TECHNICAL MANUAL
for

MULTI-MODE EXCITER
MODEL MMX(M)-2

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, ONTARIO

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NOTICE

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,* fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes*furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

CHANGE NO. 1

INSTRUCTION BOOK CHANGE NOTICE

Date November 22, 1971

Manual affected: MMX(M)-2, Multi-Mode Exciter IN 2033

On page 5-18, change the first sentence in the first NOTE to read:

"The signal level displayed on the analyzer should be at a -6 db level."

SHOULD ADDITIONAL COPIES OF THIS CHANGE NOTICE BE REQUIRED, PLEASE CONTACT:

THE TECHNICAL MATERIEL CORP., 700 Fenimore Road, Mamaroneck, New York

Attn.: Director of Eng. Services.

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

LIST OF ILLUSTRATIONS

LIST OF TABLES

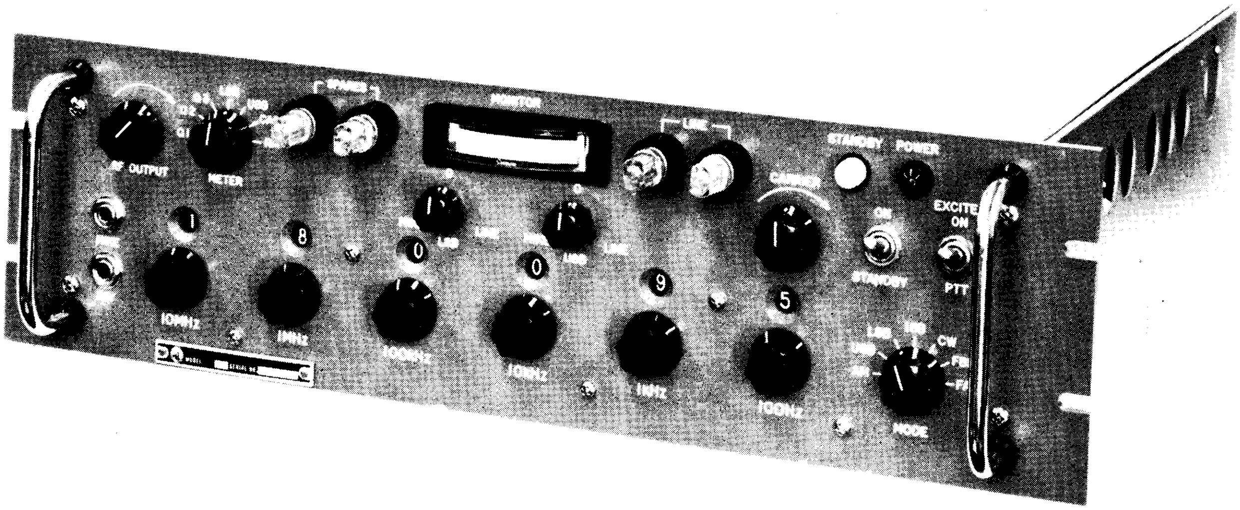


Figure 1-1. Multi-Mode Exciter MMX(M)-2

SECTION 1

GENERAL INFORMATION

1-1. FUNCTIONAL DESCRIPTION

This manual presents operating and maintenance instructions for Multi-Mode Exciter, Model MMX(M)-2, designed and manufactured by the Technical Materiel Corporation, Mamaroneck, New York. The manual includes a general description of the equipment; installation and operating procedures; principles of operation; maintenance data; and a parts list.

Multi-Mode Exciter, Model MMX(M)-2 (figure 1-1), hereinafter referred to as the MMX(M)-2, or the Exciter, is a solid-state Exciter which generates rf output frequencies between 1.5 and 29.9999 MHz. Modulation capabilities are CW, AM, SSB (USB, LSB), ISB, FSK and FAX. The bandwidth of the upper and lower sidebands is specified by the customer (refer to table 1-1). The carrier frequency is selectable in discrete 100 Hz increments by means of six frequency selector switches. The Exciter also features built-in frequency stability of 1 part in 10^8/day, and provides a continously adjustable 250 mv output in AM, SSB, AME, and optional ISB modes of operation. In addition, the Exciter provides an output of up to one watt for continuous wave (CW), frequency shift keyer (FSK) and facsimile (FAX) operation.

Front panel controls permit operator selection of the operating mode (AM, USB, LSB, ISB (when provided), CW, FSK or FAX). A variable CARRIER control is included in the front panel of the Exciter to permit the operator to establish the desired amount of carrier insertion. Additional front panel controls are provided to adjust the level of the USB or LSB mike/line input, the rf output level, and for monitoring critical circuits. Two front panel jacks permit a 55 dbm low-impedance microphone and a dry-contact keyer to be coupled to the Exciter. A front panel ammeter, used in conjunction with the meter select switch, enables the operator to select and monitor one of seven circuits; Q1, Q2, Q3, LSB, USB, CARR, or RF. Selection of Exciter or press to talk (PTT) operation is accomplished by a front panel selector switch.

Standard BNC connectors are provided on the rear panel of the Exciter to interface the standard 1 MHz output frequency, 1 MHz monitor, Automatic Load and Drive Control (ALDC) circuit, rf output and rf monitor with the external equipment. The remaining interface connections with the external equipment are made at three rear panel mounted terminal boards. These connections are detailed in Section 2, Installation.

NOTE

The terms MHz, kHz and Hz, as used herein, represent megacycles (Mc), kilocycles (Kc) and cycles (cps), respectively.

1-2. PHYSICAL DESCRIPTION

The majority of electronic components which constitute the Exciter are mounted on 17 printed circuit boards which plug into chassis-mounted Cinch connectors. In addition, a standard extender board and power supply extender board are included, and mate with the respective printed circuit boards and chassis connectors, thereby facilitating maintenance, alignment and troubleshooting procedures. The chassis is designed for installation in a standard 19-inch wide electrical equipment cabinet; removable top and bottom protective covers are provided on the chassis.

1-3. TECHNICAL SPECIFICATIONS

Table 1-1 presents a listing of the pertinent electrical and mechanical specifications for the Exciter.

TABLE 1-1. EXCITER SPECIFICATIONS

FREQUENCY RANGE:	1.5 to 29.9999 MHz in 100 Hz incremental steps. For remote tuning, see OPTIONS/ACCESSORIES.
FREQUENCY PRESENTATION:	Direct reading.
MODES OF OPERATION:	CW, AM, SSB, (including AME full carrier), FSK, FAX and ISB (optional extra).
OUTPUT POWER:	Continuously adjustable from 0 to 1 watt for CW, FSK, FAX. Continuously adjustable from 0 to 250 mv PEP for SSB, ISB, AM and AME.
OUTPUT IMPEDANCE:	50 ohms nominal.
FREQUENCY STABILITY:	1 part in 10^8 per day for ambient change of 15°C within the range of 0-50° C (using internal standard). 1 part in 10^9 per day (optional with external standard).
FREQUENCY CONTROL:	All frequency determining elements referenced to a built-in 1 MHz source.
METERING:	Built-in multimeter allows monitoring of critical circuits and RF output.
TUNING:	Digital frequency selection by front panel controls.
SIGNAL/DISTORTION RATIO:	Distortion products are at least 40 db below either tone of a two-tone test at 250 mv, which exceeds FCC requirement.
UNWANTED SIDEBAND REJECTION:	A signal of 500 Hz is at least 60 db down from PEP in the unwanted sideband.
SPURIOUS SIGNALS:	Spurious signals greater than 120 Hz removed from the carrier are at least 60 db below full PEP output.
HUM AND NOISE LEVEL:	Noise level is at least 60 db down from either tone of a two-tone test.
CARRIER INSERTION:	-55 db to full output, continuously variable.
AUDIO RESPONSE:	1. Flat within ±1.5 db, 350-3500 Hz, either upper or lower sideband. 2. A filter providing ±1.5 db, 250-3040 Hz is available on special order. 3. A filter providing ±1.5 db, 250-6080 Hz is available on special order.
AUDIO INPUT LEVEL:	1. For ISB, 2 independent 600-ohm channels balanced or unbalanced, -20 dbm to +5 dbm. 2. Built-in microphone pre-amplifier for low level dynamic mike with front panel selection.
MIKE INPUT:	-55 db into 47,000 ohms, front panel jack.
AUDIO CONTROL:	Two front panel "fader" controls allow ease in selecting microphone or line input into either the upper or the lower sideband.

TABLE 1-1. EXCITER SPECIFICATIONS (Cont)

ALDC INTERNAL:	Adjustable, establishes a controlled rf output level.
ALDC EXTERNAL:	Will accept 0 to approximately -11 vdc from an associated linear amplifier to improve linearity, limit distortion and deliver a relatively constant output level during high modulation peaks or load changes.
ENVIRONMENTAL CONDITIONS:	Designed to operate in any ambient temperature between 0° and +50° C, and in any value of humidity up to 95%.
CW KEYING INFORMATION:	Key jack on front panel and connection on rear panel for up to 300 wpm dry contact carrier keying in CW mode.
FSK CAPABILITY:	
KEYING INPUT:	60 ma, 20 ma, 50 volt, 100 volt or CONT either positive or negative with respect to ground.
KEYING SPEED:	Up to 75 baud (higher keying speeds available).
SHIFT:	±42.5 Hz, ±85 Hz, ±170 Hz, or ±425 Hz.
FACSIMILE INPUT:	+1 to +10 volts will provide a linear frequency shift.
INSTALLATION DATA:	Size: 5-1/4" H x 19" W x 18"D. Weight: Approximately 35 lbs.
PRIMARY POWER:	115/230 vac ±10% 50/60 Hz, single-phase, 60 watts.
LOOSE ITEMS:	Mating coaxial fittings (BNC) and instruction manual.
COMPONENTS AND CONSTRUCTION:	All equipment manufactured in accordance with JAN/MIL specifications wherever practicable
OPTIONS/ACCESSORIES	
1. External Standard CSS-2	Provides 1 part in 10^9 stability.
2. Bandwidth Capability:	6 kHz bandpass filters may be substituted for 3 kHz at additional cost.
3. Remote Operation: (KIT-363)	May be equipped for remote operation of the digital frequency selector and the mode switches by hardwire. Teletype digital format using external components is available on a special order.
4. Remote Control Panels:	Control panels for convenient performance of the above functions are available at extra cost. Please consult TMC on the most economical solution to your remote control requirements.
5. Harmonic Suppression Filter: (with Z114 installed)	Secondary harmonics are attenuated 45 db below full PEP output, and all others at least 55 db below full PEP output, depending upon the Linear Amplifier utilized.

SECTION 2

INSTALLATION

2-1. GENERAL

The Exciter is calibrated and tested at the factory prior to shipment. When the Exciter is received at the operating site, inspect the packing case and contents for possible damage that might have occurred during transit. Unpack the equipment carefully, and inspect all packaging material for parts that have been shipped as loose items. With respect to damage to the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and furnishing of replacement parts.

2-2. POWER REQUIREMENTS

CAUTION

When ON/STANDBY switch (9, figure 3-1) is set to STANDBY and the line cord is connected to appropriate power source, the power supply is energized.

The exciter is designed for 115/230 vac, 50/60 Hz, single phase power operation. Unless specifically ordered otherwise, the unit is shipped wired for 115 vac operation. For 230 vac operation, wiring changes must be made, as shown in figure 7-2. For 230 vac operation, replace line protective fuses having 1/2 the 115 vac fuse rating.

2-3. MECHANICAL INSTALLATION

The Exciter is equipped with a standard 19-inch wide front panel. To install the unit in an equipment rack, fasten the front panel to the rack with four screws and four washers (supplied).

When the Exciter is equipped with a tilt-lock slide mechanism, installation is as follows: (See figure 2-1.)

a. Pull out center sections of tracks, located in equipment rack, until they lock in extended position.

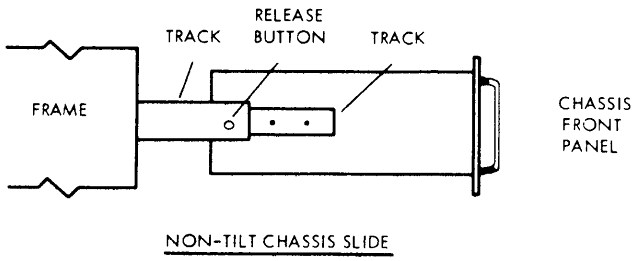
b. Position slide mechanisms of unit in tracks, and ease unit into rack until release fingers engage holes in tracks.

c. Press release fingers and slide unit completely into rack. Secure front panel of unit to rack with screws and washers.

d. Make necessary electrical connections, as described in paragraph 2-4.

2-4. ELECTRICAL INSTALLATION

All electrical connections between the Exciter and associated equipment are made at the rear of the unit. Figure 2-2 illustrates all rear panel connections, while table 2-1 lists the panel designation and function of each connection.



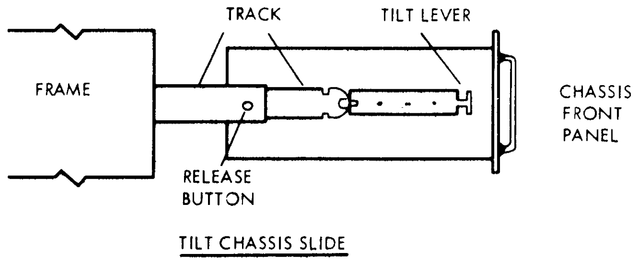


Figure 2-1. Tilt-Lock Slide Mechanism

TABLE 2-1. REAR PANEL CONNECTIONS

Panel Designation	Function
J116 (POWER)	Power input for 115 vac or 230 vac line power.
J119 (Remote Input)	Optional input connector for remote control operation.
J120 (1 MHz OUT)	1 MHz standard output jack.
J121 (1 MHz MON)	1 MHz standard monitor jack.
J122 (EXT STD)	Input for external frequency standard.
J123 (ALDC)	Input from an associated linear amplifier to improve linearity, limit distortion and deliver a relatively constant output level during high modulation peaks or load changes.
J124 (RF OUT)	RF output jack.
J125 (RF MON)	RF output monitor jack.
TB103 (USB)	
-1, -2, -3	USB 600-ohm balanced input
-4	Ground terminal
-5, -6	TRANS terminals for connecting PTT relay contacts to external equipment

TABLE 2-1. REAR PANEL CONNECTIONS (Cont)

Panel Designation	Function
TB104 (LSB)	
-7, -8, -9	LSB 600-ohm balanced input
-10	Ground terminal
-11	Keyer input terminal for CW keying
-12	Ground terminal for CW keying
TB105	
-13, -14	FSK inputs for FSK transmission (TTY) battery loop
-15, -16	FAX input
-17, -18	Dry contact input for FSK mode of operation

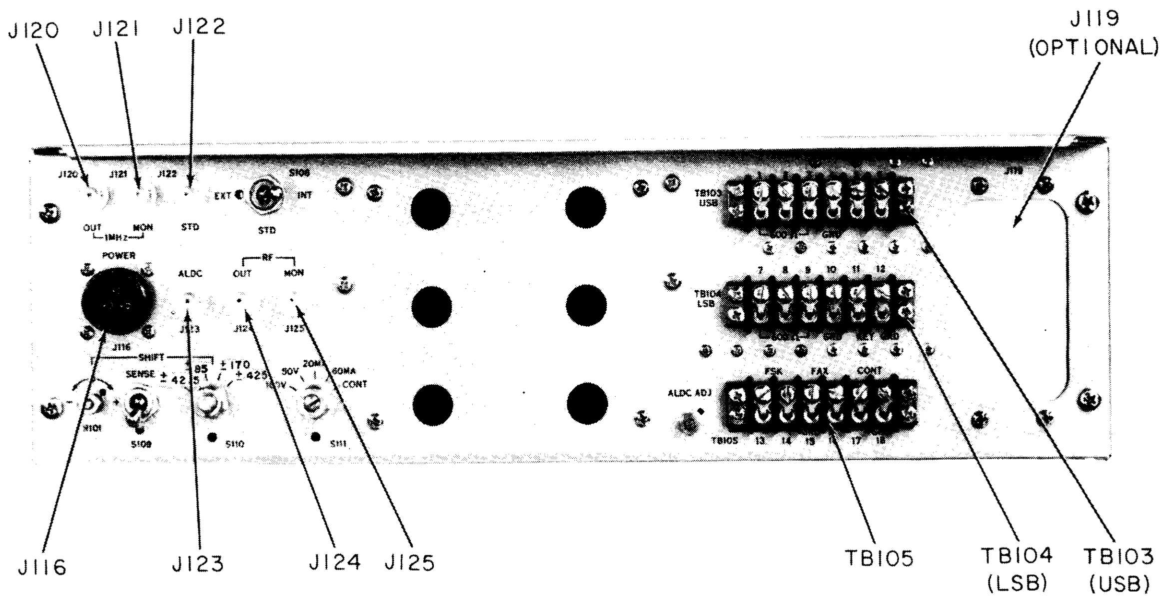


Figure 2-2. Rear Panel Connectors

2-5. INITIAL CHECKOUT PROCEDURE (See figures 2-2 and 2-3.)

Although the Exciter has been aligned and thoroughly checked against the manufacturer's specifications prior to shipment, it is necessary to ensure correct installation and proper Exciter operating conditions by performing the following checkout procedures. Refer to Section 3 for location and functions of all operating controls and indicators.

NOTE

Unless otherwise indicated, item numbers (numbers in parenthesis) and callouts referred to figure 3-1.

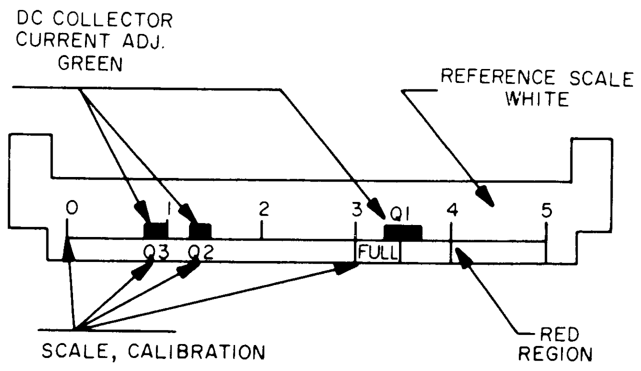


Figure 2-3. Front Panel Monitor Indicator

a. Set ON/STANDBY switch (9) to STANDBY position.

b. Connect source of 115 vac line power to connector J116 (figure 2-2). STANDBY indicator (8) shall illuminate amber.

c. Position RF OUTPUT control (1) fully counterclockwise.

d. Using frequency selector switches (14), set output frequency to 29.9999 MHz.

e. Position CARRIER control (13) fully counterclockwise.

f. Position MODE switch (12) to ISB.

g. Position EXCITER Switch (11) to ON.

h. Set MIKE/LINE controls (4) and (6) to 0.

i. Position METER switch (2) to Q1.

j. Connect Hewlett-Packard Model 200 CD Audio generator (or equivalent) to USB 600-ohm terminals (TB103) and LSB 600-ohm terminals (TB104), located on rear panel of Exciter. Set audio frequency for 1000 Hz at 1 volt RMS.

k. Position ON/STANDBY switch (9) to ON. STANDBY indicator (8) shall extinguish and POWER indicator (10) shall illuminate red.

l. Verify the MONITOR meter (5) is in the green region marked Q1. (See figure 2-3.)

m. Set METER switch (2) to Q2. MONITOR meter (5) shall indicate in the green region marked Q2. (See figure 2-3.)

n. Set METER switch (2) to Q3. MONITOR meter (5) shall indicate in the green region marked Q3. (See figure 2-3.)

o. Set METER switch (2) to RF; MONITOR meter (5) shall indicate zero with RF OUTPUT control (1) fully counterclockwise.

p. Connect a VTVM (Hewlett-Packard HP411A, or equivalent) to RF OUT jack J124 (figure 2-2) across a 47-ohm 2 watt noninductive load resistor.

q. Adjust RF OUTPUT control (1) for a minimum indication of 3.5 volts on VTVM.

r. Set METER switch (2) to USB and adjust USB MIKE/LINE control (6) for an indication of 2/5 full scale on MONITOR meter (5).

s. Set METER switch (2) to LSB and adjust LSB MIKE/LINE control (4) for an indication of 2/5 full scale on MONITOR meter (5).

t. Set METER switch (2) to CARR position. MONITOR meter (5) shall indicate zero.

u. Rotate CARRIER control (13) slowly clockwise; MONITOR meter (5) indication shall increase to FULL when CARRIER control (13) is fully clockwise.

v. Disconnect all test equipment and remove power from Exciter.

SECTION 3

OPERATOR'S SECTION

3-1. GENERAL

The MMX(M)-2 provides rapid rf frequency selection of AM, USB, LSB, or ISB intelligence in the 1.5 to 29.9999 MHz transmission range. Tuning over this frequency range is accomplished manually in incremental tuning steps of 100 Hz using six front panel frequency-select switches. In addition, the Exciter contains provisions for operating in the CW, FSK and FAX modes.

3-2. CONTROLS AND INDICATORS

All operator controls and indicators are located on the front and rear panels of the Exciter. Figure 3-1 illustrates the front and rear panels, and table 3-1 presents a listing of the controls and indicators and explains the function of each.

