ARMY TM 11-5820-792-14
AIR FORCE TO 31R5-4-50-71

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT

AND GENERAL SUPPORT MAINTENANCE MANUAL

RADIO SET AN/FRC-154(V)

MODEL 1 THROUGH 28

This copy is a reprint which includes current pages from Changes 1 and 2.

DEPARTMENTS OF THE ARMY, AND THE AIR FORCE

JUNE 1975

WARNING

DANGEROUS VOLTAGES

Dangerous potentials (1200, 750, 500, 200, 48 volts dc) are present within this equipment. For general safety, avoid physical contact with all energized components while operating or maintaining the equipment. Observe good working practices at all times.

During installation of the equipment covered in this manual, conform to all safety requirements set forth in TB SIG 291. Comply with all safe practices. When working with any station signal or power cable, make certain that the cable is not energized. Also make certain that all power switches of the radio set are set to OFF before connecting cables.

Before operating the equipment covered in this manual, make certain that all requirements of TB SIG 291 are met.

Operator and maintenance personnel should be familiar with the requirements of TB SIG 291 before attempting maintenance of the equipment covered in this manual. Turn off the radio set corresponding Klystron power supply before removing or installing a Klystron tube, a Klystron driver, or RF components on RF panel 1A6. Whenever replacing either a Klystron power supply or the low voltage power supply, the corresponding meter panel dc power switch must be turned off. Do not turn off the radio set when removing or installing plug-in modules on door assemblies. Maintenance adjustments of the radio set are made with power applied. For general safety, avoid physical contact with all energized components except those designated in appropriate instructions. Observe good working practices at all times.

During disassembly of the equipment conform to all safety requirements set forth in TB SIG 291.

WARNING

The fumes of trichloroethane used for cleaning purposes are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

WARNING

COMPRESSED AIR

Compressed air is dangerous and can cause serious bodily harm. It can also cause mechanical damage to the equipment. Do not use compressed air to dry parts where trichloroethane has been used.

CHANGE
No. 1

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON, DC, 24 October 1978

Operator's, Organizational, Direct Support, and
General Support Maintenance Manual
RADIO SET AN/FRC-154(V)1 (NSN 5820-00-461-0733)
RADIO SET AN/FRC-154(V)2 (NSN 5820-00-461-0736)
RADIO SET AN/FRC-154(V)3 (NSN 5820-00-461-0738)
RADIO SET AN/FRC-154(V)4 (NSN 5820-00-461-0739)
RADIO SET AN/FRC-154(V)5 (NSN 5820-00-461-0740)
RADIO SET AN/FRC-154(V)6 (NSN 5820-00-461-0741)
RADIO SET AN/FRC-154(V)7 (NSN 5820-00-461-0742)
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RADIO SET AN/FRC-154(V)10 (NSN 5820-00-461-0765)
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RADIO SET AN/FRC-154(V)23 (NSN 5820-00-222-4637)
RADIO SET AN/FRC-154(V)24 (NSN 5820-00-472-4003)
RADIO SET AN/FRC-154(V)25 (NSN 5820-00-461-0865)
RADIO SET AN/FRC-154(V)26 (NSN 5820-00-461-0866)
RADIO SET AN/FRC-154(V)27 (NSN 5820-00-461-0867)
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TM 11-5820-792-14/T0 31R5-4-50-71, 30 June 1975, is changed as follows:

1. Title is changed as indicated above.
2. Remove old pages and insert new pages as indicated below.
3. New or changed material is indicated by a vertical bar in the margin of the page.
4. Added or revised illustrations are indicated by a vertical bar adjacent to the illustration figure number.

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Figure FO-16	Figure FO-16

5. File this change sheet in the front of the manual for reference purposes.
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11-302
29-134
29-136
29-207 (2)
29-610 (2)
DCA (1)
NG: None
USAR: None
For explanation of abbreviations used see, AR 310-50.

TECHNICAL MANUAL
No. 11-5820-792-14
TECHNICAL ORDER
TO 31R5-4-50-71

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE

WASHINGTON, DC, 30 June 1975

Operator's, Organizational, Direct Support, and General Support Maintenance Manual

RADIO SET AN/FRC-154(V)1 (NSN 5820-00-461-0733)
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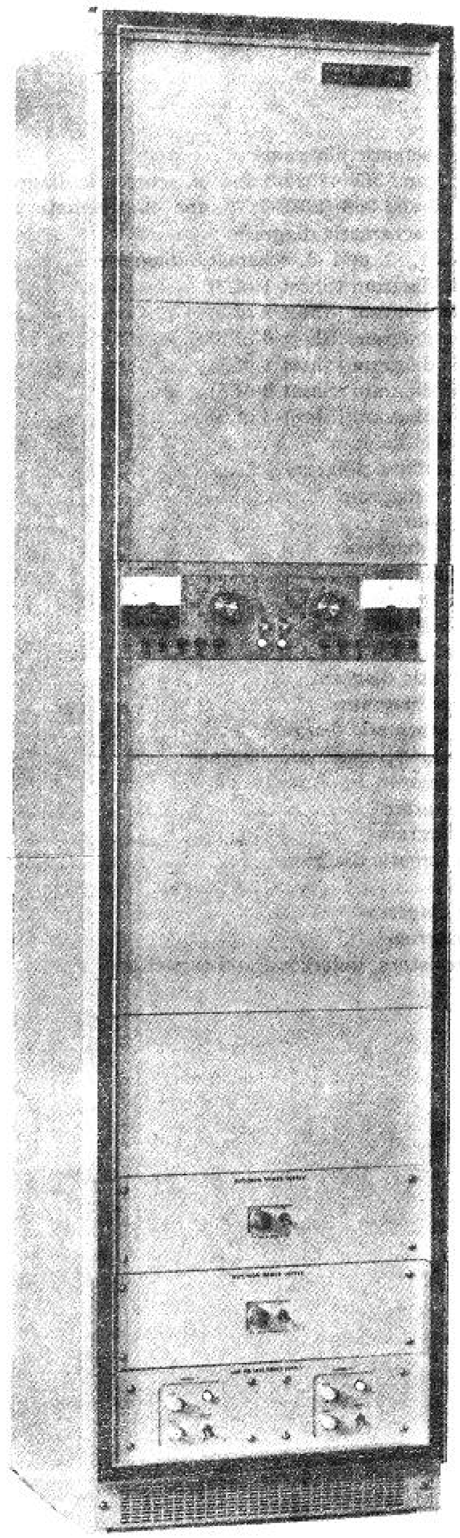

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Figure 1-1. Radio Set AN/FRC-154(V), models 1 through 28.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope

a. This manual describes Radio Set AN/FRC-154(V) (Models 1 through 28) (fig. 1-1), hereafter, referred to as the radio set. The manual includes information on description and data, installation, operation, functioning of equipment, maintenance, shipment and limited storage, demolition to prevent enemy use, and appendixes.

b. Throughout this manual, where appropriate, references are made to other publications which contain information applicable to the operation and maintenance of the radio set. A complete listing of applicable reference publications is provided in appendix A.

c. The maintenance allocation chart (MAC) appears in appendix C. The BIIL is not applicable to this equipment.

d. Items comprising an operable equipment are listed in paragraph 1-9.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to the latest issue of DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Maintenance Forms, Records and Reports

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management System (Army). Air Force personnel will use AFM 66-1 for maintenance reporting and TO-00-35D54 for unsatisfactory equipment reporting.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DLAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

1-4. Reporting Errors and Recommending Improvements

a. You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703.

b. For Air Force, submit AFTO Form 22 (Technical Order System Publication Improvement Report and Reply) in accordance with paragraph 6-5, Section VI, TO 00-5-1. Forward direct to prime ALC/MST.

c. In either case, a reply will be furnished direct to you.

1-4.1. Reporting Equipment Improvement Recommendations (EIR)

a. Army. If your AN/FRC-154(V) needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. We'll send you a reply.

b. Air Force. Air Force personnel are encouraged to submit EIR's in accordance with AFM 900-4.

1-5. Administrative Storage

Before and after administrative storage (1 to 45 days), perform the procedures in paragraphs 2-3 and 5-7. Administrative storage of equipment issued to and used by Army activities shall be in accordance with paragraphs 2-3 and 5-7 and local standard operating procedures (SOP).

1-6. Destruction of Army Materiel

Destruction of Army materiel to prevent enemy use shall be as prescribed in TM 750-244-2.

Section II. DESCRIPTION AND DATA

1-7. Purpose and Use

a. Purpose. Radio Set AN/FRC-154(V), models 1 through 28, provides standard line-of-sight (LOS) microwave fixed radio communications between various sites of a communication system.

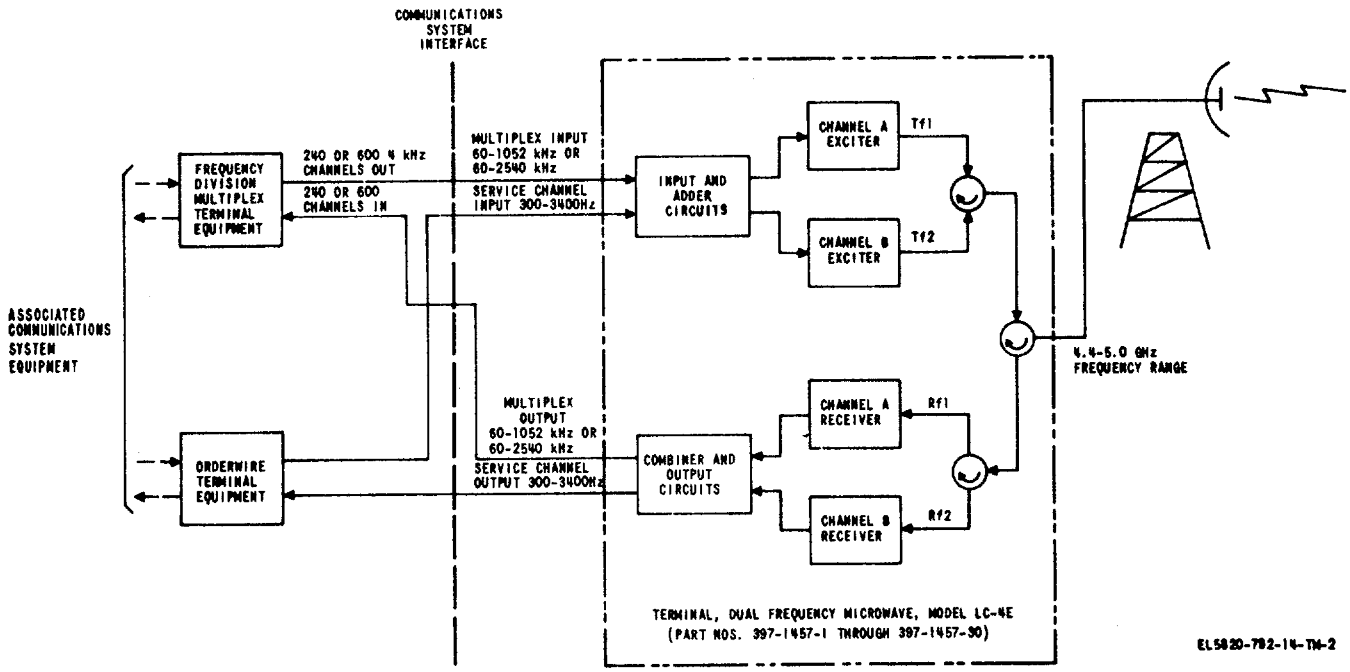

Figure 1-2. Radio set, system block diagram.

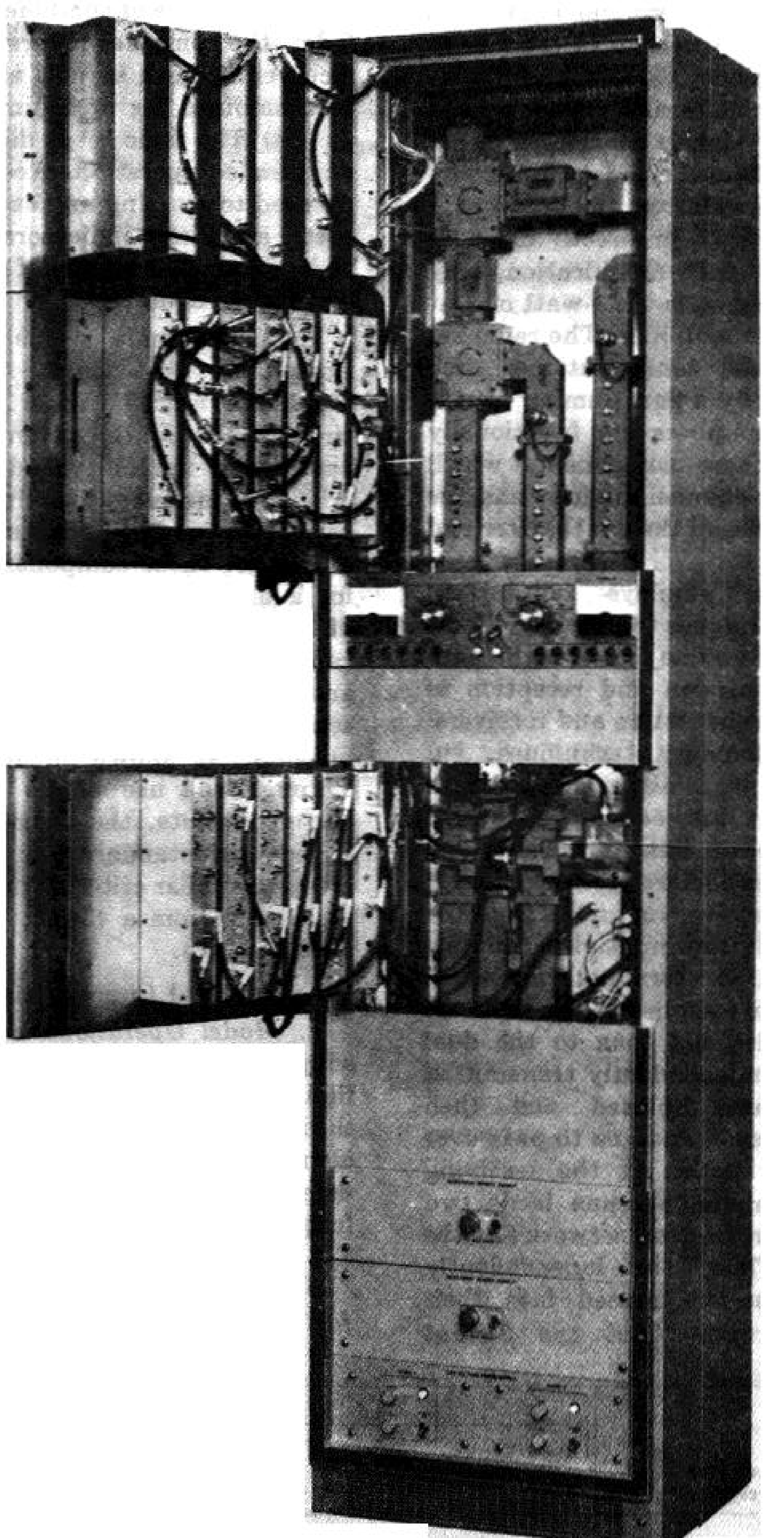

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Figure 1-3. Radio set, exterior front view with doors open.

b. Use.

(1) Radio Set AN/FRC-154(V) is a microwave dual-channel, full duplex, transmitting and receiving radio terminal equipment which operates on fixed frequencies in the 4.4- to 5.0-GHz superhigh frequency (SHF) band (fig. 1-2). The equipment transmits and receives fixed frequency-modulated rF signals containing either 240 or 600 multiplex channels and an orderwire channel. Nominal transmitter output power is 1 watt which is primarily used to directly drive an antenna. The radio set, with modification, may also be used as an exciter, with the 1-watt output driving a separate power amplifier. The radio set is supplied in 28 model configurations, each configuration identified by a part number from 1 through 28. All part numbers are functionally identical, except for those components which determine the multiplex channel capacity and the fixed operation frequencies of the dual exciter and dual receiver channels.

(2) The radio set employs full-duplex, frequency-diversity techniques to provide reliable communications over the same line-of-sight path by simultaneous transmission and reception of intelligence from dual transmitters and receivers. By using frequency-diversity techniques, environmental conditions are minimized where both transmitted frequencies are equally absorbed; thus, the possibilities of link downtime and periods of marginal reception are greatly reduced.

(3) The radio set receives its inputs from the associated frequency-division multiplex terminal equipment and the orderwire terminal equipment. The respective signals are applied to the radio set input and adder circuits and then to the dual exciter channels. The independently transmitted output frequencies are diplexed and then propagated from a common antenna to pass over the same line-of-sight path. At the receiving end of the link, a common antenna feeds two independent receiver preselector networks of the distant radio set. Thus, the independently transmitted frequencies are routed into their corresponding radio receivers at the distant station to complete the communications link. These received signals are later merged to form a single signal at the output of the radio set through the use of combiner action. As one signal fades, the combiner favors the other channel and vice versa. Both signals are always present and are combined for optimum performance.

(4) The radio set is designed for continuous, unattended operation. Accordingly, operation is reduced to starting and stopping the equipment. Meter and alarm indicators are provided for local and remote observation of the status of the radio set during operation.

(5) The radio set is of solid-state design except for the vacuum tube Klystron power amplifiers in the exciter. Its major functional circuits are contained in plug-in modules for operational flexibility and ease of maintenance. All components are interchangeable with corresponding components of all radio set models, except for those components which are required for a different multiplex channel capacity or a different operating frequency. The equipment cabinet is composed of a basic equipment rack and a number of panel and door assemblies which contain the various modules and other components, as shown in figures 1-1 and 1-3. Through the use of its adjustable input and output circuits, the radio set is capable of interface with standard communications equipment meeting similar criteria. The radio set is designed to operate from a 48-volt direct current primary power source.

1-8. Technical Characteristics

a. Model Operational Data. The radio set is supplied in 28 model configurations, each configuration identified by a part number from 1 through 28. All configurations are functionally identical except for those components which determine the channel capacity and the operating frequencies of the dual exciter and dual receiver.

b. Channel Capacity and Operating Frequency for Each Configuration.

Assigned operating frequency (MHz)

Radio set part No.	Channel capacity	Assigned operating frequency (MHz) Exciter channel A	Exciter channel B	Receiver channel A	Receiver channel B
397-1457-1	240	4712.00	4856.00	4418.00	4662.00
397-1457-2	240	4418.00	4562.00	4712.00	4856.00
397-1457-3	600	4454.00	4598.00	47 8.00	4892.00
397-1457-4	600	4748.00	4892.00	4454.00	4598.00
397-1457-5	600	4490.00	4634.00	4784.00	4928.00
397-1457-6	600	4784.00	4928.00	4490.00	4634.00

Assigned operating frequency (MHz)

Radio set part No. A	Channel capacity B	Exciter channel A	Exciter channel B	Receiver channel	Receiver channel
397-1457-7	600	4526.00	4670.00	4820.00	4964.00
397-1457-8	600	4820.00	4964.00	4526.00	4690.00
397-1457-9	600	4436.00	4580.00	4730.00	4871.00
397-1457-10	600	4730.00	4874!00	4436.00	4580.00
397-1457-11	600	4472.00	4616.00	4766.00	4910.00
397-1457-12	600	4766.00	4910.00	4472.00	4616.00
397-1457-13	240	4544.00	4688.00	4838.00	4982.00
397-1457-14	240	4838.00	4982.00	4544.00	4688.00
397-1457-15	240	4418.00	4562.00	4712.00	4856.00
397-1457-16	240	4712.00	4856.00	4448.00	4562.00
397-1457-17	240	4766.00	4910.00	4472.00	4616.00
397-1457-18	240	4472.00	4616.00	4766.00	4910.00
397-1457-19	240	4820.00	4964.00	4526.00	4967.00
397-1457-20	240	4526.00	4670.00	4820.00	4964.00
397-1457-21	240	4802.00	4946.00	4508.00	4652.00
397-1457-22	240	4508.00	4652.00	4802.00	4946.00
397-1457-23	240	4490.00	4634.00	4784.00	4928.00
397-1457-24	240	4784.00	4928.00	4490.00	4634.00
397-1457-25	240	4748.00	4892.00	4454.00	4598.00
397-1457-26	240	4454.00	4598.00	4748.00	4892.00
397-1457-27	600	4838.00	4982.00	4544.00	4688.00

c. Electrical. Alarm indicators; one set assigned to each channel for indication of following conditions:

Primary power
Transmit RF power (local and remote)
Transmit modulation loss (local and remote)
Receiver AGC (local and remote)
Receiver pilot tone (local and remote)
Receiver baseband pilot tone (local and remote)
Receiver noise (local and remote)

Assigned operating radio frequencies. Assigned according to model number. Refer to b above.

Channel capacity............. Capable of transmitting and receiving 240 nominal 4-kHz telephone channels occupying baseband frequency spectrum from 60 kHz to 1052 kHz or transmitting and receiving 600 nominal 4-kHz telephone channels occupying baseband frequency spectrum from 60 kHz to 2540 kHz. Refer to b above for specific channel capacity.

IF bandpass filter module (part No. 398-12067-3):
Bandwidth (1 db)............. 25 ± 1 MHz.
Insertion loss................... 11 ± 1 db.

Input/output impedance:
Multiplex .... 75 ohms, unbalanced.
Orderwire .... 600 ohms, balanced.

Input/output impedance:

Input levels:
Multiplex ....-45 dbm (range: -15 dbm to –45 dbm in 1 db increments).
Orderwire ....-35 dbm (range: -15 dbm to -35 dbm in 1 db increments).

Output level
Multiplex ....-15 dbm (range: -15 dbm to -45 dbm in 1 db increments.
Orderwire ....-15 dbm (range: -15dbm to -45 dbm in 1 db increments.

Input/output waveguide connection ....Type CPR -187F waveguide flange.

Panel meters; one assigned to each channel for measurement of following:
AGC (-5V) voltage (also provisions for remote indication).
Combiner (+ 20V) voltage.
Receiver mixer crystal current.

RF output power.
Low voltage power supply. -28 V dc.
Low voltage power supply. -6 V dc.
Klystron power supply. .....-750 V dc.
AFC Voltage:,
Klystron power supply. ..-500 V dc.
Klystron power supply. ..-200 V dc.

Mode of Operation ....Full-duplex, dual-channel, frequency-diversity.

Modulation technique ....Frequency modulation.

Pilot tone:
Frequency............................3.2 MHz ± 0.005% .
Level...................................6 db below SCTT, at the output of baseband combiner unit prior to filtering.
Suppression ....The pilot-tone signal at output of radio set (multiplex and service channel basebands) is suppressed 55 db with respect to the per-channel-test-tone level at same point.

Primary power requirements........-48 V dc (nominal) (-46 V dc to -52 V dc) with 100 millivolt peak-to-peak ripple (max.). Power consumption approximately 600 watts.
Radiofrequency range ....4.4 to 5.0 GHz.
Receiver IF center frequency ....70 MHz.
Receiver noise figure ....11.0 db.
RF output power rating........1.0 watt (nominal). 750 milliwatts (minimum).

d. Deemphasis Network. Refer to *a* above for specific channel capacity.

240 channel capacity
Location ....Limiter-discriminator module (part No. 368-13489-6).
Network...............................1300 kHz max. (part No. 398-
600 channel capacity...........11360-6).
Location ....Limiter-discriminator module (part No. 398-43489-8).
Network...............................2540 kHz fmax. (part No. 398-11360-7).

e. Deviation Capability.

Multiplex Capable of accepting single channel test tone levels from -15 dbm to -45 dbm with per channel deviations from 50 kHz to 200 kHz rms.
Service channel ....Capable of accepting single channel test tone levels from -15 dbm to -35 dbm with per channel deviations from 50 kHz to 200 kHz rms.
Diversity frequency separation......144.00 MHz.
Exciter amplifier..................Reflex klystron.

f. Exciter RF Filters. To determine filter part number, use basic part number 368-43346 for tuned center frequencies of 4.4 to 4.7 GHz, or 368-43627 for tuned center frequencies of 4.7 to 5.0 GHz. Select frequency range to accommodate complete bandwidth. Follow basic part number with the six digits of the tuned center frequency. *For example,* part number 368-43346456200 has a tuned center frequency of 4562.00 MHz, while 368-43627471200 has a tuned center frequency of 4712.00 MHz.

Bandwidth (0.1 db) ....21 MHz (minimum).
Bandwidth (-3 db)................52 MHz (maximum).
Center-frequency range:
Part number 368-43346.......4400 to 4700 MHz.
Part number 368-43627.......4700 to 5000 MHz.
Construction........................4 section, iris coupled
Rejection.............................20 db (minimum) at f. ± 70 MHz.
Tuned center frequency ......Same as operating frequency of assigned channel.

g. Frequency Response.

Multiplex ....60 kHz to 2540 kHz, ± 0.5 db 4.3 kHz to 60 kHz, ± 1.0 db.
Service channel ....300 Hz to 3.4 kHz, ± 1.0 db.

h. Frequency Source Crystal Data.

Radio set part No.	Crystal frequencies (MHz)			
	Channel A exciter local AFC oscillator	Channel B exciter local AFC oscillator	Channel A receiver local oscillator	Channel B receiver local oscillator
397-1457 -1	108.6818	111.9545	098.8181	102.0909
-2	098.8181	102.0909	108.6818	111.9545
-3	099.6364	102.9091	109.5000	103.3750
-4	109.5000	103.3750	099.6364	102.9091
-5	100.4545	103.7273	110.3182	104.1250
-6	110.3182	104.1250	100.4545	103.7273
-7	101.2727	104.5455	111.1364	104.8750
-8	111.1364	104.8750	101.2727	104.5455
-9	099.2273	102.5000	109.0909	103.0000
-10	109.0909	103.0000	099.2273	102.5000
-11	100.0455	103.3182	109.9091	103.7500
-12	109.9091	103.7500	100.0455	103.3182
-13	101.6818	104.9645	111.5455	105.2500
-14	111.5455	105.2500	101.6818	104.9545
-15	102.0000	105.2727	105.5000	108.7727
-16	105.5000	108.7727	102.0000	105.2727
-17	109.9091	103.7500	100.0455	103.3182
-18	100.0455	103.3182	109.9091	103.7500
-19	111.1364	104.8750	101.2727	104.5455
-20	101.2727	104.5455	111.1364	104.8750
-21	110.7273	104.5000	100.8636	104.1364
-22	100.8636	104.1364	110.7273	104.5000
-23	100.4545	103.7273	110.3182	104.1250
-24	110.3182	104.1250	100.4545	103.7273
-25	109.5000	103.3750	099.6364	102.9091
-26	099.6364	102.9091	109.5000	103.3750
-27	111.5455	105.2500	101.6818	104.9545
-28	101.6818	104.9545	111.5455	105.2500

NOTE

To determine crystal part number, use basic part number 364-8029 followed by the seven digits of the crystal frequency. *For example,* crystal part number 364-80291086818 is ground to frequency 108.6818 MHz.

i. Frequency Source Frequency Ranges.

Part No.	*Frequency range of untuned source*
368-42299 (MSC-49X-02).	4330 to 4930 MHz.
368-42299-37 (MSC-51X).	4812.5 to 5312.5 MHz.
Frequency source harmonic multiplication factor.	44.
Frequency source operating frequencies:	
Channel A AFC local oscillator (1A6Y1).	70 MHz above assigned operating frequency of exciter channel.
Channel B AFC local oscillator (1A6Y2).	70 MHz above assigned operating frequency of exciter channel.
Channel A receiver local oscillator (1A6Y3).	70 MHz below assigned operating frequency of receiver channel.
Channel B receiver local oscillator (1A6Y4).	70 MHz below assigned operating frequency of receiver channel.
Frequency source power output.	5 milliwatts (nominal).
Frequency stability	Unmodulated output RF carrier frequency of each exciter channel within ± 0.01% of assigned operating frequency.

j. Preemphasis Network.

NOTE

Refer to b above for specific channel capacity.

240 channel capacity:
Location .... Klystron driver module (part No. 368-43490-6).
Network.................................. 1300 kHz fmax. (part No. 368-41959-7).

600 channel capacity:
Location .... Klystron driver module (part No. 368-43490-2).
Network.................................. 2540 kHz fmax. (part No. 368-41959-8).

k. Receiver RF Filters.

Bandwidth (0.1 db) .... 21 MHz (minimum).
Bandwidth (-3 db)................... 46 MHz (maximum).
Center-Frequency range:
Part number 368-43869 ...... 4400 to 4700 MHz.
Part number 368-43871 ...... 4700 to 5000 MHz.
Construction........................... 6 section, iris coupled.
Rejection................................ 55 db (minimum) at f. ± 70 MHz.
Tuned center frequency .... Same as operating frequency of assigned channel.

NOTE

To determine filter part number, use basic part number 368-43869 for tuned center frequencies of 4.4 to 4.7 MHz, or 368-43871 for tuned center frequencies of 4.7 to 5.0 MHz. Select frequency range to accommodate complete bandwidth. Follow basic part number with the six digits of the tuned center frequency. For example, part number 368-43869441800 has a tuned center frequency of 4418.00 MHz, while 368-43871471200 has a tuned center frequency of 4712.00 MHz.

l. Environmental Operating Conditions.

Ambient operating conditions:
Temperature .... + 32° F to 122° F (0° to + 50° C).
Altitude .... 10,000 ft (max.).
Relative humidity .... 0-90% (max.).
Storage conditions:
Temperature .... -50° to + 176° F (-50° to 80° C).
Altitude.................................. 40,000 ft (max.).
Relative humidity .... 0-96% (max.).

1-9. Items Comprising an Operable Equipment

Item	Dimensions (in.) Height	Depth	Width	Unit Weight (lb)	Figure No.
Adder module	11 15/16	4 7/16	1 15/16	2 max	3-4(1)
Afc module	11 15/16	4 7/16	1 15/16	4 max	3-4(2)
Baseband combiner module	11 15/16	4 7/16	1 15/16	2 max	3-4(3)
Dual pilot-tone detector module	11 15/16	4 7/16	1 15/16	2 max	3-4(4)
IF amplifier module	11 15/16	4 7/16	1 15/16	2 max	3-4(5)
IF bandpass filter module	11 15/16	4 7/16	1 15/16	1 max	3-4(6)
IF preamplifier module	1 1/2	4	3	1 max	FO-4
Klystron driver module	5	3	14 1/2	3 max	3-4(11)
Klystron power supply	6	16 1/4	19 3/4	40	3-2
Limiter-discriminator module	11 15/16	4 7/16	1 15/16	2 max	3-4(7)
Low voltage power supply	6	16 1/4	19 3/4	40	3-3
Meter panel	6	4 3/4	i9 3/4	8 max	3-1
Noise amplifier module	11 15/16	4 7/16	1 15/16	2 max	3-4(8)
RF panel	54	8	19 3/4	30	FO-4
Terminal filter module	11 15/16	4 7/16	1 15/16	1 max	3-4(9)

1-10. Common Names.

Common name	Reference designation	Functional description
Cabinet	1	Houses all assemblies.
Receiver door assembly	1A1	Mounts all receiver modules.
IF bandpass filter module	1A1MD1	Establishes receiver IF bandwidth parameters for channel B.
Limiter-discriminator module	1A1MD2	Demodulates 70-MHz IF signal into baseband signal for channel B.
IF amplifier module	1A1MD3	Amplifies 70-MHz IF signals for channel B.
IF bandpass filter module	1AMD4	Establishes receiver IF bandwidth parameters for channel A.
Limiter-discriminator module	1A1MD5	Demodulates 70-MHz IF signal into baseband signal for channel A.
IF amplifier module	1A1MD6	Amplifies 70-MHz IF signals for channel A.
Combiner door assembly	1A2	Mounts all combiner modules.
Dual pilot-tone detector module	A2MD1	Detects loss of pilot-tone signal in baseband A or baseband B.
Receiver terminal filter module	1A2MD2	Separates multiplex and supervisory channel outputs from corresponding composite baseband signals; provides necessary electrical interface for signals.
Baseband combiner module	1A2MD3	In conjunction with baseband combiner module 1A2MD4 (channel A), combines baseband signals from receiver channels A and B to form a single composite baseband signal.
Baseband combiner module	1A2MD4	In conjunction with baseband combiner module 1A2MD3 (channel B), combines baseband signals from receiver channels A and B to form a single composite baseband signal.
Noise amplifier module	1A2MD5	Amplifies noise slot signal; rejects multiplex and orderwire channel signals in channel B.
Dual pilot-tone detector module	1A2MD6	Detects loss of receiver pilot-tone in receiver channel A or B.
Noise amplifier module	1A2MD7	Amplifies noise slot signal; rejects multiplex and orderwire channel signals in channel A.
Meter panel	1A3	Provides mounting for metering, switching, and indicating components used for operation, monitoring and maintenance.
Exciter door assembly	1A4	Mounts exciter modules.
AFC module	A4MD1	Compares output frequency with reference frequency; generates error signal for corrective purposes in channel B.
Dual pilot-tone detector module	1A4MD2	Detects loss of modulation in exciter channels A and B.
AFC module	1A4MD3.	Compares output frequency with reference frequency; generates error signal for corrective purposes in channel A.
Adder module	1A4MD4	Adds multiplex and service channel signals to form composite baseband signal for channel B.
Transmit terminal filter module	1A4MD5	Receives multiplex and supervisory channel signals; provides necessary electrical interface for signals.
Adder module	1A4MD6	Adds multiplex and service channel signals to form composite baseband signal for channel A.
Low voltage power supply	1A5	Produces + 28v dc, + 20v dc, and -6v dc operating voltages.
RF panel	1A6	Mounts exciter and receiver components.
IF preamplifier module	1A6MD1	Provides necessary preamplification gain for 70-MHz IF signal in receiver channel A.
IF preamplifier module	1A6MD2	Provides necessary preamplification gain for 70-MHz IF signal in receiver channel B.
Klystron driver module	1A6MD3	Provides baseband signal amplification, preemphasis, and signal injection into klystron for exciter channel A.
Klystron driver module	1A6MD4	Provides baseband signal amplification, preemphasis, and signal injection into klystron for exciter channel B.
Klystron power supply	1PS1	Produces de operating voltages for exciter channel A klystron driver module and kystron.
Klystron power supply	1PS2	Produces dc operating voltages for exciter channel B klystron driver module and klystron.

1-11. Description

a. Equipment Cabinet. The radio set is housed in an 82.5-inch high cabinet (designated with numeral 1). The equipment cabinet is composed of a receiver door assembly (1A1), a combiner door assembly (1A2), a meter panel (1A3), an exciter door assembly (1A4), two identical klystron power supplies (1PS1 and 1PS2, respectively), a low voltage power supply (1A5), and an RF panel (1A6). The equipment is of solidstate design with the exception of the reflex klystron amplifiers, which are vacuum tubes. The major functional circuits are contained in plug-in or nonplug-in type modules located on the various door assemblies and the RF panel. Figure 1-4 illustrates the cabinet layout of the radio set and the location of the various plug-in modules.

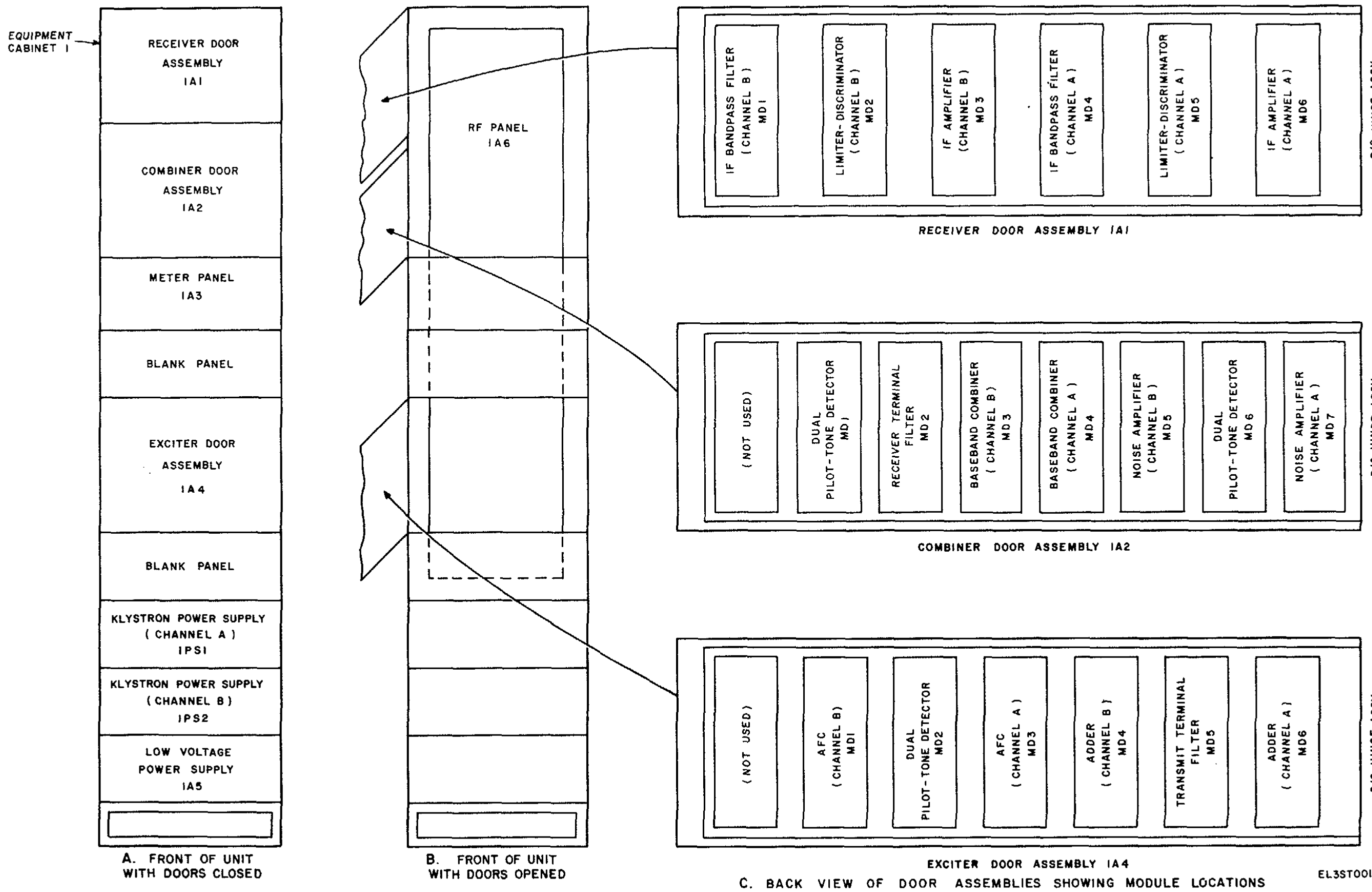

Figure 1-4. Cabinet layout and location of modules.

b. Major Assemblies.

(1) The receiver door assembly provides mounting for six receiver plug-in modules. Three of these modules are associated with receiver diversity channel A, and the remaining three modules are associated with receiver diversity channel B. The module units for each diversity channel are an IF amplifier, an IF bandpass filter, and a limiter-discriminator. For either 240 or 600 channel operation, specific limiter-discriminator modules must be used; each of the channel capacities requires a different deemphasis network which is contained in the limiter-discriminator. The remaining modules may be used for either channel operation.

(2) The combiner door assembly provides mounting for seven combiner plug-in modules. In the frequency-diversity configuration, each of the two channels is assigned a baseband combiner module and a noise amplifier module; in addition, each channel shares a baseband dual pilot-tone detector module and a receiver dual pilot-tone detector module. Also, a receiver terminal filter is common to both channels.

(3) The exciter door assembly provides mounting for six exciter plug-in modules. An adder module and an AFC module are assigned to each of the dual exciter channels, white the terminal filter module and dual pilot-tone detector module are common to both channels.

(4) The meter panel assembly provides mounting for dual metering switching, and indicating components. This panel is used for monitoring and maintenance.

(5) The radio set contains two identical Klystron power supply assemblies shown in figure 1-4. One assembly is associated with channel A and the other with channel B. These two supplies furnish all the necessary operating voltages for the Klystron and the Klystron driver modules.

(6) The dual low voltage power supply provides the dc operating voltages (other than those provided by the Klystron supplies) for the circuits of the radio set. All supply circuits are of solid-state design. Channel A section is designated1A5PS1 and channel B, 1A5PS2.

(7) The RF panel is fully accessible from the front of the equipment cabinet when the three door assemblies are in the opened position (fig. 1-3). The panel contains waveguide sections and components, and certain modules which are mounted so that their outputs are physically close to the high-impedance inputs of their associated circuitry. Examples of this are the Klystron driver and the IF preamplifier module. The Klystron driver is mounted so that its signal interconnecting elements are physically close to the high-impedance points of the associated Klystron. The IF preamplifier module is mounted direct to the receiver-mixer with four mounting screws. The signal interconnection is made by a probe extending from the mixer into the IF preamplifier module. All the circuit elements that determine the RF output frequencies or receiver frequencies are located on the RF panel. To change the operating frequencies, only these components must be changed. The components include the exciter AFC frequency sources, exciter RF filters, receiver frequency sources, and receiver RF filters. For either 240- or 600-channel operation, specific Klystron driver modules must be used; each of the channel capacities requires a different preemphasis network which is contained in the Klystron driver.

c. Differences in Model Configurations.

(1) The radio set is supplied in 28 model configurations, each identified by a part number from 1 through 28. All part numbers are functionally identical except for those components which determine the channel capacity and the operating frequencies of the dual exciter and dual receiver. The components which vary according to channel capacity include the klystron driver module and the limiter-discriminator module for each of the dual channels. The components which vary according to RF assignment include the exciter AFC frequency sources, the exciter RF filters, the receiver frequency sources, and the receiver RF filters. All other components of the radio set are common for all configurations; this commonality includes the meter panel and the lower supplies which contain the external controls of the radio set. Therefore, all externally located controls of the various configurations are correspondingly identical. Since the various configurations differ only in channel capacity and operating frequencies, the components which effect the differences are located internally in the modules and certain other parts mentioned above. However, these components do not affect the externally located controls of modules and parts in which they are contained; therefore, all externally located controls of these modules and such of the various radio set part numbers are correspondingly identical.

(2) The radio set is a dual-channel, full-duplex, fixed-frequency, transmitting and receiving microwave radio terminal which is designed for continuous, unattended operation. Since the channel capacity and operating frequencies are fixed as designated by the

microwave communications system, no change to these requirements is required by operating personnel. Accordingly, operation of all configurations is reduced to starting and stopping the equipment using the correspondingly identical controls.

(3) The differences in configurations are basically operational in nature; therefore, they have been presented in paragraph 1-8 because of the extensive number of configurations and accompanying data.

CHAPTER 2

INSTALLATION

WARNING

During installation of this equipment, conform to all safety requirements set forth in TB SIG 291. Injury or DEATH could result from failure to comply with safe practices.

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

2-1. Siting Instructions

The radio set is designed for installation in the equipment room of a building or other type of fixed location shelter. The radio set can also be installed in an appropriate mobile van. Any structural changes to a building and minor revisions to existing power distribution, if necessary, must be performed in accordance with approved installation drawings.

2-2. Shelter Requirements

a. No special siting procedure is required to locate the radio set in an equipment room. Its position will be determined by the location of associated equipment, such as RF power amplifier, multiplex equipment, and miscellaneous equipment racks, and interconnection facilities, such as distribution frames and patch bays. Since radio interference with nearby equipments is extremely low, the radio sets can be placed immediately adjacent to the associated equipment cabinets. Facility layout and installation drawings should be inspected before the actual installation.

b. Shelter Specifications Data.

Floorspace:	
Equipment	2.4 sq ft
Maintenance	14.4 sq ft
Floor loading	277 lb/sq ft
Ceiling height	9 ft min
Cable raceway height	8 ft min
Waveguide or coaxial bending radius (min):	
Helix elliptical waveguide)	30 degrees
7/8 Styroflex (coaxial)	12 degrees

c.The equipment room is normally air conditioned with the temperature held at 70 +-10 F with a relative humidity of 60 -20 percent; however, the equipment is capable of storage and operation within the temperature and humidity limits listed in paragraph 1-81.

d. The primary power requirements for the radio set are 48 vdc (--46 to 52 vdc), with 100 millivolts peak-to-peak ripple (maximum). The radio set dissipates approximately 600 watts of power.

e. The radio set requires a minimum floorspace 20.5 inches wide by 17.0 inches deep. A minimum clearance of 4 feet at the front of the radio set is required for maintenance. A minimum clearance of 4 inches is required at the rear of the equipment to allow sufficient airflow to the power supplies at the bottom of the unit. Refer to figure 2-1 for the cabinet outline dimensions. The dimensions given on the bottom view of the cabinet should be used by the installer to fabricate a template for accurately locating the mounting holes on the floor of the equipment room.

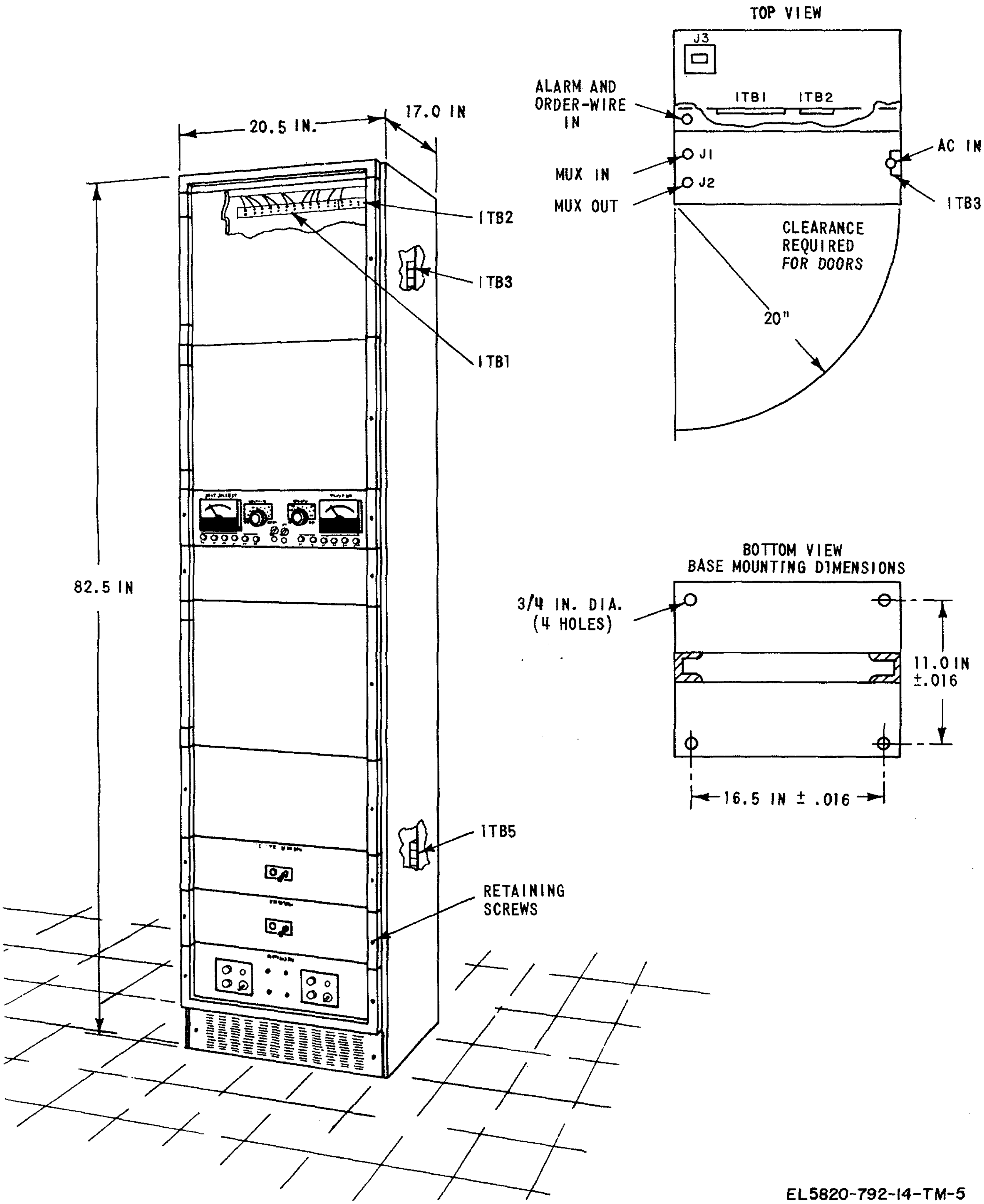

Figure 2-1. Cabinet outline dimensions and installation details.

2-3. Packaging Data.

a. Receiving Data. The equipment is shipped in a wooden crate with all assemblies already mounted in the cabinet for the particular configuration and ready for installation. Refer to paragraph 1-9 for a listing of the components of the radio set.

b. Dimensions and Weights.

Dimensions, crated:

Length	95 in.
Width	30 in.
Depth	28.5 in.

Dimensions, uncrated:

Height	82.5 in.
Width	20.5 in.
Depth	17.0 in.

Weight (approx):

Crated	650 lb.
Uncrated	500 lb.

c. Material Handling.

(1) The radio set is shipped in a wooden crate mounted on alifting pallet base and is designed to be transported in a horizontal position.

(2) The material handling equipment necessary to enable safe handling of the crated radio set includes a forklift truck, for use in unloading the crate from its transport vehicle and positioning it in a suitable area prior to uncrating. Also required for safe handling is a lifting sling with a chain hoist or block and tackle; these items are necessary to remove the radio set from its shipping crate. Although the radio set is shock mounted within the shipping crate, care should be used when moving the radio set to avoid any excessive shock or vibration. If the material handling equipment is not available at the installation area, roller bars and nylon cargo straps TM 11-5820-792-14 /-TO 31 R5-4-50-71 may be used provided that adequate manpower is utilized.

(3) A summary of the material handling equipment required to handle the radio set at the installation area is as follows:

(a) Forklift truck, capable of safely handling the packaged weight of the equipment.

(b) Chain hoist or block and tackle, capable of safely supporting the packaged weight of the equipment.

(c) Lifting sling, capable of supporting the weight of the equipment.

(4) The common tools required for unpacking the radio set are as follows:

(a) Nailpuller (or pry-bar or ripping-chisel if nailpuller is not available).

(b) Claw hammer.

(c) Metal shears.

(d) Common scissors.

(e) Phillips-head screwdriver.

(5) A positioning dolly should be used to move the radio set cabinet to its permanent location in the equipment room after the anchor bolts have been installed. If a dolly is not available, a piece of canvas can be used to move the cabinet into position to prevent marring the floor.

d. Unpacking Instructions.

(1) Move the shipping crate to a suitable area for unpacking, as close as possible to the final radio set location. Refer to figure 2-2 and unpack the equipment as follows:

CAUTION

If a pry-bar or ripping chisel is used, proceed carefully to avoid damage to the equipment.

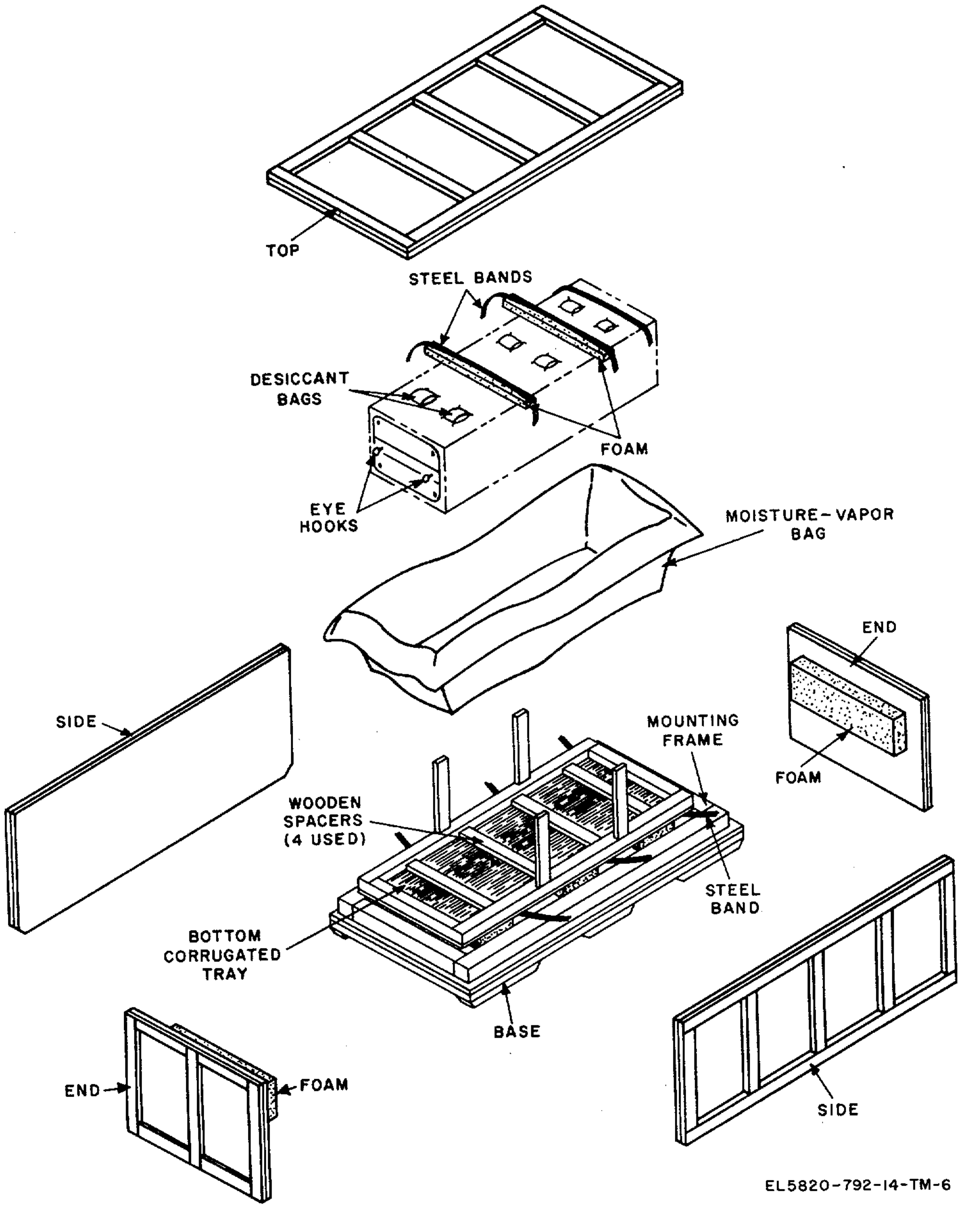

Figure 2-2. Radio set, packaging diagram.

