF55K-4.32K	ASE	4701-03-4321	1
R17,R18	RES,MF,1/8W,1%,19.6K RF213-196	MF55K-19.6K	ASE	4701-03-1962	2
R19	RES,MF,1/8W,1%,2.10K RF212-210	MF55K-2.10K	ASE	4701-03-2101	1
R20 R30	RES,C,1/4W,5%,1.8K RC103-218	CF1/4-1.8K	ASE	4700-15-1801	2
R21	RES,C,1/4W,5%,1K RC103-210	CF1/4-1K	ASE	4700-15-1001	1
R23	RES,C,1/4W,5%,15K RC103-315	CF1/4-15K	ASE	4700-15-1502	1
R24	RES,C,1/4W,5%,2.7K RC103-227	CF1/4-2.7K	ASE	4700-15-2701	1
R28	RES,C,1/4W,5%,160K RC103-416	CF1/4-160K	ASE	4700-15-1603	1
R29	RES,C,1/4W,5%,20K RC103-320	CF1/4-20K	ASE	4700-15-2002	1
9	CABLE,SEMI RIGID,50 .056OD,WC000-004	MA50056	PRSN	6011-40-0003	3
5	PC BOARD, Z419	Z419	W-I	1710-00-1120	1
3	DECAL,CAN M31A	CD8-125	W-I	2410-04-0236	1

WAVETEK PARTS LIST	TITLE KHZ STEPS MODULE M31A	ASSEMBLY NO. 1114-00-0143 PAGE: 4	REV

MODEL 3001 OPTION -3

RF Output Protection

1. INTRODUCTION

Option "-3" is a circuit breaker in the RF output system of the instrument. This prevents damage to the RF output system in the event that large RF signals are fed into the signal generator while testing a transceiver. In addition to the RF protection, the option contains a DC block which will prevent damage to the attenuator if the RF output is connected to a circuit operating at a DC potential.

2. SPECIFICATIONS

Frequency Range	1 to 520 MHz
Insertion Loss	<.2 dB
VSWR	< 1.15
Trip Time	< 2 msec
RF Trip Voltage	≃ .7 W
Max RF	50 W
DC Blocking Voltage	100 Volts

3. OPERATING INSTRUCTIONS

If an external RF voltage of approximate-aly 6 V RMS or more is accidentally applied to the instrument's RF output connector, an internal switch in series with the RF output will open. This prevents damage to the instrument's attenuator or output amplifier. This open switch will be indicated on the front panel by the flashing of the "unlevel" light. Once the switch is tripped, it will latch in the open position and remain open until reset. Also, a combination of a high mismatch, high output level (over .1 V) and changing frequency can cause the circuit breaker to trip.

After removing the RF signal causing the overload, the switch can be reset by momentarily turning the front panel AC power switch to the off position.

NOTE: Normal operation of the "unlevel" light is a steady glow if the instrument is unleveled. If the circuit breaker is tripped while the instrument is unleveled, the "unlevel" light will vary in intensity instead of flashing on and off.

4. THEORY OF OPERATION

Figure 1 is a block diagram of the RF circuit breaker. This block along with the overall schematic contained in Section 7 should be used to follow the information contained in this section.

With the instrument's AC line switch set to its "off" position, relay K1 is in it's normally open position. This prevents any damage to the instrument while it is not in use. As soon as AC power is applied to the instrument, IC1 will compare the voltage from the RF monitor CR1 to a fixed reference voltage of approximately 5 V. As long as the output of the monitor CR1 is less than the 5 V reference voltage, the output of IC1 will be approximately +17 V. This positive output from IC1 turns on the relay driver Q1. This energized relay K1, thus completing the RF output circuit.

The positive output from IC1 also turns on Q2. This effectively grounds pin 7 of timer IC2, which is being operated as as astable oscillator. With pin 7 grounded, the timer is inoperative and its output, pin 3, is high. The high output from IC2 turns off Q3. This prevents any current flow to the front panel "unlevel" light.