TABLE 3-1. FUNCTIONS OF CONTROLS AND INDICATORS

Item Number (figure 3-1)	Panel Designation	Function
1	RF OUTPUT control	Adjusts rf output level
2	METER switch (seven-position)	Selects circuit in MMX(M)-2 to be monitored by MONITOR meter
	Q1	Displays rf output transistor Q1 collector current (350 ma) on MONITOR meter
	Q2	Displays rf output transistor Q2 collector current (130 ma) on MONITOR meter
	Q3	Displays rf output transistor Q3 collector current (65 ma) on MONITOR meter
	LSB	Displays LSB output level on MONITOR meter
	USB	Displays USB output level on MONITOR meter
	CARR	Displays carrier level on MONITOR meter
	RF	Displays RF output level on MONITOR meter
3	SPARES (2) fuses	Spare one-ampere line voltage fuses

TABLE 3-1. FUNCTIONS OF CONTROLS AND INDICATORS (Cont)

Item Number (figure 3-1)	Panel Designation	Function
4	LSB MIKE/LINE control	Adjusts level of LSB input
5	MONITOR meter	Monitors circuit function selected by METER switch
6	USB MIKE/LINE control	Adjusts level of USB input
7	LINE (2) fuses	One-ampere line voltage fuses
8	STANDBY indicator	Illuminates amber when ON/ STANDBY switch is positioned to STANDBY
9	ON/STANDBY switch	When positioned to ON, applies 12 and 24 vdc to modules and illuminates red POWER indicator When positioned to STANDBY, removes dc voltages from modules and illuminates amber STANDBY indicator
10	POWER indicator	Illuminates red when ON/ STANDBY switch is positioned to ON
11	EXCITER ON/PTT switch	Set to ON position for all operating modes using inputs other than MIKE. Set to PTT when using MIKE input
12	MODE switch (seven-position)	Establishes one of seven operating modes, depending upon options supplied: AM, USB, LSB, ISB, CW, FSK or FAX
13	CARRIER control	Establishes the amount of carrier used
14	100 Hz, 1 kHz, 10kHz, 100 kHz, 1 MHz and 10 MHz switches	Used to establish the desired operating frequency
15	MIKE jack	Accept a 47,000-ohm impedance microphone input
16	KEY jack	Accepts dry contact keyer input used for CW mode of operation
17	STD-INT/EXT switch	Used to select the internal 1 MHz oscillator frequency, or an external 1 MHz standard input frequency

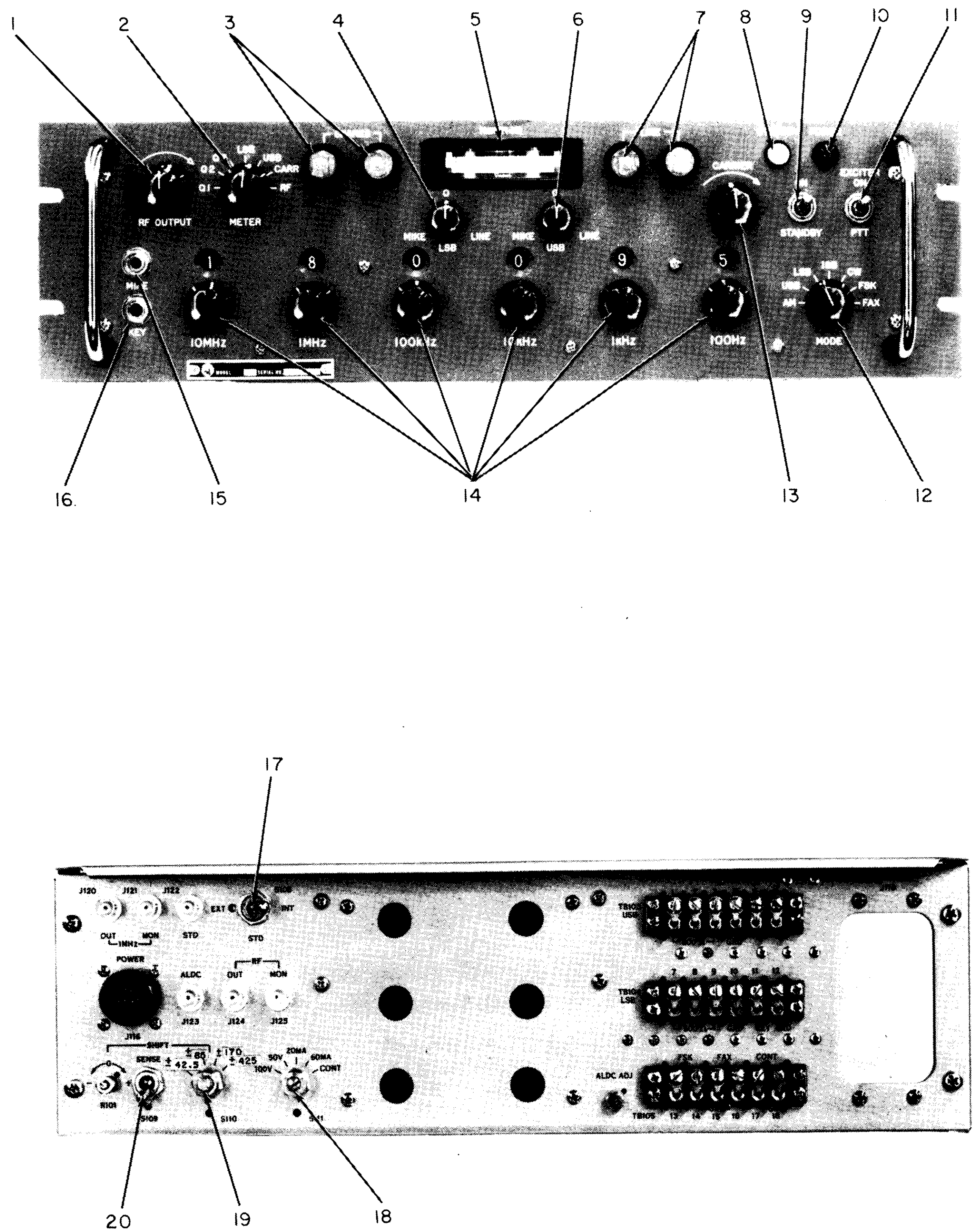


Figure 3-1. Controls and Indicators

TABLE 3-1. FUNCTIONS OF CONTROLS AND INDICATORS (Cont)

Item Number (figure 3-1)	Panel Designation	Function
18	FSK LOOP input switch	Selects proper FSK loop input; 100V, 10V, 20MA, 60MA or CONT
19	SHIFT switch (four-position)	Determines the "mark" and "space" frequency shift above or below the carrier frequency: ±42.5 Hz, ±85 Hz, ±170 Hz or ±425 Hz
20	SENSE switch (two-position)	Establishes sense + (positive) or - (negative) in the FSK mode of operation

3-3. OPERATING PROCEDURES

Before initially placing the Exciter in operation, perform the initial checkout procedure outlined in Section 2, Installation. To place the Exciter in operation:

NOTE

Verify that ON/STANDBY switch (9, figure 3-1) is set to STANDBY.

a. Connect a source of 115 vac, single-phase power to connector J116 (figure 2-2). Observe that STANDBY indicator (8) illuminates amber.

b. Make necessary interface connection on rear panel jack (figure 2-2).

NOTE

When operating the Exciter in the SSB and ISB, AM modes it is desirable to monitor the rf output with a Spectrum analyzer to establish the proper modulations with respect to the carrier. An RF MON jack J125 is provided on the rear panel for this purpose.

3-4. SINGLE SIDEBAND WITH ANY DEGREE OF CARRIER INSERTION (INCLUDING AME FULL CARRIER).

a. Set ON/STANDBY switch (9) to ON.

b. Set EXCITER switch (11) to ON position when using either the USB or LSB 600-ohm line (external signal source) inputs. Set EXCITER switch to PTT position when using MIKE input (15).

c. Select desired sideband with MODE switch (12).

d. Turn METER switch (2) at the desired sideband.

e. Connect a Mike to the front panel MIKE jack (15) if used.

f. Adjust the MIKE/LINE control of sideband used to appropriate level as indicated on MONITOR (5).

NOTE

DO NOT ENTER RED REGION. When mike input is used, adjust level so as not to exceed red region with highest input from microphone.

g. Turn METER switch (2) to CARR position. Adjust CARRIER control (13) to the desired level as indicated on MONITOR meter (5).

h. Turn METER switch (2) to RF position. Adjust RF OUTPUT control (1) for desired level of RF output as indicated on MONITOR meter (5).

NOTE

Turn RF OUTPUT control (1) fully CCW before selecting different modes of operation.

3-5. INDEPENDENT SIDEBAND WITH ANY DEGREE OF CARRIER

a. Set ON/STANDBY switch (9) to ON position.

b. Set EXCITER switch (11) to ON position when using either the USB or LSB 600-ohm line (external signal source) inputs. Set EXCITER switch (11) to PTT position when using a MIKE input (15).

c. Set USB (6) and LSB (4) controls to zero.

d. Select ISB position on MODE switch (12).

e. Turn METER switch (2) to LSB position. Adjust the LSB GAIN control (4) for a MONITOR meter (5) indication of up to but not to exceed the red region.

f. Turn METER switch (2) to USB position. Adjust USB GAIN control (6) for a MONITOR meter (5) indication of up to but not to exceed the red region.

g. Turn METER switch (2) to the CARR position. Adjust CARRIER control (13) to full or the desired level as indicated on MONITOR meter (5).

h. Turn METER switch (2) to the RF position and adjust RF OUTPUT control (1) for the level of RF output indicated on MONITOR meter (5).

3-6. CONVENTIONAL AM OPERATION

a. Set ON/STANDBY switch (9) to ON position.

b. Set EXCITER switch (11) to ON position when using either the USB or LSB 600-ohm line (external signal source) input. Set EXCITER switch (11) to PTT position when using MIKE input (15).

c. Set MODE switch (12) to AM position.

d. Connect a mike to front panel MIKE jack (15) if used.

e. Adjust the MIKE control (4) or (6) of sideband used to appropriate level as indicated on MONITOR meter (5).

f. Turn METER switch (2) to RF. Vary RF OUTPUT control (1) for desired level of RF output as indicated on MONITOR meter (5).

3-7. FREQUENCY SHIFT TELEGRAPH OPERATION

a. Set ON/STANDBY switch (9) to ON position.

b. Set EXCITER switch (11) to ON position.

c. Turn MODE switch (12) to FSK position.

d. Select appropriate FSK operation by setting FS LOOP (18) and SHIFT (19) switches.

e. Place SENSE switch (20) to desired sense (+) or (-).

f. Place METER switch (2) to the RF position. Adjust RF OUTPUT control (1) for desired MONITOR meter (5) reading.

3-8. FACSIMILE (FAX) OPERATION

a. Set ON/STANDBY switch (9) to ON position.

b. Set EXCITER switch (11) to ON position.

c. Turn MODE switch (12) to FAX position.

d. Place METER switch (2) to the RF position. Adjust RF OUTPUT control (1) for desired MONITOR meter (5) reading.

3-9. CW TELEGRAPH OPERATION

a. Set ON/STANDBY switch (9) to ON position.

b. Set MODE switch (12) to CW position.

c. Connect key to KEY input (16).

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

The principles of operation for the MMX(M)-2 are presented in three parts. The first part, paragraph 4-2, describes the frequency synthesis technique used in the equipment and provides a typical selected frequency example to illustrate operation of the synthesizer circuits. The second part, paragraph 4-3, provides a block diagram description of the equipment to specify which assembly boards are responsible for generating each of the exciter functions and to define the signal flow between board assemblies. The third part, paragraph 4-4, describes the operation of each functional group of circuits on the assembly boards to better understand circuit operation and to identify the associated circuit controls and adjustments for operation and maintenance.

4-2. FREQUENCY SYNTHESIZER. (See figure 4-1.)

Six front panel frequency selector switches provide selection of the carrier frequency in 100 Hz increments from 1.5 MHz to 29.9999 MHz. The synthesizer uses a precision 1 MHz signal from which are developed other basic signal frequencies which, in turn, are used to synthesize the rf carrier output. The basic signal frequencies are applied to mixer-divider and mixer-multiplier circuits to derive discrete rf frequencies. A typical frequency synthesis is shown in figure 4-1 to illustrate the synthesis process. Figure 4-1 illustrates a selected frequency of 21.7146 MHz, the appropriate switch positions are shown darkened on the diagram. The basic 8 MHz signal is mixed with the basic 1 MHz signal to produce 9 MHz; this is mixed with the 100 Hz switch-selected 1.6 MHz signal to produce a 10.6 MHz which, when divided by ten, produces 1.06 MHz, 6 being the least significant digit of the desired frequency. The 1.06 MHz frequency is then mixed with the basic 8 MHz signal to produce 9.06 MHz; this is mixed with the 1 kHz switch-selected 1.4 kHz signal to produce 10.46 MHz which, when divided by ten, produces 1.046 MHz, 4 being the next significant digit of the desired frequency. The 1.046 MHz frequency is then mixed with the basic 8 MHz signal to produce 9.046 MHz; this is mixed with the 10 kHz switch-selected 1.1 MHz signal to produce 10.146 MHz which, when divided by ten, produces 1.0146 MHz, 1 being the next significant figure of the desired frequency. The 1.0146 MHz is then mixed with the basic 8 MHz signal to produce 9.0146. This is mixed with the 100 kHz selected 1.7 MHz signal to produce 10.7146 MHz.

Generation of the two most significant digits (10 MHz and 1 MHz) is done in a different manner than the four least significant digits; these circuits use frequency multipliers and mixers to produce the desired frequencies. The selected 10.7146 MHz signal is first mixed with a 3 MHz modulation frequency to produce a 13.7146 MHz frequency. This 3 MHz frequency is varied by the selected modulation to provide carrier frequency deviations in response to the selected modulation mode; however, for this discussion only, the center frequency (3 MHz) is described. The 13.7146 frequency is mixed with a 120 MHz basic signal derived by multiplying the 40 MHz basic signal by three, the output of the mixer will then be 133.7146. The 1 MHz switch-selected 0.8 MHz signal is mixed with the 10 MHz switch-selected 12 MHz signal to produce a 11.2 MHz frequency; this is first multiplied by five to produce 56 MHz, then multiplied by two to produce 112 MHz. The 112 MHz frequency is then mixed with the 133.7146 MHz frequency to produce the final 21.7146 MHz carrier signal. The 10 MHz selector switch selects a 14 MHz basic signal for the 0 digit position which is used to derive the 01 MHz to 10 MHz range of frequencies, a 13 MHz basic signal is selected in the 1 digit position of the 10 MHz selector to derive the 11 MHz to 20 MHz range of frequencies and the 12 MHz basic signal is selected in the 2 digit position which is used to derive the 21 MHz to 29 MHz range of frequencies. The derivation of each of these discrete frequencies are listed in tables 4-1, 4-2 and 4-3. The derivation of the 21 MHz frequency is illustrated on figure 4-1.

TABLE 4-1. 01 MHz TO 10 MHz FREQUENCY SYNTHESIS

14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
- .8	- .9	-1.0	-1.1	-1.2	-1.3	-1.4	-1.5	-1.6	-1.7
13.2	13.1	13.0	12.9	12.8	12.7	12.6	12.5	12.4	12.3
x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5
66.0	65.5	65.0	64.5	64.0	63.5	63.0	62.5	62.0	61.5
x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2
132.0	131.0	130.0	129.0	128.0	127.0	126.0	125.0	124.0	123.0
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
133.0	133.0	133.0	133.0	133.0	133	133	133	133	133
-132.0	-131.0	-130.0	-129	-128	-127	-126	-125	-124	-123
01 MHz	02 MHz	03 MHz	04 MHz	05 MHz	06 MHz	07 MHz	08 MHz	09 MHz	10 MHz

TABLE 4-2. 11 MHz TO 20 MHz FREQUENCY SYNTHESIS

13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
- .8	- .9	-1.0	-1.1	-1.2	-1.3	-1.4	-1.5	-1.6	-1.7
12.2	12.1	12.0	11.9	11.8	11.7	11.6	11.5	11.4	11.3
x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5
61.0	60.5	60.0	59.5	59.0	58.5	58.0	57.5	57.0	56.5
x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2
122	121	120	119	118	117	116	115	114	113
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
133.0	133	133	133	133	133	133	133	133	133
-122.0	-121	-120	-119	-118	-117	-116	-115	-114	-113
11 MHz	12 MHz	13 MHz	14 MHz	15 MHz	16 MHz	17 MHz	18 MHz	19 MHz	20 MHz

TABLE 4-3. 21 MHz TO 29 MHz FREQUENCY SYNTHESIS

12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
- .8	- .9	-1.0	-1.1	-1.2	-1.3	-1.4	-1.5	-1.6
11.2	11.1	11.0	10.9	10.8	10.7	10.6	10.5	10.4
x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5	x 5
56.0	55.5	55.0	54.5	54.0	53.5	53.0	52.5	52.0
x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2	x 2
112	111	110	109	108	107	106	105	104
↓	↓	↓	↓	↓	↓	↓	↓	↓
133	133	133	133	133	133	133	133	133
-112	-111	-110	-109	-108	-107	-106	-105	-104
21 MHz	22 MHz	23 MHz	24 MHz	25 MHz	26 MHz	27 MHz	28 MHz	29 MHz

NOTE:
A SELECTED FREQUENCY OF 21.7146 IS SHOWN TO ILLUSTRATE THE SYNTHESIS PROCESS; THE CORRESPONDING SWITCH POSITIONS ARE SHOWN DARKENED.

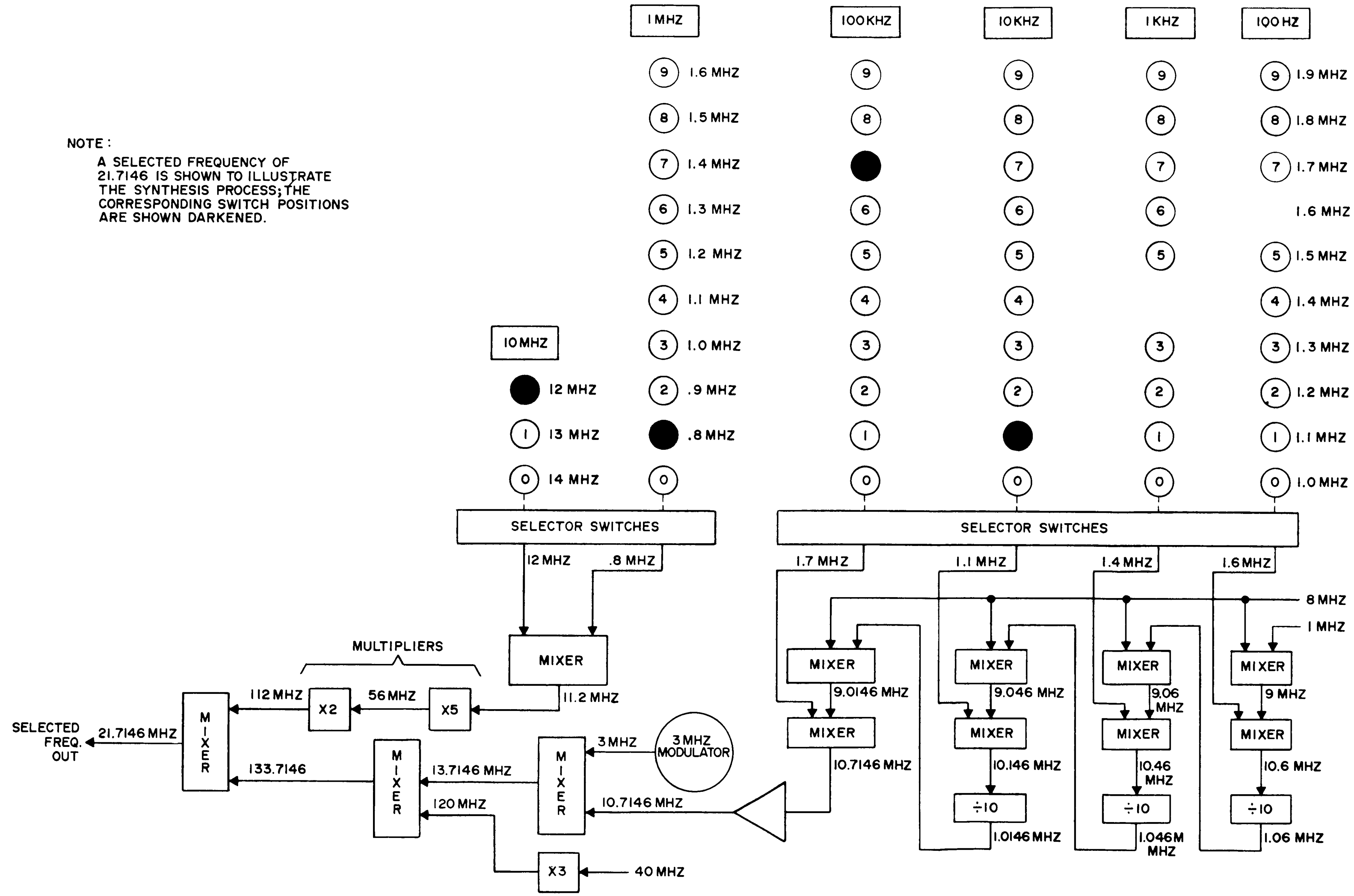


Figure 4-1. Frequency Synthesis, Example

4-3. <u>BLOCK DIAGRAM DESCRIPTION</u>. (See figure 4-2.)

A block diagram of the equipment is shown in figure 4-2. The spectrum generator board Z101 develops seven basic signal frequencies from the incoming precision 1 MHz signal. The 1 MHz input is amplified and sent to the mixer-divider circuits. The 1 MHz input is also clipped, divided by a factor of 10 and applied to a 100 kHz spectrum generator; this output, containing the 100 kHz fundamental, plus harmonics, is applied to the comb filter circuits. The 1 MHz input is squared to produce a 1 MHz spectrum containing the required harmonics for generation of five additional output frequencies of 8, 12, 13, 14 and 40 MHz. The 8 MHz output is applied to the mixer-dividers; the 40 MHz output is coupled to the frequency translator for determination of final output frequency range; and the 12, 13 and 14 MHz outputs are sent to the step generator circuits for derivation of the frequency ranges.

The 100 kHz spectrum output signal is applied to the two comb filter boards, Z102 and Z103. Circuits on these boards produce 12 precise output frequencies from 0.8 to 1.9 MHz in 100 kHz steps and apply them to the frequency select switch network. These frequencies are generated by exciting corresponding crystal-filters at the appropriate harmonic of the 100 kHz spectrum input.

The 8 MHz basic signal is mixed with the selected mixing frequencies in mixer-divider boards Z104, Z105, and in mixer-final board Z106 as previously described in paragraph 4-2; the output signal from mixer-final Z106 establishes the four least significant digits of the output frequency and is applied to the translator board, Z112.

The step generator boards Z110, Z111 and Z113 contain mixer and multiplier circuits that derive the two most significant digit frequencies of the selected output frequency as previously described in paragraph 4-2. Step generator board Z113 contains the 12 MHz mixer circuits and the X2 multiplier circuits for the three frequency ranges. The three frequency ranges are combined in this board by a summing amplifier and coupled as the 104 MHz to 132 MHz to the translator Z112.

The carrier generator board Z109 receives a 1 MHz standard input signal and divides this frequency by four to obtain a 250 kHz basic subcarrier signal; this subcarrier is amplitude-modulated in AM mode of operation, is shifted in frequency by teletype mark and space modulation in FSK mode of operation, is applied to balanced modulators in the sideband generator board Z107 to derive upper and lower single-sideband signals and is applied to the frequency shift generator board Z108 for CW mode of operation and for carrier reinsertion when desired. The 250 kHz is also multiplied by 11 on the carrier generator board to produce the 2.75 MHz carrier which is applied to a mixer circuit in the frequency shift generator board. The 2.75 MHz carrier is combined with the modulated 250 kHz signal to produce an AM, a single-sideband (SSB) or independent sideband (ISB) output with a 3 MHz center frequency.

The sideband generator board Z107 contains a microphone audio preamplifier and an audio impedance-matching transformer for translation of an external 600-ohm balanced or unbalanced audio line to a 500 ohm audio for application to the upper sideband (USB), lower sideband (LSB) and AM modulator circuits. Two balanced modulators produce the upper and/or lower sideband intelligence from the 250 kHz signal subcarrier and the incoming USB and LSB audio signals; the 250 kHz subcarrier is suppressed. The resulting USB and LSB signals are sent to the frequency shift generator board Z108.

The frequency shift generator board Z108 contains two circuit sections: the frequency shift generator section and the converter section. The frequency shift generator section provides either frequency shift keyer (FSK) or facsimile (FAX) modes of operation. The FSK mode applies the 250 kHz subcarrier to the keyer modulator which also receives external teletype input via the FS Loop switch. The 250 kHz subcarrier is modulated by the teletype current input producing a shift in frequency above and below the 250 kHz center frequency representing marks and spaces. This shift is rectified and translated to a dc level which is then amplified and applied to the modulation input of the 3 MHz voltage-controlled crystal oscillator (VXCO) which produces the required frequency shift above and below the 3 MHz center frequency. The FAX mode connects an external FAX signal through a dc regulator circuit which produces a variable dc level at the input of the VXCO thereby producing the required frequency shift of the 3 MHz center frequency output signal. The converter section of Z108 mixes the incoming 2.75 MHz carrier signal with the selected modulation signal (250 kHz AM, USB, LSB, ISB or CW from the carrier and sideband generator boards). The modulated 3 MHz sum signal is amplified and sent as modulation to the translator board Z112.

The translator board Z112 contains an X3 multiplier circuit which produces a 120 MHz frequency from the 40 MHz basic signal and mixer circuits that mix the selected carrier frequency of the four least significant digits with the 3 MHz modulator frequencies and mix the modulated sum frequency with the selected step generator frequency representing the two most significant digits of the selected carrier frequency. When the upper frequency range (20 - 29.9999 MHz) is selected, a ground enable is applied to a filter in series with the rf signal from the RF OUTPUT control. Therefore, the rf signal is prefiltered prior to being applied to rf output section Z115.

