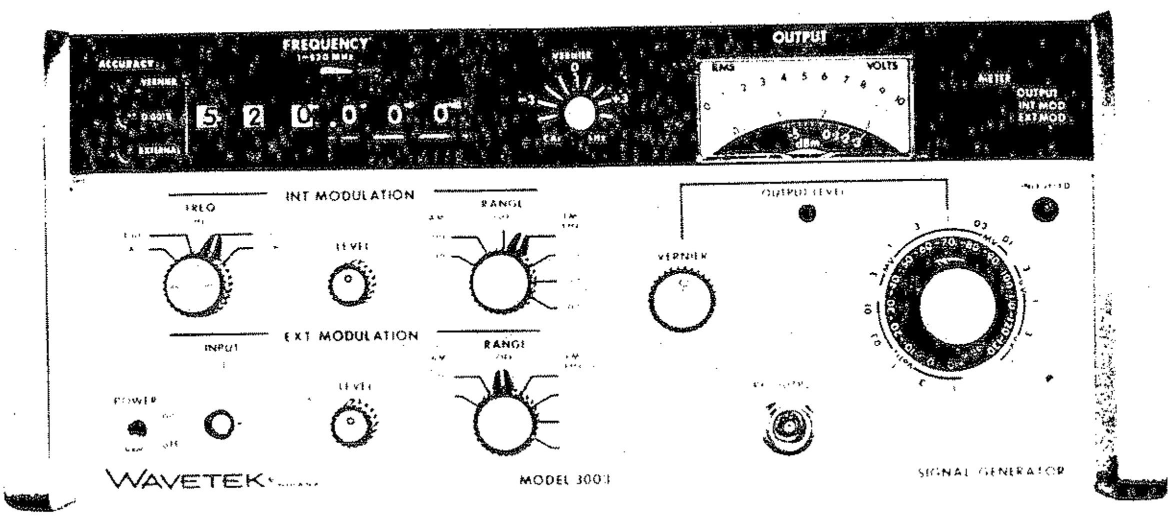
Serial No. ____________

INSTRUCTION MANUAL

MODELS 3003-3006

SIGNAL GENERATOR



CONTENTS

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek Models 3003 through 3006 are rugged, completely solid-state Signal Generators covering the frequency range of .001 or 1 to 520 MHz. Models 3004 and 3006 cover the range of .001 to 520 MHz while Models 3003 and 3005 cover the 1 to 520 MHz range. Models 3005 and 3006 offer 100 Hz resolution while on Models 3003 and 3004 the resolution is 1 kHz. 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 instrument is set via 6 or 7 front-panel Lever/Indicator switches which yield a resolution of 1 kHz or 100 Hz. In addition, remote programmers are available to facilitate semi-automatic programming of frequency and GPIB 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 instrument to provide high-stability signals to an accuracy of 0.001% over its specified frequency 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 Auxilliary RF output option is also available to drive a counter. Refer to Section 1.3 for a listing of options available for each instrument.

1.1.2 MODULATION

These instruments also feature both internal and external AM and FM capabilities. The internal and external sources can operate independently, or may be used simultaneously to produce complex modulation.

Internal modulation frequencies include 400 Hz, 1000 Hz, and two preset frequencies between 100 Hz and 10 kHz, selected by the user.

Modulation is indicated on a front-panel meter calibrated for full-scale readings of 30% and 100% AM, and 3, 10, 30, and 100 kHz deviation for FM operation.

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. A Programmable Attenuator option is available covering the range of from 0 to 109.9 dB attenuation in .1 dB steps with +13 dBm as the 0 dB reference level.

The calibrated output of the instrument 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	
Model 3006	1 kHz to 520 MHz selectable in 100 Hz steps.
Model 3005	1 MHz to 520 MHz selectable in 100 Hz steps.
Model 3004	1 kHz to 520 MHz selectable in 1 kHz steps.
Model 3003	1 MHz to 520 MHz selectable in 1 kHz steps.
READOUT	
Models 3005, 3006	7 digit Lever/Indicator switches.
Models 3003, 3004	6 digit Lever/Indicator switches.
RESOLUTION	
Models 3005, 3006	100 Hz
Models 3003, 3004	1 kHz
ACCURACY	±0.001% after 15 min. (Typically ±0.0002% after 2 hours within 3 months of calibration.) (±0.001% ±10 kHz when FREQUENCY VERNIER is not in the CAL position.)
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 μVRMS)
LEVEL CONTROL	Continuously adjustable in 10 dB steps 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	(Typically ±0.75 dB)
-7 to -77 dBm	±1.95 dB	(Typically ±1.25 dB)
-77 to -137 dBm	±2.75 dB	(Typically ±1.5 dB)

Accuracy Breakdown

Flatness (+13 to -7 dBm) ±0.75 dB (Typ ±0.5 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

RFI 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 dBc 1 kHz to 1 MHz and 10 MHz to 520 MHz
< -26 dBc 1 MHz to 10 MHz

SUB–HARMONICS

None detectable

NON–HARMONICS

Fundamental (MHz)	Non-Harmonic (MHz)	Non-Harmonic Level (dBc)
below 3	below 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

< -65 dBc 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.) <100 Hz in 300 Hz to 3 kHz post-detection bandwidth. (Typically 50 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, 1000 Hz, and two preset frequencies between 100 Hz and 10 kHz (accuracy = ±2%).

EXTERNAL

DC to 20 kHz (3 dB bandwidth). Input level required ~1 VRMS into 600 Ω to provide full-scale adjustment with EXT MOD LEVEL control.

RANGE

0 to 90%

DISTORTION

<3% to 70% AM. (Typically 1.5% to 30% AM)
<5% to 90% AM (At a frequency of 1 kHz)

METER

Scales of 30% AM and 100% AM
Accuracy = ±(2% of full-scale reading +5% of METER reading) at 1 kHz modulation frequency.

1.2.5 FREQUENCY MODULATION

FREQUENCY

INTERNAL

Same sources as AM (see Section 1.2.4)

EXTERNAL

50 Hz to 20 kHz (1 dB bandwidth) with FREQ VERNIER in CAL
DC to 20 kHz (1 dB bandwidth) with FREQ VERNIER not in CAL
Input level required ~1 VRMS into 600 Ω to provide full-scale adjustment with EXT MOD LEVEL control.

RANGE — 0 to 100 kHz deviation

DISTORTION — <2% 10 kHz to 100 kHz deviation.
<4% 3 kHz to 10 kHz deviation (At a frequency of 1 kHz.)

METER — Scales of 3, 10, 30, and 100 kHz deviation.
Accuracy = ±3% of full scale reading at 1 kHz modulation frequency.

1.2.6 GENERAL

OPERATING TEMPERATURE — 25 ±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 13¾").

WEIGHT — 11.4 kg (25 lb) net
13.6 kg (30 lb) shipping

1.3 OPTIONS

Options 1A, 4, and 7 are factory installed; Options 3, 5, and 6 are either factory or field installed. Options available for each instrument are:

Model 3003
(1A or 3) + 4 + 5 + 6 + 7
Model 3004
(1A or 3 or 4) + (4 or 6) + 5 + 7
Model 3005
(1A or 3 or 4) + (4 or 6) + 5 + 7
Model 3006
(1A or 3 or 4) + (4 or 5) + 7

1.3.1 RF LEVEL PROGRAMMING

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

NOTE

For Option 1A, the instrument is calibrated for +13 dBm at 50 MHz like a standard unit, but due to greater losses in Programmable Attenuators, a calibrated output is guaranteed only to +12 dBm.

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.)

NOTE

DC protection not included on Models 3004, 3006.

1.3.3 AUXILLIARY 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 INTERNAL/EXTERNAL REFERENCE

Option 5A provides a rear-panel BNC input for accepting an external frequency reference (5 or 10 MHz, .5 to 5 VRMS), which is used to improve the instrument accuracy from 10 ppm to that of the external source. Option 5A also includes an internal TCXO (accuracy = ±1 ppm) which can be used in lieu of the external source, and can also be used to drive other devices which require a high stability TTL input.

1.3.6 HIGH STABILITY REFERENCE

Option 5 is required with Option 6.

If Option 6 cannot be installed, use Model 2102 (see Section 1.4).

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
Output Level	TTL
Temp Stability (1 hr warm-up) over 10° to 40°C range	0.05 ppm
Aging	0.005 ppm/day
	0.05 ppm/month
	0.3 ppm/year
Typical Overall Accuracy (within 3 months of calibration)	0.2 ppm

1.3.7 LOW LEAKAGE

Option 7 reduces the instrument RFI leakage by a factor of 10. <0.1 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.

1.4 ACCESSORIES

Furnished with instrument

- Instruction Manual
- Rear-panel PROGRAMMING plug and pins

Additional Accessories

- Rack Mount Kit, K108
- Programmers for single push-button or GPIB control of selected frequencies and output levels, Series 3900.
- High-stability frequency source (5 MHz, TTL) useable to drive Option 5, Model 2102.
- Module Service Kit, K004

SECTION 2
OPERATION

2.1 INTRODUCTION

This section provides complete installation and operating instructions for the Wavetek Models 3003 through 3006. The instructions include information on 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	1410-00-4650
B (Side)	2 ea	1410-00-5260
C (Screw)	8 ea	2810-17-8108
D (Screw)	4 ea	2810-17-8110

PROCEDURE

Remove the screws from one side panel. Mount items A and B against side panel of the instrument and secure with screws provided. Repeat for other side of unit. If rack mount kit is removed from unit, use screws originally installed in side panels to avoid possible internal damage.

2.3 ELECTRICAL INSTALLATION

The instrument can operate from either 115 VAC or 230 VAC supply mains. The rear-panel AC LINE switch selects which of these operating voltages is being used, and adjusts the Power Supply accordingly. The Power Supply is designed to operate over an AC supply frequency range of 50 to 400 Hz.

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

NOTE

Before operating the instrument, check that the rear-panel AC LINE fuse is the correct value for the supply voltage (see Section 2.5).

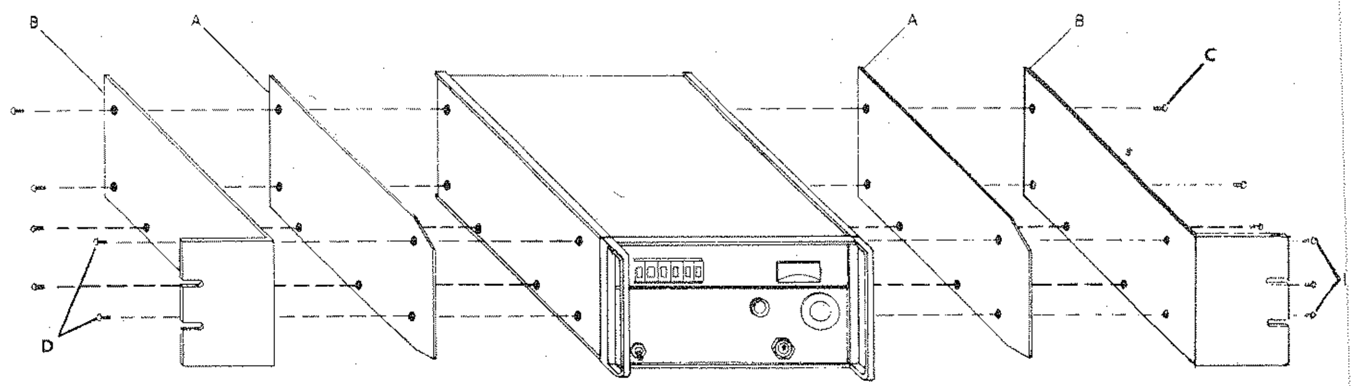


Figure 2-1. K108 Rack Mount

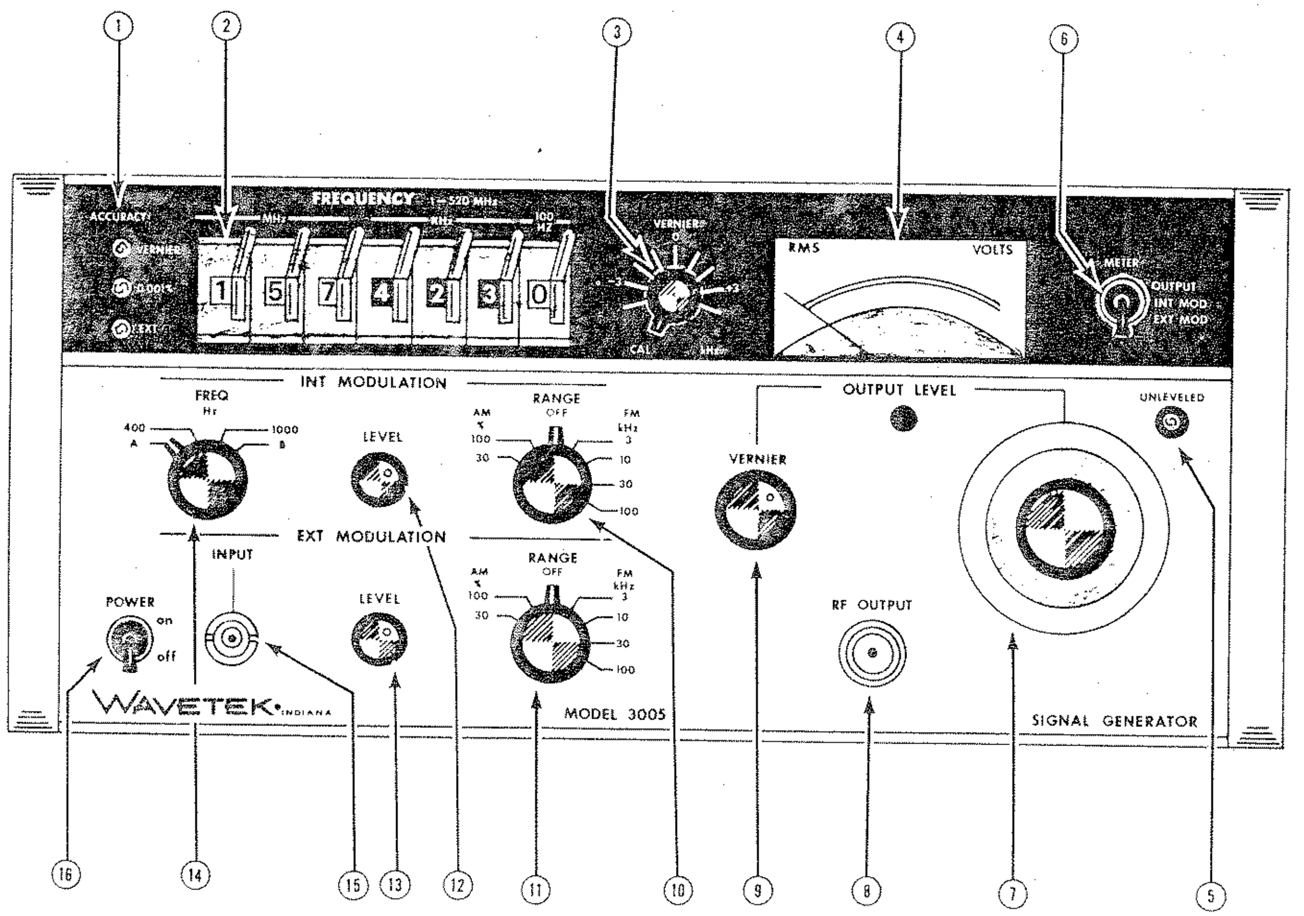


Figure 2-2. Front Panel

2.4 DESCRIPTION OF FRONT PANEL

Refer to Figure 2-2.

(1) ACCURACY lamps indicate the frequency accuracy of the instrument.

"VERNIER" indicates ±0.001% +10 kHz
"0.001%" indicates ±0.001%
"EXT" indicates accuracy of external source

Typically, the lamp will flash for a few seconds after the instrument is turned on. Normally, a steady light indicates that the instrument is phase locked and the frequency accuracy indicated is valid. A continuously flashing light indicates that one or more of the phase-locked loops is open.

(2) Lever/Indicator switches select and indicate output frequency.

(3) FREQ VERNIER shifts output frequency over a 10 kHz range (-5 kHz to +5 kHz).

With the FREQ VERNIER in CAL, the instrument accuracy is ±0.001%. When the FREQ VERNIER is not in CAL, the instrument accuracy is ±0.001% +10 kHz.

(4) OUTPUT METER indicates RF output level over a 10 dB range in VRMS and dBm, %AM, or FM deviation, depending on the METER switch setting.

(5) UNLEVELED lamp lights when the OUTPUT METER reading is not valid.

(6) METER switch selects measurement of RF output, internal modulation, or external modulation.

(7) OUTPUT Step Attenuator controls the RF output level over a 140 dB range from +10 to -130 dBm in 10 dB steps. The Attenuator dial indicates both dBm and VRMS.

(8) RF OUT provides the RF output signal from the instrument (type N connector).

(9) OUTPUT VERNIER controls the RF output level over an 11 dB range.

(10) (11) INT/EXT MOD RANGE switches select amplitude, frequency, or no modulation, and the appropriate METER range.

(12) (13) INT/EXT MOD LEVEL controls provide continuous adjustment of % modulation (AM) and frequency deviation (FM).

(14) INT MOD FREQ switch selects one of four internal modulation frequencies, 400 Hz, 1000 Hz, A, or B, where A and B are user-preset frequencies between 100 Hz and 10 kHz.

(15) EXT MOD INPUT connector (type BNC) accepts external modulating signals (1 VRMS level) as follows:

AM	DC to 20 kHz
FM ((3) in CAL)	50 Hz to 20 kHz
FM ((3) not in CAL)	DC to 20 kHz

(16) POWER switch provides AC power to Power Supply.

2.5 DESCRIPTION OF REAR PANEL

Refer to Figure 2-3.

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

(2) AC LINE Fuse (time-delay); 1.0 amp for 115 VAC operation; 0.5 amp for 230 VAC operation.

(3) AC LINE Cord provides connection to AC mains via 3 prong plug.

(4) PROGRAMMING JACK provides connection for remote programming of frequency.

(5) MOD TP provides convenient connection for monitoring amplitude and/or frequency of internal 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 available line voltage, and that the proper fuse is installed (see Section 2.5). Turn the POWER switch to ON. One of the front-panel ACCURACY lamps will indicate operation. No warmup is needed for the following checks.