If an external RF signal exceeding 6 V rms is applied to the instrument's RF output connector, the output from monitor diode CR1 will go above 5 V. This will produce a negative output from IC1. The positive feedback provided by R7 will latch IC1 in this state. The negative output from IC1 will turn off relay driver Q1. This causes relay K1 to return to its normally open position, re-

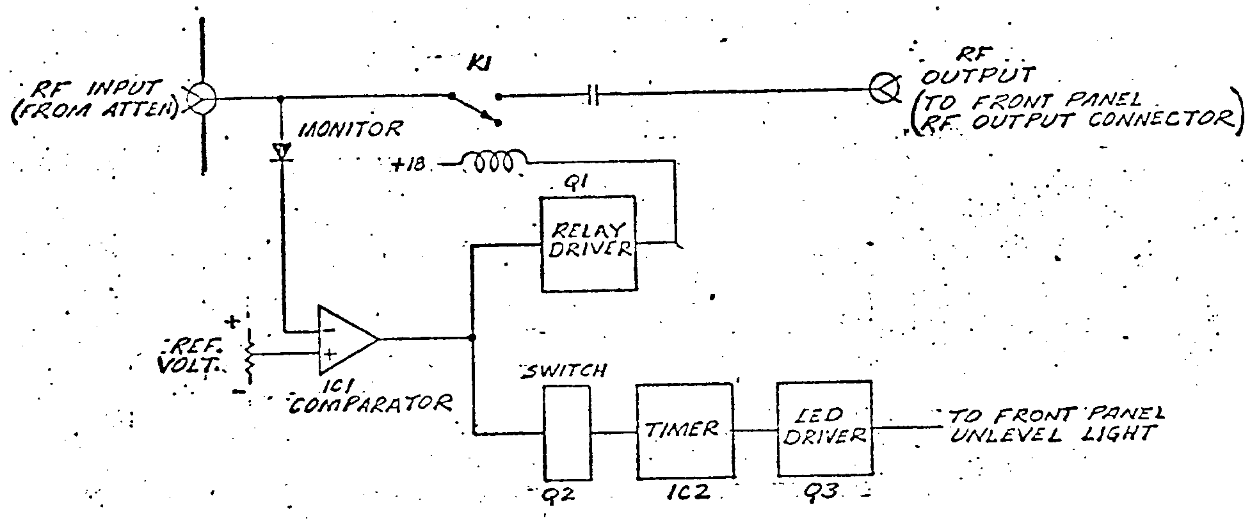


Figure 1. Block Diagram

moving the external RF signal from the instrument.

The negative output from IC1 also turns off Q2, thus removing the short on pin 7 of timer IC2. This allows the timer to operate as an astable oscillator. The output, pin 3 of IC2, then varies between 0 and 7 volts. This causes Q3, the LED driver, to supply current intermittently to the front panel "unlevel" light causing it to flash.

After the RF overload is removed, IC1 can be unlatched by momentarily removing AC power to the instrument.

5. OPERATION CHECK

The following procedure is recommended to insure proper operation of the protection device. The top cover must be removed from the instrument.

With the instrument operating normally in the CW mode, set the output level to +5 dBm. Connect a 50 ohm detector to the output of the signal generator. The DC output of the detector should be monitored on a suitable oscilloscope. Set the output frequency to 50 MHz.

The circuitry in the M35-1 is checked by pushing the momentary switch located on top of the module. This switch lowers the trip level of the module. While holding down the switch slowly increase the output of the 3001 using the vernier until the M-35-1 trips. This causes the circuit breaker to open, latch and the "unlevel" light to flash and the detected output displayed on the oscilloscope to go to zero. The circuit breaker can then be reset by momentarily turning the AC power switch off. The M-35-1 should have tripped at +7.5 dBm ±1 dB. Perform the same test at 520 MHz. It should then trip at an output level of +10.5 dBm ±2 dB.

The above procedure while not a complete performance check is considered adequate for most applications. Additional tests can be performed as desired. For example, insertion loss and VSWR can be checked in the same manner as any passive device. Also, if available, a high power RF signal source, set for an output of slightly over .7 W can be used to verify circuit breaker operation.

6. MAINTENANCE

The only maintenance for the RF circuit breaker is periodic testing to insure its operation. If a malfunction occurs, a trouble can be localized and repaired with the aid of the theory of operation and the schematic. If the problem is a defective monitor diode, care should be observed to keep lead length and position the same as the original diode.