The rf output board Z115 amplifies the incoming rf carrier frequency and produces an automatic level dc voltage (ALDC) for feedback to the translator board Z112. The ALDC is used to control the rf output level. A metering circuit monitors the collector currents of the three amplifiers on rf output section Z115 and the rf output level of the selected frequency; these parameters are selected by a METER switch and displayed on the front panel MONITOR meter.

The output filter board Z114 may be one of two optional items and is not normally supplied. One board (A4507) contains six relay-selected bandpass filters; these relays are powered in the appropriate positions of the 10 MHz switch, the 1 MHz switch and the 100 kHz switch relative to the selected rf output frequency. Thus, the switch-selected frequency is filtered by an appropriate L-C network prior to appearing at the RF OUT jack J124 and MON jack J125. The other optional filter (A4654) is a low pass filter, passing frequencies below 32 MHz. If neither filter is selected, Z114 is bypassed.

4-4. FUNCTIONAL ASSEMBLY SECTIONS. (See figure 4-3.)

The following paragraphs provide detailed circuit descriptions for each assembly board. Since the interrelationship of the signals was previously described in paragraphs 4-2 and 4-3, signal flow between boards will not be discussed in the following paragraphs; only individual circuit stages will be discussed in conjunction with their particular controls, connections to the boards and clarifies individual circuit operation. Refer to figure 4-2 for an illustration of each board assembly.

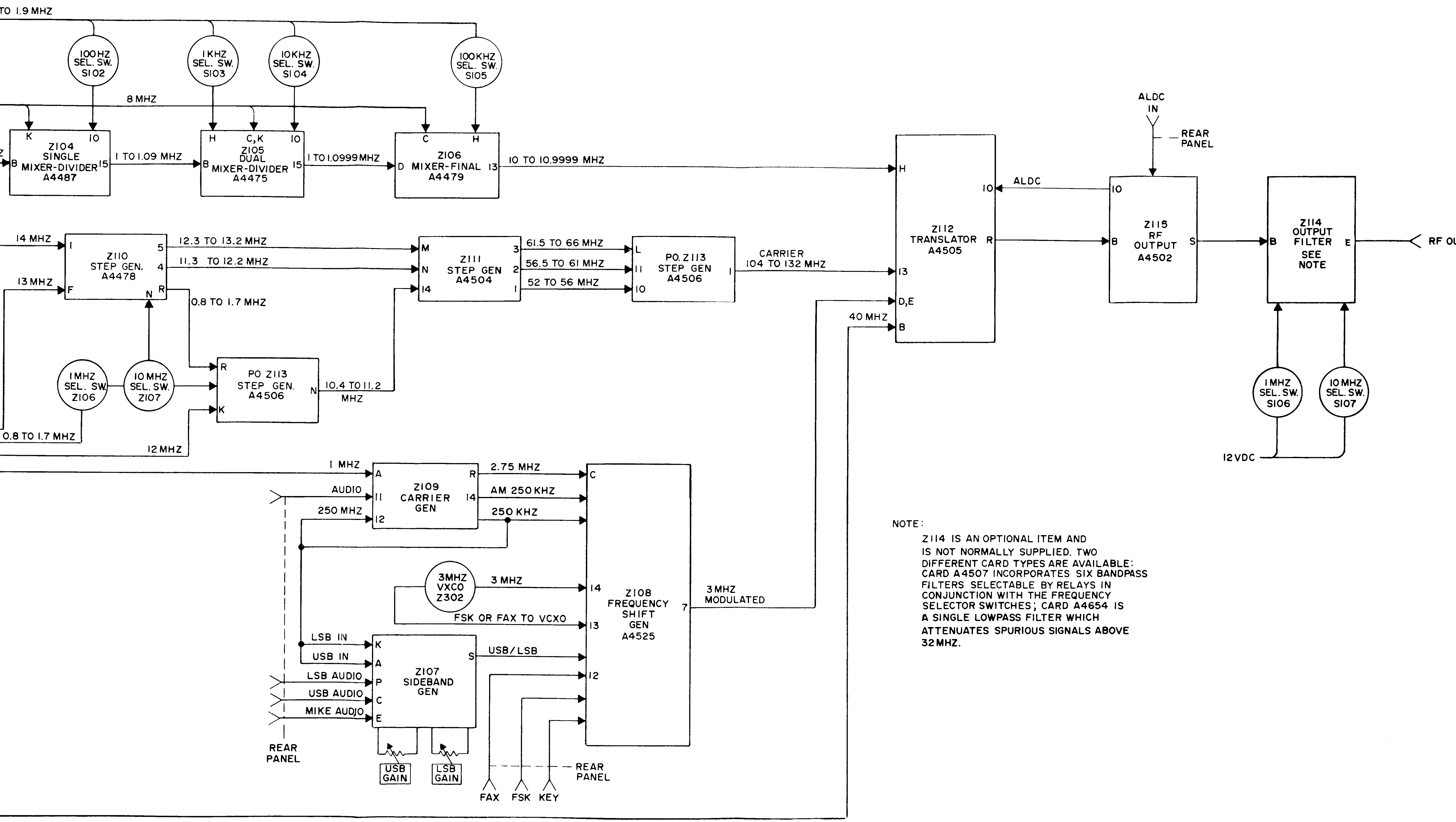
a. POWER SUPPLY ASSEMBLY. Three subassemblies are incorporated into the power supply; namely, rectifier and filter capacitor board (A) Z304, regulator Z303, and heat sink Z305. Also included are power transformer T301, 1 MHz standard oscillator Z301 and 3 MHz VXCO Z302. Input power of either 115 or 230 vac is supplied to power transformer T301 via power input jack J116 and line fuses F101 and F102. For 115-volt operation, the primaries of T301 are connected in parallel and line fuses of 1.0 ampere value are used; for 230-volt operation, the primaries of T301 are connected in series and fuse value is 0.5 ampere. The secondary output voltages are rectified and applied to the voltage regulator boards. Output voltages are +12V, +24V and +30V.

b. SPECTRUM GENERATOR Z101. The 1 MHz frequency from the standard is coupled into the board via pin 5 and simultaneously applied to the 1 MHz output amplifier, the 1 MHz squarewave generator and a 1 MHz clipper circuit. The 1 MHz output amplifier is a single stage tuned amplifier that couples the 1 MHz standard signal directly to the 1 MHz OUT jack J120 on the rear panel and through an isolation resistor to the 1 MHz MON jack J121 on the rear panel. The 1 MHz signal is coupled through LEVEL ADJ potentiometer R60 to the single mixer-divider board Z104. The 1 MHz squarewave generator is a two stage overdriven amplifier that produces an output squarewave from an input 1 MHz sinewave; the squarewave is rich in harmonics and is used to shock excite four harmonic crystals: 8 MHz, 12 MHz, 13 MHz and 14 MHz. The 8 MHz signal is amplified and multiplied by five to produce the 40 MHz basic signal. The 12 MHz, 13 MHz and 14 MHz basic signals are amplified and coupled out to the step generator boards for derivation of the two significant digit frequencies as previously explained in paragraph 4-2. The 1 MHz clipper circuit conditions the 1 MHz sinewave for application to a divide-by-10 integrated circuit. The divided 100 kHz signal is amplified and coupled out an emitter-follower circuit to the two comb filter boards Z102 and Z103.

c. COMB FILTERS Z102, Z103. These boards each contain six harmonic crystals and their associated tuned amplifier circuits. These are shock-excited by the 100 kHz squarewave from the spectrum generator board. Each tuned output stage has a LEVEL ADJ potentiometer to adjust the amplitude of the basic frequency signals.

d. MIXER-DIVIDERS Z104, Z105 AND MIXER-FINAL Z106. These boards contain almost identical circuits with the following exceptions: (1) the mixer-divider board Z104 contains only one channel whereas dual mixer-divider board Z105 contains two identical channels and (2) these two boards incorporate a divide-by-ten integrated circuit at their output, the mixer-final board does not incorporate a divide-by-10 integrated circuit. These boards function as previously explained in paragraph 4-2.

e. SIDEBAND GENERATOR ASSEMBLY Z107. The sideband generator includes upper and lower sideband circuits which are similar in configuration and operation; the exception is the tuned frequency of the USB and LSB amplifier circuits. The sideband generator also contains a microphone audio preamplifier, and an audio impedance-matching transformer for translation of externally applied 600-ohm USB/LSB line audio to a 500-ohm audio output. When a microphone input is used, the front panel EXCITER switch is set to the press-to-talk (PTT) position to furnish a PTT ground enable to the carrier generator via the mode switching network; in all other modes, the EXCITER switch is set to the ON position, which supplies a permanent ground to the same point, except in the case of CW. Microphone audio from 300 Hz to 7.5 kHz is applied to the sideband generator audio preamplifier circuit, and then to the mode switching network for redistribution to either, or both, of the sideband generator modulator circuits. Similarly, 600-ohm line audio from 350 Hz to 3.5 kHz is translated to a 500-ohm line output and applied to the mode switching network. In the USB, LSB and ISB



NOTE:

Z114 IS AN OPTIONAL ITEM AND IS NOT NORMALLY SUPPLIED. TWO DIFFERENT CARD TYPES ARE AVAILABLE: CARD A4507 INCORPORATES SIX BANDPASS FILTERS SELECTABLE BY RELAYS IN CONJUNCTION WITH THE FREQUENCY SELECTOR SWITCHES; CARD A4654 IS A SINGLE LOWPASS FILTER WHICH ATTENUATES SPURIOUS SIGNALS ABOVE 32 MHZ.

Figure 4-2. Exciter, Block Diagram

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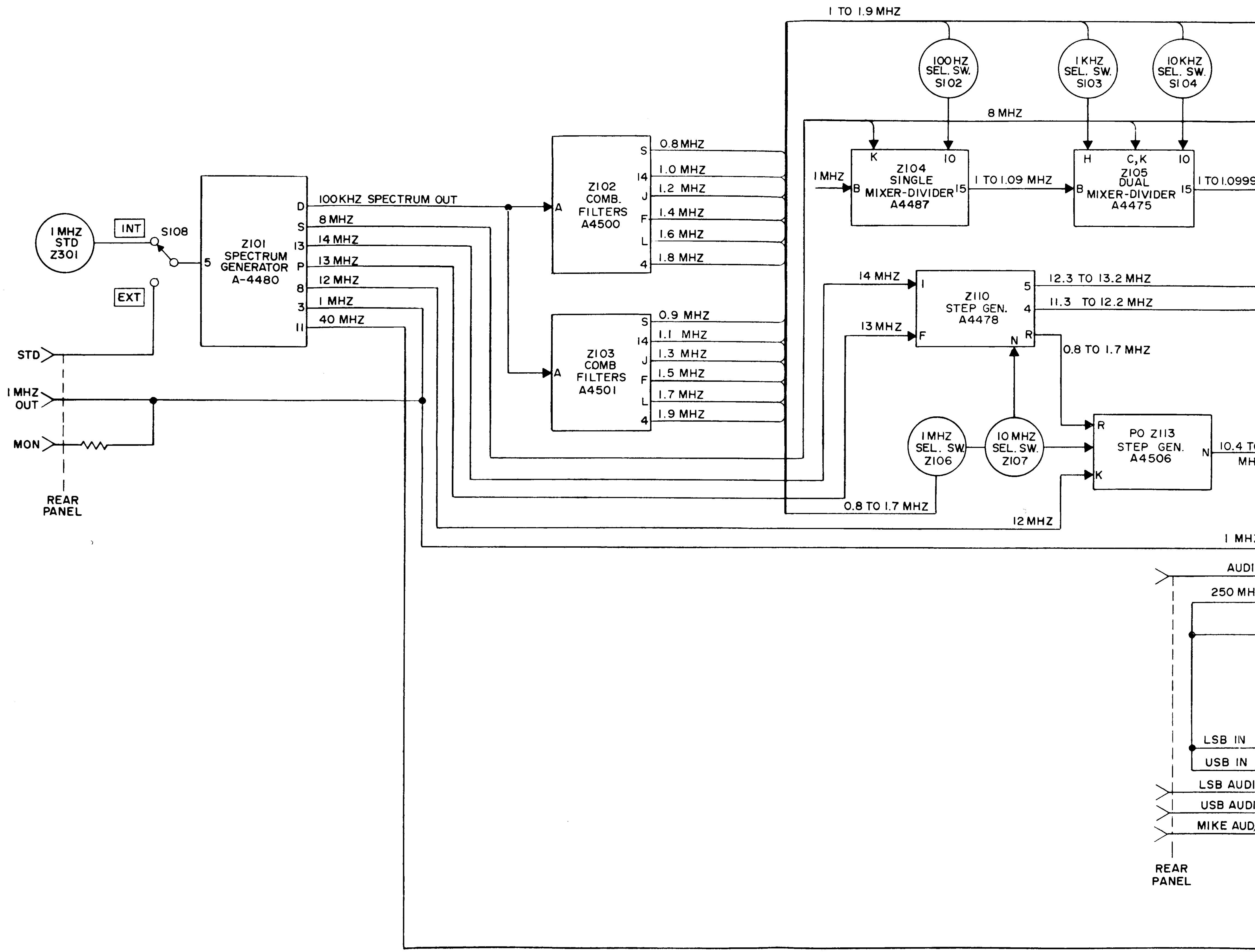

1 MHZ STD Z301
INT
EXT
S108
STD
1 MHZ OUT
MON
REAR PANEL
Z101 SPECTRUM GENERATOR A-4480
100KHZ SPECTRUM OUT
8 MHZ
14 MHZ
13 MHZ
12 MHZ
1 MHZ
40 MHZ
Z102 COMB. FILTERS A4500
0.8 MHZ
1.0 MHZ
1.2 MHZ
1.4 MHZ
1.6 MHZ
1.8 MHZ
Z103 COMB FILTERS A4501
0.9 MHZ
1.1 MHZ
1.3 MHZ
1.5 MHZ
1.7 MHZ
1.9 MHZ
1 TO 1.9 MHZ
100HZ SEL. SW. S102
1KHZ SEL. SW. S103
10KHZ SEL. SW. S104
8 MHZ
Z104 SINGLE MIXER-DIVIDER A4487
1 TO 1.09 MHZ
Z105 DUAL MIXER-DIVIDER A4475
1 TO 1.0999
Z110 STEP GEN. A4478
12.3 TO 13.2 MHZ
11.3 TO 12.2 MHZ
0.8 TO 1.7 MHZ
1 MHZ SEL. SW. Z106
10 MHZ SEL. SW. Z107
PO Z113 STEP GEN. A4506
10.4 T
MH
0.8 TO 1.7 MHZ
12 MHZ
1 MH
AUDI
250 MH
LSB IN
USB IN
LSB AUDI
USB AUDI
MIKE AUD
REAR PANEL

modes, the audio is routed to the modulation input of the respective, or each, sideband generator; in the AM mode, the respective audio signal is applied to the AM amplifier in carrier generator Z109. USB and LSB audio amplitude is controlled by a respective front panel MIKE/LINE gain control.

The SSB modulation section of the sideband generator accepts both a 250 kHz subcarrier input and the USB/LSB audio signal via the MODE switch. These two signals are applied to a balanced modulator to derive the upper and/or lower sideband intelligence; the 250 kHz subcarrier is suppressed. The resulting USB and/or LSB signals are supplied to the mode switching network and are then routed to the converter section of frequency shift generator Z108.

f. FREQUENCY SHIFT GENERATOR ASSEMBLY Z108. The frequency shift generator consists of two sections: namely, the frequency shift generator section and the converter section. The frequency shift generator section operates in the frequency shift keyer (FSK) and facsimile (FAX) modes; it contains a 3 MHz amplifier, a keyer-modulator and dc amplifier section, and the FAX circuit. FSK operation is controlled by the SHIFT and FS LOOP switches. The converter section operates in all other modes except FSK and FAX, and functions to produce an amplitude-modulated (AM) or single sideband (SSB) rf carrier of 3 MHz for use in frequency translator Z112.

Selecting the FSK mode applies the 250 kHz subcarrier to the keyer modulator, which also receives an external teletype input via the FS LOOP switch. Therefore, the subcarrier is effectively modulated by a current input representing teletype marks and spaces; the FS LOOP switch network is set to the appropriate voltage rating, and when a dry-contact keyer is used, the switch is set to the contact (CONT) position. The keyer-modulator thus produces a shift in frequency above and below the 250 kHz center frequency. This shift is rectified and translated to a dc level, which is then amplified and applied to the 3 MHz variable crystal-controlled oscillator (VXCO) in the power supply assembly via the SHIFT switch network.

Selecting FSK or FAX operation supplies +12 vdc to both the frequency shift generator and to the VXCO in the power supply assembly. The VXCO will operate at the center frequency of 3 MHz. Upon application of the variable dc level (E MOD) from the SHIFT switch, the frequency of the VXCO is shifted above and below center frequency, corresponding to respective marks and spaces, by an amount determined by SHIFT switch setting (±42.5, ±85, ±170, ±425). The frequency-shifted VXCO signal of 3 MHz is re-applied to the 3 MHz VXCO amplifier section of the frequency shift generator and then to the 3 MHz amplifier circuit of the converter section. Selecting FAX operation connects an externally applied FAX signal through a dc regulator circuit. This produces a variable dc level which is applied to the VXCO to produce the required frequency shift.

The converter section of Z108 accepts the 2.75 MHz carrier from carrier generator Z109; the 250 kHz AM, USB, LSB, ISB or CW input from the mode switching network; or the 3 MHz VXCO input from the 3 MHz VXCO amplifier in the frequency shift generator section.

In the AM mode, the 2.75 MHz carrier and the amplitude-modulated 250 kHz signal are mixed in a balanced modulator to produce a sum amplitude-modulated carrier of 3 MHz, which is amplified and applied to translator Z112. In the USB, LSB and ISB modes, the input signals consist of the 2.75 MHz carrier and USB and/or LSB audio with, or without, the 250 kHz signal, depending upon the amount of carrier suppression introduced by the CARRIER control network. This control permits continuously variable carrier reinsertion from zero (0) to full by attenuating the 250 kHz input from the mode switching network. The attenuated 250 kHz subcarrier from the CARRIER control is applied to the mode switching network, where it is reinserted with the USB and/or LSB audio as a pilot carrier prior to being sent to the converter section of Z108. Therefore, the 250 kHz USB, LSB or ISB signal is mixed with the 2.75 MHz carrier to again produce a single sideband or independent sideband output with a 3 MHz center frequency.

In the CW mode, the 250 kHz input is interrupted at the keyer rate and thus results in a 3 MHz CW output. In the FSK and FAX modes, the 250 kHz and 2.75 MHz inputs are not present; the only input is the 3 MHz VXCO signal from the frequency shift generator 3 MHz amplifier section, which is further amplified in the converter section and then applied to translator Z112. A keying relay is energized whenever the EXCITER switch is set to the ON position. As a result, when the CW mode is selected, the ground from the external key is coupled through the MODE switch and the normally-closed contacts of the relay to both the carrier generator and the translator, thereby initiating CW operation.

g. CARRIER GENERATOR ASSEMBLY Z109. The carrier generator develops a basic subcarrier frequency of 250 kHz, and a 2.75 MHz carrier frequency; it also contains a meter amplifier circuit for upper and lower sideband audio translation to an equivalent level for display on the MONITOR meter, when USB or LSB audio is selected by the METER switch. In addition, an AM amplifier circuit provides an audio amplitude-modulated 250 kHz output when the AM mode of operation is selected.

The carrier generator receives a 1 MHz standard frequency input which is supplied to both the 250 kHz and 2.75 MHz frequency generation circuits. In the 250 kHz channel, the 1 MHz input is divided by 4 to derive the basic 250 kHz subcarrier frequency; a switched ground enable is applied from the mode switching network in the AM, USB, LSB, ISB and FSK modes to enable a 250 kHz subcarrier output signal; in the CW mode, the ground enable is interrupted at the key rate, thereby producing a 250 kHz CW output. The 250 kHz output is applied to the mode switching network for distribution to the various sections of the Exciter in accordance with the MODE switch setting, and to the CARRIER control network for carrier reinsertion, when desired. In the FAX mode, the 250 kHz channel is disabled.

The 2.75 MHz channel produces an rf output by dividing the 1 MHz input by 4 and then multiplying the resultant by 11 to derive the 2.75 MHz translation frequency. Switched +12 vdc to this channel and to the AM amplifier section is controlled by the MODE switch and is present in the AM, USB, LSB, ISB and CW positions. The 2.75 MHz output is supplied to the converter section of the frequency shift generator.

The AM amplifier section develops an amplitude-modulated 250 kHz signal in the AM mode of operation, and consists of an audio amplifier and mixer circuit. In the AM mode, USB and/or LSB audio is routed to the audio amplifier stage and then to the mixer; the 250 kHz subcarrier is applied directly to the mixer. The resultant amplitude-modulated 250 kHz signal is then routed through the AM position of the MODE switch to the converter section of frequency shift generator Z108.

h. STEP GENERATOR ASSEMBLY Z110. The step generator board Z110 contains three single stage input amplifiers, two mixers and four 3-stage bandpass amplifiers. The basic frequencies, 13 MHz and 14 MHz, are mixed with the selected mixing frequency (0.8 MHz to 1.7 MHz) to produce the required difference frequencies as previously specified in tables 4-1 and 4-2. The required channel is energized by switching ground and B+ (12V) to the channel via the 10 MHz selector switch. Each input amplifier is provided with a separate LEVEL ADJ potentiometer. The mixing frequency input amplifier (0.8 to 1.7 MHz) is always energized since the amplifier output is also coupled to step generator board Z113 for the 14 MHz mixer channel which is incorporated on that board.

i. STEP GENERATOR ASSEMBLY Z111. The step generator board Z111 contains three X5 multipliers, three bandpass filters and three tuned rf amplifiers. The required channel is energized by switching B+ (12V) to the channel via the 10 MHz selector switch. The function of each of these channels is shown in figure 4-1; the particular mixing frequency for each frequency step selection is specified in tables 4-1, 4-2 and 4-3 for the three frequency bands.

j. STEP GENERATOR ASSEMBLY Z113. The step generator board Z113 contains the 12 MHz mixer-bandpass amplifier channel, three X2 multipliers, three bandpass amplifiers and a summing amplifier. The basic 12 MHz frequency is mixed with the selected mixing frequency (0.8 to 1.7 MHz) to produce the required difference frequencies as previously specified in table 4-3. The X2 multipliers function as shown on figure 4-1 to produce the carrier mixing frequency to the input of the translator board Z112; each of these carrier mixing frequencies are specified in tables 4-1, 4-2 and 4-3. The outputs of the X2 multipliers are amplified by three 3-stage tuned bandpass amplifiers and resistively summed at the base input of a single stage amplifier. The output of this amplifier is then coupled to the translator.

k. TRANSLATOR ASSEMBLY Z112. The translator board Z112 contains a three stage 40 MHz tuned amplifier, an X3 multiplier which multiplies the 40 MHz to 120 MHz, a two stage 120 MHz amplifier, a 10 to 11 MHz input amplifier, a balanced mixer circuit which combines the modulated 3 MHz signal with the 10 to 10.9999 MHz least significant digits frequency, a two-stage 13 to 13.5 MHz tuned amplifier and a two-stage 13.5 to 14 MHz amplifier, three-stage ALDC amplifier which produces a dc level to control gain of the 13 to 13.5 MHz and 13.5 to 14 MHz amplifiers, a sum mixer which mixes the 13 to 14 MHz signal with the 120 MHz frequency to produce a 133 to 134 MHz signal, a four-stage 133.5 tuned amplifier, a difference mixer to mix the 133 to 134 MHz signal with the selected carrier frequency (104 to 132 MHz) to produce the final rf carrier frequency (1.5 to 29.9999 MHz), and a single-stage rf amplifier to match the rf carrier to the output.

l. RF OUTPUT ASSEMBLY Z115. The rf output board Z115 contains three tuned rf stages that provide a nominal 20 dB gain across the complete rf frequency bandwidth (1.5 MHz to 29.9999 MHz). A diode detector and associated filtering network provide an automatic level dc voltage (ALDC) as a function of rf output strength; this dc level can be adjusted from zero to -11 volts by the ALDC ADJ potentiometer on the rear panel of the Exciter. Additionally, an external minus ALDC level can be coupled in the ALDC connector J123 on the rear panel to be summed with the internal ALDC level; this allows control of the rf output from an external linear power amplifier to improve linearity and limit distortion. Each rf stage has an individual BIAS ADJ potentiometer; these are set while monitoring the current flow through each stage to adjust each stage for optimum performance.

m. OUTPUT FILTER ASSEMBLY Z114 (A4507). The output filter board A4507 contains six L-C bandpass filter networks; each filter network is selected by an associated 30 vdc relay. The filters provide the following frequency ranges:

K1	1.6 MHz to 2.5 MHz
K2	2.5 MHz to 4.0 MHz
K3	4.0 MHz to 7.0 MHz
K4	7.0 MHz to 12.0 MHz
K5	12.0 MHz to 20.0 MHz
K6	20.0 MHz to 29.9999 MHz

n. OUTPUT FILTER ASSEMBLY Z114 (A4654). The output filter board A4654 contains one L-C low-pass filter network which attenuates spurious signals above 32 MHz.