(a) Using a nailpuller (or pry-bar or ripping-chisel if nailpuller is not available), carefully remove the nails that secure top of crate to sides and ends of crate. Set crate top aside.

(b) Using a, nailpuller, remove the nails that secure the two sides of crate to ends and shipping base. Remove sides of crate.

(c) Using a nailpuller, remove the nails that secure two ends of crate. Set ends aside.

WARNING

Take care to prevent the steel banding from recoiling when cut.

(d) Using the metal shears, cut thesteel banding as close as possible to the mounting frame.

(e) Remove holddown bars and set bars aside.

(f) Using scissors, cut open the moisture/vapor-proof bag. Carefully fold bag down to shipping base.

(g) Attach lifting device to two eyebolts at top of cabinet. Lift the cabinet until it clears the base of crate.

(h) Remove crate and skid and lower cabinet into position.

(i) Using Phillips-head screwdriver, open front panels. Remove bands and package materials that are used to prevent vibration of the plug-in modules.

(j) Secure front panels.

(2) If the shipping crate is to be stored for future reshipment, perform the following.

Remove any protruding nails remaining in wooden members of crate, carefully place all packing material on mounting frame and secure packing material to shipping base, and store in this knocked-down condition to conserve storage space.

e. Checking Unpacked Equipment.

(1) Inspect the equipment for damage that may have occurred during shipment. If the equipment has been damaged, fill out and forward DD Form 6 (para 1-3b).

(2) Check to see that the equipment is complete as listed on the packing slip. If a packing slip is not available, check the equipment TM 11-5820-792-14 /-TO 31 R5-4-50-71 against the items listed in paragraph 1-9. Report all discrepancies in accordance with TM 38-750.

The equipment should be placed in service even though a minor assembly or part that does not affect proper functioning is missing.

(3) Check to see whether the equipment has been modified. If the equipment has been modified, the MWO number will appear on the front panel, near the nomenclature plate. Check also to see whether all MWO's current at the time the equipment is placed in use have been applied.

NOTE

Current MWO's applicable to the equipment are listed in DA Pam 310-7.

(4) Check the latest issue of DA Pam 310-4 (never more than 1 year old) and its latest changes (never more than 6 months old) to see whether you have the latest editions of all applicable maintenance literature.

Section II. INSTALLATION INSTRUCTIONS

When working with any station signal or power cable, make certain that the cable is not energized. Also make certain that all power switches of the radio set are in the OFF position.

2-4. Tools, Test Equipment, and Materials Required for Installation

No special tools are required to install the radio set. For installation of the equipment, use appropriate items listed in items comprising an operable equipment list (para 1-8).

2-5. Installation Procedures

a. Cabinet Mounting.

(1) The method of securing the cabinet in place varies depending upon the composition of the equipment room floor. On wooden floors, it is necessary to use lag bolts to secure the cabinet; on concrete floors, it is necessary to drill holes for anchor bolts. By using the cabinet base mounting dimensions shown in figure 2-1, the installation team can easily fabricate a template to accurately position the mounting holes in the floor of the equipment room.

(2) After the mounting holes have been prepared, secure the cabinet to the equipment room floor as follows:

(a) Remove the dual low voltage power supply from the cabinet by removing the two retaining screws (fig. 2-1) and pulling the power supply forward.

(b) Remove the eight screws that fasten the screen at the lower rear of the cabinet and remove the screen.

(c) Slide the cabinet into position and align the cabinet base mounting holes over the holes in the equipment room flooring. Secure the cabinet to the floor using appropriate mounting hardware.

(d) Reinstall the power supply and the screen removed in (a) and (b) above.

b. Cabling Data.

Radio set terminal or connector	*Wire size*	*Description*
1TBl-1	24 AWG	Channel A receiver AGC remote alarm (COM). a
-2	24 AWG	Channel A receiver AGC remote alarm (N.O.). b
-3	....	Not used.
-4	25 AWG	Channel A receiver AGC remote monitor meter.
-5	Shield	Station ground for channel A receiver AGC monitor meter.
-6	24 AWG	Channel A receiver pilot-tone remote alarm (COM).
-7	24 AWG	Channel A receiver-pilot-tone remote alarm (N.O.)
-8	24 AWG	Channel A receiver noise remote alarm (COM).
-9	24 AWG	Channel A receiver noise remote alarm (N.O.).
-10	24 AWG	Channel A baseband pilot-tone remote alarm (COM).
-11	24 AWG	Channel A baseband pilot-tone remote alarm (N.O.).
-12	24 AWG	Channel A exciter RF power remote alarm (COM).
-13	24 AWG	Channel A exciter RF power remote alarm (N.O.).
-14	24 AWG	Channel A exciter modulation loss alarm (COM).
-15	24 AWG	Channel A exciter modulation loss alarm (N.O.).
-16	....	Not used.
-17	....	Not used.
-18	Shield	Station ground for service channel input.
-19	24 AWG	Service channel input.
-20	24 AWG	Service channel input.
1TB2-1	24 AWG	Channel B receiver AGC remote alarm (COM).
-2	24 AWG	Channel B receiver AGC remote alarm (N.O.
-3	....	Not used.
-4	24 AWG	Channel B receiver AGC remote monitor meter.
-5	Shield	Station ground for channel A receiver AGC monitor meter.
-6	24 AWG	Channel B receiver pilot-tone remote alarm (COM).
-7	24 AWG	Channel B receiver pilot-tone remote alarm (N.O.).
-8	24 AWG	Channel B receiver noise remote alarm (COM).
-9	24 AWG	Channel B receiver noise remote alarm (N.O.).
-10	24 AWG	Channel B baseband pilot-tone remote alarm (COM).
-11	24 AWG	Channel B baseband pilot-tone remote alarm (N.O.).
-12	24 AWG	Channel B exciter RF power remote alarm (COM).
-13	24 AWG	Channel B exciter RF power remote alarm (N.O.).
-14	24 AWG	Channel B exciter modulation loss alarm (COM).
-15	24 AWG	Channel B exciter modulation loss alarm (N.O.).
-16	....	Not used.
-17	....	Not used.
-18	Shield	Station ground for service channel output.
-19	24 AWG shielded	Service channel output.
-20	24 AWG shielded	Service channel output.
1TB3-1	10 AWG	Station power + 48 V dc.
-2	....	Not used.
-3	....	Not used.
-4	6AWG	Station power -48 V dc.
1J1	RG-59/B type (VIKOA 2690 double-shielded).	Multiplex input.
1J2	RG-59B type (VIKOA 2690 double-shielded).	Multiplex output.
1J3	Waveguide	Antenna.
1W1E2	6 AWG	Chassis ground

[a] COM is abbreviation for common contact of dry form "C" relay typically used at remote alarm location.
[b] N. O. is the abbreviation for a normally open contact of a dry form "C" relay normally used at a remote alarm location.

c. Primary DC Power and Cabinet Grounding. The radio set requires a primary power input of 48 volts dc which is supplied by two separate cables (a --48 volt dc cable and a +48 volt dc cable). Refer to figure FO-5 (). The two cables are inserted into the cabinet through the access hole located at the top of the cabinet. The --48 volt cable is connected directly to terminal board 1TB3-4. The +48 volt cable is connected to chassis ground 1WiE2 and is connected to terminal board ITB3-1 through a cable connector (Frankel). Terminal board 1TB3 is accessible when the receiver door is in the opened position. Perform the following procedures:

(1) Insert a cable clamp through the access hole located at the top of the cabinet. Secure clamp to the cabinet with the clamp retaining nut.

(2) Insert the two primary power cables through the cable clamp. Do not tighten the cable clamp at this time.

(3) Connect the -48 volt power cable (6 AWG) to terminal board 1TB3-4.

(4) Connect the +48 volt cable (6 AWG) from the primary power source to chassis ground lug 1WIE2; then, using a connector, connect a cable (10 AWG) from the 6 AWG cable to terminal board 1TB3-1. Secure the two cables to the connector by tightening the Allen-head screw.

Secure the cover of the connector with the metal clamp.

(5) Check to see that the two primary power cables are properly inserted through the cable clamp at the top of the cabinet, then tighten the clamp to secure the cables.

d. Signal Connections. The signal cables are connected to the radio set as listed below. Use cabling data given in b above. Terminal boards ITBI and 1TB2 are accessible when the receiver door is in the opened position.

(1) Prepare and connect channel A remote alarm cable and orderwire input cable to terminal board LTBI. Insert and clamp cables through use of access hole located at top of cabinet.

(2) Prepare and connect channel B remote alarm cable and orderwire output cable to terminal board 1TB2. Insert and clamp cables through use of access hole located at top of cabinet.

(3) Connect the multiplex input coaxial cable to connector 1J1.

(4) Connect the multiplex output cable to connector 1J2.

e. Antenna Connection. The station waveguide is connected to connector 1J3 located at the top of the cabinet.

2-6. Initial Check and Adjustment of Equipment

a. Installation Adjustments. Perform the following:

(1) The radio set is factory shipped with the various T and H pad attenuators and level-setting potentiometers of the transmit terminal filter 1A4MD5 and receiver terminal filter 1A2MD2 adjusted for certain testing standard baseband (multiplex and orderwire) input and output levels. This was necessary to facilitate final production testing of the radio set. This process is explained in detail in the introductory material of section TM 11-5820-792-14 / TO 31 R5-4-50-71 IV, chapter 5. Upon receipt of the equipment in the field it may be necessary to adjust the inputoutput circuits to different levels specified for the communications system. For these levels (and any other criteria), refer to the appropriate system literature. The instructions for making these adjustments to the equipment are contained in paragraphs 5-16 through 5-29.

(2) The radio set is factory-shipped with the proper preemphasis and deemphasis networks installed as required for the intended radio set installation. The preemphasis networks are installed in the klystron driver modules and the deemphasis networks are installed in the limiterdiscriminator modules. The networks are a function of the assigned channel capacity as denoted by the radio set part number. Information describing the networks is contained in paragraph 1-6. To change the networks to accommodate a different channel capacity, certain alignments (ch 5, section IV) and tests (ch 5, sect V) must be performed. This information is covered in detail in the referenced sections.

(3) The radio set is factory-shipped with the necessary components installed, with the exciter and receiver channels aligned to the operating frequencies required for the intended radio set installation. These assigned frequencies are a function of the communications system, and are denoted by the radio set part number. To change te frequency, certain components of the rF panel must be changed or aligned to accommodate the new frequency.

b. Radio Set Component/Frequency Change.

	Exciter channel A	Exciter channel B
AFC frequency source .	A6Y1	1A6Y2
RF filter	1A6FL3	1A6FL4
	Receiver channel A	Receiver channel B
Local oscillator frequency source.	1A6Y3	1A6Y4
RF filter	1A6FL1	1A6FL2

c. Information. Information describing these components is contained in paragraph 1-6. Following change of the affected components, certain alignments (ch 5, sect IV) and tests (ch 5, sect V) must be performed. This information is covered in detail in the referenced sections.

d. Visual Checks. Prior to the application of power and after all external cables to the radio set have been installed, and initial adjustments completed, make the following visual checks:

(1) Check each of the modular assemblies to insure that it is inserted and properly secured.

(2) Check to see that all dc primary power wiring connections have been made and are properly insulated.

(3) Check to see that all grounding connections have been properly made.

(4) Check the module interconnecting coaxial cables for proper connection according to figure FO-7.

(5) Check for proper termination of all interconnecting cables.

(6) Check each fuseholder for correct fuse.

e. Initial Operational Checks.

(1) To make sure that radio set is functioning properly following installation, perform the tests (ch. 5, sec. V).

(2) If any of the tests indicate an abnormal condition, refer to the troubleshooting procedures (ch. 5, sec III).

CHAPTER 3
OPERATION

WARNING

Before operating this equipment make certain all requirements of TB SIG 291 are met. Injury or DEATH could result from improper or careless operation.

Section I. OPERATOR'S CONTROLS AND INDICATORS

3-1. Meter Panel Controls, Switches, and Indicators (fig. 3-1)

Control, switch, or indicator	*Description or function*
A PRI PWR switch	Applies primary power to channel A of the radio set.
B PRI PWR switch	Applies primary power to channel B of the radio set.
CHANNEL A meter function switch.	A multiple-position rotary switch used to select voltages and currents at designated points for monitoring channel A (para 3-7).
CHANNEL B meter function switch.	A multiple-position rotary switch used to select voltages and currents at designated points for monitoring channel B. Switch positions are a duplicate of the requirement for channel A.
A RCVR AGC indicator	Indicates (red) channel A receiver AGC is lacking or below threshold.
A RCVR PLT TONE indicator.	Indicates (red) channel A receiver pilot-tone signal is lacking or below threshold.
A RCVR NOISE indicator.	Indicates (red) receiver A noise level has risen above its predetermined threshold.
A RCVR BB PT indicator.	Indicates (red) channel A receiver baseband pilot-tone signal is lacking or below threshold.
A XMIT RF PWR indicator	Indicates (red) channel A exciter RF power output has decreased below normal value.
A XMIT MOD LOSS indicator.	Indicates (red) channel A exciter pilot-tone signal is lacking.
A PRI PWR indicator	Indicates (clear) primary power is available to all channel A power supplies.
B PRI PWR indicator	indicates (clear) primary power is available to all channel B power supplies.
B XMIT MOD LOSS indicator.	Indicates (red) channel B exciter pilot-tone signal is lacking.
A XMIT RF PWR indicator.	Indicates (red) channel B exciter RF power output has decreased below normal value.
B RCVR BB PT indicator.	Indicates (red) channel B receiver baseband pilot-tone signal is lacking or below threshold.
B RCVR PLT TONE indicator.	Indicates (red) channel B receiver pilot-tone signal is lacking or below threshold.
B RCVR AGC indicator	Indicates (red) channel B receiver AGC is lacking below threshold.
CHANNEL A meter	Indicates voltages and currents selected by channel A meter function switch.
CHANNEL B meter	Indicates voltages and currents selected by channel B meter function switch.

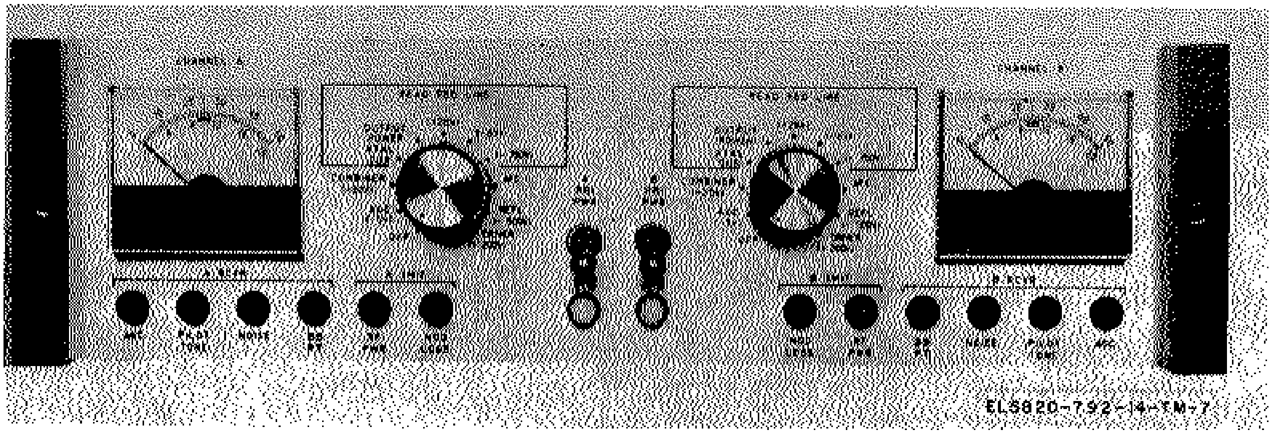

Figure 3-1. Meter panel controls, switches, and indicators.

3-2. Klystron Power Supply Switch and Fuse (fig. 3-2)

Switch or fuse	*Description or function*
ON-OFF switch....................	Applies primary power to Klystron power supply.
FUSE 10 AMP fuse	A 10-ampere fuse indicator which protects input of klystron power supply. Indicates (clear) to show application of primary power and electrical continuity of fuse.

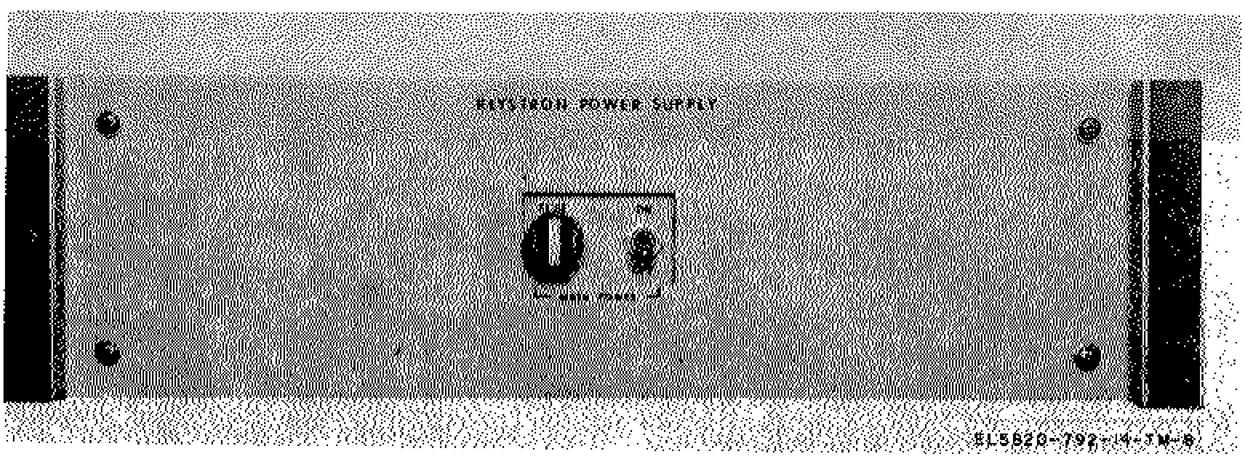

Figure 3-2. Klystron power supply switch and fuse.

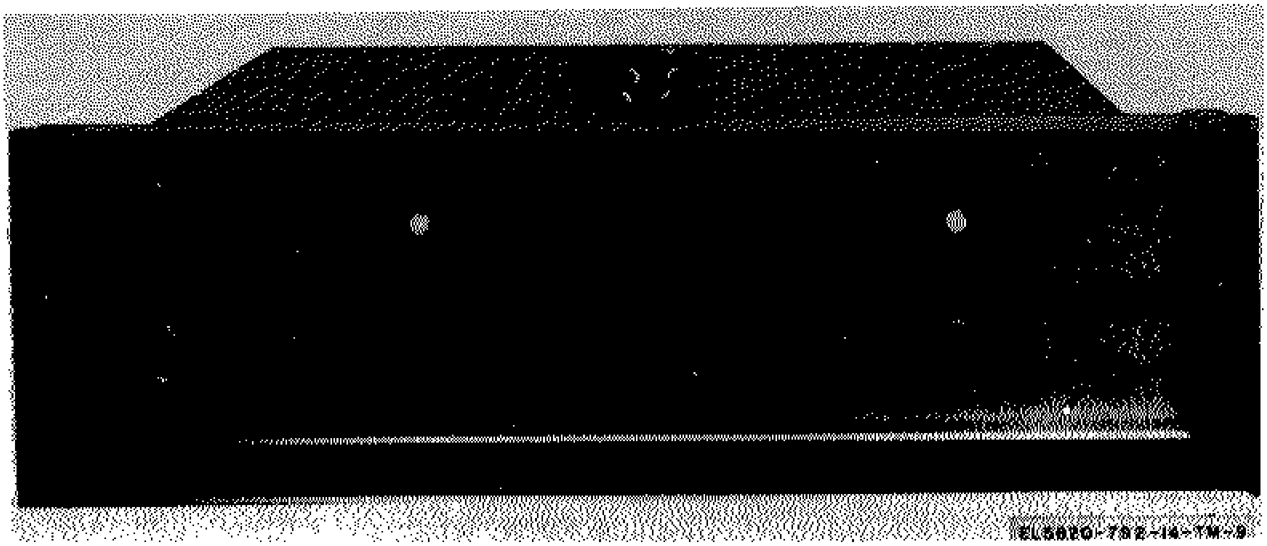

Figure 3-3. Low voltage power supply switches and fuses.

3-3. Low Voltage Power Supply Switches and Fuses (fig. 3-3)

Switch or fuse	*Description or function*
CHANNEL A 8A FUSE........	An 8-ampere fuse which protects input of channel A power supply section.
CHANNEL A 5A FUSE........	A 5-ampere fuse which protects voltage regulation circuit from outputs exceeding 36 V dc.
CHANNEL A POWER ON-OFF switch.	Controls application of primary power to channel A power supply section. In ON position, applies power. In OFF position, removes power.
CHANNEL B 8A FUSE	An 8-ampere fuse which protects input of channel B power supply section.
CHANNEL B 5A FUSE	A 5-ampere fuse which protects voltage regulation circuit from outputs exceeding 36 V dc.
CHANNEL B POWER ON-OFF switch.	Controls application of primary power to channel B power supply section. In ON position, applies power. In OFF position, removes power.

3-4. Module Switches

a. Although not considered as part of operator's controls, switches located externally on certain modules require setting to designated positions during operation of the radio set. The switch positions are symbolized on the module case, adjacent to the associated switch for identification. The modules and module switches are illustrated in figure 3-4. Figure 3-4 also illustrates controls and test points used elsewhere in this manual.

Module	*Switch*	*Function*
AFC (1A4MD3)	S1	In ON position, AFC controls the reflector voltage output (45OVdc) of channel A Klystron power supply 1PS1. In OFF position, controlled operation is removed.
AFC (1A4MD1.)	S	In ON position, AFC controls the reflector voltage output (450 V dc) of channel B Klystron power supply 1PS2. In OFF position, controlled operation is removed.
Baseband dual pilot-tone detector (1A2MD1).........................	S1	Controls routing of pilot-tone input signal for channel A combiner baseband. In NORM position, pilot tone is applied unattenuated. In TEST position, signal is attenuated 6 db; used for testing purposes.
	S2	Controls pilot-tone operation for channel A combiner baseband. In PLT NORM position, pilot-tone function is retained in baseband. In PLT BYP position, pilot-tone function is made inoperative: used for testing purposes.

Module	*Switch*	*Function*
	S3	Same as switch S2 except used for channel B.
	S4	Same as switch S1 except used for channel B.
Klystron driver (lA6MD3	S1	In MUX position, permits transmission of multiplex in channel A. In TV/DATA position, permits transmission of television or data.
Klystron driver (lA6MD4)..	S1	In MUX position, permits transmission of multiplex in channel B. In TV/DATA position, permits transmission of television or data.
Noise amplifier (1A2MD7)..	S1	In NORM position, permits normal operation of excess noise squelch circuit in receiver channel A. In BYP position, disables excess noise squelch and the fault indication.
Noise amplifier (lA2MD5)...	S1	In NORM position, permits normal operation of excess noise squelch circuit in receiver. channel B. In BYP position, disables excess noise squelch and the fault indication.
Receiver dual pilot-tone detector 1IA2MD6),.........................	S1	Controls routing of pilot-tone input signal for channel A receiver baseband. In NORM position, pilot tone is applied unattenuated. In TEST position, signal is attenuated 6 db; used for testing purposes.
	S2	Controls pilot-tone operation for receiver channel A. In PLT NORM position, pilot-tone function is retained in receiver baseband. In PLT BYP position, pilot-tone function is made inoperative.
	S3	Same as switch S2 except used for channel B.
	S4	Same as switch S1 except used for channel B.
Transmit dual pilot-tone detector (1A4MD2)...........................	S1	Controls routing of pilot-tone input signal for channel A exciter. In NORM position, pilot tone is applied unattenuated. In TEST position, signal is attenuated 6 db; used for testing purposes.
	S2	Controls pilot-tone operation for exciter channel A. In PLT NORM position, pilot-tone function is retained in exciter baseband. In PLT BYP position, pilot-tone function is made inoperative; used for testing purposes.
	S3	Same as switch S2 except used for exciter channel B.
	S4	Same as switch S1 except used for exciter channel B
Transmit terminal filter (1A4MD5)..	S1	In OFF position, disables operation of pilot-tone oscillators in channel A adder and channel B adder. In A ON position, pilot-tone oscillator in channel A adder is turned on exclusively. In B ON position, pilot-tone oscillator in channel B adder is turned on exclusively. **NOTE** **Either oscillator supplies both channels simultaneously. During operation, S1 is placed in either A or B position, exclusively.**

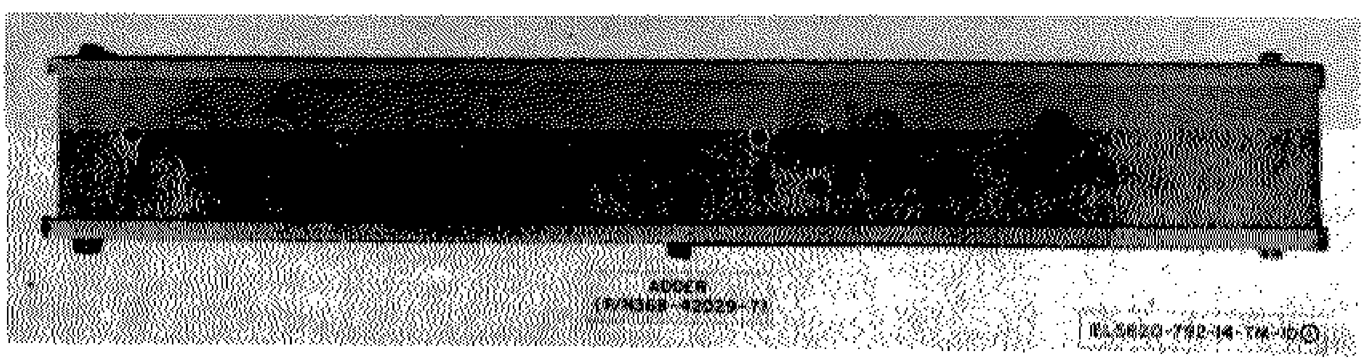

Figure 3-4. (1) Module switches, location of controls, switches and test points (sheet 1 of 11).

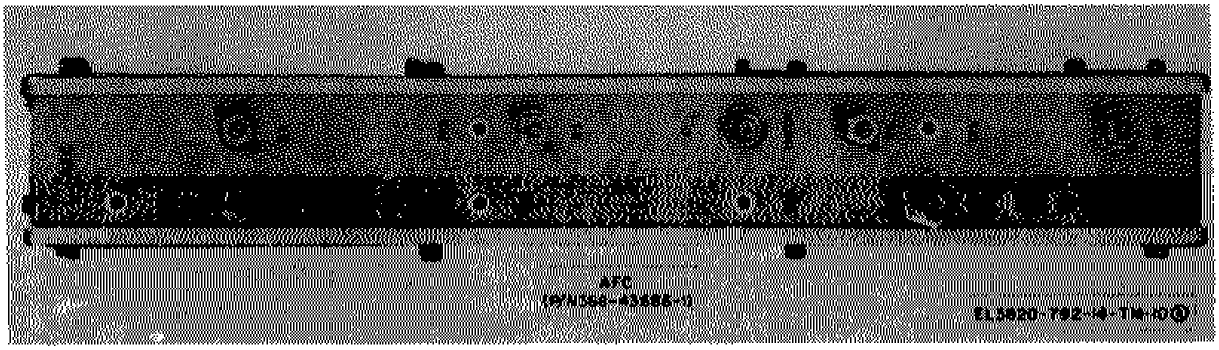

Figure 3-4. (2) Module switches, location of controls, switches, and test points)- (sheet 2 of 11).

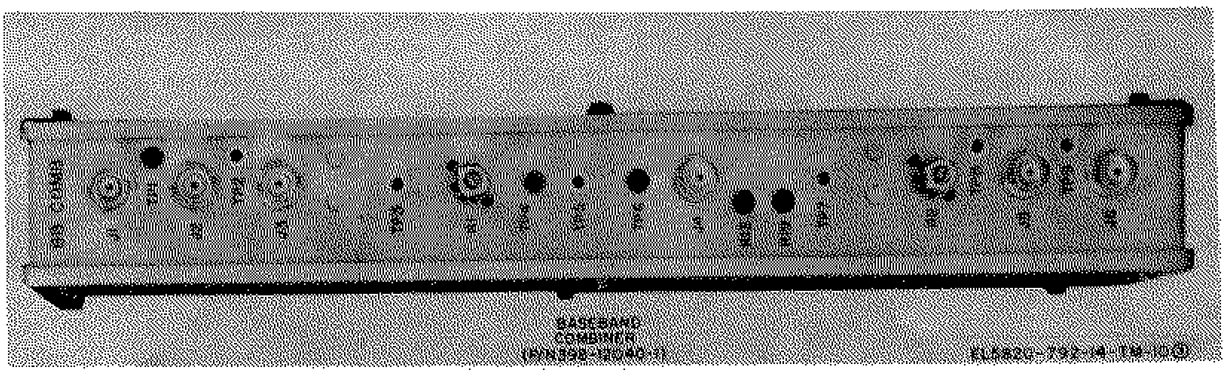

Figure 3-4. (3) Module switches, location of controls, switches and test points (sheet 3 of 11).

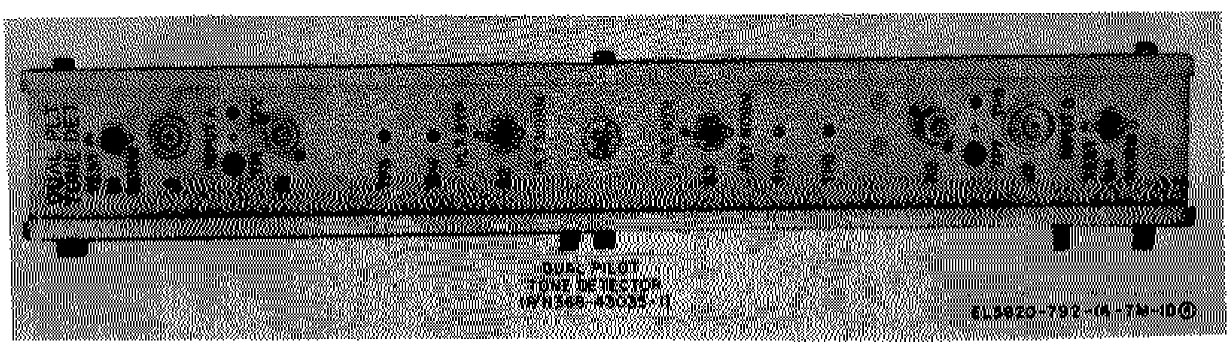

Figure 3-4. (4) Module switches, location of controls, switches, and test points (sheet 4 of 11).

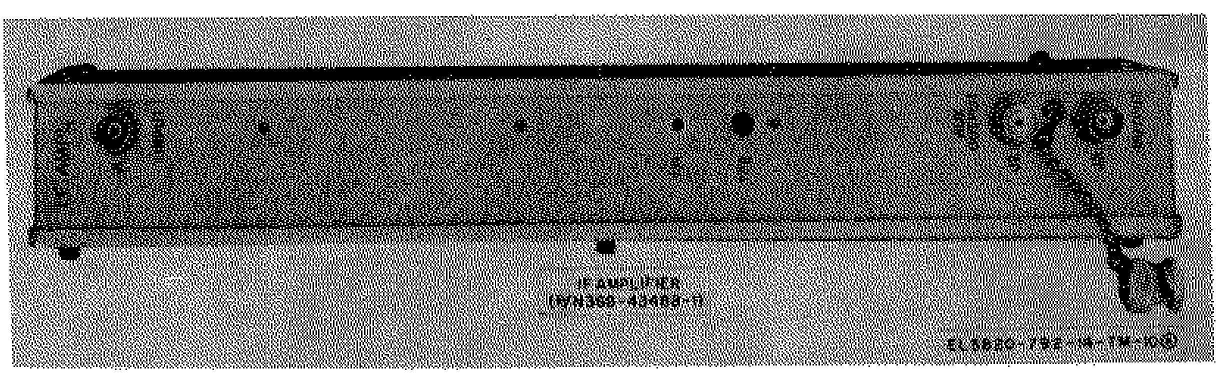

Figure 3-4. (5) Module switches, location of controls, switches, and test points (sheet 5 of 11).

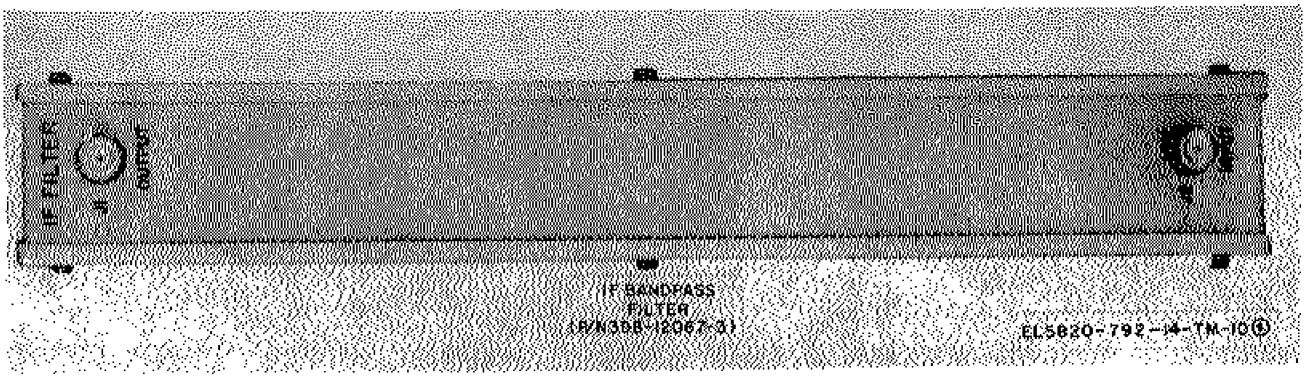

Figure 3-4. (6) Module switches, location of controls, switches, and test points (sheet 6 of 11).

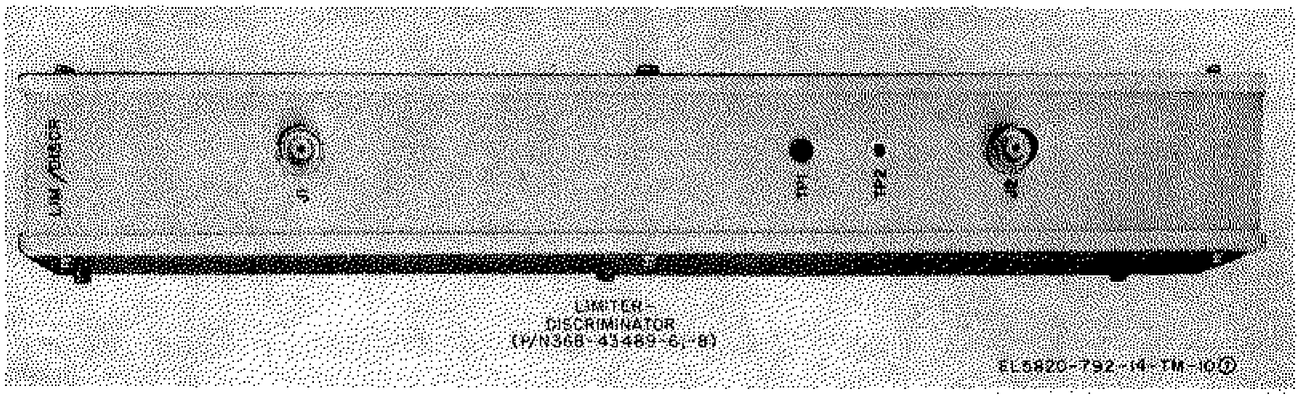

Figure 3-4. (7) Module switches, location of controls, switches, and test points (sheet 7 of 11).

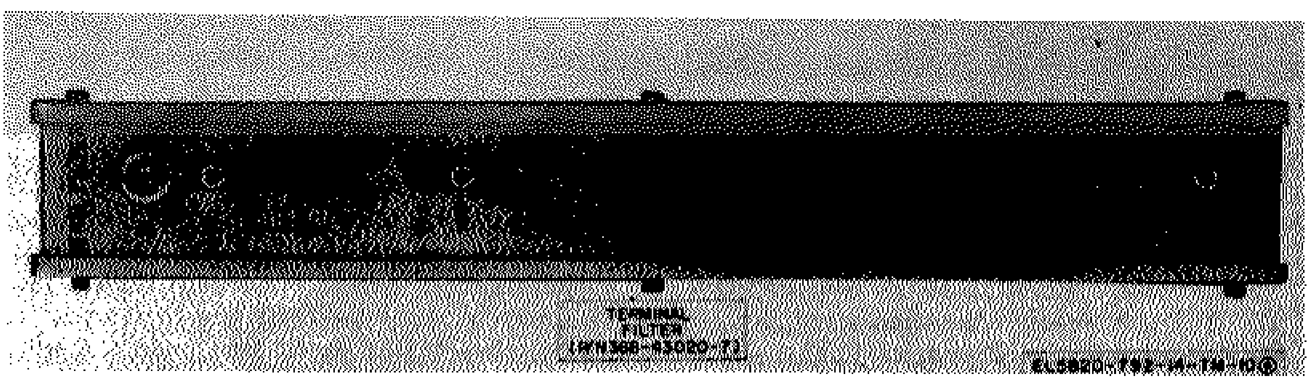

Figure 3-4. (8) Module switches, location of controls, switches, and test points (sheet 8 of 11).

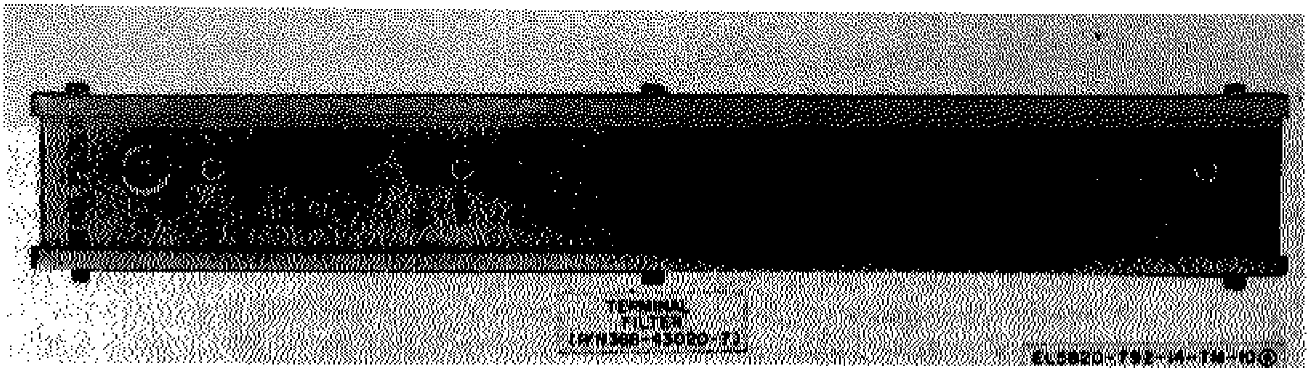

Figure 3-4. (9) Module switches, location of controls, switches, and test points (sheet 9 of 11).

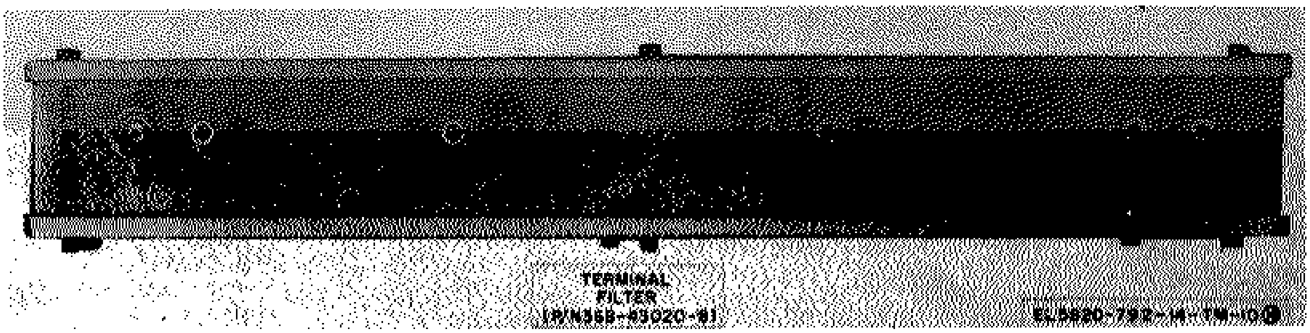

Figure 3-4. (10) Module switches, location of controls, switches, and test points (sheet 10 of 11).

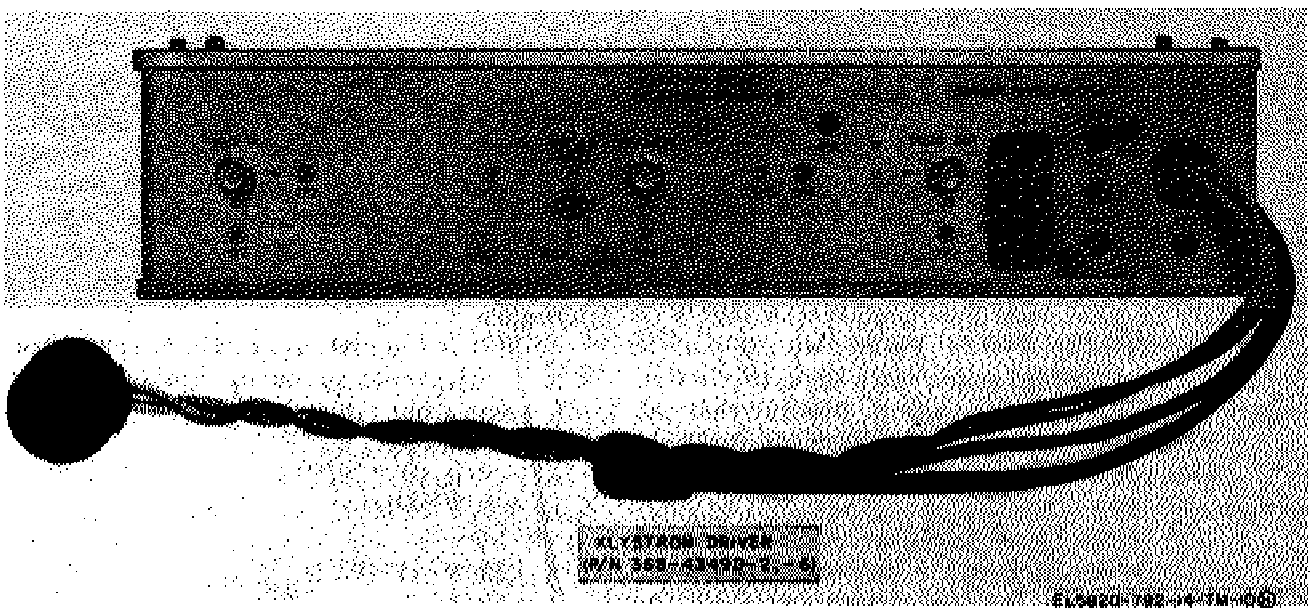

Figure 3-4. (11) Module switches, location of controls, switches, and test points (sheet 11 of 11).

Section II. OPERATION UNDER USUAL CONDITIONS

3-5. Starting Radio Set

a. The operational description which follows is based upon starting the equipment from a completely OFF position. Set the two PRI POWER switches on the meter panel to their OFF positions by pulling each switch outward and downward simultaneously. Set the POWER ON-OFF switches on each power supply to the OFF position. On the meter panel, set the CHANNEL A and CHANNEL B meter function switches to their respective OFF positions.

b. Open receiver door assembly 1A1, combiner door assembly 1A2, and exciter door assembly 1A4. Inspect each door assembly and the RF panel 1A6 to make certain that the properly assigned complement of modules is installed, and that all modules are secured properly in place. In addition, all interconnection cables must be properly terminated. Failure to set the required switches to the designated positions will cause abnormal operation of the radio set.

c. Designated switch positions.

Module	*Switch*	*Function*
AFC (1A4MD3)	S1	ON
AFC (IA4MD1)	S1	ON
Baseband dual pilot-tone detector (IA2MD1)	S1	NORM
	S2	PLT NORM
	S3	PLT NORM
	S4	NORM
Klystron driver (1A6MD3)	S1	MUX
Klystron driver (1A6MD4)	S1	MUX
Noise amplifier (1A2MD7)	S1	NORM
Noise amplifier (IA2MD5)	S1	NORM
Receiver dual pilot-tone detector (1A2MD6)	S1	NORM
	S2	PLT NORM
	S3	PLT NORM
	S4	NORM
Transmit dual pilot tone detector (1A4MD2)	S1	NORM
	S2	PLT NORM
	S3	PLT NORM
	S4	NORM
Transmit terminal filter (1A4MD5)	S1	A ON or B ON

d. Perform the following procedures:

NOTE

Failure to obtain the prescribed indications during turn-on indicates an abnormal condition or result. Refer to the troubleshooting instructions contained in chapter 4.

(1) On the meter panel, grasp the toggle of the CHANNEL A PRI PWR switch, pull it outward and upward at the same time; this action sets switch to the ON position. Observe that the A PRI PWR indicator lights. Also observe that the fuse lamp of channel A Klystron power supply lights.

(2) On the meter panel, grasp the toggle of B PRI PWR switch, pull it outward and upward at the same time; this action sets switch to the ON position. Observe that the B PRI PWR indicator lights. Also observe that the fuse lamp of channel B Klystron power supply lights.

(3) On the meter panel, place both CHANNEL A and CHANNEL B meter function switches to the +28V position.

(4) On the low voltage supply, set CHANNEL A POWER switch to ON position.

(5) On the meter panel, observe the CHANNEL A meter indicates in redline zone.

(6) On the meter panel, place. CHANNEL A meter function switch to -6V position. Observe that CHANNEL A meter indicates in redline zone.

(7) If the distant station is not transmitting or is transmitting an unacceptable signal, the following indicator lamps light:

A RCVR AGC
A RCVR PLT TONE
A RCVR NOISE
BB PT
A XMIT RF PWR
A XMIT MOD LOSS

If the distant station is transmitting an acceptable signal, only the A XMIT RF PWR lamp and A XMIT MOD LOSS lamp light.

(8) On the low voltage power supply, set CHANNEL B POWER switch to ON position.

(9) On the meter panel, observe CHANNEL B meter, which should indicate the redline zone.

(10) On the meter panel, place CHANNEL B meter function switch to -6V position. Observe that CHANNEL B meter indicates in redline zone.

(11) If the distant station is not transmitting, or is transmitting an. unacceptable signal, the following indicator lamps light: B RCVR AGC
B RCVR PLT TONE
B RCVR NOISE
BB PT
B XMIT RF PWR
B XMIT MOD LOSS
If the distant station is transmitting an acceptable signal, only the B XMIT RF PWR lamp and B MOD LOSS lamp light.

(12) If the RCVR AGC, RCVR PLT TONE, RCVR NOISE, and BB PT indicator lamps for both channels remain lighted (signifying the continued reception of an unacceptable signal), then set the CHANNEL A and CHANNEL B meter function switches to their AGC (-5-V), COMBINER (+20V), and XTAL CUR positions in succession. Check that these measurements are within normal limits as prescribed in paragraph 37 b, c, and d, respectively, for the existing conditions.

(13) On the meter panel, set the CHANNEL A and CHANNEL B meter function switches to their DRIVER (+200V) positions.

(14) On diversity channel A klystron power supply, set the MAIN POWER switch to ON position. Observe that the fuse lamp of channel A klystron power supply remains lit. Observe that the A XMIT RF PWR indicator remains lighted and that the CHANNEL A meter indicates 120 V dc. After a time delay of about 1 minute, the A XMIT RF PWR indicator extinguishes.

NOTE

If the delay period has passed and the A XMIT RF PWR lamp has not extinguished, it is necessary to flip switch S1 on AFC module 1A4MD1 to the OFF position, then immediately return it to the ON position.

(15) On diversity channel B Klystron power supply, set the MAIN POWER switch to ON position. Observe that the fuse lamp of channel B klystron power supply remains lit. Observe that the B XMIT RF PWR indicator remains lit and that the CHANNEL B meter indicates 120 V dc. After a time delay of about 1 minute, the B XMIT RF PWR indicator extinguishes.

NOTE

If the delay period has passed and the B XMIT RF PWR lamp has not extinguished, it is necessary to flip switch S1 on AFC module 1A4MD1 to the OFF position, then immediately return it to the ON position.

(16) On the meter panel, set the CHANNEL A and CHANNEL B meter function switches to their REF (-500V), AFC, -750V, and OUTPUT POWER positions in succession. Check that these measurements are within normal limits as prescribed in paragraph 3-7j, i, h, and e, respectively.

(17) Observe the meter panel indicators; the only indicators which should remain lighted are the A and B PRI PWR lamps, except as noted as in (7) and (11) above.

3-6. Operating the Radio Set

a. The radio set is designed for continuous, unattended operation. Accordingly, operation is reduced to starting and stopping the equipment. The meter and the alarm indicators, located on the meter panel and also provided for remote duplication, permit observation of the status of the radio set during operation. The significance and interpretation of these devices is described in later paragraphs. Paragraph 3-7 describes the various readings obtainable at strategic points within the radio set. Paragraph 3-8 describes the indicators which light to denote a failure of various internal circuits or functions. Paragraph 3.9 explains the interaction of the various lamps for the various operational conditions which arise. The significance of the indicators is interpreted in terms of symptoms which permit the malfunctions to be localized; detailed troubleshooting procedures must then be employed to isolate the malfunction.

NOTE

Failure to obtain the prescribed meter indications (para 3-7), normal indicator lamp indications (pars 3-8), or general conditions of paragraph 3-9 during operation, indicates an abnormal condition. Refer to the troubleshooting instructions contained in chapter 4.

b. During. operation of the radio set, an acceptable signal is required to be received from the distant station. An acceptable signal is defined as a signal whose characteristics meet minimum standards for that particular station, as set by the microwave communications system.

3-7. Meter Indications During Operation

a. Panel Meters.

(1) One panel meter is provided for each diversity channel to indicate the voltage or current selected by its associated meter function switch. These meters are dual-scale units allowing greater reading accuracy than could be obtained using a single-scale meter. The upper scale is calibrated from 0 to 50; the lower scale is calibrated from 0 to 20. Thus, for example, when the associated meter switch is in the AGC (-5V) position, the AGC voltage is read on the 0 to 50 scale, but is interpreted as being 0 to -5 volts.

(2) Notice that the meter function switch positions are divided into two types: those that are fixed readings and those that are variable readings. The fixed readings are included within the symbolized boxed area indicated as READ REDLINE. As long as the meter indication is within the red painted zone on the meter face for these switch positions, the reading being made is considered satisfactory.

(3) The variable readings are functions of the transmission path and other factors which vary for each particular radio set. For instance, the REFL (-500V) position of the meter switch monitors the dc voltage applied to the klystron reflector, but the actual value of the dc voltage applied to the klystron reflector is dependent upon the AFC requirement. The AFC requirement, in turn, is dependent on the klystron RF center-frequency requirement of the particular radio set channel. Thus, if the channel is tuned to 4.6 GHz, one meter indication will be obtained; if it is tuned to 4.9 GHz, a different reading will be obtained. However, for any given radio set, the meter indication should always be the same. The same thing is true for the AGC (--5V) position of the meter function switch, as well as other switch positions not included in the "read redline" category. The term "station normal" applies to voltage readings that do not change with equipment operation, but do change as a function of radio set frequency allocations and geographical location.

b. AGC (-5V) Meter Position. The AGC (-5V) position of the meter function switch connects the associated panel meter to the AGC bus of the radio set receiver. The AGC voltage provides a direct indication of the signal strength at any given instant. An increase in meter deflection (toward 5 volts) indicates a decrease in received signal strength, an increase in AGC voltage, and an increase in receiver sensitivity. A decrease in meter deflection (toward 0 volt) indicates an increase in received signal strength, a decrease in AGC voltage, and a decrease in receiver sensitivity. When a strong signal is present at the receiver input, the meter indication, in the AGC (-5V) position of the associated function switch, should be between -0.05 and -1.0 volt.

c. COMBINER (+20V) Meter Position.

(1) The COMBINER (+20V) position of the meter panel function switch connects the associated panel meter to the output circuit of the noise amplifier. The combiner voltage provides a direct indication of the instantaneous noise level present in the associated receiver. An increase in meter deflection (toward 20 volts) indicates an increase in noise level. As the signal-to-noise ratio increases, the noise content of the baseband decreases, and the result is a decrease in meter deflection (toward 0 volt). When a strong signal is present at the receiver input, the meter indication at the COMBINER (+20V) function switch position should be between 7 and 10 volts.