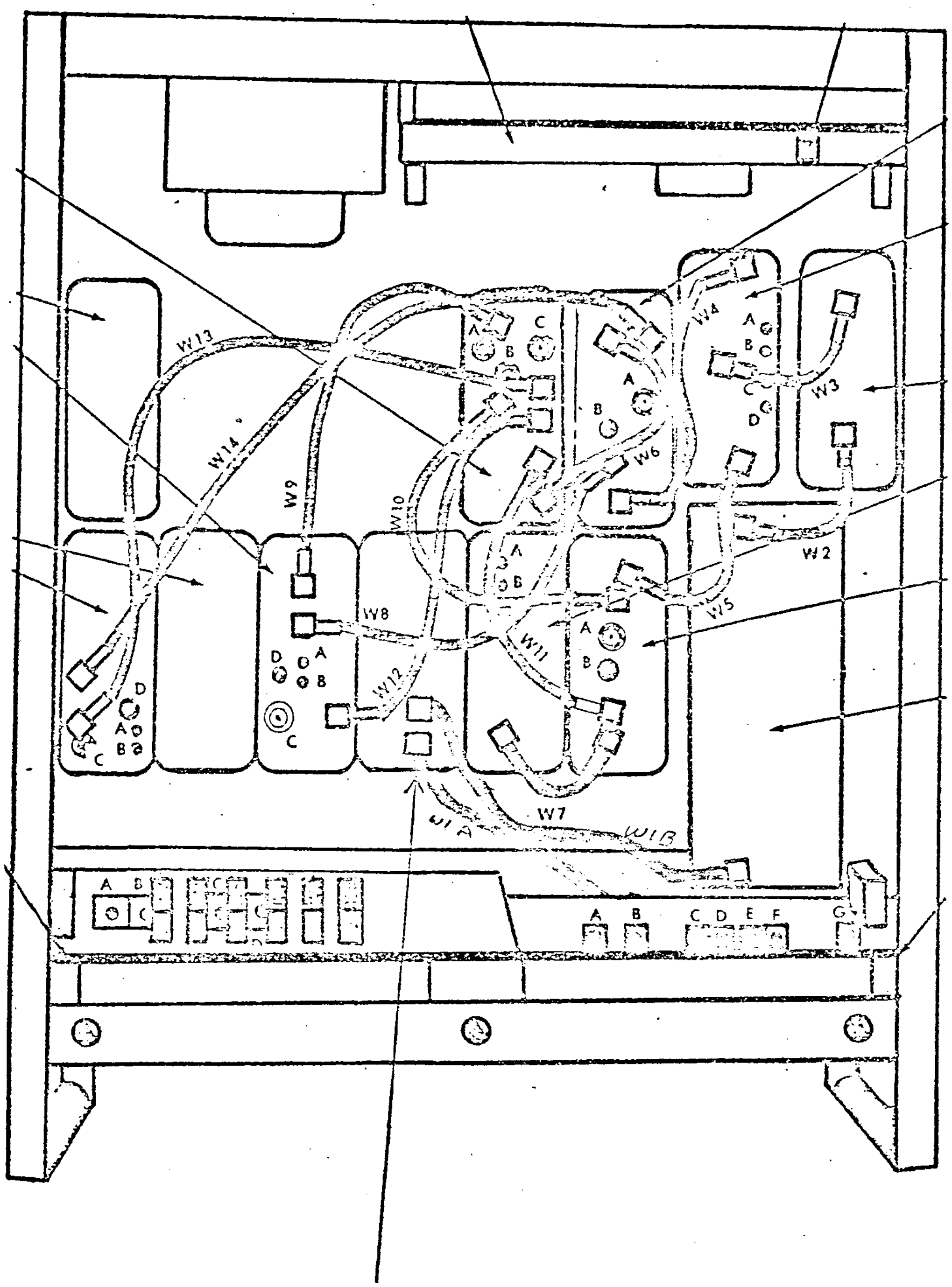
Option -3 can be factory or field installed. The following procedure should be followed for field installation.

OPTION -3 FIELD INSTALLATION KIT

QTY	DESCRIPTION	PART #
1	RF Circuit Breaker Module	M35-1
1	RF Cable	W1-A
1	RF Cable	W1-B
5	Pin Sockets	MC000-002
1	Wiring Harness	WY-OPT-3
1	6/32 x 5/8 Screw	HS101-610