NOTE

If neither output filter Z114 is installed, the rf output is by-passed to the RF OUT jack.

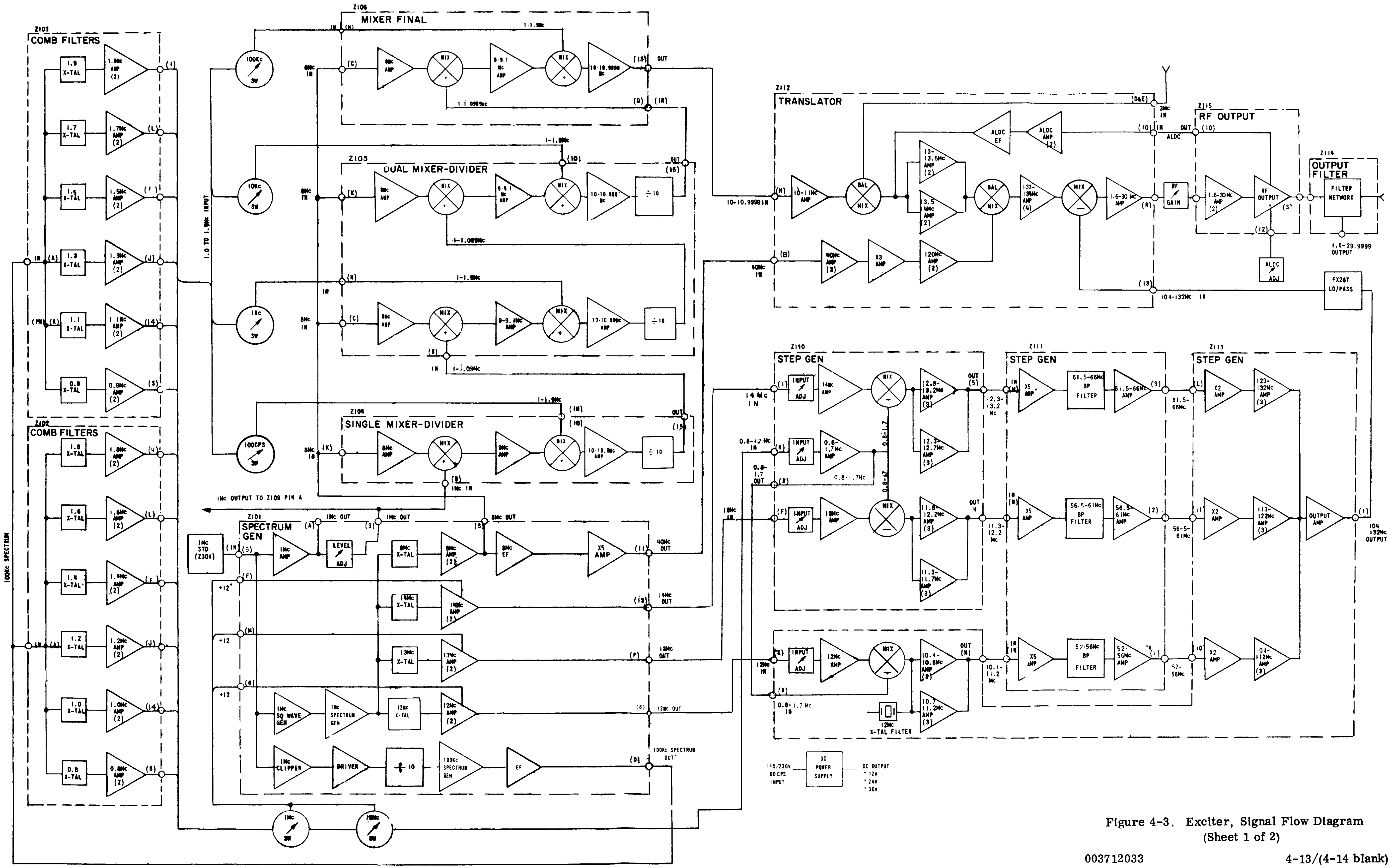

Figure 4-3. Exciter, Signal Flow Diagram
(Sheet 1 of 2)

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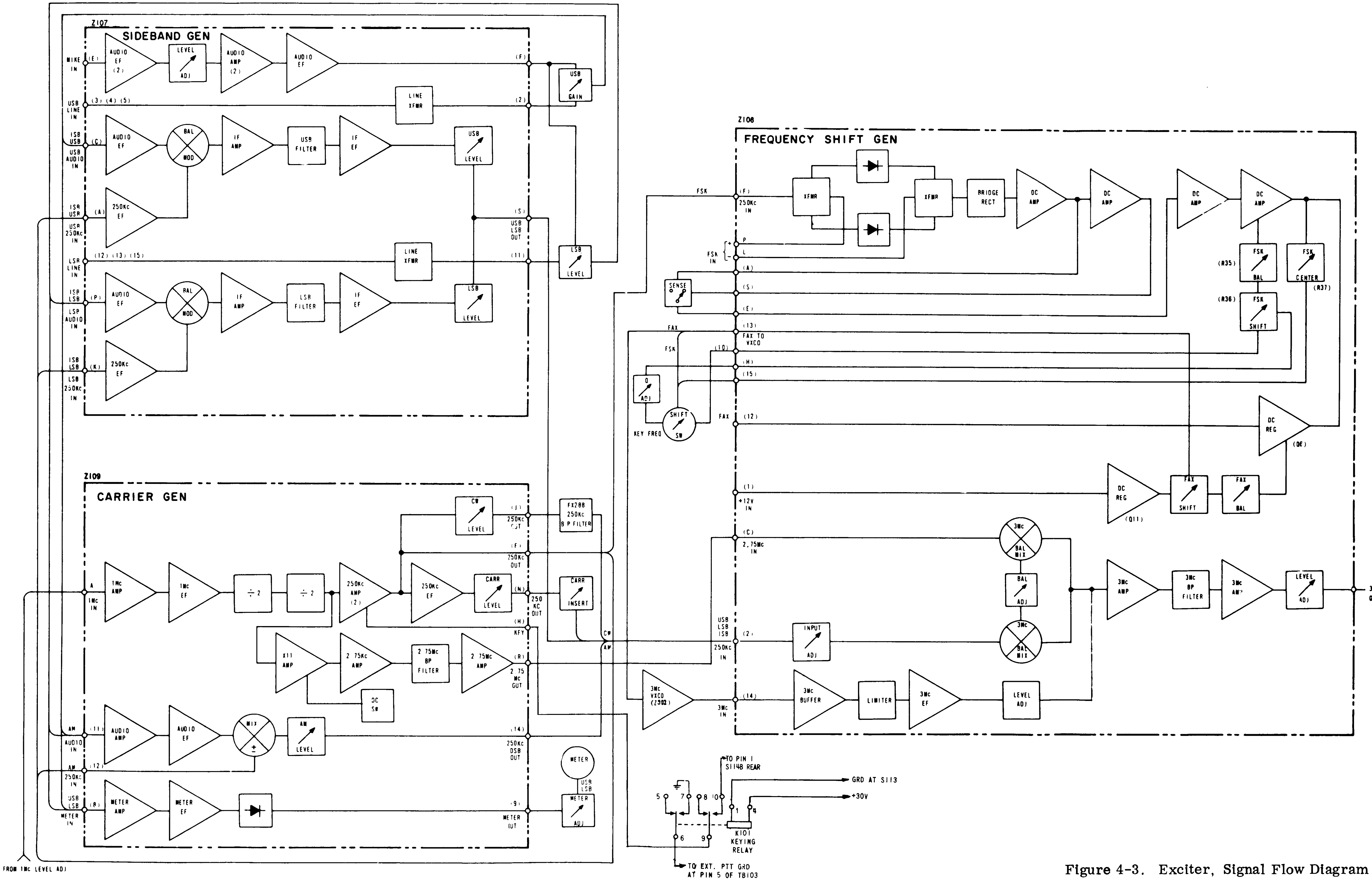

Figure 4-3. Exciter, Signal Flow Diagram
(Sheet 2 of 2)

SECTION 5

MAINTENANCE

5-1. PREVENTIVE MAINTENANCE

The following paragraphs describe procedures to inspect, check and clean the components of the MMX(M)-2. In general, preventive maintenance provides a basis for recognizing future probable causes of equipment malfunction in the early stages of deterioration. Many such causes are apparent to the senses of sight, touch and smell. Therefore, by adhering to a stringent program of preventive maintenance, involving periodic inspection and checks, the most probable causes of equipment malfunction can be avoided, thereby minimizing equipment downtime and the possibility of compromising important schedules. Paragraph 5-3b presents a listing of test equipment required for MMX(M)-2 maintenance.

a. INSPECTION AND TEST. The following paragraphs describe equipment inspection and power supply checks to be performed on a weekly basis.

(1) General Inspection. A most important and least expensive tool in the preventive maintenance program is the sense of sight; a thorough visual inspection of an assembly or component for tell-tale signs of deterioration prior to failure can save hours of test and troubleshooting time after a complete breakdown. Table 5-1 presents a weekly inspection checklist for the MMX(M)-2.

TABLE 5-1. WEEKLY INSPECTION ROUTINE

Assembly or Subassembly	Check
Line Power Cord	Check three-wire line power cord for cracks, nicks or fraying.
Main Chassis Assemblies	1. Check underside of chassis for dirt and dust.
	2. Check all inter-connector wiring for nicks, cracks or fraying.
	3. Check all printed circuit boards for cracks; check components for looseness and evidence of deterioration from possible overheating.
	4. Check printed circuit board jacks for tightness against chassis.
	5. Check ground connections for security.
Front and Rear Panels	1. Check panel for general cleanliness.

TABLE 5-1. WEEKLY INSPECTION ROUTINE (Cont)

Assembly or Subassembly	Check
Front and Rear Panels (Cont)	2. Check all control knobs for smooth action from limit-to-limit. Check all switches for positive action. 3. Check MONITOR meter face for cracks, scratches, etc. 4. Check indicator faces for cracks. 5. Remove line fuses and check for proper 1-ampere or 0.5-ampere value and condition (0.5-ampere with 230 vac line). 6. Check all input/output jacks for security against panel.

(2) Power Supply Checks. Perform the power supply checks on a weekly basis as follows:

(a) Disconnect the line power cord from the 115 or 230 vac source.

(b) Unplug power supply regulator board Z303 from its receptacle at the rear center of the chassis; insert the small extender board in the vacated receptacle and mount the regulator board on the extender board.

(c) Place POWER switch on front panel to ON position. Connect line power cord to 115 or 230 vac source as applicable.

(d) Using a VTVM, or equivalent, check dc voltage at pin F of Z303; voltage should be +12 vdc ±1%.

(e) Check voltage at pin 4 of Z303; voltage should be +24 vdc ±1%.

(f) Check voltage at pin 3 of Z303; voltage should be +30 vdc ±1%.

(g) Remove line cord from power source, and replace regulator board into mating jack J303 after removing extender board.

(3) Functional Test. Perform the checkout procedure for the MMX(M)-2 outlined in Section 2, paragraph 2-5, on a weekly basis, after a check has been made of the power supplies.

b. <u>CLEANING INSTRUCTIONS</u>. In general, the MMX(M)-2 should be cleaned once a month, using a soft camel's hair brush, forced air pressure of not more than 20 psi and a suitable cleaning agent such as trichlorethylene or methylchloroform.

WARNING

When using toxic solvents, make certain that adequate ventilation is provided; prolonged or repeated breathing of the vapor shall be avoided. Avoid prolonged or repeated contact with skin. Flammable solvents shall not be used on energized equipment or near other equipment from which a spark may be received.

CAUTION

TRICHLORETHYLENE CONTAINS A PAINT REMOVING SOLVENT; AVOID CONTACT WITH PAINTED SURFACES.

Remove dirt or grease from wiring and chassis surfaces using cleaning solvent; dry with compressed air. Remove dust from printed circuit boards using a soft camel's hair brush. Blow out accumulated dust from inaccessible areas of chassis using forced air.

5-2. TROUBLESHOOTING

The circuits of the MMX(M)-2 are contained on PC boards accessible from the top of the chassis. The card Zxxx numbers are the circuit reference designation prefix. Numbers prefixed with an "A" are the PC assembly part numbers by which they are identified and ordered. The "Z" prefix number is silkscreened both on the card and on the chassis adjacent to the PC board receptacle. Some PC boards in the MMX(M)-2 and in other TMC equipment, although they are assigned different "Z" designations, have the same assembly "A" prefix and are thus identical and interchangeable. These PC boards have similar keying at their plug ends and mating receptacles. The power supply assembly heat sink is mounted against the rear wall of the chassis; the smaller power supply boards are mounted forward of the heat sink and are removable.

In general, a malfunction of the MMX(M)-2 will usually manifest itself by lack of, or improper readings on the MONITOR meter, and can be quickly localized to a particular printed circuit board by the logical process of elimination. If a second MMX(M)-2 is obtainable, or a set of spare PC boards is available, troubleshooting can be facilitated by the board substitution method. In some instances, a particular board may require alignment or adjustment as outlined in paragraph 5-3. Table 5-2 presents a troubleshooting chart for the MMX(M)-2; figures 5-1 and 5-2 show respective top and bottom views of the equipment.

TABLE 5-2. TROUBLESHOOTING CHART

Step	Trouble	Probable Cause	Remedy
1	No rf output at any selected frequency.	Check that POWER indicator is illuminated with POWER switch ON.	If lamp is not illuminated, check power supply voltages as outlined in paragraph 5-1 a.(2). If lamp is illuminated, proceed to step 2.
2		Check that STD switch is set to INT.	Set switch at INT. If switch is at INT, proceed to step 3.
3		Check for normal display on MONITOR with METER switch in Q1, Q2 and Q3 position.	If all readings are normal, proceed to step 4. If any reading is abnormal, replace Z115.
4		Check for 1 MHz output at 1 MHz MON jack on rear chassis.	If 1 MHz is present, proceed to step 5. If 1 MHz is not present, check for 1 MHz output at J302 on the power supply assembly. If not present, replace 1 MHz standard Z301.
5		Check for 8, 12, 13, 14 and 40 MHz from 1 MHz spectrum generator on Z101.	If present, proceed to step 6. If not replace Z101.
6		Check for 100 kHz spectrum output at pin D of Z101.	If present, proceeu to step 7. If not replace Z101.

TABLE 5-2. TROUBLESHOOTING CHART (Cont)

Step	Trouble	Probable Cause	Remedy
7		Check for 3 MHz input to translator Z112, pin D.	If not present, proceed to step 8. If present proceed to step 9.
8		Check for 2.75 MHz, 250 kHz or 3 MHz input to frequency shift generator Z108, pin C.	If not present, replace Z109. If present, replace Z108.
9		Check for 10-11 MHz, 40 MHz, and 104 to 132 MHz input to translator Z112.	If 10-11 MHz input is missing, check final mixer Z106. If 40 MHz is missing, check spectrum generator Z101. If 104 to 132 MHz input is missing, check step generator Z113. If all inputs to translator Z112 are present, and still no output, replace Z112.

5-3. ALIGNMENT PROCEDURES AND EQUIPMENT REQUIRED

The following paragraphs present alignment procedures on a PC card level required to maintain the Exciter in a satisfactory operating condition. Table 5-3 presents a listing of test equipment required for complete alignment of the Exciter.

TABLE 5-3. TEST EQUIPMENT REQUIRED

Equipment	Manufacturer
Signal Generator	Hewlett-Packard Model 606B, or equivalent
Oscilloscope	Tektronix, Model 541A, or equivalent
Spectrum Analyzer	Lavoie Laboratories, Inc. Model LA-40A, or equivalent
Audio Generator	Hewlett-Packard Model 200 CD, or equivalent
VTVM	Ballantine Model 314, or equivalent
RF VTVM	Hewlett-Packard Model 411A
Frequency Counter	Hewlett-Packard Model 5244L, or equivalent
Attenuator	Telonic Model D-950 or equivalent
Millivolt Meter	Millivac Model MV-28B, or equivalent
VOM	Simpson 260, or equivalent

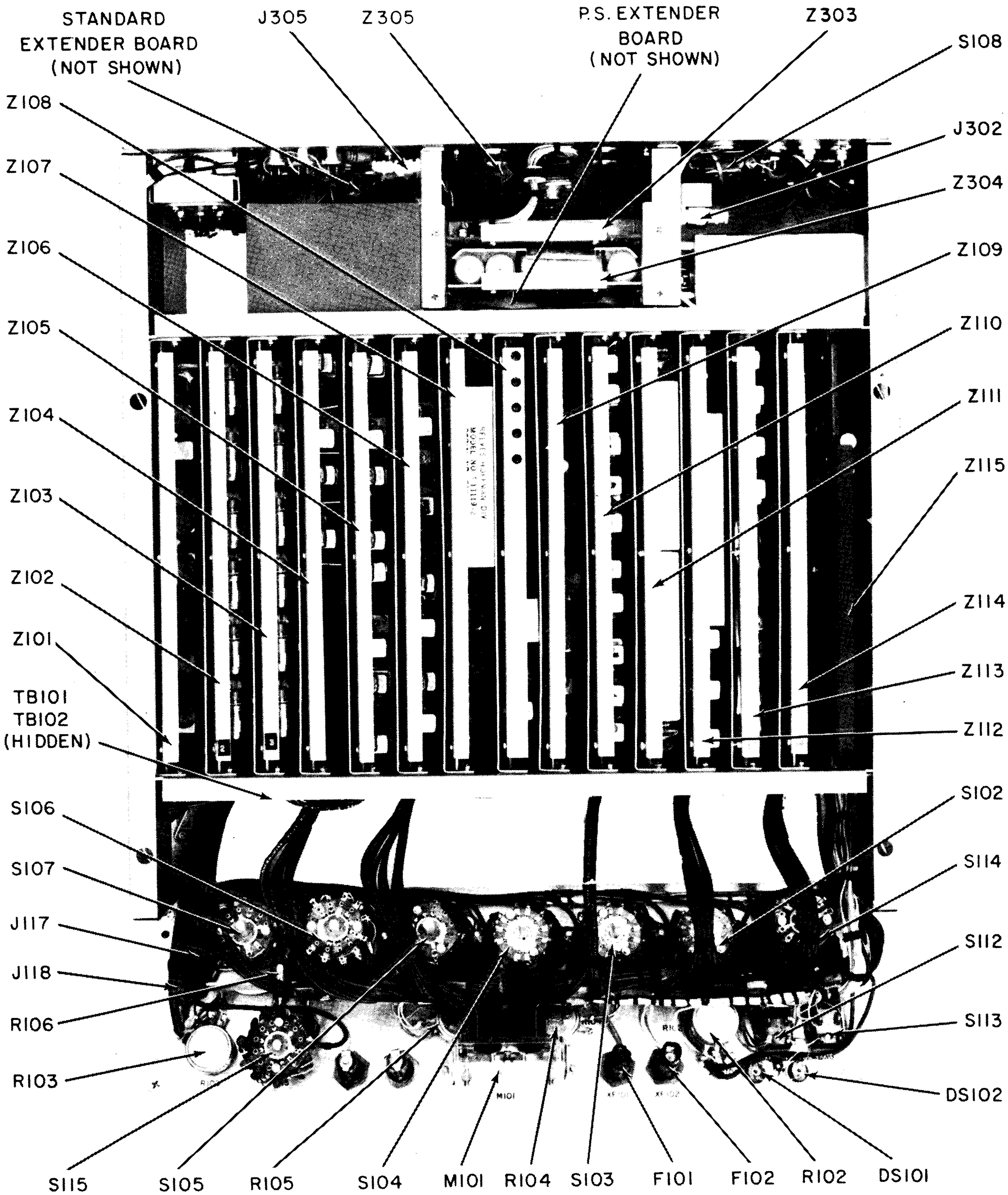

Figure 5-1. Top View, Location of Major Components

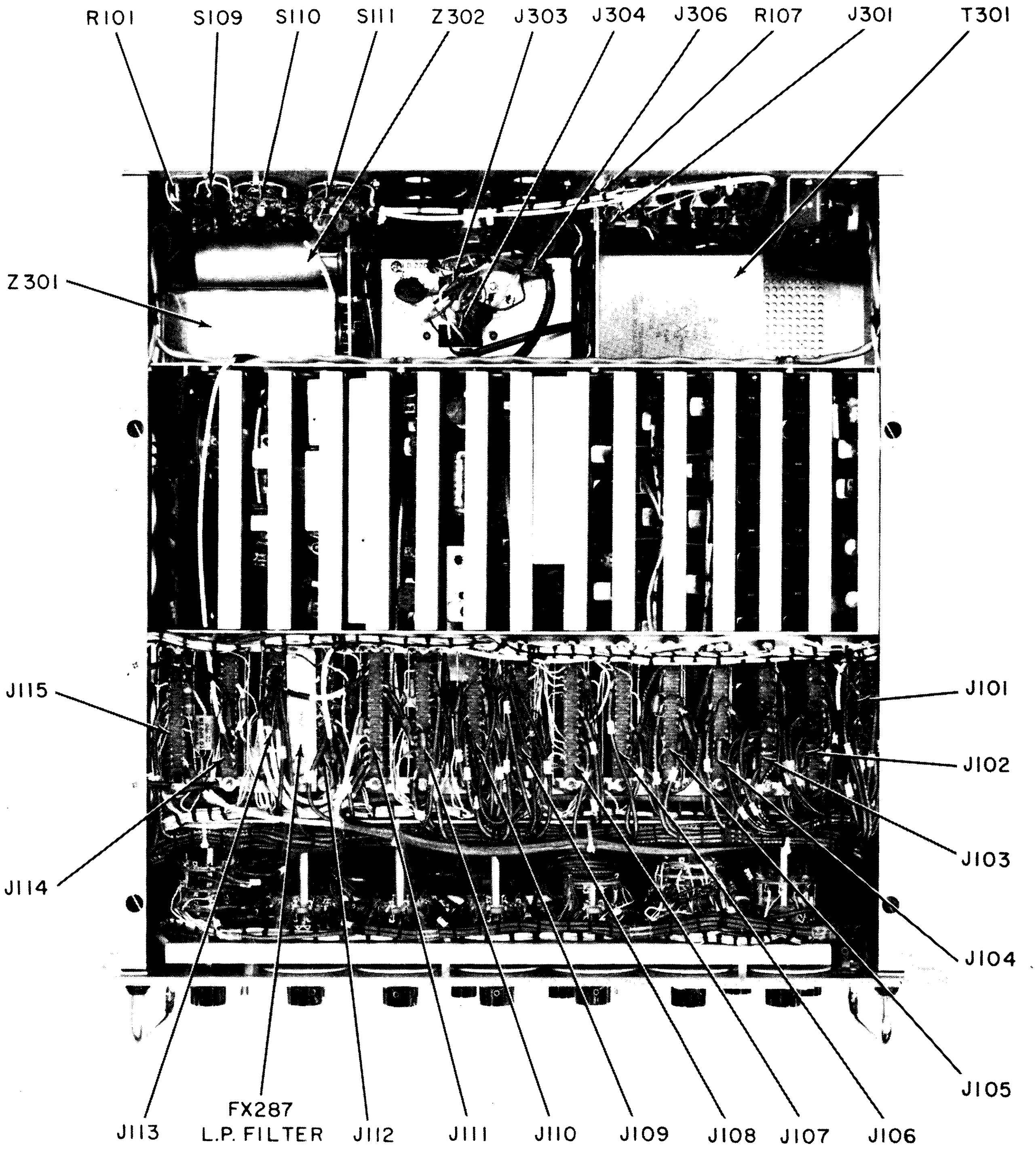

Figure 5-2. Bottom View, Location of Major Components

a. POWER SUPPLY BOARDS Z303 AND Z304 (see figure 5-3). Check the power supply boards as follows:

(1) Remove RF output card Z115.
(2) Plug in ac line cord, STANDBY indicator shall illuminate amber.
(3) Position ON/STANDBY switch to ON. POWER indicator shall illuminate red and STANDBY indicator shall extinguish.