(2) If *b* above and (1) above are carefully read again, you will see that the AGC (-5V) and the COMBINER (+20V) positions track each other. As the signal strength decreases, the AGC voltage increases and reduces the loss through the IF amplifiers, which permits an increase in receiver sensitivity and general noise level.

d. XTAL CUR Position. This position of the meter function switch connects the panel meter to read the receiver mixer crystal current. The proper crystal current should range between 1.5 and 2.0 milliamperes. An attentuator adjustment in the RF panel of the receiver permits the adjustment of crystal current so that it will register as a READ REDLINE measurement.

e. OUTPUT POWER Position. This position of the meter function switch connects the panel meter in series with a crystal detector/directional coupler in the output circuit of the exciter power amplifier. This circuit permits reading the RF power output. Although the exciter power amplifier is adjusted for maximum RF power output, the RF power output for each exciter is different. Internal adjustments, located behind the meter panel, are provided to bring the meter indication into the READ REDLINE area of its scales during calibration.

f. +28V Position. This position of the meter function switch connects the panel meter to a fixed voltage divider across the 28-volt power supply for purpose of reading that voltage. This regulated voltage is a READ REDLINE measurement.

g. -6V Position. This position of the meter function switch connects the panel meter to a fixed voltage divider across the negative 6-volt power supply for purpose of reading that voltage.

This regulated voltage is a READ REDLINE measurement.

h. 750V Position. This position of the meter function switch connects the panel meter to read the Klystron 750-volt beam voltage. To avoid dangerous potentials in the meter panel circuits, the voltage actually driving the panel meter is taken from a voltage divider network connected to the 750-volt dc-to-dc converter of the kystron power supply. This is a READ REDLINE measurement.

i. AFC Position. The AFC position of the meter function switch connects the panel meter to a dc correction voltage in the AFC module. The 0 to 20 scale of the meter should be used for AFC voltage readings. If the exciter frequency requires little or not AFC correction, the voltmeter will indicate nearly 0 volt. As the need for frequency correction increases, the voltmeter will move toward the fullscale limit of the meter. These figures show that the average AFC voltage is always indicated in the positive direction by the meter. The directional sense of the error voltage can only be determined by output frequency measurements. Approximate values for a nonmodulated signal are listed in j below. Due to the design of the radio set, the AFC voltage may be higher, value for-value, for the same frequency drift when a high modulation index is used.

j. AFC Correction Voltages and Frequency Drift.

AFC voltage (vdc)	*Approximate corresponding frequency drift*
0.02	0
0.32	±140 kHz
1.29	± 1 MHz
1.58	± 2 MHz
1.65	± 3 MHz
1.69	± 4 MHz
1.71	± 5 MHz

k. Reflector(500V) Position. The position of the function switch connects the panel meter to read the Klystron 500-volt reflector voltage. To avoid dangerous potentials in the meter panel circuit, the voltage actually driving the panel meter is taken from a voltage divider network connected to the 450-volt dc-to-dc converter of the Klystron power supply. The voltage indicated by the meter depends upon the output frequency assigned to the radio set, since output frequency and reflector voltage are linearity related. A fundamental property of a Klystron is the relationship between its reflector dc voltage and its output frequency. A rough frequency guide for the Klystron used in the radio set is 0.004 GHz-per-volt; thus, if the Klystron requires 300 volts at 4.4 GHz, it will require approximately 350 volts at 4.6 GHz. Hence, the meter indication limits are set between -210 and -500 Vdc, but the actual reading for a given radio set is a constant value somewhere between these limits and is referred to as the "station normal." Although the meter indication slightly varies due to AFC voltage changes, the average change is not easily detectable since an ideal system would yield an AFC (error) voltage of 0 volt.

l. Driver (+200V) Position. This position of the function switch connects the panel meter to the 120-volt section of the Klystron power supply for purpose of reading that voltage. The indication should be between 105 and 125 volts on lower scale of meter.

3-8. Indicator Lamps

a. PRI PWR Indicators. One indicator lamp is assigned to each channel to indicate application of primary power.

b. XMIT RF PWR Indicators. One indicator lamp is used in each exciter channel to indicate loss of RF output power. This indicator function is also available on terminal strips LTBI and 2 for supplying remote indicators. The threshold of the indicator is set to be activated when the RF power output of the power amplifier falls approximately 3 db below normal. The threshold of the indicator is set to the desired level using controls located behind the meter panel.

c. XMIT MOD LOSS Indicators. One indicator lamp is used in each exciter channel to indicate loss of modulation. This indicator function is also available on terminal strips ITBI and 2 for supplying remote indicators. The modulation loss indicators are directly controlled by circuits within the transmit pilot tone detector module.

d. RCVR AGC Indicators. One indicator lamp is used in each receiver channel. This indicator function is also available on terminal strips ITBI and 2 for supplying remote indicators. Unlike the panel meter, which varies over the complete range, the RCVR AGC indicator is activated only when the AGC voltage falls below a preset threshold value (approximately -80 dbm) This action signifies that the transmission from the distant radio set has ceased, or that the receiver of the local radio set has failed. The threshold of the indicator is set to the desired level using controls located behind the meter panel.

e. RCVR PILOT TONE Indicators. One indicator lamp is used in each receiver channel. This indicator function is also available on terminal strips ITBI and 2 for supplying remote indicators. The receiver pilot-tone indicators are directly controlled by circuits within the receiver pilot-tone detector module. Pilot-tone alarm circuits are also included in the noise amplifier modules, and operate in conjunction with the receiver dual pilot-tone detector module. These lamps illuminate to indicate loss of receiver pilot-tone for the particular channel involved. It is important to realize that whenever this alarm is activated in one receiver channel only, the combiner circuits have also squelched the corresponding receiver. If the receiver pilot-tone alarm comes on in both receiver channels however, receiver squelching does not occur.

f. RCVR BB PT Indicators. One indicator lamp is used in each receiver channel. This function is also available on terminal strips ITBL and 2 for supplying remote indicators. Unlike the receiver dual pilot-tone detector, the baseband dual pilot-tone detector provides only a visual indication of the loss of baseband pilot-tone and no resulting squelching action occurs.

g. RCVR NOISE Indicators. One indicator lamp is used in each receiver channel. This indicator function is also available on terminal strips ITBI and 2 for supplying remote indicators. Unlike the panel meter, which varies over the complete range, the RCVR NOISE indicator is activated only when the noise level rises above a preset threshold value (approximately --78 dbm). Notice that there is a 2 db difference between the threshold of the AGC indicator and noise indicators. The noise indicators are directly controlled by circuits within the noise amplifier modules.

3-9. Significance of Indicator Lamps During Operation

a. During normal operation of the radio set with all circuits functioning properly and no transmission path abnormalities present, all indicator lamps assigned to each channel will not be lighted. The lighting of individual indicators, or groups of indicators signifies the presence of an abnormal condition. These conditions are briefly described in the following subparagraphs.

b. When the receiver pilot-tone indicator of each receiver channel lights without the lighting of corresponding AGC and noise indicators, there are two possible conditions that generally arise. The first conditions is that both channel receiver pilot-tone indicators light simultaneously. Such a situation is caused by the distant radio set. Possible causes at the distant radio set are that the pilot-tone oscillator in the adder module has failed or has been intentionally shut down. (In the transmit terminal filter module, setting the pilot-tone switch to the OFF position removes the power supply voltage from the pilot-tone oscillator, so that the pilot-tone is removed from both diversity channels.) In cases where both receiver pilot-tone indicators of the local radio set are extinguished while both receiver pilot-tone lamps are lit, the baseband pilot-tone detector module should be investigated. If you are informed that the distant radio .set pilot-tone oscillator will be out of service for an extended time and the lighted indicator lamps on the local radio set are objectionable, the indicators of the local radio set may be extinguished at the respective pilot-tone modules.

c. For the second condition, when a baseband pilot-tone lamp is extinguished and a single receiver pilot-tone alarm lights without the accompanying AGC alarm, the complete loss of baseband in one channel becomes the possible cause. The distant radio set can experience a complete loss of baseband in the affected channel. When either of these situations occurs, the Klystron driver of the affected channel fails to modulate the klystron output signal and the Klystron simply produces its assigned RF center frequency. The Klystron RF center frequency enters the local station receiver and accounts for the absence of the AGC and noise indications. This loss of baseband is not restricted to the distant station by any means. Loss of complete baseband in one local radio set receiver channel can occur any time during or following demodulation. The baseband pilot-tone alarm is not lighted because the unsquelched diversity channel is passing pilot-tone into the baseband pilot-tone detector. This indicates that the pilot-tone has failed to pass through the demodulator, combiner, noise amplifier, or pilot-tone detector modules of the defective diversity channel.

d. It is highly probable that periods of marginal operation will occur to one diversity channel or the other, where the two pilot-tone alarms, noise alarm, and AGC alarm for the diversity channel affected are activated. In those situations where pilot-tone, noise, and AGC indicators light abruptly and remain lit continuously, it is most likely that the exciter at the distant station (corresponding to the alarmed diversity channel) has failed. The distant radio set will become aware of this problem through its RF power alarm. When the pilot-tone, noise, and AGC alarms are erratic, it is more probable that a period of marginal reception caused by path absorption is in progress. Finally, when these alarms are activated for both diversity channels, then the distant radio set is probably experiencing a total primary power failure.

e. When the RF power and modulation loss alarms are lighted simultaneously for either channel, a failure or malfunction of the exciter has occurred. Loss of modulation alone activates the modulation loss alarm; however, the klystron, in the absence of modulation, still produces the assigned center frequency and RF output power.

Klystron tube failure or interruption of the Klystron power supply voltages lights both indicators.

3-10. Stopping the Radio Set

The radio set is turned off as follows:

a. Set the MAIN POWER switches of the Klystron power supplies to their OFF position. The channel A and channel B XMIT RF PWR and MOD LOSS indicators light.

b. Set the POWER switches of the low voltage power supply to their OFF positions. All equipment indicator lamps extinguish except the A and B PRI PWR lamps.

c. On the meter panel, grasp the toggle of the A PRI PWR switch, pull it outward and downward at the same time. Observe that the A PRI PWR lamp extinguishes.

d. On the meter panel, grasp the toggle of the BPRI PWR switch, pull it outward and downward at the same time. Observe that the B PRI PWR lamp extinguishes.

e. The radio set is now stopped.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

3-11. General

a. Two types of failures can occur to the radio set. The first type is a failure of the signal circuits and the second type is a power supply failure. The dual frequency diversity mode of operation greatly reduces the possibility of total operational failure through the use of duplicate transmit and receive channels. The radio set may be temporarily operated on a single channel until such time that corrective measures can be taken. Only through a simultaneous failure of both channels can a complete loss of duplex communications occur.

b. In the case of exciter signal failures that affect one channel, transmission continues without interruption by means of the remaining diversity channel. In the case of receiver signal failures that affect only one channel, the continuity pilot-tone for that channel is absent. The defective receiver channel is then squelched out by the combiner, and the corresponding pilot-tone alarm is activated. Uninterrupted communications are carried on by the remaining diversity-receiver channel, because the combiner output now consists entirely of signals from the normal channel.

c. Loss of communication due to the second type of failure, involving power supply malfunctions, is reduced through the use of an individual Klystron power supply for each exciter channel, and a dual low voltage power supply. Each half of the dual low voltage power supply serves an individual channel. To insure alarm detection and proper squelching action, certain modules have their dc operating voltages supplied in parallel from each half of the low voltage power supply. The modules include the adders, transmit terminal filter, the three dual pilot-tone detectors, and the two baseband combiners. Should a power supply section assigned to its channel fail, dc operating voltages derived from the alternate supply will permit the aforementioned circuits to operate which detect the failure, and also direct the necessary squelching action so communication may be maintained.

3-12. Primary Power Failure

The radio set low voltage and Klystron power supplies are designed to operate from a primary power input of minus 48 volts dc. This source voltage is generally derived from a floating 48 V dc battery plant. The battery plant, in a typical installation, uses a floating recharge supplied by an alternating current powered rectifier. Should the ac supplying the rectifier fail (or the rectifier itself fail), the battery plant will continue to supply emergency direct current operating power for a specified uninterrupted period of time as determined by its discharge rate. The specified period is usually stated in the microwave communications system instructions for the specific radio set site. Restoration of the alternating current power returns the rectifier to service and terminates the emergency.

NOTE

It is suggested that the radio set be turned off after the specified period following initiation of operation on emergency power. Operation of the radio set on emergency battery power for a

period greater than the specified period will cause degradation of performance because of the decreasing electrical capability of the battery plant through discharge action. It is to be noted, however, that the power supply regulation circuits of the radio set will prevent electrical damage to the equipment due to the decreasing direct current input voltage.

3-13. Limitations of Environmental Operating Conditions

The radio set is designed for installation in the equipment room of a building or other type of fixed location shelter. The radio set can also be installed in an appropriate mobil van. The site of installation is normally air conditioned, with the temperature held at 70° ± 10° F with a relative humidity of 60 ± 20 percent to achieve maximum equipment performance. However, the radio set will operate within the range of environmental conditions specified in paragraph 1-6. Because of the solid-state design of the equipment, maximum performance cannot be expected as the conditions approach specification limits. The radio set is not intended to be operated in environmental conditions exceeding its specified limits.

CHAPTER 4

FUNCTIONING OF EQUIPMENT

4-1. General

a. This chapter contains information that explains the operation of the radio set on a block diagram level. Detailed operation of the individual modules and circuits is explained in chapter 6. Except for variations which result from these components which affect multiplex channel capacity and operating frequencies, the information is applicable to all models of the radio set. Where variations exist, they are so noted.

b. The radio set is composed of an exciter section, a receiver section, a combiner, and a power supply section. The major physical elements which correspond, respectively, to each section are the exciter door assembly 1A4, receiver door assembly 1A1, and combiner door assembly 1A2. The RF panel 1A6 is common to both exciter and receiver sections. The power supply section is formed by the klystron A and klystron B power supplies, 1PSI and 1PS2, respectively, and the low voltage power supply 1A5. A functional description of each section of the radio set is presented in the following paragraphs, and illustrated in block diagram form in figures FO-1 through FO-3.

4-2. Exciter Section

(fig. FO-1)

a. The exciter door of the microwave radio set contains all of the modules which process the lowlevel exciter signals. The multiplex signals are applied to the radio set at coaxial connector 1Jl at the top of the cabinet and delivered to transmit terminal filter 1A4MD5. The service channel signals are applied to terminal strip 1TB2 at the top of the cabinet and routed over a two-wire line into the transmit terminal filter via the printed circuit connector of the module. The multiplex and service channel signal levels applied to the microwave radio set are functions of the communications system equipment, and are determined by individual station requirements. In the transmit terminal filter module, prevailing system levels are adjusted by means of fixed attenuators to levels suitable for driving the radio set exciter. Following attenuation, the passband for both the multiplex and service channels is shaped prior to delivery to the adder modules. The multiplex signals are transferred from the transmit terminal filter by coaxial cable to each adder module. The service channel signals are transferred from a printed circuit connector of the transmit terminal filter by wiring to a printed circuit connector of each adder module.

b. Channel A adder module 1A4MD6 and channel B adder module 1A4MD4 both contain an internal pilot-tone oscillator operating at 3.2 MHz. A switch in the transmit terminal filter module permits selecting either oscillator to exclusively supply pilot-tone for both adder modules. In each adder module, the multiplex, service channel and pilot-tone signals are added to form a complete baseband signal. From this point, the A and B baseband signals leave the exciter door via coaxial cable enroute to their respective klystron driver modules on the RF panel.

c. The exciter door also contains channel A and channel B AFC modules; these are 1A4MD3 and lA4MD1, respectively. At the output of the klystron, a sample of the output signal is extracted using a combination directional coupler/AFC mixer unit. As an example, a portion of the exciter signal moves through the directional coupler into the mixer as one of the incoming mixer signals. Frequency source Y1 provides the injection signal into the mixer as the second incoming signal. The mixer output is sent along the 70-MHz AFC output line into one of the AFC modules, in the case, module 1A4MD3. The input signal to the AFC module is immediately divided into two signal branches, where the primary branch is sent into the AFC circuits and the secondary branch is filtered and sent out of the AFC module toward the meter panel along line E. This secondary output voltage is used to monitor the transmitter output level and drive the power alarm. The AFC module uses a 9 kHz switching signal to interlace the 70-MHz AFC input signal (containing modulation) with a locally generated 70-MHz reference signal. The interlaced signal is then demodulated to obtain an error voltage related to frequency error. The frequency error signal is fed into two independent paths. One path leaves the AFC module and is sent into the corresponding input of the transmit pilot-tone detector module along the baseband A line. The primary path continues through the AFC module where it is filtered to remove the pilot-tone signal and all modulation, and then transformed from a square waveform into a sinusoidal waveform. After receiving further amplification, this filtered signal is coupled out of the module over line C and sent to the afc metering circuit. In the final stages of the module, the filtered signal is compared with the interlacing signal in a phase detector to produce a dc correction or error voltage which is transferred out of the AFC module to its corresponding Klystron power supply. Within the power supply, the dc correction voltage is used to control the instantaneous output level of --450 volts added to the --750 volts which is supplied to the klystron reflector. The carrier frequency generated by the klystron changes in direct proportion to the instantaneous applied reflector voltage. Thus, as the Klystron carrier output frequency shifts from its assigned value, the AFC circuits generate a dc error voltage whose amplitude is proportional to the magnitude and whose polarity is related to the direction of the frequency shift, causing the output frequency to return to its assigned value.

d. The transmit pilot-tone detector accepts the baseband containing the pilot-tone frequency from the AFC module of each diversity channel. The applied baseband is filtered to reject all frequencies except the pilot-tone frequency. The pilot-tone in each diversity channel is amplified and then detected to drive a modulation loss alarm; channel A modulation loss indicator is lA3DS6, while channel B modulation loss indicator is 1A3DS9. Loss of the pilot tone in the exciter is interpreted as a loss of the modulating signal.

e. Since the circuits for both exciter channels are the same, only channel A exciter is discussed. The baseband signal is transferred from adder module 1A4MD6 on the exciter door to the Klystron driver module, 1A6MD3, on the RF panel. Following low-level amplification in the Klystron driver module, the baseband signal is applied to a preemphasis network, which introduces a 5-db loss at the pivot frequency. Two modes of operation are provided multiplex/service channel operation and television/data operation. The radio set is configured exclusively for multiplex/service channel operation. Television/data operation requires special reconfiguration of the equipment and is therefore, not covered in this manual. The final stages of the Klystron driver module are high level amplifiers which provide approximately 44-db overall gain. The Klystron driver module for each diversity channel is mounted close to its associated reflex klystron because of high impedance and stray coupling considerations.

f. A reflex Klystron is used as a modulator, power amplifier, and carrier frequency generator. A fixed dc potential of --750 volts is applied across the cathode to collector electrodes (the collector is held at ground potential) of the klystron. It is this voltage which accelerates the electrons into the vicinity of the reflector. A second potential is applied to the Klystron between the collector and reflector, which is variable over an approximate range of 320 to 450 volts. Assuming that the AGC voltage and the baseband signal amplitudes are zero, the carrier frequency of the Klystron is fixed by the voltage level applied to the reflector element; this operating potential is adjusted when the klystron is installed in the radio set. If the carrier frequency drifts from its assigned value, the AFC circuits pump a dc correction voltage through the --450-volt section of the Klystron power supply which is, in turn, applied to the reflector, to maintain a constant output carrier frequency. Application of the baseband instantaneously changes the value of the applied reflector voltage, which produces a deviation in the output frequency of the Klystron, thus frequency modulation takes place.

g. The reflex Klystron linearity characteristic is adequate for low density communications configurations (less than 240 channels) that an external linearizer is not required. When the communication system requires in excess of 240 channels, as in the radio set, the Klystron linearity characteristic must be corrected by an internal linearizer which provides a variable phase and magnitude voltage-to-stand-wave-ratio load to the Klystron. At the output of the Klystron, the waveguide is fitted with a directional coupler/AFC mixer unit, DC1, for AFC application. Directional coupler DC1 is a 30-db unit with a built-in, single-ended mixer diode. The second input to the mixer is obtained from frequency source Y1. The frequency of the Y1 output signal is 70 MHz higher than the operating frequency of the klystron. The 70-MHz output signal from the mixer is sent by coaxial cable from the RF panel to the AFC module in the exciter door. Overall operation of the directional coupler/mixer DC1 and AFC frequency source is explained in c above.

h. Linearizer A7 is a passive device using an inductive post and adjusting stubs that are spaced apart by 1/318 of a wavelength. The linearizer also requires close impedance matching with the klystron. Therefore, matching section A9 is included in the exciter waveguide line. The matching section is adjusted by a capacitive element (tuning stub). To preserve the linearizer characteristic, a 40-db ferrite isolator AT5 terminates the linearizer unit to reduce the effects of pulling caused by mismatches on the feedline. The klystron and linearizer are essentially terminated in a load having a reflection coefficient of less than 0.025.

i. The signal is then filtered in four section filter FL3, which has a bandwidth of 21 MHz at the 0.1-db points, and 52 MHz at the 3-db points. The rejection characteristics of the filter are 35 db at the operating frequency + 80 MHz, and 45 db at the operating frequency l100 MHz. The insertion loss and VSWR of the filter are 0.8 db and 1.1 to 1, respectively. This filter is a bandpass unit to remove undesired modulation products.

j. Probe A3 is included to permit measurement of test signals individually in each exciter. It is nondirectional and has a 33-db loss. Diversity channel A and B exciter signals are diplexed in transmit circulator HY3. The two exciter signals now travel the same transmission path; but this poses no problem, since these output signals are maintained at two different frequencies, separated by the required fixed diversity spacing.

k. The final routing of the signal is through designated portions of the mode operation assembly which consists of circulators HY3, HY2, and HY1, and isolators AT2 and AT1. The exciter signal from channel B enters port 2 of transmit circulator HY3 and is routed past port 1 and out of port 3. The exciter signal from channel A enters port 1 of circulator HY3 and leaves via port 3. Thus the exciter signals for channels A and B, separated by 144 MHz, travel together from port 1 to port 3 of circulator HY3. After passage through 20-db isolator AT2, the A and B exciter signals enter port 2 of circulator HY1, and travel out of port 3 toward the antenna.

4-3. Receiver Section

(fig. FO-1)

a. Two received signals in the 4.4 GHz to 5.0 GHz frequency band, separated by 144 MHz, travel in the station waveguide toward the radio set and are routed from entry at port 3 to exit at port 1 of terminal circulator HY1. These receiver signals are passed through 20-db isolator AT1 into the radio receiver circulator, HY2. In circulator HY2, both diversity receiver signals travel through port 3 together and are circulated to port 1. At port 1, diversity channel A receiver frequency encounters a short circuit, because of the tuned circuits in filter FL1, thus channel A receiver frequency is routed into diversity A receiver. Diversity channel B receive frequency cannot enter port I because it encounters an open circuit at this port. It is forced to circulate to port 2, where diversity B receiver encounters the short circuit that routes this signal into channel B receiver.

b. Since the circuits for both diversity radio receiver channels are the same, only the channel A receiver is discussed. Probe Al is included to permit injection of test signals into the receiver; it is nondirectional and has a 33-db loss. Filter FL1 establishes the assigned operating frequency of the radio receiver and fixes the initial receiver bandwidth. Each filter network consists of a 6section, iris-coupled network using direct waveguide coupling. The filters are tuned using capacitive-property tuning stubs. The output bandwidth of the filter is 21 MHz at the 0.1-db points of its gain-frequency characteristics. The rejection characteristics of the filter are 60 db at the operating frequency ±80MHz and 71 db at the operating frequency + 100MHz. The insertion loss and VSWR of the preselector filter are 1.0 db and 1.1 to 1, respectively.

c. Ferrite isolator AT3 provides an isolation of 20 db between the preselector filter FL1 at one end and the mixer A6 at the other end. The isolator is used to reduce the effect that the mixer input impedance produces on the preselector filter bandpass characteristics.

d. Local oscillator Y3 consists of a solid-state oscillator and multiplier which are phase locked to a crystal-referenced multiplier. Selection of the basic crystal oscillator frequency is determined by the operating frequency of the receiver. The crystal oscillator and multiplier provide a receiver stability of ±0.001 percent without the use of automatic frequency control. The 5 milliwatt (minimum) output signal of the local oscillator is passed through waveguide-type resistive card attenuator AT7 into the mixed unit where it is mixed with the incoming RF signals to produce an IF output signal of 70 MHz. Attenuator AT7 also sets the crystal current to the READ REDLINE position for metering XTAL CUR (crystal current).

e. Frequency conversion is performed by mixing the local oscillator signal and the received signal to obtain the intermediate frequency; this is accomplished using a cross mode mixer assembly. Mixer A6 and preamplifier MD1 are considered as a single, nonseparabie unit and are replaced together when maintenance substitutions are made, The reason for this is that conversion noise is the single greatest contributor to total internal radio set noise levels. Adjustments made in the preamplifier module adjust the combination for the best possible noise figure and noise-power ratio. At this point, the IF signal leaves the RF panel and is transferred into receiver door assembly 1A1.

f. The receiver door of the radio set contains all of the modules which process the receiver signals at 70 MHz 1F.

g. Diversity channel A receiver is processed by IF bandpass filter module 1A1MD4, IF amplifier module 1A1MD6, and limiter-discriminator module 1A1MD5. Diversity channel B receiver signal is processed by IF bandpass filter module 1A1MD1, IF amplifier module 1A1MD3, and limiter-discriminator module 1A1MD2. The input to each diversity receiver at the IF level is taken from its corresponding IF preamplifier in the RF panel using coaxial cables. Similarly, the output from each diversity receiver at the IF level is sent into its corresponding baseband combiner module on the combiner door using coaxial cables.

h. The IF bandwidth filter for either diversity channel is used to set the overall bandwidth of the microwave receiver at the 70-MHz IF level. The bandpass of the filter used in the radio set is 25 MHz. The 70-MHz signal in the filter is passed through a three-stage filter network, a filter termination, and a series of equalizer networks. These equalizers compensate for group delay characteristics of the IF filter, IF amplifier, and limiter-discriminator to provide a uniform overall time-delay response over the information bandwidth. There are no dc operating potentials applied to this module.

i. The IF amplifier module receives the 70-MHz IF signal from the IF bandpass filter module, amplifies the frequency modulated signal, and delivers it to the limiter-discriminator. The 70 MHz FM input signal, ranging between -70 dbm and --10.dbm, enters the IF amplifier module through a coaxial connector. An AGC signal is developed within this module to maintain the primary output signal level at approximately +5 dbm across 75 ohms. An auxiliary output can be taken from the IF amplifier module which ranges between +3 and +6 dbm. The AGC voltage is passed to the meter panel for monitoring purposes.

j. The limiter-discriminator module accepts the frequency modulated 70-MHz IF signal from the IF amplifier module, and delivers a demodulated output signal to its associated baseband combiner. The 70-MHz FM input signal, at approximately +5 dbm, is applied to a 75-ohm termination. This signal is then processed by a phase equalizer to minimize any envelope delay distortion which might be developed in the module. Limiting action is obtained using peakclipping amplifiers; the clipping level occurs at approximately 0.7 volt rms. The Travis discriminator develops a linear output for inputs ranging between 30 Hz and 10 MHz. Facilities are provided in the module to perform signal deemphasis following detection. The deemphasis network produces the final baseband output signal. The output signal level of the limiter-discriminator is approximately -23 dbm.

4-4. Combiner Section

(fig. FO-1)

a. The combiner door of the radio set contains all of the modules used to combine the baseband signals from each diversity receiver into a single composite baseband signal. Diversity channel A baseband signal is processed by baseband combiner 1A2MD4 and noise amplifier module 1A2MD7; receiver and baseband pilot-tone detectors associated with diversity channel A use one-half of modules 1A2MD6 and 1A2MD1, respectively. Diversity channel B baseband signal is processed by baseband combiner module 1A2MD3 and noise amplifier module 1A2MD5; receiver and baseband pilot-tone detectors associated with diversity channel B use one-half of modules 1A2MD6 and 1A2MD1, respectively. The final baseband output signal is then applied to receiver terminal filter module 1A2MD2 to separate the multiplex and service channel signals. The pilot-tone signal is blocked by this module, because the pilot-tone is only used internally in the radio set. The input to each baseband combiner module is taken from its corresponding limiter-discriminator module in the receiver door. The multiplex output, taken from the receiver terminal filter, is conveyed by coaxial cable to connector 1J2 at the top of the equipment cabinet. The multiplex line must be terminated in 75 ohms (unbalanced). The service channel output, taken from the receiver terminal filter, is conveyed by two-wire lines to terminal board 1TB2 at the top of the equipment. The service channel line must be terminated in 600 ohms (balanced).

b. In frequency-modulated diversity systems, the baseband information from the two receivers is the same (coherent), while the noise level present in the two receivers is not the same (incoherent). Receiver noise level varies as a function of receiver path noise plus internal noise generated in the receiver front end. The signal-to-noise ratio in each diversity receiver is used to control combiner action. The two baseband combiners serve as a transientless-type switch, providing a combined signal-to-noise ratio that is equal to or better than that of the least noisy receiver, while maintaining the composite signal level constant in magnitude.

c. The baseband combiners accept the baseband signal from the limiter-discriminator. From this point, two distinct signal paths are used-the primary path which actually accomplishes the combining action; and the secondary path which produces the combiner bias signal governing the ratio of the A and B baseband signals in the composite output.

d. The secondary baseband path leaves the baseband combiners and is passed into its corresponding noise amplifier module. After initial amplification, the baseband signal is split once again. Part of this baseband signal is sent out of the noise amplifier module to the corresponding input line of receiver dual pilot-tone detector module. The other part remains within the noise amplifier module and is sent into a filter which rejects the baseband and passes an out-of-band noise slot located above the information band. At the output of the noise slot filter, the pilot-tone signal (returning from the receiver dual pilot-tone detector module) is mated with the noise slot signal. These two signals are amplified by logarithmic amplifiers, filtered, and then detected to provide a dc combiner bias voltage. A voltage divider routes a portion of this combiner bias voltage to the meter panel for monitoring noise amplifier A and for noise amplifier B.

e. The noise amplifier also houses two alarm detection circuits. The first alarm detector signifies loss of pilot-tone signal through the noise amplifier module. The output of this alarm is tied in parallel with the receiver pilot-tone alarm and sent to the meter panel for channel A receiver pilot-tone alarm indicator 1A3DS2 and for channel B receiver pilot-tone alarm indicator 1A3DS13. The remaining alarm detection circuit signifies that the receiver noise level has risen above threshold and is sent to the meter panel for receiver noise alarm indicator 1A3XDS3 and channel B receiver noise alarm indicator 1A3XDS12.

f. The combiner bias voltage, taken from the A and B noise amplifier modules, is applied to the corresponding A and B baseband combiner modules. These bias signals are applied to a control amplifier, half of which is located in baseband combiner A and half of which is located in baseband combiner B. Interconnection between the halves of the combiner control amplifier is made by a coaxial cable joining the baseband combiner modules.

g. The primary signal paths of the two diversity channels are considered next. The dc control bias from each noise amplifier module is injected into the combiner control amplifier which senses the square of the signal-to-noise ratio of each diversity receiver. Thus, differential control of the combiner stage in each baseband combiner is obtained. For example, the noise level in channel A may increase, while the noise level in channel B remains the same. For this condition, the control bias applied to the combiner stage in baseband combiner A is decreased, while the control bias applied to the B baseband combiner is increased. Looking at the composite output of the A and B combiners, the signal level consists of an increased channel B component and a decreased channel A component; however, the overall composite signal level has not changed despite the level shifts of its component parts.

h. The baseband signal is passed out of the noise amplifier following an initial stage of amplification into the corresponding input of the receiver dual pilot-tone detector module. The applied baseband signal is immediately filtered to block all frequencies, except the pilot-tone frequency. The pilot tone is amplified, then broken up into two distinct paths. One path returns a portion of the pilot-tone signal to the noise amplifier module as previously discussed. The second path provides additional amplification prior to detection. The detected signal is then used to drive a pilot-tone squelch and alarm circuit via line 0.

i. In the event that channel A pilot-tone is lost, a 28 V dc squelch signal is sent into the channel A baseband combiner module. The combiner control amplifier becomes unbalanced and squelches channel A baseband combiner signal while correspondingly increasing channel B baseband combiner signal to its maximum limit. Hence, the composite output signal of both baseband combiner modules consists of channel B baseband only. The reverse situation results in the composite output consisting of channel A baseband only. If the pilot-tone signal is missing from both diversity receiver channels, a 28-volt dc squelch signal is sent into both baseband combiner modules from their respective pilot-tone detector circuits. The combiner control amplifier becomes balanced once more and passes channel A and channel B basebands as though the pilot-tone were still present in both channels. This feature prevents communications downtime whether from operational failure in both receiver or from failure in both exciters at the distant radio set.

j. Recall that the receiver pilot-tone detector obtains its signal through the input of the baseband combiners, and noise amplifier modules. Loss of pilot-tone through the remainder of the baseband combiner modules to the terminal filter module would go undetected without the use of a baseband pilot-tone detector module. The baseband signal from J2 of each baseband combiner module is sent into J1 (channel A) and J2 (channel B) of the dual pilot-tone detector module MD1. Since the module used for baseband pilot-tone detection is the same as the module used for receiver pilot-tone detection, its functional operation is not described here.

k. Returning to the A and B combiners, the primary baseband path in each combiner is amplified and split into two output paths at an output level of -14 dbm. One output path is the wideband multiplex line at both baseband combiner modules; these are joined by a coaxial T-connector prior to entry in the receiver terminal filter MD6. The other output path is the narrow band service channel line at coaxial connectors of both baseband combiner modules; these are joined by a coaxial T-connector prior to entry in the receiver terminal filter MD2.

l. The receiver terminal filter receives two baseband input signals. The multiplex input line accepts wideband signals and the service channel input line accepts narrow band signals. Within this module, the signals are properly attenuated and processed for delivery to communications equipment external to the radio set. Signal output levels for the multiplex and service channel output lines are functions of the communications equipment in the system and are determined by individual station requirements.

4-5. Meter Panel
(fig. FO-2)

a. The meter panel provides facilities for controlling the application of 48 V dc primary power and for monitoring equipment performance. Diversity channel A is used as the example in this discussion and is also applicable to diversity channel B as long as the corresponding points of figure FO-2 are used. Each indicator circuit has provisions for supplying remote indicators through the use of a relay assigned to each circuit.

b. The exciter RF power is sampled at the output of the klystron through directional coupler/AFC mixer DC1 (fig. FO-1) to derive a direct current proportional to the prevailing RF power level. This current is brought out into point E and applied to a dc amplifier-threshold circuit in the meter panel. The input to the dc amplifier circuit also contains a control which permits the output of the circuit to be adjusted to obtain the READ REDLINE level on meter Ml. The output of the dc amplifier is then split into two signal paths. One path is routed to the meter through the meter function switch. The remaining path is passed through another control and into the threshold detector to activate the RF power alarm indicator 1A3DS5. The purpose of the second variable control is to set the threshold of the alarm circuit. The threshold of the circuit is adjusted to activate the alarm indicator when the RF power output of the klystron falls approximately 3 db below normal output level.

c. Operation of MOD LOSS indicator 1A3DS6 which indicates loss of modulation has been explained in paragraph 4-2d.

d. The AGC voltage, taken directly from the IF amplifier module is applied to the meter panel through point I. Panel meter M1 indicates the prevailing AGC voltage generated in the IF amplifier module. The AGC signal is also applied to a threshold detector which activates the AGC alarm indicator 1A3DS1. The threshold of the AGC alarm is set by means of a potentiometer on the output of the threshold detector to obtain maximum isolation between the metering voltage and the alarm drive voltage. The threshold of the circuit is set to activate the alarm indicator when the AGC voltage falls below a preset value of approximately -80 dbm. This action signifies that the transmission from the distant station has ceased, or that the receiver of the local radio set has failed.

e. The combining operation is monitored at the meter panel by a dc signal which enters the meter panel along wire L. The signal is taken direct from the noise amplifier module. The metering signal is indicated on meter M1 as the combiner voltage which provides a direct indication of the instantaneous noise level present in the associated receiver.

f. The excess noise alarm signal is taken direct from a threshold circuit located within the noise amplifier module. The excess noise alarm signal is the application of +28vdc from the noise amplifier module to the meter panel indicator through point K. The threshold control for the excess noise alarm circuit is located in the noise amplifier module. The receiver A noise alarm indicator 1A3DS3 is activated when the noise level rises above a preset threshold value of approximately -78 dbm. Operation of the noise amplifier portion of the circuit is explained in paragraph 44e.

g. The receiver pilot-tone alarm indicator 1A3DS2 derives its signal voltage from circuits described in paragraph 4-4 k and i. The receiver pilot-tone is designated as lost or missing when +28V is applied to light the meter panel indicator lamp.

h. The receiver baseband pilot-tone alarm indicator 1A3DS4 derives its signal voltage along line Q from circuits described in paragraph 4-4j. The indicator lights to signify loss of baseband pilot-tone when +28 vdc is applied along the line Q.

i. The receiver mixer crystal current, taken from receiver mixer 1A6A6, is brought directly from the mixer to the meter panel along line G to the meter function switch. This is a READ. REDLINE position of the meter function switch. The crystal current is adjusted to the redline zone by adjustment of attenuator 1A6AT7 in the line between the receiver local oscillator 1A6Y3 and the mixer itself.

j. The power supply voltages monitored by meter 1A3M1 are taken from their associated Klystron or low voltage power supply. The significance of these voltages and the points from which they are derived is explained in paragraphs 4-6 and 4-7.

4-6. Klystron Power Supply
(fig. FO-3)

a. The Klystron power supply furnishes operating potentials to the Klystron driver module and the reflex Klystron power amplifier stage. The input to the Klystron power supply requires negative 48 vdc. The supply provides three fixed output voltages and one variable voltage under direct control of the AFC module. The three fixed voltages are 120 volts dc required for the high-level amplifiers in the Klystron driver module, 6.0 volts dc for the Klystron filament, and --750 volts dc for the klystron beam supply. The variable supply, which delivers a nominal -450 volts dc, is variable over a wide range of manual adjustment, and over a narrow range under direct and automatic control of circuits in the AFC module. The manual variation is used to bring the Klystron to its assigned operating frequency at the time of installation; whereas, the automatic variation is used to prevent the Klystron from drifting from its assigned frequency during operation.

b. Each of the Klystron power supply output voltages provides an associated sampled voltage to the meter panel for monitoring purposes. The sampled beam voltage is a fixed 10 volts, the sampled reflector voltage ranges between -38 and --47 volts, and the driver voltage is fixed at 12 vdc.

4-7. Low Voltage Power Supply
(fig. FO-3)

The low voltage power supply furnishes all operating potentials for general dc power distribution throughout the radio set.. The input to the low voltage power supply requires --48 vdc. Each supply provides four fixed output voltages. The positive 28-volt supply furnishes the general operating potentials to the majority of components of the terminal. The negative 6-volt supply provides operating voltages for the IF amplifier and baseband combiner modules. The positive 20-volt supply is used to power the frequency sources mounted on the RF panel. The 60-volt supply is not used. The +28 vdc and --6 vdc power supply voltages are also used in the appropriate sections of the 1A3 meter panel.

CHAPTER 5

ON-SITE MAINTENANCE

WARNING

Dangerous electrical potentials and currents are present within the radio set and associated station power cables. Turn off the radio set corresponding klystron power supply before removing or installing a klystron tube, a klystron driver module, or RF components on RF panel 1A6. Whenever replacing either a klystron power supply or the low voltage power supply, the corresponding dc power switch on the meter panel must be turned off. Do not turn off the radio set when removing or installing plug-in modules on the door assemblies. For general safety, avoid physical contact with all energized components except those designated in appropriate instructions. Observe good working practices at all times. Failure to comply with this warning could result in injury or DEATH.

Section I. GENERAL

5-1. Scope of On-site Maintenance

a. Maintenance for the radio set is separated into two categories designated as on-site maintenance and off-site maintenance. On-site maintenance is covered in this chapter, while off-site maintenance is provided in chapter 6. An understanding of the content and limitations of each category is necessary to effectively maintain the radio set.

b. The on-site category includes an integrated grouping of operator, organizational, and direct support levels of maintenance. This maintenance involves all those maintenance functions normally performed at microwave radio communication sites where the radio set is installed. These functions are listed as follows together with a reference to the sections which provide the information:

(1) Preventive maintenance (sec II).

(2) Troubleshooting and fault isolation (sec III).

(3) Repair by replacement of modules, assemblies, subassemblies, and components which are not a part of easily removable or replaceable assemblies or subassemblies of the radio set (secs III and IV).

(4) Limited repairs within modules, assemblies, or subassemblies where these efforts do not require the use of general support or general support/depot test equipment, or involved realignment techniques (secs III, IV, and V).

(5) Adjustment and alignment of the radio set (sec IV).

(6) Performance testing and requalification of the repaired radio set (sec V).

(7) Special on-site maintenance (sec VI).

5-2. Tools, Test Equipment, and Materials Required

a. The tools and test equipment required for onsite maintenance are listed and identified in the maintenance allocation chart (app B).

b. The materials required for maintenance are listed below:

(1) Lint free cloth.

(2) Brush, paint, /2 inch width.

(3) Trichloroethane.

5-3. Supporting Information

a. Procedure References.

(1) The radio set is symmetrically configured because of the dual-diversity function of the equipment. Therefore, all maintenance procedures of this chapter apply equally to both diversity channels. Unless otherwise noted, all maintenance procedures have been written for channel A only; when servicing channel B, it is necessary to substitute corresponding references to components and functions of channel B.

(2) The procedures are presented in a sequential and logical manner. The order of the alignment procedures must be strictly adhered to whenever a complete realignment or refurbishing of a terminal or radio link is necessary. Whenever replacing a single module due to a failure, it is necessary to make only those adjustments and performance test related to the replaced assembly. These test and adjustments are listed

in the module replacement matrix, paragraph 529 *a*.

(3) It is essential that organizational and direct support level maintenance personnel be aware of the controls and adjustments which are authorized to be aligned on-site. All other controls are sealed at the general support level. (Refer to paragraph 5-16b for details.)

b. On-Line and Off-Line Definitions. The terms on-line and off-line as applied to procedures in this chapter refer to the operational status of the overall radio set and particularly its individual exciter or receiver diversity channels. The overall radio set may be on-line during maintenance which denotes a partially operational status, or it may be off-line in a standby or shutdown status.

(1) For on-line procedures, one diversity channel is serviced at a time while communications are maintained over the alternate channel. Certain procedures require that no RF signal be received from the distant radio set for the off-line receiver channel. This condition is particularly critical because the received signal would interfere with the locally generated testing signals and levels.

(2) Off-line procedures require that all radio set transmission and reception for both channels be suspended until the procedure is completed. Only a few test procedures require that the terminal be taken off-line. These are the receiver noise-figure test and the frequency response from multiplex input to multiplex output.

(3) Prior to suspension of communications for any channel, it is the general practice to notify associated communications system activities of the intended shutdown and the expected length of circuit outage. At completion of procedures, notification is given for the return of the channel to operational status.

c. Operation of Test Equipment. Detailed operation of test equipment is covered in manuals separately provided for those equipments. The test parameters for the procedures of this chapter are given in terms that allow direct reading on test equipment and indicate tolerances where they apply.

d. Turn-On, Operation, and Turnoff of Radio Set. Turn-on, operation, and turnoff of the radio set during maintenance is governed by the conditions of all warnings listed on the back of the cover page of this manual.

e. Control of Alarm Conditions and Indications. When exciter or receiver channels are placed off-line during maintenance, certain local (and consequently remote) alarm conditions result which may be disabled because of the annoyance or for other reasons designated by the communications system. After maintenance has been completed, return switches to their former normal operating positions.

f. Alarm Condition and Control.

Section	Channel	Module location	Switch	Normal position	Test position and function
Exciter	A	Transmit dual pilot-tone detector 1A4MD2..................	S2	PLT NORM	PLT BYP-Disables modulation loss alarm.
Exciter	B	Transmit dual pilot-tone detector 1A4MD2..................	S3	PLT NORM	PLT BYP-Disables modulation loss alarm.
Receiver	A	Noise amplifier 1A2MD7	S1	NORM	BYP-Disables receiver excess noise squelch and noise alarm.
Receiver	B	Noise amplifier 1A2MD5	S1	NORM	BYP-Disables receiver excess noise squelch and noise alarm.
Receiver	A	Baseband dual pilot-tone detector 1A2MD1................	S2	PLT NORM	PLT BYP -Disables baseband pilot-tone alarm.
Receiver	B	Baseband dual pilot-tone detector 1A2MDl.................	S3	PLT NORM	PLT BYP-Disables baseband pilot-tone alarm.
Receiver	A	Receiver dual pilot-tone detector 1A2MD6..................	S2	PLT NORM	PLT BYP-Simulates presence of normal pilot-tone signal in channel A thereby disabling squelch and alarm.
Receiver	B	Receiver dual pilot-tone detector 2A2MD6..................	S3	PLT NORM	PLT BYP--Simulates presence of normal pilot-tone signal in channel B thereby disabling squelch and alarm.

Section II. PREVENTIVE MAINTENANCE INSTRUCTIONS

5-4. Scope of Preventive Maintenance

The preventive maintenance duties assigned to on-site maintenance personnel are listed below together with a reference to the paragraphs covering the specific maintenance functions.

a. Organizational weekly preventive maintenance checks and services.

b. Organizational/direct support quarterly preventive maintenance checks and services.

c. Direct support semiannually and annually preventive maintenance checks and services.

d. Cleaning.

e. Touchup painting.

5-5. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, reduce downtime, and assure that the equipment is serviceable and is performing to its maximum operational capability.

a. Systematic Care. The procedures given in paragraphs 5-7 through 5-10 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services.

(1) The preventive maintenance checks and services charts present procedures to be performed at specific intervals. These checks and services are used to maintain Army electronic equipment in a combat serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist personnel in maintaining serviceability, the charts indicate what to check, how to check, and what are the normal resulting conditions. The charts also make reference to other parts of this manual (or to other manuals) for further clarification of the resulting conditions. As the radio set is a complex radio equipment that requires extensive testing to confirm and correct malfunctions, it is beyond the scope of these charts to recommend direct corrective action. Rather, the note below applies as a general statement.

NOTE

Failure to obtain the prescribed indications during preventive maintenance procedures indicates an abnormal condition or result. Consult the references given for clarification of result, and the troubleshooting instructions contained in section III.

(2) The organizational weekly preventive maintenance checks and services procedures assume that the radio set is in on-line continuous service and that no action may be taken that would interfere with system operation and the passing of communications traffic. Therefore, the procedures reflect only those conditions and responses which occur during normal operation. No attempt is made to initiate checks which would result in communications system interference through the temporary disablement of radio set circuits.

(3) The quarterly preventive maintenance checks and services are performed by on-site technical personnel as routine checks. These tests do not interrupt communications while performed. At no time is the radio terminal to be completely turned off for these tests. The recording of data during these quarterly checks allow maintenance management personnel to evaluate the performance and detect certain trends in degradation. From these trends, preventive measures can then be taken to preclude a possible catastrophic failure.

(4) The semiannual preventive maintenance checks and services are accomplished by off-site maintenance teams. This test effort determines the accuracy of the testing performed on a quarterly basis by on-site personnel. Certain parameters are examined at this time to ascertain that individual modules, or groups of modules, or functions are within required specifications. The testing effort does not cause a break in communications since only parts of the terminal are examined at a time.

(5) The annual preventive maintenance checks and services are also performed by off-site maintenance teams. At this time it will be necessary to request downtime in order to perform certain checks. Parameters such as noise figure, antenna waveguide VSWR, and link tests are made. The annual testing requires special skills and special test equipment normally not found at the organizational level.

(6) Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

5-6. Preventive Maintenance Checks and Services Periods

a. Preventive maintenance checks and services of the radio set are required weekly, quarterly, semiannually, and annually.

b. The procedures in the following charts are provided for channel A of the transmitters and receivers. Repeat these procedures for channel B in order to test the complete terminal.

5-7. Weekly Preventive Maintenance Checks and Services

Sequence No.	Item to Be Inspected	Procedure	References
1	Cables and connectors	Inspect cords, cables, and wires for chafed, cracked, or frayed insulation. Replace defective cables, cords, wires, and connectors that are broken, arced, stripped, or excessively worn during next downtime.	
2	Interior integrity	Open receiver door assembly 1A1, combiner door assembly 1A2, and exciter door assembly 1A4. Inspect each door assembly and the RF panel 1A6 to make certain that the properly assigned complement of modules and components are installed, and that all items are secured properly in place.	Fig. 1-4 and FO-4.
3	Locking devices and hardware	Inspect locking devices and hardware on door assemblies for looseness; replace or tighten as necessary.	None.
4	Exterior surfaces	Inspect and clean exposed metal surfaces of rust and corrosion; touch up paint as required. Clean meter glass and indicator lenses.	Para 5-11 and 5-12.
5	Low voltage power voltages	On meter panel, set channel A function switch to 28V and -6Vpositions, in turn. The CHANNEL A meter should indicate in redline area of meter scale for each switch position.	
		a. + 28	Para 3-7*f*.
		b. -6V	Para 2-7*g*.
6	Klystron power supply -750V voltage.	On meter panel, set channel A function switch to -750V and observe redline area indication of CHANNEL A meter.	Para 3-7 *h*.
7	RF output power	On meter panel, set channel A function switch to OUTPUT POWER and observe redline area indication of CHANNEL A meter,.	Para 3 *e*.
8	Receiver mixer crystal current	On meter panel, set channel A function switch to XTAL CUR and observe redline area indication of CHANNEL A meter.	Para 3-7 *d*.
		NOTE **The values indicated by panel meter in sequence numbers 9 through 13 are not correspondingly the same for all radio sets in communication system. These values will vary due to differences in operating frequency, environment, and trams-missionpath specific values for the particular radio set. Also refer to paragraph 3-7*a*.**	
9	Klystron power supply driver (+ 200V) voltage.	On meter panel, set channel A function switch to DRIVER (+ 200V). Observe indication between 105 and 125 volts on lower scale of CHANNEL A meter.	Para 3-7 *l*.
10	Klystron -500 volt reflector voltage.	On meter panel, set channel A function switch to REFL (-500 volts on upper scale of CHANNEL A meter.	Para 3-7 *k*.
11	AFC voltage	On meter panel, set channel A function switch to AFC. Observe indication between 0 and 1.0 volts (nominal 0.5 volt) on lower scale of CHANNEL A meter.	Para 3-7*i*.
12	Combiner (+ 20V) voltage	On meter panel, set channel A function switch to COMBINER (+20V). Observe indication between 7 and 9 volts on lower scale of CHANNEL A meter.	Para 3-7*c*.
13	AGC (-5V) voltage	On meter panel, set channel A function switch to AGC (-5V). Observe indication between 0 and 3 volts on upper scale of CHANNEL A meter.	Para 3-7 *b*.
14	Channel A meter function switch.	Set CHANNEL A meter function switch to OFF	None.
15	Primary power indicator	The meter panel A PRI PWR indicator should be lit.	Para 3-8*a*.
16	Modulation loss alarm indicator	The meter panel A XMIT MOD LOSS alarm indicator should not be lit.	Para 3-8*c*.

Sequence No.	Item to Be Inspected	Procedure	References
17	RF output power alarm indicator.	The meter panel A XMIT RF PWR alarm indicator should not be lit.	Para 3-8*b.*
18	Receiver baseband pilot-tone alarm indicator.	The meter panel A RCVR BB PT alarm indicator should not be lit (assuming normal signal reception).	Para 3-8 *f*
19	Receiver excess noise alarm indicator.	The meter panel A RCVR NOISE alarm indicator should not be lit (assuming normal signal reception).	Para 3-8*g.*
20	Receiver pilot-tone alarm indicator.	The meter panel A RCVR PILOT TONE alarm indicator should not be lit (assuming normal signal reception).	Para 3-8*e.*
21	Receiver AGC alarm indicator	The meter panel A RCVR AGC alarm indicator should not be lit (assuming normal signal reception).	Para 3-8 *d.*
22	Alarm checks for dual pilot-tone detector modules.	One at a time, place the dual pilot-tone detector module TEST/NORM switches to TEST position and then return to NORM position, and note that the corresponding meter panel indicator lamps come on and then go off. *Module switch* — *Meter panel lamp* 1A2MD1S1 — A RCVR BB PT 1A2MD1S2 — B RCVR BB PT 1A2MD6S1 — A RCVR PILOT TONE 1A2MD6S2 — B RCVR PILOT TONE 1A4MD2S1 — A XMIT MOD LOSS 1A4MD2S2 — B XMIT MOD LOSS	Fig. 1-4 and 3-1.
23	Alarm checks for noise amplifier modules and for AGC circuitry.	Disconnect, one at a time, the output of each IF bandpass filter module. The corresponding NOISE lamp and AGC lamp should light.	Fig. 1-4 and 3-1.
24	Alarm checks for transmitter output level.	Disconnect, one at a time, the input cable of each AFC module. The RF PWR lamp for the corresponding module should come on.	Fig. 1-4 and 3-1.

5-8. Quarterly Preventive Maintenance Checks and Services

Sequence No.	Item to Be Inspected	Procedure	References
1	Terminal blocks, connectors, and station waveguide.	Inspect terminal blocks LTBI, 1TB2, and 1TB3. All terminal screws should be tight and there should be no evidence of dirt or corrosion. Check connectors 1J1 and 1J2 for correct seating and tightness. Inspect station waveguide for correct attachment.	None.
2	Interior of cabinet	Clean interior of radio set cabinet. Touch up paint as required.	Para 5-11 and 5-12
3	Publications	Check to see that all publications are complete, serviceable, and current.	DA Pam 310-4.
4	Modifications	Check DA Pam 310-7 to determine if new applicable MWO's have been published. All URGENT MWO's must be applied immediately. All NORMAL MWO's must be scheduled.	TM 38-750 and DA Pam 310-7.
5	Spare parts	Check all on-site spare parts for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	None.
6	Transmitter output power measurement.		
7	Transmitter output frequency measurement.	Perform in accordance with paragraph 5-38. Perform in accordance with paragraph 5-41.	Fig. FO-4. Fig. FO-4.
8	Local oscillator frequency measurement.	Perform in accordance with paragraphs 5-40 or 5-43. Also check lock-voltage for 10 ± 3 vdc.	Fig. FO-4.
9	Exciter amplifying stages gain measurement.	Perform in accordance with paragraph 5-37. Check level of a multiplex incoming group pilot from the MUX input to TP7 of the klystron driver module.	Fig. FO-4.