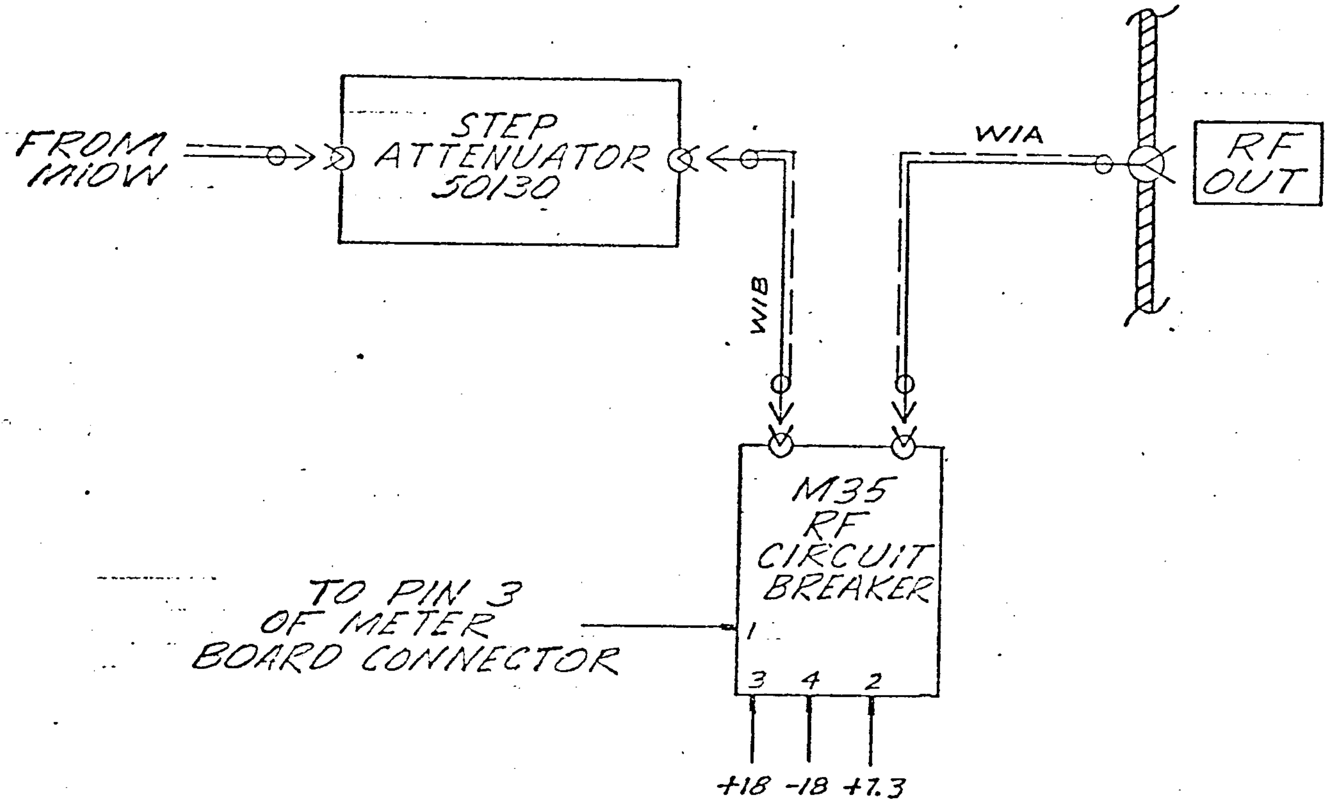
Install the pin sockets in the location shown in Figure 2. Install the harness as shown in Figure 2. The M35-1 module can then be installed as shown in Figure 3 and secured with the 6/32 hold-down screw, shown in Figure 2. Remove the front panel RF output cable (W1) and replace with W1A and W1B as shown in Figure 3.

Before use, the module should be tested by the procedure shown in Operational Check.