NOTE

Allow at least 30 minutes for equipment to warm up.

(4) Connect VOM between J304 pin G (ground) and J304 pin A. Voltmeter shall indicate approximately +40 vdc.
(5) Connect VOM between J304 pin G (ground) and J304 pin E. Voltmeter shall indicate +20 volts.
(6) On board Z303, connect VOM to J303 pin E. Voltmeter shall indicate approximately +20 vdc.
(7) Connect VOM to J303 pin A. Voltmeter shall indicate approximately +40 vdc.
(8) Connect VOM between J303 pin F and ground. Voltmeter shall indicate 12.0 vdc.
(9) Remove VOM from J303 pin F and connect oscilloscope. Maximum ac ripple shall not exceed 5 mv.
(10) Connect VOM between J303 pin 4 and ground. Voltmeter shall indicate 24.0 vdc.
(11) Remove VOM from J303 pin 4 and connect oscilloscope. Maximum ac ripple shall not exceed 2 mv.
(12) Connect VOM between J301 pin E and ground. Voltmeter shall indicate +30 vdc ±1 vdc.
(13) Position ON/STANDBY switch to STANDBY.
(14) Position METER switch to Q1.
(15) Connect VOM to J115 pin J as shown in figure 5-3.
(16) Adjust potentiometer R106 (located at rear of METER switch) for equal indications on the MMX MONITOR meter and the VOM.

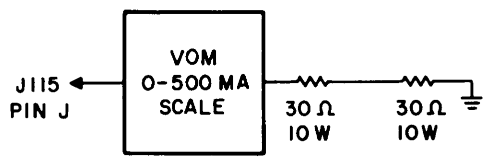

Figure 5-3. Power Supply Board Test Setup

b. SPECTRUM GENERATOR Z101. (See figure 5-4.) Align the spectrum generator board as follows:

NOTE

Place cards Z103, Z105 and Z106 into unit for 1 MHz load.

(1) For 1 MHz set STD INT/EXT switch on rear panel to INT position.
(2) Connect the oscilloscope and counter between pin A and ground and adjust T1 for maximum 1 MHz output.
(3) Connect the scope & counter to J101 pin 3, and adjust R60 for 0.6 volt P-P. 1 MHz signal output.
(4) Connect scope and counter to J101 pin 8; connect ground lead to J101 pin J. Set frequency selectors to 11.0000 MHz. Adjust T3 for maximum 12 MHz signal, amplitude should be about 0.4 volt P-P.
(5) Connect scope and counter to J101 pin P; connect ground lead to J101 pin R. Adjust T9 for maximum 13 MHz signal. The amplitude should be about 0.4 volts P-P.
(6) Connect scope and counter to J101 pin S; connect ground lead to J101 pin 15. Adjust T11 for maximum 8 MHz signal. The output should be about 1.5 volts P-P.

(7) Connect scope and counter to J101 pin 13; connect ground lead to J101 pin 12. Adjust T7 for maximum 14 MHz signal. The amplitude should be about 0.75 volt P-P.

(8) Connect Millivac MV-28B VTVM to J101 pin 11; connect ground lead to J101 pin 10. Adjust C86, C89 for maximum output, about 70 mv rms. Measure the frequency, it should be 40.0 MHz.

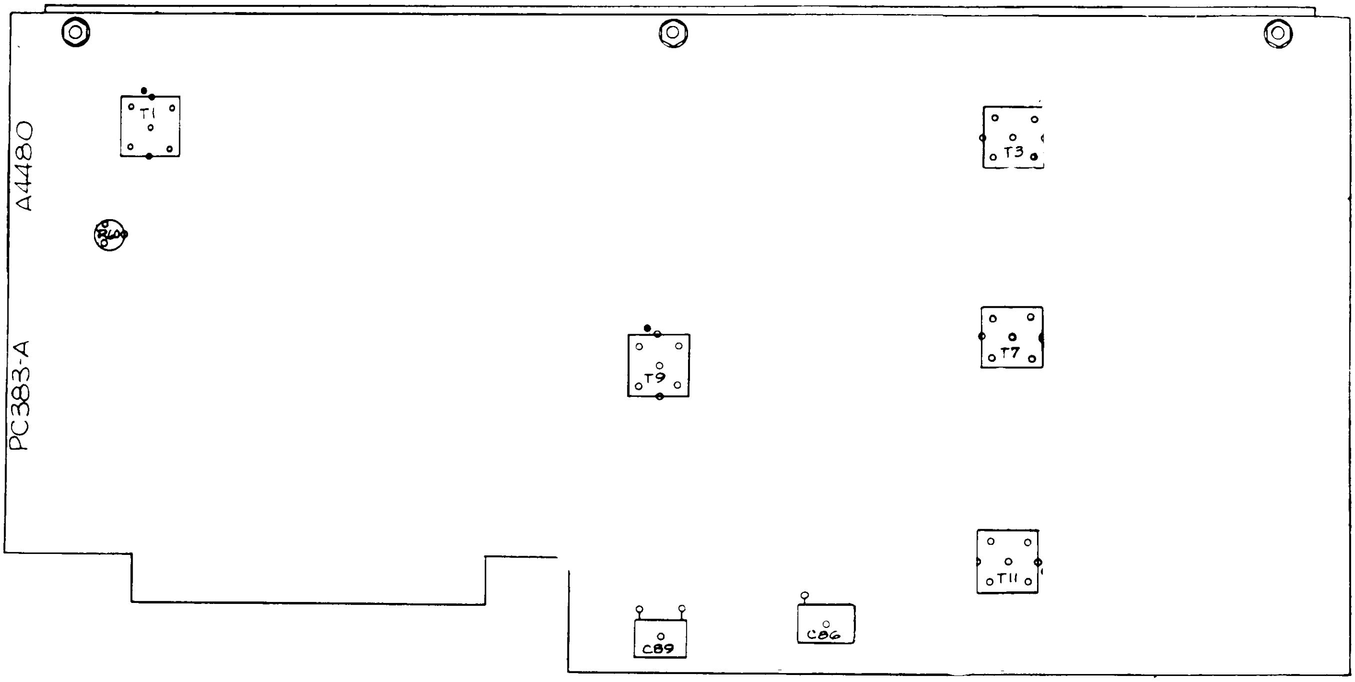

Figure 5-4. Spectrum Generator Z101, Adjustments

c. COMB FILTER Z102. (See figure 5-5.)

(1) Place 100 kHz, 10 kHz, 1 kHz, 100 Hz switches to blank positions.

(2) Connect scope and counter to TP12, ground lead to pin 15. Adjust T12 for maximum 800 kHz signal. Then adjust R42 for 0.7 volt P-P.

(3) Connect scope and counter to TP10. Adjust T10 for maximum 1.0 MHz signal; then adjust R35 for 0.7 volt P-P.

(4) Connect scope and counter to TP8. Adjust T8 for maximum 1.2 MHz signal; then adjust R28 for 0.7 volt P-P.

(5) Connect scope and counter to TP6. Adjust T6 for maximum 1.4 MHz signal; then adjust R21 for 0.7 volt P-P.

(6) Connect scope and counter to TP3. Adjust T4 for maximum 1.6 MHz signal; then adjust R14 for 0.7 volt P-P.

(7) Connect scope and counter to TP2. Adjust T1 for maximum 1.8 MHz signal; then adjust R3 for 0.7 volt P-P.

d. COMB FILTER Z103. (See figure 5-6.)

(1) Set 100 kHz, 10 kHz, 1 kHz, 100 Hz selectors to blank positions.

(2) Connect scope and counter to TP12, ground lead to pin 15. Adjust T12 for maximum 900 kHz signal; then adjust R42 for 0.7 volt P-P.

(3) Connect scope and counter to TP10. Adjust T10 for maximum 1.1 MHz signal; then adjust R35 for 0.7 volt P-P.

(4) Connect scope and counter to TP8. Adjust T8 for maximum 1.3 MHz signal; then adjust R28 for 0.7 volts P-P.

(5) Connect scope and counter to TP6. Adjust T6 for maximum 1.5 MHz signal; then adjust R21 for 0.7 volt P-P.

(6) Connect scope and counter to TP3. Adjust T4 for maximum 1.7 MHz signal; then adjust R14 for 0.7 volt P-P.

(7) Connect scope and counter to TP2. Adjust T1 for maximum 1.9 MHz signal; then adjust R3 for 0.7 volt P-P.

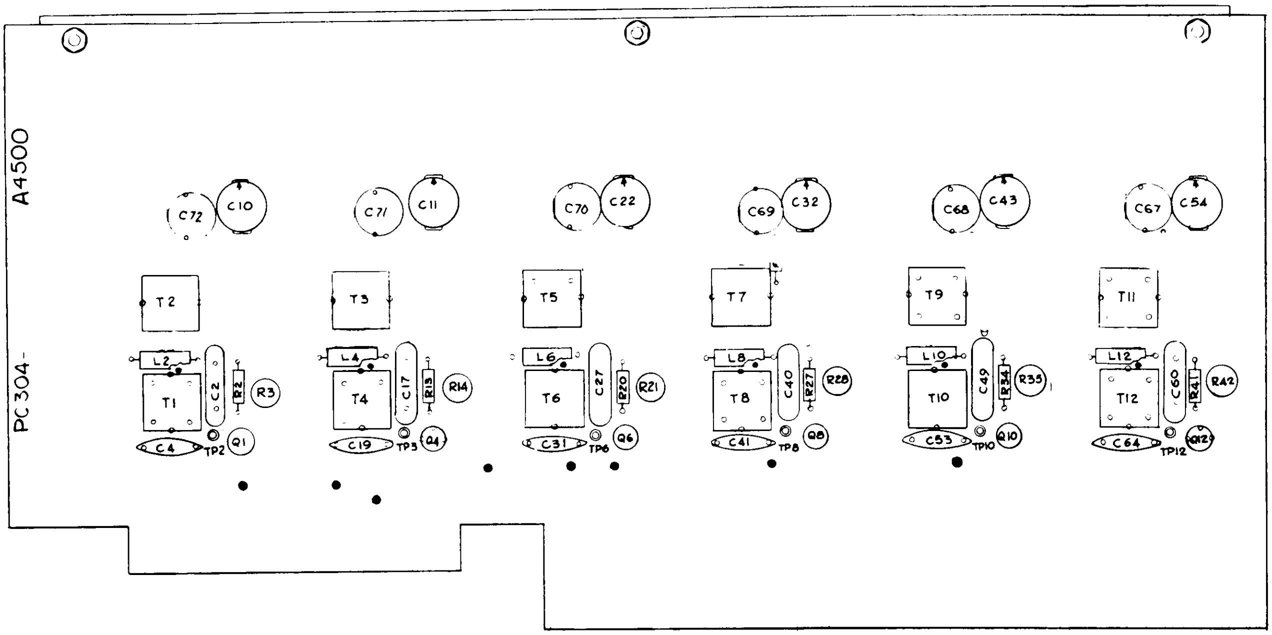

Figure 5-5. Comb Filter Z102, Adjustments

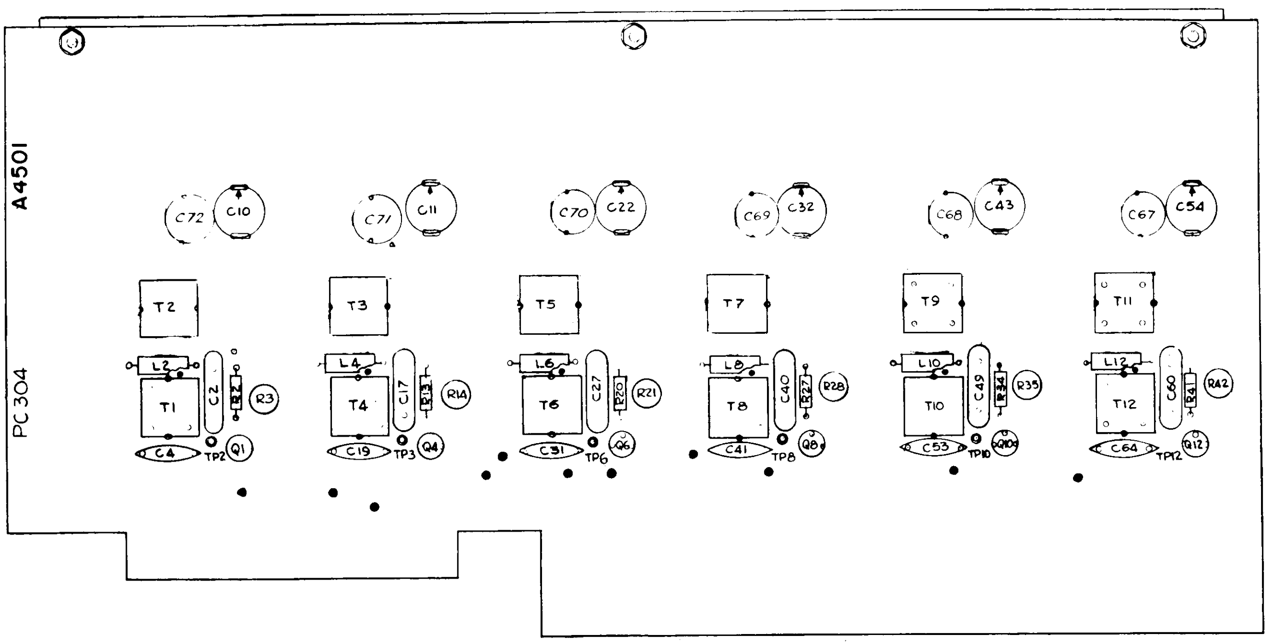

Figure 5-6. Comb Filter Z103, Adjustments

e. SINGLE MIXER-DIVIDER Z104.

(1) Set 100 kHz, 10 kHz, and 1 kHz frequency selectors to blank positions.

(2) Connect the scope and counter to J104 pin 15. Select each position of the 100 Hz selector; for all positions the signal should be 0.6 volt minimum. (1 to 1.09 MHz).

f. DUAL MIXER - DIVIDER Z105.

(1) Set 100 kHz frequency selector to a blank position.
(2) Connect scope and counter to J104 pin 15. The amplitude should be 0.6 volt P-P minimum in all 0-9 positions of the 10 kHz, 1 kHz and 100 Hz selectors. The indicated frequency should vary from 1.0 MHz to 1.0999 MHz as these selectors are rotated through their 10 positions.

g. MIXER - FINAL Z106.

(1) Connect scope and counter to J106 pin 13.
(2) Place 100 kHz, 10 kHz, 1 kHz and 100 Hz selector switches to "0". The signal should be 0.2 volt P-P minimum and the frequency should be 10.0000 MHz.
(3) Rotate the 100 Hz, 1 kHz, 10 kHz and 100 kHz selector switches to 9. The frequency should increase to 10.9999 MHz in 100 Hz, 1 kHz, 10 kHz and 100 kHz steps. The amplitude in each switch position should be 0.2 volt P-P minimum.

h. CARRIER GENERATOR Z109. (See figure 5-7.)

(1) Adjust R27 fully CCW, place STANDBY-ON switch to ON and MODE switch to AM position.
(2) Connect scope and counter to TP1. The signal should be 1 MHz, 10 volt P-P.
(3) Connect scope and counter to TP4. The signal should be 250 kc, 1.4 volt P-P (approximately).
(4) Connect scope and counter to TP7. The signal should be 2.75 MHz. Adjust R47 for 70 millivolts P-P.

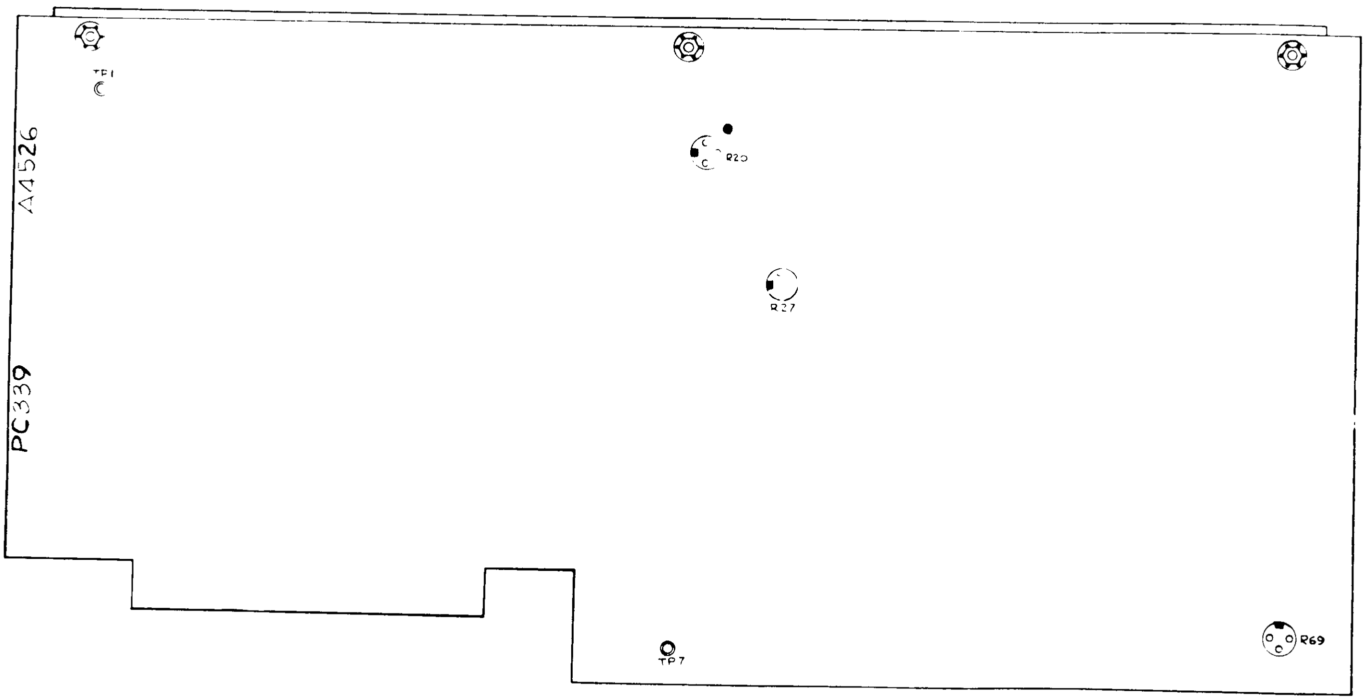

Figure 5-7. Carrier Generator Z109, Adjustments

i. SIDEBAND GENERATOR Z107. (See figure 5-8.)

NOTE

It is necessary that carrier generator card Z109 be checked and inserted previous to the alignment of Z107.

(1) Remove Frequency Shift Card Z108.
(2) Connect audio generator HP200 CD with one side grounded to USB terminals on rear panel of MMX unit. Adjust the audio generator for a 1 KHz output at a level of 78 millivolts (-20dbm).
(3) Set MODE switch and METER switch on front panel to USB positions.
(4) Adjust USB MIKE/LINE control for 2/5 of full scale reading on front panel meter. (Reading of 2)

(5) Connect Ballantine VTVM to TP4. The level should be approximately 16 millivolts RMS (44 mv Peak to Peak).

(6) Connect the scope and counter to TP10 (output of the USB filter). The amplitude should be about 75 mv P-P at one single frequency of 251 kHz.

(7) Remove the audio generator from the USB terminals and connect the audio generator with one side grounded to the LSB terminals on rear panel of MMX unit. Adjust the audio generator for a 1 kHz output at a level of 78 millivolts (-20 dbm).

(8) Set MODE and METER switches on front panel to LSB positions.

(9) Set LSB MIKE/LINE control for 2/5 of full scale reading on front panel meter. (Reading of 2).

(10) Connect Ballantine VTVM to TP1. The level should be approximately 16 millivolts RMS (44 mv Peak to Peak).

(11) Connect the scope and counter to TP9 (output of the LSB filter). The amplitude should be about 75 mv P-P at one single frequency of 249 kHz.

(12) Connect audio generator to front panel MIKE input. Adjust the audio generator to 1 kHz, at 1 mv RMS. (Measure with a Ballantine 314 VTVM.)

(13) Connect a short jumper across C49.

(14) Connect the VTVM Ballantine 314 to TP3.

(15) Adjust R9 for indicated level of 40 mv RMS.

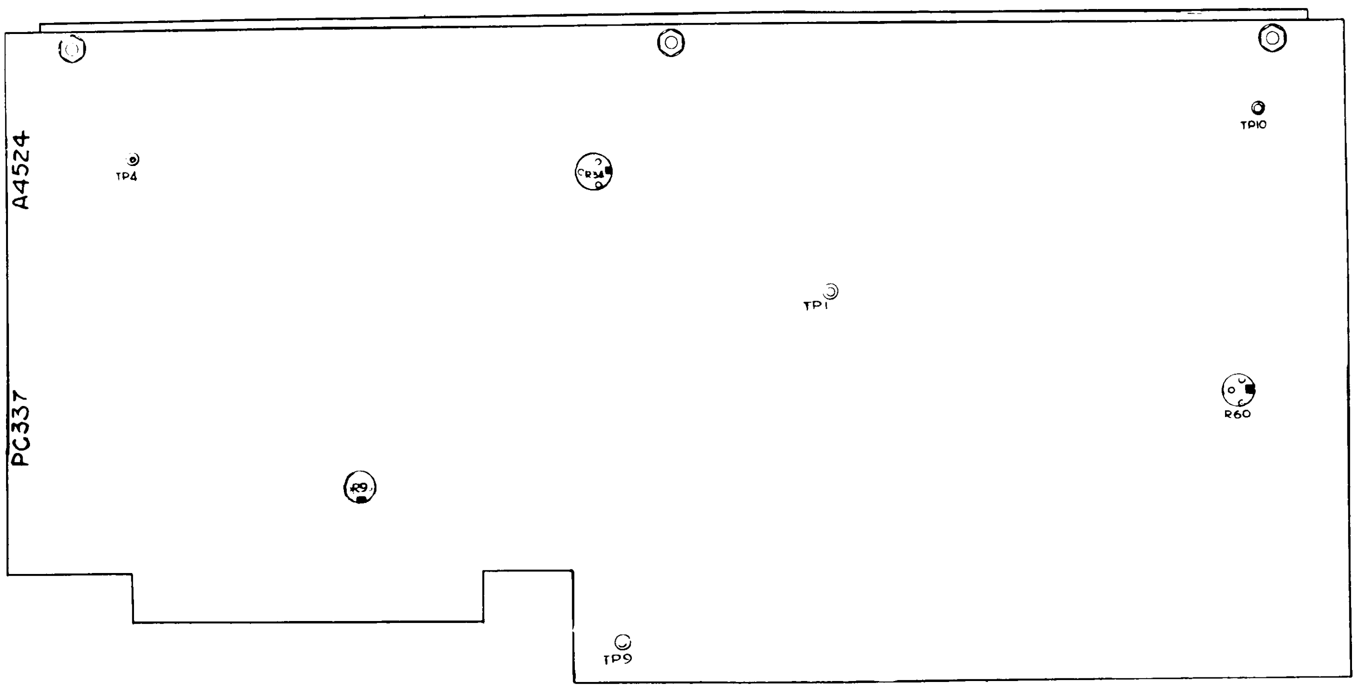

Figure 5-8. Sideband Generator Z107, Adjustments

j. <u>FREQUENCY SHIFT GENERATOR Z108.</u> (See figure 5-9.)