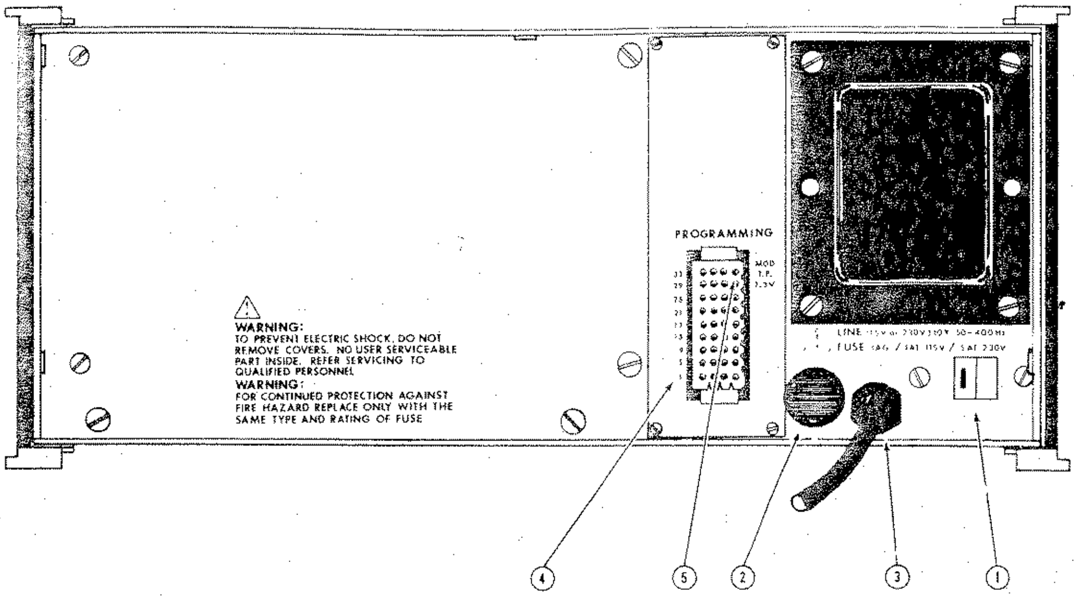


Figure 2-3. Rear Panel

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

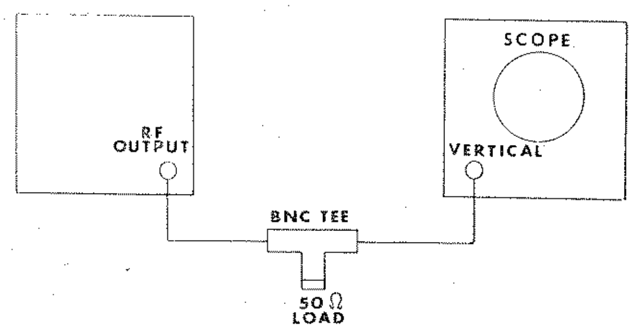


Figure 2-4. Test Setup

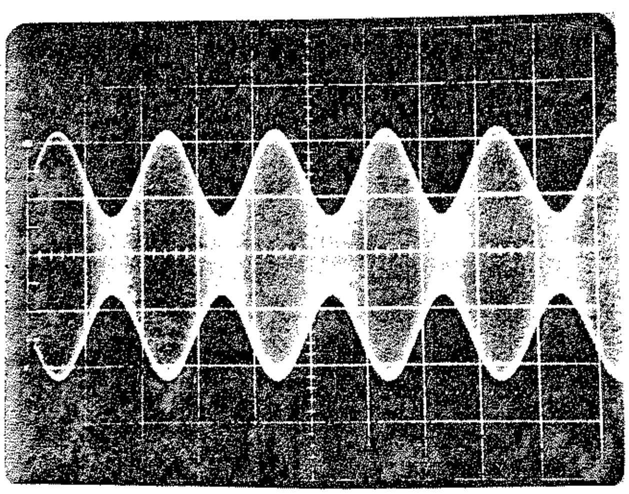


Figure 2-5. Amplitude Modulation

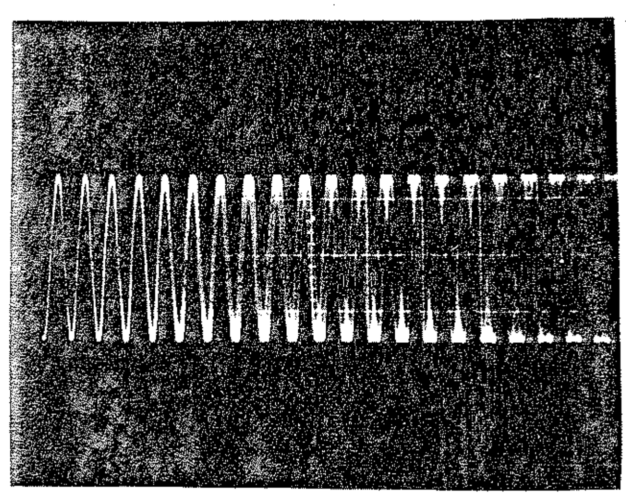


Figure 2-6. Frequency Modulation

2.6.2 INITIAL CONTROL ADJUSTMENT

Set the instrument front-panel controls as follows:

Lever/Indicator switches	010.0000
FREQ VERNIER	CAL
INT MOD RANGE	OFF
EXT MOD RANGE	OFF
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
EXT MOD LEVEL	N/A
METER switch	OUTPUT
OUTPUT Step	0 dBm
OUTPUT VERNIER	full cw

2.6.3 RF OUTPUT CHECK

Connect the equipment as shown in Figure 2-4. The 10 MHz signal should be ~0.9 Vpp. (A high-frequency oscilloscope must be used for these checks.)

2.6.4 AM CHECK

Set the INT MOD RANGE switch to 100% AM, the METER switch to INT MOD, the INT MOD FREQ switch to 1000, and adjust the INT MOD LEVEL control so that the METER reads 50% AM (half scale). Verify that the AM envelope displayed on the oscilloscope has a peak-to-valley voltage of ~0.45 V, and period of 1 msec (see Figure 2-5).

Set the INT MOD FREQ switch to 400. The peak-to-valley voltage should still be ~0.45 V, and the period should now be 2.5 msec.

Turn the INT MOD LEVEL control both ways, verifying that the % AM shown on the METER and the AM envelope on the scope display rise and fall accordingly. Set the METER switch to OUTPUT and verify that turning the INT MOD LEVEL control causes a change in RF output level.

NOTE

The UNLEVELED lamp may come on during this test.

Return the METER switch to the INT MOD position.

2.6.5 FM CHECK

Set the INT MOD RANGE switch to 3 kHz FM. Turn the INT MOD LEVEL control both ways, verifying that an FM display appears on the oscilloscope (see Figure 2.6).

Repeat for INT MOD RANGE settings of 10, 30, and 100 kHz FM.

2.6.6 ATTENUATION CHECK

Set the METER switch to OUTPUT and the INT MOD RANGE switch to OFF. Verify that both the OUTPUT Step and VERNIER controls vary the amplitude of the signal displayed on the oscilloscope, and that the OUTPUT VERNIER varies the METER reading of RF output level.

2.6.7 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.

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 instrument will perform as stated in the specifications, the instrument should have a two-hour warmup before using.

2.7.1 TURN ON

Turn the POWER switch to ON. One of the front-panel ACCURACY lamps will light, indicating an operating condition. 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 OUT connector, otherwise damage may occur to the output circuitry of the instrument.

2.7.2 CW OPERATION

With the METER switch set to OUTPUT and the INT and EXT MOD RANGE switches set to OFF, adjust the output frequency and level to the desired settings. The FREQ VERNIER should be in its CAL position.

NOTE

With the FREQ VERNIER in the CAL position, output frequencies having an accuracy of ±0.001% may be selected by the Lever/Indicator switches. When the FREQ VERNIER is out of the CAL position, the selected output frequency can be shifted ±5 kHz with the FREQ VERNIER

control. The output frequency at the "0 kHz" position of the FREQ VERNIER corresponds closely to the output frequency in CAL.

Connect the RF output to the device under test.

2.7.3 INT AM/FM OPERATION

Starting with the basic set-up of Section 2.7.2, set the METER switch to INT MOD, the INT MOD RANGE switch for the desired modulation function and METER range, and the INT MOD FREQ switch for the desired modulation frequency (400 Hz, 1000 Hz, or pre-set frequencies A or B, see Section 5.4.8). Adjust the INT MOD LEVEL control for the desired % AM or frequency deviation (read on the METER scale).

2.7.4 EXT AM/FM OPERATION

Starting with the basic set-up of Section 2.7.2, set the METER switch to EXT MOD, the EXT MOD RANGE switch for the desired modulation function and METER range, and connect the modulating signal (level should be ~1 VRMS for best resolution of the EXT MOD LEVEL control) to the EXT MOD INPUT connector. Adjust the EXT MOD LEVEL control for the desired % AM or frequency deviation (read on METER scale).

NOTE

At modulating frequencies less that 50 Hz, the METER may start to "wobble". In this case, the "peak" Meter reading is the valid measurement of % AM or frequency deviation.

CAUTION

Input voltage greater than ±5 VDC or 3.5 VRMS should not be applied to the EXT MOD INPUT connector, or damage to the instrument may occur.

NOTE

When amplitude modulating, care must be taken to not exceed the +13 dBm maximum level, or excessive distortion and an unleveled condition can exist. In some cases, a high % AM may cause the UNLEVELED light to come on when the 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 UNLEVELED light should then go out.

2.7.5 SIMULTANEOUS INT/EXT MODULATION

Internal and external modulation can be performed simultaneously by following the procedure given in Sections 2.7.3 and 2.7.4 with both INT and EXT MOD RANGE switches active. In this way, FM/FM, FM/AM, or AM/AM can be accomplished.

NOTE

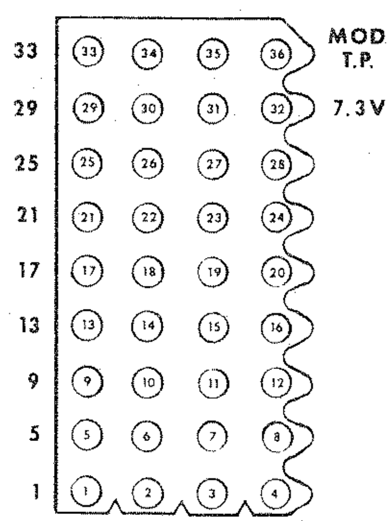
The METER switch provides for reading the internal and external modulations separately. The METER will not show the complex modulation.

2.7.6 PROGRAMMING

Frequency is programmable via a rear-panel input connector using standard 8-4-2-1 BCD contact closure or TTL signals. (Logic "0" = open = ≥ 2.2 V. Logic "1" = closed = ≤0.4 V.) The rear-panel PROGRAMMING jack pins are in parallel with the front-panel Lever/Indicator switches; thus, if rear-panel programming is to be implemented, the front-panel switches must indicate all zeroes.

Example - To program 132.4508 MHz (refer to Figure 2-7):

FREQ DIGIT	1	3	2.	4	5	0	8
GND PINS	4	7,8	11	14	18,20	–	26



PIN	FUNCTION
1	NC
2	400 MHz
3	200 MHz
4	100 MHz
5	80 MHz
6	40 MHz
7	20 MHz
8	10 MHz
9	8 MHz
10	4 MHz
11	2 MHz
12	1 MHz
13	800 kHz
14	400 kHz
15	200 kHz
16	100 kHz
17	80 kHz
18	40 kHz
19	20 kHz
20	10 kHz
21	8 kHz
22	4 kHz
23	2 kHz
24	1 kHz
25	GND
26	800 Hz
27	400 Hz
28	200 Hz
29	100 Hz
30	NC
31	NC
32	7.3 V
33	NC
34	NC
35	NC
36	MOD TP

Figure 2-7. PROGRAMMING Jack Pins

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 - 3.17 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 signal generator is essentially a voltage controlled oscillator to which phase-locked loops and a crystal reference have been added for improved accuracy and 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 osciallators 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 Lever/Indicator 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 multi-stage, 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 attenuator. The monitor detects the peak output of the Output Amplifier. 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 Amplifier 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 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 Amplifier can provide a carrier at the highest possible power.

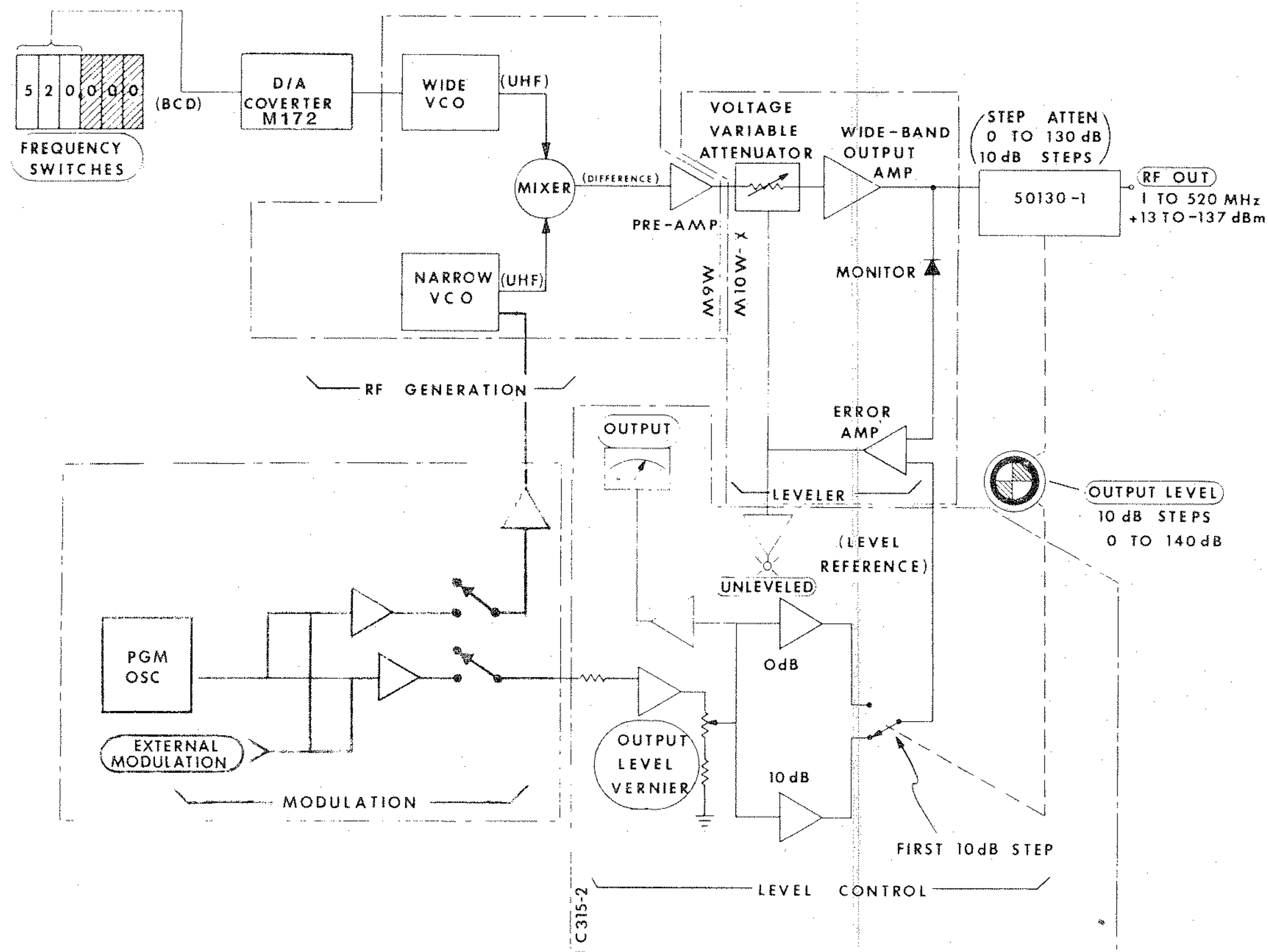


Figure 3-1. Basic Block Diagram

Since the RF level can be voltage controlled, AM can be accomplished by applying the modulating signal to the OUTPUT 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 either an internal oscillator or 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 frequency accuracy is only 3 MHz with 1 MHz resolution. To achieve the desired resolution and accuracy, the instrument includes five phase-locked loops.

A down-conversion system (Models 3004 and 3006) enables the instrument to output frequencies less than 1 MHz. Its operation will be covered in Section 3.17.

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 Lever/Indicator switch setting to reference frequencies for PLL 4.

PLL 3 and 5 provide stabilization to the Narrow VCO 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 5 is also used to program 100 Hz offset steps into the Narrow VCO for 100 Hz resolution (Models 3005 and 3006).

Figure 3-2 illustrates the relationship between the five numbered loops and the "basic signal generator".

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 3-3 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 001 to 039 MHz. These CW steps are then repeated every 40 MHz throughout the entire 1 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 in the same way 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 001.000 to 520.000.