M35

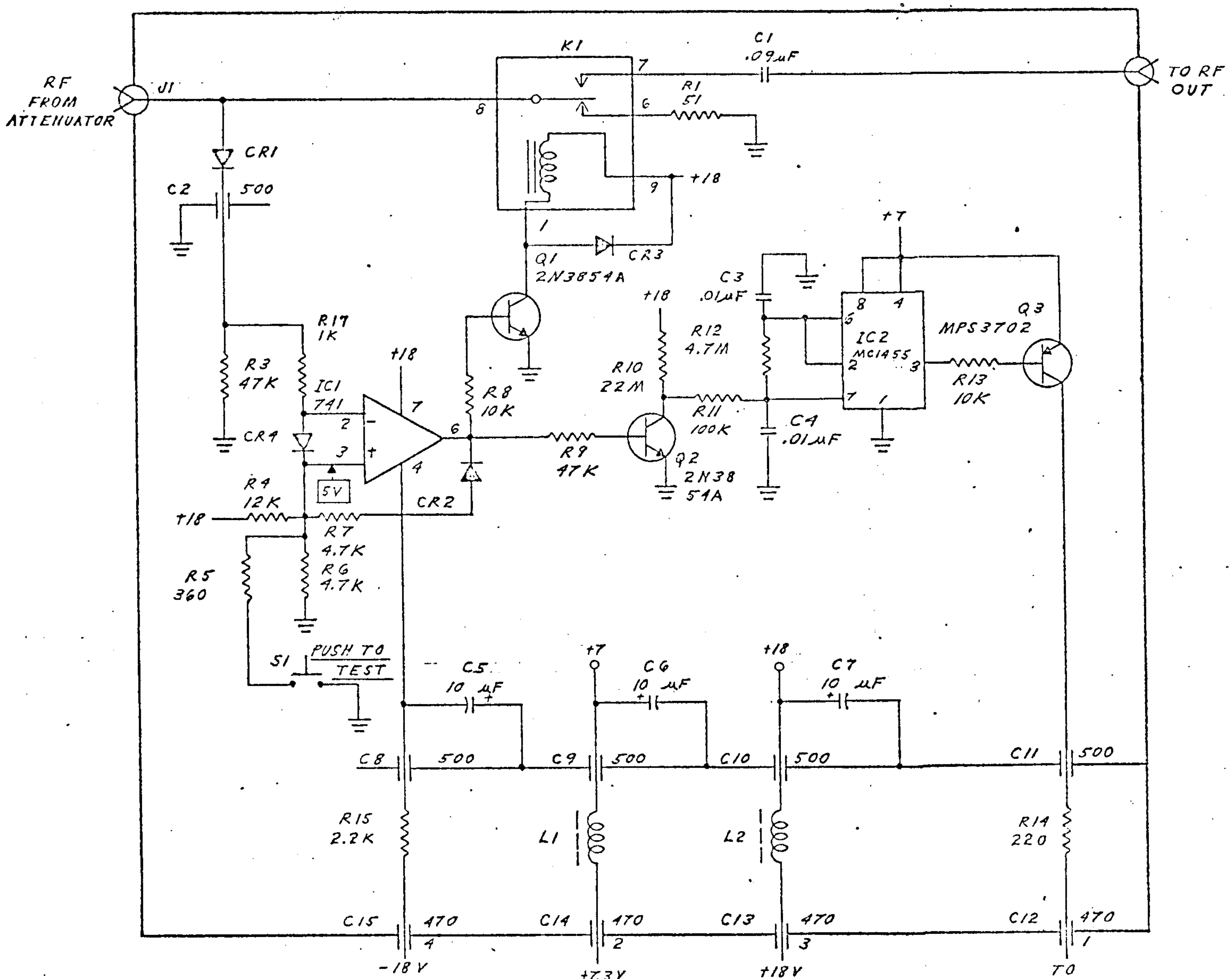
Figure 3 - RF Circuit Breaker Location



Model 3000 option -3, additional Wiring

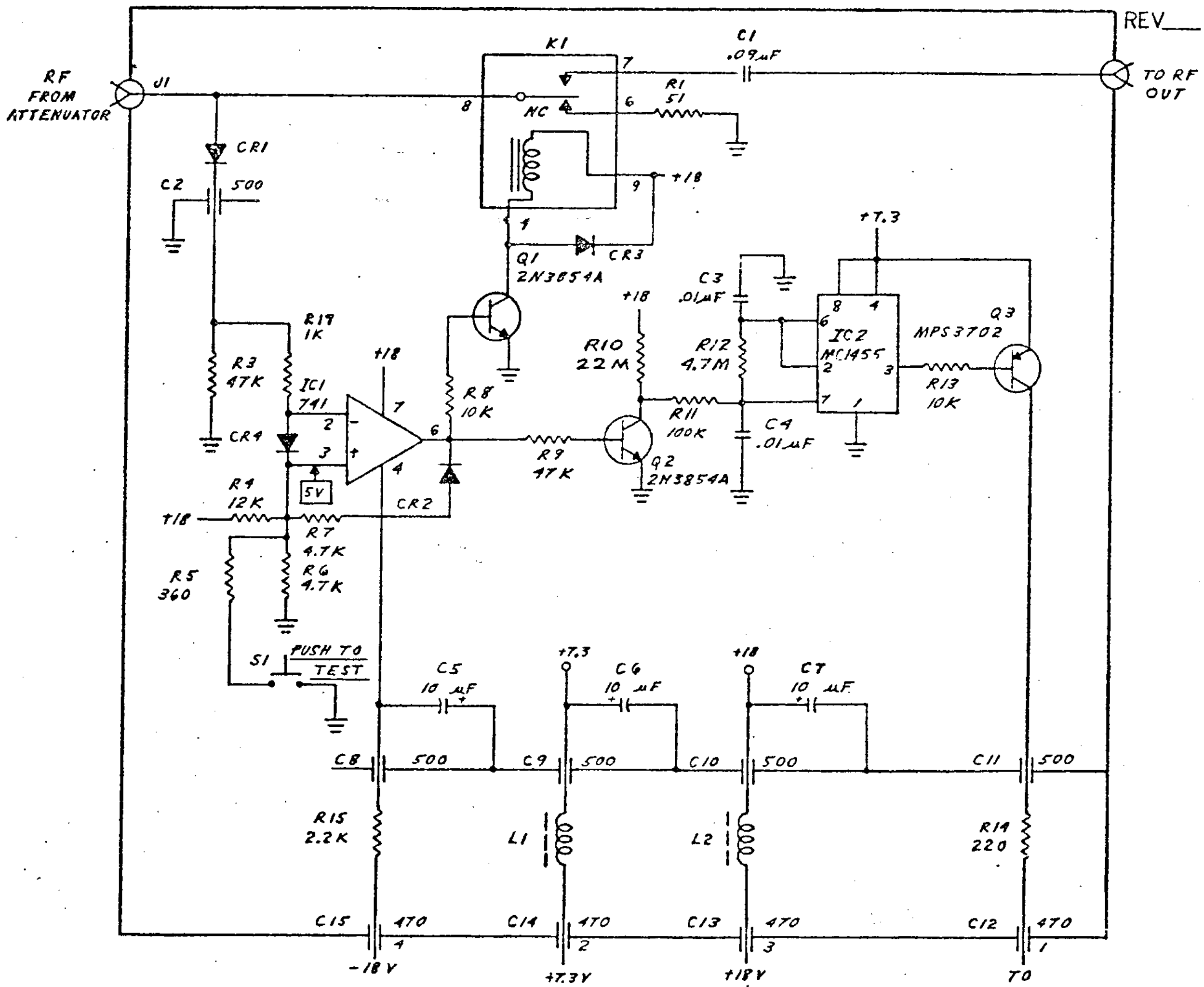
RF CIRCUIT BREAKER M35-1

REV____



	-18V	+7.3V	+18V
NORMAL OPERATION	1ma	4ma	12ma
[illegible]	[illegible]	[illegible]	[illegible]

SCHEMATIC 15
RF CIRCUIT BREAKER
M35-1



CURRENT INPUTS	-18V	+7.3V	+18V
NORMAL OPERATION	1ma	4ma	12ma
TRIPPED	3ma	8ma (AV)	3ma