NOTE

Do not attempt an alignment of the FSK and FAX adjustments without a one hour warmup of the 3 MHz oven.

(1) Plug Z108 into its chassis slot with extender card. Place MODE switch to ISB position. Adjust R58 fully CCW. Turn CARRIER (front panel) control fully CW and place STANDBY-ON switch to ON position.

(2) Connect scope and counter to TP1. A 2.75 MHz signal at 70 millivolts P-P should be present.

(3) Connect scope and counter to TP2. A 250 kHz signal at 70 millivolts P-P should be present.

(4) Connect scope and counter to TP5.

(5) Rotate MODE switch to FSK position.

(6) Set R101 on rear panel of MMX to mid range, set SHIFT switch to ± 425 cycles, and place SENSE switch to + (up) position.

(7) Adjust R-56 for maximum signal.
(8) Insert Z108 into chassis slot without extender.

NOTE

Five adjustment holes are on top of card; these are 25 turn potentiometers and are identified on figure 5-10.

(9) Adjust R35 and R36 fully CCW.
(10) Adjust R37 for 3 MHz on the frequency counter.
(11) Adjust R36 for 2,999,575 cycles on the frequency counter.
(12) Set SENSE switch to (-) (DOWN) and adjust R35 for 3,000,425 cycles.
(13) Place SENSE switch to (+), readjust R36 for 2,999,575 cycles. Place SENSE switch to (-) and adjust R35 for 3,000,425 cycles. Repeat these steps until both frequencies are within 5 cycles of the required frequencies.
(14) Set the rear panel SHIFT switch to ± 170 cycles, and place the SENSE switch to (+). The counter should read 2,999,830 ±15 cycles.
(15) Set SENSE switch to (-). The counter should read 3,000,170 ±15 cycles.
(16) Set rear panel SHIFT to ±85 position, and SENSE switch to (+). The counter should read 2,999,915 ±10 cycles.
(17) Place SENSE switch to (-). The counter should read 3,000,085 ±10 cycles.
(18) Set rear panel SHIFT to ±42.5 position and place SENSE switch to (+). The counter should read 2,999,958 ±5 cycles.
(19) Place the SENSE switch to (-). The counter should read 3,000,042 ±5 cycles.
(20) Rotate the MODE switch to FAX position and adjust R25 fully CW.
(21) Connect a variable d-c power supply to the FAX terminals on the rear panel.
(22) Monitor the power supply output with a dc meter and adjust the power supply output for plus one volt.
(23) Adjust R27 for 2,999,600 ±5 cycles.
(24) Adjust the power supply output for plus 10 volts and adjust R25 for 3,000, 400 ±5 cycles.
(25) Repeat the adjustments of R25 with +1.0 volt and R27 with +10 volts, until the specified frequencies can be obtained within five cycles.
(26) Check the linearity of the FAX circuits by changing the input voltage from +1 to +10 volts. For each change of 1 volt, the frequency should change 89 ±5 cycles. A typical measurement is shown below:

DC VOLTS	FREQUENCY
1	2,999,600 ±5 cycles
2	2,999,689 ±5 cycles
3	2,999,778 ±5 cycles
4	2,999,867 ±5 cycles
5	2,999,956 ±5 cycles
6	3,000,045 ±5 cycles
7	3,000,134 ±5 cycles
8	3,000,223 ±5 cycles
9	3,000,312 ±5 cycles
10	3,000,400 ±5 cycles

k. STEP GENERATOR Z110. (See figure 5-11.)

(1) Remove Comb Filters Z102 and Z103.
(2) Set the front panel frequency selectors to 03.0000 MHz.
(3) Connect scope and counter to the collector of Q1, and adjust R1 for a 14 MHz signal at 2 volts P-P.
(4) Connect an rf signal generator as shown in figure 5-12.
(5) Adjust signal generator for an output of 1.05 MHz, at a level of 100 millivolts, rms. The 100 millivolts to the counter will allow continuous frequency monitoring. In all cases, set the generator frequency as close as possible to the specified frequency.
(6) Connect scope to J110 pin R, and adjust R28 for 0.4 volts P-P. (1.05 MHz).
(7) Connect scope and counter to J110 pin 5. Carefully vary the frequency of the signal generator from 800 kHz to 1.2 MHz. The scope level should be approximately 2 volts P-P minimum, and the output frequency should vary from 13.2 MHz to 12.8 MHz. Adjust T8 for maximum indication.
(8) Set the signal generator to 1.55 MHz, 100 millivolts, as before. Change the frequency selectors on the MMX front panel to 07.0000 MHz.

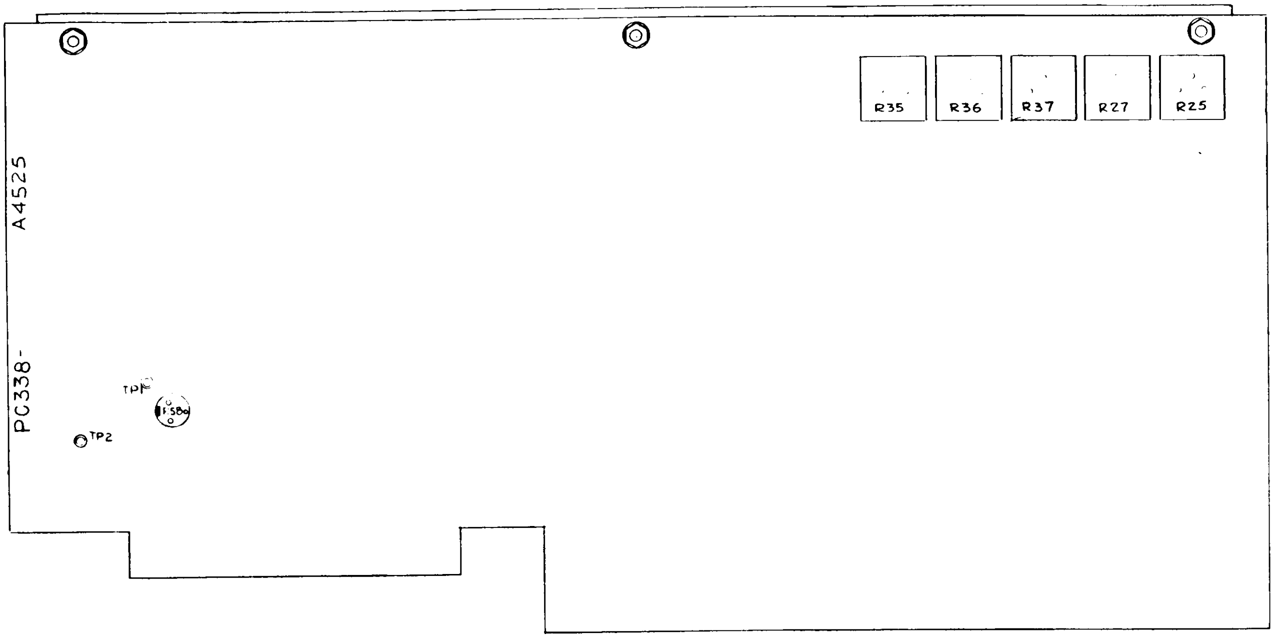

Figure 5-9. Frequency Shift Generator Z108, Adjustments

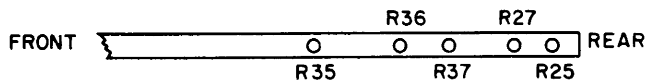

Figure 5-10. Z108, Card Potentiometer Locations

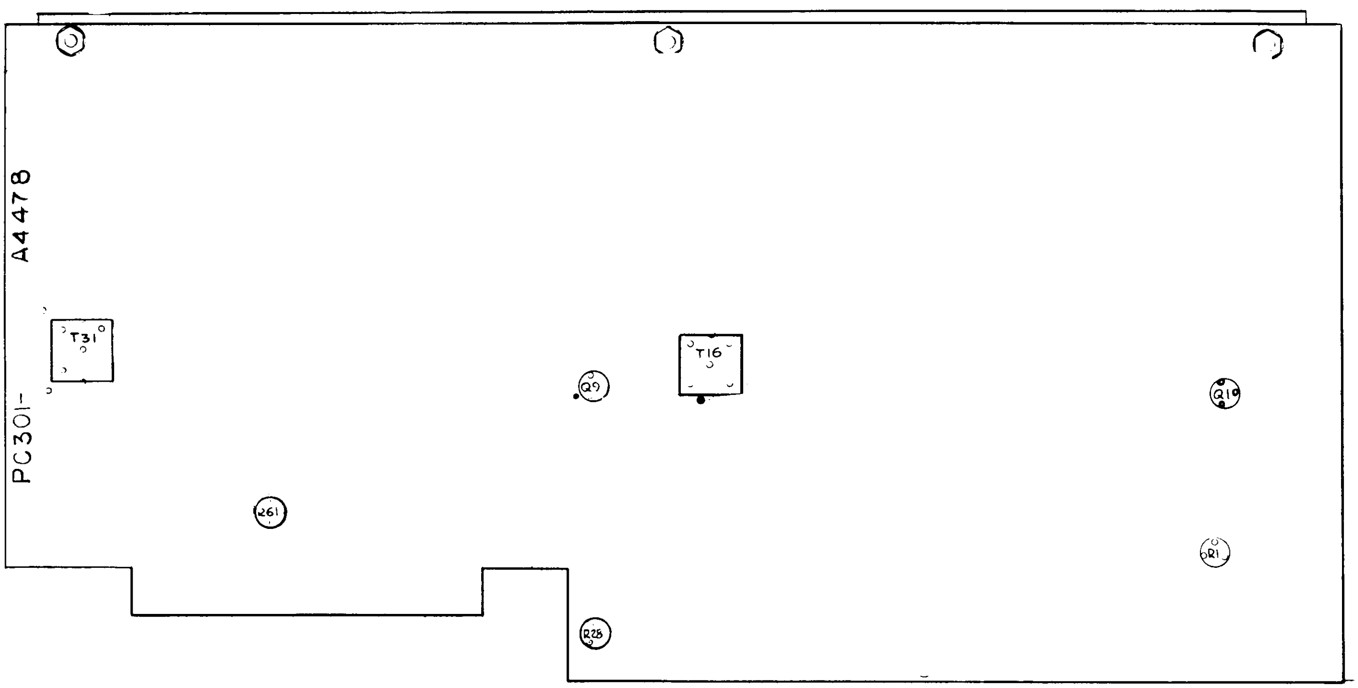

Figure 5-11. Step Generator Z110, Adjustments

(9) Vary the frequency of the signal generator from 1.3 MHz to 1.7 MHz. The output on the scope should be 2.0 volts P-P minimum, and the output frequency should vary from 12.7 to 12.3 MHz. Adjust T16 for maximum indication.

(10) Place MMX front panel selectors to 13.0000 MHz and adjust signal generator for 1.05 MHz.

(11) Connect scope to the collector of Q9 and adjust R61 for a level of 2 volts P-P.

(12) Connect scope and counter to J110, pin 4 and adjust T24 for maximum indication.

(13) Carefully vary the signal generator from .8 MHz to 1.2 MHz. The output on the scope should be about 2.0 volts P-P minimum, and the frequency should vary from 12.2 MHz to 11.8 MHz.

(14) Adjust signal generator to 1.55 MHz and change front panel selectors to 17.0000 MHz.

(15) With scope still at pin 4, J110, adjust T31 for maximum indication. Carefully vary the signal generator from 1.3 MHz to 1.7 MHz. The scope output should be about 2.0 volt P-P minimum, and the output frequency should vary from 11.7 MHz to 11.3 MHz. Adjust T31 for maximum indication.

(16) Replace comb filters Z102 and Z103 and remove signal generator.

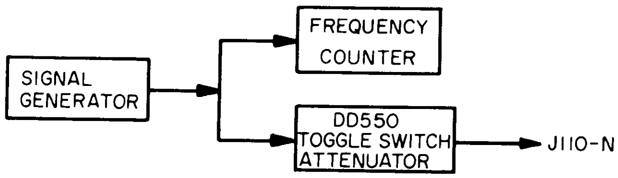

Figure 5-12. Signal Generator, Test Setup

l. STEP GENERATORS Z111 AND Z113. The following procedures are inter-related and must be performed in the following order: Step Generator, Z113, paragraph m, then step generator Z111 paragraph n.

m. STEP GENERATOR Z113. (See figure 5-13.)

(1) Remove comb filters Z102 and Z103.

(2) Set front panel selectors to 28.0000 MHz.

(3) Connect scope at the collector of Q14 and adjust R78 for maximum 12 MHz indication.

(4) Connect scope at the junction of T11 and CR1 and adjust T11 for maximum 12 MHz signal.

(5) Connect scope to the junction of C104 and R88 and adjust C101 and R84 alternately, in small increments, until minimum 12 MHz signal is achieved.

(6) Connect scope to the collector of Q14 and adjust R78 for a 12 MHz level of 2.0 volts P-P.

(7) Connect a H.P. 606B signal generator to J110, pin N as shown in figure 5-12; use no attenuation unless directed.

(8) Set the signal generator to 1.6 MHz at a level of 100 millivolts RMS.

(9) Connect scope and counter to J113 pin N and adjust T18 for maximum 10.4 MHz signal.

(10) Carefully vary the signal generator from 1.4 MHz to 1.6 MHz. The output should be about 1.0 volt P-P minimum, and the frequency should vary from 10.6 MHz to 10.4 MHz.

(11) Set the signal generator to 1.1 MHz at an output level of 400 millivolts P-P, and set the MMX front panel selectors to 23.0000.

(12) Connect scope and counter to J113 pin N and adjust T25 for maximum 10.9 MHz indication.

(13) Carefully vary the signal generator from 0.8 MHz to 1.3 MHz. The output should be 1.0 volt P-P minimum, and the frequency should vary between 11.2 MHz and 10.7 MHz.

(14) Replace comb filters Z102, Z103 and remove signal generator.

n. STEP GENERATOR Z111. (See figure 5-14.)

(1) Set front panel selectors to 25.0000.

(2) Connect the rf VTVM Millivac MV28B to J111 pin 1.

(3) Adjust C19 for maximum meter deflection.

(4) Vary the front panel selectors from 21.0000 to 31.0000 MHz in 1 MHz steps. The VTVM shall indicate 40 millivolts RMS minimum throughout the range. If not, slightly adjust C19 (with front panel selectors at 25.0000 MHz) until gain can be equalized across the band (as closely as possible).

(5) Set front panel selectors to 15.0000 MHz.

(6) Connect rf VTVM Millivac MV28B to J111 pin 2.

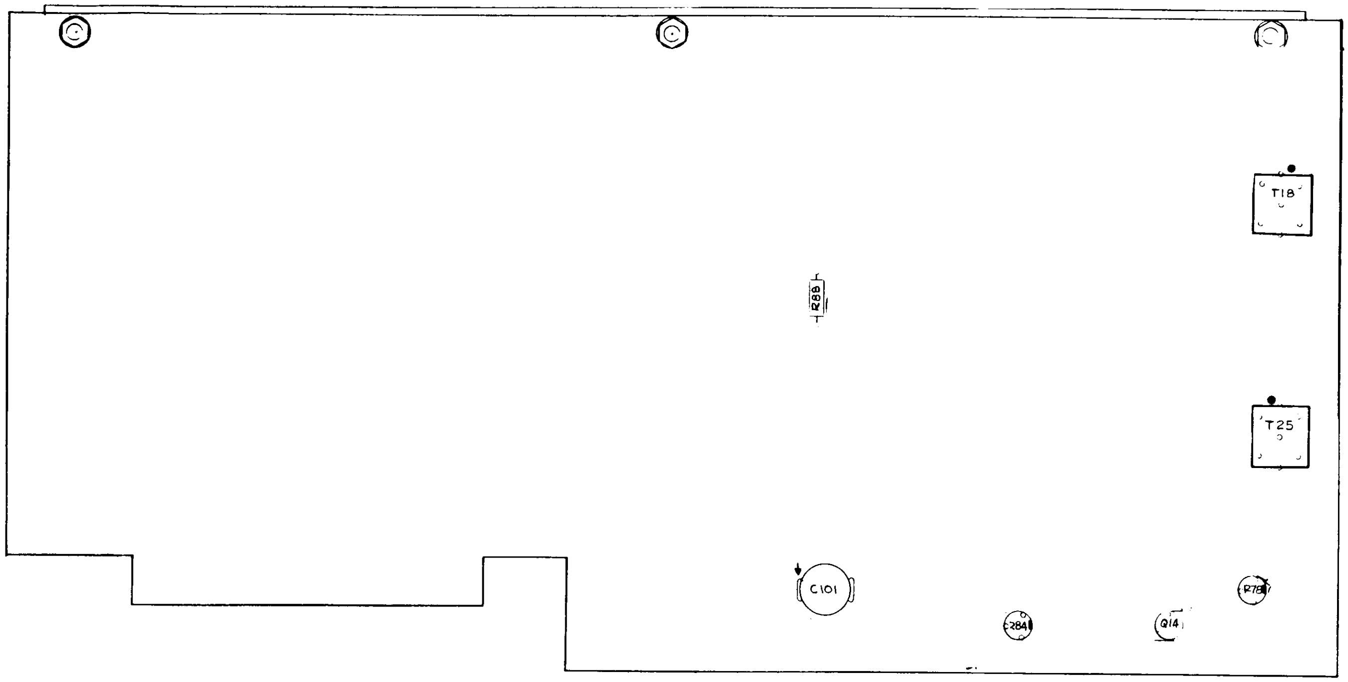

Figure 5-13. Step Generator Z113, Adjustments

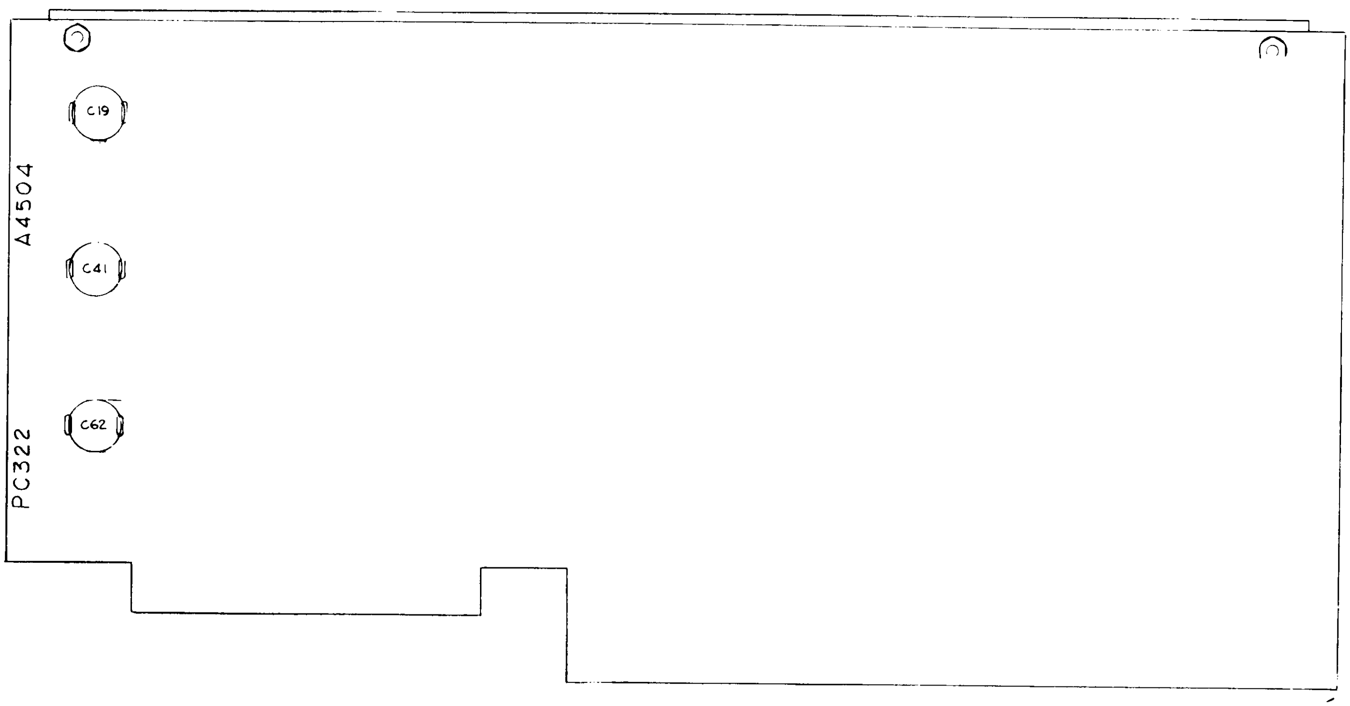

Figure 5-14. Step Generator Z111, Adjustments

(7) Adjust C41 for maximum meter deflection.

(8) Vary the front panel selectors from 11.0000 to 20.0000 MHz in 1 MHz steps. The VTVM shall indicate 40 millivolts RMS minimum throughout the range. If not slightly adjust C41 (with front panel selectors at 15.0000 MHz) until gain can be equalized across the band (as closely as possible).

(9) Set the front panel selectors to 05.0000 MHz.
(10) Connect the rf VTVM Millivac MV28B to J111 pin 3.
(11) Adjust C62 for maximum meter deflection.
(12) Vary the front panel selectors from 01.0000 to 10.0000 MHz in 1 MHz steps. The VTVM shall indicate 40 millivolts RMS minimum throughout the range. If not slightly adjust C62 (with front panel selectors at 05.0000 MHz) until the gain can be equalized across the band (as closely as possible).

o. RF OUTPUT Z115. (See figure 5-15.)

CAUTION

Do not adjust the RF output card until a complete alignment of power supply is accomplished.

(1) Connect a 50 ohm (2 watt noninductive) load to RF OUTPUT connector on rear panel. Connect HP411A VTVM across the load, select the 10 volt range. Turn ALDC control on rear panel fully CCW and set front panel selectors to 29.999 MHz. Connect a short jumper from J115 pin S to J114 pin B.
(2) Connect scope to J115 pin B. Turn RF OUTPUT control on front panel CW until the scope reading is 220 millivolts P-P, the HP411A VTVM should read 3.55 volts RMS.
(3) Using the VOM, measure the dc voltage on pin 12 of J115. It should bary from 0 to 12 volts as the ALDC control on the rear panel is rotated. Adjust the ALDC control to its full CCW position.