The Wide Oscillator frequency is offset by Mixers 1 and 2 and compared to the 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 Oscillator range is heterodyned in Mixer 1 with 1448 MHz, the difference frequency produced ranges from

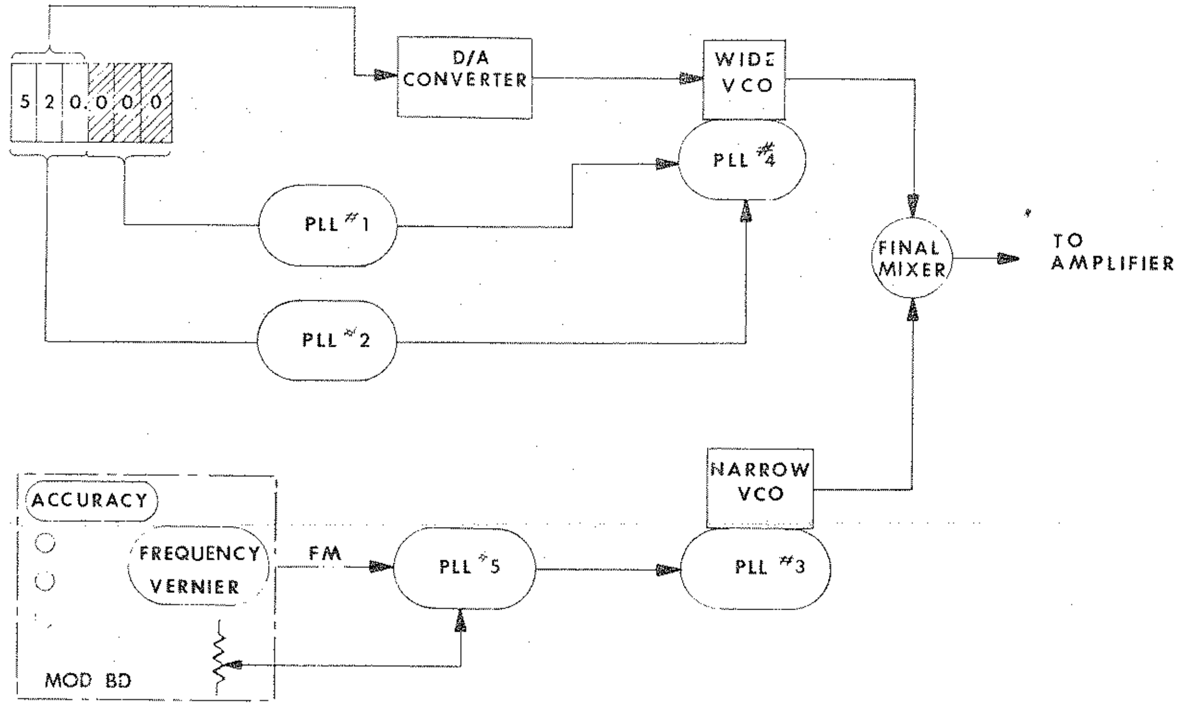


Figure 3-2. PLL Relationships

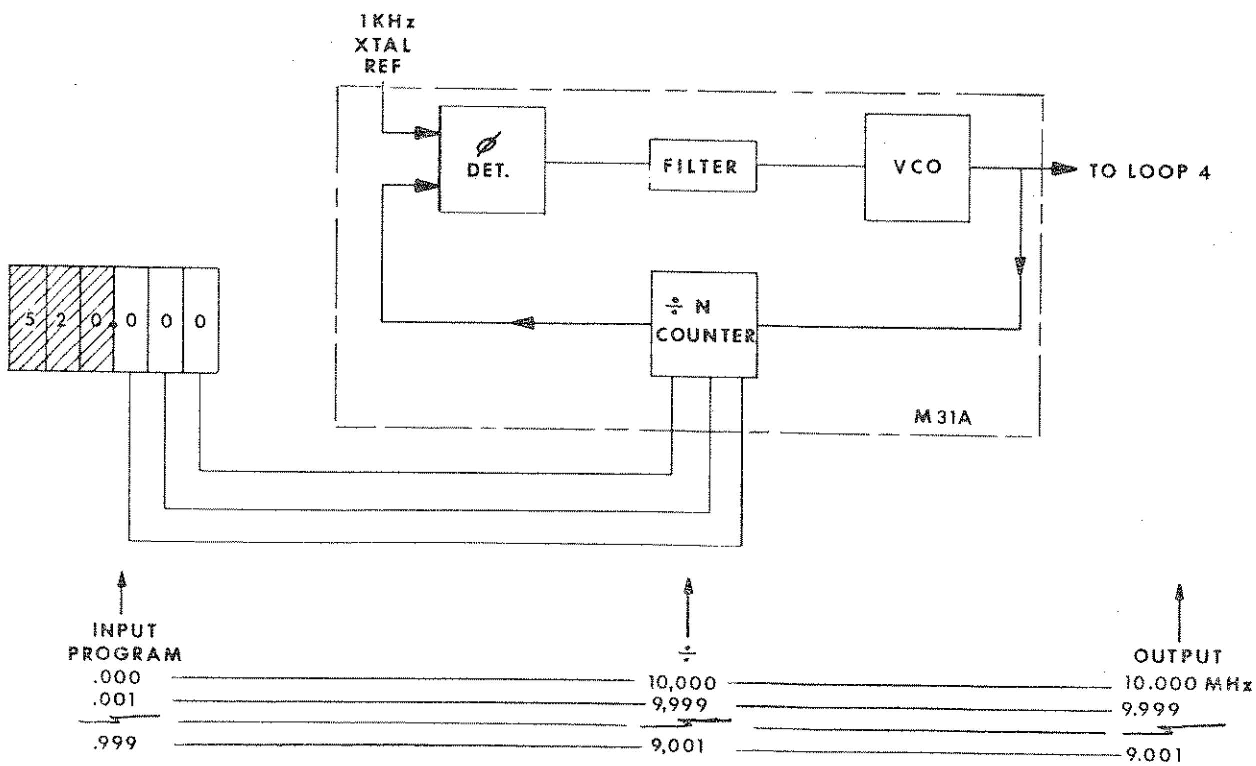


Figure 3-3. PLL 1

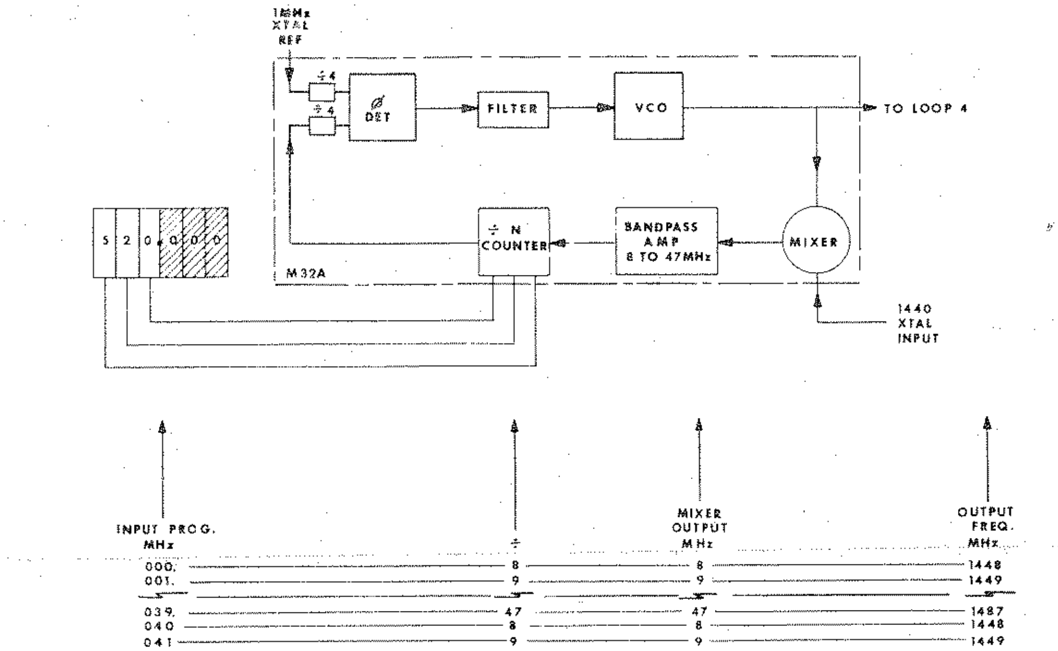


Figure 3-4. PLL 2

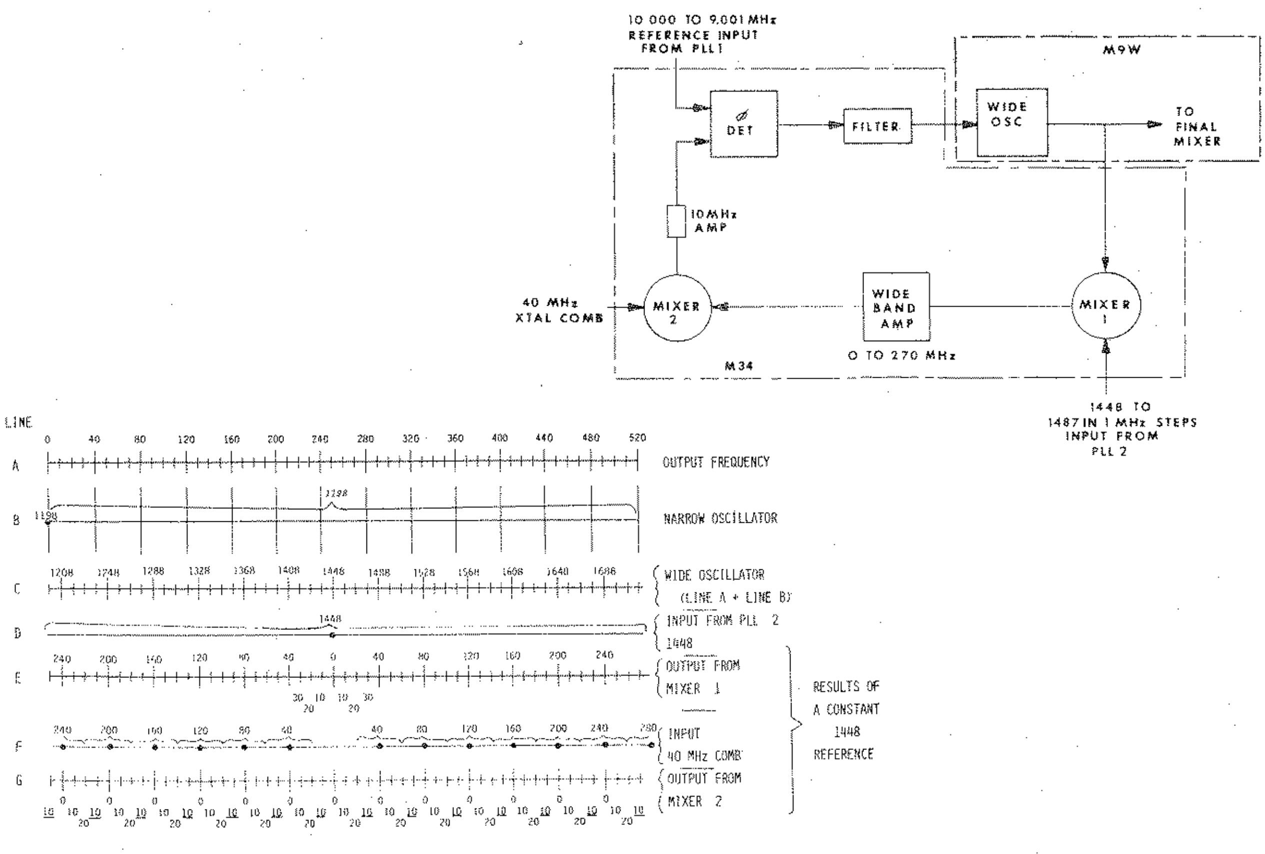


Figure 3-5. PLL 4

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 lines 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 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.

On Models 3005 and 3006, the "2 kHz reference" (refer to Figure 3-7) is replaced by a reference from the 100 Hz Steps circuit. This reference is produced by taking a 40 MHz reference signal from the Crystal Reference and dividing it by a number (20000-19991) determined by the 100 Hz Lever/Indicator switch. This divided signal (2.0000-2.0009 kHz) then becomes the reference for PLL 5; thus the PLL 5 output signal to PLL 3 can be offset from 0 to 900 Hz in 100 Hz steps, and 100 Hz resolution is accomplished.

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 two printed circuit board assemblies, a power supply, and 12 (Model 3003), 13 (Models 3004, 3005), or 14 (Model 3006) module assemblies. These can be identified in Figure 5-6. Sections 3.3 thru 3.17 describe the operation of each subassembly. The name of the subassembly describes, to an extent, the primary fuction it performs.

3.3 C315-2 - METER BOARD

The primary functions of this assambly are to provide the program voltage to the Output Amplifier leveler circuit and indicate the RF output amplitude and modulation (see Figure 3-8).