Sequence No.	Item to Be Inspected	Procedure	References
10	Noise power ratio measurement of radio link.	Check radio link from klystron driver module to limiter-discriminator module (across the radio link). Perform in accordance with paragraph 5-46.	Fig. FO-4 and 1-4.
11	Low voltage power supply measurements.	Check power supply output voltages for correct outputs at TB1 (on rear of supply): TB1-2 and TB1-5 for + 28 vdc ± 0.1 vdc TB1-3 and TB1-5 for + 20vdc ± 0.5 vdc TB1-6 and TBI-8 for -6 vdc ± 0.06 vdc	Fig. FO-26 and 5-2.

5-9. Semiannual Preventive Maintenance Checks and Services

Sequence No.	Item to Be Inspected	Procedure	References
1	Deviation sensitivity of transmitter	Perform in accordance with paragraph 5-50. Check and adjust only if required.	Fig. FO-4 and 1-4.
2	AFC check.	Check transmitter frequency with and without AFC control. Perform in accordance with paragraph 5-41.	Fig. FO-4.
3		Perform all quarterly preventive maintenance checks.	

5-10. Annual Preventive Maintenance Checks and Services

Sequence No.	Item to Be Inspected	Procedure	References
1	AN/FRC-154(V)	Perform all of the required performance checks as listed in paragraphs 5-30 through and including 5-53. If certain parameters are not met, perform the suggested corrective maintenance, then realign the affected section (s).	Para 5-14 and 5-29 a
2	Radio link	Perform an entire link frequency MUX response test in accordance with paragraph 5-48.	None.
3	Radio link	Perform an entire link NPR test in accordance with paragraph 5-46.	None.

5-11. Cleaning

WARNING

Dangerous electrical potentials and currents are present within the radio set and associated station cables. Before cleaning any internal areas of the cabinet, turn off the radio set. Failure to comply with this warning could result in injury or DEATH.

a. The exterior and interior surfaces of the radio set should be free of dust, dirt, grease, and fungus.

CAUTION

Do not remove the solid panels from the upper-rear section of the cabinet. These panels provide mounting for the Klystrons, waveguide assemblies, and other RF components which will be damaged if the panels are removed.

b. Access to the interior areas of the cabinet is made by opening the three door assemblies located at the front of the equipment, and also by removing the perforated ventilation panel from the lower-rear section of the equipment; the panel is retained by mounting screws.

c. Perform the following cleaning procedures:

CAUTION

Use extreme care not to disturb component lead dress or cause damage to components mounted within the cabinet. Do not apply excessive pressure to any wiring harness or assembly mounted inside the cabinet or on the hinged door assemblies.

(1) Using a vacuum cleaner equipped with a plastic cleaning head and extension hose, carefully remove any accumulated dust and dirt from the cabinet interior, power supplies, and the three door assemblies.

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but

exposure of the fumes to an open flame converts the fumes to highly toxic dangerous gases.

(2) Use a dry, clean, lint free cloth or brush to remove persistent dust or dirt. If necessary, moisten the cloth or brush with trichloroethane. Also use the cloth and trichloroethane to remove grease and fungus. After cleaning, wipe dry with a clean cloth.

(3) Remove dust and dirt from plugs and jacks with a brush, or a vacuum cleaner if possible.

WARNING

Compressed air is dangerous and can cause serious bodily harm. It can also cause mechanical damage to the equipment. Do not use compressed air to dry parts where trichloroethane has been used.

(4) Dry compressed air, not to exceed 60 pounds per square inch, may be used to remove dirt and dust from inaccessible places.

CAUTION

Do not press on any meter face (glass) when cleaning; the meter may become damaged.

(5) Clean the meter panel, control knobs, and indicator lamp lenses; use a soft, clean cloth dampened with water. Mild soap may be used. Check the meter faceplates and lamp lenses for damage or discoloration.

5-12. Touchup Painting

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB 746-10.

Section III. TROUBLESHOOTING

5-13.Introduction to Troubleshooting

a. General Information. The radio set is a complex radio equipment that requires, for the most part, extensive testing to confirm and correct malfunctions. It is assumed that the radio terminal was in good operating condition prior to the malfunction. The malfunctions considered are radical failures in the signal paths and not degradation of performance. Once the problem has been isolated to a faulty module or assembly, and this module replaced, certain adjustment and performance tests must be accomplished to requalify the performance of the radio terminal. Refer to section IV for pertinent information on the necessary adjustments and tests.

b. Fault Detection.

(1) Personnel operating and servicing the radio set become aware of a malfunction by a combination of three basic conditions, as follows:

(a) Through indicator lamps, principally on the meter panel, which are lighted when a malfunction is detected by automatic monitors located at strategic circuit points within the radio set.

(b) Through a degradation or failure of radio communications between affected stations of the system.

(c) During maintenance periods, at which time performance test results are abnormal or substandard.

(2) All three conditions produce symptoms which can be broadly classified as occurring during-starting the radio set, transmitter symptoms occurring during operation, and receiver symptoms occurring during operation. These symptoms permit the malfunction to be localized; detailed procedures must then be employed to isolate the trouble. On-site maintenance permits only replacement or substitution of the defective component as described in paragraph 5-29. Figure 5-1 is a highly simplified block diagram of the radio set, with special intention to show the modules intervening between metering and alarm monitoring points available on the meter panel as an aid to rapid troubleshooting. In some instances, a simple adjustment to the low voltage power supply will relieve the trouble; figure 5-2 is provided to show the location of the adjustment controls.

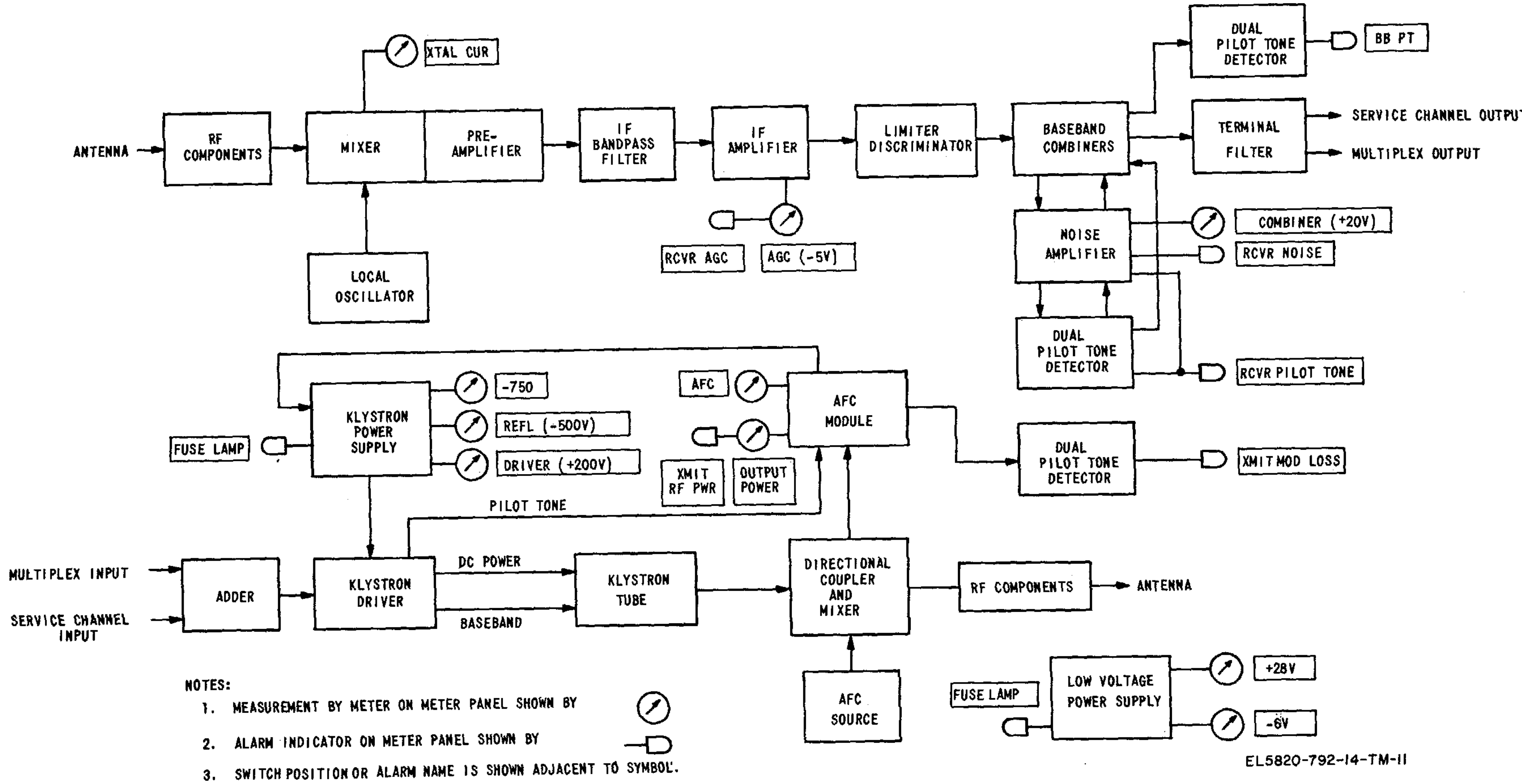

Figure 5-1. Relationship of metering and alarm indications to the overall radio set.

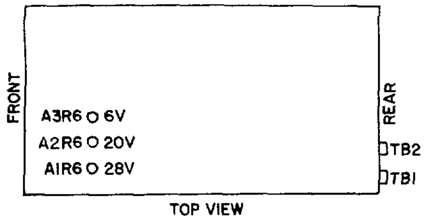

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Figure 5-2. Lou; voltage power supply, location of adjustment controls.

c. Visual Inspection. Visual inspection of the equipment often points out areas of trouble. If any of the conditions listed below appear, effort should be directed to discover whether the condition is intentional, and if not, then make the necessary repairs. The following are some suggested general items:

(1) Check each of the modular assemblies to insure that it is properly seated in position.

(2) Check that all dc primary power wiring connections are properly secured and insulated.

(3) Check that all grounding connections are properly and securely made.

(4) Inspect connectors and plugs for broken, worn, or warped contact surfaces.

(5) Check for proper termination of all interconnecting cables.

(6) Inspect all parts for evidence of overheating caused by short circuits or leakage paths. Discoloration and sometimes accompanying odors of wires and components indicate excessive heat has been generated.

d. Use of Multimeter AN/PSM-6B. Multimeter AN/PSM-6B can be used for simple electrical measurements. When using the ohmmeter portion of the multimeter (or any ohmmeter), observe the following precaution:

CAUTION

As a general rule, it is not recommended that the Rx1 range of any ohmmeter be used when testing transistors. The Rx1 range on most ohmmeters normally connects an internal 1.5-volt battery directly across the test leads, causing comparatively high current (50 milliamperes or more) to flow which may damage the transistor under test. Before using any ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads for each meter range.

5-14. Test and Signal Points

Reference designation	Location	Function
1A1MD2TP1	Limiter-discriminator module (channel B)	Ground.
1A1MD2TP2	Limiter-discriminator module (channel B)	Detected discriminator output. Used for discriminator output crossover-voltage monitor point.
1A1MD3TP1	IF amplifier module (channel B)	Output of AGC amplifier to AGC metering circuit on meter panel.
1A1MD3TP2	IF amplifier module (channel B)	Ground.
1A1MD5TP1	Limiter-discriminator module (channel A)	Ground.
1A1MD51P2	Limiter-discriminator module (channel A)	Detected discriminator output. Used for discriminator output crossover-voltage monitor point.
1A1MD6TP1	IF amplifier module (channel A)	Output of AGC amplifier to AGC metering circuit on meter panel.
1AMD6TP2	IF amplifier module (channel A)	Ground.
1A2MD1TP1	Baseband dual pilot-tone detector module	Ground.
1A2MD1TP2	Baseband dual pilot-tone detector module	Input monitor. Auxiliary baseband pilot-tone output from channel A baseband combiner.
1A2MD1TP3	Baseband dual pilot-tone detector module	Channel A test point for potentiometer R1. Monitors specific level at which loss of baseband pilot-tone alarm circuit is activated.
1A2MD1TP4	Baseband dual pilot-tone detector module	Channel A detected baseband pilot-tone control signal; supplied to relay driver for alarm action
1A2MD1TP5	Baseband dual pilot-tone detector module	Channel B detected baseband pilot-tone control signal; supplied to relay driver for alarm action
1A2MD1TP6	Baseband dual pilot-tone detector module	Channel B test point for potentiometer R2. Monitors specific level at which loss of baseband pilot-tone alarm circuit is activated.
1A2MD1TP7	Baseband dual pilot-tone detector module	Ground.
1A2MD1TP8	Baseband dual pilot-tone detector module	Input monitor. Auxiliary base from channel B baseband combiner.
1A2MD2P1	Receiver terminal filter module	Monitor for multiplex output.
1A2MD2TP2	Receiver terminal filter module	Ground.
1A2MD2TP3	Receiver terminal filter module	Ground.

Reference designation	Location	Function
1A2MD2TP4	Receiver terminal filter module	Monitor for baseband input.
1A2MD2TP5	Receiver terminal filter module	Monitor for service channel input.
1A2MD2TP6	Receiver terminal filter module	Ground.
1A2MD2TP7	Receiver terminal filter module	Monitor for service channel balanced output.
1A2MD2TP8	Receiver terminal filter module	Monitor for service channel balanced output.
1A2MD3TP1	Baseband combiner module (channel B)	Monitor for + 28 vdc
1A2MD3TP2	Baseband combiner module (channel B)	Monitor for multiplex baseband output.
1A2MD3TP3	Baseband combiner module (channel B)	Output monitor of first combiner amplifier stage.
1A2MD3TP4	Baseband combiner module (channel B)	Monitor for -6 vdc
1A2MD3TP5	Baseband combiner module (channel B)	Monitor for potentiometer R1 used to set gain of amplifiers for output level adjustment.
1A2MD3TP6	Baseband combiner module (channel B)	Ground.
1A2MD3TP7	Baseband combiner module (channel B)	Monitor for combiner current adjustment.
1A2MD3TP8	Baseband combiner module (channel B)	Monitor for combiner balance adjustment.
1A2MD3TP9	Baseband combiner module (channel B)	Monitor for potentiometer R2 used to adjust baseband input signal level.
1A2MD4TP1	Baseband combiner module (channel A)	Monitor for + 28 vdc
1A2MD4TP2	Baseband combiner module (channel A)	Monitor for multiplex baseband output.
1A2MD4TP3	Baseband combiner module (channel A)	Output monitor of first combiner amplifier stage.
1A2MD4TP4	Baseband combiner module (channel A)	Monitor for -6 vdc
1A2MD4TP5	Baseband combiner module (channel A)	Monitor for potentiometer R1 used to set gain of amplifiers for output level adjustment.
1A2MD4TP6	Baseband combiner module (channel A)	Ground.
1A2MD4TP7	Baseband combiner module (channel A)	Monitor for combiner current adjustment.
1A2MD4TP8	Baseband combiner module (channel A)	Monitor for combiner current adjustment.
1A2MD4TP9	Baseband combiner module (channel A)	Monitor for potentiometer R2 used to adjust baseband input signal level.
1A2MD5TP1	Noise amplifier module (channel B)	Monitor for input baseband signal.
1A2MD5TP2	Noise amplifier module (channel B)	Ground.
1A2MD5TP3	Noise amplifier module (channel B)	Monitor for bias input from baseband combiner.
1A3MD5TP4	Noise amplifier module (channel B)	Output of noise bandpass filter FL1.
1A2MD5TP5	Noise amplifier module (channel B)	Monitor for potentiometer R2 used for noise level adjustment.
1A2MD5TP6	Noise amplifier module (channel B)	Monitor for potentiometer R3 used for receiver pilot-tone level adjustment.
1A2MD5TP7	Noise amplifier module (channel B)	Ground.
1A2MD6TP1	Receiver dual pilot-tone detector module	Ground.
1A2MD6TP2	Receiver dual pilot-tone detector module	Input monitor. Output signal from channel A noise amplifier.
1A2MD6TP3	Receiver dual pilot-tone detector module	Channel A test point for potentiometer R1. Monitors specific level at which loss of receiver pilot-tone alarm and squelch circuits are activated.
1A2MD6TP4	Receiver dual pilot-tone detector module	Channel A detected receiver pilot-tone control signal; supplied to relay driver for alarm and squelch action.
1A2MD6'TP5	Receiver dual pilot-tone detector module	Channel B detected receiver pilot-tone control signal; supplied to relay driver for alarm and squelch action.
1A2MD6TP6	Receiver dual pilot-tone detector module	Channel B test point for potentiometer R2. Monitors specific level at which loss of receiver pilot-tone alarm and squelch circuits are activated.
1A2MD6TP7	Receiver dual pilot-tone detector module	Ground.
1A2MD6TP8	Receiver dual pilot-tone detector module	Input monitor. Output signal from channel B noise amplifier.
1A2MD7TP1	Noise amplifier module (channel A)	Monitor for input baseband signal.
1A2MD7TP2	Noise amplifier module (channel A)	Ground.
1A2MD7TP3	Noise amplifier module (channel A)	Monitor for bias input from baseband combiner.
1A2MD7TP4	Noise amplifier module (channel A)	Output of noise bandpass filter FL1.
1A2MD7TP5	Noise amplifier module (channel A)	Monitor for potentiometer R2 used for noise level adjustment.
1A2MD7TP6	Noise amplifier module (channel A)	Monitor for potentiometer R3 used for receiver pilot tone level adjustment.
1A2MD7TP7	Noise amplifier module (channel A)	Ground.
1A4MD1TP1	AFC module (channel B)	Output monitor. AFC correction signal to klystron power supply.
1A4MD1TP2	AFC module (channel B)	Undetected output of audio amplifier chain.
1A4MD1TP3	AFC module (channel B)	Detected output of 70-MHz discriminator. Used for discriminator output crossover-voltage monitor point.

Reference designation	Location	Function
1A4MD1TP4	AFC module (channel B)	Interlaced 70-MHz signal output of switching circuit.
1A4MD1TP5	AFC module (channel B)	Monitor for potentiometer R4 used to set level of square wave signal into signal switches.
1A4M1D1TP6	AFC module (channel B)	Ground.
1A4MD2TP1	Transmit dual pilot-tone detector module	Ground.
1A4MD2TP2	Transmit dual pilot-tone detector module .	Input monitor. Detected modulated signal output from channel A noise amplifier.
1A4MD2TP3	Transmit dual pilot-tone detector module	Channel A test point for potentiometer R1. Monitors specific level at which loss of modulation alarm circuit is activated.
1A4MD3TP3	AFC module (channel A)	Detected output of 70-MHz discriminator. Used for discriminator output crossover-voltage monitor point.
1A4MD3TP4	AFC module (channel A	Interlaced 70-MHz signal output of switching circuit.
1A4MD3TP5	AFC module (channel A)	Monitor for potentiometer R4 used to set level of square wave signal into signal switches.
1A4MD3TP6	AFC module (channel A)	Ground.
1A4MD4TP1	Adder module (channel B)	Monitor for output A.
1A4MD4TP2	Adder module (channel B)	Monitor for output B.
1A4MD4TP3	Adder module (channel B)	Ground.
1A4MD4TP4	Adder module (channel B)	Not used.
1A4MD4TP5	Adder module (channel B)	Monitor for multiplex input signal after attenuation (if used).
1A4MD4TP6	Adder module (channel B)	Monitor for multiplex input signal before attenuation.
1A4MD4TP7	Adder module (channel B)	Output of pilot-tone oscillator.
1A4MD5TP1	Transmit terminal filter module	Monitor for multiplex input.
1A4MD5TP2	Transmit terminal filter module	Ground.
1A4MD5TP3	Transmit terminal filter module	Ground.
1A4MD5TP4	Transmit terminal filter module	Monitor for exciter channel A baseband output.
1A4MD5TP5	Transmit terminal filter module	Monitor for exciter service channel output.
1A4MD5TP6	Transmit terminal filter module	Ground.
1A4MD5TP7	Transmit terminal filter module	Monitor for service channel balanced input.
1A4MD5TP8	Transmit terminal filter module	Monitor for service channel balanced input.
1A4MD5TP9	Transmit terminal filter module	Monitor for exciter channel A baseband output.
1A4MD6TP1	Adder module (channel A)	Monitor for output A.
1A4MD6TP2	Adder module (channel A	Monitor for output B.
1A4MD6TP3	Adder module (channel A)	Ground.
1A4MD6TP4	Adder module (channel A)	Not used.
1A4MD6TP5	Adder module (channel A)	Monitor for multiplex input signal after attenuation (if used).
1A4MD6TP6	Adder module (channel A)	Monitor for multiplex input signal before attenuation.
1A4MD6TP7	Adder module (channel A)	Output of pilot-tone oscillator.
	Warning: Dangerous high voltages exist at klystron driver test points TP8, TP9, and TP10. Observe the necessary safety precautions when working with these test points. Failure to comply with this warning could result in injury or DEATH.	
1A6MD3TP1	Klystron driver module (channel A)	Monitor for multiplex input signal.
1A6MD3TP2	Klystron driver module (channel A)	Ground.
1A6MD3TP3	Klystron driver module (channel A)	Monitor for potentiometer R1 used to set input level into high level amplifiers.
1A6MD3TP4	Klystron driver module (channel A)	Monitor for TV data input signal.
1A6MD3TP5	Klystron driver module (channel A)	Monitor for output of first-stage high-level amplifiers.
1A6MD3TP6	Klystron driver module (channel A)	Ground.
1A6MD3TP7	Klystron driver module (channel A)	Monitor for output of second-stage high-level amplifiers.
1A6MD3TP8	Klystron driver module (channel A)	Monitor for - 1200 vdc input.
1A6MD3TP9	Klystron driver module (channel A)	Monitor for -6.3 vdc -750 vdc input.
1A6MD3TP10	Klystron driver module (channel A)	Monitor for 6.3 vdc filament return.
1A6MD3TP1	Klystron driver module (channel A)	Monitor for klystron ground.
1A6MD4TP1	Klystron driver module (channel B)	Monitor for multiplex input signal.
1A6MD4TP2	Klystron driver module (channel B)	Ground.
1A6MD4TP3	Klystron driver module (channel B)	Monitor for potentiometer R1 used to set input level into high-level amplifiers.
1A6MD4TP4	Klystron driver module (channel B)	Monitor for TV data input signal.

Reference designation	Location	Function
1A6MD4TP5	Klystron driver module (channel B)	Monitor for output of first-stage high-level amplifiers.
1A6MD4TP6	Klystron driver module (channel B)	Ground.
1A6MD4TP7	Klystron driver module (channel B)	Monitor for output of second-stage high-level amplifiers.
1A6MD5TP8	Klystron driver module (channel B)	Monitor for - 1200 V dc input.
1A6MD4TP9	Klystron driver module (channel B)	Monitor for -6.3 V dc/-750 V dc input.
1A6MD4TP10	Klystron driver module (channel B)	Monitor for 6.3 V dc filament return.
1A6MD4TP11	Klystron driver module (channel B)	Monitor for klystron ground.
1A6A1	Receiver probe (channel A)	Provides auxiliary RF input to receiver.
1A6A2	Receiver probe (channel B)	Provides auxiliary RF input to receiver.
1A6A3	Exciter probe (channel A)	Provides auxiliary RF output from exciter.
1A6A4	Exciter probe (channel B)	Provides auxiliary RF output from exciter.
1PS1TB1-1	Klystron power supply (channel A) NOTE All terminals of 1PS1TB1 are located on klystron power supply (channel A).	AFC correction voltage input.
1PS1TB1-2		AFC correction voltage return.
1PS1TB1-3.		Chassis ground.
1PS1TB1-4		Chassis ground.
1PS1TB1-5		Not used.
1PS1TB1-6		+ 120 V dc monitor output.
1PS1TB1-7		+ 120 V dc output.
1PS1TB1-8		-750 V dc monitor output.
1PS1TB2-1	Klystron power supply (channel A) NOTE All terminals of IPSlTB2 are located on klystron power supply (channel A).	-450 V dc monitor output.
1PS1TB2-2		-1200 V dc output.
1PS1TB2-3		-750 V dc output.
1PS1TB2-4		Not used.
1PS1TB2-5		6.3 V dc filament return.
1PS1TB2-6		6.3 V dc filament.
1PS1TB2-7		-450 V dc return.
1PS1TB2-8		-750 V dc return.
1PS2TB1-1	Klystron power supply (channel B)	Sane as for channel A klystron power supply 1PS1. through -8.
1PS2TB2-1	Klystron power supply (channel B)	Same as for channel A klystron power supply 1PS1. through -8.
1A5PS1TB1-7	Low voltage power supply (channel A)	+ 65 V dc output (not used).
1A5PS1TB1-9	Low voltage power supply (channel A)	-65 V dc return (not used).
1A5PS1TB1-2	Low voltage power supply (channel A)	+ 28 V dc output.
1A5PS1TB1-3	Low voltage power supply (channel A)	+ 20 V dc output.
1A5PS1TB1-6	Low voltage power supply (channel A)	-6 V dc output.
1A5PS1TB1-4, -5, -6	Low voltage power supply (channel A)	Ground.
1A5PS1TB1-7	Low voltage power supply (channel B)	+ 65 V dc output (not used).
1A5PS2TB1-9	Low voltage power supply (channel B)	-65 V dc output (not used).
1A5PS2TB1-2	Low voltage power supply (channel B)	+28 V dc output.
1A5PS2TB1-3	Low voltage power supply (channel B)	+ 20 V dc output.
1A5PS2TB1-6	Low voltage power supply (channel B)	--6 V dc output.
1A5PS2TB1-4,-5,-6	Low voltage power supply (channel B)	Ground.
1TB1, terminals -1 through -20.	Internally at top of radio set cabinet	Channel A remote monitor outputs and service channel input cabling signal points listed in paragraph 2-5b.
1TB2, terminals -1 through -20.	Internally at top of radio set cabinet	Channel B remote monitor outputs and service channel output cabling signal points listed in paragraph 2-5b.
1TB3-1	Internally at top of radio set cabinet	Station power + 48 V dc.
1TB3-3		Not used.
1TB3-4	Internally at top of radio set cabinet	Station power -48 V dc.

5-15. Troubleshooting Procedures

Item No.	Symptom	Probable cause	Corrective action
1	Primary power indication does not light when PRI PWR switch is set to its on position.	*a.* Loss of dc power to the radio set. *b.* Defective indicator lamp. *c.* Defective switch.	*a.* Inspect to see that dc power cables are properly connected and that the associated circuit breakers are operating properly. *b.* Remove lens and lamp from lampholder and substitute a new lamp. *c.* Replace power switch.
2	CHANNEL A POWVER ON indicator does not light when channel A low voltage power supply is turned on.	If PRI PWR lamp is lighted, a defective fuse 1A5PS1F1 or defective indicator lamp 1A5PS1DS1 is indicated.	Set meter function switch for the proper channel to is +28V position. If meter indicates redline, replace 1A5PS1DS1 lamp; otherwise, replace fuse 1A5PS1F1. If replaced fuse blows or the indicator still does not light, replace the channel A section of low voltage power supply, and return the defective unit for off-site maintenance.
3	Channel A meter does not indicate in the redline zone of its scale when set to measure + 28 V.	*a.* Defective + 28-volt section of the low voltage power supply 1A5PS1 if no voltage is indicated. *b.* Setting of voltage output control is incorrect if voltage is not in redline zone.	Check output of +28-volt section of the low voltage power supply. Measure +28 V dc ± 100 mV between terminals 1A5PS1TB1-2 (positive) and 1A5PS1TB1-5 (ground). If voltage is incorrect, adjust A1R6 on the low-voltage power supply for +28 V dc ±10 mV. If voltage cannot be obtained, replace the channel A section of the low voltage power supply, and return the defective unit for off-site maintenance.
4	Channel A does not indicate in redline zone of its scale when set to measure -6V.	*a.* Defective -6 volt section of the low voltage power 1A5PS1 if no voltage is indicated. *b.* Setting of voltage output control in low voltage power supply is set incorrectly.	Check output -6 volt section of low voltage power supply. Measure -6 V dc ± 60 MV between terminals 1A5PS1TB1-8 (negative) and 1A5PS1TB1-5 (ground). If voltage is incorrect, adjust A3R6 on the low voltage power supply for --6 V dc ± 30 mV. If voltage cannot be obtained, replace the channel A section of the low voltage power supply, and return defective unit for off-site maintenance.
5	Fuse indicator of Klystron power supply does not light when PRI PWR switch is placed in the on position.	*a.* If PRI PWR lamp is lighted, a defective fuse F1 or lamp DS1 in the Klystron power supply is indicated. *b.* If PRI PWR lamp is not lighted, loss of dc power to the radio set is most probable.	*a.* Set meter function switch to its -750V position. If meter indicates in redline zone, replace lamp 1PS1DS1. *b.* If replaced fuse blows or the indicator still does not light, replace the channel A Klystron power supply, and return the defective unit for off-site maintenance .
6	After a Klystron power supply is turned on, the high voltage section does not energize after approximately one minute.	*a.* If the XMIT RF PWR indicator lamp does not go out, the AFC module is in a "lockout" condition. *b.* The Klystron power supply is defective, but fuse does not blow.	Reset related AFC module switch S1 to its ON position several times. If the malfunction is not cleared after the first two or three reset trials, set meter function switch to its AFC position. Then set the AFC switch S1 to its OFF position. If meter indicates near zero (approximately 1), the trouble is probably in the Klystron power

Item No.	Symptom	Probable cause	Corrective action
			supply. Replace channel A Klystron power supply, and return the defective unit for off-site maintenance.
		c. If main power fuse of Klystron power supply blows when high voltage section of the supply energizes, then the power supply is defective.	Replace channel A Klystron power supply, and return the defective unit for off-site maintenance.
7	Channel A meter does not indicate the correct voltage when set to measure DRIVER (+ 200V).	*a.* If no voltage is indicated, the Klystron power supply is defective.	Replace channel A Klystron power supply, and return the defective unit for off-site maintenance.
		b. If approximately 120 V dc is not indicated, the setting of the power supply regulator in the driver supply requires adjustment.	
8	Channel A meter does not indicate the correct voltage when set to measure REFL (-500V). Correct reflector voltage is indicated in the station log.	*a.* Defective Klystron power supply.	*a.* Replace channel A Klystron power
		b. Defective AFC module.	*b.* Set AFC switch S1 to its OFF position. If a normally observed REFL (-500V) is then obtained, the trouble is located in the AFC circuitry. Replace the AFC module first, then if problem still persists, check out the AFC local oscillator frequency (para 5-40) and output level (para 5-39). Repeat if necessary and return the defective unit for off-site maintenance.
9	Channel A meter does not indicate a near zero voltage when set to its AFC position, or the indication is fluctuating.	Defective AFC module.	Replace AFC module and return defective unit for off-site maintenance. With the new AFC module switch S1 in the OFF position, monitor the AFC position on the meter and very slightly adjust the 450V section control for a minimum indication on the meter. Return the AFC switch to ON position.
10	Channel A meter does not indicate in the redline zone of its scale when set to measure -750V.	*a.* If no voltage is indicated, the klystron power supply is defective.	*a.* Replace channel A Klystron power supply, and return the defective
		b. Misadjusted klystron supply.	*b.* If approximately correct voltage is indicated, the setting of the power supply output level of the --750-volt section requires adjustment (para 5-18*d* (9)).
11	Channel A meter does not indicate in the redline zone of its scale when set to measure XTAL CUR, and cannot be adjusted by using attenuator 1A6AT7.	*a.* Defective 20-volt section of the low voltage power supply.	*a.* Check output of +20-volt section of the low voltage power supply. Measure +20 V dc ± 500 mV between terminals 1A5PS1TB1-3 (positive) and 1A5PS1TB1-5 (ground). If voltage is incorrect, adjust A2R6 on the low voltage power supply for +20 V dc ±100 mV. If adjustment cannot be obtained, replace the channel A section of the low voltage power supply, and return defective unit for off-site maintenance.
		b. Defective local oscillator.	*b.* Check output power of local oscillator (para 5-42). Replace the oscillator if defective, and return the faulty oscillator for off-site maintenance.

Item No.	Symptom	Probable cause	Corrective action
		c. Defective mixer diodes.	*c.* Replace mixer diodes.
12	Channel A meter does not indicate in the redline zone of its scale when set to measure OUTPUT POWER.	*a.* Defective alarm-amplifier in meter panel, if no indication is present. *b.* If approximately correct power is indicated, the setting of the alarm-amplifier controls probably require resetting.	*a.* Replace the defective meter panel, and return the faulty assembly for off-site maintenance. *b.* Perform RF power alarm and metering adjustment (para 5-21).
13	RCVR AGC indicator lamp lights without corresponding lighting of RCVR NOISE, and RCVR PILOT TONE indicators.	*a.* Defective IF amplifier module. *b.* Defective alarm-amplifier assembly behind the meter panel.	*a.* Replace the IF amplifier module, and return defective assembly for off-site maintenance. *b.* Replace the meter panel assembly, and return defective unit for off-site maintenance.
14	RCVR PILOT TONE indicator lamps lights without corresponding RCVR AGC and RCVR NOISE indicators, and also without lighting RCVR PILOT TONE indicator in the other diversity channel, provided that distant station has not disconnected any cables in the related transmitter circuitry.	*a.* Limiter-discriminator module as failed. *b.* Faulty receiver dual pilot-tone detector module.!	Replace the limiter-discriminator module. If problem still remains, replace original limiter-discriminator module into the rack, and then replace the dual pilot-tone detector module. Return defective module for off-site maintenance.
15	RCVR NOISE indicator lamp lights with corresponding AGC indicator.	*a.* Failure of distant station transmitter. *b.* Faulty receiver local oscillator. *c.* Faulty preamplifier, IF bandpass filter, of IF amplifier modules.	*a.* If distant station does not concur with a probable transmitter failure, proceed with further checks. *b.* Set meter function switch to XTAL CUR position. If the meter indication is near zero, check the local oscillator output level. (para 5-42). If meter indication is within redline area, proceed with further checks. *c.* Inject local signal from J2 (AUX OUTPUT) of IF amplifier in service, in turn, to J2 of IF filter and to J1 of IF amplifier under test. If alarms clear at first test point, preamplifier or interconnecting cable is defective; if alarms clear at second test point, IF filter is defective; if alarms do not clear, IF amplifier is defective. Replace defective module and return for off-site maintenance.
16	RCVR NOISE indicator lamp lights without corresponding RCVR AGC, and RCVR PILOT TONE indicators.	Received signal is fading into marginal levels, or fault in noise amplifier module.	Set channel meter function switch to its AGC (-5V) position. If meter Indicates near midscale, the received signals are fading. If meter indicates near zero, the noise amplifier is defective and must be replaced. Return the module for off-site maintenance.
17	RCVR PILOT TONE indicator lamps in both receiver channels, and the BB PT indicator lamps are lit.	Pilot-tone signal removed at the distant station transmitter.	Notify the distant station that the transmit pilot-tone is absent.
18	BB PT indicator lamp is lighted without a corresponding RCVR PILOT TONE indicator alarm.	*a.* Failure of baseband combiner module.	*a.* Check the input signal into the dual pilot-tone detector module section of the related baseband combiner module in accordance with the levels shown on figure FO-1. If no level is indicated, replace the baseband combiner module and return it for off-site maintenance. If a correct level is measured, proceed with the next step.

Item No.	Symptom	Probable cause	Corrective action
		b. Failure of dual pilot-tone detector module monitoring the baseband pilot tone.	*b.* Replace the dual pilot-tone detector module, and return the defective module to off-site maintenance.
19	Both BB PT indicator lamps and one RCVR PILOT TONE lamp are lighted.	Failure of baseband combiner module for channel having RCVR PILOT TONE lamp lit.	Replace faulty module in accordance with on-line procedure (para 29b.).
20	XMIT RF PWR indicator lamp is lighted without corresponding XMIT MOD LOSS indication.	*a.* Faulty metering circuitry on meter panel.	*a.* Set channel meter function switch to its OUTPUT POWER position. If meter indicates in redline zone, the meter alarm circuitry is defective. If no metering indication is present, proceed with the next steps.
		b. Faulty AFC module.	*b.* Replace AFC module with a spare unit. Return the defective unit for off-site maintenance.
21	XMIT RF PWR indicator lamp lights with corresponding MOD LOSS indication.	*a.* Faulty Klystron power supply.	*a.* Set channel meter function switch to the -750V position. If the meter indicates near zero, replace channel A klystron power supply, and return the defective unit for off-site maintenance. Set channel meter function switch to the driver (+200V) position. If meter indicates near zero, replace channel A klystron power supply, and return the defective unit for off-site maintenance.
		b. Faulty Klystron driver module.	*b.* Final stages in klystron driver module may be faulty, replace klystron driver module, and return defective unit for off-site maintenance.
		c. Faulty AFC module.	*c.* Set channel meter function switch to the REFL (-500V) position. If meter indicates abnormal voltage to that shown in station log, place the AFC switch to OFF position. If problem clears-up, replace the AFC module. If no change is observed in the metering indication, -replace Klystron power supply, and return defective unit for off-site maintenance.
		d. Low voltage power supply failure.	*d.* Check low voltage power supply +28-volt section for proper output voltage. Measure +28 V dc - 100 mV between terminals lA5PSITB1-2 (positive) and 1A5PS1TB1-5 (ground). If the voltage is incorrect, replace the channel A section of the low voltage power supply, and return the defective unit for off-site maintenance.
		e. Faulty Klystron tube.	*e.* Replace in accordance with paragraph 5-29c.
22	XMIT MOD LOSS indicator lamp lights without corresponding XMTR RF PWR indication.	*a.* Faulty adder module.	*a.* Check whether both XMIT MOD LOSS indicators are lighted, if so the pilot-tone oscillator in the switch selected adder module has failed.

Item No.	Symptom	Probable cause	Corrective action
		b. Faulty klystron driver module.	b. If only one XMIT MOD LOSS indicator is lighted, check the pilot-tone level at the output of the adder module, then at the output of the klystron driver module, in accordance with FO-1. Replace the faulty module and return it for off-site maintenance.
		c. Faulty dual pilot-tone detector module.	c. Replace dual pilot-tone detector module, and return the defective module for off-site maintenance.
23	Multiplex or service channel output is missing from local receiver with all alarm conditions normal, at the local and distant stations.	a. Local receiver terminal filter module is faulty. b. Distant station transmitter terminal filter module is faulty.	Check input and output level of a known reference test tone level, on the terminal filters at each station of the radio link. If no output is present for the missing portion of the baseband (MUX or service channel), replace the defective module and return it for off-site maintenance.

Section IV. ADJUSTMENT, ALIGNMENT, REPAIR, REMOVAL, AND REPLACEMENT

5-16. Introduction to Adjustment and Alignment

a. General.

(1) The radio set as received for installation is ready for operation. The adjustment and alignment procedures given in the following paragraphs are to be performed whenever the radio set is relocated, or when the scheduled annual preventive maintenance check recommends a complete realignment of the radio set.

(2) The adjustment and alignment procedures are to be performed sequentially to insure correct interaction between the various stages of the radio set. If a particular assembly, module, or component part is found defective and is replaced, it is then necessary to only readjust or realign the affected stages. This information is given in paragraph 5-29 of this section.

(3) It is important that the on-site maintenance personnel adjust only the authorized onsite controls, as shown in figures 5-3, 5-4, and 5-5.

NOTE

For brevity, the following procedures are given for channel A components only (using channel A reference designations) unless otherwise specified. For using the procedures for channel B components, simply substitute channel B components and reference designations.

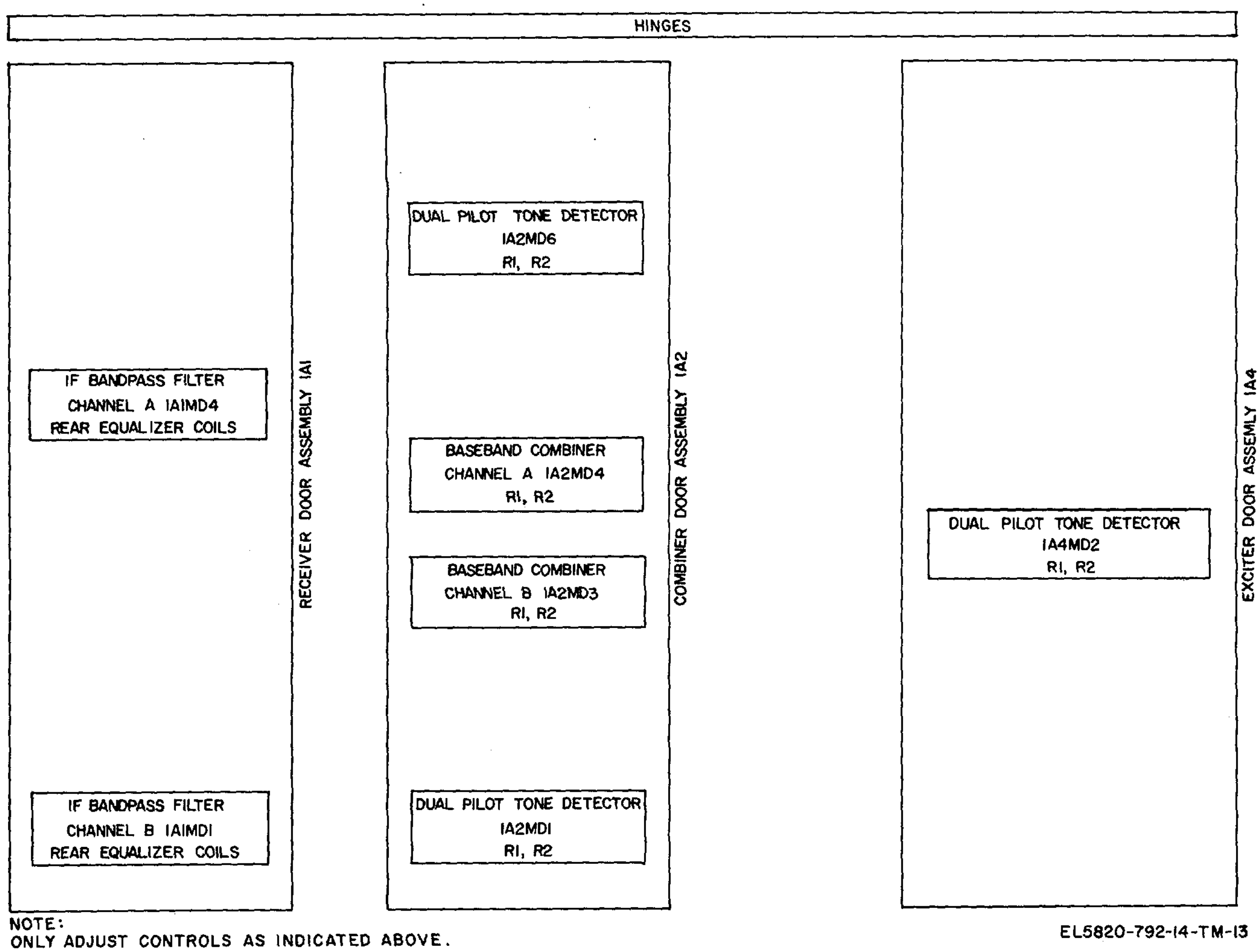


Figure 5-3. Authorized on-site door assembly adjustment controls.

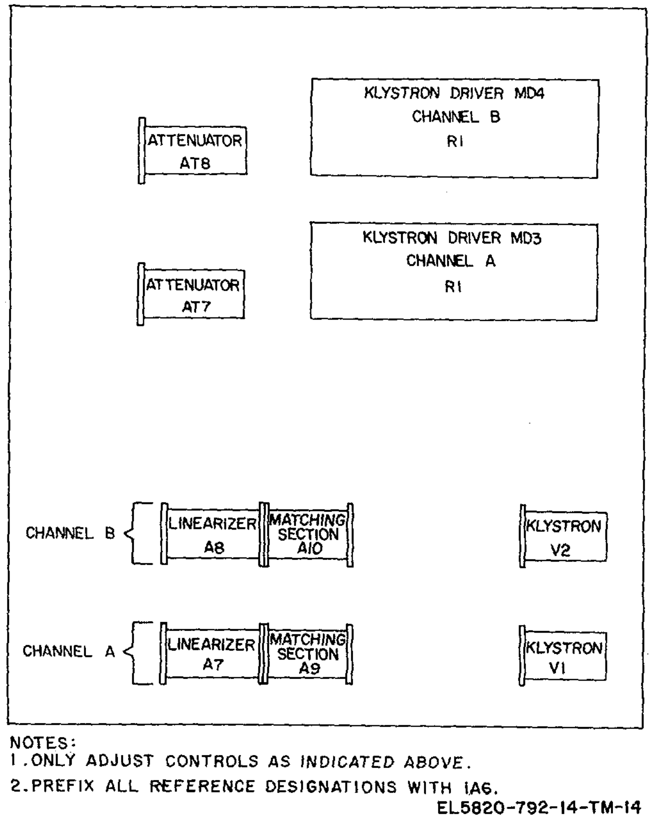
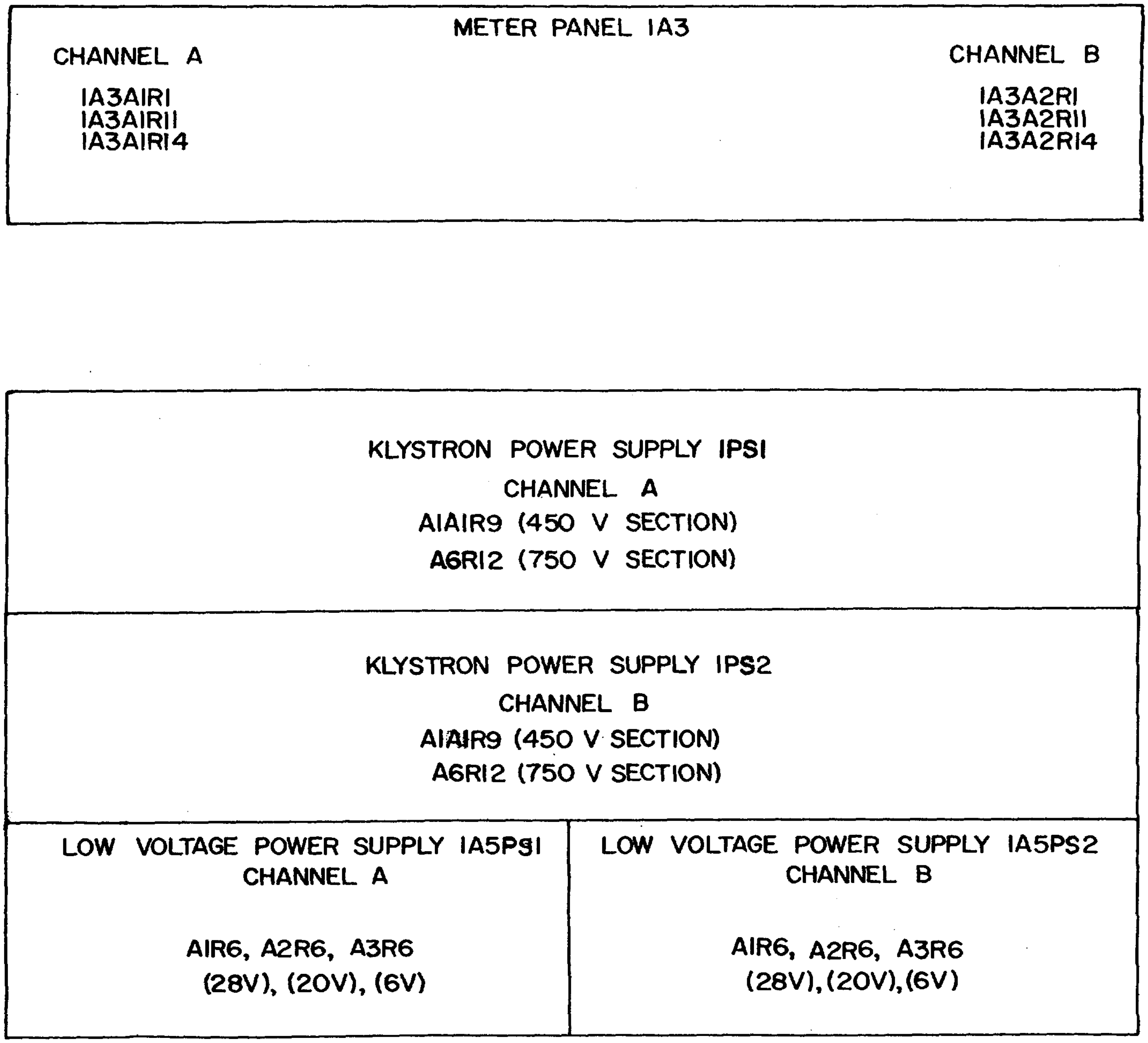


Figure 5-4. Authorized on-site RF panel adjustment controls.



EL5820-792-14-TM-15

Figure 5-5. Authorized on-site panel meter and power supply adjustment controls

b. On-Site Adjustments and Alignments.

(1) The on-site adjustments and alignments of the radio set are as follows:

(a) Low-voltage power supply.
(b) Klystron moding and linearization.
(c) Transmitter deviation sensitivity.
(d) Modulation loss alarm.
(e) RF power alarm and metering.
(f) Receiver crystal current.
(g) Radio link delay equalization.
(h) Baseband combiner input/output levels.
(i) Receiver pilot-tone alarm.
(j) Receiver baseband pilot-tone alarm.
(k) Receiver AGC alarm.

(2) The on-site adjustments and alignments are provided in a logical manner, and in detailed step-by-step procedures. If difficulty is en

countered in the procedures, the on-site maintenance personnel should request assistance from off-site maintenance personnel.

(3) The adjustment and alignment controls which have been sealed by off-site maintenance personnel are not to be readjusted by on-site maintenance personnel for any reason. Such an unauthorized adjustment will only hide the real problem by faulty compensation.

(4) The following modules of the radio set have been preset by off-site maintenance personnel and require no further readjustment by onsite maintenance personnel.

(a) Terminal filter (transmit and receive).

(b) Adder.

(c) AFC.

(d) If preamplifier.

(e) IF amplifier.

(f) Limiter-discriminator.

(g) Local oscillator (transmit and receive).

(h) Noise amplifier.

(5) The adjustment and alignment procedures are based on the radio set having the following characteristics.

(a) Multiplex input level of -45 dbm.

(b) Multiplex output level of -15 dbm.

(c) Per-channel deviation sensitivity of 140 kHz rms.

(d) Pilot-tone level of -6 dBm0 (6 dB below SCTT).

NOTE

If different characteristics are required, it will be necessary to modify the levels in the adjustment procedures for both the on-site and off-site maintenance. These changes effect only the strapping of padding in the terminal filter modules. Refer to paragraph 5-32 for instructions in input/output level changes, operating frequency change, deviation sensitivity change, and channel capacity modification.

(6) In the following paragraphs, all signal levels are expressed in volts or millivolts, with the circuit impedance (if standard value is 75 or 600 ohms), and actual power. This allows the measurements to be accomplished using any voltmeter, or measuring instrument providing voltage indications. Levels are expressed in the following manner:

48 mV/75-ohm (-15 dBm)

Where 48 mV is the ac voltage.

75-ohms is the circuit impedance

-15 dBm is the actual power.

NOTE

When using a voltmeter calibrated to indicate 0 dB for a 0.775 V input level across 600 ohms, it is necessary to use a correction factor if the measured level is specified across a 75-ohm impedance. For example, given a -45 dBm level (actual power) from an ac voltmeter calibrated to indicate 0 dB across 600 ohms, will indicate -54 dB. Note that the indication is dB and not dBm. The voltage indicated in any case is constant at 0.48 mV.

5-17. Low Voltage Power Supply Adjustment

a. General.

(1) The +28 volt section of the low voltage power supply is used by every active module in the radio set. The +28 volt section must be set accurately to insure that all modules in the radio set operate at a relatively close level to that of the +28 volt supply used in the initial off-site adjustment.

(2) The +20 and -6 output voltages of the low voltage power supply will also be checked, and then adjusted if necessary.

b. Test Equipment and Materials Required.

(1) Counter, Electronic, Digital Readout AN/USM-207A.

(2) Digital voltmeter; Hewlett-Packard 5265A.

(3) Test leads, banana/alligator clips; Pomona 1959-48.

c. Procedure.

CAUTION

When pulling out the low voltage power supply drawer, insure that no cables are caught. The drawer is heavy and careful handling is required.

(1) Pull out low voltage power supply drawer iA5 from radio set.

(2) Connect digital voltmeter (electronic counter with digital voltmeter unit) to TB1 or channel A power supply 1A5, by connecting the positive lead from voltmeter to TB1-2 and connecting the negative lead to TB1-4.

(3) The digital voltmeter should indicate +28 +0.100 volts. If out of tolerance, adjust +28V output control 1A5AlR6 for +28 ±0.010 volts on voltmeter. See figure 5-2 for location of low voltage power supply adjustment controls.

(4) Disconnect digital voltmeter from TB1-2 and reconnect it to TBI-3.

(5) The digital voltmeter should indicate +20 ± 0.500 volts. If out of tolerance, adjust +20V

output control 1A5A2R6 for +20 ± 0.100 volts on voltmeter.

(6) Disconnect digital voltmeter from TB1-3 and reconnect it to TB1-8.

(7) The digital voltmeter should indicate -6 ± 0.060 volts. If out of tolerance, adjust -6V output control 1A5A3R6 for -6   0.030 volts on voltmeter.

(8) The channel A low voltage power supply 1A5 is now checked. Disconnect all test equipment connections, and repeat (2) through (7) above for channel B low voltage power supply 1A5.

(9) Disconnect all test equipment. Replace and secure low-voltage power supply drawer 1A5 into radio set.

5-18. Klystron Moding and Linearization Alignments

a. General.