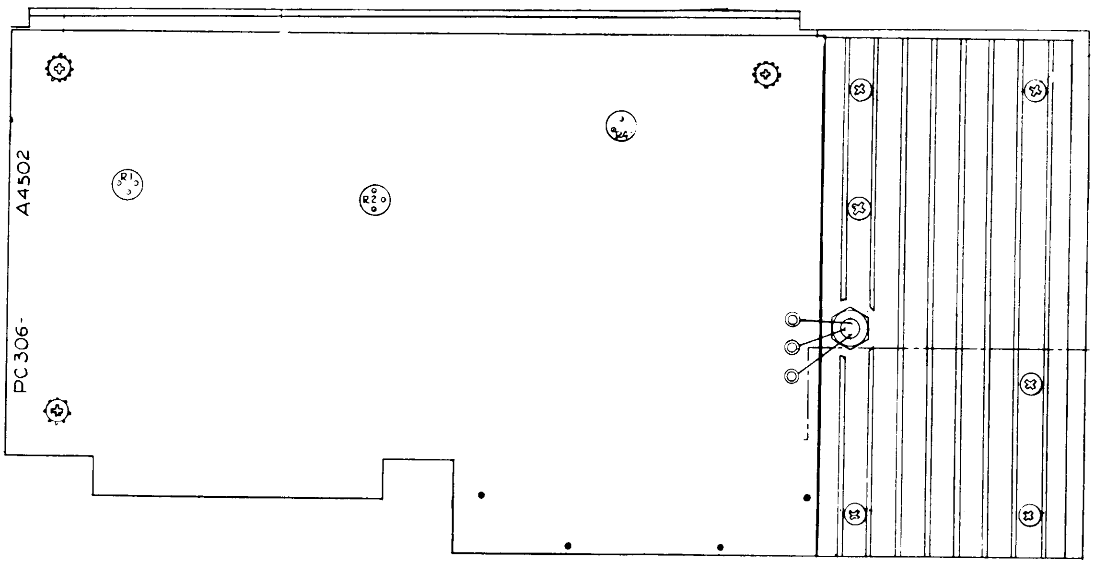

Figure 5-15. RF Output Z115, Adjustments

p. FINAL ALIGNMENT.

NOTE

To be completed after individual circuit boards have been adjusted in accordance with the previous procedures.

(1) Preliminary Steps:

Insure that all cards are inserted and aligned.
Place RF OUTPUT control fully CCW
Set front panel selectors to 29.9999 MHz
Rotate CARRIER control fully CCW

Set the MODE switch to ISB position.
Place the STANDBY-ON switch to ON.

(2) Connect the audio generator HP200CD to both 600 ohm sideband inputs on rear panel. Adjust generator for a 1 kHz output at a level of 78 millivolts RMS unbalanced.

(3) Set exciter controls as follows:

Set both MIKE/LINE controls to "0".
Set METER switch to Q1 position.
Rotate the ALDC control on the rear panel fully CCW.
Turn METER switch to Q1. The MONITOR needle indicates in the GREEN region marked Ql.
Turn METER switch to Q2 position. The MONITOR needle should indicate in the GREEN region marked Q2.
Turn METER switch to Q3. The MONITOR needle indicate in the GREEN region marked Q3.

(4) Connect an oscilloscope to TP1 of Z107 and adjust the LSB MIKE/LINE control for 44 millivolts P-P.

(5) Set METER switch to LSB, the front panel MONITOR should read 2/5 of full scale. Return the LSB MIKE/LINE control to zero.

(6) Connect an oscilloscope to TP4 of Z107 (see figure 5-8) and set USB MIKE/LINE control for 44 millivolts P-P. Set METER switch to USB, the front panel meter should indicate 2/5 of full scale. Return USB MIKE/LINE control to zero.

(7) Connect the spectrum analyzer LA-40A to the RF MONITOR jack on the rear of the MMX.

(8) Connect a 50 ohm (2 watt noninductive) load resistor to the RF OUTPUT jack on the rear of the unit and connect the HP411A VTVM across the 50 ohm load.

(9) Remove Z109 and insert into chassis with the extender card.

(10) Turn MODE switch to ISB position.

(11) Connect scope to J109 Pin N and adjust the 250 kHz signal with R27 on Z109 (see figure 5-7) for a level of 70 millivolts P-P on the scope.

(12) Rotate front panel CARRIER control fully CW and adjust the RF OUTPUT control on the front panel for 3.5 volts RMS on the VTVM.

(13) Connect the oscilloscope across the 50 ohm load. Use the front panel selectors to choose frequencies at random.

CAUTION

Keep RF output below 7.0 volts RMS on VTVM using RF output control.

(14) Examine the resultant sine waves by moving the TIME/CM oscilloscope controls through a wide range. There should be no trace of modulation. Remove the oscilloscope.

(15) Set the MMX frequency to 29.2500 MHz. With Front Panel carrier control fully CW, adjust RF OUTPUT control for 2.5 volts on the VTVM. Set MMX frequency to 29.7500 MHz, and adjust R109 on Z112 for the same output level. (some models only)

(16) Vary the frequency selectors from 29.0000 to 29.9999 MHz and find the frequency with the lowest indicated output amplitude. Then adjust R97 on Z112 (see figure 5-16) for maximum signal at that frequency.

(17) Turn MODE switch to CW position.

(18) Select 29.9999 MHz on front panel.

(19) Rotate RF OUTPUT control fully CW; adjust R58 on Z108 (see figure 5-9) for 7.0 VRMS on the VTVM.

(20) Turn MODE switch to ISB position and rotate CARRIER control fully clockwise.

(21) Set front panel frequency selectors to 12.0000 MHz.

(22) Adjust RF OUTPUT control for 3.5 VRMS on HP411A VTVM. (Do not touch RF output control for the rest of these adjustments unless told to do so.) Observe that one signal is present on the spectrum analyzer. Adjust the spectrum analyzer display so that this signal is at a 0DB reference.

(23) Turn MODE switch to CW position.

(24) Adjust R20 on Z109 (mounted on the extender card) for 3.5 VRMS on the VTVM. Observe that one signal is present at 0 db level on the spectrum analyzer.

(25) Switch from ISB (Full Carrier, no Audio) to CW; there should be no change on the VTVM RF output voltage indication.

(26) Turn MODE switch to AM (no modulation applied).

(27) Adjust R69 on Z109 an indication of 1.75 VRMS on VTVM.

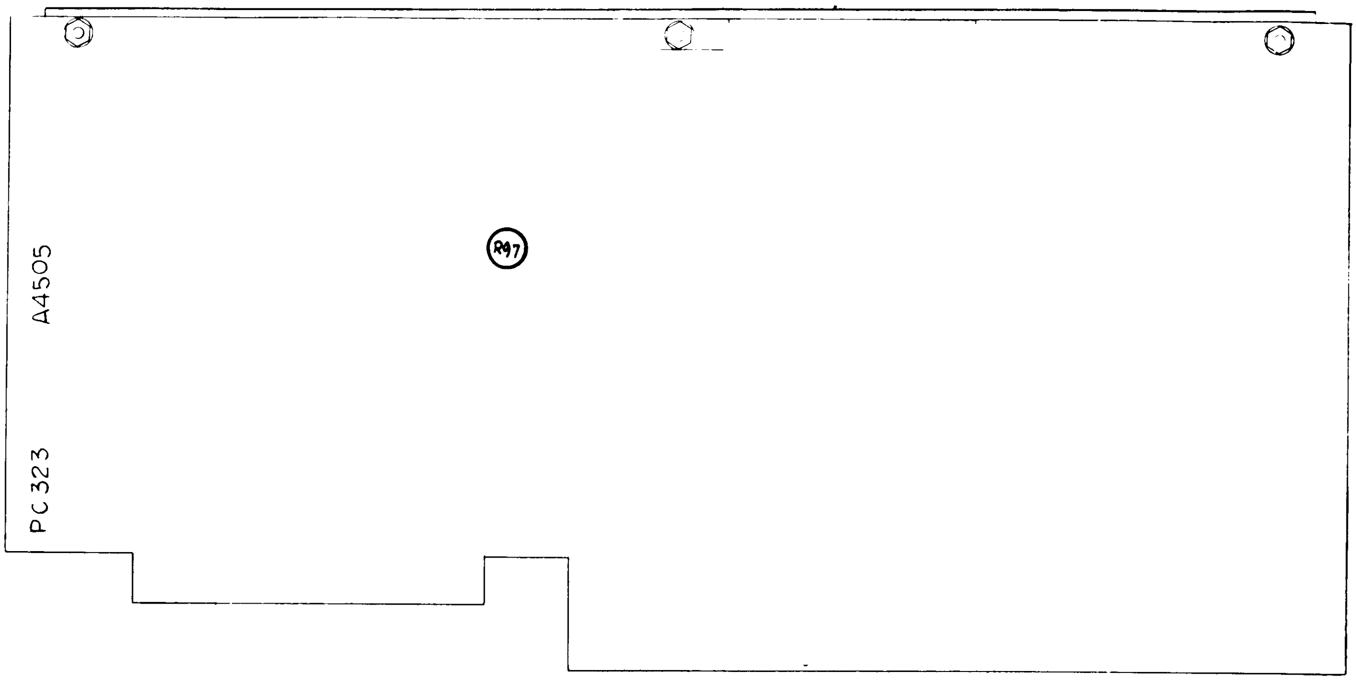

Figure 5-16. Translator Z112, Adjustments

NOTE

The signal level displayed on the analyzer should be at a -60DB level. This should change 6DB when the MODE switch is placed in the CW, USB or LSB Full Carrier and ISB Full Carrier positions.

(28) Remove Z109 from the extender card and replace it in its chassis socket.
(29) Remove Z108 and mount it to the chassis on the extender card.
(30) Turn MODE switch to FSK position.
(31) Adjust R56 on Z108 (See figure 5-9) for 3.5 VRMS on the VTVM.

NOTE

Maintain RF output control adjustment from previous procedure (0 DB rf level indicated on spectrum analyzer).

(32) Remove Z108 from extender card and replace it in its chassis socket.
(33) With front panel CARRIER control fully clockwise, the following voltages should be observed on the VTVM connected to the RF output. One signal should be displayed on the analyzer at the following specified DB levels:

MODE		VTVM		ANALYZER
AM	-	1.76	VRMS	-6.0 DB
USB	-	3.5	VRMS	0.0 DB
LSB	-	3.5	VRMS	0.0 DB
ISB	-	3.5	VRMS	0.0 DB
CW	-	3.5	VRMS	0.0 DB
FSK	-	3.5	VRMS	0.0 DB
FAX	-	3.5	VRMS	0.0 DB

q. MODULATION LEVEL CHECK AND ADJUSTMENT.

(1) Set front panel selectors to 12.0000 MHz.
(2) Turn MODE switch to ISB and adjust CARRIER control fully CW.

(3) Insure that USB and LSB-MIKE/LINE controls are set at "0".
(4) Adjust RF output control for a reading of 3.5 VRMS across the 50 ohm load connected to RF Out jack J-124.

NOTE

DO NOT change RF output position for the following adjustments.

(5) Connect spectrum analyzer to RF MON jack J125 and adjust display to indicate 0 DB.

NOTE

A single tone (Carrier) should be displayed on the spectrum analyzer.

(6) Rotate CARRIER control fully CCW; signal on analyzer should decrease to -55 DB (or lower.)
(7) Set METER switch to USB. Adjust USB-MIKE/LINE for 4/5 full scale reading. The VTVM on dummy load (J-124) shall indicate 3.5 VRMS. If not, adjust R34 on Z107 (see figure 5-8) until it does.
(8) Rotate USB-MIKE/LINE control fully CCW (0 on meter).
(9) Set METER switch to LSB position and adjust LSB/MIKE gain control to indicate 4/5 full scale. Observe that VTVM, across 50 ohm load indicates 3.5 VRMS. If not, adjust R60 on Z107 (see figure 5-8).
(10) Rotate LSB-MIKE/LINE control fully CCW (0 on meter) and adjust RF OUTPUT fully CCW.
(11) Remove the audio generator from the sideband inputs on the rear panel and connect a two-tone generator (TTG) to both rear panel sideband inputs.
(12) Set METER switch to USB position and adjust USB MIKE/LINE control for 4/5 full scale indication on meter.
(13) Adjust RF OUTPUT control for 3.5 VRMS out on VTVM connected across 50 ohm dummy load. Two rf tones should be displayed on the spectrum analyzer. Distortion products should be down -40 DB from the displayed two-tone signals.
(14) Rotate USB-MIKE/LINE control to "0".
(15) Set METER switch to LSB position and adjust LSB-MIKE/GAIN control for 4/5 full scale indication on meter.
(16) Observe that distortion products are down at least -40 DB from the two tones displayed on the spectrum analyzer.
(17) Rotate LSB-MIKE/LINE control to "0".
(18) Adjust the output of the two tone generator for one tone out at a level of 78 millivolts RMS.
(19) Adjust the LSB-MIKE/LINE control for a 4/5 full scale indication on meter.
(20) Set MODE switch to AM position.
(21) Observe that VTVM across output indicates 3.5 VRMS.
(22) Observe that the distortion products on the spectrum analyxer are down -25 DB or lower from the carrier spike and the upper and lower sideband tones are down approximately -7 DB from the carrier as shown in figure 5-17.

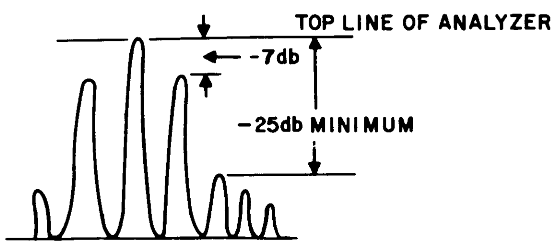

Figure 5-17. Carrier Double-Sideband Modulation Waveform

SECTION 6

PARTS LIST

6-1. INTRODUCTION. The parts list presented in this section is a cross-reference list of parts identified by a reference designation and TMC part number. Parts appearing on the schematic diagram are assigned reference designations. In most cases, the reference designations are marked on or close to the part identified. The mechanical and electro-mechanical parts have TMC part numbers stamped on them. Be certain when ordering any parts to specify the following:

1. The reference designation and the TMC part number
2. The description in the parts list.
3. Model and serial numbers of the equipment; this can be obtained from the equipment nameplate.

6-2. CIRCUIT CARD REPLACEMENT. When it is determined that a circuit card assembly is defective, it is recommended that the circuit card assembly be returned to the Technical Materiel Corporation for repair and testing. Address all orders to:

The Technical Materiel Corporation
700 Fenimore Road
Mamaroneck, New York 10543

Ref Symbol	Description	TMC Part Number
CR101	SEMICONDUCTOR DEVICE, Diode	1N627
CR102	Same as CR101	
CR103	SEMICONDUCTOR DEVICE, Diode	1N39A
CR301	SEMICONDUCTOR DEVICE, Diode	1N2484
CR302	Same as CR301	
C101	CAPACITOR, Fixed, mica, .001 ufd, 10 pct, 300 wvdc	CB21QB102K
C102	Same as C101	
C103	Same as C101	
C104	CAPACITOR, Fixed, ceramic, .01 ufd, gmv, 500 wvdc	CC100-16
C105	Same as C104	
C106	CAPACITOR, Fixed, ceramic, 1000 uufd, gmv, 500 wvdc	CC100-29
C107 thru C109	Same as C101	
C110	Same as C104	
C111	Same as C101	
C112	Same as C104	
C113	Same as C101	
C114	Same as C101	
C115	Same as C104	
C116	Same as C101	
C117	Same as C101	
C118	Same as C104	
C119	CAPACITOR, Fixed, ceramic, .1 ufd, +8-20 pct, 100 wvdc	CC100-28
C120	Same as C104	
C121 thru C123	Same as C119	
C124	Same as C104	
C125	Same as C104	
C126	Same as C101	
C127	Same as C119	
C128	CAPACITOR, Fixed, ceramic, 100 pfd	CC100-30
C129 thru C131	Same as C119	
C132	CAPACITOR, Fixed, ceramic, .2 ufd, 25 wvdc	CC100-33
C133	Same as C104	
C134	CAPACITOR, Fixed, mtlz, 1 ufd, 5 pct, 50 wvdc	CN114-1RO-5J
C135	Same as C119	
C136	Same as C119	
C137	Same as C104	
C138	Same as C106	
C139	Same as C106	
C140	Same as C106	
C141	Same as C119	
C142	CAPACITOR, Fixed, ceramic, dual, 2 x .01 ufd, gmv, 1000 wvdc	CC100-47

Ref Symbol	Description	TMC Part Number
C143	Same as C142	
C144	Same as C104	
C145	Same as C119	
C146	Same as C106	
C147	Not Used	
C148	Same as C106	
C149	Same as C104	
C150 thru C153	Same as C106	
C154	Same as C119	
C155 thru C182	Same as C106	
C183	Same as C119	
C184	Same as C104	
C185	Same as C119	
C186	CAPACITOR, Fixed, ceramic, .01 ufd	CC100-41
C187	Same as C142	
C301	CAPACITOR, Fixed, ceramic, 1. ufd	CC100-37
C302	CAPACITOR, Fixed, 1 ufd	CN112A-105-M2
C303	CAPACITOR, Fixed, electrolytic, 150 ufd, 75 wvdc	CE105-150-75
C304	CAPACITOR, Fixed, metalized, .47 ufd, 50 wvdc	CN114R47-5J
C305 thru C308	Same as C301	
DS101	LAMP, Incandescent	B1110-7
DS102	Same as DS101	
F101	FUSE, Cartridge, 230 vac, 1/2 amp	FU102-.50
F101	FUSE, Cartridge, 115 vac, 1 amp	FU102-1.0
F102	Same as F101	
FL101	FILTER	FX287
J101 thru J115	CONNECTOR, Receptacle, female	JJ319A150FE
J116	CONNECTOR, Receptacle, male	MS3102A16S5P
J117	JACK, Telephone	JJ034
J118	JACK, Telephone	JJ033
J120 thru J125	CONNECTOR, Receptacle, rf, female	UG625/U
J301	CONNECTOR, Receptacle, male	JJ242-5P
J302	CONNECTOR, Receptacle, rf	JJ211
J303	CONNECTOR, Receptacle, female	JJ319-6DPE
J304	Same as J303	
J305	Same as J302	
J306	CONNECTOR, Receptacle, female	JJ242-5S
K101	RELAY, Keying	RL156-1
L101 thru L103	COIL, Rf, fixed, 120 uh, ±10%	CL1240-120
L104 thru L106	COIL, Rf, fixed, 120 uh, ±10%, molded	CL275-121
L107 thru L109	Same as L101	

Ref Symbol	Description	TMC Part Number
L110	Same as L104	
L111 thru L114	Same as L101	
L115	Same as L104	
L116	Same as L101	
L117	Same as L101	
L119 thru L121	Same as L104	
L125	Same as L104	
L126	Same as L104	
L127	Not Used	
L128	Same as L104	
L129	COIL, Rf, fixed	CL275-8R2
L130 thru L136	Same as L104	
L301	COIL, Rf, fixed	CL275-121
M101	METER	MR191-9
P301	CONNECTOR, Plug, female	PL225-8S
P302	CONNECTOR, Plug, female	PL204
P303	Not Used	
P304	Not Used	
P305	Same as P302	
P306	CONNECTOR, Receptacle, male	PL225-8P
Q301	TRANSISTOR, Silicon, npn	2N1488
Q302	Same as Q301	
Q303	Same as Q301	
R101	RESISTOR, Variable, composition, 1K ohms, 10 pct, 1/2 watt	RV106UX8B 102A
R102A, B	RESISTOR, Variable, dual, composition, front 1K ohms, rear 10K ohms, 10 pct, 2 watt	RV108-2
R103	RESISTOR, Variable, composition, 100 ohms, 10 pct, 1/2 watt	RV4NAYSD 101A
R104	RESISTOR, Variable, composition, 500K ohms, 10 pct	RV110-1
R105	Same as R104	
R106	RESISTOR, Variable, composition, 10K ohms, 10 pct, 1/2 watt	RV106UX8B 103A
R107	Same as R106	
R108 thru R110	RESISTOR, Fixed, wirewound, 1 ohm, 5 pct, .66 watts	RW126-4-1RO
R111	RESISTOR, Fixed, composition, 1K ohms, 5 pct, 1/4 watt	RC07GF102J
R112	Same as R111	
R113	RESISTOR, Fixed, composition, 220 ohms, 5 pct, 1/4 watt	RC07GF221J
R114	RESISTOR, Fixed, composition, 300K ohms, 5 pct, 1/4 watt	RC07GF304J

Ref Symbol	Description	TMC Part Number
R115	RESISTOR, Fixed, composition, 47K ohms, 5 pct, 1/4 watt	RC07GF473J
R116	Same as R115	
R117	Same as R111	
R118	Same as R111	
R119	RESISTOR, Fixed, composition, 2200 ohms, 5 pct, 1/4 watt	RC07GF222J
R120	RESISTOR, Fixed, composition, 6200 ohms, 5 pct, 1/4 watt	RC07GF622J
R121	RESISTOR, Fixed, composition, 56K ohms, 5 pct, 1/4 watt	RC07GF563J
R122	RESISTOR, Fixed, composition, 27K ohms, 5 pct	RC07GF273J
R123	RESISTOR, Fixed, composition, 1500 ohms, 5 pct, 1/4 watt	RC07GF152J
R124	RESISTOR, Fixed, composition, 150 ohms, 5 pct, 2 watt	RC42GF151J
R125	Same as R124	
R126	RESISTOR, Fixed 5.6K	RC07GF562J
R127	RESISTOR, Fixed, composition, 2200 ohms, 5 pct	RC20GF222J
R128	RESISTOR, Fixed, composition, 1K ohms, 5 pct	RC20GF102J
R129	RESISTOR, Fixed, composition, 100 ohms, 5 pct, 1/4 watt	RC07GF101J
R130	RESISTOR, Fixed, composition, 82 ohms, 5 pct, 1/4 watt	RC07GF820J
R131	RESISTOR, Fixed, composition, 68 ohms, 5 pct, 1/4 watt	RC07GF680J
R132 thru R160	Mounted on resistor board assembly TB101	
R161 thru R192	Mounted on resistor board assembly TB102	
R193	RESISTOR, Fixed, composition, 8200 ohms, 5 pct, 1/4 watt	RC07GF822J
R194	Same as R121	
R301	RESISTOR, Fixed, composition, 47, 5 pct, 1/2 watt	RC20GF470J
R302	RESISTOR, Fixed, wirewound, 15, 10 pct, 5 watt	RW107-10
S101	Not Used	
S102	SWITCH, Rotary, 100 Hz selector	SW443
S103	SWITCH, Rotary, 1 kHz selector	SW443
S104	SWITCH, Rotary, 10 kHz selector	SW443

Ref Symbol	Description	TMC Part Number
S105	SWITCH, Rotary, 100 kHz selector	SW441
S106	SWITCH, Rotary, 1 MHz selector	SW440
S107	SWITCH, Rotary, 10 MHz selector	SW442
S108	SWITCH, Toggle, spdt, internal-external STD selector	ST103-11-62
S109	Same as S108, sense selector	
S110	SWITCH, Rotary, shift selector	SW447
S111	SWITCH, Rotary, FS loop selector	SW446
S112	SWITCH, Toggle, spdt, standby-on selector	ST22N
S113	Same as S112	
S114	SWITCH, Rotary, mode selector	SW244
S115	SWITCH, Rotary, meter selector	SW445
TB101	RESISTOR BOARD ASSEMBLY	A4592
TB102	RESISTOR BOARD ASSEMBLY	A4593
TB103 thru TB105	TERMINAL BOARD, Barrier strip	TM100-6
T301	TRANSFORMER, Power	TF0352
XDS101	LIGHT, Indicator, white lens	TS153-5
XDS102	LIGHT, Indicator, red lens	TS153-1
XF101	FUSE HOLDER	FH104-3
XF102	Same as XF101	
XK101	SOCKET, Relay	TS171-1
XZ301	SOCKET, Electron tube, 8 pin	TS100-3
XZ302	Same as XZ301	
Z101	CIRCUIT CARD ASSEMBLY, Spectrum Generator	A-4480
Z102	CIRCUIT CARD ASSEMBLY, Comb Filter A	A-4500
Z103	CIRCUIT CARD ASSEMBLY, Comb Filter B	A-4501
Z104	CIRCUIT CARD ASSEMBLY, Single Mixer-Divider	A-4487