PARTS LIST RF CIRCUIT BREAKER MODULE M35-1 REV

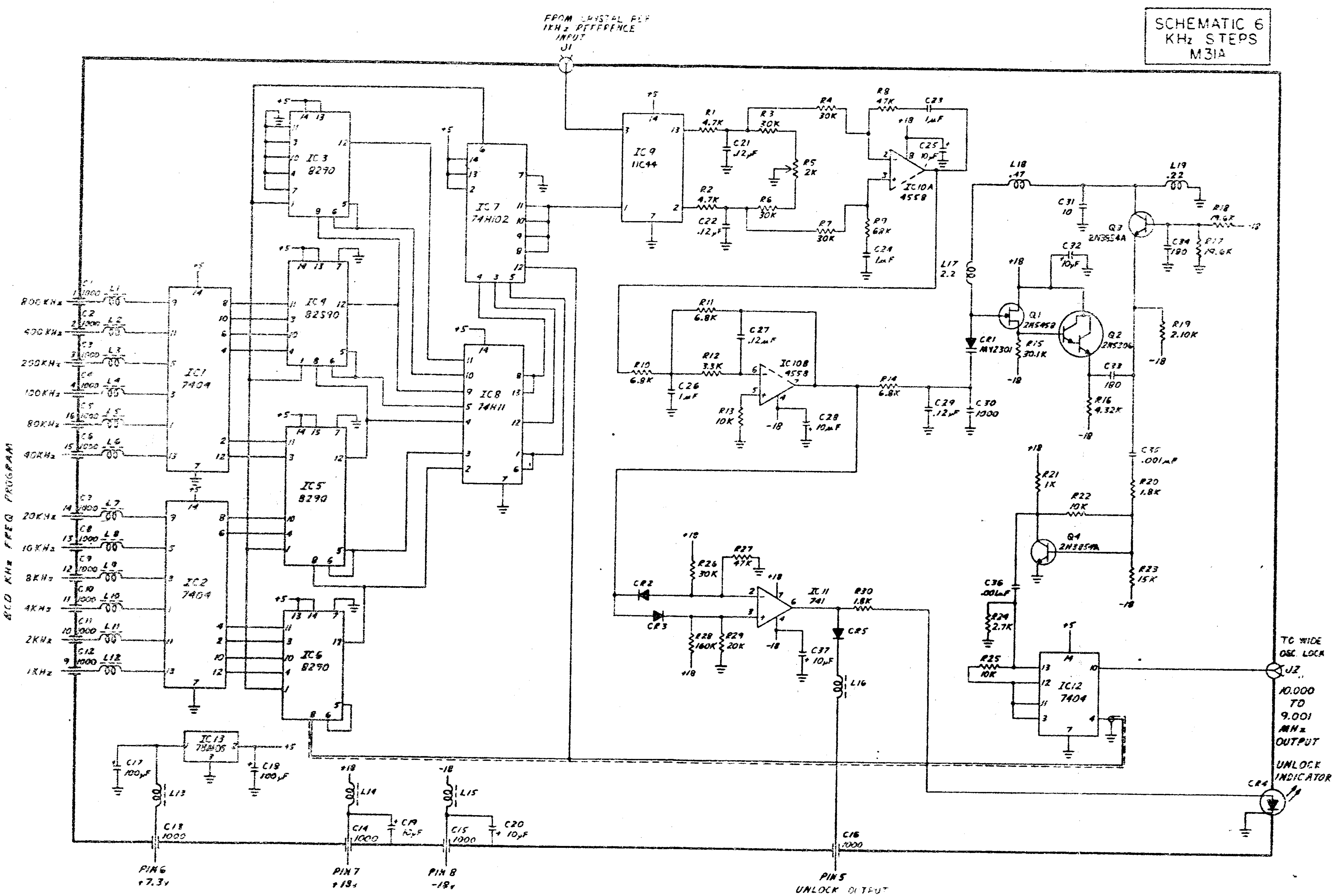
REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"C "	CAPACITORS				
1	Cer ft, .09 µF, 100 V	CF111-390	A-B	CLD03DA-903P	1
2,8,9,10,11,	Cer ft, 500 pF ±20%, 250 V	CF104-150	AER	EF-4	5
12,13,14,15	Cer ft, 470 pF ±20%, 500 V	CF101-147	A-B	FA5C	4
3,4	Cer disc, .01 µF, ±20%, 100 V, Z5U	CD103-310	SPR	TG-S10	2
5,6,7	Ta, 10 µF, ±20%, 20 V	CE120-010	SPR	162D106X0-025DD0	3
"CR "	DIODES				
1,4	Germanium, Point Contact	DG100-341	HIT	1N34AS	2
2,3	Si, Junction, 100 PIV	DR000-001	DIO	1N4004	2
"IC "	INTEGRATED CIRCUITS				
1	Operational Amplifier, 8 pin, DIP	IC000-002	SIG	N5741V	1
2	Timer, 8 pin, DIP	IC000-006	MOT	MC1455P1	1
"J "	CONNECTORS (JACKS)				
1,2	SMA receptacle	JE000-007	O-S	OSM211	2
"K "	RELAYS				
1	2PDT RF Relay	MR000-003	G-E	3SCS5007K1	1
"L "	INDUCTORS				
1,2	10 Turn Toroid	LA006-010	W-I	LA006-010	2
"Q "	TRANSISTORS				
1,2	NPN, Si	QA038-541	G-E	2N3854A	2
3	PNP, Si	QB000-009	MOT	MPS3702	1
"R "	RESISTORS				
1	Comp, 51 Ω, ±5%, ¼ W	RC103-051	A-B	CB5105	1
3,9	Comp, 47 K Ω, ±10%, ¼ W	RC104-347	A-B	CB4731	2
4	Comp, 12 KΩ, ±5%, ¼ W	RC103-312	A-B	CB1235	1
5	Comp, 360 Ω, ±5%, ¼ W	RC103-136	A-B	CB3615	1
6	Comp, 4.7 KΩ, ±5%, ¼ W	RC103-247	A-B	CB4725	1
7	Comp, 4.7 KΩ, ±10%, ¼ W	RC104-247	A-B	CB4721	1
8,13	Comp, 10 K Ω, ±10%, ¼ W	RC104-310	A-B	CB1031	2
10	Comp, 22 MΩ, ±10%, ¼ W	RC104-622	A-B	CB2261	1
11	Comp, 100 KΩ, ±10%, ¼ W	RC104-410	A-B	CB1041	1
12	Comp, 4.7 M Ω, ±10%, ¼ W	RC104-547	A-B	CB4751	1
14	Comp, 220 Ω, ±10%, ¼ W	RC104-122	A-B	CB2211	1
15	Comp, 2.2 KΩ, ±10%, ¼ W	RC104-222	A-B	CB2221	1
17	Comp, 1 KΩ, ±10%, ¼ W	RC104-210	A-B	CB1021	1
"S "	SWITCH				
1	Pushbutton SPDT-N.O., momentary	SM000-007	G-H	30-1	1