(1) The radio set has a maximum capacity of 600 channels. This large bandwidth requires the use of a linearizer in order to flatten the response of the Klystron. Since the baseband signals are applied to the repeller of the Klystron and thereby cause the center frequency of the Klystron (fo) to vary in accordance with the input level, and since by nature reflex Klystrons do not exhibit a linear modulation sensitivity, then severe intermodulation distortion occurs during busy hours when maximum bandwidth is required.

(2) To overcome this problem of poor modulation sensitivity, linearizer and matching sections are used in the transmitter path. These two devices are tunable mismatches which will reflect power of a suitable phase and amplitude such that the modulation sensitivity is flattened and becomes acceptably linear over the required bandwidth. See figure 5-6.

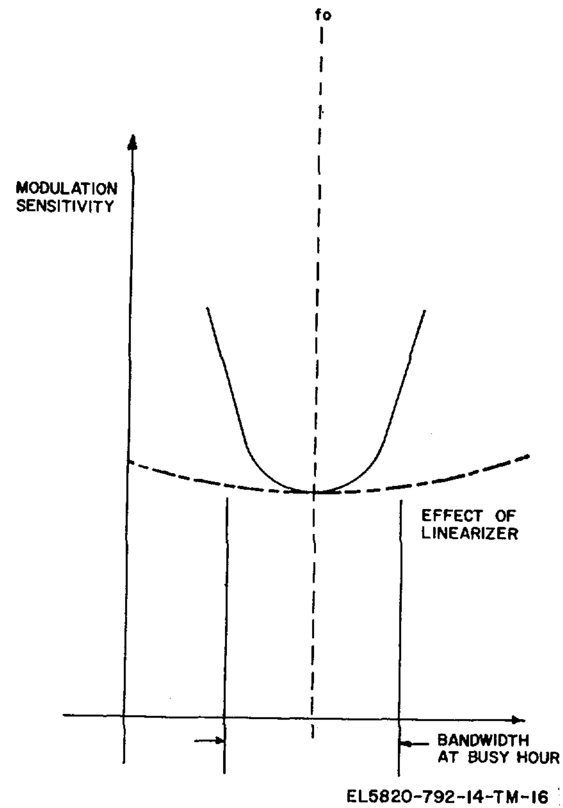


Figure 5-6. Klystron linearizer effects.

(3) The usage of a linearizer demands that the Klystron mode be set correctly. The linearizer is effective only when the Klystron mode is centered on fo+0.5 MHz. Therefore it is essential that the moding of the Klystron be accomplished correctly whenever a new Klystron is installed or during special maintenance verification tasks.

(4) The Klystron moding and linearization procedures are on-line procedures and require

close coordination between the local and distant stations.

b. Test Equipment and Materials Required.

(1) Generator, Signal AN/USM-205T.

(2) Counter, Electronic, Digital Readout AN /USM-207A.

(3) Comparator, Frequency CM-77/USM.

(4) Digital voltmeter; Hewlett-Packard 5265A.

(5) Multimeter TS-352B/U.

(6) Generator, Signal AN/URM-52B.

(7) Oscilloscope AN/USM-182A.

(8) Preamplifier, dual-trace, oscilloscope; Tektronix 1A2.

(9) Wattmeter AN/URM-98A.

(10) Thermistor mount; Hewlett-Packard 478A.

(11) Microwave link analyzer; Hewlett-Packard, composed of following items:

(a) Transmission generator 3701A.

(b) Demodulator display 3702A.

(c) Group delay detector 3703A.

(12) RF detector, coaxial; Hewlett-Packard 420A.

(13) Coaxial mixer; Sage 247M.

(14) Attenuator, fixed, 30 dB coaxial; Narda 757B-30.

(15) Adapter, Connector UG-107B/U.

(16) Adapter, BNC (F) to dual minigator; Pomona 2631.

(17) Adapter, Connector UG-201A/U.

(18) Adapter, N (F) to TNC (M); Amphenol 79825.

(19) Adapter, TNC (M) to TNC (F); Amphenol 79125.

(20) Adapter, N (M) to N (M); UG-57/U.

(21) Adapter, Right-Angle N; UG-27/U.

(22) Cable Assembly, Radio Frequency CG92F/U.

(23) Cable; Pomona BNC-E-( ).

c. Preliminary Procedure.

(1) It is assumed that a new Klystron has been installed and that the 450-volt section of the Klystron power supply has not been disturbed.

Allow the Klystron to warm up for minimum of 1 hour before starting the adjustments; this is required to mechanically stabilize the cavity and other elements of the Klystron.

(2) Notify distant station that klystron moding and linearizing alignment will be performed. The distant station is to disconnect the channel A receiver by disconnecting the cable from output connector J2 of channel A limiterdiscriminator module 1A1MD5.

d. Procedure for Moding the Klystron.

(1) Connect test equipment as shown in figure 5-7. Turn on and warm up test equipment.

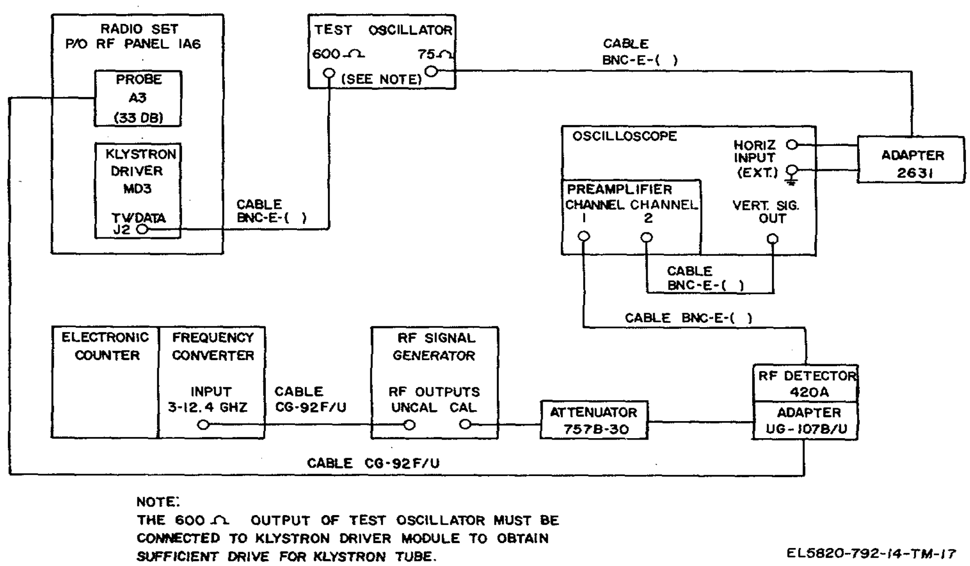


Figure 5-7. Klystron moding alignment, test equipment setup

(2) Adjust RF signal generator OUTPUT ATTEN level control for minimum attenuation.

(3) Using electronic counter, set RF signal generator to the transmitter frequency within ± 10 kHz.

(4) Adjust oscilloscope controls as follows:

(a) CHANNEL 1: VOLTS/CM to 0.05.
INPUT to AC.

(b) CHANNEL 2: VOLTS/CM to 2.
INPUT to AC.

(c) MODE to ADD.

(d) HORIZONTAL DISPLAY to EXT.

(5) Adjust test oscillator for frequency of approximately 3 kHz and output level of +20 dB.

(6) Set MUX/TV-DATA switch S1 of channel A klystron driver module 1A6MD3 to TV-DATA position. Set ON-OFF switch S1 of channel A AFC module 1A4MD3 to OFF position. Adjust potentiometer R1 of channel A klystron driver module 1A6MD3 fully clockwise.

(7) Carefully unlock and rotate the adjustment screw of channel A matching section 1A6A9 and the two adjustment screws of channel A linearizer section 1A6A7 counterclockwise until the screws are fully withdrawn from the waveguide sections, but not removed. Refer to figures 5-4 and FO-4 for location of these waveguide sections.

(8) Adjust Klystron coupling screw fully counterclockwise. See figure 5-8 for location of coupling screw.

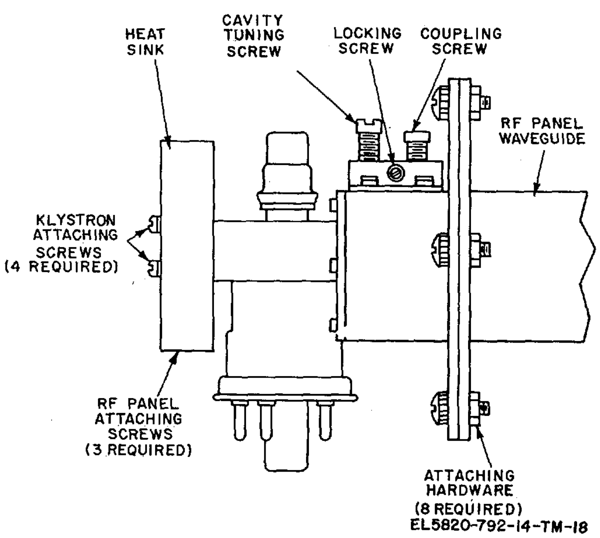


Figure 5-8. Klystron mechanical details.

WARNING

Dangerous electrical potentials as high as 1200 volts dc are present in Klystron power supplies 1PS1 and 1PS2. Be extremely careful when testing and adjusting voltages of Klystron power supply.

(9) Using differential voltmeter (electronic counter with digital voltmeter unit), insure that the output voltages of Klystron power supply are correct. Check 750-volt section of Klystron power supply by connecting ground lead from differential voltmeter to J9 and positive lead to J6. When connecting test leads to test points, a small spark will occur; this is normal. Refer to figure 5-9 for location of controls and test jacks on Klystron power supply. The voltmeter should indicate 750 ± 2.0 volts. If the indication is out of tolerance, adjust 750 V control A6R12 for 750 ±0.25 volts on voltmeter.

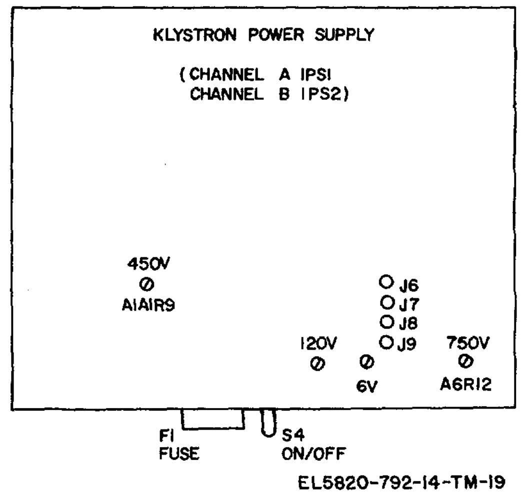


Figure 5-9. Klystron power supply, adjustment controls location.

(10) The 450-volt section of Klystron power supply IPS1 will now be checked. The 450-volt section may be preset for a discrete voltage which is directly related to the output frequency. As a general rule, the deviation of the Klystron is nominally 4 MHz/V, with a minimum reflector voltage of 305 volts and a maximum voltage of 440 volts. Since the transmit frequency is known, it is then possible to preset the reflector voltage (450-volt) for the approximate required level. The following formula may be used to set the reflector voltage (Vr):

$$\frac{f_o - 4400\ 7}{4} + 305\ V = Vr$$

Where: fo is the transmit frequency (MHz).

4400 is the lowend of the band (MHz).

4 is the deviation sensitivity of the Klystron (MHz/V).

305 V is the reflector voltage for the low end of the band.

Example: fo = 4580 MHz

$$V_r = \frac{(4580-4400)}{4} + 305$$

$$V_r = \frac{(180\ )}{4} + 305$$

$$V_r = 45 + 305 = 350$$

(11) Connect multimeter to output of 450volt section of Klystron power supply. Connect negative lead from multimeter to J7 and positive lead to J6. The multimeter should indicate within ± 10 volts of the calculated voltage. If necessary, adjust 450V control A1AlR9 (fig. 5-9) for multimeter indication within ±10 volts of the calculated voltage.

(12) Set test oscillator coarse adjustment control until the trace begins to lose linearity on both ends of the trace. Adjust X variable 1-10 control on oscilloscope to obtain a 5 cm horizontal display on oscilloscope. Adjust test oscillator frequency to properly place true display. On oscilloscope plug-in adjust variable control in channel 2 volts/cm knobs to obtain desired vertical amplitude.

(13) If a horizontal straight line trace appears on oscilloscope, adjust Klystron cavity tuning screw (fig. 5-8) until a test marker and Klystron mode pattern appear on oscilloscope.

(14) Using RF signal generator, check Klystron mode pattern for 20 MHz bandwidth. Figure 5-10 shows klystron mode pattern with marker positioned at one end of the band.

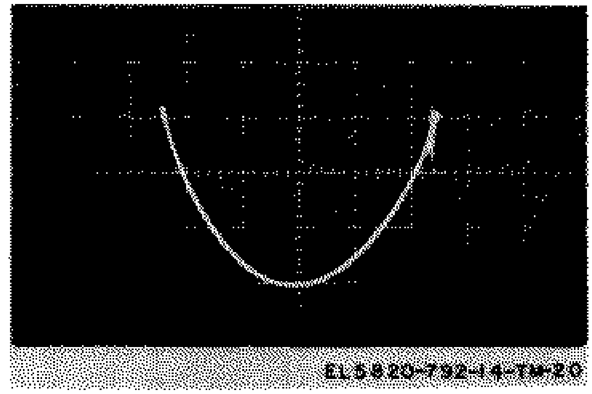


Figure 5-10. Klystron mode pattern, with marker at one end of band.

(15) The Klystron must now be tuned mechanically to bring it on frequency. It is necessary to mark the center frequency on the display by adjusting the RF signal generator to fo0 This will bring the marker signal to the center of the oscilloscope display. If it does not, slightly adjust the oscilloscope horizontal positioning control.

(16) The Klystron tuning is accomplished, as follows. Adjust Klystron tuning screw until a dip is observed on oscilloscope display; see figure 511. To insure that Klystron is on frequency, reduce output of test oscillator until a narrow display, as shown in figure 5-12, is obtained. The marker should be centered. Adjust tuning screw very slightly to position marker at center of trace. Then once again increase sweep to provide 20 MHz total bandwidth (5 cm horizontal), as shown in figure 5-11.

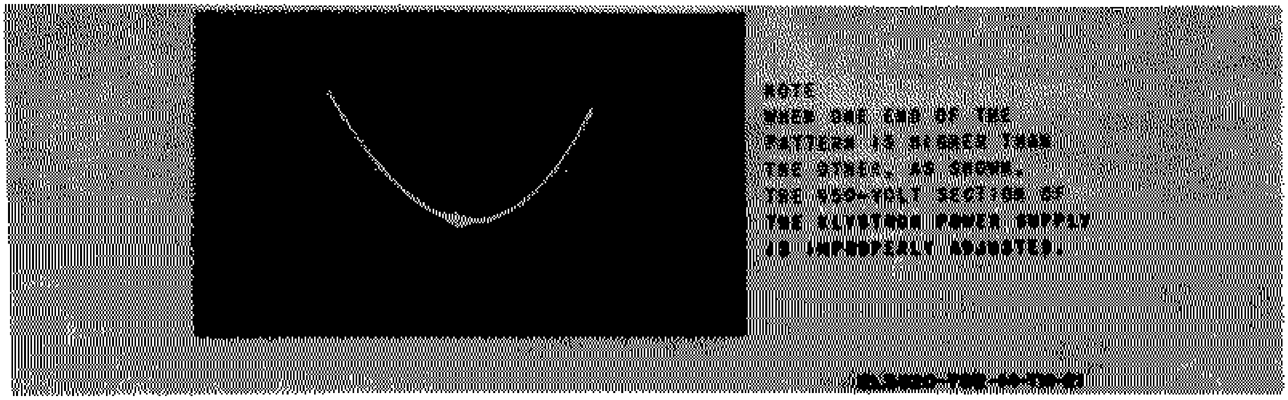


Figure 5-11. Correct Klystron mode pattern but 450-volt section improperly adjusted, marker centered.

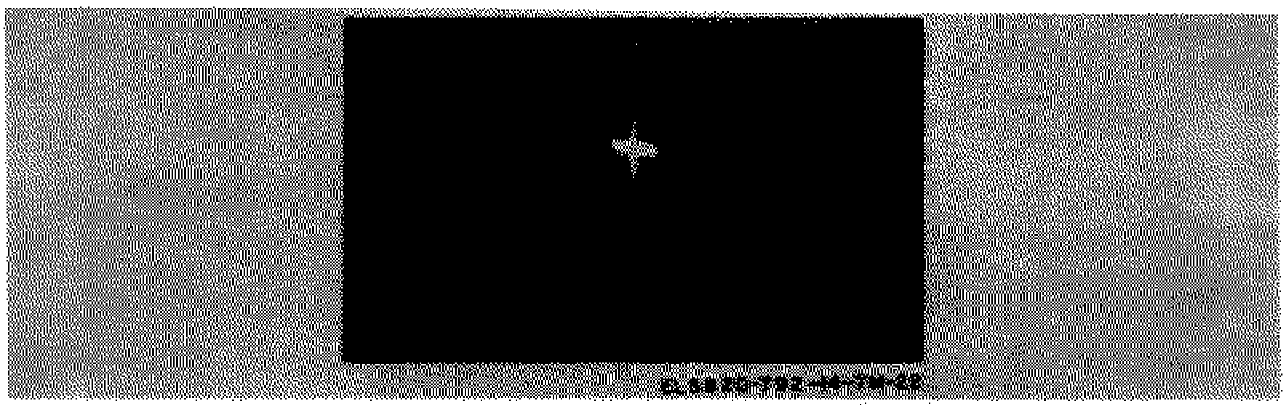


Figure 5-12. Klystron mode pattern with narrow sweep marker centered

(17) The correct Klystron mode pattern will be obtained by using a combination of 450-volt section and Klystron tuning screw adjustments. Refer to figures 5-11, 5-13, 5-14, and 5-15 for Klystron moding patterns.

(18) The Klystron coupling screw is used to compensate for the VSWR set up by the load. Generally speaking, a clockwise rotation of the coupling screw will take the Klystron tube into an over-coupled phase, while a counterclockwise rotation will undercouple the tube (fig. 5-16). The use of the coupling screw during the procedure, will have a tendency to detune the tube slightly, making it necessary to readjust the frequency with the tuning screw (fig. 5-8). The coupling or tuning screws should never be forced against their mechanical stop. With the correct Klystron mode pattern obtained ((17) above), adjust Klystron coupling screw for maximum power output.

(19) Disconnect mode detector cable CG92F/U from probe A3 (33 dB) of RF panel 1A6.

(20) Connect power meter and thermistor mount to probe 1A6A3.

(21) Adjust Klystron coupling screw clockwise to obtain maximum indication on power meter, then turn screw counterclockwise one-half turn. The Klystron frequency has most likely changed at this time.

(22) Disconnect power meter and thermistor mount from probe 1A6A3, and reconnect mode detector cable CG-92F/U to probe 1A6A3.

(23) Readjust the Klystron tuning screw and the 450-volt section of the Klystron power supply, as required, to obtain correct Klystron mode pattern. Be sure that the mode pattern is centered by narrowing the sweep and observing that the marker is in the center of the pattern (fig. 5-12).

NOTE

Alignment of the Klystron at the low and high portions of the 4.4 to 5.0 GHz band may take longer than at the center

frequencies. This is normal since the Klystron is being operated on its band edges. Improper Klystron alignment will occur if some high mismatch is present in the output line. See figure 5-17 for incorrect mode responses.

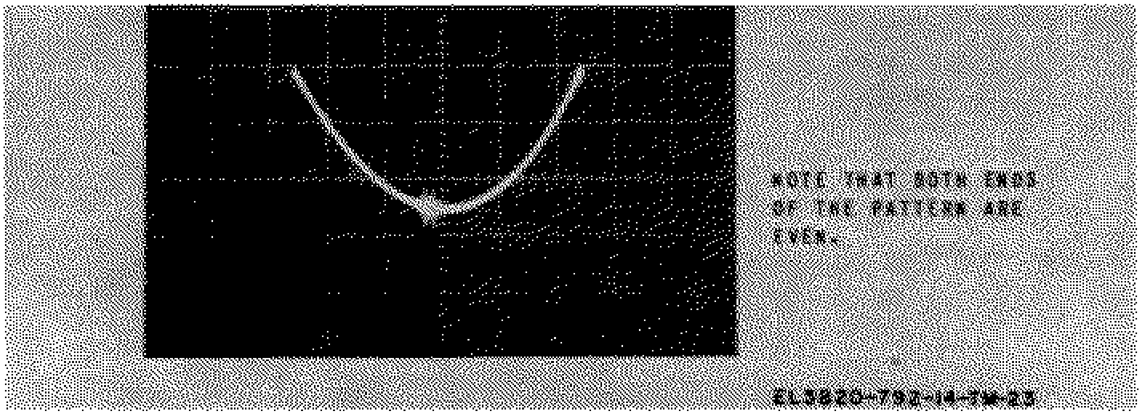


Figure 5-13. Correct Klystron mode pattern with 450-volt section properly adjusted.

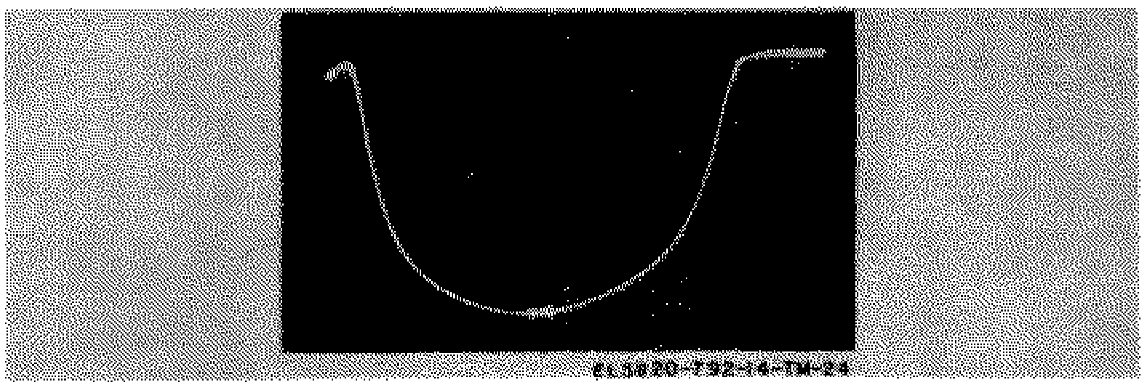


Figure 5-14. Correct Klystron mode pattern with extended sweep.

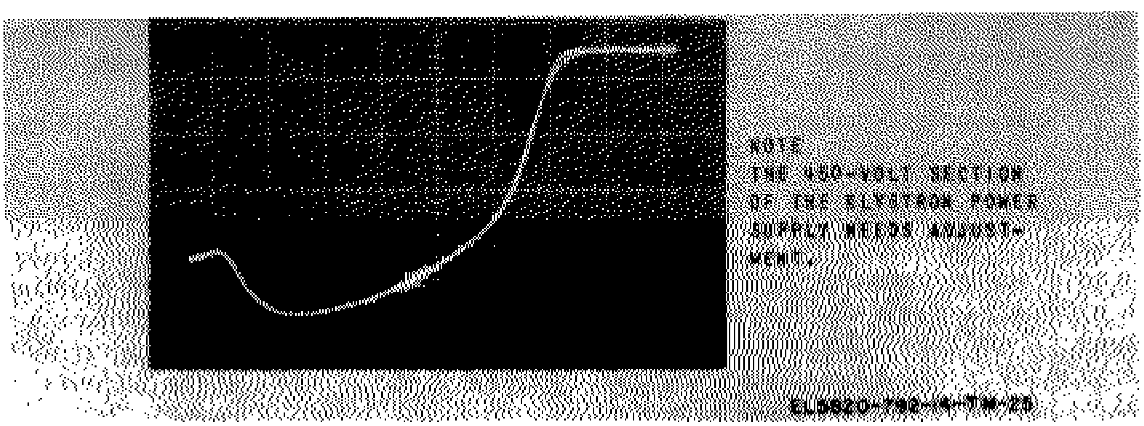


Figure 5-15. Incorrect Klystron mode pattern, 450-volt section improperly adjusted.

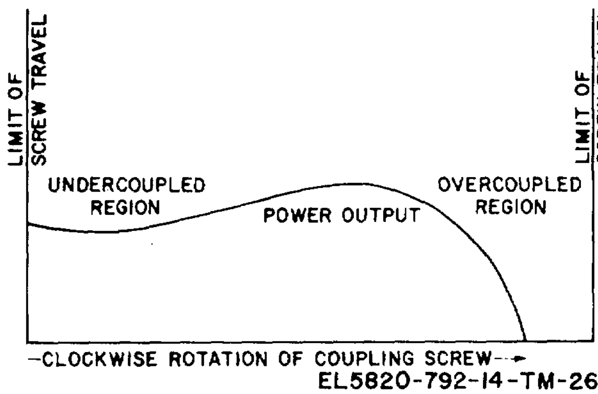


Figure 5-16. Klystron ouput power response when using Klystron coupling screw.

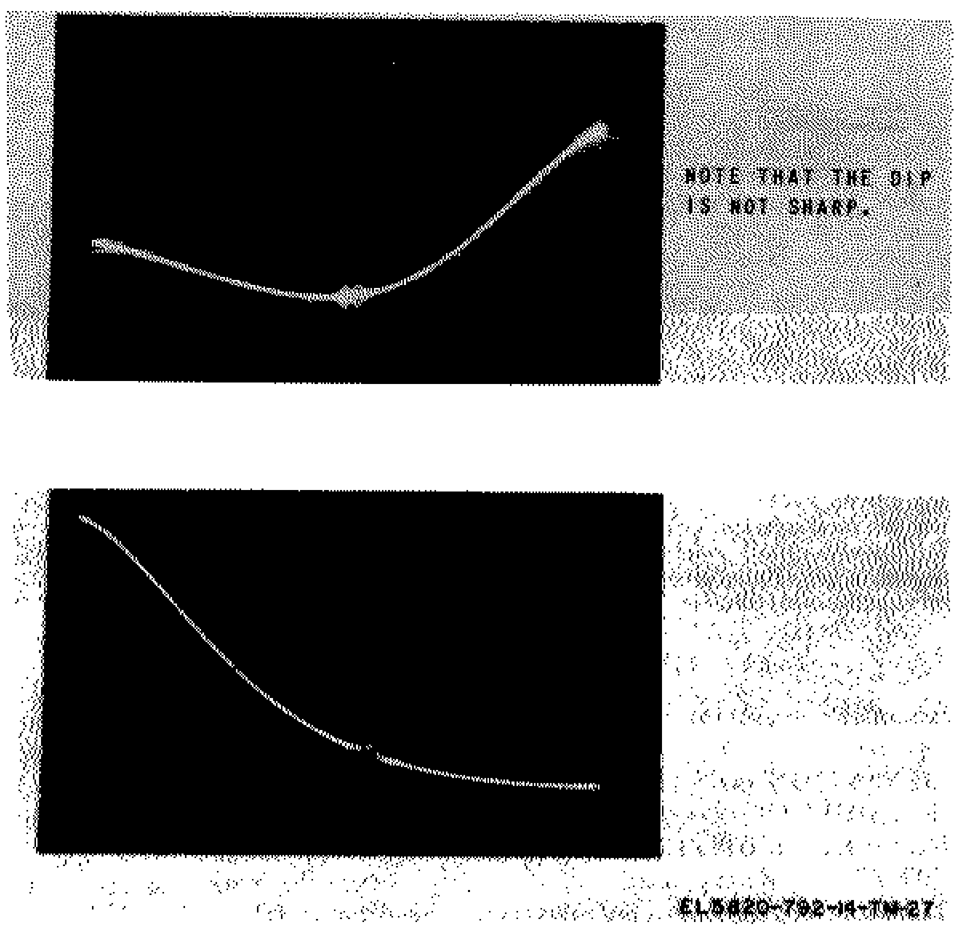


Figure 5-17. Incorrect Klystron mode patterns.

(24) The Klystron mode test and adjustment is complete. Disconnect all test equipment. Perform the following procedure for linearizing the Klystron.

e. Procedure for Linearizing the Klystron.

(1) Connect test equipment as shown in figure 5-18. Read the entire procedure before proceeding to understand the alignment technique.

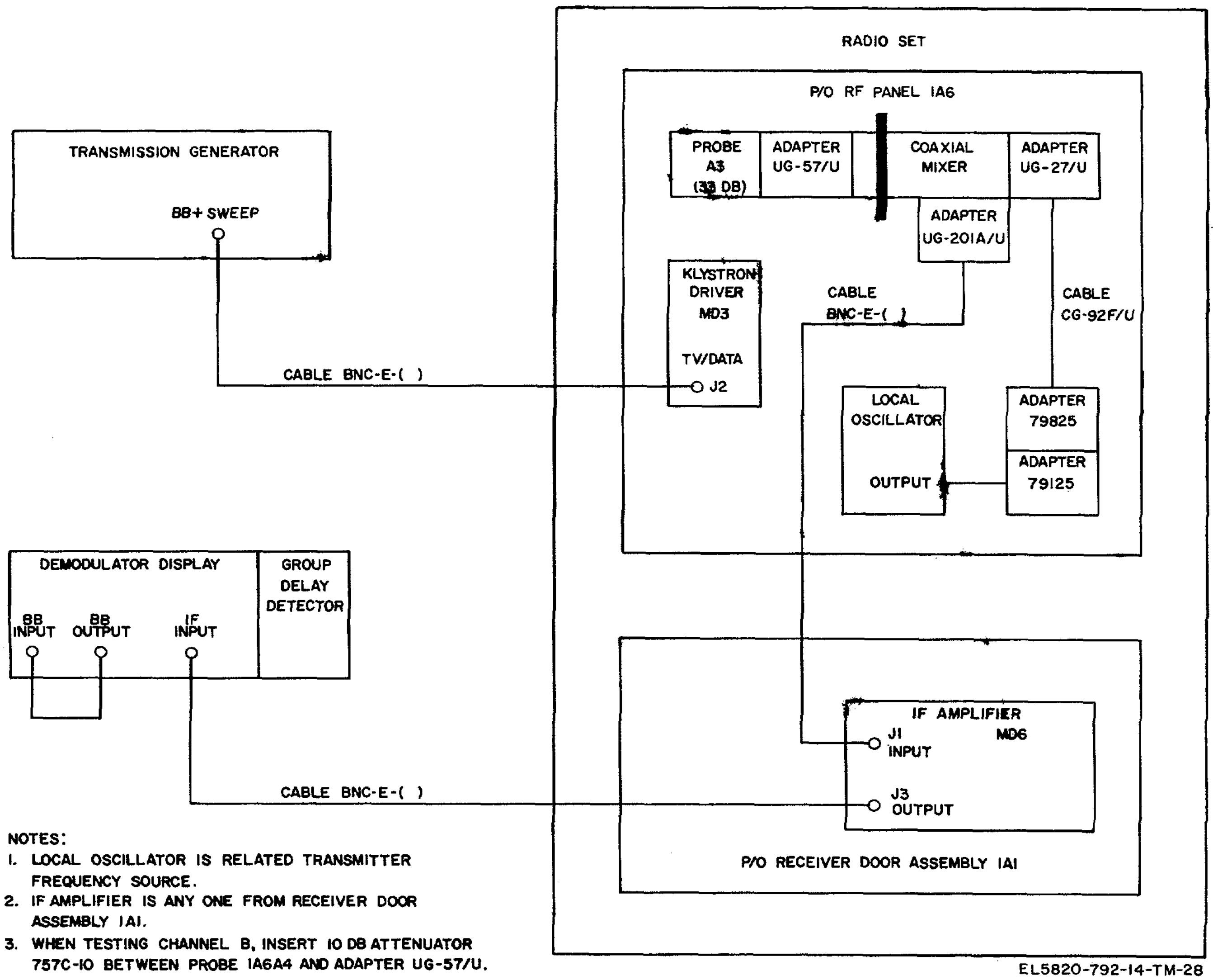


Figure 5-18. Klystron linerization alignment, test equipment setup

(2) Set transmission generator controls as follows:

(a) BB DEVIATION (kHz RMS) to 140.

(b) BB FREQUENCY (kHz) to 500.

(c) MODE to BB + SWEEP.

(d) BB POWER (-dBm) to 25.

(3) Set demodulator display controls as follows:

(a) DISPLAY to IF.

(b) MARKER OFFSET (MHz) to 7.

(c) IF LEVEL to 15 dB. (* This adjustment is finalized by obtaining a zero on the IF/BB LEVEL meter.)

(4) Set group delay detector controls as follows:

(a) BB FREQUENCY (kHz) to 500.

(b) DEMOD INPUT to INT.

(c) Adjust the SET LEVEL control until the PHASE LOCK/LEVEL meter indicates in the green zone.

(d) DELAY OUTPUT to NORMAL.

(5) On rear of demodulator display, set Y2 switch to DELAY and SWEEP switch to INT.

(6) On rear of transmission generator, set SWEEP switch to NORMAL.

(7) Increase BB SWEEP LEVEL control on transmission generator to provide a full horizontal display on demodulator display. It may be necessary to adjust X GAIN control on demodulator display to observe the markers on the horizontal trace, and it may be necessary to increase the BB SWEEP LEVEL control on

transmission generator to obtain an indication on the display. Also, disregard any relay chatter that may occur in meter panel 1A3 during the alignment procedure.

(8) Locate the adjustment screw of channel A matching section 1A6A9 (fig. 5-4 and FO-4). While observing the display, insert the adjustment screw (clockwise rotation) into the matching section. The sweep will enlarge horizontally; BB SWEEP LEVEL control on transmission generator will need readjustment. When a 14 MHz sweep is obtained and the markers are visible on the trace, do not insert the matching screw any further.

(9) Locate the two adjustment screws of channel A linearizer 1A6A7 (fig. 5-4). Adjust the two adjustment screws until some reasonably flat response trace is observed.

(10) Calibrate the Y1 trace as follows:

(a) Set DISPLAY switch to BB.

(b) Adjust BB POWER (-dBm) to obtain a zero indication on IF/BB LEVEL meter.

(c) Set CALIBRATION (dB) % to 1.

(d) Adjust Y1 GAIN to provide a 1 cm separation between the chopped traces (fig. 5-19).

(e) Set CALIBRATION (dB) % switch to OFF.

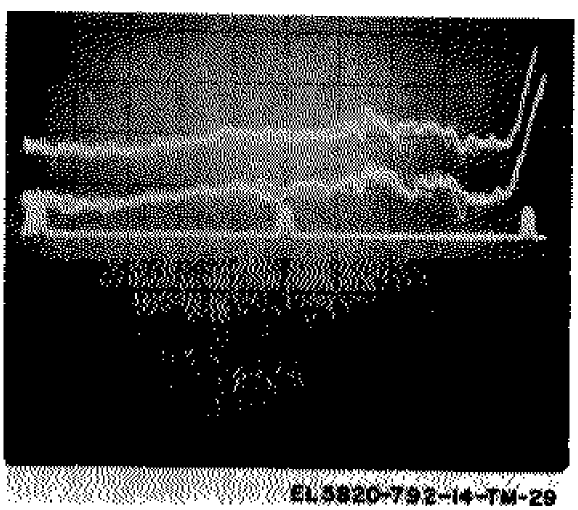


Figure 5-19. Amplitude linearity (Y1) trace calibration.

(11) Adjust the matching and linearizer adjustment screws to provide a flat Yl trace (amplitude linearity) within 1 percent (1 cm) across +7 MHz; then carefully lock the screws without disturbing the settings. A typical amplitude linearity curve is shown in figure 5-20. If it is impossible to obtain the required amplitude linearity and the display is similar to that shown in figure 5-21, then the Klystron tube is not functioning satisfactorily (even if new) and must be replaced.

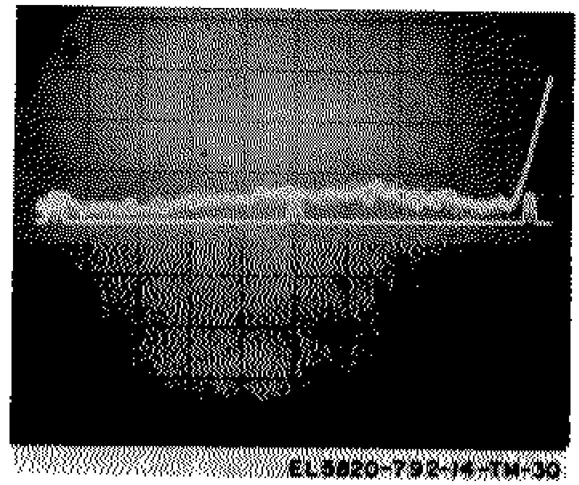


Figure 5-20. Typical linearity curve (Y1).

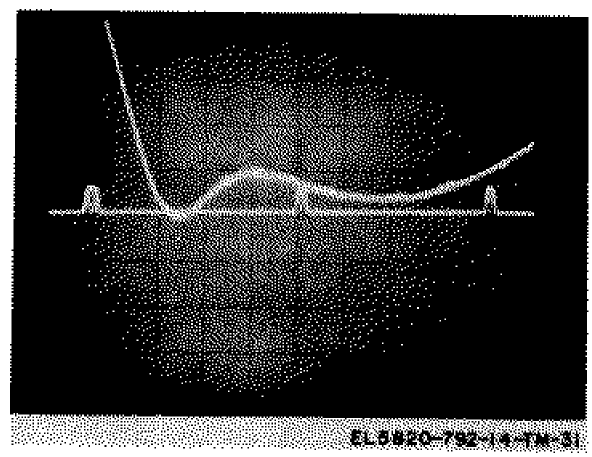
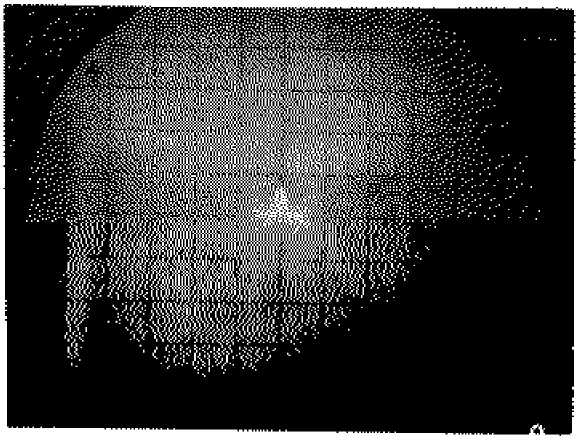


Figure 5-21. Typical linearity curve with poor Klystron.

(12) Check to see that frequency-pulling of the Klystron has not occurred. The marker on the Y2 trace should be at the center of the display. If necessary, adjust the 450-volt section control A1A1R9 (fig. 5-8) slightly to bring the marker to the center of the display. Adjust BB SWEEP LEVEL control on the transmission generator for a narrow sweep. If the marker is not at the center, slightly readjust control AlA1R9. See figure 5-22 for display.



EL5820-792-14-T M-32

Figure 5-22. Test marker centered on narrow sweep.

(13) The Klystron moding and linearization alignments are completed. Disconnect all test equipment, reconnect all radio set cables.

(14) Place switch S1 of AFC module 1A4MD3 + to ON position.

(15) Notify the distant station that moding and linearization alignment procedure is complete, and that next the transmitter deviation sensitivity must be checked, as given in paragraph 5-19. The output cable on limiterdiscriminator at the distant station is not to be reconnected until the deviation is set.

(16) Replace switch S1 of Klystron driver module to MUX position.

5-19. Transmitter Deviation Sensitivity Alignment

a. General.

(1) The Klystron linearity adjustment (para 5-18e) insures that the Klystron modulation sensitivity is linear. The following alignment procedure sets the baseband level into the Klystron. The baseband modulation level is directly related to the frequency shift from the transmit frequency (fo). The Klystron sensitivity is set for 140 kHz rms per channel deviation. The levels and frequencies used as modulating signals are calculated for a -45 dBm, single channel test tone (SCTT) multiplex input level. If different levels are required, it is necessary to adjust these levels according to paragraph 5-32.

(2) The radio terminal is very sensitive to modulation level. The modulation sensitivity at which the link normally operates is the optimum value at which the radio link normally operates for minimum noise and distortion-free transmission. This value must be constant in time to within 5 percent.

(3) If a decrease in sensitivity occurs, the deviation decreases and a decrease in signal-to-noise (S/N) ratio results. If the deviation increases, distortion results since the receiver IF path is band-limited.

(4) The following procedures are first performed using a spectrum analyzer (carrier null method) whereby a reference signal level is established. Thereafter, the reference signal level is used whenever a module in the exciter chain is replaced.

b. Test Equipment and Materials Required.

(1) Generator, Signal AN/USM-205.

(2) Oscilloscope AN/USM-182A.

(3) Spectrum analyzer Set AN/UPM-84A.

(4) Voltmeter, Electronic ME-30E/U.

(5) Counter, Electronic, Digital Readout AN/USM-207A.

(6) Step attenuator; Kay Electric 442D.

(7) Frequency selective voltmeter; Sierra 128A.

(8) Attenuator, fixed, 30 dB coaxial; Narda 757B-30.

(9) Adapter, Connector UG-274C/U.

(10) Adapter, BNC (F) to dual pin-tips; Pomona 3221.

(11) Cable Assembly, Radio Frequency CG426F/U.

(12) Cable Assembly Radio Frequency CG92F/U.

c. Procedure for Transmitter Deviation Sensitivity Alignment, using Carrier Null Technique.

(1) Disconnect equipment cable from J1 of channel A Klystron driver 1A6MD3.

(2) Connect radio set and test equipment as illustrated in figure 5-23.

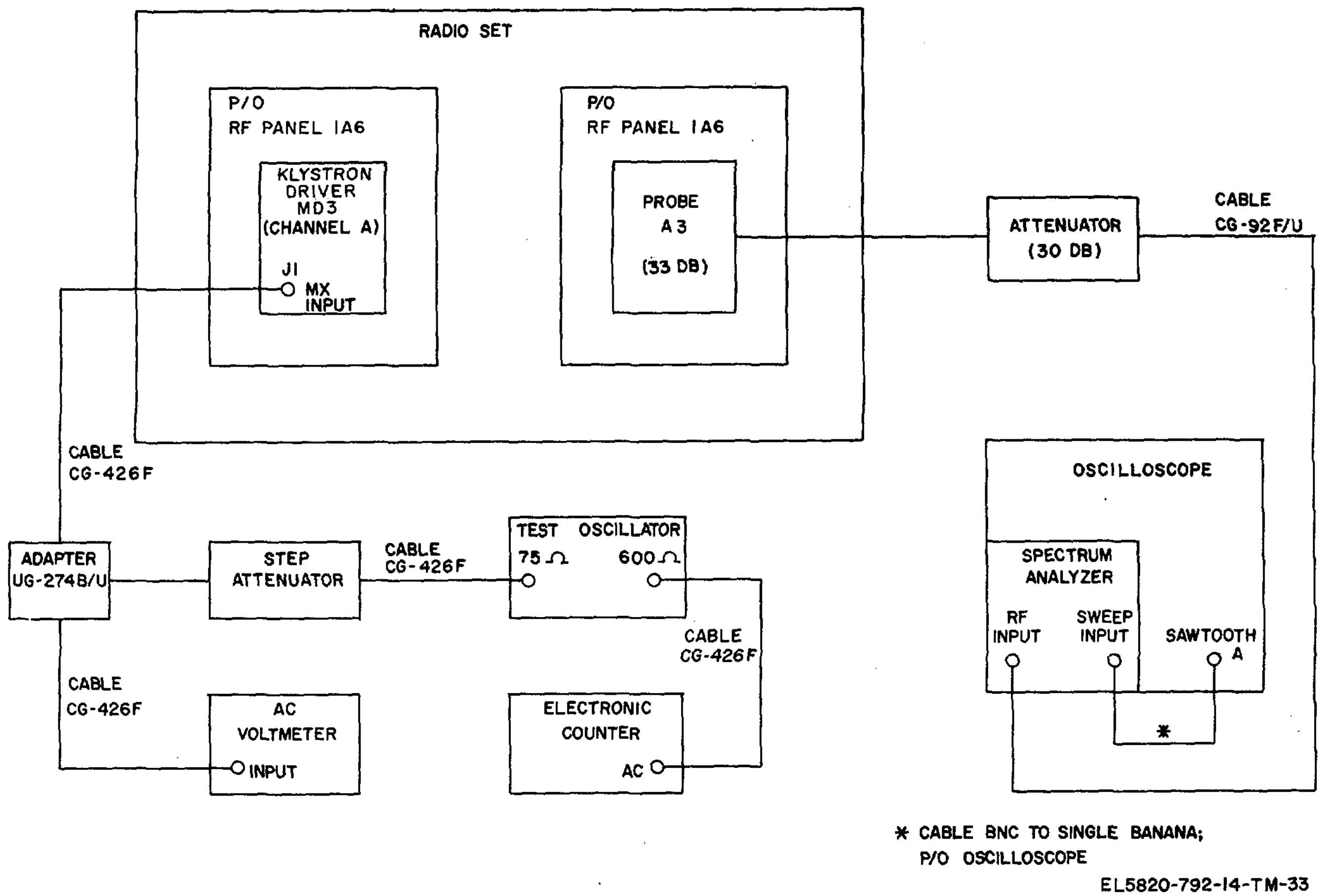


Figure 5-23. Transmitter deviation sensitivity alignment, test equipment setup

(3) Place at least 60 dB of attenuation in step attenuator.

(4) Turn on and warm up test equipment.

(5) If not already done in a previous adjustment procedure, notify the distant station that adjustments are to be performed. The distant station is to disconnect the radio set cable from output connector J2 of channel A limiterdiscriminator module 1AlMD5.

(6) Adjust oscillator output level to drive electronic counter.

(7) Set test oscillator frequency to 639.6 kHz for 240-channel capacity or to 1544 kHz for 600channel capacity on electronic counter.

(8) Set test oscillator output into Klystron driver 1A6MD3 level, by adjusting test oscillator COARSE and FINE controls and step attenuator for ac voltmeter indication of 40 mV/75-ohm (-16.7 dBm) for 240-channel capacity, or 97.2 mV/75-ohm (-9.0 dBm) for 600-channel capacity.

(9) Adjust potentiometer R1 of channel A Klystron driver 1A6MD3 fully counterclockwise.

(10) Set oscilloscope controls as follows:

(a) TIME/CM to 1 millisecond.

(b) HORIZONTAL DISPLAY to A.

(11) Set spectrum analyzer plug-in unit controls as follows:

(a) VERTICAL DISPLAY to LOG.

(b) VIDEO FILTER to down position.

(c) DISPERSION RANGE to MHz/CM.

(d) DISPERSION to 200.

(e) COUPLED RESOLUTION to match DISPERSION control.

(f) IF ATTEN DB to OFF.

(12) Tune spectrum analyzer plug-in unit to the transmit frequency. See figure 5-24 for required display.

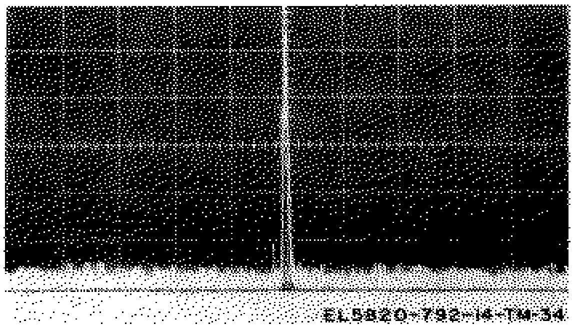


Figure 5-24. Transmitter carrier.

(13) While observing the transmit carrier on spectrum analyzer, slowly adjust potentiometer R1 of channel A klystron driver 1A6MD3 clockwise until the transmit carrier starts to decrease in amplitude and the sidebands start to appear. Continue clockwise rotation until the carrier is completely in the noise level of the display. See figure 5-25 for display. Change DISPERSION control on spectrum analyzer plug-in to be sure that the carrier is completely nulled.

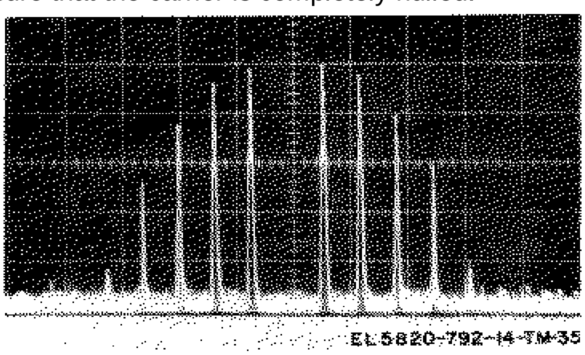


Figure 5-25. Transmitter carrier is in noise level.

(14) Measure the level at the output of Klystron driver 1A5MD3 by connecting frequency selective voltmeter (set in 75 ohm BRIDGING), through a coaxial cable and adapter 3221 to TP7 and TP6 (ground) of 1A5MD3. Observe the level and frequency being measured; this level and frequency are used for future reference whenever a module in the transmitter chain is replaced. Record the reference level and the frequency and date on a tag, and fasten near TP7 of 1A5MD3.

NOTE

The deviator sensitivity can be reset by readjusting potentiometer R1 on Klystron driver 1A5MD3 while monitoring TP7; this procedure is given in d below.

(15) Disconnect test cable from input connector J1 of Klystron driver 1A6MD3, and reconnect radio set cable to J1.

(16) Request distant station to reconnect radio set cable to output connector J2 of channel A limiter-discriminator 1A1MD5.

(17) The transmitter deviation sensitivity alignment is complete. Disconnect all test equipment.

d. Procedure for Transmitter Deviation Sensitivity Alignment, using Reference Signal.

(1) Disconnect equipment cable from J1 of channel A Klystron driver 1A6MD3.

(2) Connect radio set and test equipment as illustrated in figure 5-23, except do not connect the spectrum analyzer.

(3) Notify the distant station that adjustments are to be performed. The distant station is to disconnect the radio set cable from output connector J2 of channel A limiter-discriminator 1A1MD5.

(4) Adjust the oscillator output level to drive electronic counter.

(5) Set the test oscillator frequency to 639.6 kHz for 240-channel capacity or to 1544 kHz for 600-channel capacity, on the electronic counter.

(6) Set test oscillator output into Klystron driver 1A6MD3 for proper level, by adjusting test oscillator COARSE and FINE controls and step attenuator for selective voltmeter indication (set in 75 ohm bridging) of 40MV/75-ohm (-16.7 dBm) for 240-channel capacity, or 97.2 mV/ 75-ohm (-9.0dBm) for 600-channel capacity.

(7) Reconnect selective voltmeter through coaxial cable and adapter 3221, to TP7 and TP6 (ground) of Klystron driver 1A6MD3.

(8) Adjust potentiometer R1 of Klystron driver 1A4MD5 until the voltmeter indicates the reference indication recorded on the tag near TP7. Be sure that R1 is set accurately.

(9) The procedure is complete; disconnect test equipment from radio set. Reconnect all radio set cables at both the local and distant stations.

5-20. Modulation Loss Alarm Adjustment

a. General. The following adjustment of the dual pilot-tone detector 1A4MD2 sets the alarm point for the monitoring of the transmitter modulating path. This procedure is to be per formed only after the transmitter deviation sensitivity procedure (para 5-19) has been completed.

b. Test Equipment and Materials Required. No test equipment or materials are required.

c. Procedure.

(1) Set potentiometer R1 on dual pilot-tone detector 1A4MD2 fully clockwise.

(2) Set switch S1 on 1A4MD2 to TEST position The corresponding XMIT MOD LOSS alarm indicator should extinguish.

(3) Adjust potentiometer R1 slightly counterclockwise until the corresponding XMIT MOD LOSS alarm indicator just lights.

(4) Set switch S1 to NORM position; XMIT MOD LOSS alarm indicator should extinguish.

(5) Test alarm indicator function by switching S1 from NORM to TEST positions. The corresponding XMIT MOD LOSS alarm indicator should light with switch S1 in TEST position and should extinguish with switch in NORM position.

(6) Set switch S1 in NORM position. The modulation loss alarm adjustment is complete.

5-21. RF Power Alarm and Metering Adjustment

a. General.

(1) This procedure aligns the RF power metering and the alarm circuitry for both the local radio terminal and the remote location.

(2) Before performing this adjustment, make sure that the transmitter power output is at a minimum of 0.5 watt (refer to performance test, paragraph 5-38).

b. Test Equipment and Materials Required. No test equipment or materials are required.

c. Procedure.

(1) Refer to figure 5-33 for location of meter panel 1A3 controls used in this procedure.

(2) On meter panel 1A3, set channel A meter function switch to OUTPUT POWER position.

(3) Adjust potentiometer 1A3A1R1 on channel A power alarm assembly of meter panel 1A3 for channel A meter indication of 7 volts dc on bottom scale of meter.

(4) Rotate potentiometer 1A3A1R11 on channel A power alarm assembly slowly counterclockwise until channel A XMIT RF PWR indicator 1A3DS6 just lights; then slowly rotate 1A3A1R11 clockwise until indicator just extinguishes.

(5) Readjust potentiometer iA3AIR1, if necessary, for channel A meter indication in the center of the redline area.

(6) The RF power alarm .and metering adjustment is complete.

5-22. Receiver Crystal Current Adjustment

a. General The receiver local-oscillator output level is adjusted in terms of crystal (or diode) current to a known nominal level.

b. Test Equipment and Materials Required. No test equipment or materials are required.

c. Procedure.

(1) On meter panel 1A3, set channel A meter function switch to XTAL CUR position.

(2) Adjust attenuator AT7 on RF panel 1A6 for channel A meter indication in the center of the redline area.

(3) The receiver crystal current adjustment is completed.

5-23. Radio Link Delay Equalization Alignment

a. General.

(1) The radio link delay equalization alignment is performed by white-noise loading the transmitter. Maximum linearity over the radio link is achieved when the intermodulation effects, as reflected by white-noise loading test set, are minimized. See paragraph 5-33 for discussion of the subject.