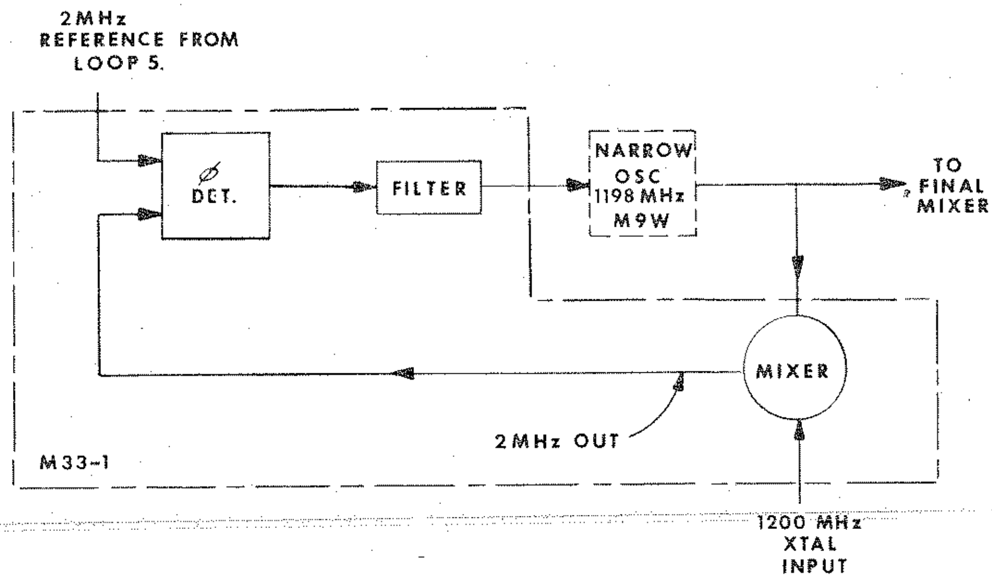


Figure 3-6. PLL 3

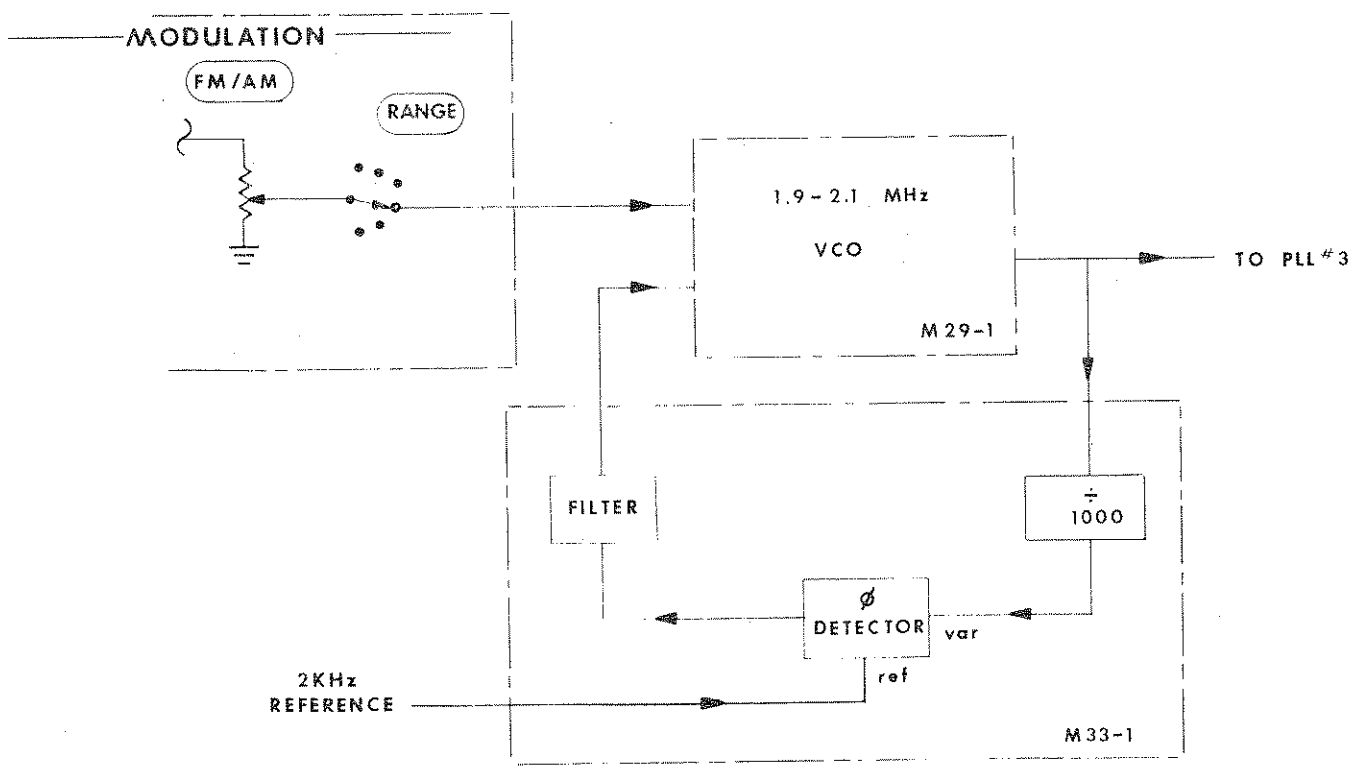


Figure 3-7. PLL 5

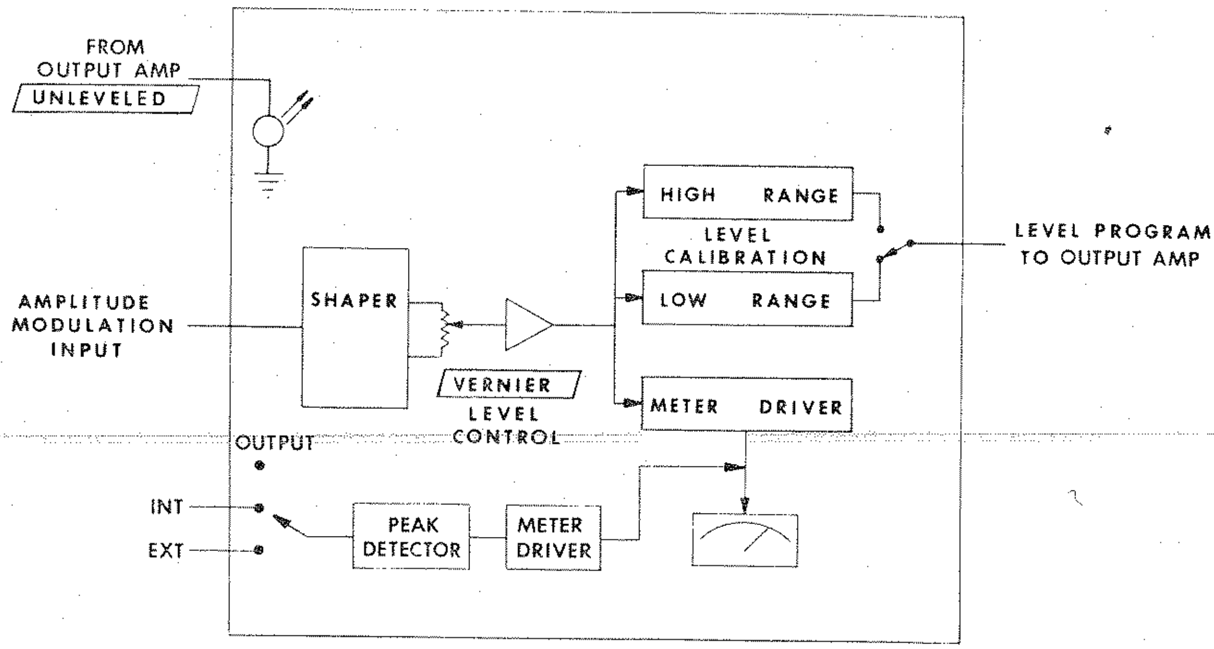


Figure 3-8. C315-2 Meter Board

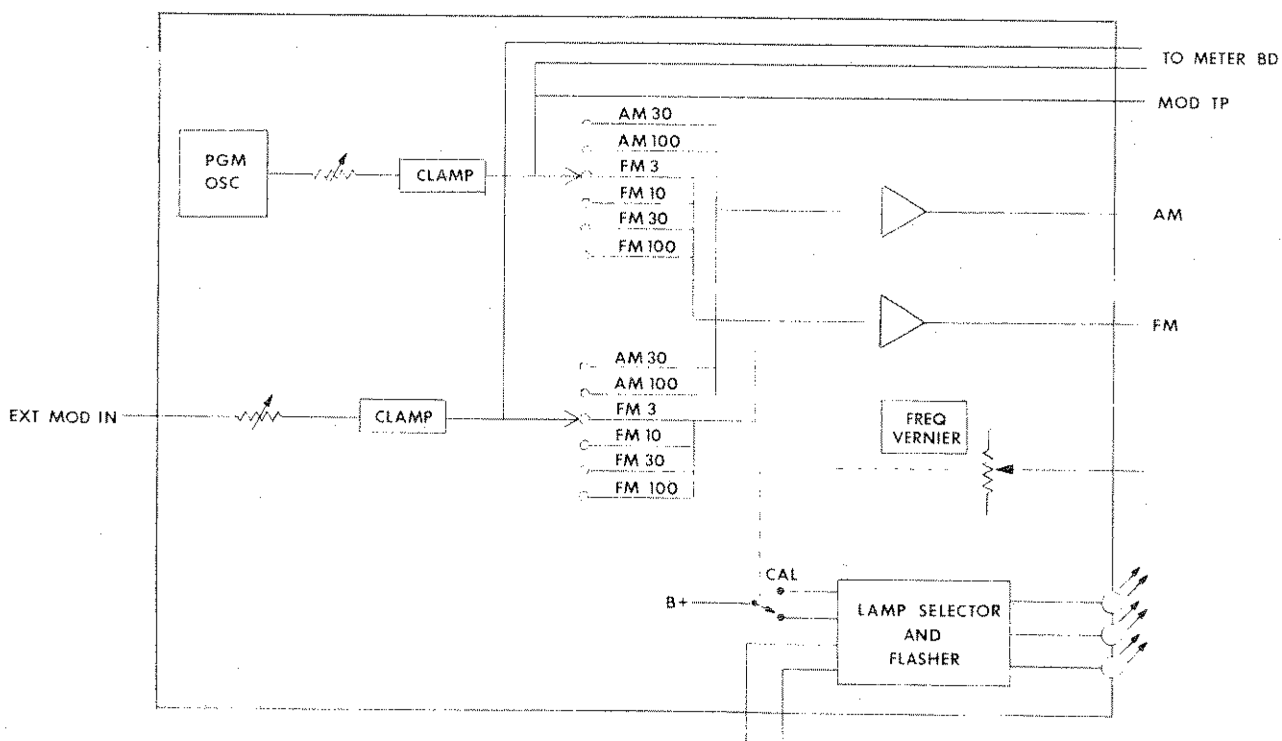


Figure 3-9. Modulation Board

3.3.1 LEVEL PROGRAM

During CW operation of the instrument, the level program is controlled by the OUTPUT VERNIER on the front panel. The output of this control goes to two range calibration circuits which convert the voltage from the OUTPUT VERNIER to a voltage level appropriate to drive the leveler circuit in the Output Amplifier module.

The "low" circuit provides the program for all ranges of the dented 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 Output Amplifier to be used when the output is not amplitude modulated.

During amplitude modulation, the modulating signal from the Modulation Board is applied to the OUTPUT VERNIER, which ultimately causes the RF level to change. The leveler in the Output Amplifier does not cause the RF level to respond linearly to changes in the level program voltage. To compensate for this, a stage is included to shape the modulation signal before it is applied to the OUTPUT VERNIER.

3.3.2 METER

The front-panel METER is controlled by the level program when the METER switch is set to OUTPUT. The METER and its driver circuits are calibrated to display a reading corresponding to the actual RF level from the Output Amplifier module.

When the METER switch is set to either INT MOD or EXT MOD, the METER displays the modulation present (%AM or FM deviation) on the selected circuit. The METER scale being read is selected by the front-panel INT MODULATION RANGE and EXT MODULATION RANGE switches.

3.3.3 UNLEVELED LIGHT

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

3.4 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 RANGE switches.

The front-panel INT MODULATION FREQ switch selects one of four internal modulating frequencies derived from a programmable oscillator. The INT MODULATION RANGE switch selects the type of modulation (AM or FM), and the proper resistor network corresponding to the selected METER scale. The INT MODULATION LEVEL control adjusts the ammount of modulating signal fed into the resistor networks, and so the ammount of modulation (%AM or FM deviation) produced.

An EXT MODULATION INPUT connector is provided for modulating from an external source. The EXT MODULATION RANGE and LEVEL controls perform the same functions as their INT counterparts.

IC4A sums together the INT and EXT AM signals, while IC4B sums together the INT and EXT FM signals, enabling complex (AM/FM, FM/AM, FM/FM, AM/AM) modulation to be accomplished.

3.4.2 ACCURACY LAMPS

The CAL switch on the FREQUENCY VERNIER (or an input from Option 5 or 5A) determines which lamp is lit. If any of the phase-locked loops unlock, the energized LED is made to flash by an IC timer activated by a DC level from any of the five phase-locked loops in the instrument.

3.5 DPS2A - POWER SUPPLY

The DPS2A 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. Both the +18 V and −18 V supplies use protected pass transistors with integral current limiting and thermal protection.

3.5.2 +18 V SUPPLY

The +18 V circuit has a temperature-compensated precision voltage reference. This reference is compared to the output voltage by an error amplifier which corrects any error in the output voltage.

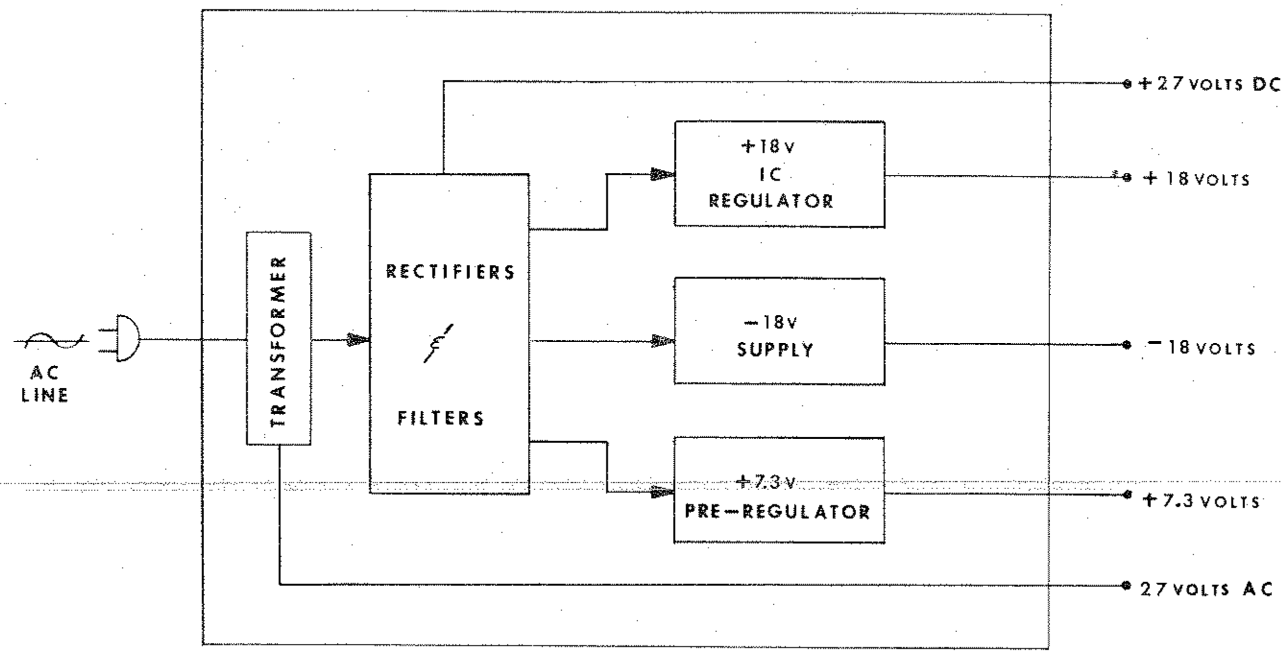


Figure 3-10. DPS2A Power Supply

Figure 3-11 is deleted

3.5.3 −18 V SUPPLY

The −18 V circuit compares the +18 V and −18V outputs and holds the difference in their magnitudes to zero.

3.5.4 +7.3 V SUPPLY

The +7.3 V circuit uses a three-terminal adjustable voltage regulator IC to provide a pre-regulated +7.3 V output. This voltage supplies other voltage regulators throughout the instrument.

3.6 DELETED

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).

3.7.2 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 Output Amplifier.

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 the VCO from the phase detector in PLL 4. 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. The frequency of this oscillator is further controlled by a "fine tuning" bias voltage from the phase detector. The deviation can be controlled up to 100 kHz.

In CW mode on Models 3005 and 3006, the 100 Hz steps are programmed through PLL 3, and thus into the Narrow Oscillator (see Section 3.14).

3.7.4 LEVELERS

This module contains three RF leveling circuits as shown in Figure 3-12. 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.

3.8 M10W-6/M10W-8 - OUTPUT AMPLIFIER

Models 3003 and 3005 use an M10W-6 Output Amplifier module, while Models 3004 and 3006 use an M10W-8.

The main function of the M10W-6 and M10W-8 Output Amplifier modules 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 cirucit exceeds its proper operating range (see Figure 3-13).

The M10W-8 also contains a switch which routes the RF output to either the Step Attenuator or the M115 for down-conversion (Models 3004 and 3006).

3.8.1 SWITCH (M10W-8)

The switch is normally set to route the output signal to the Step Attenuator; however, when the front-panel "MHz" selector switches are set to "000.", the logic signal from the M115 into pin 5 of the M10W-8 triggers the switch (relay K1) and routes the RF signal to the M115.

3.8.2 AMPLIFIER

This section is a four-transistor, wide band amplifier which can increase the RF by about 23 dB.

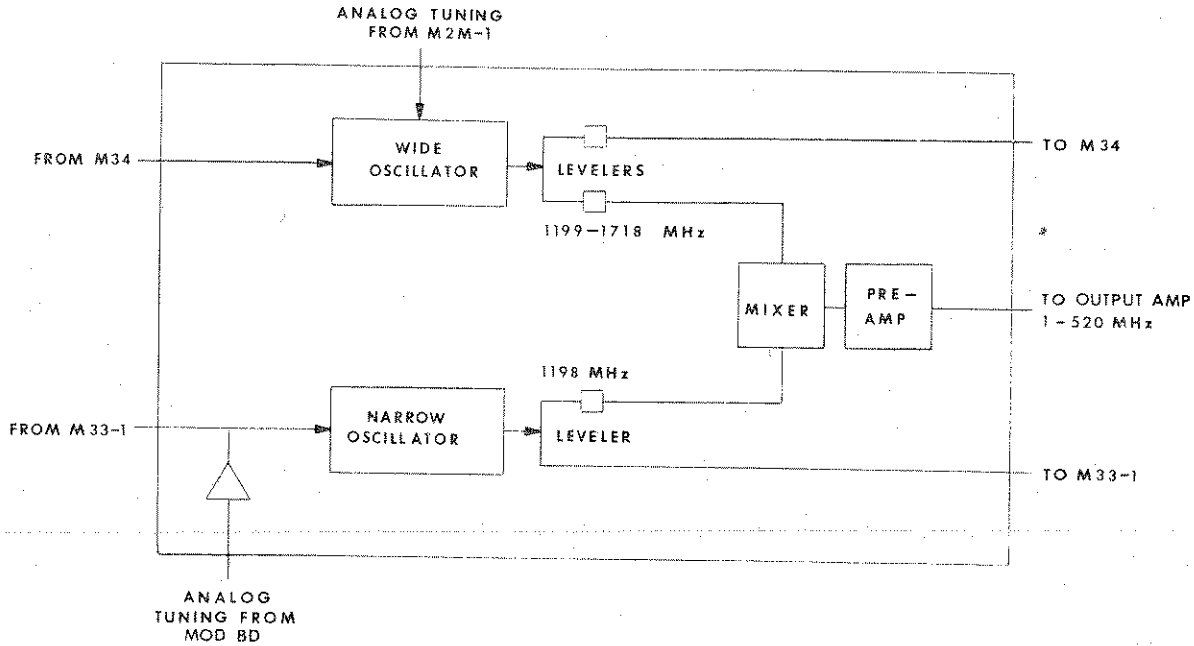


Figure 3-12. M9W Sweep Oscillator

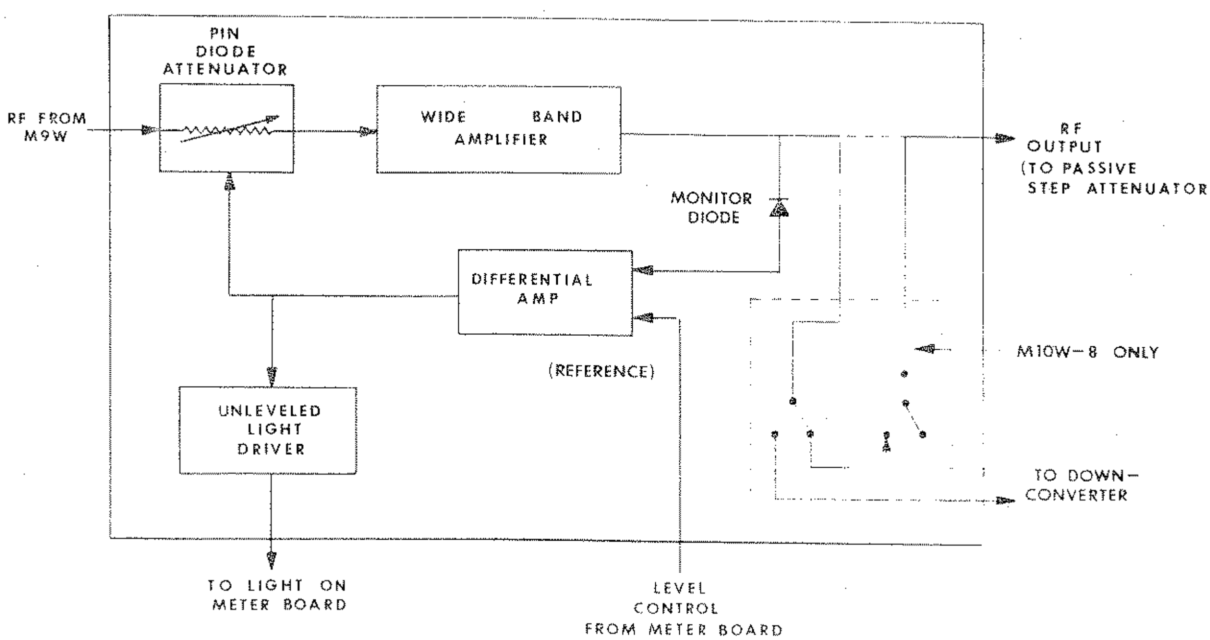


Figure 3-13. M10W-6/8 Output Amplifier

3.8.3 LEVELER

The leveler uses a peak detector, differential amplifier and 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.

3.8.4 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. These extreme voltage levels, which are applied to the UNLEVELED light driver, are adequate to turn on a source of current for the indicator which appears through the front panel.

3.9 M172 – SWEEP DRIVE/DAC

This module provides two output voltages. One is linear from 0 V to -5 V as the frequency goes from 0 to 39 MHz, repeating every 40 MHz; the other varies from +7 V to -8 V as the frequency goes from 0 to 520 MHz. The second voltage is shaped to linearize the VCO in the M9W Sweep Oscillator.

Two digital-to-analog converter ICs, programmed by the front-panel Lever/Indicator switches, provide the 0 to 520 MHz voltage. This is shaped in the next section of the module. A third DAC provides the repeating 0 - 40 MHz voltage. Since the state of the 20's line depends on the 100's line, the 20's line is inverted when the 100's line is high.

The analog tuning signal from the M172 is "shaped" before driving the M9W wide oscillator. The shaper is an inverting DC amplifier which amplifies the input by a smaller factor for smaller magnitude inputs. Shaping this analog voltage compensates for the non-linear change in capacitance of the varactor diodes in the oscillator circuit.

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 PLL 5. 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 the VCO is locked).

3.10.1 CURRENT SOURCES

This circuit provides both a positive and a negative source of current. The 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 relationship 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/M30-4 - CRYSTAL REFERENCE

Models 3003 and 3004 use an M30-1 Crystal Reference module, while Models 3005 and 3006 use an M30-4.

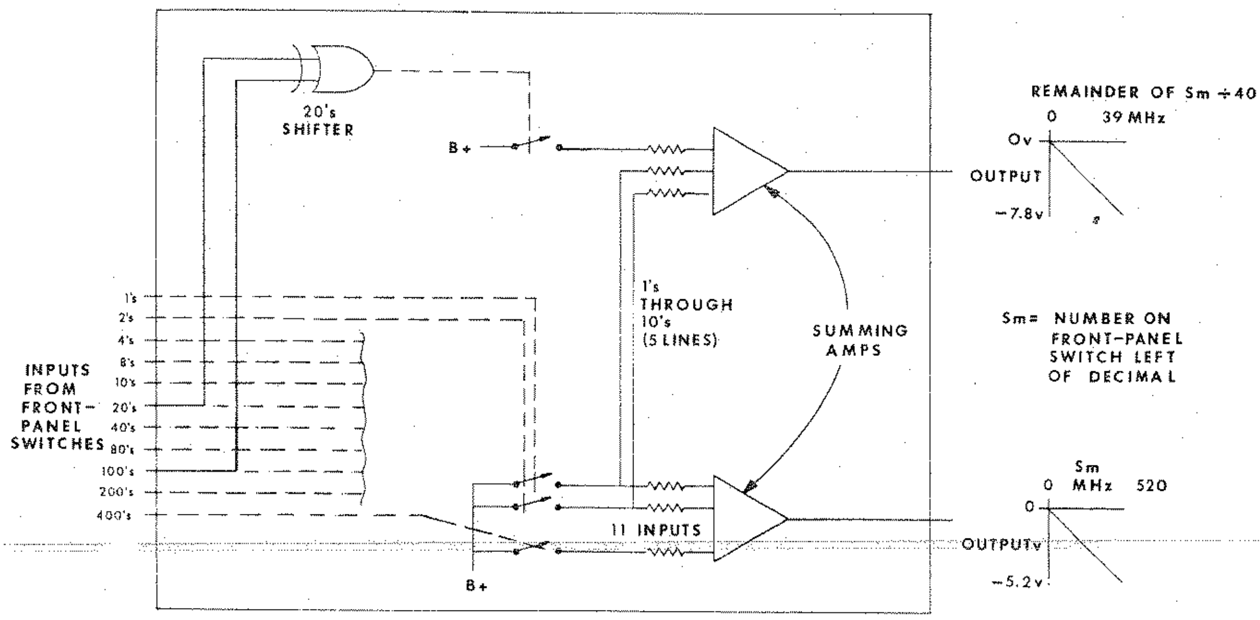


Figure 3-14. M22 DAC

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
. . .		