PRELIMINARY
PARTS LIST

RF CIRCUIT BREAKER M35-1 REV

REFERENCE SYMBOL	DESCRIPTION	WAVETEK PART NO.	MANUFACTURER CODE	MANUFACTURER NUMBER	T Q
"	CAPACITORS				
	Ceramic Feedthru, .09 µF GMV 100 V	CF111-390	A-B	CLD03DA	1
8,9,10,11	Ceramic Feedthru, 500 pF ±20% 250 V	CF104-150	AER	EF-4	5
12,13,14, 15,	Ceramic Feedthru, 470 pF ±20% 500 V	CF101-147	A-B	FA5C	4
3	Ceramic Disc, .01 µF ±20% 100 V	CD103-310	SPR	TG-S10	2
6,7	Electrolytic, 10 µF 20 V	CE120-010	ACI	100DE106M 20C2	3
R "	DIODES				
4	Germanium Point Contact	DG100-341	HIT	1N34AS	2
3	SIlicon, Junction 100 PIV	DR000-001	DIO	1N4004	2
C "	INTEGRATED CIRCUITS				
	Timer, 8 pin, DIP	IC000-006	MOT	MC1455	1
	Operational Amplifier, 8 pin DIP	IC000-002	SIG	N741V	1
"	RELAY				
	2PDT	MR000-003	G-E	3SCS5007K1	1
"	INDUCTORS				
,2	10 Turn Toroid	LA006-010	W-I	LA006-010	2
"	TRANSISTORS				
,2	NPN, Silicon	QA038-541	G-E	2N3854A	2
	PNP, Silicon	QB000-009	MOT	MPS3702	1
"	RESISTORS				
4,	Composition, 220 ohm ±10% ¼ W	RC104-122	A-B	CB2211	1
5	Composition, 2.2 Kilohm ±10% ¼ W	RC104-222	A-B	CB2221	1
	Composition, 4.7 Kilohm ±10% ¼ W	RC104-247	A-B	CB4721	1
,13	Composition, 10 Kilohm ±10% ¼ W	RC104-310	A-B	CB1031	2
	Composition, 12 Kilohm ±5 % ¼ W	RC103-312	A-B	CB1235	1
,9	Composition, 47 Kilohm ±10% ¼ W	RC104-347	A-B	CB4731	2
1	Composition, 100 Kilohm ±10% ¼ W	RC104-410	A-B	CB1041	1
2	Composition, 4.7 Megohm ±10% ¼ W	RC104-547	A-B	CB4751	1
0	Composition, 22 Megohm ±10% ¼ W	RC104-622	A-B	CB2261	1
	Composition, 51 ohm ±5% ¼ W	RC103-051	A-B	CB5105	1
	Composition, 4.7 Kilohm ±5% ¼ W	RC103-247	A-B	CB4725	1
	Composition, 360 ohm ±5% ¼ W	RC103-136	A-B	CB3615	1
7	Composition, 1 Kilohm ±10%, ¼ W	RC104-210	A-B	CB1021	1
"	SWITCH				
	Switch Push Button N.O.	SM000-007	G-H	30-1	1
J "	CONNECTORS (JACKS)				
1,2	SMA Receptacle	JE000-007	O-S	OSM211	2

H027


SCHEMATIC 6
KHz STEPS
M31A
FROM CRYSTAL REF
1KHz REFERENCE
INPUT
J1
IC3 8290
IC4 82S90
IC5 8290
IC6 8290
IC7 74H102
IC8 74H11
IC9 11C44
IC10A 4558
IC10B 4558
IC11 741
IC12 7404
IC1 7404
IC2 7404
IC13 78M05
BCD KHz FREQ PROGRAM
800KHz
400KHz
200KHz
100KHz
80KHz
40KHz
20KHz
10KHz
8KHz
4KHz
2KHz
1KHz
Q1 2N5452
Q2 2N5206
Q3 2N3564A
Q4 2N3854A
CR1 MVZ301
TO WIDE OSC. LOCK
J2
10.000 TO 9.001 MHz OUTPUT
UNLOCK INDICATOR
CR4
PIN 6 +7.3v
PIN 7 +18v
PIN 8 -18v
PIN 5 UNLOCK OUTPUT

SCHEMATIC 6
KHz STEPS
M31A