Ref Symbol	Description	TMC Part Number
Z105	CIRCUIT CARD ASSEMBLY, Dual Mixer-Divider	A-4475
Z106	CIRCUIT CARD ASSEMBLY, Mixer-Final	A-4479
Z107	CIRCUIT CARD ASSEMBLY, Sideband Generator	A-4524
Z108	CIRCUIT CARD ASSEMBLY, Frequency Shift Generator	A-4525
Z109	CIRCUIT CARD ASSEMBLY, Carrier Generator	A-4526
Z110	CIRCUIT CARD ASSEMBLY, Step Generator A	A-4478
Z111	CIRCUIT CARD ASSEMBLY, Step Generator B	A-4504
Z112	CIRCUIT CARD ASSEMBLY, Translator	A-4505
Z113	CIRCUIT CARD ASSEMBLY, Step Generator C	A-4506
Z114	CIRCUIT CARD ASSEMBLY, Bandpass Output Filter (option 1)	A-4507
Z114	CIRCUIT CARD ASSEMBLY, Lowpass Output Filter (option 2)	A-4654
Z115	CIRCUIT CARD ASSEMBLY, RF Output	A-4502
Z116 thru Z118	Not Used	
Z119	CIRCUIT CARD ASSEMBLY, Switched Filter	A-4751
Z301	1 MHz STANDARD ASSEMBLY	NF116
Z302	OVENIZED OSCILLATOR, VXCO, 3 MHz	A0121
Z303	CIRCUIT CARD ASSEMBLY, PWR Board B	A-4513
Z304	CIRCUIT CARD ASSEMBLY, PWR Board A	A-4512
Z305	HEATSINK ASSEMBLY	BMA173

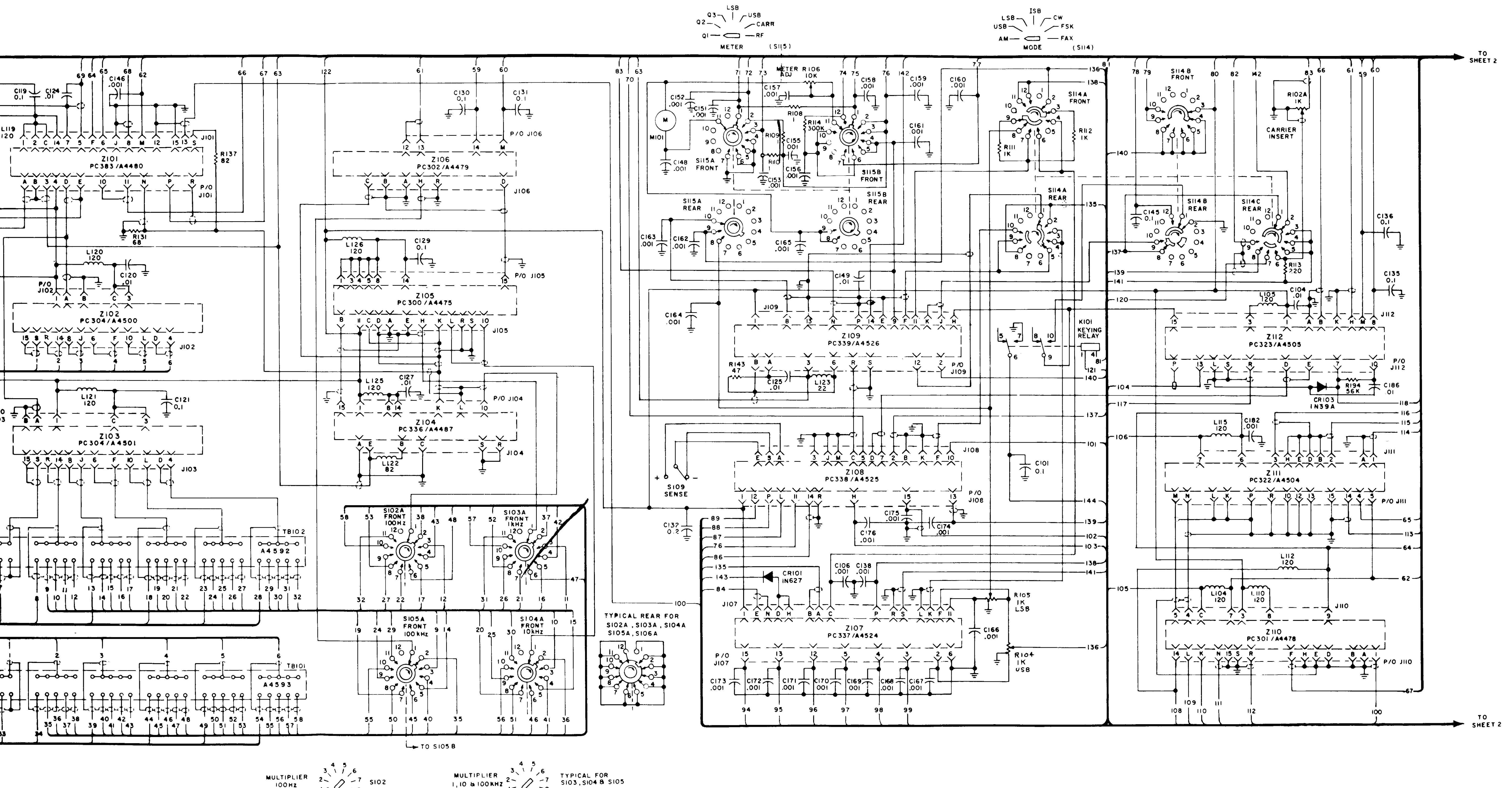

Figure 7-1. Overall Wiring Diagram, MMX(M)-2 (Sheet 1 of 2)

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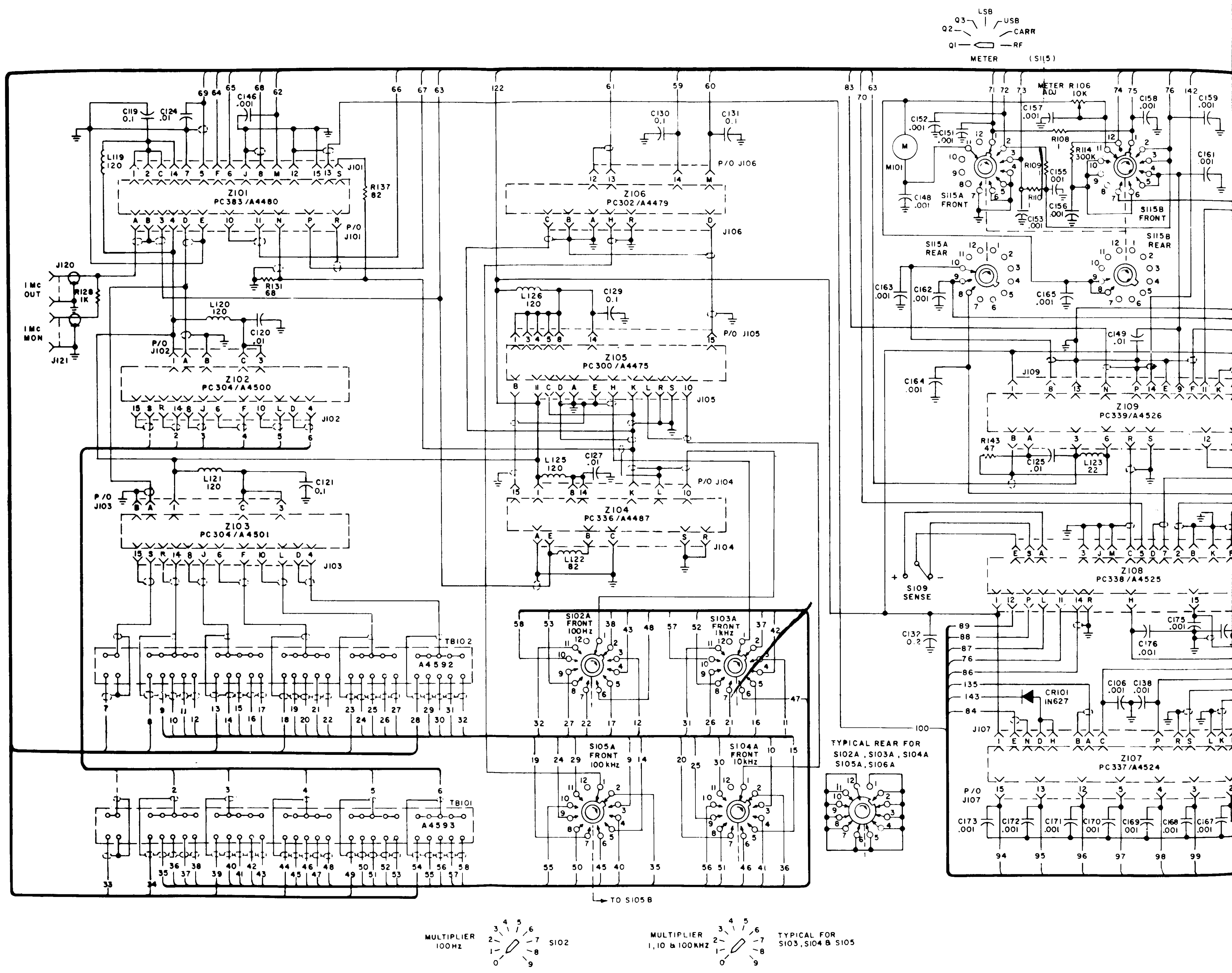
METER (S115)
LSB
USB
CARR
RF
M101
S115A FRONT
S115A REAR
S115B FRONT
S115B REAR
Z109 PC339/A4526
Z108 PC338/A4525
Z107 PC337/A4524
S109 SENSE
TYPICAL REAR FOR S102A, S103A, S104A S105A, S106A
Z106 PC302/A4479
Z105 PC300/A4475
Z104 PC336/A4487
S103A FRONT 1KHZ
S104A FRONT 10KHZ
S102A FRONT 100HZ
S105A FRONT 100KHZ
TO S105B
MULTIPLIER 1,10 & 100KHZ
TYPICAL FOR S103, S104 & S105
MULTIPLIER 100HZ
S102
TB102 A4592
TB101 A4593
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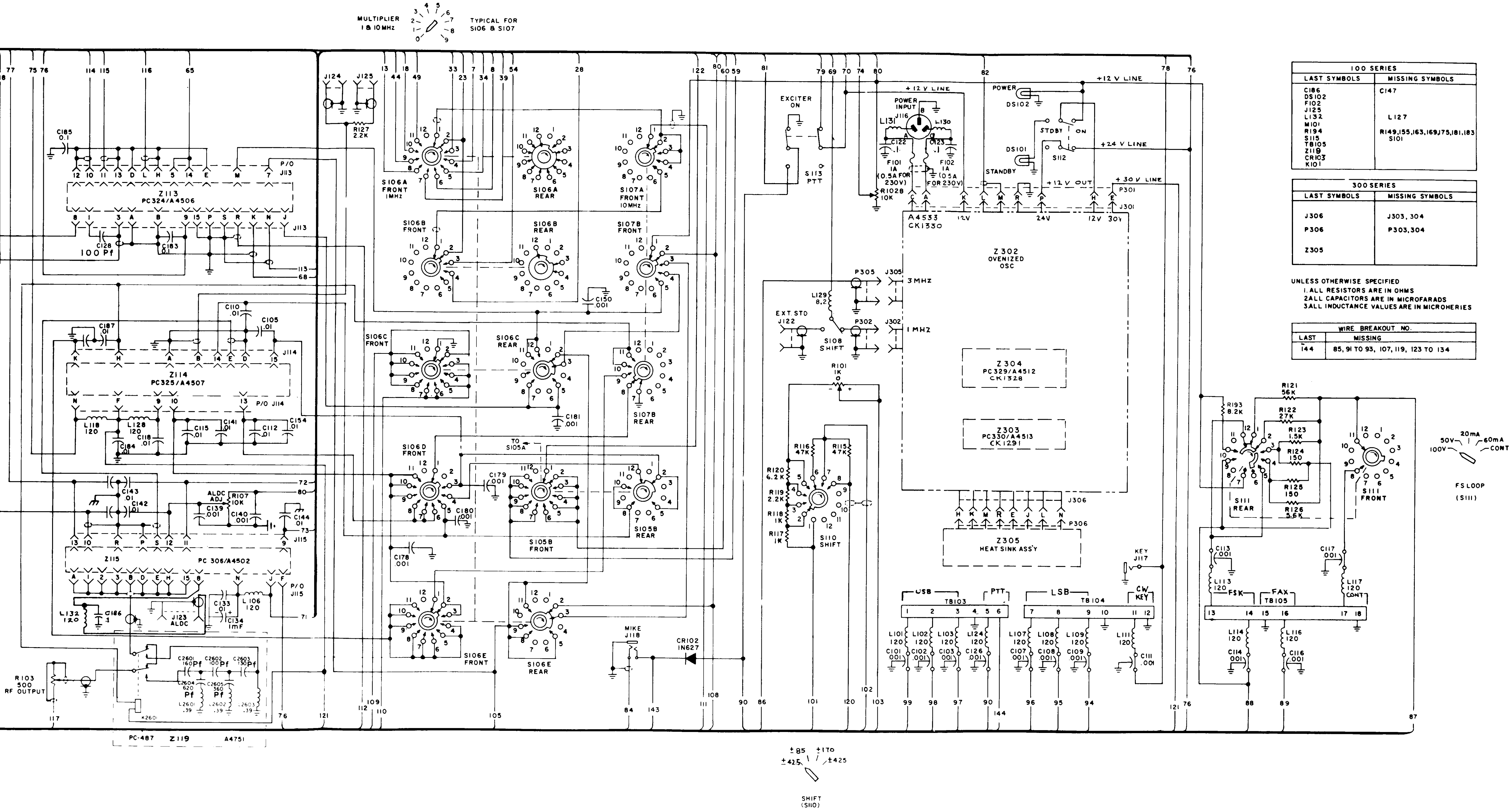
Z102 PC304/A4500
Z103 PC304/A4501
J120
J121
1MC OUT
1MC MON



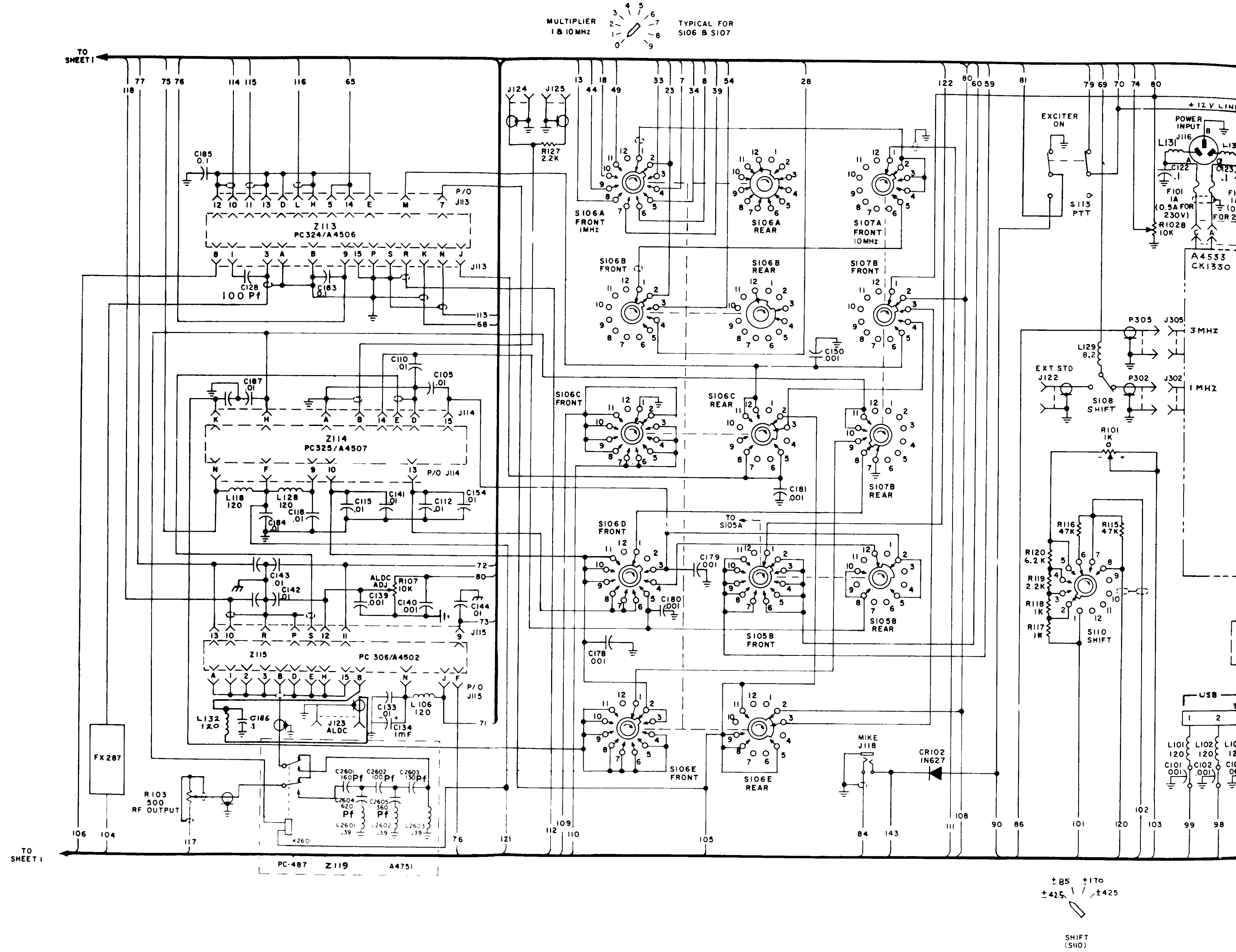
100 SERIES	
LAST SYMBOLS	MISSING SYMBOLS
C186 DS102 F102 J125 L132 M101 R194 S115 TB105 Z119 CR103 K101	C147 L127 R149,155,163,169,175,181,183 S101

300 SERIES	
LAST SYMBOLS	MISSING SYMBOLS
J306	J303, 304
P306	P303,304
Z305	

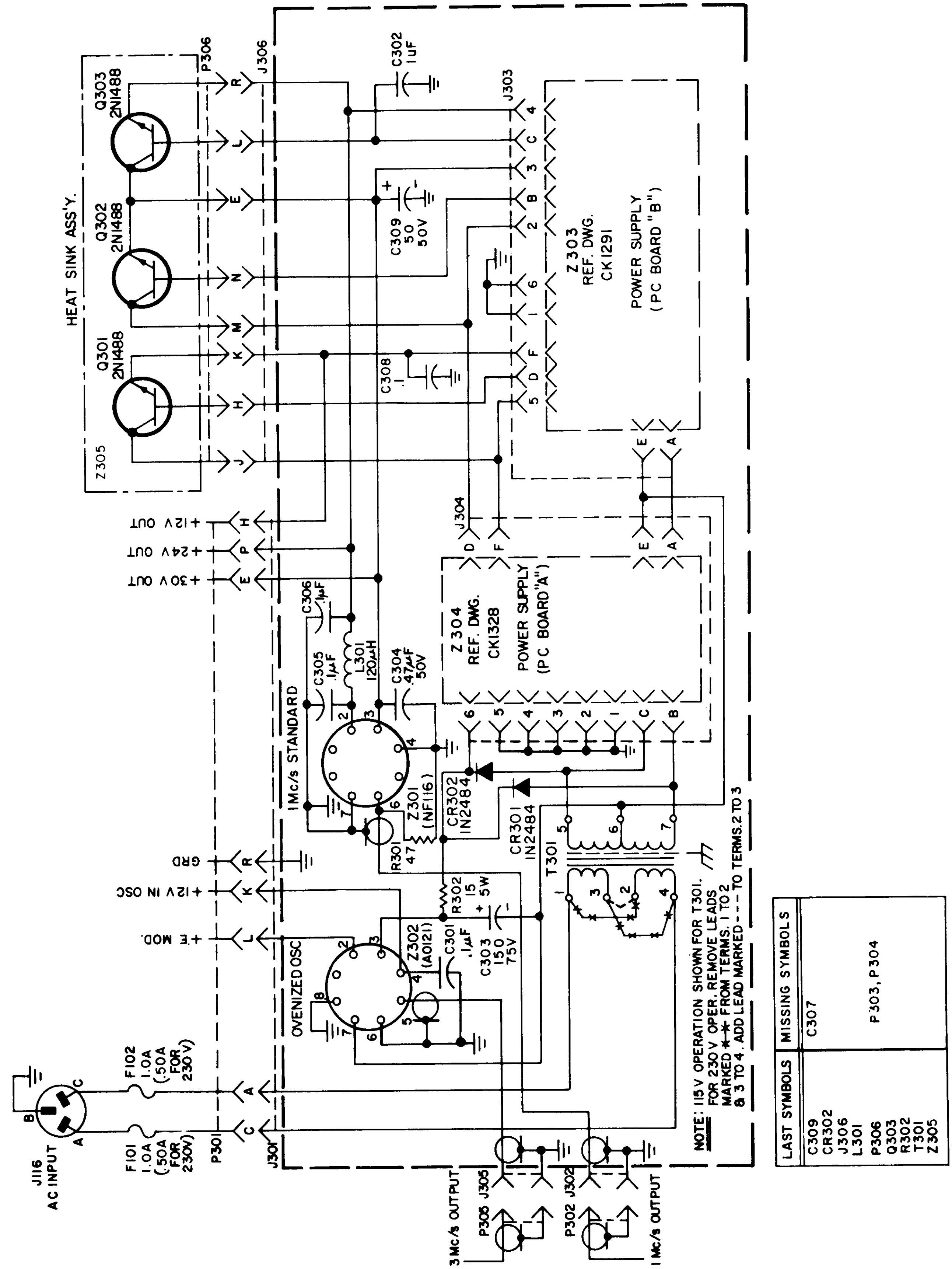
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. ALL INDUCTANCE VALUES ARE IN MICROHENRIES

WIRE BREAKOUT NO.	
LAST	MISSING
144	85, 91 TO 93, 107, 119, 123 TO 134

Figure 7-1. Overall Wiring Diagram, MMX(M)-2
(Sheet 2 of 2)



MULTIPLIER 1 & 10MHZ
TYPICAL FOR S106 & S107
TO SHEET 1
POWER INPUT
EXCITER ON
S113 PTT
EXT STD J122
S108 SHIFT
S110 SHIFT
S107A FRONT 10MHZ
S107B FRONT
S107B REAR
S106A FRONT 1MHZ
S106A REAR
S106B FRONT
S106B REAR
S106C FRONT
S106C REAR
S106D FRONT
S105B FRONT
S105B REAR
S106E FRONT
S106E REAR
TO S105A
CR102 1N627
MIKE J118
Z113 PC324/A4506
Z114 PC325/A4507
Z115 PC 306/A4502
J123 ALDC
ALDC ADJ
R103 500 RF OUTPUT
FX287
PC-487 Z119 A4751
TO SHEET 1
SHIFT (S110)



LAST SYMBOLS	MISSING SYMBOLS
C309 CR302 J306 L301 P306 Q303 R302 T301 Z305	C307 P303, P304

Figure 7-2. Power Supply Wiring Diagram