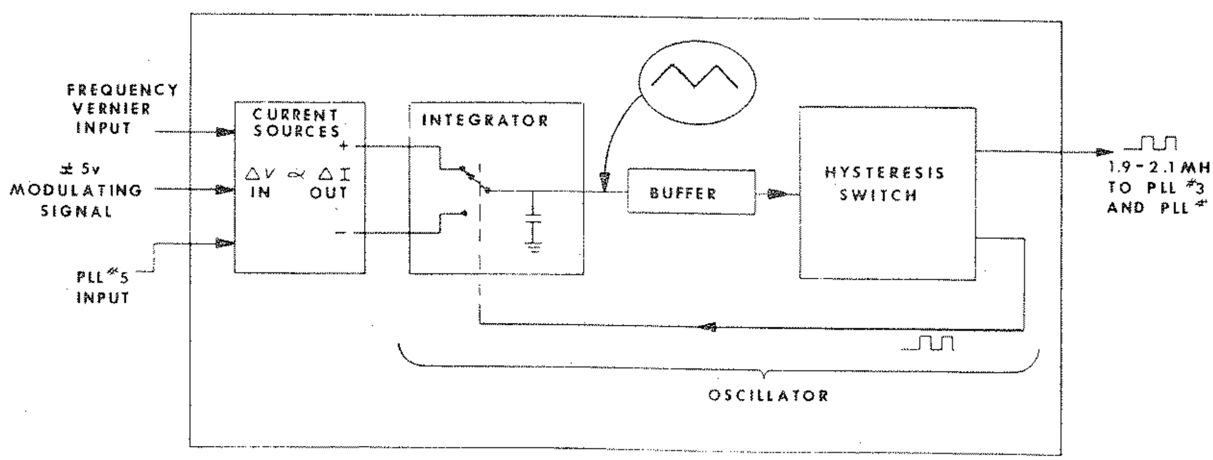


Figure 3-15. M29-2 FM Reference

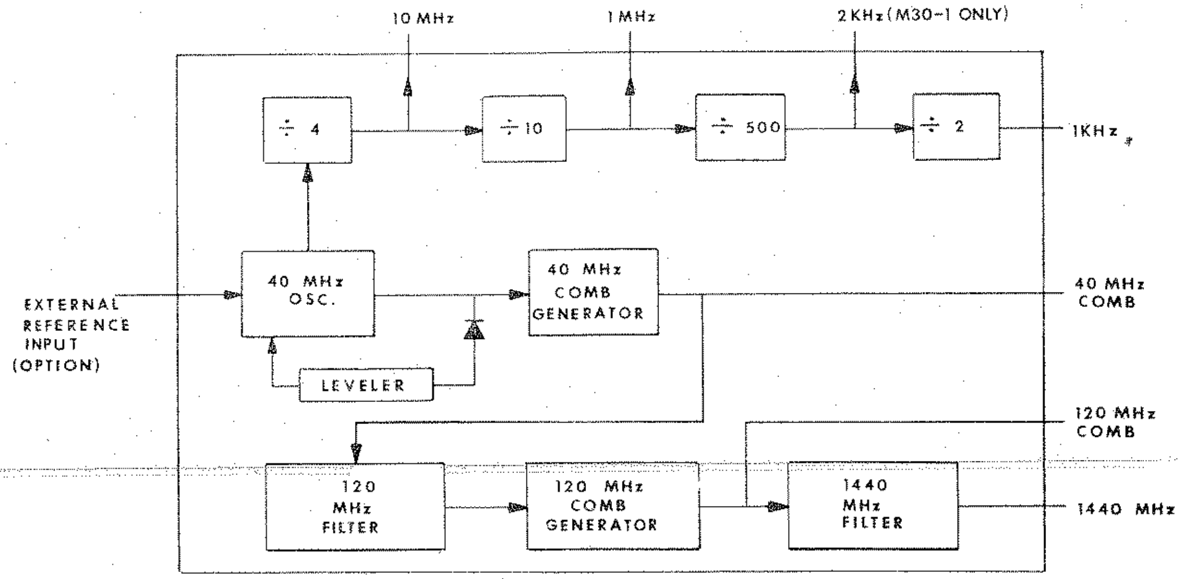


Figure 3-16. M30-1/4 Crystal Reference

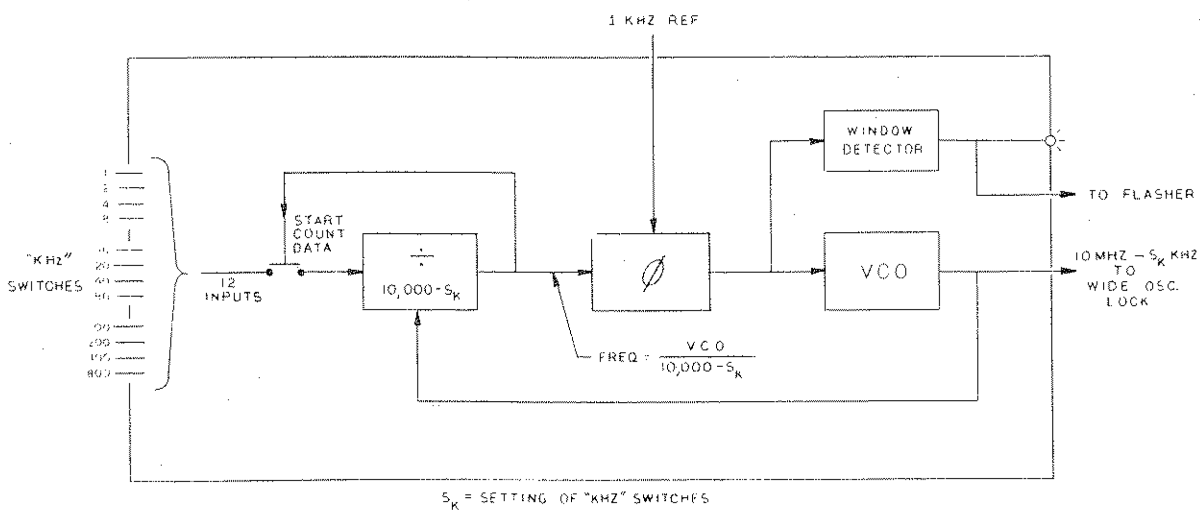


Figure 3-17. M31A kHz Steps

This module supplies reference frequencies at 1 kHz, 2 kHz (M30-1only), 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 M30-1/4 modules.

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 reference outputs.

3.11.3 MULTIPLIERS

The 40 MHz CW is fed to a harmonic generator which procudes 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 M31A - kHz STEPS

The input to this module is the BCD data from the three front-panel "kHz" switches (to the right of the decimal point). The output frequency is (10 MHz– Sk kHz), where Sk is the number indicated by the kHz switches. If the frequency is set to 333.333 MHz, for example, the M31A output is 9.667 MHz. The block diagram of the M31A is shown in Figure 3-17.

3.12.1 VCO

The output frequency is generated by a voltage controlled oscillator which is tuneable from 9.001 to 10.000 MHz.

3.12.2 PHASE LOCKED LOOP

Including the VCO is a phase-locked loop permits accurate programmability. The VCO tuning voltage comes from the phase/frequency detector circuit. A 1 kHz signal from the Crystal Reference is applied to one input of the phase detector (IC9). A sample of the VCO output is divided by the programmable divider, and the result is applied to the other input of the phase detector. Any difference in phase or frequency in the signals applied to the phase detector inputs produces an error voltage at the phase detector output, which controls the VCO. The system is stable only when the phase and frequency error is zero, so that the output frequency is phase locked to the 1 kHz reference signal.

3.12.3 PROGRAMMABLE DIVIDER

In order for the M31A to perform properly, the divider is designed to divide the VCO frequency by (10,000–Sk) where Sk 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 (1 kHz) only if the VCO output were 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 lamps 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 the Modulation Board.

3.13 M32A - MHz STEPS

The M32A provides, for the M34, a reference frequency which corresponds to the setting on the "MHz" switches (see Figure 3-18). The M32A output range is 1448 to 1487 MHz, which repeats itself with every 40 MHz change of the frequency switches. Any specific M32A output relates to the "MHz" switch setting (Sm) by the equation (Output = (1448 + R) MHz), where R is the Remainder of dividing Sm 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 M32A would then be 1448 +13 = 1461 MHz.

3.13.1 VCO

The output of the M32A is produced by a voltage controlled oscillator. This VCO is coarsely tuned by the

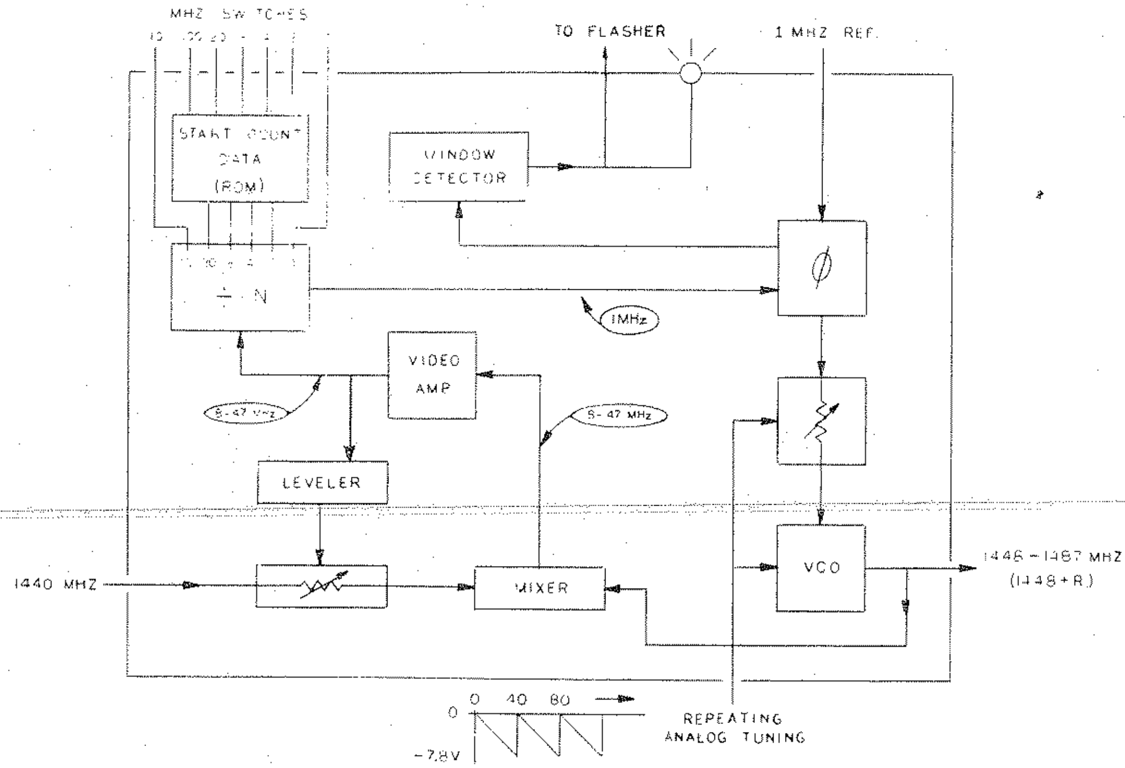


Figure 3-18. M32A MHz Steps

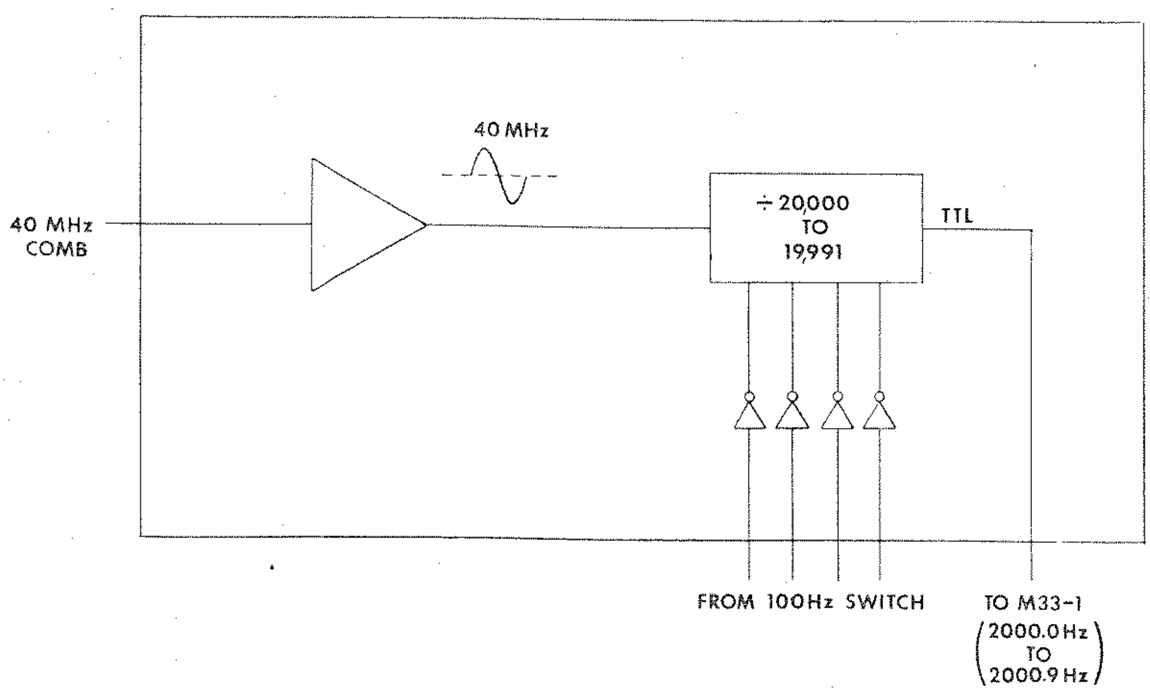


Figure 3-19. M149 100 Hz Steps

repeating analog output of the M172. 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 PROGRAMMABLE DIVIDER

A sample of the VCO output is mixed with the 1440 MHz signal from the Crystal Reference producing a difference frequency of from 8 to 47 MHz, which is then shaped into TTL pulses and applied to the programmable divider.

The divider counts the falling edges of the 8-47 MHz input pulses, resetting each time a count of 47 is reached. The reset pulse is applied to one input of the phase detector. By controlling the starting count of the programmable divider, the effective divisor can be controlled.

The starting count of the programmable divider is selected by a read only memory, which is programmed to provide the correct "R" information for each "Sm" setting. This "R" is then applied to the programmable divider as the starting count . Thus, as the starting count varies from 0 to 39, the effective divisor varies from 47 to 8.

When the VCO is running at the correct frequency, the programmable divider reset pulse rate will be 1 MHz.

3.13.3 PHASE DETECTOR

One input to the phase detector is the reset pulse from the programmable divider. The other input is a 1 MHz fixed reference signal from the Crystal Reference. The phase detector output is a voltage determined by the difference in phase at the phase detector inputs, and is used to correct any error in the VCO frequency or phase.

If the VCO output frequency is too high, for example, the phase detector output becomes more negative, thus increasing the VCO varactor diode tuning capacitance and lowering the VCO frequency. If the VCO frequency is too low, the reverse occurs. Thus, the loop will tend to maintain zero phase or frequency error. A voltage-controlled attenuator between the phase detector circuit and the VCO keeps the open-loop gain of the phase-locked loop relatively constant over the programmed frequency range, allowing the loop noise to be minimized.

3.13.4 UNLOCKED INDICATOR

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

A window detector monitors the voltage level 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 the Modulation Board.

3.14 M149 - 100 Hz STEPS

The M149 100 Hz Steps module enables 100 Hz resolution on Models 3005 and 3006.. The module is essentially a programmable ÷N counter which produces a reference signal for PLL 5 from a reference input from the M30-4 Crystal Reference.

The 40 MHz comb signal from the M30-4 is amplified and fed into the programmable counter which divides the signal by (20000—H) where H is the 100 Hz Lever/Indicator switch setting. For example, if the front-panel switch setting were 214.6127, the counter would divide by 19993 (20000-7). Dividing 40 MHz by 19993 yields a counter output of 2.0007 kHz. The counter output is then used as the reference for PLL 5, and thus ultimately the PLL 3 reference and Narrow Oscillator are offset (shifted) by 700 Hz.

NOTE

Due to the manner in which the 100 Hz steps offset to the Narrow Oscillator is obtained, the exact offsets for each 100 Hz Lever/Indicator switch setting are as follows:

100 Hz SWITCH SETTING	OFFSET (Hz)	ERROR (Hz)
0	000.0000	0.0000
1	100.0050	0.0050
2	200.0200	0.0200
3	300.0450	0.0450
4	400.0800	0.0800
5	500.1250	0.1250
6	600.1801	0.1801
7	700.2451	0.2451
8	800.3201	0.3201
9	900.4052	0.4052

Note that the maximum error is less than 0.5 Hz.

On Model 3006, at frequencies below 40.5 kHz, the fixed error introduced by the 100 Hz digit may cause the output frequency accuracy to not meet its .001% specification; however, the actual output frequency may be determined within .001% by adding the error from the above list to the selected output frequency.

When the FREQUENCY VERNIER is not in its CAL position, PLL 5 is disabled, and the M149 has effectively no function (100 Hz resolution is not obtainable with the FREQUENCY VERNIER not in CAL).