(2) The alignment procedure consists of the adjustment of the equalizer coils in IF bandpass filter 1A1MD4, and, if required, the adjustment of matching section A9 of transmit RF panelA6 at the distant station.

(3) The alignment procedure is performed over one channel of the radio link, while normal traffic is carried over the other channel.

(4) During the alignment procedure, it is essential that close coordination exists between the local station and the distant station.

b. Test Equipment and Materials Required.

(1) White-noise loading test set; Marconi OA-2090A (composed of noise generator TF2091A and noise receiver TF2092A).

(2) White-noise loading test set accessories, as required (highpass, lowpass, bandstop, bandpass filter, and oscillators); see paragraph 533f

(3) Voltmeter, Electronic ME-30E/U.

(4) Adapter, Connector UG-274C/U.

(5) Cable, Assembly, Radio Frequency CG426F/U.

(6) Tuning tool; Cambion 2033.

c. Procedure.

(1) The local station notifies distant station that alignment is to be accomplished.

(2) Both stations connect test equipment as shown in figure 5-26, and turn on and warm up test equipment.

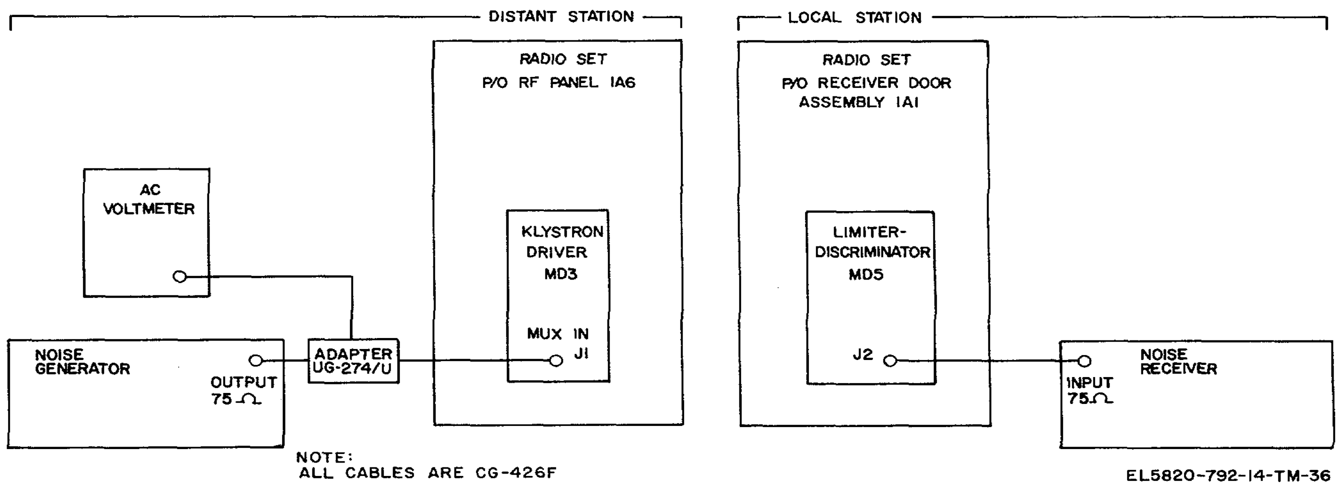


Figure 5-26. Radio link delay equalization alignment, test equipment setup

(3) The distant station sets noise generator highpass filter to IN position, lowpass filter to IN position, and bandstop filters to OUT position.

(4) The distant station, using ac voltmeter, adjusts noise generator output level to 40 mV/75ohm (-16.7 dBm) for 600-channel capacity or to 25 mV/75-ohm (-20.7 dBm) for 240-channel capacity.

(5) The local station adjusts noise receiver to obtain a REF meter indication on the highest frequency slot for the bandwidth.

NOTE

Set the REF meter indication with a minimum of attenuation on the dials of noise receiver so as to obtain a large dynamic range. Set attenuation dials to 00 positions (back plate of knobs).

(6) The distant station locates the bandstop filter for the highest frequency slot for the bandwidth and sets it to IN position.

(7) The local station removes IF bandpass filter 1AlMD4 from its position in receiver door assembly. Do not disconnect input and output cables from 1A1MD4.

(8) The local station locates equalizer coils A3L1 and A4L1 of IF bandpass filter 1AIMD4. Equalizer coil A3L1 is accessible through the center hole on the back of 1AIMD4. (Do not adjust any other components on lAlMD4 at this time.)

(9) The local station adjusts equalizer coil A3L1 for minimum indication on noise receiver. While adjusting coil, reset noise receiver attenuator dials to obtain a REF indication on meter. Adjust equalizer coil A3L1 for at least the required system NPR (as shown on noise receiver attenuator dials). If the required system NPR cannot be obtained with A3L1 adjusted alone, then A4L1 is adjusted at this time.

(10) The local station returns noise receiver attenuator dials to 00, and notifies distant station that adjustment is complete.

(11) The local station selects the 70 kHz slot on noise receiver.

(12) The distant station sets the highest slot bandstop filter to OUT position.

(13) The local station insures that a REF meter indication is obtained; adjust noise receiver, if necessary.

(14) The distant station sets 70 kHz bandstop filter to IN position.

(15) The local station resets attenuator dials to obtain a REF meter indication. If attenuator dial indication is equal to or better than the required system NPR, the adjustment is complete; proceed to step (22). If attenuator dial indication is less than the minimum requirement, proceed to step (16).

(16) The local station notifies distant station that adjustment of his matching section 1A6A9 is necessary. The distant station locates the adjustment screw on matching section 1A6A9. See figure FO-4 for location of matching section 1A6A9.

NOTE

The adjustment screw on matching section must not be rotated more than one-half turn in either direction from the original setting obtained during Klystron

linearization, or the results will be a loss in RF power output, poor Klystron linearization, or incorrect transmitter deviation sensitivity. The local and distant stations must coordinate this adjustment effort.

(17) The local station coordinates with the distant station, while observing noise receiver. The distant station rotates the adjustment screw on matching section 1A6A9 about 1/8 of a turn, then waits for local station to notify the results before proceeding with the next small increment. Normally less than one-half a turn in either direction from the original setting is required to obtain satisfactory system NPR. Do not over adjust this control once the minimum requirement is obtained. Carefully lock control in place.

(18) The local station returns the attenuator dials to 00, and notifies distant station that adjustment is complete. The local station then selects the highest frequency slot again.

(19) The distant station places the bandstop filter for the highest frequency slot for the bandwidth to IN position.

(20) The local station checks the NPR by adjusting noise receiver attenuator dials to obtain a REF meter indication. The attenuator dials should indicate the minimum system required NPR; if not, slightly readjust equalizer coils A3L1 (center hole) and A4L1 in IF bandpass filter 1A1MD4.

(21) Both stations should repeat the procedure for verification of the 70 kHz slot.

(22) The local station installs IF bandpass filter 1AlMD4 in its position in receiver door assembly.

(23) The local and distant stations reconnect radio set cables. The radio-link delay-equalization alignment is completed.

5-24. Baseband Combiner Input/Output Level Adjustments

a. General.

(1) The input and output levels of baseband commoner module (s) are adjusted in this procedure. The input level is associated with the limiter-discriminator module output level. Since all limiter-discriminator modules have slightly different demodulation sensitivities, a reference level must be obtained preceding the active stages of the baseband combiner module. Also, distant transmitter deviation must be verified to be properly adjusted before combiner adjustment is begun.

(2) The adjustment procedure for a single TM 11-5820-792-14/TO 31 R5-4-50-71 module replacement (A or B channel) is performed while normal traffic is carried over the radio link (on-line). When a baseband combiner module is to be adjusted while it is essential to maintain communications, it is necessary to remove this module from the radio set in accordance with the removal and replacement directions given in paragraph 5-29b. If this is not done, the signal level of the traffic channel will be disturbed. Failure to remove the module in proper sequence will result in a 6 dB drop in baseband level, or possibly in a total loss of traffic.

(3) Whenever both baseband combiner modules have to be adjusted, as a requirement during radio set overhaul, or due to module failures, then the off-line procedure must be followed. Traffic is not carried during off-line procedure steps.

(4) Only two potentiometers, R1 and R2, are to be adjusted on the baseband combiner module. See figure 5-3 for authorized on-site adjustments.

b. Test Equipment and Materials Required.

(1) Frequency selective voltmeter; Sierra 128A.

(2) Multimeter; AN/PSM-6B.

(3) Cable, CG-426F.

(4) Adapter, BNC (F) to dual pin-tips; Pomona 3221.

(5) AC voltmeter; Hewlett-Packard 400E.*

(6) Test oscillator; Hewlett-Packard 651B02.*

(7) Termination, 75 ohms (BNC); Tektronix 011-0055-00.*

(8) Adapter, BNC (T); UG-274C/U.*

c. Procedure for On-Line Adjustment.

(1) Carefully remove the faulty baseband combiner module from combiner door assembly 1A2 by following module removal instructions of paragraph 5-29 b.

(2) Connect frequency selective voltmeter, set to 75-ohm BRIDGE mode, to TP9 (input) and TP6 (ground) of baseband combiner module carrying traffic, using cable CG-426F and adapter 3221. Set bandwidth to NARROW.

(3) Tune frequency selective voltmeter, for a group pilot-tone having a level of -50 dBm. It is important that the level of this group pilot-tone level be accurate at the distant station. Adjust R2 if necessary.

(4) Connect frequency selective voltmeter to TP2 and TP6 of baseband combiner module carrying traffic.

(5) Adjust R1 on the baseband combiner module carrying traffic for a level of -35 dBm +0.1 dBm.

*Used in off-line procedure only.

(6) While holding the replacement baseband combiner module in hand, connect the coaxial cable from connector J2 of the associated limiter-discriminator module to connector J6 of baseband combiner module.

(7) While still holding baseband combiner module in hand, connect coaxial cable from input connector J1 of associated noise amplifier module to input connector J5 of baseband combiner module.

(8) Connect coaxial cable from the applicable connector J1 or J2 of dual-pilot tone detector 1A2MD1 to the baseband pilot-tone output connector J2 of baseband combiner module.

(9) Disconnect the frequency selective voltmeter from the combiner module carrying traffic, and reconnect the voltmeter to the corresponding test points on the combiner in hand.

(10) Adjust potentiometer R2 on baseband combiner module for -50 dBm. This corresponds to a single channel test tone (SCTT) of -30 dBm at TP9. Being careful not to change the frequency setting of frequency selective voltmeter, disconnect voltmeter from TP9 and TP6.

(11) Set the TEST-NORM switch on associated dual pilot-tone detector module to TEST position.

(12) Connect multimeter (set on ohms X1 scale) between TP5 and TP6 (ground) of baseband combiner module.

(13) Rotate potentiometer R1 on baseband combiner module fully clockwise, then slowly rotate counterclockwise until a 30-ohm indication is obtained on multimeter, then disconnect the multimeter.

(14) Connect coaxial cable from connector J2 of receiver terminal filter 1A2MD2 to multiplex output connector J3 of replacement baseband combiner module.

(15) With frequency selective voltmeter still set to the same frequency as in step (7), connect frequency selective voltmeter to TP1 (output) and TP2 (ground) of receiver terminal filter 1A2MD2.

(16) Insert the replacement baseband combiner module into its location in combiner door assembly. Immediately adjust potentiometer R1 for a -35 dBm indication on frequency selective voltmeter. This indication corresponds to -15 dBm SCTT level.

(17) Connect coaxial cable from connector J3 of receiver terminal filter 1A2MD2 to orderwire output connector J1 of replacement baseband combiner module.

(18) Set TEST-NORM switch on associated dual pilot-tone detector to NORM position.

(19) Connect coaxial cable from connector J4 of the other baseband combiner module connector J4 of replacement baseband combiner module.

(20) Slightly readjust setting of potentiometer R1 of both baseband combiner modules 1A2MD4 and 1A2MD3 to obtain an indication of 4.8 mV/75-ohm (-35 dBm ±0.1dB) at TP1 and TP2 (ground) of terminal filter 1A2MD2, as indicated on frequency selective voltmeter.

(21) Disconnect frequency selective voltmeter. The baseband combiner input/output level adjustments are complete.

d. Procedure for Off-Line Adjustment.

(1) Request distant station to set up test equipment and to send a single channel test tone, as follows:

(a) Set up test equipment as shown in figure 5-27 for distant station. (Disconnect radio set coaxial cable 1W9 from multiplex input connector J1 of transmit terminal filter 1A4MD5, and connect adapter UG-274C/U to J1 via cable CG-426F.)

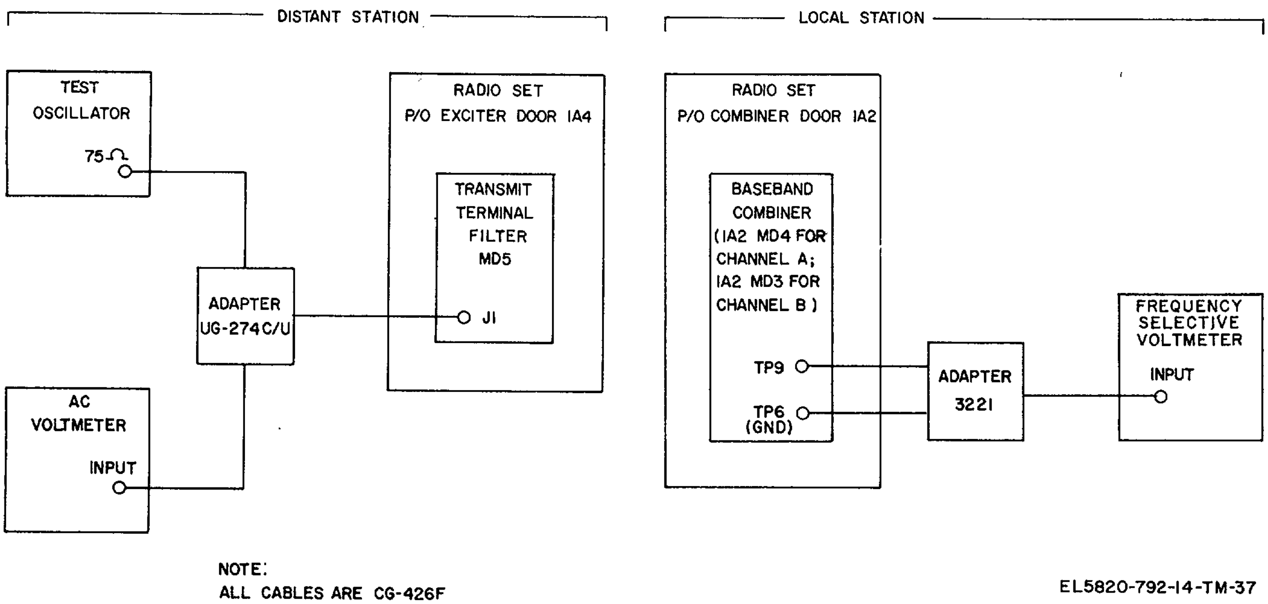


Figure 5-27. Baseband combiner adjustment, test equipment setup (off-line).

(b) Insure that the pilot-tone switch S1 of transmit terminal filter 1A4MD5 is ON.

(c) Adjust test oscillator for 1544 kHz (dial accuracy) frequency and set output level for 1.5 mV/75-ohm (-45 dBm) indication on ac voltmeter.

(2) Local station, connect test equipment as shown in figure 5-27. Set selective voltmeter to 75-ohm BRIDGE mode and tune to 1544 kHz.

(3) Allow test equipment to warm up at both local and distant stations.

(4) Adjust input potentiometer R2 on A channel baseband combiner 1A2MD4 for exactly -30 dBm indication on frequency voltmeter, then lock potentiometer. Be sure to fine tune the selective voltmeter.

(5) Disconnect frequency selective voltmeter from TP6 and TP9 of channel A channel baseband combiner 1A2MD4, and reconnect it to corresponding test points TP9 and TP6 (ground) of B channel baseband combiner 1A2MD3.

(6) Adjust input potentiometer R2 on B channel baseband combiner 1A2MD3 for exactly -30 dBm indication on frequency selective meter, then lock potentiometer.

(7) Disconnect short coaxial cable 1A2W7 from J4 of A channel baseband combiner 1A2MD4.

(8) Disconnect coaxial cable 1W4 from connector J6 of B channel baseband combiner 1A2MD3.

(9) Disconnect coaxial cable 1W6 from multiplex output connector J1 of receiver terminal filter 1A2MD2, and connect 75-ohm termination to J1.

(10) Disconnect frequency selective voltmeter from TP6 and TP9 of B channel baseband combiner 1A2MD3 and reconnect it to TP1 and TP2 of 1A2MD4.

(11) Adjust potentiometer R1 of A channel baseband combiner 1A2MD4 for exactly -21 dBm indication on frequency selective voltmeter.

(12) Reconnect coaxial cable 1W4 to connector J6 of B channel baseband combiner 1A2MD3.

(13) Disconnect coaxial cable 1W5 from connector J6 of A channel baseband combiner 1A2MD4.

(14) Disconnect frequency selective voltmeter from TP1 and TP2 of A channel baseband combiner 1A2MD4, and reconnect it to corresponding test points TP1 and TP2 of B channel baseband combiner 1A2MD3.

(15) Adjust potentiometer R2 of B channel baseband combiner 1A2MD3 for exactly -21 dBm indication on frequency selective voltmeter.

(16) Disconnect frequency selective voltmeter from B channel baseband combiner and reconnect it to multiplex output test points TP1 and TP2 (ground) of receive terminal filter 1A2MD2.

(17) Reconnect short coaxial cable 1A2W7 to J4 of A channel baseband combiner.

(18) Reconnect coaxial cable 1W5 to connector J6 of A channel baseband combiner.

(19) Note indication on frequency selective

voltmeter; this indication must be exactly 15 dBm. If voltmeter indicates a value close to -15 dBm, then split the difference between both baseband combiners. For example, if -15.5 dBm indication is noted, slightly increase the setting of potentiometer R2 on A channel baseband combiner until -15.25 dBm is obtained, then increase R2 on B channel baseband combiner until -15 dBm obtained. Carefully lock both potentiometers R2 so as not to disturb their settings.

(20) At the local station, disconnect the 75ohm termination from multiplex output connector J1 of receiver terminal filter 1A2MD2, and reconnect radio set coaxial cable 1W6 to J1.

(21) Note indication on frequency selective voltmeter, this indication must be exactly 15 dBm. If voltmeter indicates a value close to -15 dBm, then split the difference between both baseband combiners. For example, if 15.5 dBm indication is noted, slightly increase the setting of potentiometer R2 on A channel baseband combiner until -15.25 dBm is obtained, then increase R2 on B channel baseband combiner until -15 dBm is obtained. Carefully lock both potentiometers R2 so as not to disturb their settings.

(22) This completes the alignment procedure. Disconnect test equipment at both local and distant stations. Have the distant station reconnect radio set coaxial cable 1W9 to multiplex input connector J1 of transmit terminal filter 1A4MD5.

5-25. Receiver Pilot-Tone Alarm Adjustment

a. General.

(1) This procedure sets the level at which the receiver should alarm when the pilot-tone signal is missing from the receiver chain up to the noise amplifier module input.

(2) The following adjustments are accomplished only after the baseband combiner input/output adjustments have been completed.

b. Test Equipment and Materials Required. No test equipment or materials are required.

c. Procedure.

(1) Set potentiometer R1 on dual pilot-tone detector 1A2MD6 fully clockwise.

(2) Set switch S1 on 1A2MD6 to TEST position. The corresponding RCVR PILOT TONE alarm indicator on meter panel should extinguish .

(3) Adjust potentiometer R1 slightly counterclockwise until the corresponding RCVR PILOT TONE alarm indicator just lights.

(4) Set switch S1 to NORM position; RCVR PILOT TONE alarm should extinguish.

(5) Test alarm indicator function by switching S1 from NORM to TEST positions. The corresponding RCVR PILOT TONE alarm indicator should light with switch S1 in TEST position and should extinguish with switch in NORM position.

(6) Set switch S1 to NORM position. This completes the receiver pilot-tone alarm adjustment.

5-26. Receiver Baseband Pilot-Tone Alarm Adjustment a. General.

(1) The following procedure sets the level at which the receiver should alarm when the pilot tone signal is missing from the receiver chain to the baseband combiner module output.

(2) The adjustments are performed only after the baseband combiner input/output adjustments have been accomplished.

b. Test Equipment and Materials Requirements. No test equipment or materials are required.

c. Procedure.

(1) Set potentiometer R1 on dual pilot-tone detector 1A2MD1 fully clockwise.

(2) Set switch S1 on 1A2MD6 to TEST position. The corresponding RCVR BB PT alarm indicator should extinguish.

(3) Adjust potentiometer R1 slightly counterclockwise until the corresponding RCVR BB PT alarm indicator just lights.

(4) Set switch S1 to NORM position; RCVR BB PT alarm should extinguish.

(5) Test alarm indicator function by switching S1 from NORM to TEST positions. The corresponding RCVR BB PT alarms indicator should light with switch S1 in TEST position and should extinguish with switch in NORM position.

(6) Set switch S1 to NORM position. This completes the receiver baseband pilot-tone alarm adjustment.

5-27. Receiver AGC Alarm Adjustment

a. General.

(1) The following procedure adjusts the alarm point of the receiver AGC circuitry. A low-level RF signal will provide a high-level AGC signal. This high-level will then trigger the AGC alarm indicator.

(2) The procedure is based on an effective -78 dBm input level into the receiver. Since a 33 dB probe is used to inject the RF signal, the probe coupling factor (33 dB) must be accounted for in the procedure.

(3) It is necessary for the corresponding transmitter at the distant station to be off during this adjustment.

b. Test Equipment and Materials Required.

(1) Generator, Signal AN/URM-52B.

(2) Counter, Electronic, Digital Readout AN/USM-207/A.

(3) Comparator, Frequency CM-77/USM.

(4) Wattmeter, AN/URM-98A.

(5) Thermistor mount; Hewlett-Packard 478A.

(6) Cable, Assembly, Radio Frequency.

(7) Radio Frequency Adapter UG-29B/U.

c. Procedure.

(1) Notify distant station to discontinue transmission over the corresponding RF channel.

(2) Adjust output attenuator control on RF signal generator for maximum attenuation (fully clockwise).

(3) Connect test equipment as shown in figure 5-28. Allow test equipment to warm up.

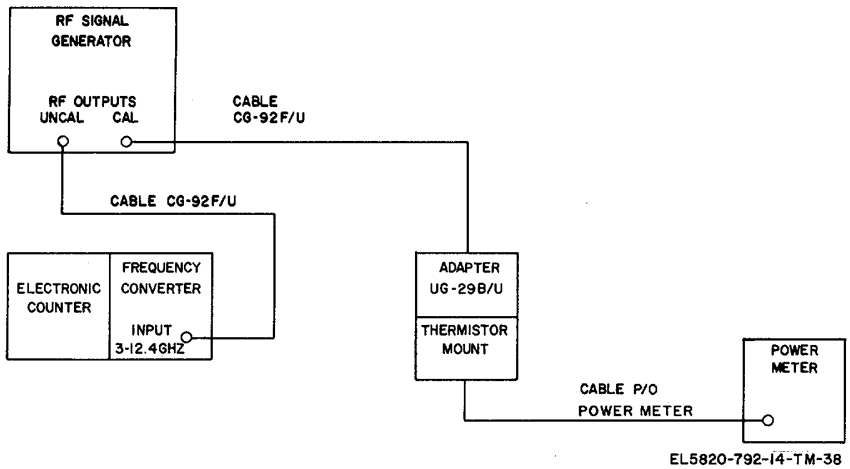


Figure 5-28. Receiver AGC alarm adjustment, test equipment setup.

(4) Set RF signal generator frequency for the required receive frequency ±100 kHz.

(5) Adjust output attenuator control of RF signal generator for 0 dBm indication on power meter.

(6) Using RF signal generator POWER SET control, calibrate RF signal generator attenuator for 0 dB indication on attenuator dial. The RF signal generator is now calibrated for 0 dBm at the output coaxial cable.

(7) While observing electronic counter, refine RF signal generator for the required frequency ±100 kHz.

(8) Reset attenuator dial on RF signal generator for -45 dB indication. This corresponds to -78 dBm input signal through a 33 dB probe.

(9) Disconnect cable CG-92F/U from adapter UG-29B/U and connect cable to probe Al of RF panel 1A6.

(10) Locate potentiometer 1A3AlR14 on radio set meter panel (fig. 5-33).

(11) Adjust this control fully counterclockwise. Note that the corresponding RCVR AGC indicator is extinguished.

(12) Slowly adjust potentiometer 1A3A1R14 clockwise until RCVR AGC lamp comes on; then lock potentiometer.

(13) Verify setting of control by increasing RF signal generator output to -42 dB setting. This corresponds to -75 dBm input signal. The indicator lamp should extinguish before the -75 dBm input level signal point is reached.

(14) This completes the adjustment of the receiver AGC alarm; disconnect test equipment and request the distant station to resume normal communications.

5-28. Repair

a. Scope of Repairs. Repairs to the radio set within the definitions of the on-site maintenance category include repair by replacement of modules, assemblies, subassemblies, and components. To facilitate these repairs, use all existing data (schematic diagrams, alignments, tests, etc.) contained in this manual.

b. General Repair Techniques. Careless replacement of parts often creates new faults. Observe good workmanship at all times. When performing repairs by replacement of parts (other than those covered in paragraph 5-29), follow the general precautions given below.

(1) Do not disturb the settings of potentiometers that have been sealed at off-site maintenance.

(2) Before a part is unsoldered, note the position of the leads. If the part to be replaced has a number of connections, such as a local oscillator, tag each of the leads.

(3) Be careful not to damage other leads by pulling or pushing them out of the way.

(4) Do not allow drops of solder to fall into the equipment; they may cause short circuits.

(5) Make well-soldered joints; a carelessly soldered joint may create a new fault, and a poorly soldered joint is one of the most difficult faults to find.

(6) Do not use a large soldering iron when soldering; overheating may ruin components. Use heat sinks if necessary.

(7) When a part is replaced, it must be positioned exactly as the original part. A defective part must be replaced with one which has the same electrical value and physical size. Pay particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may result in unwanted oscillations or instability.

5-29. Removal and Replacement

a. General.

(1) *Module and assembly replacement*. Whenever replacing a module or assembly after a fault has been detected, refer to the following replacement matrix. The replacement matrix indicates the module or assembly being replaced, the necessary applicable alignment procedure to be performed, and the qualification or performance test procedure essential to be sure that the radio set is still performing at optimum.

(2) *Replacement matrix.*

Module or assembly	Reference designator	Alignment procedure	Performance test procedure	Remarks
Transmit terminal filter	1A4MD5	Transmitter deviation sensitivity (reference signal, (para 5-19d).	Exciter stages gain check, (para 5-37).	
Adder	1A4MD3, 1A4MD4	Transmitter deviation sensitivity (reference signal, (para 5-19d)	Exciter stages gain check (para 5-37).	See removal instructions (b (3) below).
AFC	1A4MD1, 1A4MD3	Modulation loss alarm (para 5-20).	Transmitter frequency accuracy (para 5-41).	
Transmit dual pilot-tone detector	1A4MD2	Modulation loss alarm (para 5-20).		
Klystron driver	1A6MD3, 1A6MD4	Transmitter deviation sensitivity (reference signal, (para 5-19d)		
Preamplifier	lA6MD1, 1A6MD2	None	Receiver sensitivity and AGC calibration (para 5-44).	
IF filter	1AlMD1, 1A1MD4	Radio link delay equalization (para 5-23).		Affects high slot.
IF amplifier	1AlMD3, 1A1MD6		Link NPR (para 5-46).	
Limiter-discriminator	lAIMD2, 1AlMD5	Baseband combiner input/output (on-line, para 5-24c).	Link NPR (para 5-46).	
Baseband combiner	1A2MD3, 1A2MD4	Baseband combiner input/output (on-line, para 5-24c).		See removal instructions, paragraph 5-29b (2).
Noise amplifier	1A2MD5, 1A2MD7	Receiver pilot-tone alarm (para 5-25).		
Receiver dual pilot-tone detector	1A2MD6	Receiver pilot-tone alarm (para 5-25).		
Baseband dual pilot-tone detector	1A2MD1	Receiver baseband pilot-tone alarm (para 5-26).		
Receiver terminal filter	1A2MD2		Receiver demodulation level (multiplex) (para 5-45).	
AFC local oscillator	1A6Y1, 1A6Y2		Transmitter frequency accuracy (para 5-41).	See d below.
Receiver local oscillator	1A6Y3, 1A6Y4	Receiver crystal current (para 5-22).		See d below.
Meter panel	1A3	RF power alarm and metering (para 5-21). Receiver AGC alarm (para 5-27).		
Mixer	1A6A5, 1A6A6	Receiver crystal current (para 5-22).	Receiver sensitivity and AGC calibration (para 5-44).	See e below.
Klystron	1A5V1, 1A6V2	Klystron moding and linearization (para 5-18). Transmitter deviation sensitivity (carrier null, para 5-19). Modulation loss alarm (para 5-20). RF power alarm and metering (para 5-21).	Link NPR (para 5-46).	Replace in accordance with c below.
RF filter, receiver	1A6FL1, 1A6FL2	Radio link delay equalization (para 5-23).		Affects high slot.
RF filter, transmit	1A6FL3, 1A6FL4	Radio link delay equalization (para 5-23).		Affects high slot.
Low voltage power supply	1A5PS1, 1A5PS2	Low voltage power supply (para 5-17).		See removal instructions (f below).
Klystron power supply	1PS1, 1PS2	Klystron moding (para 5-18). Reset 450-volt section of Klystron power supply only.	Link NPR; paragraph 5-46.	See removal instructions (f below).

b. Modules and Module Mounting Plates.

CAUTION

Do not replace modules in their positions on the doors without locking them in place with the snap slides. Friction between connector elements is not sufficient to hold the module in place even for short periods of time.

(1) The modules are mounted on module mounting plates in the various cabinet doors. As shown in figure 5-29, the modules are secured to the mounting plates by snap slides which fit into the groove on the module positioning pins. The module mounting plate is similarly secured with snap slides to angle brackets welded to the door panel. To remove a module from its mounting plate, grasp the module handle with one hand and, with the other hand, slide the upper and lower snap slides straight up and straight down, respectively, and pull the module straight out from the mounting plate.

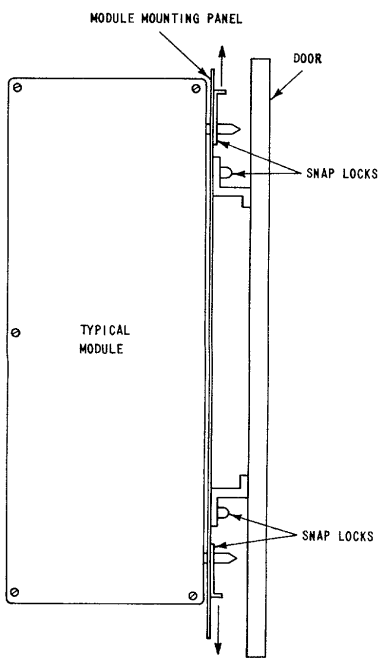


Figure 5-29. Module mounting details.

(2) The baseband combiner modules (1A2MD3 and 1A2MD4) must be replaced using the following directions to prevent a failure of communications over the link:

(a) Disconnect cable from J4 on good baseband combiner module.

(b) Remove cable connected to J1 of faulty baseband combiner module.

(c) Remove cable connected to J2 of faulty module.

(d) Disconnect cable connected to J5 of faulty module. The faulty module is now squelched.

(e) Remove faulty module from its position in door assembly. The multiplex output level will only drop by one dB.

(f) Disconnect cable connected to J3 of faulty module. Multiplex output level is now back to normal.

(g) Disconnect cable from J6 of faulty module. The faulty module is now free.

(h) Perform the baseband combiner alignment procedure (on-line) as instructed in paragraph 5-24 to reconnect the new module.

(3) The adder module (1A4MD4 and 1A4MD6) must be removed and replaced, using the following directions to prevent a 6 dB drop in baseband levels:

(a) Disconnect the coaxial cable from J2 on the module (MUX output).

(b) Disconnect-the coaxial cable from J1 on the module (MUX input).

(c) Remove the module from the door assembly.

(d) To replace the module, connect the two coaxial cables to the module first, then plug the module into its mounting location.

c. Klystron Tube. To remove and replace a Klystron tube (1A6V1 and 1A6V2), proceed as follows. Refer to figure 5-8 for mechanical details of the Klystron.

(1) Set MAIN POWER switch on the associated Klystron power supply (1PS1 for channel A, 1PS2 for channel B) to OFF position.

WARNING

Before attempting to remove the Klystron tube, wait approximately one-half hour after turning off the Klystron power supply to allow the Klystron tube to cool.

(2) Remove the repeller cap and the socket from the Klystron tube.

(3) Remove the three screws that hold the Klystron assembly to the RF plate (A6).

(4) Remove the eight screws that hold the Klystron assembly to the RF panel waveguide.

(5) Remove the Klystron assembly from the radio set.

(6) Separate the Klystron from the heat sink

by loosening the four screws that fasten the Klystron to the heat sink.

(7) Disassemble the Klystron cavity from the Klystron tube, by removing the six screws.

(8) Exchange the Klystron tube with a spare tube. Reassemble the Klystron tube to the Klystron cavity.

(9) Reassemble and install the Klystron assembly by reversing the steps in (2) through (6) above. Be sure that a suitable heat sink compound is first applied between the Klystron and the heat sink.

(10) Set MAIN POWER switch on the associated Klystron power supply to ON position.

NOTE

Do not tighten the screws that hold the Klystron to the heat sink until the Klystron assembly is aligned properly with the waveguide adapter plate.

d. Local Oscillator Assembly. To remove and replace any one of the four local oscillator assemblies (1A6Y1 through 1A6Y4), proceed as follows:

(1) Set MAIN POWER switch on the associated low-voltage power supply to OFF position.

(2) Remove the four mounting screws holding the local oscillator assembly to the RF panel.

(3) Unsolder the wiring harness from +20V and ground terminals.

(4) Resolder the wiring harness to the replacement assembly.

(5) Reinstall the replacement assembly.

(6) Set MAIN POWER switch on associated low voltage supply to ON.

e. Mixer Assembly. Remove and replace either one of the mixer assemblies (1A6A5 and 1A6A6) as follows:

(1) Disconnect the local oscillator cable connected to the variable RF attenuator.

(2) Disconnect all cables from the IF preamplifier module.

(3) Remove the four mounting screws holding the preamplifier module to the mixer assembly, and remove module.

(4) Remove the eight mounting screws holding the isolator to the RF receive filter.

(5) Slightly loosen the two mounting screws holding the mixer mounting bracket to the RF panel.

(6) Unsolder the wiring harness from the feedthrough capacitors, then lift out and remove the mixer assembly.

(7) Replace the mixer with a spare assembly using the reverse order of previous steps.

f. Power Supplies. To remove and replace either a Klystron or low voltage power supply, perform the following procedures:

(1) Set the associated PRI-PWR switch on meter panel 1A3 to OFF position.

(2) Remove front panel machine screws securing power supply to cabinet; slide out and remove supply from cabinet. Set supply on a short-height crate or stand.

(3) Disconnect cables from rear terminal blocks of supply. Mark each wire with its assigned terminal using small tags or paper tape to facilitate reconnection.

(4) Reinstall supply using the reverse order of previous steps.

g. Fuses. All fuses are located on front panels of the two Klystron power supplies and the low voltage power supply. Fuses are cartridge type. To replace a fuse, perform the following:

(1) Press in on the fuseholder cap and turn it counterclockwise to unlock it.

(2) Pull out the fuseholder cap and the fuse, and discard the defective fuse.

(3) Insert the replacement fuse in the fuseholder cap and insert it in the fuseholder; press in on the cap and turn it clockwise to lock it in place.

h. Fuse Complement.

Reference designation	Rating in amperes	Circuit or function
1A5PSF1	8	Protects primary power input to power supply section 1A5PS1.
1A5PS1F2	5	Protects voltage regulation circuit.
1A5PS2F1	8	Protects primary power input to power supply section 1A5PS2
1A5PS2F2	5	Protects voltage regulation circuit.
1PS1F1	10	Protects primary power input to Klystron power supply 1PS1
1PS2F1	10	Protects primary power input to Klystron power supply 1PS2.

i. Indicator Lamps. All-alarm indicator lamps are located on the meter panel 1A3. To replace a lamp, perform the following:

(1) Remove the lamp lens by unscrewing it from lampholder.

(2) Remove defective lamp.

(3) Insert replacement lamp in lens, and replace as a single unit by screwing lens into lampholder.

(4) To replace the neon indicator part of the

fuse indicator used on a Klystron power supply, refer to instructions of g above for preparatory removal or restoration of associated fuse.

j. Indicator Lamp Complement.

Reference designation	Type	Color	Rating	Function of indicator
1A3XDS1	327	Clear	28 V, 60 ma	Channel A receiver AGC alarm.
1A3XDS2	327	Clear	28 V, 60 ma	Channel A receiver pilot-tone alarm.
1A3XDS3	327	Clear	28 V, 60 ma	Channel A receiver noise alarm.
1S3XDS4	327	Clear	28 V, 60 ma	Channel A receiver baseband pilot-tone alarm.
1A3XDS5	327	Clear	28 V, 60 ma	Channel A exciter RF power alarm.
1A3XDS6	327	Clear	28 V, 60 ma	Channel A exciter modulation loss alarm.
1A3XDS7	327	Clear	28 V, 60 ma	Channel A primary power.
1A3XDS8	327	Clear	28 V, 60 ma	Channel B primary power.
1A3XDS9	327	Clear	28 V, 60 ma	Channel B exciter modulation loss alarm.
1A3XDS10	327	Clear	28 V, 60 ma	Channel B exciter RF power alarm.
1A3XDS11	327	Clear	28 V, 60 ma	Channel B receiver baseband pilot-tone alarm.
1A3XDS12	327	Clear	28 V, 60 ma	Channel B receiver noise alarm.
1A3XDS13	327	Clear	28 V, 60 ma	Channel B receiver pilot-tone alarm.
1A3XDS14	327	Clear	28 V, 60 ma	Channel B receiver AGC alarm.
1PS1F1 (no designation for indicator).		Clear		Indicates application of primary power and continuity of fuse.
1PS2F1 (no designation for indicator).		Clear		Indicates application of primary power and continuity of fuse.

Section V. TESTING PROCEDURES

5-30. Introduction to Testing

The data and procedures presented in paragraphs 5-31 through 5-46 provide instructions for performance testing the overall operation of the radio set. These procedures are performed:

a. Following installation, to determine if the radio set is operating normally after shipment or storage.

b. When the radio set is suspected of improper operation as denoted by the troubleshooting symptoms of section III.

c. In their entirety, or necessary parts thereof, as applicable, following repair or replacement' of any part, component, or assembly affecting major operation of the radio set or affected circuits.

d. During scheduled maintenance to determine the operability of the equipment.

e. On-site testing is categorized as normal onsite procedures normally performed by organizational level personnel using authorized test equipment. These tests do not interrupt communications at any time. Some testing may be required on a yearly basis to determine if some of the radio link equipment (antenna, waveguide, path obstructions, reflectors, etc.) are creating a problem. These yearly tests may or may not stop communications and are performed only during special maintenance and performance periods. See paragraph 5-47 for further explanations of special on-site testing.

5-31. Summary of Standard Test Parameters

a. The test procedures contained within this section are based on standard test parameters. These parameters concern channel loading, multiplex input and output levels for the single channel test tone (SCTT) and the noise loading, and service channel input and output levels. The following paragraphs present explanations of the various parameters; sufficient data is also given to calculate new values and settings for any change to the standard test parameters.

b. The procedures in this section are based on the following parameters:

(1) Channel capacity is 240 and 600.

(2) RMS per channel deviation is 140 kHz.

(3) Multiplex input level is -45 dBm.

(4) Multiplex output level is -15 dBm.

(5) Link NPR at -30 dBm input level is 54 dB nominal (actual NPR is determined by system requirements).

5-32. Changes to Deviation, Frequency, and Channel Capacity

a. Deviation Changes.

(1) Deviation sensitivity change of the radio set is accomplished by changing the input level going into the Klystron driver module. This is done by adding additional padding in the terminal filter module, just as required whenever changing the input and output levels into and out of the radio set.

(2) The multiplex input has been adjusted to require a SCTT of -45 dBm to produce a deviation of 140 kHz (rms), the assigned per channel deviation sensitivity of the radio set.

The multiplex output level has been adjusted for -15 dBm. The multiplex input of the radio set is, however, capable of accepting SCTT input levels from -15 dBm to -45 dBm, with per channel deviations from 50 kHz to 200 kHz (RMS) in accordance with the necessary input level. The multiplex attenuators permit adjustment of input and output signal levels over the 30 dB range in increments of 1 dB.

(3) The multiplex section of the transmit terminal filter employs T-pad attenuators which are placed in use through strap connections. Additional components required within the module are also strap connected. The orderwire section employs a 1-dB H-pad attenuator for the required -35-dBm input level. Any change in level setting involves selecting the appropriate attenuator and making the necessary strap connections. This change in attenuator settings is to be performed by off-site maintenance personnel only.

(4) When the frequency deviation must be changed from the standard 140 kHz, it is necessary to reset the baseband drive of the Klystron driver. Do this by calculating a new baseband input level to the radio set and making the necessary attenuation adjustments for the input signal.

(5) A standard mathematical table of *Bessel Functions* shows that the phenomenon of *first carrier dropout* occurs for a frequency modulation index (m) of 2.405. First carrier dropout is defined as the level of modulation required to cause the carrier to *null-out* or disappear (as viewed on a spectrum analyzer); also referred to as the *first carrier null*. The test tone frequency normally used in a radio set employing a preemphasis network is the pivot frequency or 0.608 f max., where f max. is the baseband highest frequency. At the pivot frequency (fp), the relationship between the peak deviation when the "first carrier dropout" occurs and the baseband highest frequency is described in the following formulas; the formulas are used to calculate the new input baseband level in dBm0 symbolized by the letter "L." The dBm0 values are referenced to the standard SCTT input levels.

(6) The formula to use when calculating the required input level for a particular deviation sensitivity is:

$$\underline{F} = \frac{\text{Peak Deviation}}{\text{Modulating Frequency}}$$

(a) m= f_{mod}

At the first carrier null, m=2.4

(b) Peak deviation:

F= (m) • (f_{mod}).

(c) Since the modulating frequency to be used is the pivot frequency then:

$f_{mod} = f_{pivot}$

NOTE

The deviation sensitivity setting will only be correct when done at f pivot.

(d) Therefore:

F = (m) • (f pivot)

(e) To convert peak deviation to RMS deviation:

RMS deviation = (m) • (f pivot) • (0.707)

(f) The RMS deviation obtained is not the required deviation and since the modulating frequency cannot be changed (f pivot), the input level must be corrected:

$$\text{Correction level} = \underline{L} = 20 \log \frac{\text{Required Deviation}}{\text{RMS Deviation}}$$

(g) The correction level (L) is then added to the SCTT level.

(h) For example, to convert from 140 kHz RMS deviation to 170 kHz the following calculations must be done for a 600-channel system:

$f_{mod} = f_{pivot}$ = (0.608) • f_{max}

= (0.608 • (2540 kHz)

= 1544 kHz

RMS deviation = (m) • (f mod) • (0.707)

= (2.4) • (1544 kHz) • (0.707)

= 2620 kHz

Required RMS deviation = 170 kHz

$$\underline{L} = 20 \log \frac{170\text{kHz}}{2620\text{ kHz}}$$

= -23.8 dB

(i) Substracting. from a SCTT level of -34.5 dBm, we obtain: -34.5 dBm-(-23.8 dB) = -10.7 dBm. This level must be used to obtain a carrier null with a pivot frequency used as a modulating frequency for a 600-channel bandwidth and to have an actual RMS deviation of 170 Khz.

b. Operating Frequency Change.

(1) The radio set is factor-shipped with the necessary components installed with the exciter and receiver channels aligned to the operating frequencies required for the intended radio set installation. These assigned frequencies are a function of the communications system, and are denoted by the radio set part number. To change the frequency, certain components of the RF

panel must be changed or aligned to accommodate the new frequency. The specific components affected for each radio set channel are as follows:

Exciter channel A
AFC local oscillator 1A6Y1
RF filter 1A6FL3
Exciter channel B
AFC local oscillator 1A6Y2
RF filter 1A6FL4
Receiver channel A
Receiver local oscillator 1A6Y3
RF Filter 1A6FL1
Receiver channel B
Receiver local oscillator 1A6Y4
RF filter 1A6FL2

(2) Changing the operating frequency of the local oscillator involves selecting the proper basic source to cover the required frequency assignment and its associated crystal.

(3) The RF filter requires replacement by a unit which has been aligned by the facilities provided by off-site maintenance. Alignment of the RF filter requires extensive test equipment beyond the facilities of on-site maintenance.

(4) Following incorporation of the necessary changes, perform the alignment procedures and tests of section V.

c. Channel Capacity Change.

(1) The radio set is supplied in a 240 channel and a 600 channel configuration. A change to the alternate channel capacity involves the changing of certain components and the subsequent realignment of the affected stages.

(2) The components which vary according to channel capacity include the Klystron driver module and the limiter-discriminator module for each of the dual channels. The preemphasis network in the Klystron driver module must complement the deemphasis network in the limiter-discriminator module. Changes to the assigned capacity require replacement of the parent modules with modules containing the proper networks. Realignment of the radio set for those affected stages must then be performed.

5-33. Noise Load Testing a. Concept.

(1) Noise load testing is extremely useful when determining the dynamic load capacity of the radio set in terms of its noise performance and in measuring the effects of intermodulation distortion. It consists of fully loading the transmit baseband of the radio set with white noise and measuring the noise level in sample 3-kHz channels or test slots at the receive baseband output. The band of white noise simulates the full baseband signal load of the multichannel radio set. Normally, one low frequency, one center frequency, and one high frequency channel within the baseband are selected as the sample test channels. The upper and lower frequency limits of the band of white noise are set by low and high pass filters to agree with the baseband of the radio set under test.

(2) Noise load tests are performed by blocking energy in the test slots in the transmit baseband and measuring the noise present in the slots at the receiver baseband. By switching the slot filters, at the transmitter, in and out, the noise power ratio (NPR) of the radio set can be determined. See figure 5-30.

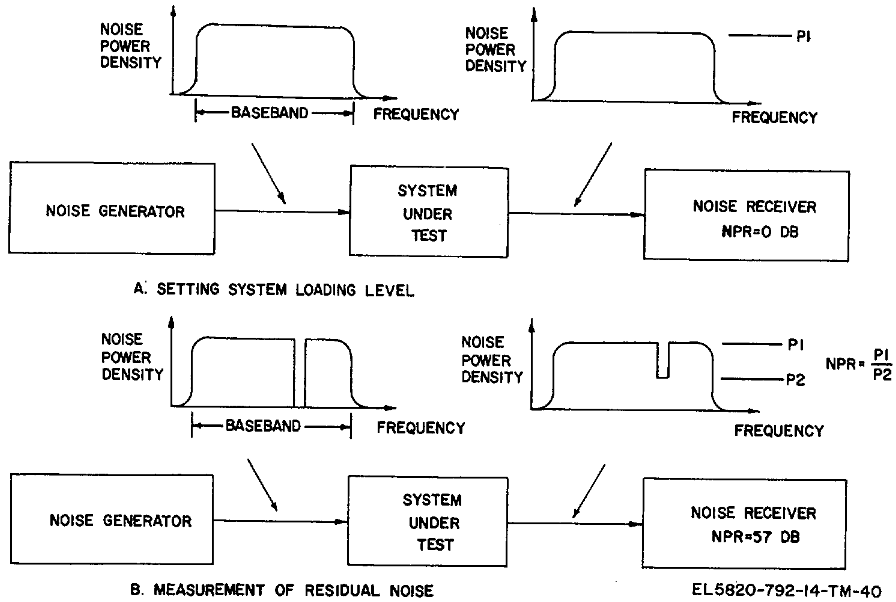


Figure 5-30. Principles of noise load testing.

b. Advantages.

(1) The complex baseband signal of the radio set is derived from signals originating from telephone, teletypewriter and data terminal equipment. The number of fundamental frequencies in this complex signal can be quite large. Such a complex signal resembles white Gaussian noise. When such a signal passes through nonlinear circuit elements, harmonics and intermodulation components appear in the output signal.

(2) Intermodulation noise has a critical effect on the performance of the radio set. As the traffic load increases, the intermodulation noise also increases. This noise increases slowly until the overload point is reached, and then it increases very rapidly.

(3) The load capacity of the radio set is based on the probable signal load during the time of heaviest traffic; therefore, it is important to be able to measure the limits of the noise performance of high density radio set under actual operating conditions.

(4) The load capacity of the radio set depends on the types and quantities of signals to be carried by the system. Suitable loading formulas have been derived for any given number of channels, which are used to calculate the RMS power load in the baseband.

(5) Noise load testing provides a convenient means of measuring the optimum input power level of a multichannel system. This is accomplished by varying the level of white noise applied to the radio set exciter and measuring the change in noise level, typically in three test channels at the receiver. Decreasing the transmit level causes an increase in thermal noise distortion, while increasing the level causes an increase in intermodulation distortion. Using a noise loading test set, curves can be plotted showing the effects of both thermal and intermodulation noise. An example of such a general curve is shown in figure 5-31. The range where channel noise is lowest prescribes the optimum input level for the radio set under test. A study of the shape of a set of noise loading curves can reveal several important characteristics about the performance of a radio set. The most significant characteristics are:

(a) Load capacity of the radio set.

(b) Degree of thermal and intermodulation noise contribution.

(c) Optimum noise performance of the radio set.

(d) Presence of static or dynamic types of intermodulation distortion.

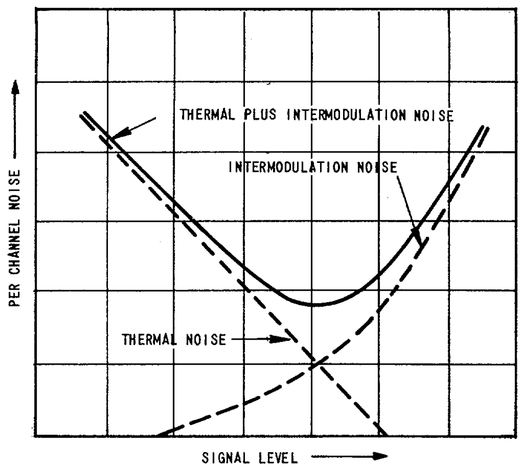


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Figure 5-31. Effect of thermal and intermodulation noise.

(6) The ability to measure these characteristics on a timely basis provides a useful maintenance tool to correct poor radio set performance and to prevent system degradation.

c. White Noise and NPR Test Data. When the noise-power-ratio (NPR) measurement is made on any microwave system, the multiplex input level must be adjusted to properly load the baseband with white noise. The noise loading is based on standards set forth by the Defense Communications Agency (DCA). As the channel capacity of the system is increased, the noise level, referenced to the SCTT, must also be increased.

$$Pn = -10 + 10 \log_{10} N$$

where Pn = amount multiplex input level must be increased with white noise over SCTT level (noise power) and where N is the number of channels, 120 or more.

For example: For a 240 channel loading configuration, using a SCTT input level of -45dBm, the DCA white noise loading of +13.8 dBm0 is added to the -45 dBm to give a white noise input loading level of -31.2 dBm

d. Channel Versus White Noise Loading.

Channel loading	DCA white noise loading (dBm 0)*
120	+10.8
180	+12.6
240	+13.8
300	+14.8
600	+17.8

e. Marconi Noise Loading Test Set, Model 0A2090A. If any prescribed bandstop filter, bandpass filter, or oscillator module is not available for the frequency specified in *f* below, use the available component whose frequency is closest to that specified. However, substitution is restricted to the frequency limits of the corresponding high-pass band limit and low-pass band limit filters.

f. Marconi Noise Loading Test Set Data.

* Based on preceding DCA formula.

Channel loading	Noise generator (part No. TF 2091)						Noise receiver (part No. TF 2092)			
	High-passband-limit filter		Low-passband-limit filter		Bandstop filter		Oscillator module		Bandpass filter	
	kHz	Part No.	kHz	Part No.	kHz	Part No.	kHz	Part No.	kHz	Part No.
240	60	TM-7728/1	1052	TM-7720/11	70	TM-7729/2	70	TM-7794	70	TM-7730/2
					534	TM-7729/6	534	TM-7794/4	534	TM-7730/6
					1002	TM-7729/15	1002	TM-7795/5	1002	TM-7730/15
600	60	TM-7728/1	2540	TM-7724/11	70	TM-7729/2	70	TM-7794	70	TM-7730/2
					1002	TM-7729/15	1002	TM-7795/5	1002	TM-7730/15
					2438	TM-7729/8	2438	TM-7795/1	2438	TM-7730/8

5-34. Group Delay and Linearity Testing

a. General. Group delay and linearity testing is accomplished by using a known reference, such as a link analyzer test set. The group delay is the differential delay across the bandwidth of interest, while the linearity is more commonly referred to as amplitude response.

b. Group Delay Testing. Group delay (or differential delay or differential phase delay) nonlinearity a form of phase distortion and has about the same effect in frequency-modulated systems as amplitude distortion has in amplitude modulated systems. The nonlinearity of the signal phase occurs when different frequency bands are transmitted through the system with different delays. This results in noise, crosstalk, and large intermodulation products in the receiver. Refer to A, figure 5-32. The dark line in the figure is the group delay curve as observed on the Y2 trace of the demodulator display section of the link analyzer. The curve shows group delay versus frequency. Group delay is composed of linear and parabolic components. Refer to B, figure 5-32 for a representation of these components.