3.15 M33-1 - NARROW OSCILLATOR LOCK

The M33-1 contains the circuits to phase lock the Narrow Oscillator in the M9W (PLL 3) and the M29-1 FM Reference (PLL 5). As explained in Section 3.2.2, PLL 5 provides the reference frequency for PLL 3.

3.15.1 PHASE DETECTOR FOR PLL 3

This circuit compares the reference frequency to the variable frequency which represents the M9W Narrow Oscillator output. If the frequency 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 Narrow Oscillator to lower the frequency.

3.15.2 MIXER

The phase detector cannot operate at UHF frequencies, so the Narrow Oscillator signal 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.

3.15.3 PHASE DETECTOR FOR PLL 5

This circuit compares the 2 kHz reference from the M30-1 Crystal Reference (or the M149 100 Hz Steps module) 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 intregrator filter, and the error voltage is fed to the M29-1.

3.15.4 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.

3.16 M34 - WIDE OSCILLATOR LOCK

This module provides the fine tuning program for the Wide Oscillator in the M9W. Figure 3-21 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 3-22 and 3-23. The M34 phase locks the Wide Oscillator to 1198 MHz plus the frequency indicated on all six front-panel switches (discounting the 100 Hz switch on Models 3005 and 3006 which affects the Narrow Oscillator). 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 off-set circuit and the phase detector, several auxillary circuits are included.

3.16.1 PHASE DETECTOR

The phase detector compares the "offset" Wide Oscillator frequency to the reference frequency from the M31A. (Refer to the description of the M31A 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.

3.16.2 FREQUENCY OFFSET CIRCUIT

The Wide Oscillator 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 3-21, 3-22 and 3-23 for descriptions of signals.

Mixer 1 heterodynes the Wide Oscillator frequency with the "MHz steps" reference frequency (1448 + R MHz). The difference frequency, | 1448 + R − WO |, 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 3-22 shows the comb frequency which will yield the desired output (below 20 MHz) of mixer 2. If PLL 4 is locked, mixer 2 will produce a 10 MHz difference as shown in Figure 3-22 (assuming the "kHz" switches are set for 000). Figure 3-23 shows signals A thru F for a case when the kHz switches are not 000.

The filter after mixer 2 blocks all the outputs of the mixer except the lower frequency signal containing the Wide Oscillator 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 PLL 4 is locked, the filter decreases to 10 MHz to further eliminate phase-locked-loop-related spurious signals.

3.16.3 AUXILLARY 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 Wide Oscillator to be tuned faster

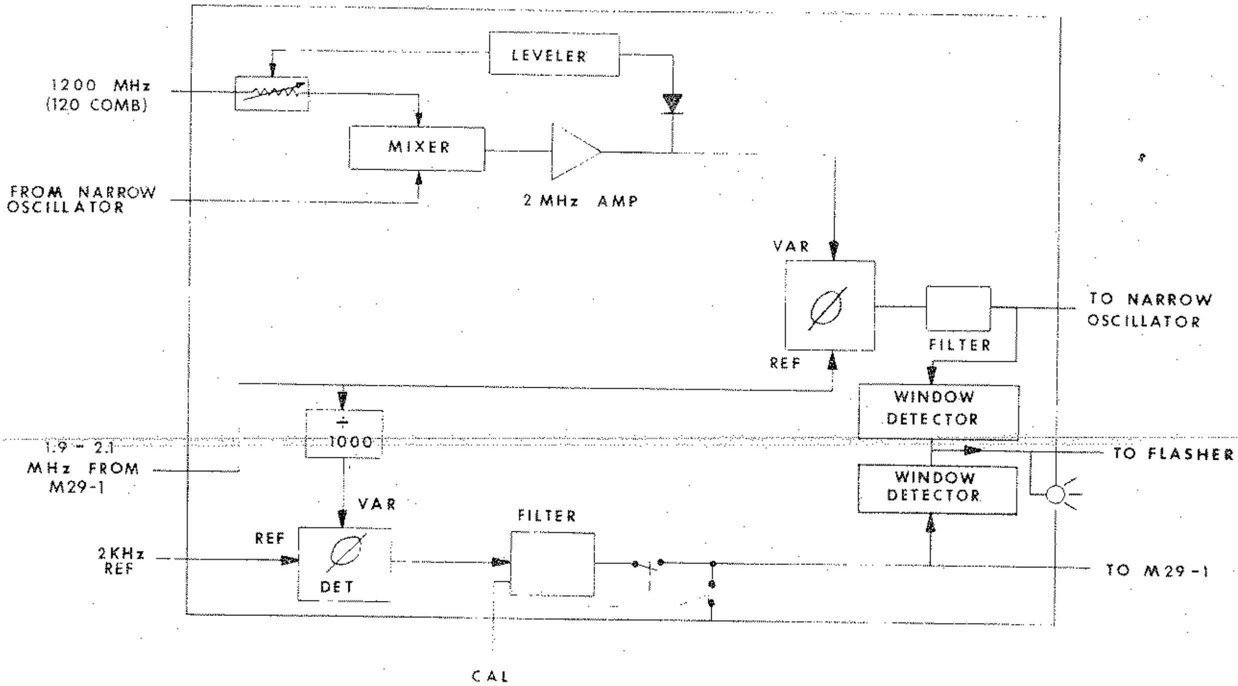


Figure 3-20. M33-1 Narrow Oscillator Lock

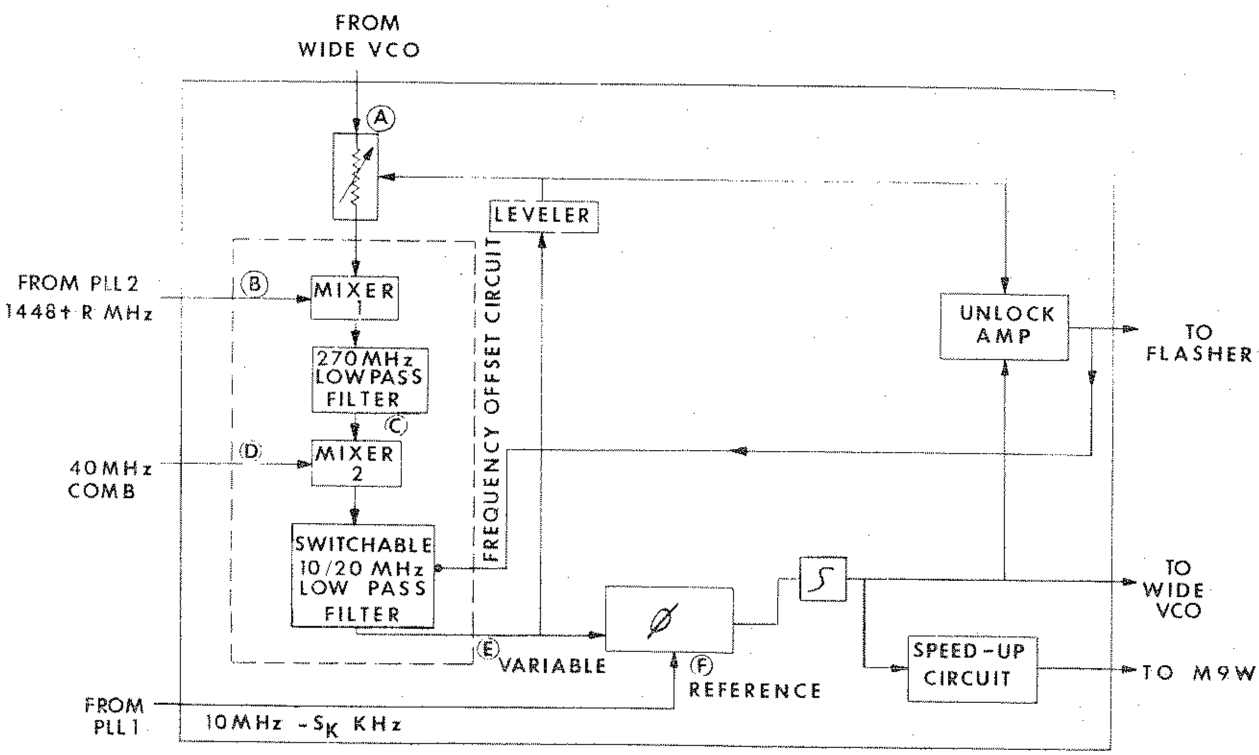


Figure 3-21. M34 Wide Oscillator Lock

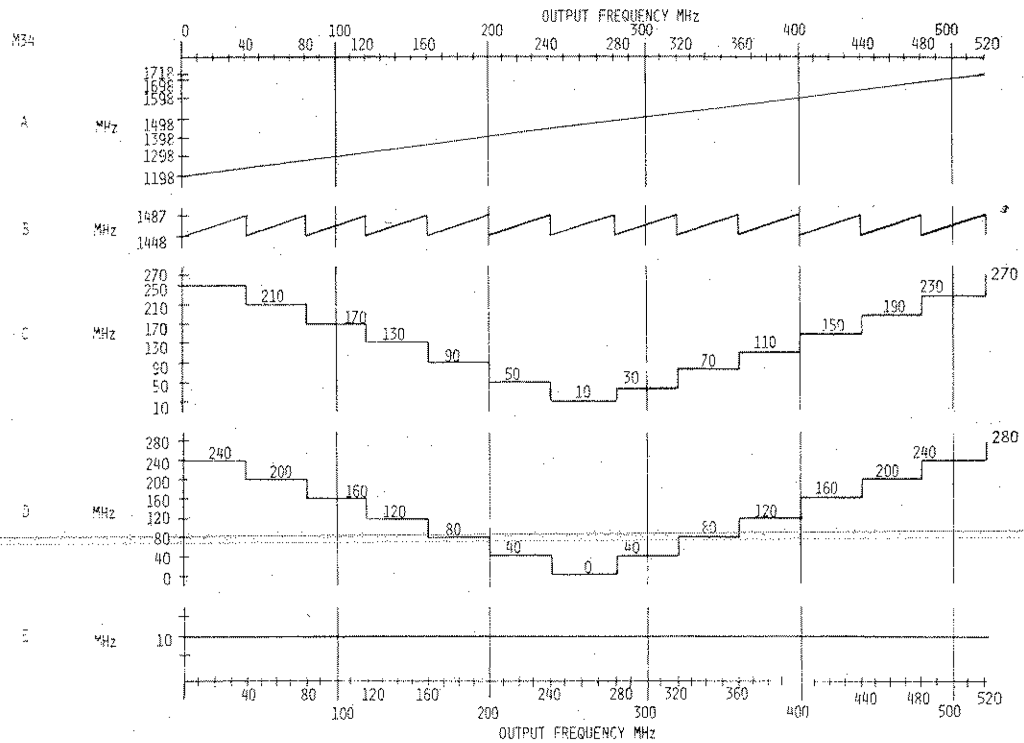


Figure 3-22. M34 Frequencies

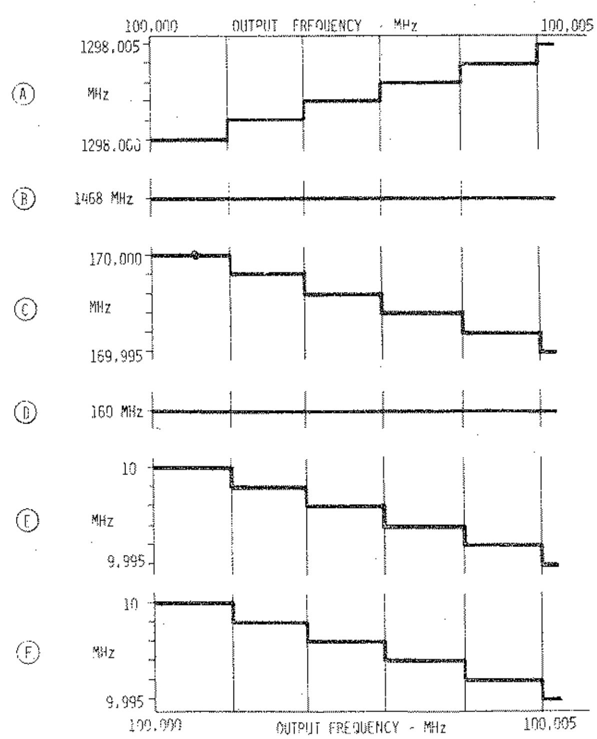


Figure 3-23. M34 Frequencies (Expanded)

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 the 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 cirucit controls a PIN diode attenuator which is between the Wide Oscillator input and mixer 1.

3.17 M115 – DOWN-CONVERTER

The M115 Down-Converter extends the low end of the frequency range of Models 3004 and 3006 to 1 kHz. The module takes the RF output from the M10W-8 (when the front-panel "MHz" selector switches are set to "000.") and converts it to the proper 1 to 999 kHz output frequency.

The BCD signals from the front-panel "MHz" selector switches are fed into a 13-input NAND gate. (Two of the inputs are held high.) This gate determines whether the switches are set for "000.", and, if so, triggers a hex inverter to send out a logic "true" to the M10W-8 and activate the 10 MHz line to the M22 and M32A. This programs the M9W for 10 MHz plus the "kHz" switch setting, and this signal is fed into the M10W-8. At this point, however, the signal is routed to the M115 (see Section 3.8) where it is mixed with the 10 MHz reference signal from the Crystal Reference. The difference frequency from this mixing is simply the "kHz" switch setting, and is output back to the M10W-8 and on to the Step Attenuator.

The M115 also contains a 20 dB attenuation pad for the input from the M10W-8, and an RF amplifier for the 10 MHz reference signal. The effect of these stages is to allow the mixer output to be directly proportional to the output from the M10W-8. The mixer output is then fed into a 3-stage amplifier with complementary push-pull output to restore the output to the proper (–7 to +13 dBm) level. Potentiometer R3 and trimcap C20 fine adjust the gain and frequency response of the module.

If the front-panel "MHz" switches are not set to "000.", the M115 has no function except that the 10 MHz program line from the switches to the M22 and M32A passes through the M115.

NOTE

If the M115 is removed for servicing, the instrument may still be used; however, the frequency range is reduced from .001-520 MHz to 1-520 MHz. In this case, pins 1 and 9 of the M115 module socket must be jumpered together.

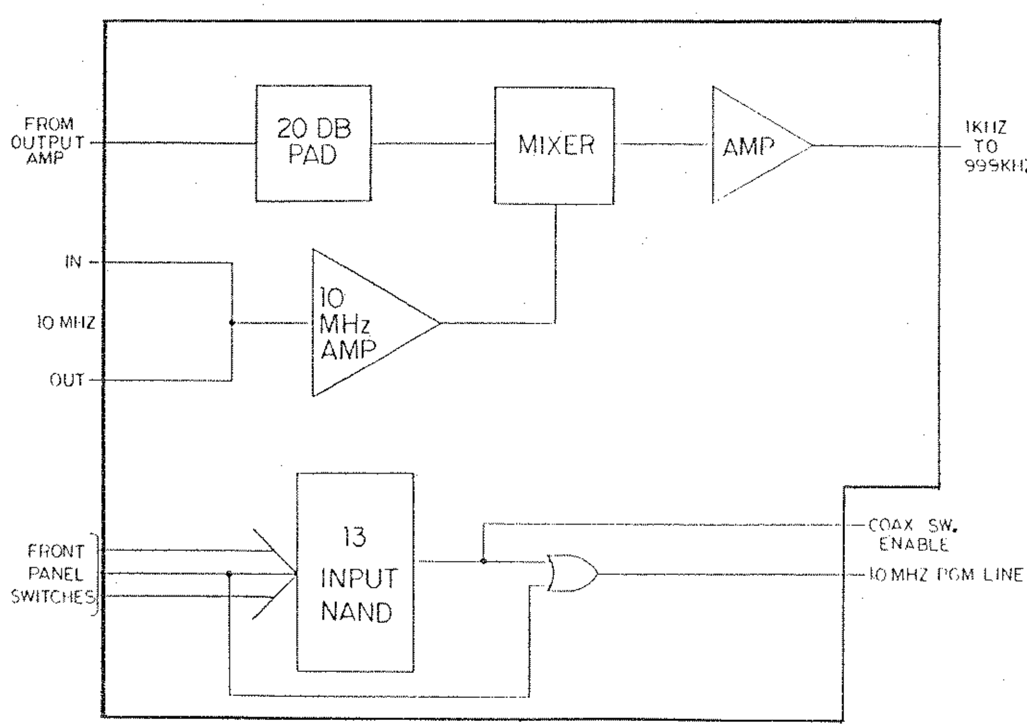


Figure 3-24. M115 Down-Converter

SECTION 4
PERFORMANCE TESTS

4.1 INTRODUCTION

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

The 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 to 400 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 Signal Generator 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 routing performance testing. The PTR lists the section, test, and specification limits. All tests refer to this record.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT FOR PERFORMANCE TESTS

INSTRUMENT	CRITICAL REQUIREMENT	RECOMMENDED
(1) Digital Multimeter	10 VDC: ±(0.07%R+0.02%FS)	Dana 4200
(2) Distortion Analyzer	Range: 5 Hz to >25 kHz	HP334A
(3) Frequency Counter	Range: to 525 MHz	HP530B/5303B
(4) Function Generator	Level: 10 Vpp sine wave into 600 ohm load Range: >0.2 Hz to >25 kHz Distortion: <1%	Wavetek 130
(5) Power Meter	Range: 10 to >520 MHz Input Level: −7 to +13 dBm Accuracy: ±1% FS	HP435A/8481A
(6) 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
(7) Oscilloscope	Range: DC to 2 MHz Sensitivity: 2 V/cm (AC coupled)	Tektronix D10/ 5A18N/5B10N
(8) Spectrum Analyzer	Range: 1 kHz to 1200 MHz Display: 2 dB log and 10 dB log	HP8558B/182T
(9) Precision Attenuator Pads	10, 20, 30, and 40 dB	Weinschel 50-10 50-20, 50-30 and 50-40
(10) Wideband Amplifier	Range: 1 to 520 MHz Gain: 26 dB Impedance: 50 ohm	HP8447D
(11) Signal Generator	Range: 1 to 520 MHz	Wavetek 3001
(12) VSWR Bridge	5 to 525 MHz, 50 ohm 50 dB directivity	Wiltron 60N50
(13) Coaxial Short	Type N female	HP11511A
(14) Coaxial Termination 50 ohm	Type N male, 1.05 SWR	HP908A
(15) 50 ohm Load	————————————	HP11593A
(16) Loop Probe	————————————	See Figure 4-5

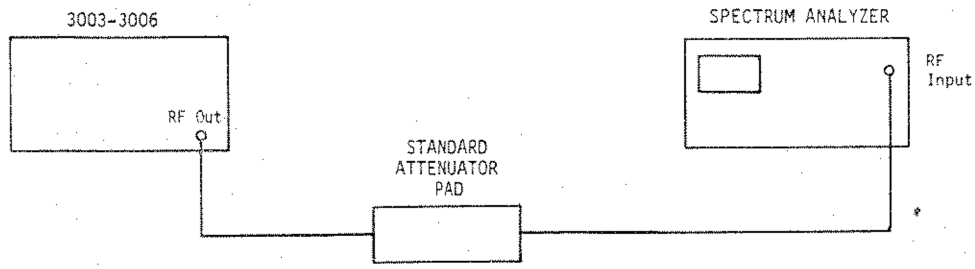


Figure 4-1. Test Set-up

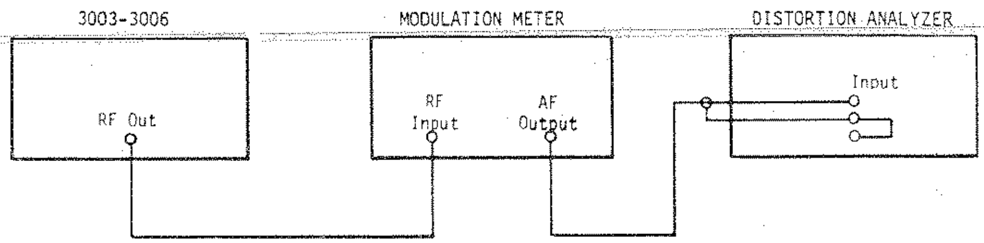


Figure 4-2. Test Set-up

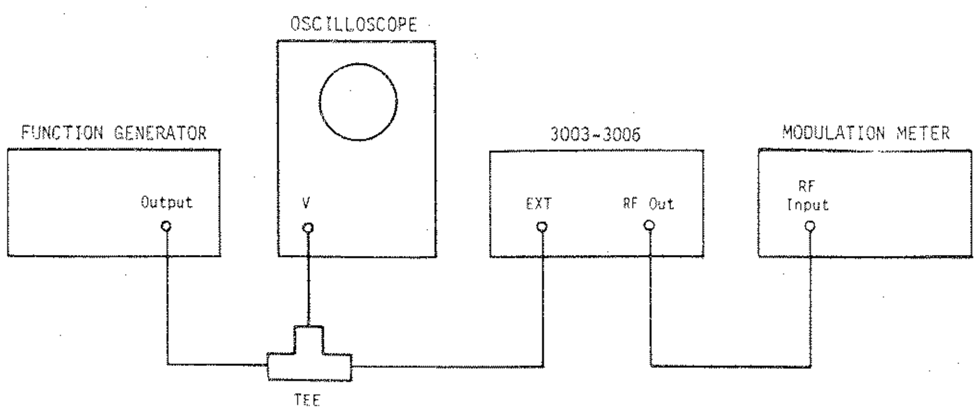


Figure 4-3. Test Set-up

4.2 FREQUENCY RANGE AND RESOLUTION TEST

SPECIFICATION	MIN FREQ	MAX FREQ	RESOLUTION
Model 3006	1 kHz	520 MHz	100 Hz
Model 3005	1 MHz	520 MHz	100 Hz
Model 3004	1 kHz	520 MHz	1 kHz
Model 3003	1 MHz	520 MHz	1 kHz

METHOD

A frequency counter is used to measure frequency range and resolution. Each digit of the Lever/Indicator switches (a total of 56 or 66, depending on the instrument being tested) will be tested.

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	050.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	NA
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	OUTPUT
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full CW

NOTE: The Lever/Indicator switch settings will be given for Models 3005 and 3006. If a Model 3003 or 3004 is being tested, ignore (the last (100 Hz) digit.

2. Connect the front-panel RF OUT connector to the 50 ohm input of the frequency counter. Set the counter resolution to 10 Hz (Models 3005, 3006) or 100 Hz (Models 3003, 3004).

3. Step through each Lever/Indicator switch digit and verify that the actual counter frequency increase per step is equal to the allowable increase per step ±1 count (see following table).

LEVER/INDICATOR SWITCH SETTINGS	COUNTER RESOLUTION	INCREASE/STEP (± 1 COUNT)
050.0000-050.0009	10 Hz	100.0 Hz
050.0000-050.0090	100 Hz	1.00 kHz
050.0000-050.0900	100 Hz	10.000 kHz
050.0000-050.9000	1 kHz	100.0 kHz
050.0000-059.0000	1 kHz	1.000 MHz
100.0000-190.0000	1 kHz	10.000 MHz
020.0000-520.0000	1 kHz	100.000 MHz

4. Verify the instrument frequency range by setting the Lever/Indicator switches to the minimum and maximum specified frequencies and noting the frequency counter readings.

5. If both the resolution (step 3) and range (step 4) are correct, place a check mark in the appropriate space on line 1 of the PTR.

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION

All modes (CW, AM and FM) ±0.001% after 15 minutes. ±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 FREQ VERNIER in CAL position, all carrier frequencies are derived from a single crystal-controlled oscillator. The instrument will be tested at one CW frequency to verify that the crystal-controlled oscillator operates within specified limits.

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

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	040.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	OUTPUT
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full cw

2. Connect the 50 ohm input of the frequency counter to the RF OUT connector.

3. The counter should read between 39,999.60 and 40,000.40 kHz. Record the counter reading to seven places on line 2 of the PTR.

4. Set the FREQ VERNIER control to 0 kHz. The frequency counter should read between 39,989.60 and 40,010.40 kHz. Record the counter reading to 7 places on line 3 of the PTR.

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

6. Subtract the frequency counter reading in Step 4 from the reading in Step 5. The frequency difference should be between 2500 and 3500 Hz. Record the difference on line 4 of the PTR.

7. Set the FREQ VERNIER to −3 kHz and subtract the frequency counter reading from the reading at 0 kHz in Step 4. The difference should be as in Step 6. Record the difference in Hz on line 5 of the PTR.

4.4 FREQUENCY STABILITY TEST

SPECIFICATION

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

METHOD

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

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	N/A
METER switch	OUTPUT
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full CW

2. Connect the 50 ohm input of the frequency counter to RF OUT connector.

3. Allow the instrument 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 6 of the PTR.

4. Set the front-panel FREQ VERNIER TO 0 kHz. 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 7 of the PTR.

4.5 OUTPUT LEVEL ACCURACY TESTS

SPECIFICATION

Power Level: +13 to −137 dBm (1 V to 0.03 uV)

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 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 substiduted. The spectrum analyzer trace is returned to the reference level by re-setting the output level. The resulting instrument 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 (5)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	050.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	OUTPUT
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full cw

2. Calibrate the power meter and power sensor. Set the power meter to the +15 dBm range. Connect the power sensor to the front-panel 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 instrument 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 front-panel 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 8 of the PTR.

4. Set the instrument OUTPUT Step Attenuator to 0 dBm and repeat step 3 above. Record the maximum output METER error on line 9 of the PTR.

4.5.2 FLATNESS TEST

EQUIPMENT (5)

PROCEDURE

1. Set the instrument controls as in Section 4.5.1.

2. Set the power meter to the +15 dBm range. Connect the power sensor to the front-panel RF OUT connector.

3. Adjust the front-panel OUTPUT VERNIER for a +12 dBm power meter reading.

4. Set the instrument 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 10 of the PTR.

5. Set the Lever/Indicator switches to 050.0000 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 11 of the PTR.

7. Set the Lever/Indicator switches 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 12 of the PTR.

4.5.3 STEP ATTENUATOR ACCURACY TEST

EQUIPMENT (5) (8) (9) (10)

PROCEDURE 1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	OUTPUT
OUTPUT Step Attenuator	0 dBm
OUTPUT VERNIER	full cw

2. Set the power meter to the +5 dBm range. Connect the power sensor to the RF OUT connector.

3. Adjust the OUTPUT VERNIER control for a +2 dBm power meter reading.

4. Disconnect the power sensor from the front-panel 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.

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 to -10 dBm.

8. Disconnect the 10 dB attenuator pad from the setup and reconnect the spectrum analyzer to the RF OUT connector.

9. Adjust the OUTPUT VERNIER control to realign the peak of the trace one division below the log reference line as in step 6.

10. Disconnect the cable from the front-panel RF OUT connector. Connect the power sensor and set the OUTPUT Step Attenuator to 0 dBm.

11. Observe the difference between the actual power meter reading and the +2 dBm reference setting in step 3. The difference or error should be ±0.7 dB maximum. Record the error on line 13 of the PTR.

12. Repeat Steps 3 through 11 using the standard attenuator pads and the instrument OUTPUT Step Attenuator settings indicated in the following table.

Steps 4 and 8 Attenuator pad (dB)	Step 7 OUTPUT Step Attenuator setting (dBm)	Step 11 Record Error on Line of PTR
10	−10	13
20	−20	14
30	−30	15
60	−60	16
90	−90	17

NOTE: To test the OUTPUT Step Attenuator below -20 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 instrument proper.

4.6 HARMONICS TEST

SPECIFICATION

< -30 dBc from 1 kHz to 1 MHz (Models 3004, 3006)
< -26 dBc from 1 to 10 MHz
< -30 dBc from 10 to 520 MHz

METHOD

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

EQUIPMENT

(8)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	001.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	OUTPUT
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full cw

2. Connect the spectrum analyzer to the instrument RF OUT connector.

3. Set the spectrum analyzer to measure harmonic distortion for fundamental frequencies below 10 MHz. Set 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 Lever/Indicator switch setting in 1 MHz steps up to 10 MHz. Record the maximum harmonic level observed (should be < -26 dBc) on line 18 of the PTR.

5. Set the OUTPUT Step Attenuator to 0 dBm and repeat steps 3 and 4. Record the maximum harmonic level observed on line 19 of the PTR.

6. On Models 3004 and 3006, repeat steps 3,4 and 5 for Lever/Indicator switch settings between 000.0010 and 000.9990, incremented in 10 kHz steps. Note the harmonic levels, but do not record them in the PTR as yet.

7. Set the front-panel frequency selector to 10 MHz and the OUTPUT Step Attenuator to +10 dBm.

8. Set the spectrum analyzer to measure the harmonic distortion of the instrument for fundamental frequencies between 10 and 520 MHz.

9. Increase the setting of the front-panel Lever/Indicator switches in 10 MHz steps between 10 and 520 MHz while observing the spectrum analyzer display. The harmonics should be >30 dB below the fundamental. Note the maximum harmonic level observed in the display, and record the greater harmonic level observed in Step 6 and Step 9 for an OUTPUT Step Attenuator setting of +10 dBm on line 20 of the PTR.

10. Set the instrument OUTPUT Step Attenuator to 0 dBm and repeat Steps 8 and 9 at the +3 dBm output level. Note the maximum harmonic level observed, and record the greater harmonic level observed in Step 6 and Step 10 for an OUTPUT Step Attenuator setting of 0 dBm on line 21 of the PTR.

4.7 NON-HARMONICS TEST

SPECIFICATION

Fundamental Range (MHz)	Non-harmonic Range (MHz)	Non-harmonic level (dBc)
below 3	below 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 nonharmonics in the frequency range of the instrument at the maximum specified output level of +13 dBm.

EQUIPMENT

(8)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	001.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD RANGE	N/A
EXT MOD RANGE	OFF
METER switch	OUTPUT
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full cw

2. Connect the front-panel RF OUT connector to the RF input of the spectrum analyzer.

3. Set the spectrum analyzer to measure the non-harmonic content of the instrument output between 0 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. On Models 3004 and 3006, set the Lever/Indicator switches to 000.0010 and increase the Lever/Indicator switch setting in 10 kHz steps up to 1 MHz while observing the spectrum analyzer. On all models, increase the setting of the Lever/Indicator switches in 0.1 MHz steps between 1 and 3 MHz. The non-harmonic below 3 MHz should be 60 dB below the fundamental. Record the maximum non-harmonic observed in the display below 3 MHz in dB below the fundemental on line 22 of the PTR.

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

6. Increase the settings of the Lever/Indicator switches 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. Using the table below, record the maximum non-harmonic level observed in each range on the applicable line of the PTR.

FUNDAMENTAL RANGE (MHz)	NON-HARMONIC RANGE (MHz)	NON-HARMONIC LEVEL (dBc)	PTR LINE NUMBER
3-250	3-250	< -65	23
3-350	3-350	< -55	24
3-520	3-1000	< -35	25

4.8 RESIDUAL AM TEST

SPECIFICATION

< -65 dBc in a 50 Hz to 15 kHz post-detection bandwidth.

METHOD

A modulation meter operating in AM mode is used to demodulate the instrument 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

(2) (6)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	500.0000
FREQ VERNIER	CAL
INT MOD FREQ	1 kHz
INT MOD LEVEL	10% METER reading
INT MOD RANGE	30% AM
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	INT MOD
OUTPUT Step Attenuator	0 dBm
OUTPUT VERNIER	–7 dB

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

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 range switch to 10 and the filter bandwidth to 50 Hz–15 kHz.

4. Adjust the front-panel INT MOD LEVEL 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 meter reading. The system is now calibrated at a reference level of -20 dBc. Since the modulating signal and carrier amplitudes are equal at 100% AM, it follows that at 10% AM the modulating signal is -20 dBc.

6. Set the front-panel INT MOD RANGE control to OFF.

7. Without disturbing the instrument or modulation meter controls, set the distortion analyzer to read residual AM. Set the range switch so that the 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 < -65 dBc. Record the residual AM in dBc on line 26 of the PTR.

As many other carrier frequencies may be tested as desired.

4.9 RESIDUAL FM TEST

SPECIFICATION

<100 Hz in a 300 Hz to 3 kHz post-detection bandwidth.
<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 instrument is operated in an FM mode where the residual FM is greater.

The residual FM is measured in an enviroment where the noise level <60 dB relative to 2×10^{-4} ubar.

EQUIPMENT

(6)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	100 kHz deviation
METER switch	OUTPUT
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full cw

2. Connect the front-panel 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 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 <200 Hz. Read the residual FM on the modulation meter with the function switch set to +FM and the –FM positions. Record the greater of the two readings in Hz on line 27 of the PTR.

As many other frequencies may be tested as desired.

4.10 INTERNAL MODULATION FREQUENCY ACCURACY TEST

SPECIFICATION

400 Hz and 1 kHz ±2% (plus two user-preset frequencies)

METHOD

A frequency counter is used to measure modulation frequency at the instrument rear-panel MOD TP. 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. NOTE: Internal frequencies A and B are set by the user; therefore, no performance test is given for their accuracy.

EQUIPMENT

(3)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	N/A
FREQ VERNIER	N/A
INT MOD FREQ	400 Hz
INT MOD LEVEL	mid-range
INT MOD RANGE	30% AM
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	N/A
OUTPUT Step Attenuator	N/A
OUTPUT VERNIER	N/A

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

3. The counter should read between 392 and 408 Hz. Record the counter reading on line 28 of the PTR.

4. Set the front-panel INT MOD FREQ control to 1 kHz.

5. The counter should read between 980 and 1020 Hz. Record the counter reading on line 29 of the PTR.

4.11 PERCENT AM ACCURACY TEST

SPECIFICATION

±(2% of full-scale reading +5% of METER reading) at a frequency of 1 kHz. NOTE: This specification applies for output limits ⩽+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 in both AM ranges with a modulation meter.

EQUIPMENT

(6)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	1 kHz
INT MOD LEVEL	30% METER reading
INT MOD RANGE	100% AM
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	INT MOD
OUTPUT Step Attenuator	0 dBm
OUTPUT VERNIER	–3 dB

Connect the modulation meter input to the instrument RF OUT connector. Set the modulation meter to read %AM at 520 MHz. Set the range switch to 100%, the RF input attenuation to 10 dB, the IF bandwidth to ±400 kHz, the meter response to fast, the function switch to +AM and the filter to 200 kHz.

3. With the METER reading exactly 30% AM, 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 26.5 and 33.5%. Record the average %AM to the nearest 0.5% on line 31 of the PTR.

4. Repeat the above procedure for the settings given in the table below. As many other points may be tested as desired.

INT MOD RANGE AND MOD METER RANGE	MOD METER FILTER	INST METER READING	MOD METER READING (MIN)	(MAX)	PTR
100% AM	200 kHz	90%	83.5%	96.5%	32
30% AM	75 kHz	10%	8%	12%	33
30% AM	75 kHz	20%	17.5%	22.5%	34

4.12 AM BANDWIDTH TEST

SPECIFICATION

External, DC to 20 kHz (±3 dB bandwidth), input level required ~1 VRMS into 600 ohms to provide full-scale adjustment with EXT MOD LEVEL 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 instrument. 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

(4) (6)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	050.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	full ccw

EXT MOD RANGE	100% AM
METER SWITCH	EXT MOD
OUTPUT Step Attenuator	0 dBm
OUTPUT VERNIER	+3 dB

2. Connect the equipment as shown in Figure 4-3.

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 range switch to 100% and the filter bandwidth to 200 kHz.

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

5. Adjust the front-panel EXT MOD LEVEL control for a modulation meter reading −6 dB (approximately 50% AM).

6. Maintain the 1 VRMS output level and increase the function generator frequency from 1 to 20 kHz. Observe the modulation meter scale. It should read between −3 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 setting as in Step 6.