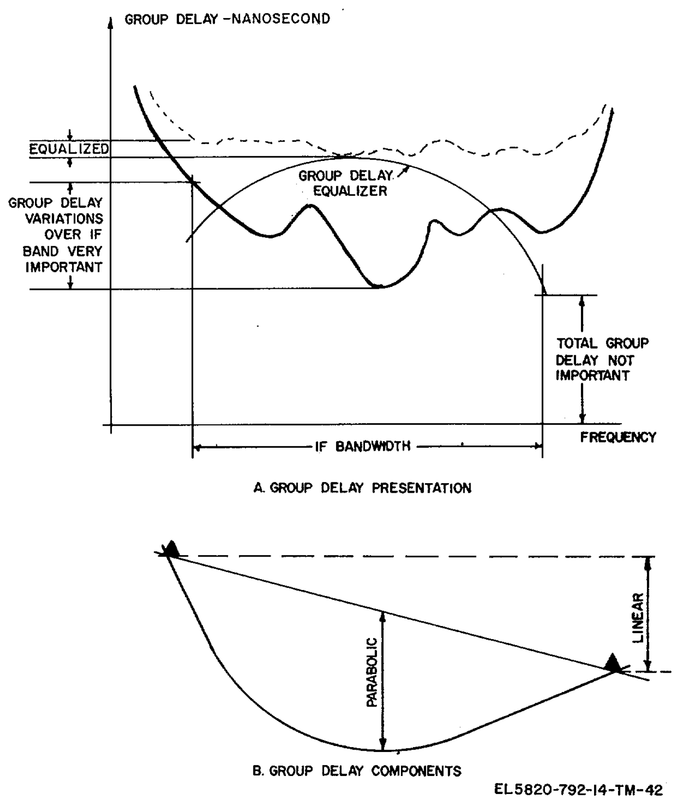

Figure 5-32. Group delay presentation.

c. Amplitude Linearity Testing. Modulators (such as Klystron drivers) and demodulators (such as limiter-discriminators) pass the information into and out of the transmission system. They must do this with minimum of distortion and optimum signal-to-noise ratio. To achieve this, the voltage-versus-frequency constant must be very linear over the IF bandwidth, and the sensitivity must be known.

d. Microwave Link Analyzer.

(1) The microwave link analyzer is composed of a transmission generator, a demodulator display, and a group delay detector. Although the three are separate assemblies they must be used simultaneously when making measurements.

(2) The main sections of the transmission generator are the 70 MHz deviable oscillator, the baseband generator, and a 70 MHz reference oscillator.

(3) The demodulator-display is basically a limiter-discriminator circuit with an oscilloscope to view the amplitude from the demodulator. The demodulator-display contains a means of identifying the required bandwidth through the use of variable markers.

(4) The group delay detector module contains a reference oscillator which tracks the reference oscillator in the transmission generator. Since these two oscillators are precision, stable, accurate types, the tracking voltage is displayed on the oscilloscope scope as delay.

(5) The possible measurements to be made with the link analyzer are:

(a) Group delay
(b) IF flatness
(c) Demodulation linearity
(d) Demodulation sensitivity
(e) VSWR (return loss)
(f) Modulation linearity
(g) Klystron testing and adjustments.

5-35. Location of Components

The following figures illustrate the locations of certain major components involved in testing and aligning the radio set. Figure FO-4 shows the RF panel; figure 5-33 shows the meter panel.

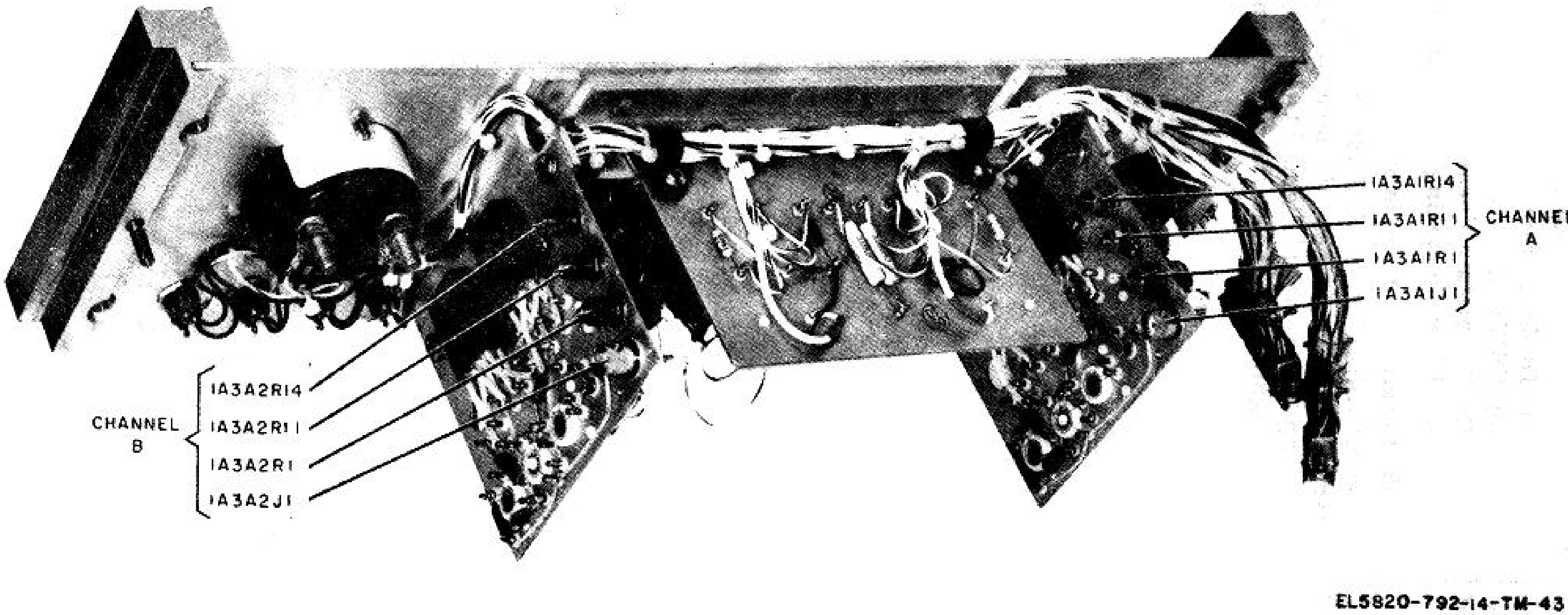

Figure 5-33. Location of meter panel components.

5-36. Preliminary Procedures

a. General. These preliminary procedures initiate the start of any testing sequence.

b. Test Equipment. The test equipment used during the following test procedures must be warmed up for at least 20 minutes prior to the start of the measurements.

c. Testing Conditions. Both the local and the distant radio sets must be trouble-free prior to the start of any test. No testing should be attempted unless full dual diversity is available at all times. It is necessary that some coordination be observed during certain performance tests.

d. Power Supply Voltages. Testing of the radio set is predicated on the low voltage power supplies being in tolerance. Measurement of these voltages must be (as mentioned in paragraph 5-17) as follows:

+28 V dc ± 0.100V dc
+20 V dc ± 0.500 V dc
-6 V dc ±0.060 V dc

5-37. Exciter Stages Gain Check

a. General. The following performance test does not affect either channel of the radio terminal. This procedure measures the gain of the exciter stages from the terminal filter module to the output of the adder module. In essence this test verifies that deviation sensitivity of the Klystron modulating stages will not be affected, either as a result of a module change or whenever trouble is suspected in the transmitter path.

b. Test Equipment and Materials Required.

(1) Frequency selective voltmeter; Sierra 128-A.

(2) Cable Assembly, Radio Frequency CG426F/U.

(3) Adapter, pin-tips to BNC (F); Pomona 3221.

c. Test Connections and Conditions.

(1) Connect the frequency selective voltmeter to TP1 and TP2 (ground) on the terminal filter module 1A4MD5.

(2) Set the frequency selective voltmeter to a test tone frequency being provided into the terminal.

d. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment undertest	Test procedure	Performance standard
1			Read and record the test tone level, as reference 1.	Reference 1 is 0 dBm0 level for input into radio set.
2			Reconnect the frequency selective voltmeter to TP1 and TP3 (ground), on A channel adder module 1A4MD6.	
3			Read and record indication on selective voltmeter as reference 2.	Reference 2 is +10.5 dB3m0 level ± 0.2 dB.
4			Disconnect test equipment from radio set.	

5-38. Transmitter Output Power Measurement

a. General. Measurement of transmitter output power by the meter on the meter panel gives only a relative indication of the Klystron power output. This test provides a measurement of actual Klystron power output and is made with the Klystron AFC circuit in operation. This procedure is an on-line test.

b. Test Equipment and Materials Required.

(1) Wattmeter AN/URM-98A.

(2) Thermistor mount; Hewlett-Packard 478A.

c. Test Connections and Conditions. Connect equipment as illustrated in figure 5-34.

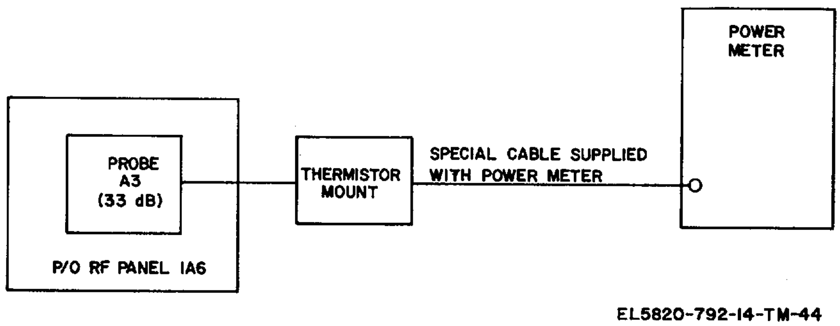

Figure 5-34. Transmitter output power, test equipment setup.

d. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	Set power meter range control to the 1 mW range.		Read and record channel A output power. Multiply the meter indication by 2000 to obtain true output power. To obtain a more accurate indication, shift the power meter range control down-scale. Disconnect test equipment from radio set.	Klystron true output power must be minimum of 500 milliwatts.

5-39. AFC Local Oscillator Output Level Measurement

a. General.

(1) This. procedure measures the output power level of the AFC local oscillator. This procedure is an on-line test.

(2) If the local oscillator does not meet the test standards, the unit must be replaced.

b. Test Equipment and Materials Required.

(1) Wattmeter AN/URM-98.

(2) Thermistor mount; Hewlett-Packard 478A.

(3) Attenuator, Fixed CN-797/U.

(4) Adapter, N (F) to TNC (M); Amphenol 79825.

(5) Adapter, TNC (M) to TNC (F); Amphenol 79215.

c. Test Connections and Conditions.

(1) Set switch S1 on AFC module 1A4MD3 to OFF position.

(2) Remove the coaxial cable from TNC output connector J1 of channel A exciter AFC local oscillator 1A6Y1.

(3) Connect equipment as illustrated in figure 5-35.

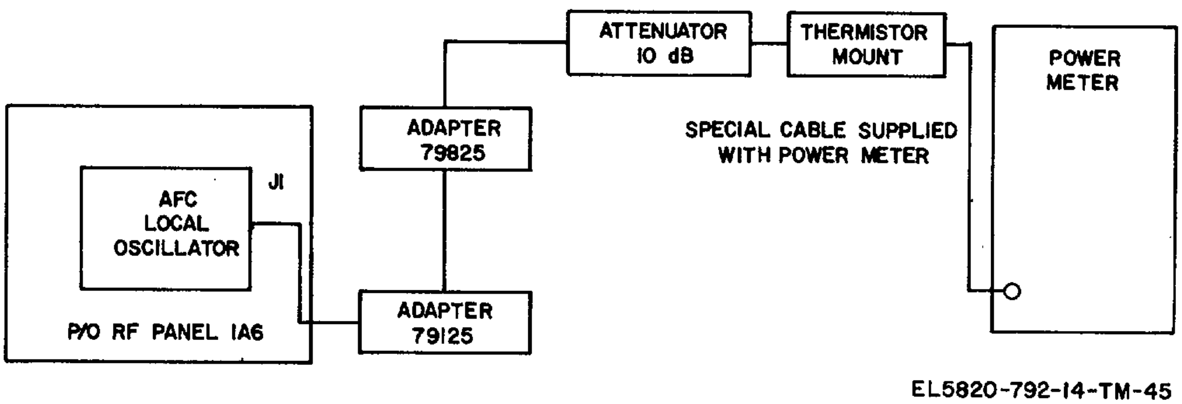

Figure 5-35. AFC local oscillator output level, test equipment setup.

d. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1			Observe power indication on power meter.	The power output level will range from 0.6 to 2.0 milliwatts, but must not be less than 0.5 milliwatts, as indicated on power meter.
2		Place switch S1 on AFC module 1A4MD3 to ON position.	Disconnect test equipment from radio set. Reconnect normal cables of radio set.	

5-40. AFC Local Oscillator Output Frequency Check

a. General.

(1) This procedure measures the output frequency of the AFC local oscillator. This procedure is an on-line test.

(2) If the local oscillator does not meet the test standards, the unit must be replaced.

b. Test Equipment and Materials Required.

(1) Counter, Electronic, Digital Readout AN/USM-207A.

(2) Comparator, Frequency CM-77/USM.

(3) Multimeter TS-352B/U.

(4) Attenuator, Fixed CN-797/U.

(5) Adapter, N (F) to TNC (M); Amphenol 79825.

(6) Cable Assembly, Radio Frequency CG92F/U.

(7) Adapter, TNC (M) to TNC (F); Amphenol 79125.

c. Test Connections and Conditions.

(1) Install frequency converter in electronic counter. Set the time base of counter to 100 milliseconds.

(2) Place switch S1 on AFC module 1A4MD3 to OFF position.

(3) Remove the coaxial cable from TNC output connector J1 of channel A exciter AFC local oscillator 1A6Y1.

(4) Connect equipment as illustrated in figure 5-36.

d. Procedure.

Step No.	Control settings		Test procedure	Performance standard
	Test equipment	Equipment under test		
1	Set electronic counter to indicate performance standard.		Read and record frequency of the local oscillator, as indicated on electronic counter.	The output frequency must be within 0.005 percent (± 250 kHz) of assigned frequency.
2	While watching the meter on frequency converter, tune converter frequency control until the first peak meter indication is obtained.			
3			Disconnect test equipment from connector J1 of local oscillator 1A6Y1.	
4		Place switch S1 on AFC module 1A4MD3 to ON position.		
5	Set multimeter to 10 V dc.		Connect multimeter to the phase-lock terminals of local oscillator 1A6Y1. Disconnect all test equipment.	The lock voltage must be 10 ± 3 V dc.

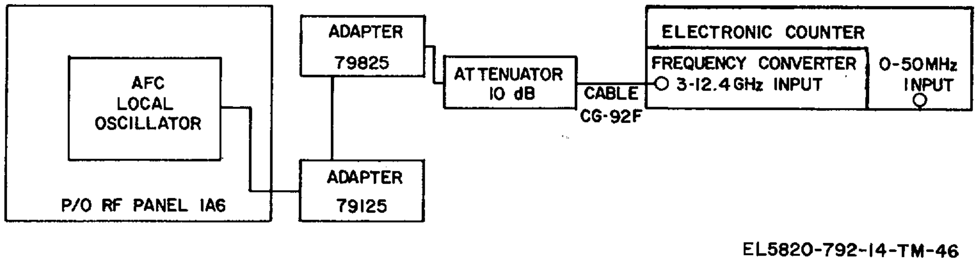

Figure 5-36. AFC local oscillator output frequency, test equipment setup.

5-41. Transmitter Frequency Accuracy Check.

a. General. This test measures the RF output frequency of the radio set. The measurement is made first, with the Klystron AFC circuit operating, then second with the circuit turned off. The procedure is an on-line test with no effects to communications.

b. Test Equipment and Materials Required.

(1) Counter, Electronic, Digital Readout AN/USM-207A.

(2) Comparator, Frequency CM-77/USM.

(3) Cable Assembly, Radio Frequency CG-92F/U.

c. Test Connections and Conditions.

(1) Disconnect coaxial cable from input connector J1 of channel A Klystron driver 1A6MD3 (disconnecting cable removes modulation to the exciter channel).

(2) Connect equipment as illustrated in figure 5-37.

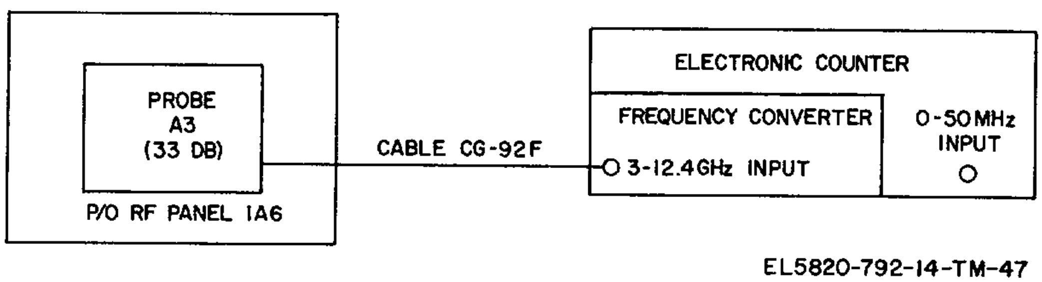

Figure 5-37. Transmitter frequency accuracy, test equipment setup.

d. Procedures.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	Set electronic counter to read performance standard.		Read and record channel A output -frequency.	Exciter output frequency must be the assigned frequency ± 0.01% (± 500 kHz).
2		On AFC module 1A4MD3, place switch S1 to OFF position.	Read and record channel A output frequency.	Reference frequency recorded in step 1 ± 500 kHz. **NOTE** If the measured frequency is out of tolerance, then it is necessary to slightly readjust the 450 V control on Klystron power supply. This is done by switching the A channel function switch 1A3S1 on meter panel to AFC position. The 450 V control (fig. 5-9) is then adjusted for minimum indication on meter.
3		On AFC module 1A4MD3, place switch S1 to ON position.	Disconnect test equipment from radio set. Reconnect normal cables of radio set.	

5-42. Receiver Local Oscillator Output Level Measurement

a. General.

(1) This procedure measures the output power level of the receiver local oscillator. This procedure is an on-line test.

(2) If the local oscillator does not meet the test standards the unit must be replaced.

b. Test Equipment and Materials Required.

(1) Wattmeter AN/URM-98A.

(2) Thermistor mount; Hewlett-Packard 478A.

(3) Attenuator, Fixed CN-797/U.

(4) Adapter, N/(F) to TNC (M); Amphenol 79825.

(5) Adapter, TNC (M) to TNC (F); Amphenol 79125.

c. Test Connections and Conditions.

(1) Disconnect coaxial cable from TNC output connector J1 of channel A local oscillator 1A6Y3.

(2) Connect equipment as illustrated in figure 5-35, except the connections are made to 1A6Y3.

d. Procedure.

Step No	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1			Observe indication on power meter.	The power output level will range from 0.6 to 2.0 milliwatts, but must not be less than 0.5 milliwatts, as indicated on power meter.
2			Disconnect test equipment from radio set. Reconnect normal cables of set.	

5-43. Receiver Local Oscillator Output Frequency Check

a. General.

(1) This procedure measures the output frequency of the receiver local oscillator. This procedure is an on-line test.

(2) If the local oscillator does not meet the test standards, the unit must be replaced.

b. Test Equipment and Materiels Required.

(1) Counter, Electronic, Digital Readout AN /USM -207A.

(2) Comparator, Frequency CM-77/USM.

(3) Multimeter TS-352B/U.

(4) Attenuator, Fixed CN-797/U.

(5) Adapter, N (F) to TNC (M); Amphenol 79825.

(6) Cable Assembly, Radio Frequency CG-92F/U.

(7) Adapter, TNC (M) to TNC (F); Amphenol 79125.

c. Test Connections and Conditions.

(1) Install frequency converter in electronic counter. Set the time base of counter to 100 milliseconds.

(2) Remove coaxial cable from TNC output connector J1 of channel A receiver local oscillator 1A6Y3.

(3) Connect equipment as illustrated in figure 5-36, except the connections are made to 1A6Y3.

d. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	Set electronic counter to indicate performance standard.			
2	While watching the meter on frequency converter, tune converter frequency control until the first peak meter counter indication is obtained.		Read and record frequency of local oscillator, as indicated on electronic counter	The output frequency must be within ±0.005 percent (±-250 kHz) of assigned frequency.
3			Disconnect test equipment from connector J1 of local oscillator or 1A6Y3. Reconnect normal cables of radio set.	
4	Set multimeter to indicate 10 V dc.		Connect multimeter to phase-lock terminals of local oscillator 1A6Y3.	The lock voltage must be 10 ±3V dc.
5			Disconnect test equipment from radio set	

5-44. Receiver Sensitivity and AGC Calibration.

a. General.

(1) This test first measures the RF signal amplitude required to overcome the noise products generated by the microwave receiver. Noise is particularly troublesome in the receiver front end components, such as the mixer-IF preamplifier. The receiver threshold is stated in terms of signal-to-noise ratio (S/N) and is a function of the IF bandwidth. The pertinent data of the test is summarized below.

Channel loading	240 or 600
IF Bandpass	25MHz
Measured frequency:.................	
240 channel capacity	639.6 kHz
600 channel capacity	1.544 MHz
Minimum signal-to-noise ratio: ..	
240 channel loading	38 dB at -75 dBm
600 channel loading	30 dB at -75 dBm

(2) This test also provides a measurement of the receiver channel A sensitivity as a function of IF AGC voltage. It is also used for calibration of the AGC circuit.

(3) These tests should be performed following extensive corrective maintenance in receiver front end. The RF input levels specified in these tests are based upon signal injection through 33-dB probe 1A6A1. Using the data in below, a graph of the AGC characteristic is then plotted using the receiver input level (dBm) as the horizontal axis and the AGC meter level (volts dc) as the vertical axis. Record on the graph the RF carrier frequency used for the receiver channel and the serial number of the radio set. The recorded data is useful for quickly performing future checks whenever the receiver is suspected of being defective. The results of the future measurement are compared to the standard to determine if any performance degradation exists.

NOTE

An increase in meter deflection (toward 5 volts) indicates a decrease in received signal strength, an increase in AGC voltage, and an increase in sensitivity. A decrease in meter deflection (toward zero volt) indicates an increase in signal strength, a decrease in AGC voltage, and a decrease in receiver sensitivity.

(4) If the tests standards are not met, possible defective units include the IF bandpass filter and IF amplifier, RF components, and noisy low voltage power supplies. This procedure is an on-line test.

b. Data Sheets.

(1) Record information following the format and using the levels shown in sample data sheet (fig. 5-38 (2)). Retain data sheet for record purposes.

(2) Plot recorded data on linear graph paper. Compare plotted performance characteristics with typical curves shown in figure 5-38 (3), (4) or (5) as applicable. Any deviation of more than 3 db from typical quieting characteristic should be investigated.

c. Test Equipment and Materials Required.

(1) Signal generator AN/URM-52B.

(2) Counter, Electronic, Digital Readout AN/USM-207A.

(3) Comparator, Frequency CM-77/USM.

(4) Wattmeter AN/URM-98A.

(5) Thermistor mount; Hewlett-Packard 478A.

(6) Frequency selective voltmeter; Sierra 128A.

(7) Radio Frequency Adapter UG-29B/U.

(8) Cable Assembly, Radio Frequency CG426F/U.

(9) Cable Assembly, Radio Frequency CG92F/U.

d. Test Connections and Conditions.

(1) Inform distant station to cease transmission on related frequency to local radio set under test until completion of test.

(2) Install frequency converter in the electronic counter.

(3) Remove coaxial cable from connector J2 of limiter-discriminator 1AlMD5.

(4) Connect equipment as illustrated in figure 5-38 (1) for CALIBRATE.

(5) On meter panel 1A3, set channel A meter function switch to AGC (-5V) position.

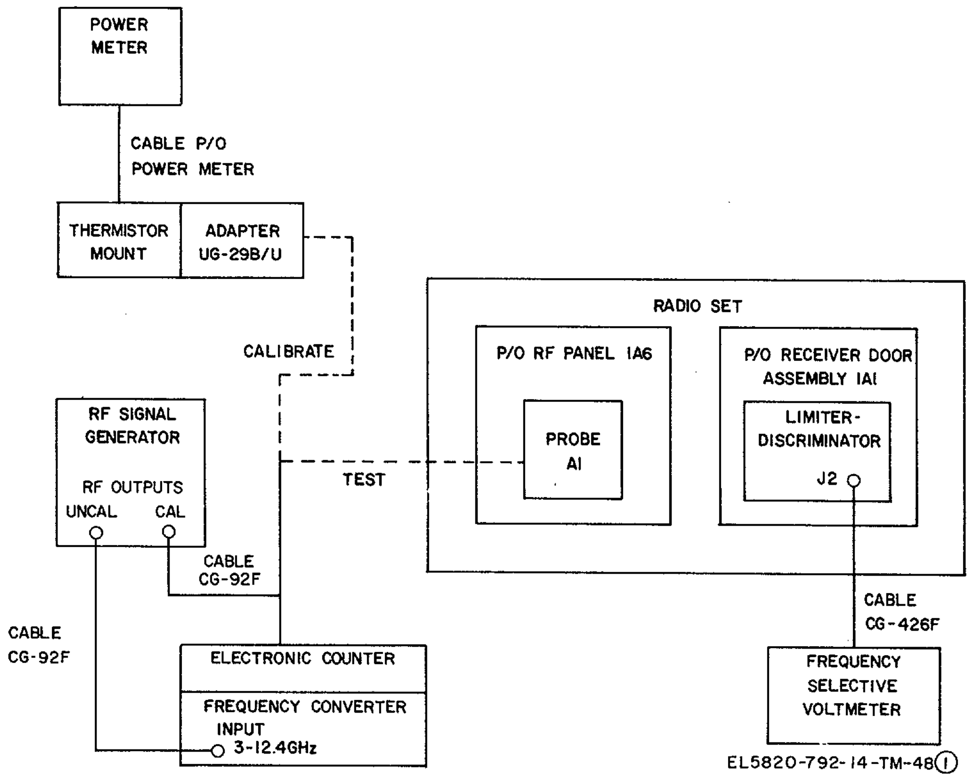

Figure 5-38 (1). Test equipment setup, data sheets, and response curves (sheet 1 of 5).

RADIO SET____________ RECEIVER________

LOW SLOT______KHz MID SLOT______KHz TOP SLOT______KHz

RSL	AGC	BASEBAND NOISE					
		LOW SLOT		MID SLOT		TOP SLOT	
(DBM)	(VOLTS)	DBM	DBMO	DBM	DBMO	DBM	DBMO
-30							
-35							
-40							
-45							
-50							
-55							
-60							
-65							
-70							
-75							
-80							
-85							
-90							
-95							
-100							

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Figure 5-38 (2). Test equipment setup, data sheets, and response curves (sheet 2 of 5).

SITE ____________ RADIO S/N __________DATE __________

STATION FROM ____________RECEIVER ________________

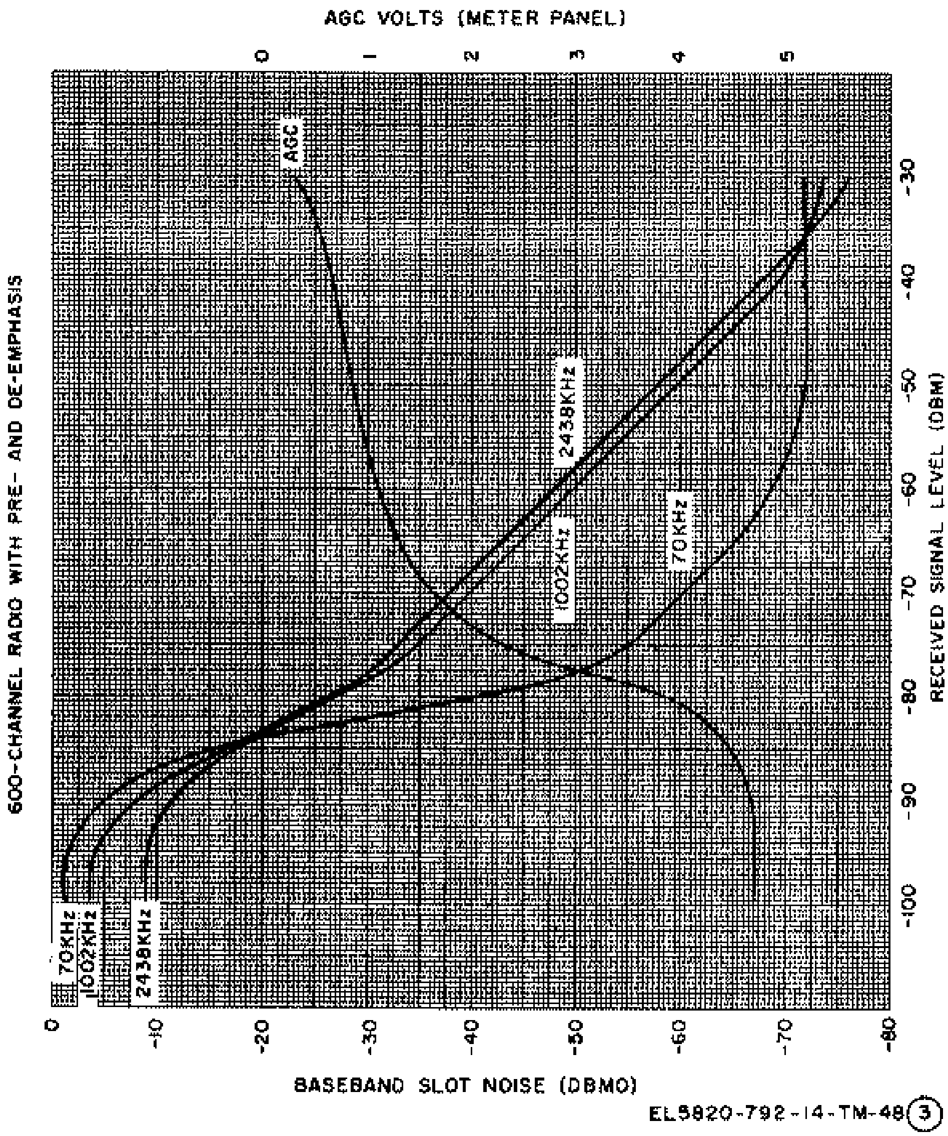


Figure 5-38 (3). Test equipment setup, data sheets, and response curves (sheet 3 of 5).

SITE _____________ RADIO S/N __________DATE __________

STATION FROM _____________RECEIVER __________________

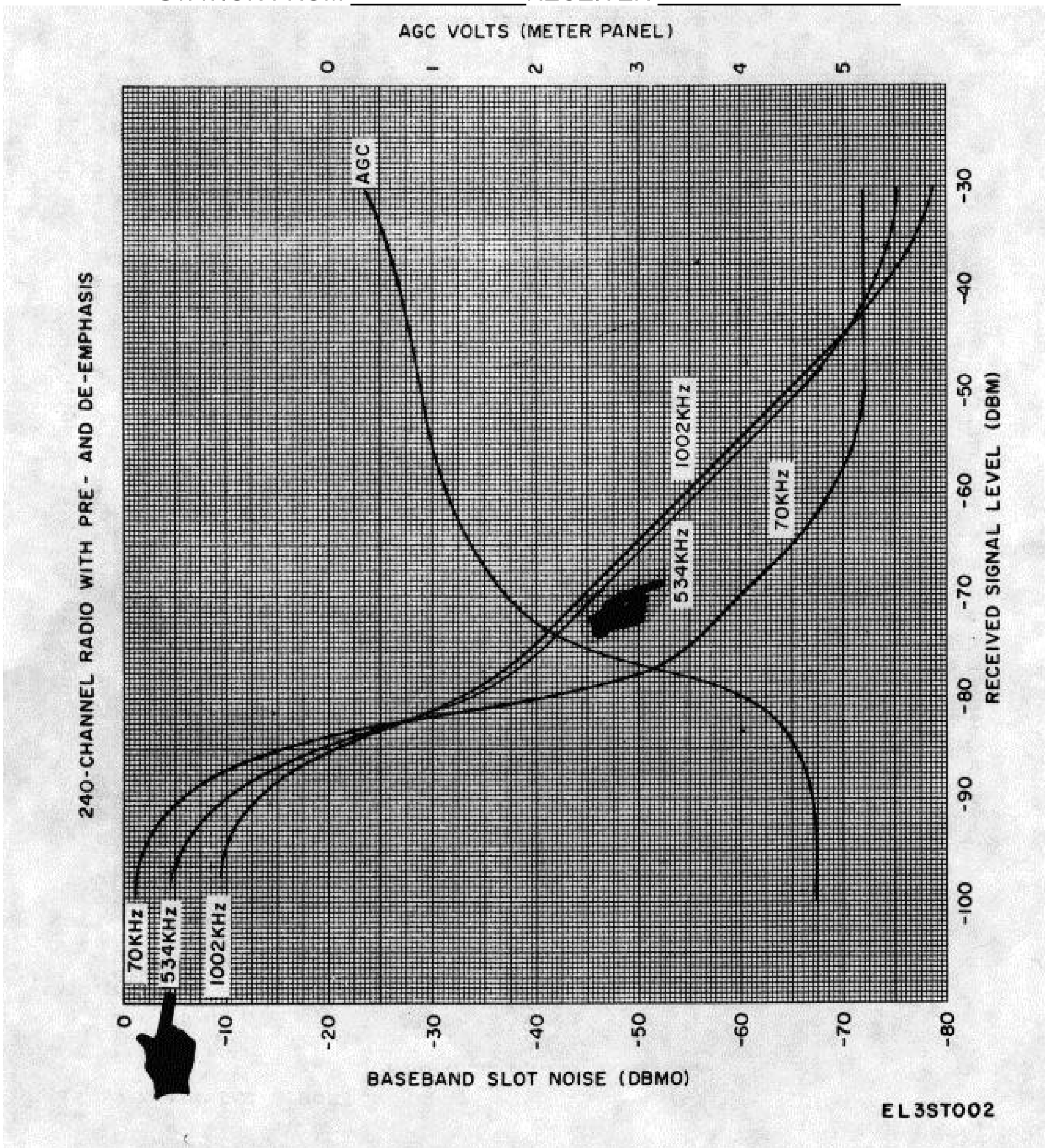


Figure 5-38 (4). Test equipment setup, data sheets, and response curves (sheet 4 of 5).

SITE ____________ RADIO S/N __________DATE __________

STATION FROM ____________RECEIVER ________________

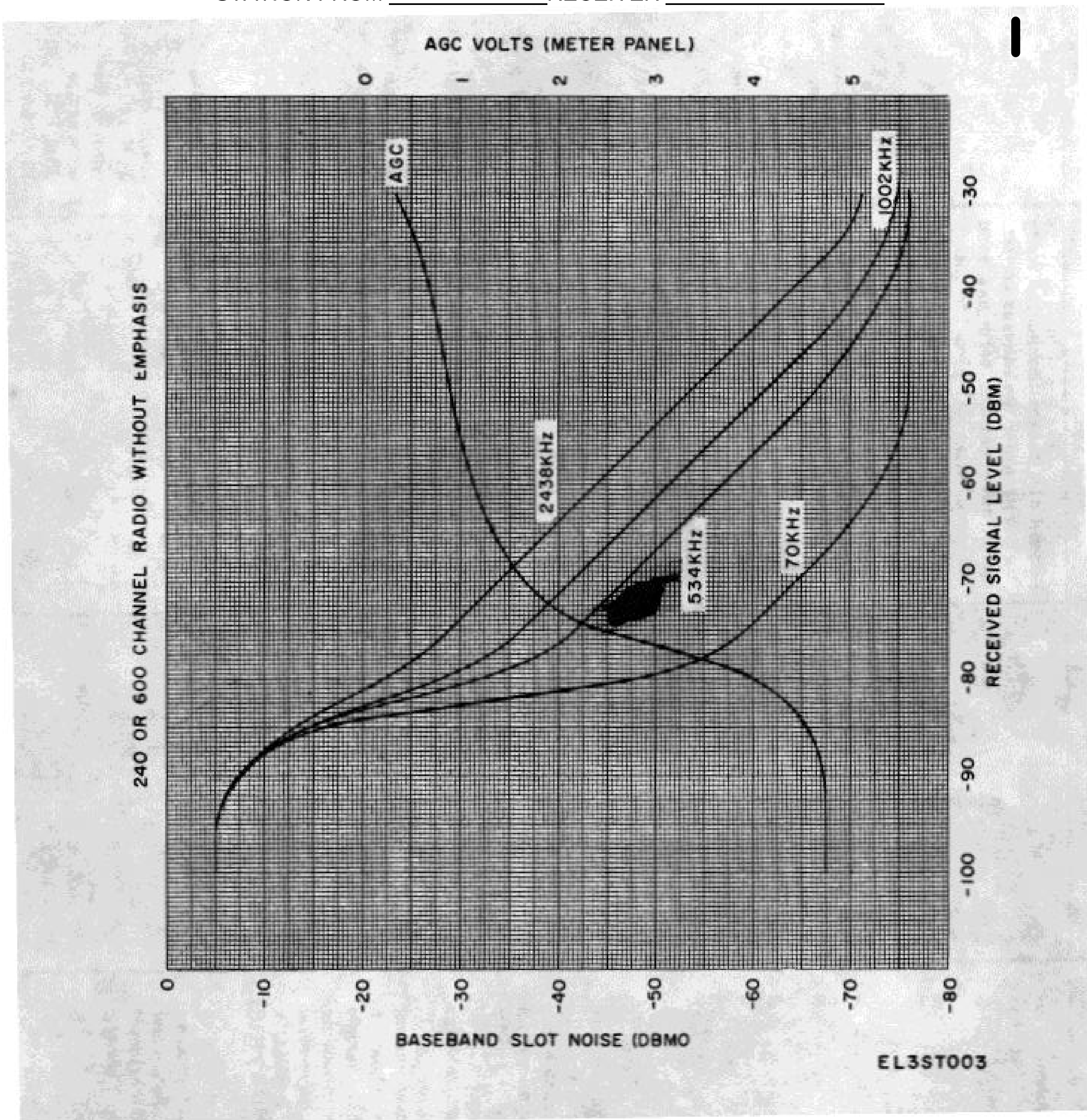


Figure 5-38 (5). Test equipment setup, data sheets, and response curves (sheet 5 of 5).

e. Procedure.

	Control settings			
Step No.	**Test equipment**	**Equipment under test**	**Test procedure**	**Performance standard**
1	Tune frequency selective voltmeter to measure pivot frequency. Set the voltmeter to 75-ohm TERMINATE		Request the distant terminal to verify that transmitter deviation is correct. Then have distant terminal send reference tone at pivot frequency (639.6 kHz for 240 channels and 1544 kHz for 600 channels), at a level of-34.5 dBm into J1 of the Klystron driver.	
2			Read and record the reference tone on the selective voltmeter.	Nominal level is -25 dBm. Record actual level. Any variation in level greater than 2 db must be investigated and corrected before proceeding.
3			Request distant terminal to stop transmitting on channel under test by turning associated Klystron power supply OFF.	
4	Set RF signal generator to assigned operating frequency for diversity channel a receiver, within ±50 kHz.			
5	Adjust RF signal generator output level controls for precisely +3 dBm as indicated by power meter.			
6	Reconnect RF signal output cable as illustrated in figure 5-38(1) for TEST.			
7	Adjust RF signal generator output attenuator to provide levels shown in the RSL(DBM) column of the sample chart. Read and record corresponding AGC voltage as indicated on receiver panel meter. READ STEP 8 BELOW BEFORE COMPLETING THIS STEP.			The recorded data and graph is a measurement of the AGC voltage vs. Received signal level of the receiver
8	Tune frequency selective voltmeter to measure 70 kHz. Set the voltmeter to 75 ohm TERMINATE. Read and record noise at each input signal level while recording AGC in step 7 above.			The recorded data and graph is a measurement of the quieting characteristics vs. received signal level of the receiver. Verify that receiver meets minimum signal-to-noise ration requirements at -75 dBm RSL. (30 dB for 600 channel. 38 dB for 240 channel systems).

	Control settings			
Step No.	Test equipment	Equipment under test	Test procedure	Performance standard
9	Tune frequency selective voltmeter to measure, in turn, 534 kHz, 1002 kHz, 2438 kHz. Read and record noise at each input level as above.			
10	Adjust RF signal generator for a -78 dBm effective input signal to the 33 dB probe. The generator attenuator should be set to approximately -48 dBm.			Related AGC indicator lamp should come on. If the lamp does not light, perform receiver AGC alarm adjustment procedure (para. 5-27).
11			Test is completed. Disconnect test equipment from radio set, reconnect normal cabling, and request distant terminal to resume transmission.	

5-45. Receive Demodulation Level (Multiplex)

a. General. This test is an on-line test with full communications maintained during the procedure. The measurement of the receive demodulation level is checked at critical stages in the receive path, such as limiter-discriminator module output, baseband combiner module output, and terminal filter module output. This test depends on correct transmitter deviation.

b. Test Equipment and Materials Required.

(1) Frequency selective voltmeter; Sierra 128A.

(2) Adapter BNC (F) to dual pin-tips; Pomona 3221.

(3) Cable Assembly, Radio Frequency CG426F/U.

(4) Test oscillator; Hewlett-Packard 651B02.

c. Test Connections and Conditions.

(1) Connect frequency selective voltmeter to TP9 and TP6 (ground) of baseband combiner 1A4MD4.

(2) Request the distant station to send a SCTT level of -34.5 dBm into channel A Klystron driver 1A6MD3, as follows:

(a) Disconnect radio set cable from J1 of Klystron driver 1A6MD3.

(b) Connect test oscillator set at a nominal dial frequency of 100 kHz to J1 on Klystron driver module.

(c) Adjust the output level of test oscillator, as measured by a bridging ac voltmeter, for -34.5 dBm indication.

d. Procedure.

	Control settings			
Step No.	**Test equipment**	**Equipment under test**	**Test procedure**	**Performance standard**
1	Tune frequency selective voltmeter to 100 kHz. Fine tune for peak indication.			
2			Read and record indication on frequency selective voltmeter.	Voltmeter should indicate nominal 9 mV/75 ohm (-30 dBm). **NOTE** **If the level is out of tolerance by more than ±0.7 dB, first have the distant station check the test tone level and deviation sensitivity in accordance with paragraph 5-37. Then if necessary, check the limiter-discriminator module by module substitution,**
3	Set frequency selective voltmeter to measure 100 mV.		Reconnect frequency selective voltmeter to TP2 and TP1 (ground) of terminal filter 1A4MD2. Read and record the indication on voltmeter.	Voltmeter should indicate a nominal 48 mV/75-ohm (-15 dBm ±0.5 dB).
4		Disconnect and quickly reconnect the input coaxial cable to J6 of A channel baseband combiner 1A4MD4.	Observe frequency selective voltmeter for a change in level. If no major change is noticed, read and record voltmeter indication. If the level changes by 6 dB or more, quickly reconnect the coaxial cable to J6 of baseband combiner module.	Voltmeter should not vary more than ±0.3 dB from recorded indication of step 3. If level drops by 6dB nominally, then there is a problem with the baseband combiner module just disconnected (A channel).
5		Disconnect and quickly reconnect the input coaxial cable to J6 of B channel baseband combiner 1A4MD3.	Same as step 4.	Same as step 4.
6			Disconnect all test equipment from the radio sets at both the local and distant stations. Reconnect all normal cables of radio sets.	

5-46. Radio Link NPR Measurement

a. General.

(1) This procedure measures the intermodulation distortion characteristics of the complete radio link. The test is performed by loading the input of the local radio set with white noise of appropriate bandwidth and level, and then measuring the ratio of loaded-to-unloaded noise in several selected 3.0-kHz wide channel slots at the distant station radio set output. The signal flow through the radio sets includes the exciter modulation and exciter radio frequency stages which are transmitting to the receiver, radio frequency receiver, intermediate-frequency, receiver demodulation, and receiver baseband stages. The resultant is a figure (in dB) of the noise-power-ratio (NPR). The test represents an evaluation of the linearity characteristics of the stages involved. Noise testing is fully discussed in paragraph 5-33. This procedure is an on-line test, with only the affected exciter and receiver channels shut down on each end of the link.

(2) The intermodulation distortion test is used as the concluding major performance test of the radio link. The NPR measurement can be performed in either diversity channel A or B of the radio link.

b. Intermodulation Distortion Test Conditions and Required Action.

Step No.	Condition	Required action
1	The required NPR is obtained in all frequency slots.	The radio sets on the link are considered to be operating normally.
2	Failure to obtain required NPR in highest frequency slot.	Perform the IF bandpass filter equalizer alignment, described in the procedure, for the filter module of that channel (para 5-23c (7), (8), and (9)).
3	Failure to obtain required NPR in lowest frequency slot.	Perform the matching screw adjustment (para 5-23c (16) and (17). If minimum requirements still cannot be met, check limiter-discriminator module by substitution with a spare.
4	Failure to obtain required NPR in all frequency slots.	Request off-site assistance on situation, prior to proceeding, and possibly introducing other problems.

c. Group Delay. The IF bandpass filter equalizer network alignment is performed when the required NPR value in the highest frequency slot is not obtained, as described in b (2) above. The IF parabolic delay in the IF portion of the exciter and receiver reduce the NPR of the frequency channels at the high end of the baseband. This delay specifically occurs in the RF filters, Klystron, and limiter-discriminator modules. The delay is compensated for by an equalizer network contained in the IF bandpass filter module. The equalizer is adjusted in the highest frequency slot for which the radio set is being used (para 5-23) during the appropriate loading check.

d. Test Equipment and Materials Required.

(1) White noise loading test set; Marconi Instruments OA-2090A (composed of noise generator TF2091 and noise receiver TF2092).

(2) White noise loading test set accessories as listed in paragraph 5-33f. Select those items designated for the particular channel loading used.

(3) Voltmeter, Electronic ME-30E/U.

(4) Adapter, Connector UG-274C/U.

(5) Cable Assembly, Radio Frequency CG426F/U.

e. Test Connections and Conditions.

(1) Disconnect local radio set cable from J1 of Klystron driver 1A6MD3.

(2) Coordinate with the distant station for this entire procedure. Have the distant station disconnect the output cable from J2 of limiter-discriminator 1A1MD5.

(3) Setup equipment as shown in figure 5-26.

f. Procedure.

	Control settings			
Step No.	**Test equipment**	**Equipment under test**	**Test procedure**	**Performance standard**
1	At the local station, set the noise generator as follows: a. High-and-low-pass filters IN. b. All bandstop filters OUT. c. Adjust the output level to 40 mV/75-ohms (-20.7 dBm) for 600-channel capacity into the klystron driver module, as indicated by the voltmeter.			
2	At the distant station, set the noise receiver as follows: a. Frequency selector to lowest frequency b. Attenuator controls to produce meter reference indication.			
3	Read and record the attenuator setting on noise receiver. Label the reading as reference 1.			
4	Local station: switch in lowend bandstop filter of noise generator.			
5	Distant station: set attenuator controls of noise receiver to produce same reference level as reference 1 (step 3).			
6	Read and record the attenuator settings of the noise receiver as reference 2.			
7	Subtract reference 1 from reference 2 to obtain the NPR at the low-noise slot.			The NPR must comply with minimum requirements for the radio link.
8	Local station: switch out lowend bandstop filter of noise generator.			
9	Distant station: reset attenuator controls of noise receiver back to reference 1.			
10	Local station: switch in middle of bandstop filter of noise generator.			
11	Distant station: set the noise receiver as follows: a. Frequency selector to middle frequency. b. Attenuator controls to produce meter reference indication.			

	Control settings			
Step No.	Test equipment	Equipment under test	Test procedure	Performance standard
12	Read and record the attenuator settings of the noise receiver as reference 3.			
13	Subtract reference 1 (step 3) from reference 3 to obtain the NPR at the middle noise slot.			The NPR must comply with the minimum requirements for the radio link.
14	Local station: switch out middle bandstop filter of noise generator.			
15	Distant station: reset attenuator controls of noise receiver back to reference 1 (step 3).			
16	Local station: switch in high-end bandstop filter of noise generator.			
17	Distant station: set the noise receiver as follows: a. Frequency selector to the highest frequency. b. Attenuator controls to produce meter reference indication.			
18	Read and record the attenuator settings of the noise receiver as reference 4.			
19	Subtract reference 1 (step 3) from reference 4 to obtain the NPR at the high-end slot.			The NPR must comply with the minimum system requirement.
20	Disconnect all cables from the radio sets at each station of the link; then reconnect the normal cables to the equipment.			

Section VI. SPECIAL ON-SITE MAINTENANCE

5-47. Introduction to Special On-Site Maintenance

a. General.

(1) Special on-site maintenance consists of some specific performance tests which must be performed by highly skilled personnel, and the use of test equipment not normally found at organizational category. Additionally, because of some site locations, it may be necessary to authorize certain test and alignment procedures which are usually reserved for off-site maintenance to be accomplished at site level.

(2) The tests performed in the following paragraphs will, in some cases, cause interruption in communications. Therefore; before performing these tests, arrangements must be made for the disruption of communications.

(3) Some of the tests are based on nominal requirements whenever other than controlled variables are part of the testing. For example, differential linearity and group delay are, in addition to being a function of the radio sets, a function of: the antenna system; the propagation conditions; and geographic reflections, cancellations, and obstructions in the path of the system.

(4) The local oscillators used in the transmitter and receiver channels are normally aligned at the off-site maintenance location and forwarded to the sites upon request, if tactical and operational conditions permit this procedure to be enforced. However, in some cases it will be necessary to align these assemblies on-site. This alignment is performed by on-site technicians.

b. Particulars. The following tests and adjustments are performed as part of annual or semiannual maintenance tasks by personnel utilizing sophisticated test equipment.

(1) Radio link total frequency response measurement.

(2) Receiver noise figure measurement.

(3) Deviation sensitivity measurement.

(4) Radio link linearity measurement (Klystron driver to IF preamplifier).

(5) Radio link linearity and group delay measurement (Klystron driver to limiter-discriminator).

(6) Local oscillator (on-site) alignment.

5-48. Radio Link. Total Frequency Response Measurement

a. General. This procedure examines the radio set signal processing circuitry (exciter baseband and modulation stages, and receiver demodulation and baseband stages) by measuring the multiplex frequency versus amplitude response. Baseband signals of preset level, within the bandwidth of interest, are inserted into the exciter section. The multiplex signals are then measured at the baseband output. The resultant levels represent the frequency versus amplitude response characteristics which are a measurement of the compatibility of the preemphasis and deemphasis networks, as well as the signal processing circuitry. The procedure is an off-line test. The suggested test frequencies for the multiplex channel at the prescribed channel loadings are listed in b below.

b. Multiplex Bandwidths.

Channel loading	Bandwidth	Multiplex reference frequencies (kHz)								
240	60-1052 kHz	60	105	185	270	342	534	695	1002	1025
600	60-2540 kHz	60	185	270	342	534	695	1002	1248	2540

c. Test Equipment and Materials Required.

(1) Voltmeter, Electronic ME-30E/U.

(2) Test oscillator; Hewlett-Packard 651B-02.

(3) Termination, 75 ohms (BNC); Tektronix 011-0055-00.

(4) Adapter, Connector UG-247C/U.

(5) Cable Assembly, Radio Frequency CG 426F/U.

d. Test Connections and Conditions.

(1) Disconnect radio sets cables from connector J1 to transmit terminal filter 1A4MD5 at the local station and connector J1 of receiver terminal filter 1A2MD2 at the distant station.

(2) Connect equipment as illustrated in figure 5-39.

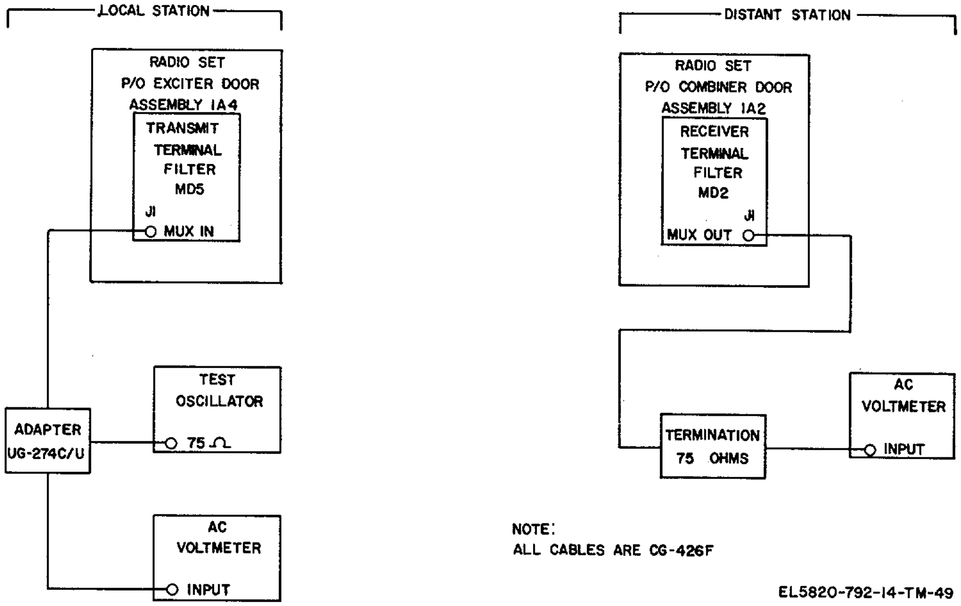


Figure 5-39. Radio link total frequency response, test equipment setup.

e. Procedure.

	Control settings			
Step No.	**Test equipment**	**Equipment under test**	**Test procedure**	**Performance standard**
1	Local station: set the output of test oscillator to obtain a 1.5 m/V75 ohm (-45 Dbm) indication on the bridging ac voltmeter. Adjust the output frequency of oscillator for 100 kHz (dial accuracy).			
2			Distant station: read and record the indication on ac voltmeter as reference 1.	Voltmeter must indicate a nominal level of 48 mV/75-ohm (-15 dBm). Record actual level.
3	Local station: set test oscillator to each multiplex reference frequency (*b* above). Maintain a constant input level for each frequency, as indicated on the bridging voltmeter. Set the frequencies by dial accuracy only.			
4			Distant station: Measure and record output level on ac voltmeter for each multipex reference frequency.	
5			Disconnect test equipment from radio set. Reconnect normal cables of radio set.	The output level within the multiplex bandwidth of interest must be "reference 1" ±3 mV.