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

4.13 AM DISTORTION TEST

SPECIFICATION

3% distortion to 70% AM (5% to 90% AM) at a frequency of 1 kHz. NOTE: This specification applies for output limits ⩽ +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

(2) (6)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	1 kHz
INT MOD LEVEL	full ccw
INT MOD RANGE	100% AM
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	INT MOD
OUTPUT Step Attenuator	0 dBm
OUTPUT VERNIER	−7 dB

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

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

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
C43	CAP.CER,F.T.,27PF CF114-027	4420-27PF	AER	1510-31-0270	1
C44 C49 C51 C52	CAP.CER,10PF,1KV CD101-010	10TCC-Q10	SPR	1510-10-0100	4
C53 C55	CAP,VARI,.5/3PF CV102-R30	R-TRIKO-107-02-M	STR	1510-70-1030	2
C54	CAP.Q.C.,.1PF CG101-110	QC-.1PF	Q-C	1510-40-0019	1
C56	CAP.M.C.,.75PF CG102-175	MC-.75PF	Q-C	1510-40-1758	1
C59	CAP,Q-C,10PF,10% CG101-310	QC-10PF	Q-C	1510-40-0100	1
CR1 CR2 CR4	DIODE DR000-001	1N4004	P-C	4806-01-4004	3
CR3	DIODE DP000-040	MA47980	M-A	4805-02-0001	1
CR5	DIODE DG100-341	1N34A	HIT	4807-01-0034	1
CR6 CR7	DIODE DG000-012	5082-0180	H-P	4811-02-0001	2
CR8	DIODE DC000-005	BB121A	ITT	4689-00-0001	1
IC1	IC,IC000-011	78M05U1C	FCD	7000-78-0500	1
IC2	IC,IC000-002	N5741CV	SIG	7000-57-4100	1
J1 J2 J3 J4 J5 J6 J7	CONN JF000-005	37JR116-1	S-C	2110-03-0002	7

WAVETEK PARTS LIST

TITLE: XTAL REF,M30-1

ASSEMBLY NO. 1114-00-0024

REV H

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
L01 L02 L03 L27	TOROID	LA009-010-1	HYT	1810-05-0004	4
L07	CHOKE .47MH 10% LA005-R04	08NR47K	ASE	1810-03-0478	1
L08 L09 L17	TOROID, 4 TURN	LA009-004-1	HYT	1810-05-0003	3
L10 L11 L21 L23 L24 L25	RF CHOKE	CHOKE	W-I	1819-99-9999	6
L12 L13 L14 L15 L19	CHOKE .22MH 10% LA005-R02	08NR22K	ASE	1810-03-0228	5
L16	FERRITE CHOKE LA009-004	T1255-1	HYT	1810-05-0001	1
L18	CHOKE .10MH 10% LA005-R01	08NR10K	ASE	1810-03-0019	1
L20	CHOKE, 1MH, 10% LA005-R10	08N1R0K	ASE	1810-03-0010	1
L26	GROUND LUG,#6,INT HG102-600	38-111	F-S	2112-03-0003	1
Q01 Q02 Q06 Q07 Q08 Q09 Q10	TRANS QA050-530	2N5053	APX	4901-05-0530	7
Q03	TRANS QA051-790	2N5179	RCA	4901-05-1790	1
Q4 Q5	TRANS QA039-040	2N3904	NAT	4901-03-9040	2
R04	RES,MF,1/8W,1%,5.11K RF212-511	MF55K-5.11K	ASE	4701-03-5111	1

WAVETEK PARTS LIST

TITLE: XTAL REF,M30-1

ASSEMBLY NO. 1114-00-0024

REV H

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R05 R50	RES, MF, 1/8W, 1%, 10K RF213-100	MF55K10K	ASE	4701-03-1002	2
R06 R18 R19	RES, MF, 1/8W, 1%, 2K RF212-200	MF55K-2K	ASE	4701-03-2001	3
R07 R14 R23 R41	RES, C, 1/4W, 10%, 100 RC104-110AB	CB1001	A-B	4705-16-1000	4
R08 R29	RES, C, 1/4W, 5%, 2.2K RC103-222	CF1/4-2.2K	ASE	4700-15-2201	2
R09 R11 R22	RES, C, 1/4W, 5%, 1K RC103-210	CF1/4-1K	ASE	4700-15-1001	3
R10	RES, C, 1/4W, 5%, 100K RC103-410	CF1/4-100K	ASE	4700-15-1003	1
R12	RES, C, 1/4W, 5%, 4.7K RC103-247	CF1/4-4.7K	ASE	4700-15-4701	1
R13	RES, C, 1/4W, 5%, 470K RC103-447	CF1/4-470K	ASE	4700-15-4703	1
R15	RES, MF, 1/8W, 1%, 40.2K RF213-402	MF55K-40.2K	ASE	4701-03-4022	1
R16	RES, MF, 1/8W, 1%, 15K RF213-150	MF55K-15K	ASE	4701-03-1502	1
R17	RES, C, 1/4W, 5%, 1.5K RC103-215	CF1/4-1.5K	ASE	4700-15-1501	1

WAVETEK
PARTS LIST

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY
R20	RES, C, 1/4W, 5%, 1.8K RC103-218	CF1/4-1.8K	ASE	4700-15-1801	1
R21	RES, C, 1/4W, 5%, 220 RC103-122	CF1/4-220	ASE	4700-15-2200	1
R24	RES, C, 1/8W, 5%, 10 RC101-010	CF1/8-10	ASE	4700-05-1009	1
R25 R26	RES, C, 1/8W, 5%, 100 RC101-110	CF1/8-100	ASE	4700-05-1000	2
R27	RES, C, 1/4W, 5%, 47K RC103-347	CF1/4-47K	ASE	4700-15-4702	1
R28	RES, C, 1/4W, 5%, 22K RC103-322	CF1/422K	ASE	4700-15-2202	1
R30 R36 R43	RES, C, 1/4W, 5%, 33K RC103-333	CF1/4-33K	ASE	4700-15-3302	3
R31 R35 R42	RES, C, 1/4W, 5%, 10K RC103-310	CF1/4-10K	ASE	4700-15-1002	3
R32 R38 R44 R45	RES, C, 1/8W, 5%, 47 RC101-047	CF1/8-47	ASE	4700-05-4709	4
R33 R39 R49	RES, C, 1/4W, 5%, 470 RC103-147	CF1/4-470	ASE	4700-15-4700	3
R34 R37	RES, C, 1/8W, 5%, 22 RC101-022	CF1/8-22	ASE	4700-05-2209	2

WAVETEK
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switch to +AM, the range switch to 100% and the filter bandwidth to 50 Hz to 15 kHz.

4. Adjust the front-panel INT MOD LEVEL control for a modulation meter reading of 70%. Set the modulation meter function switch to –AM, and observe the modulation meter reading. Readjust the INT MOD LEVEL control until the average of the modulation meter readings in the +AM and –AM positions of the 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 front-panel INT MOD LEVEL control as in Step 4 until the average of the modulation meter readings in the +AM and –AM positions of the 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 — +3% of full-scale reading at 1 kHz modulation frequency.

METHOD — The FM deviation is measured in all FM ranges with a modulation meter.

EQUIPMENT — (6)

1. Set the instrument controls as follows:

Lever/Indicator switches	050.0000
FREQ VERNIER	0 kHz
INT MOD FREQ	1 kHz
INT MOD LEVEL	full ccw
INT MOD RANGE	3 kHz FM
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	INT MOD
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full cw

2. Connect the input of the modulation meter to the instrument RF OUT connector.

3. Set the modulation meter to read FM deviation at 50 MHz. Set the 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 to 3 KHz.

4. Adjust the INT MOD LEVEL control for a METER reading of exactly 1 kHz deviation. The modulation meter should read an actual deviation of between 910 and 1090 Hz. Record the modulation meter reading on line 38 of the PTR.

5. Repeat Steps 3 and 4 for all settings in the table below. As many other points may be tested as desired.

INT MOD RANGE AND MOD METER RANGE	MOD METER FILTER	INST METER READING	MOD METER READING (Hz) (MIN)	(MAX)	PTR LINE
3 kHz	3 kHz	2 kHz	1910	2090	39
10 kHz	15 kHz	3 kHz	2700	3300	40
10 kHz	15 kHz	9 kHz	8700	9300	41
30 kHz	15 kHz	10 kHz	9100	10,900	42
30 kHz	15 kHz	20 kHz	19,100	20,900	43
100 kHz	75 kHz	30 kHz	27,000	33,000	44
100 kHz	75 kHz	90 kHz	87,000	93,000	45

4.15 FM BANDWIDTH TEST

SPECIFICATION

External, 50 Hz to 25 Hz (1 dB bandwidth), input level required ≅ 1 VRMS into 600 ohms to provide full-scale adjustment with EXT MOD LEVEL control. (DC to 25 kHz when the FREQ 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 output signal. 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

(4) (6) (7)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	full ccw
EXT MOD RANGE	100 kHz FM
METER switch	EXT MOD
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	−7 dBm

2. Connect the equipment as shown in Figure 4-3.

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 100 kHz, and the filter bandwidth to 200 kHz.

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

5. Adjust the front-panel EXT MOD LEVEL control for a modulation meter reading of −1 dB (approximately 90 kHz deviation).

6. Maintain the 1 VRMS 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 45 of the PTR.

4.16 FM DISTORTION TEST

SPECIFICATION

2% (10 kHz to 100 kHz deviation) at a frequency of 1 kHz
4% (3 to 10 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 is <60 dB relative to 2×10^{-4} ubar.

EQUIPMENT

(2) (6)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	1 kHz
INT MOD LEVEL	3 kHz METER reading
INT MOD RANGE	10 kHz FM
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	INT MOD
OUTPUT Step Attenuator	+10 dBm
OUTPUT VERNIER	full cw

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

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 10 kHz 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%.

5. Repeat Steps 3 and 4 for FM deviations up to 10 kHz. The distortion at all points should be less than 4%. Record the worst-case distortion on line 47 of the PTR.

6. Repeat steps 3, 4, and 5 for FM deviations of between 10 and 100 kHz. The distortion at all points should be less than 2%. Record the worst-case distortion on line 48 of the PTR.

4.17 IMPEDANCE TEST

SPECIFICATION

50 ohms, VSWR 1.2 at RF output levels below 0.1 VRMS.

METHOD

The measurement is made with a VSWR bridge and the return loss is displayed on a spectrum analyzer. An RF signal from a 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 instrument. The signal generator is tuned from 1 to 520 MHz and the return loss versus frequency is displayed.

EQUIPMENT

(8) (11) (12) (13)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	520.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF
METER switch	OUTPUT
OUTPUT Step Attenuator	−10 dBm
OUTPUT VERNIER	+3 dB

2. Connect the equipment as shown in Figure 4-4. Connect the 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 signal generator output level to −10 dBm, the mode to CW and the 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.

5. Disconnect the coaxial short and connect the device-under-test port of the VSWR bridge to the front-panel RF OUT connector. Use the signal generator frequency selector 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 49 of the PTR.

4.18 RFI TEST

SPECIFICATION

<1.0 uV 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 uV level using the instrument. 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 instrument with the RF OUT connector terminated in 50 ohms. A screen room may be required for this measurement.

EQUIPMENT

(8) (10) (14) (15) (16)

PROCEDURE

1. Set the instrument controls as follows:

Lever/Indicator switches	500.0000
FREQ VERNIER	CAL
INT MOD FREQ	N/A
INT MOD LEVEL	N/A
INT MOD RANGE	OFF
EXT MOD LEVEL	N/A
EXT MOD RANGE	OFF

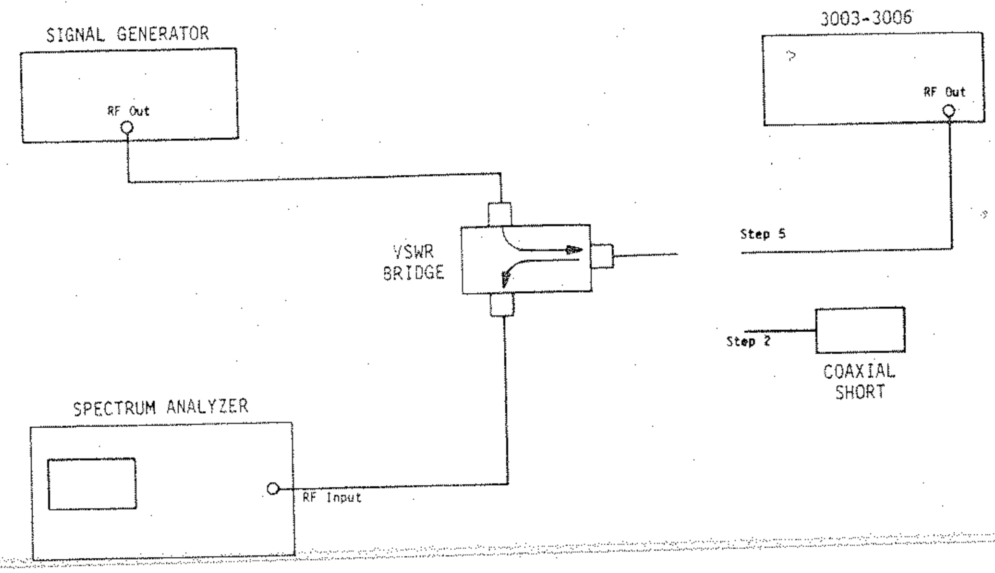
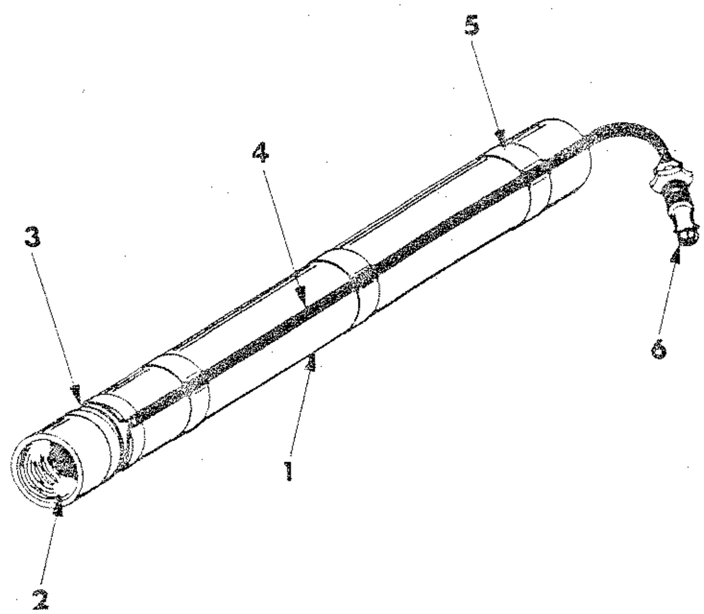


Figure 4-4. Test Set-up



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 4-5. Loop Probe

METER switch	OUTPUT
OUTPUT Step Attenuator	−110 dBm
OUTPUT VERNIER	+ 3 dB

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

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 instrument and connect the 50 ohm coaxial termination to the instrument RF OUT connector. Tighten the termination to minimize RF leakage.

5. Set the instrument OUTPUT Step Attenuator to −10 dBm.

6. Connect the loop probe to the input of the RF amplifier. Move the loop probe over the surfaces of the instrument with the two-turn loop at a one-inch distance. The signal plus noise should be less than the −107 dBm reference. Record the maximum reading in dBm on line 50 of the PTR.

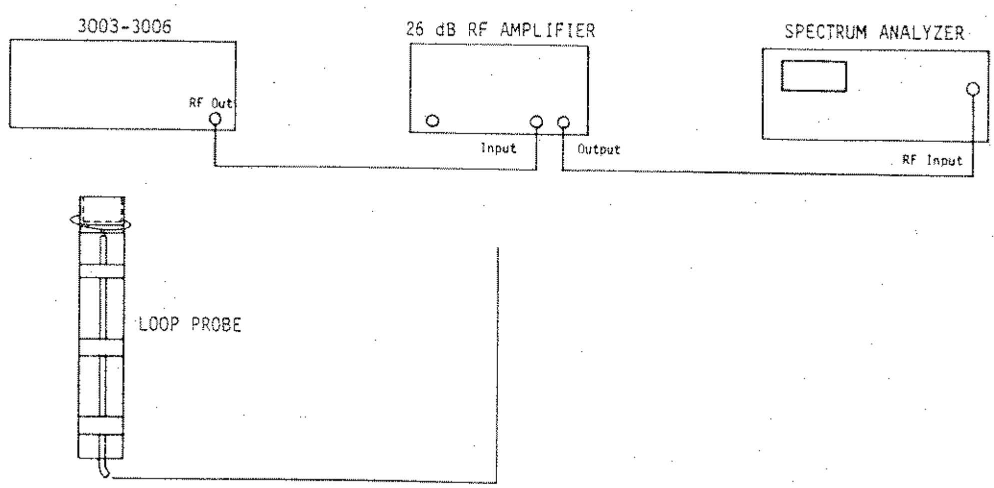


Figure 4-6. Test Set-up

PERFORMANCE TEST RECORD
MODELS 3003 THROUGH 3006

S/N ______________

DATE ______________

SEC	TEST	MINIMUM SPECIFICATION	MEASUREMENT	MAXIMUM SPECIFICATION	LINE
4.2	FREQ RANGE/RES	--------------	( ) CHECK	--------------	1
4.3	FREQ ACCURACY	39,999.60 kHz	kHz	40,000.40 kHz	2
		39,989.60 kHz	kHz	40,010.40 kHz	3
		2500 Hz	Hz	3500 Hz	4
			Hz		5
4.4	FREQ STABILITY	--------------	Hz	104 Hz	6
			Hz	500 Hz	7
4.5.1	METER ACCURACY	-0.5 dB	dB	+0.5 dB	8
			dB		9
4.5.2	FLATNESS	-0.75 dB	dB	+0.75 dB	10
			dB		11
			dB		12
4.5.3	STEP ATT ACCURACY	-0.7 dB	dB	+0.7 dB	13
			dB		14
			dB		15
			dB		16
		-1.5 dB	dB	+1.5 dB	17
4.6	HARMONICS	-26 dBc	dBc	--------------	18
			dBc		19
		-30 dBc	dBc	--------------	20
			dBc		21
4.7	NON-HARMONICS	-60 dBc	dBc	--------------	22
		-65 dBc	dBc		23
		-55 dBc	dBc		24
		-35 dBc	dBc		25
4.8	RESIDUAL AM	-65 dBc	dBc	--------------	26
4.9	RESIDUAL FM	--------------	Hz	200 Hz	27
4.10	INT MOD FREQ ACC	392 Hz	Hz	408 Hz	28
		980 Hz	Hz	1020 Hz	29
4.11	% AM ACCURACY	26.5%	%	33.5%	31
		83.5%	%	96.5%	32
		8%	%	12%	33
		17.5%	%	22.5%	34
4.12	AM BANDWIDTH	--------------	dB	3 dB	35
4.13	AM DISTORTION	--------------	%	3%	36
			%	5%	37
4.14	FM DEV ACCURACY	910 Hz	Hz	1090 Hz	38
		1910 Hz	Hz	2090 Hz	39
		2700 Hz	Hz	3300 Hz	40
		8700 Hz	Hz	9300 Hz	41
		9100 Hz	Hz	10,900 Hz	42
		19,100 Hz	Hz	20,900 Hz	43
		27,000 Hz	Hz	33,000 Hz	44
		87,000 Hz	Hz	93,000 Hz	45
4.15	FM BANDWIDTH	--------------	dB	1 dB	46
4.16	FM DISTORTION	--------------	%	4%	47
		--------------	%	2%	48
4.17	IMPEDANCE	-21 dB	dBc	--------------	49
4.18	RFI		dB	-107 dBm	50