5-49. Receiver Noise Figure Measurement

a. General.

(1) This procedure measures the thermal noise performance of the receiver down converter. The noise figure should be measured whenever an RF component, such as RF filters, circulators, isolators, and mixer-preamplifier assemblies are processed for maintenance. This is an off-line test.

CAUTION

This test is critical and may be affected by electromagnetic radiation emitted from nearby radio-frequency generators and transmitters. During the test, turn off any nearby radio-frequency generators and transmitters operating on or near the assigned operating frequency of the radio set, and also 70 MHz, if possible.

(2) If the test standard cannot be met, the units mentioned in (1) above should be checked.

b. Test Equipment and Materials Required.

(1) Noise source; Hewlett-Packard G347A.

(2) Noise figure meter (with special cable); Hewlett-Packard 342A.

(3) Transition, UG149A/U to CPR187G; Philco-Ford Part No. 368-42510-22.

(4) Matching Transformer, 50-75 ohms; A. R. Anzac TP-75.

(5) Cable Assembly, Radio Frequency CG426F/U.

(6) Precision load; Hewlett-Packard 910A.

(7) Adapter, BNC (M) to BNC (M); UG491A/U.

c. Test Connections and Conditions.

(1) Turn on and warm-up test equipment.

(2) Inform distant station to cease transmission to local radio set under test until completion of test.

(3) Turn off both Klystron power supplies.

(4) Disconnect station flexible waveguide from radio set connector 1J3.

(5) Connect transition and attached noise source to connector 1J3. Connect special cable from noise source to noise figure meter.

(6) Disconnect radio set cable from connector J2 of IF preamplifier 1A6MD1.

(7) Connect equipment as illustrated in figure 5-40.

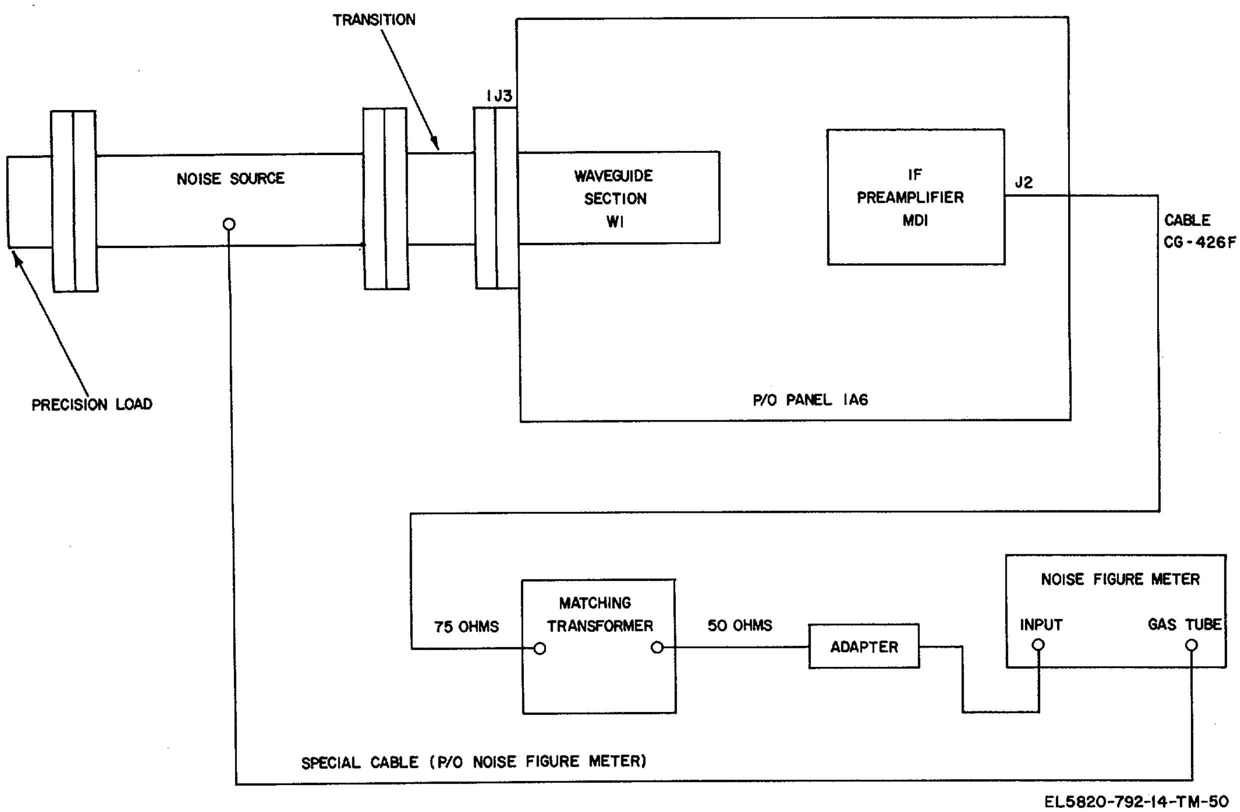


Figure 5-40. Receiver noise figure, test equipment setup.

	Control settings			
Step No.	Test equipment	Equipment under test	Test procedure	Performance standard
1	Set noise figure meter to 70-MHz input.			
2	Calibrate the zero and infinity points of noise figure meter.			
3	Set noise figure meter function switch to noise figure position.			
4	Set noise figure meter function switch to noise figure position.			
5			Read and record the noise figure as indicated by the test equipment.	The noise figure must be no greater than 11 dB.
6			Disconnect all test equipment from radio set. Reconnect all normal tables and station waveguide.	
7		Turn on Klystron power supplies 1PS1 and 1PS2.		
8			Request distant station to resume normal communications.	

5-50. Deviation Sensitivity Measurement

a. General.

(1) The following procedure evaluates and measures the transmitter deviation sensitivity adjustment. The measurement technique involves a carrier null with a given input level and frequency into the Klystron driver module.

(2) If the standard requirements are not met and the obtained value is within ± 0.5 dB of actual, then a small adjustment is permissible at this time. Before making any such adjustment, double-check the test equipment setup and levels very carefully.

b. Test Equipment and Materials Required.

(1) Generator, Signal AN/USM-205.

(2) Oscilloscope AN/USM-182A.

(3) Spectrum analyzer Set AN/UMP-184A.

(4) Voltmeter, Electronic ME-30E/U.

(5) Counter, Electronic, Digital Readout AN/USM-207A.

(6) Step attenuator; Kay Electric 442D.

(7) Attenuator, fixed, 30 dB coaxial; Narda 757B-30.

(8) Adapter, Connector UG-274C/U.

(9) Cable Assembly, Radio Frequency CG426F.

(10) Cable Assembly, Radio Frequency CG92F/U.

c. Test Connections and Conditions.

(1) Disconnect coaxial cable at J1 of channel A Klystron driver 1A6MD3.

(2) Connect radio set and test equipment as illustrated in figure 5-23.

(3) Notify distant station that testing is being performed.

d. Procedure.

	Control settings			
Step No.	**Test equipment**	**Equipment under test**	**Test procedure**	**Performance standard**
1	Place at least 60 db of attenuation in step attenuator			
2			Adjust oscillator output level to drive electronic counter.	
3	Set test oscillator frequency to 639.6 kHz for 240-channel capacity or to 1544 kHz for 600-channel capacity on electronic counter.			
4	Set oscilloscope controls as follows: TIME/CM to 1 HORIZONTAL DISPLAY to A			
5	Set spectrum analyzer controls as follows: VERTICAL DISPLAY to LOG. VIDEO FILTER to down position. DISPERSION RANGE to MHz/CM. DISPERSION to 10. COUPLED RESOLUTION to 500. IF ATTEN DB to OFF.			
6			Tune spectrum analyzer plug-in unit to the transmit frequency. See figure 5-24 for required display.	
7			While observing the transmit carrier on the spectrum analyzer, increase the output level into Klystron driver 1A6MD3 by using step attenuator, and the COARSE and FINE controls on test oscillator until transmit carrier starts to decrease in amplitude and sidebands start to appear. Continue until the carrier is completely in the noise level of the display. See figure 5-25 for display.	
8			Note indication on ac voltmeter and compare with standard.	Voltmeter must indicate 40.0 ±0.5 mV/75-ohm (-16.7 ±0.1 dBm) for 240-channel operation, or 97.2 ±1.0 mV/75-ohm (-9.0 ±0.1 dBm) for 600-channel operation. **NOTE** **Adjustment control R1 is permissible as stipulated in paragraph 5-50*a*(2)**

	Control settings			
Step No.	Test equipment	Equipment under test	Test procedure	Performance standard
9			Disconnect test equipment from radio set. Reconnect normal cable to J1 of Klystron driver 1A6MD3.	

5-51. Radio Link Linearity Measurement (Klystron Driver to IF Preamplifier)

a. General.

(1) The following performance test evaluates total link amplitude response characteristics when measured with a microwave link analyzer.

(2) This test is an on-line test with the unaffected channel maintaining communications. The results obtained by this performance check are used for analysis and correlation with previously determined data.

b. Test Equipment and Materials Required.

(1) Microwave link analyzer; Hewlett-Packard, composed of following items:

(a) Transmission generator 3701A.

(b) Demodulator display 3702A.

(c) Group delay detector, 3703A.

(2) Cable Assembly, Radio Frequency CG426F/U.

(3) Adapter, Connector UG-274C/U.

c. Test Connections and Conditions.

(1) The procedure requires close cooperation of local and distant stations.

(2) At local station, disconnect input cable at J 1 of Klystron driver 1A6MD3. Place AFC switch in OFF position.

(3) At distant station, disconnect output cable J2 at IF preamplifier 1A6MD1.

(4) Connect test equipment at each station as illustrated in figure 5-41.

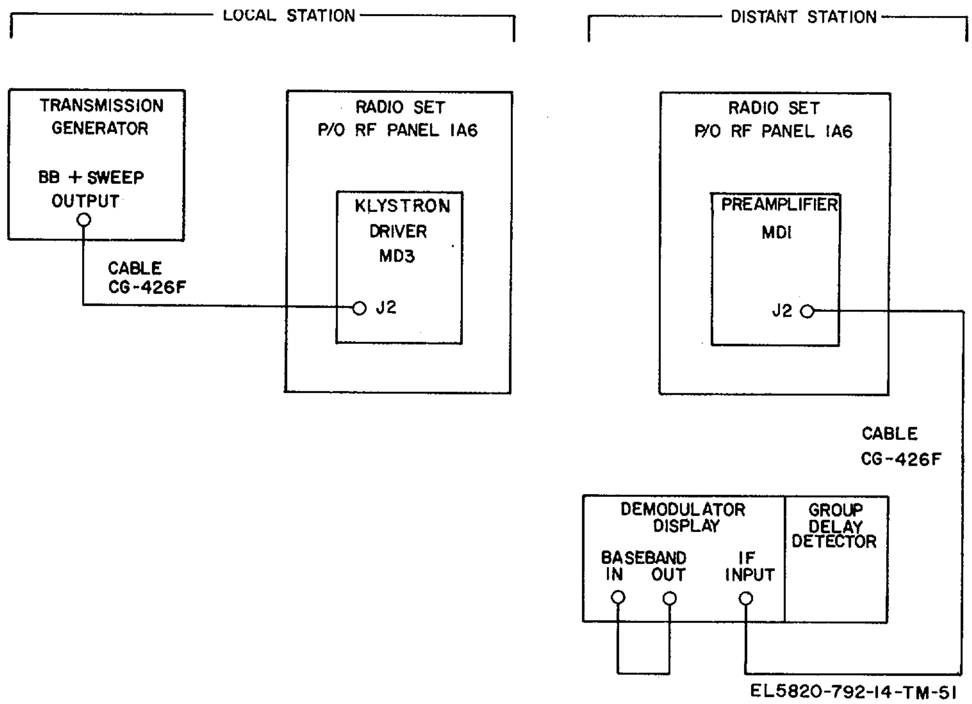


Figure 5-41. Radio link linearity (Klystron driver to IF preamplifier) test equipment setup.

d. Procedure.

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	At local station, set MODE switch of transmission generator to BB +SWEEP.			
2	Set transmission generator BB FREQUENCY to 500 kHz. Set BB POWER (-dBm) switch to -20			
3	At distant station, set DISPLAY control of demodulator display unit to IF.			
4	Adjust IF LEVEL attenuator pushbuttons as necessary to obtain 0 indication on IF/BB LEVEL meter of demodulator display unit.			
5	Set group delay detector BB FREQUENCY kHz to 500, DELAY OUTPUT to NORMAL, and DEMOD INPUT to INT. Adjust SET LEVEL to obtain a green-area indication on PHASE LOCK/LEVEL meter.			
6	On the rear apron of demodulator display unit, set RET LOSS/REF/DELAY switch to DELAY.			
7	On demodulator display unit, MARKER OFFSET MHz control to 7.			
8	At local station, increase SWEEP LEVEL, control to produce ±8 MHz sweep at distant station			The oscilloscope of demodulator display unit should display markers at 63-, and 77-MHz points along response curve.
9	Calibrate demodulator display unit as follows: a. Set CALIBRATION (dB) % switch to 1% b. Set Y1 GAIN SENSITIVITY control to provide a 1cm separation between the chopped traces. c. Set CALIBRATION (dB) % switch to OFF.		See figure 5-19 for a typical display of calibration traces	
10	Calibrate the group delay detector as follows for group delay amplitude (Y2): a. Set DELAY CALIBRATION (ns) switch to 1.		See figure 5-43 for a typical display of calibration traces for Y2 (group delay).	

	Control settings			
Step No.	Test equipment	Equipment under test	Test procedure	Performance standard
	b. Set Y2 GAIN control to obtain a 1 cm separation between the chopped traces. c. Set DELAY CALIBRATION (ns) switch to OFF.			
11			Note and record the indication on the display for a ± 7 MHz bandwidth	Record the presentation for maintenance trend analysis. Normally the amplitude linearity and differential group delay will be very close to those illustrated in figure 5-43. The amplitude linearity is a nominal 2% across the link while the differential group delay may be up to 7 nanoseconds across, ± 7 MHz; it is more important that this delay be parabolic and symmetrical.
12			Disconnect all test equipment. Restore all normal equipment cabling at both stations.	

5-52. Radio Link Linearity and Group Delay Measurement (Klystron Driver To Limiter-Discriminator)

a. General.

(1) The following procedure provides additional insight on the performance of the radio link from that gained by the link linearity measurement (para 5-51).

(2) This test is an on-line test with communications maintained over the second channel. The procedure checks out additional stages such as IF filter, IF amplifier, and limiter discriminator modules in the receiver under test.

(3) The data gathered is recorded and analyzed for degradation of system performance. Although there is a direct correlation between differential group delay and NPR, there are many external factors, in addition to the radio sets involved, which contribute to degradation.

b. Test Equipment and Materials Required.

(1) Microwave link analyzer; Hewlett-Packard, composed of following items:

(a) Transmission generator 3701A.

(b) Demodulator display 3702A.

(c) Group delay detector 3703A.

(2) Cable Assembly, Radio Frequency CG426F/U.

(3) Adapter, Connector UG-274C/U.

c. Test Connections and Conditions.

(1) The procedure requires close cooperation of the local and distant stations.

(2) At local station, disconnect input cable at J1 of Klystron driver 1A6MD3. Place associated AFC switch in OFF position.

(3) At distant station, disconnect output cable at J2 of limiter-discriminator 1A1MD5.

(4) Connect test equipment at each station as illustrated in figure 5-42.

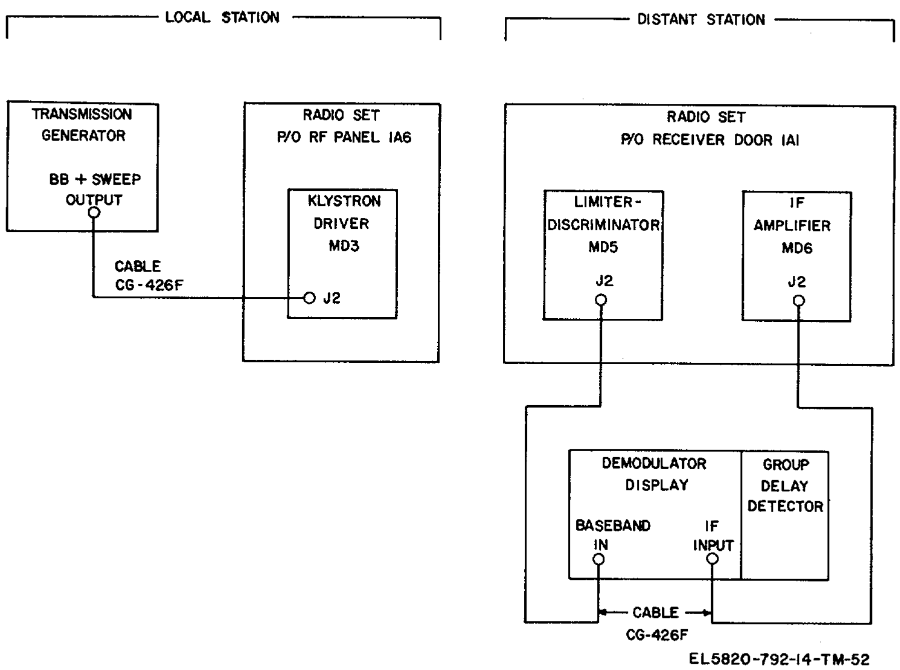
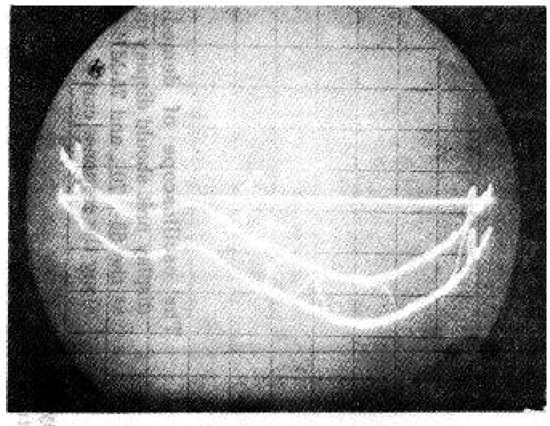
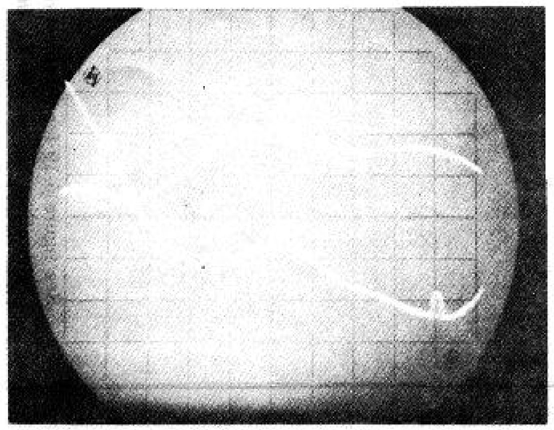


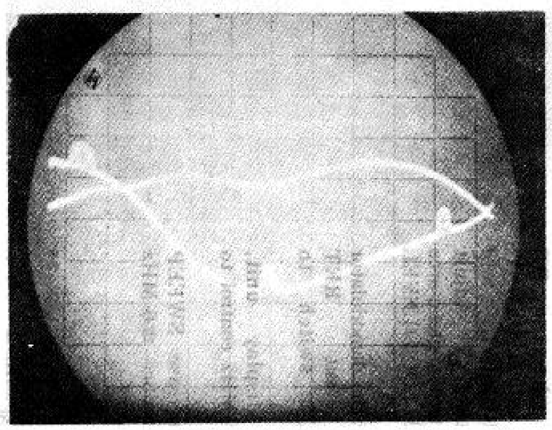
Figure 5-42. Radio link linearity and group delay (Klystron driver to limiter-discriminator), test equipment setup.



A. Y2 group delay calibration.



B. Typical group delay and linearity response.



C. Typical group delay and linearity response.

EL5820-792-14-TM-53

Figure 5-43. Radio link linearity and group delay response waveform.

d. Procedure.

	Control settings			
Step No.	**Test equipment**	**Equipment under test**	**Test procedure**	**Performance standard**
1	At local station, set MODE switch of transmission generator to BB + SWEEP.			
2	Set transmission generator BB FREQUENCY to 500 kHz. Set BB POWER (-dBm) to -20.			
3	At distant station, set DISPLAY control of demodulator display unit to IF.			
4	Adjust IF LEVEL attenuator pushbuttons as necessary to obtain a 0 indication on IF/BB LEVEL meter of demodulator display unit.			
5	Set group delay detector BB FREQUENCY kHz to 500, DELAY OUTPUT to NORMAL, and DEMOD INPUT to EXT. Adjust SET LEVEL to obtain a green-area indication on PHASE LOCK/LEVEL meter.			
6	On the rear apron of the demodulator display unit, set RET LOSS/REF/DELAY switch to DELAY position.			
7	On demodulator display unit, MARKER OFFSET MHz control to 5.			The oscilloscope of demodulator display unit should display marker at the 65-, 70-, and 75-MHz points along the response curve.
9	Calibrate demodulator display unit as follows: for amplitude linearity (Y1): a. Set CALIBRATION (dB)% switch to 1% b. Set Y1 GAIN SENSITIVITY control to provide 1cm separation between the chopped traces. c. Set CALIBRATION (Db)% switch to OFF.		See figure 5-19 for a typical display of calibration traces for Y1 (amplitude linearity).	
10	Calibrate the group delay detector as follows for group delay amplitude (Y2): a. Set DELAY CALIBRATION (ns) switch to 1.		See figure 5-43 for a typical display of calibration traces for Y2 (group delay).	

d. Procedure.

	Control settings			
Step No.	**Test equipment**	**Equipment under test**	**Test procedure**	**Performance standard**
	a. Set Y2 GAIN control to obtain a 1 cm separation between the chopped traces. b. Set DELAY CALIBRATION (ns) switch to OFF>			
11			Note and record the indication on the display for a ± 5 MHz bandwidth.	Record the presentation for maintenance trend analysis. Normally the amplitude linearity and differential group delay displays will be very close to those illustrated in figure 5-43. The amplitude linearity is a nominal 2% across the link, while the differential group delay may be up to 10 nanoseconds across 5 MHz; it is more important that this delay be parabolic and symmetrical.
12			Disconnect all test equipment . Restore all normal equipment cabling at both stations.	

5-53. Local Oscillator (On-Site) Alignment

a. General.

(1) Local oscillator alignment is governed by the general conditions discussed in paragraph 5-47. Before proceeding, understand and comply with the terms of the conditions.

(2) The local oscillator phase-lock alignment for local oscillators 1A6Y1 through Y4 is performed when the particular oscillator does not meet performance standards for power output, frequency output, or lock-voltage output.

(3) This alignment is an on-line procedure with only the affected channel shut down.

b. Test Equipment and Materials Required.

(1) Counter, Electronic, Digital Readout AN/USM-207A.

(2) Comparator, Frequency CM-77/USM.

(3) Multimeter TS-352B/U.

(4) Oscilloscope AN/USM-182A.

(5) Preamplifier AM-1841/USM.

(6) Adapter, Connector UG-201A/U.

(7) Test leads, banana/alligator clip; Pomona 1959-48.

(8) Probe, oscilloscope; Tektronic P6006 (10X) with needle tip.

(9) Tool; plastic alignment-tuning.

(10) Probe, oscilloscope; Tektronic P6006 (10X) with retractable hook.

c. Procedure.

CAUTION

When tuning the local oscillator XTAL TUNE control, use a proper noninductive plastic tuning tool. Do not use a metallic-bladed screwdriver. Also, insure that the associated low-voltage power supply is turned off when making soldering connections to local oscillator.

(1) Remove local oscillator from mounting, on RF panel and place on workbench.

(2) Remove left side plate, identified by manufacturer's placard (fig. 5-44). Four machine screws retain the plate.

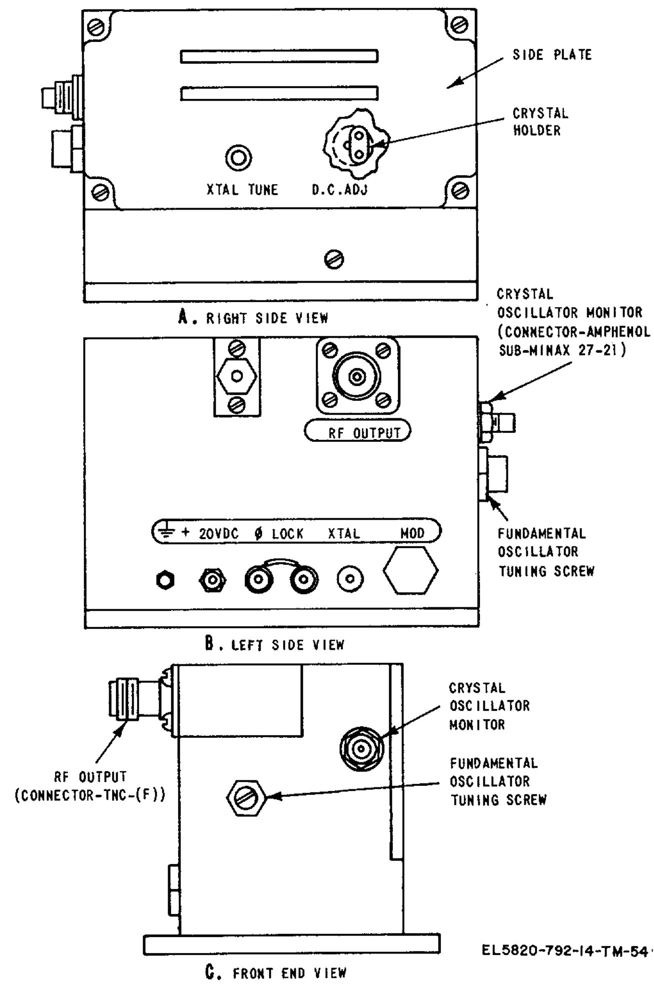


Figure 5-44. Local oscillator; location of controls, connectors, and test points.

(3) Note and record frequency of crystal as stamped on crystal holder.

(4) Remove crystal from crystal socket. Perform mechanical operations as necessary.

(5) Obtain replacement local oscillator. Verify that frequency of replacement local oscillator is correct. The oscillator works on a multiplication factor of 44 or 48 (depending on

model number) to produce the final frequency output. Observe part number data on local oscillator body.

(6) Install crystal into crystal socket. Replace side plate. Perform mechanical operations as necessary.

(7) Remake soldering connections to the unit; and then support the unit so that the following procedures can be performed.

(8) Allow sufficient time for the local oscillator to stabilize.

(9) Connect test equipment as illustrated in figure 5-45. Turn on and warm up test equipment.

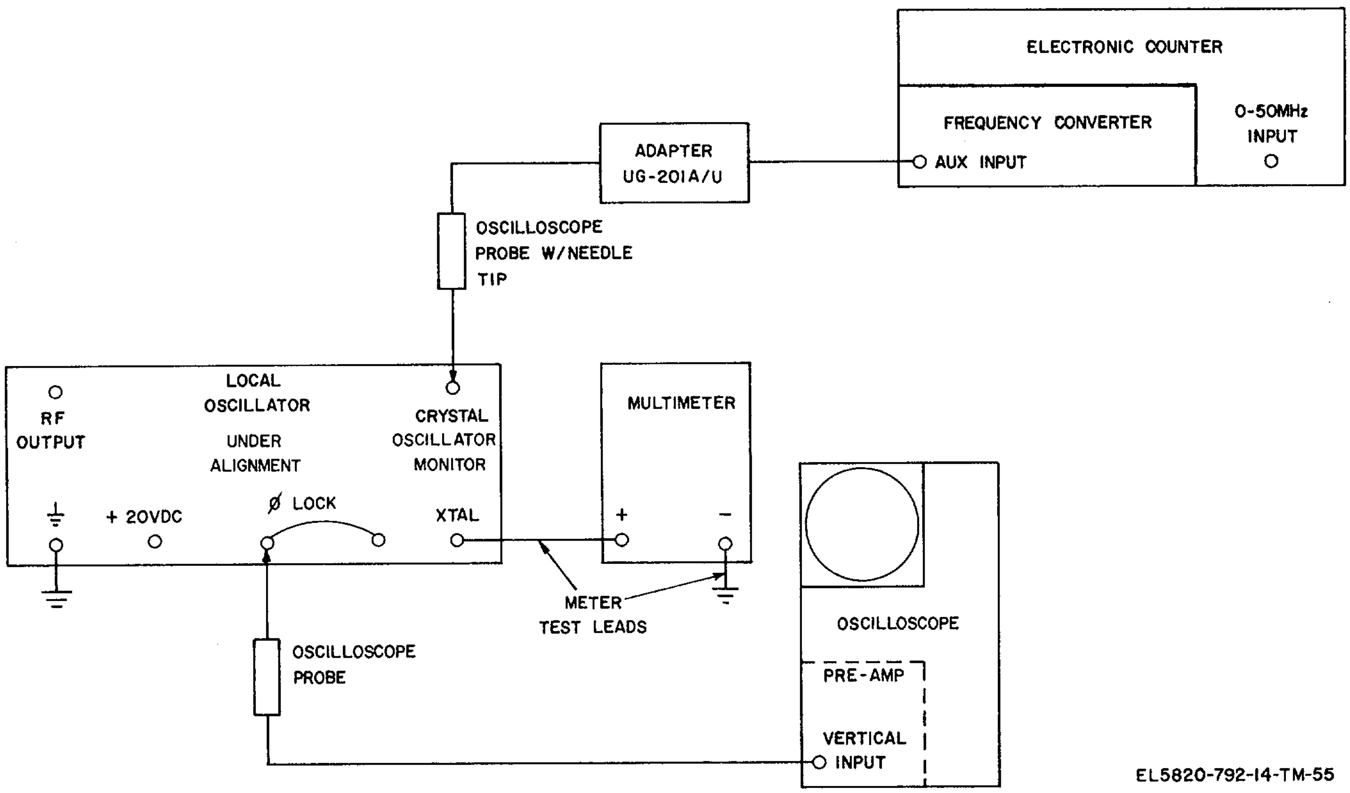


Figure 5-45. Local oscillator alignment, test equipment setup.

(10) Set multimeter to 2.5 volts dc range. Multimeter should indicate at least +0.1 volt. Peak (maximize) multimeter indication by slightly adjusting oscillator coil accessible through XTAL TUNE hole (fig. 5-44). Use a noninductive plawtic tuning tool for this adjustment. Turn screw clockwise to decrease crystal frequency, or counterclockwise to increase crystal frequency. Also observe the desired crystal frequency indication on electronic counter.

(11) Rock crystal oscillator across the desired crystal frequency using XTAL TUNE screw. This part of the procedure checks whether the new setting is sufficiently within the tuning range of the crystal oscillator; the unit should tune within ± 1.5 kHz at 100 MHz. Reset XTAL TUNE to desired frequency.

(12) Disconnect multimeter from XTAL oscillator monitor connector.

(13) On oscilloscope set controls and switches as follows:

(a) INPUT SELECTOR to AC.

(b) VOLTS/CM to 5, and associated VARIABLE to CALIBRATED.

(c) TIME/CM to 2 MILLISEC, and associated VARIABLE to CALIBRATED.

(d) TRIGGER SLOPE to INT +.

(e) TRIGGERING MODE to AUTO.

(14) The oscilloscope should indicate at least 15 V ac peak-to-peak sawtooth (search) waveform at a 50 to 500 Hz rate. A, figure 5-46 illustrates correct search waveform, and B, figure 5-46 incorrect search waveform. If there is no sawtooth waveform, insert the alignment tool in D.C. ADJ access and adjust the control until a sawtooth waveform just appears. Note the approximate position of the tuning tool slot. Continue tuning the control until waveform degenerates into a straight line again. Note the position of the tuning tool slot. Set potentiometer midway between these extremes; sawtooth waveform shou1d be observed.

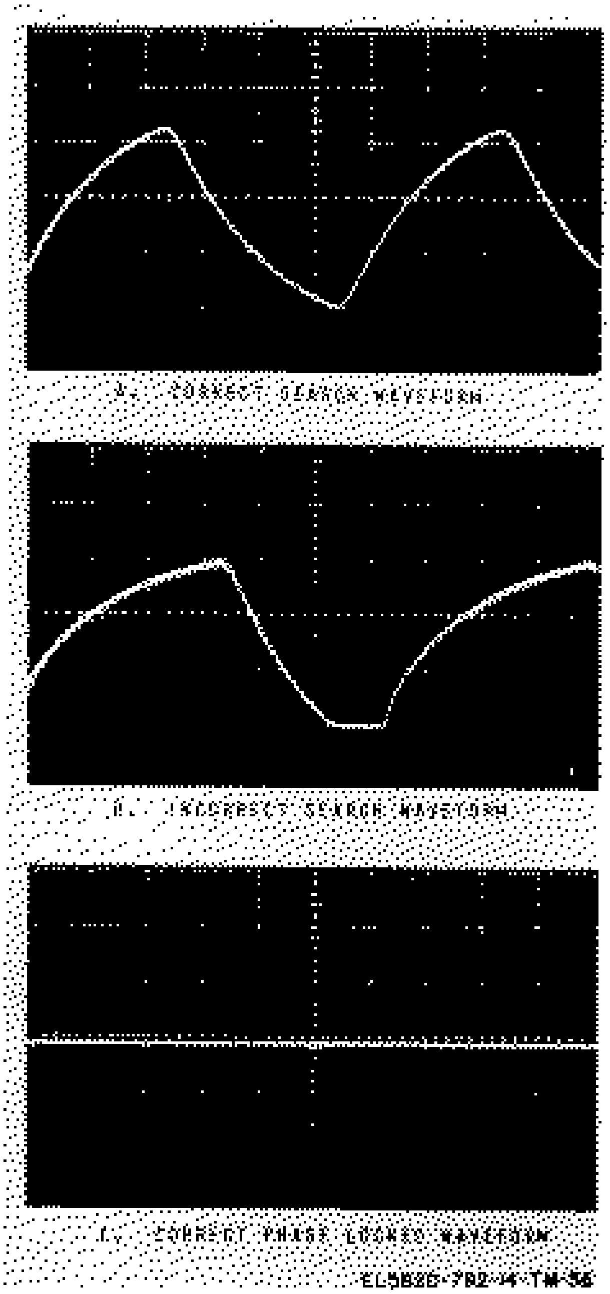


Figure 5-46. Local oscillator alignment waveforms.

(15) Observe the sawtooth waveform on oscilloscope. Slowly tune fundamental oscillator tuning screw in either direction until the sawtooth waveform degenerates into a straight line: refer to C, figure 5-46. straight line indicates that the fundamental oscillator is locked in phase with the resonant frequency of the crystal. If the unit is operating near the top of the frequency band, two lock positions occur. The correct lock position is the second position when tuning in a clockwise direction.

(16) When the oscillator is phase locked, set multimeter FUNCTION control to 20 K-ohm/V, and RANGE control to 10.

(17) Connect negative lead of multimeter to ground and positive lead to either LOCK terminal.

(18) Check for final phase-lock condition by slightly rocking fundamental oscillator tuning screw in either direction and observing the dc level of the waveform. As the tuning screw is varied slightly, the voltage level of the waveform present at 0 LOCK terminals should change.

NOTE

If the voltage does not change, the fundamental oscillator has not phaselocked, and it is necessary to repeat the alignment in (14) through (18) above.

(19) With the oscillator phase locked, slowly adjust the fundamental oscillator tuning screw until multimeter indicates 10 V dc.

(20) Slowly adjust oscillator tuning adjustment in the direction which increases the indicated voltage on the multimeter; stop the adjustment as soon as the oscilloscope indicates the search sawtooth. Carefully back off adjustment until the oscilloscope indicates phase lock. Record the multimeter indication noted at this point. Requirement is +16 VDC ± 2 volts.

(21) Adjust the oscillator tuning adjustment in the direction which decreases indicated voltage while observing the multimeter and oscilloscope. As in step (20), stop adjustment as soon as oscilloscope indicates the search sawtooth; then carefully back off adjustment until the oscilloscope indicates phase lock. Record the multimeter indication at this point. Requirement is +3VDC ±2 volts.

(22) Adjust oscillator tuning adjustment between the limits in (20) and (21) above until the multimeter indicates +10VDC. Observe oscilloscope for phase lock.

(23) Perform local oscillator output level measurement in accordance with paragraph 5-39 or 5-42, as applicable.

(24) Perform local oscillator output frequency check in accordance with paragraph 5-40 or 5-43, as applicable.

(25) Alignment is now complete. Disconnect all test equipment from local oscillator.

(26) Install the oscillator into its mounting position on the RF panel (1A6).

(27) Reconnect the normal cabling to the unit; then turn associated low voltage power supply on and notify distant station that normal communications have been restored.

CHAPTER 6

OFF-SITE MAINTENANCE

Section I. GENERAL

6-1. Scope of Off-Site Maintenance

Off-site maintenance includes an integrated grouping of general support maintenance and includes those maintenance functions normally performed at a suitably equipped repair facility. These maintenance functions are listed as follows:

a. Extensive disassembly, troubleshooting, and identification of piece-part failure within equipment modules, assemblies, and subassemblies.

b. Repair by replacement of the defective component or components in those items listed in (1) above.

c. Reassembly, alignment, and testing of those items listed in (1) above for return to the user or restoration of maintenance float stocks.

d. Overhaul of equipment modules, assemblies, and subassemblies.

e. Technical assistance to the operating sites where the radio is installed, when necessary for resolution of maintenance problems beyond the skill or material resources of the on-site support activities.

6-2. Module configurations

a. General. The chart below lists all modules covered in this chapter. Additional module configurations are also available for use in the radio set; these modules, with supporting technical data are covered in chapter 7.

Module	Section	600-channel	240-channel
Adder	II	368-42029-7	368-42029-7
AFC	III	368-43686-1	368-43686-1
Baseband combiner	IV	398-12040-1	398-12040-1
Dual pilot-tone detector	V	368-43035-1	368-43035-1
IF amplifier	VI	368-43488-1	368-43488-1
IF bandpass filter	VII	398-12067-3	398-12067-3
IF preamplifier	VIII	398-12215-1	398-12215-1
Klystron driver [a]	IX	368-43490-2	368-43490-6
Klystron power supply	X	368-43580-1	368-43580-1
Limiter-discriminator[a]	XI	368-43489-8	368-43489-6
Local oscillator	XII	368-42299	368-42299
Low-voltage power supply	XIH	398-12051-1	398-12051-1
Meter panel	XIV	398-12041-1	398-12041-1
Noise amplifier	XV	368-43018-1	368-43018-1
RF filter (receive)	XVI	368-43869 [b]	368-43871[C]
Rf filter (transmit)	XVI	368-43346 [b]	368-43627 [C]
Terminal filter (receive)	XVII	368-43020-8	368-43020-8
Terminal filter (transmit)	XVII	368-43020-7	368-43020-7

[a] K!ystron driver 368-43490-1 and Limiter-discriminator 368-43489-1 are included.
[b] Covers 4.4 to 4.7 GHz range
[C] Covers 4.7 to 5.0 GHz range

b. Test Equipment. The maintenance allocation chart (app C) identifies the test equipment necessary for performing the test and alignment procedures given in this chapter. If the model identified is not available, substitute items having equivalent technical characteristics may be used.

c. General Testing Notes. Throughout this chapter, certain practices are used as standard procedure.

(1) In the following paragraphs, all signal levels are expressed in volts or millivolts, with the circuit impedance (if standard value is 75 or 600 ohms), and actual power. This allows the measurements to be accomplished by using any voltmeter, or measuring instrument providing voltage indications. Levels are expressed as follows:

48 mV/75-ohm (-15 dBm)
Where 48 mV is the ac voltage.

75-ohm is the circuit impedance
-15 dBm is the actual power.

NOTE

When using a voltmeter calibrated to indicate 0 dB for a 0.775 V input level across 600 ohms, it is necessary to use a 9 dB correction factor if the measured level is specified across a 75-ohm impedance. For example, given a --45 dBm level (actual power) an ac voltmeter calibrated to indicate 0 dB across 600 ohms will indicate 54 dB. Note that the indication is dB and not dBm. The voltage indicated in any case is constant at 1.54 mV.

(2) Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter leads. Do not use the ohmmeter if this voltage exceeds 1.5 V dc. Also since the RX1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 mA or more) may damage the transistor under test. As a general rule, the Rx1 range of any ohmmeter should not be used when testing low power transistors.

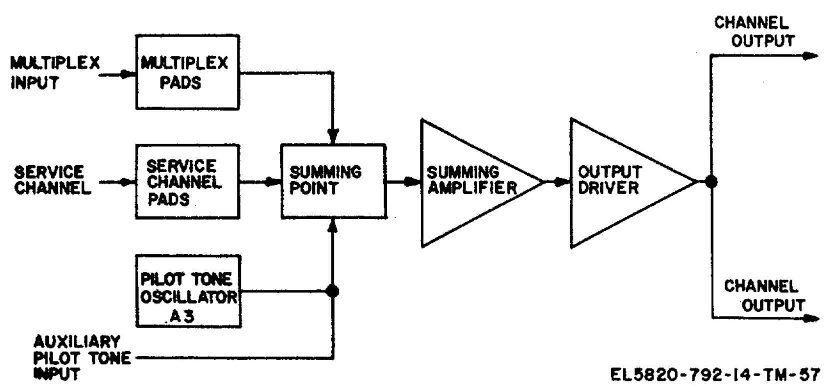
Section II. ADDER MODULE (368-42029-7)

6-3. Introduction

a. General. The adder module is located in the microwave transmitter and is used to combine the individual multiplex signals, service channel signals, and pilot-tone signals, thereby forming one composite baseband output signal. The multiplex and service channel signals are received from external sources; the pilot-tone signal is generated by a submodule (A3) within the adder itself. The adder module consists of two printed-wiring cards (A2) and (A3) on which all components, with the exception of controls, test jacks, and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis (A1).

b. Functional Description.

(1) As shown in figure 6-1, the multiplex and service channel input signals are attenuated using pads which are selected on the basis of overall radio performance. The multiplex pads are 75ohm T-pads, capable of providing 1 to 31 dB attenuation. Each adder module contains a pilottone oscillator which uses a single series resistance as an attenuator. The multiplex, service channel, and pilot-tone signals are applied to a summing point, which is a low impedance (virtual ground) and provides high isolation between the various input signal channels.



■**Figure 6-1. Adder module, functional block diagram.**

(2) The pilot-tone oscillator generates a tone for indicating radio system continuity between the transmitting and receiving stations. Each adder module contains a single pilot-tone to the local summing point, it may also be interconnected with the pilot-tone oscillator of a remote adder module to preclude the loss of pilottone signal due to failure of one. Controls are provided on certain terminal filter modules to select or stop the pilot-tone oscillator in order to check system operation.

(3) The output driver feeds the baseband into two identical parallel output circuits.

6-4. Circuit Functioning

a. Figure FO-11 shows that the multiplex input, signal is applied to the 75-ohm unbalanced T-pad networks via MX INPUT connector J3. The T-pad networks provide a maximum of 31 dB attenuation in 1 dB steps. The attenuators are selected by overall system parameters and as necessary to obtain a multiplex input level of -49 dBm (SCTT) measured between test points TP5 and TP3.

b. As shown in figure FO-11, the service channel input signal is brought into the adder module via pins 16 and 14 (ground) of printed-circuit connector J1. It is applied to a set of 600-ohm unbalanced T-pad attenuators, which provides signal attenuation capability of 1 to 31 dB. These pads are selected by overall system parameters to attenuate the service channel input signal so that it is equal to the SCTT multiplex level, measured between output test points TP1/TP3 for diversity channel B and test points TP2/TP3 for diversity channel A.

c. The output of the pilot-tone oscillator, on submodule A3, is sent through resistor R63, combined with the service channel, and applied to the junction of R1, R2, and C1. The output signal from the pilot-tone oscillator is adjustable to a level between 6 and 10 dB below the SCTT level measured between test points TP1 or TP2 to TP3 (ground). The adjustment is performed using the PLT ADJ potentiometer behind an access port in the adder module casing.

d. The three input signals are combined at the junction of resistors R1 and R2 and capacitor C1, which is known as the summing point. After amplification by transistor Q1, the baseband signal is direct coupled into transistor Q2 to eliminate the possibility to undesirable phase shifts. A portion of the output signal, developed across Q2 emitter resistance, is fed back to the base of transistor Q1 through RC network R64 and C14. This feedback path holds the input circuit of Q1 (summing point) at a very low impedance which provides isolation of the input signals to prevent undesirable intermodulation distortion. Isolation of the multiplex signal from the service channel or pilot-tone is 26 dB. Isolation of the service channel or pilot-tone from the multiplex signal is 35 dB.

e. The baseband output signal from transistor Q2 is RC-coupled into the base of emitter follower Q3. Emitter follower Q3 is an output driver providing impedance transformation and isolation between the summing amplifiers and the output circuits of the module. The output circuit of emitter follower Q3 is capacitively coupled to dual 75-ohm output circuits at coaxial connectors J1 and J2. The composite output level, measured between test points TP1 or TP2 and ground (TP3), is about -31 dBm.

f. The dc operating supply is taken from two independent positive 28-volt power supplies. Diodes CR1 and CR2 are the steering and isolation diodes. Under normal operating conditions diodes CR1 and CR2 are forward biased so that the voltage drop across each diode is very small. If one of the power supplies fails, the diode associated with the failing power supply is reverse-biased into cutoff, thereby isolating this supply from the adder module. The adder module continues to function using power from the remaining power supply.

g. Figure FO-13 shows the schematic diagram of the pilot-tone oscillator submodule used with the adder module. The oscillator stage Q1 is a modified Colpitts oscillator using collector-to-base feedback. Control of the oscillator is maintained by a crystal, Y1, in series with the feedback path. The output frequency of the oscillator is only slightly variable, using adjustable inductor L1 which resonates with the crystal holder and stray wiring capacitances. Emitter-follower stage Q2 isolates the oscillator from its load to improve frequency stability. The output from emitter-follower Q2 is applied to a dual lowpass filter with the pilot-tone signal as its cutoff frequency, and all undesired frequencies are attenuated. The output level control, R15, is adjusted to obtain an output tone that is 6 dB below the single channel test tone level.

h. In certain applications, two adder modules are used in a single microwave terminal. Such installations require special pilot-tone oscillator interconnections. The pilot-tone oscillator output at A3A5 of figure FO-11 is passed through resistor R19 to terminal A3E8. A strap wire from A3E8 to A2E34 routes the pilot-tone signal to pin 17 of printed-circuit connector J1. At this point, the pilot-tone can be routed into another adder module. A cross-connection is used in the radio terminal which inserts the second pilot-tone signal into the adder module at pin 21 of J1 to terminal H. Terminals H and G are then strapped together forming a direct path into the summing point of the adder. The pilot-tone selector switch is located on the terminal filter module and applies + 28 volts to pin 22 of J1. The 28-volt line is then completed to the pilot-tone oscillator using a strap between E and A3E2 as shown in figure FO-11.

i. Technical Characteristics.

Parameter	Specifications
Adder Module	
Multiplex input impedance	75 ohms, unbalanced
Service channel impedance	600 ohms, unbalanced
Multiplex input level	-45 to -15 dBm (nominal)
Service channel input level	-35 to - 15 dBm
Output level	-35 dBm
Minimum gain	+ 13 dB (multiplex)
Input attenuators	
Multiplex	0-31 dB in 1 dB steps
Service Channel	0.31 dB in 1 dB steps
Frequency response	
Multiplex	12 kHz to 2.8 MHz ± 0.2 dB
Service Channel	300 Hz to 12 kHz
Signal Isolation	
Multiplex to service channel or pilot Lone signals	26 dB
Service channel or pilot tone signals to multiplex signal	35 dB
Power requirements	100 ma at + 28 V dc
Pilot tone oscillator	
Output frequency	3.2 MHz ± 20 Hz
Output impedance	70 ohms, unbalanced
Output level	17 mV (adjustable)

6-5. Maintenance Data

a. Performance Test and Trouble Analysis Procedure (General). This paragraph contains procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Tolerances. Dc voltage readings should be within 10 percent and ac voltage readings within 20 percent.

c. Test Equipment Setup. Figure 6-2 shows the basic test equipment setup.

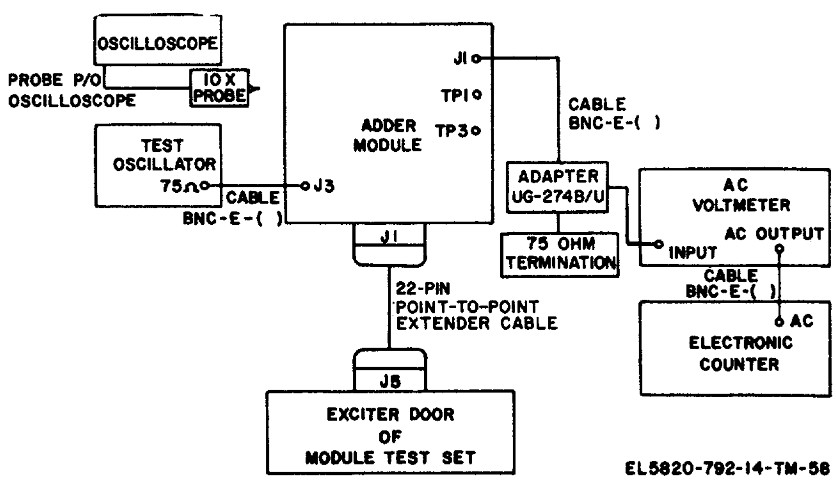


Figure 6-2. Adder module, initial test equipment setup.

d. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove the top and bottom covers from the adder module; in addition, remove the cover from the pilot-tone oscillator submodule.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the + 28-volt power supply in the test set for 28 ±0.5V.

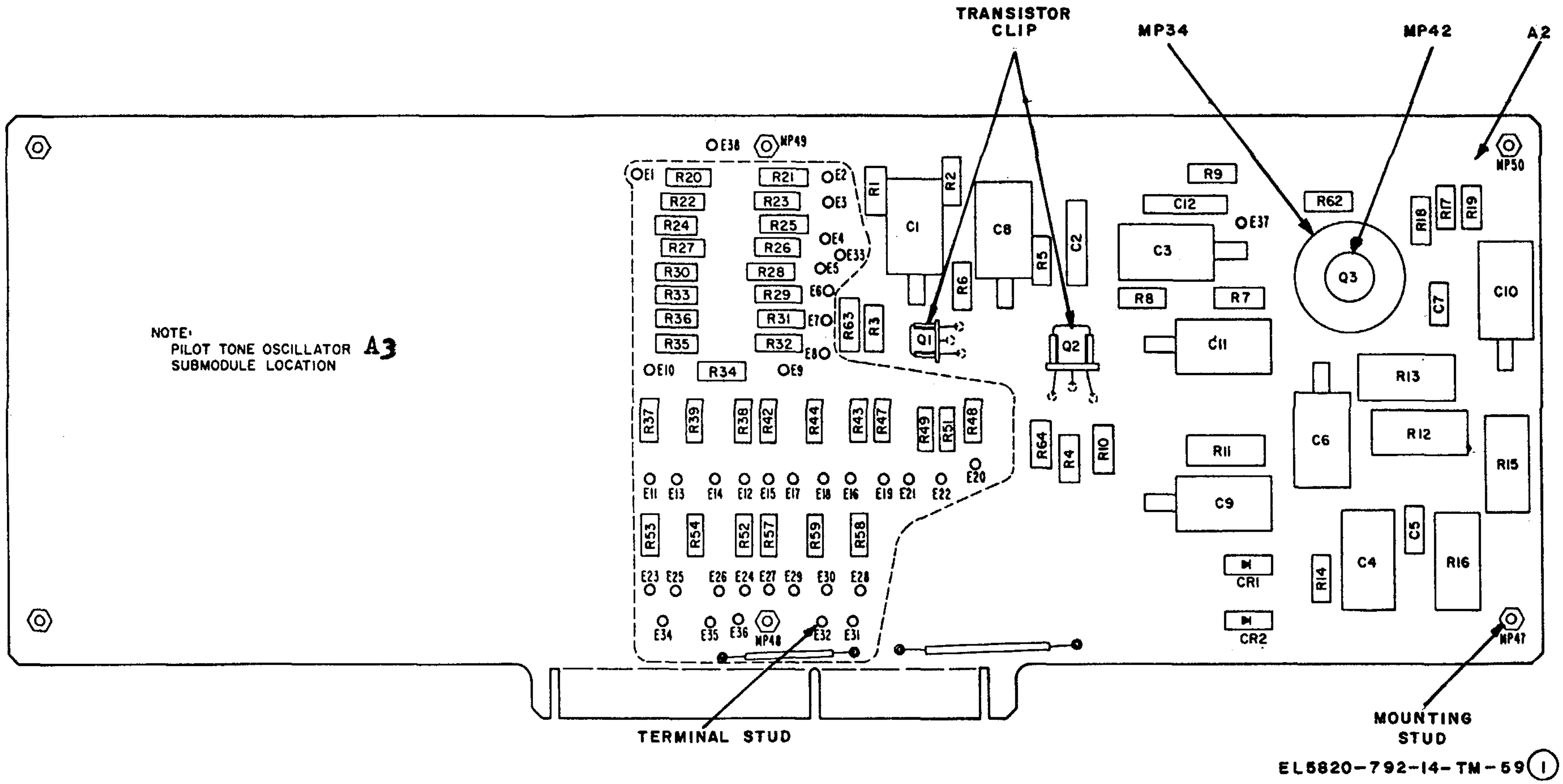


Figure 6-3. Adder module, parts location diagram (sheet 1 of 3).

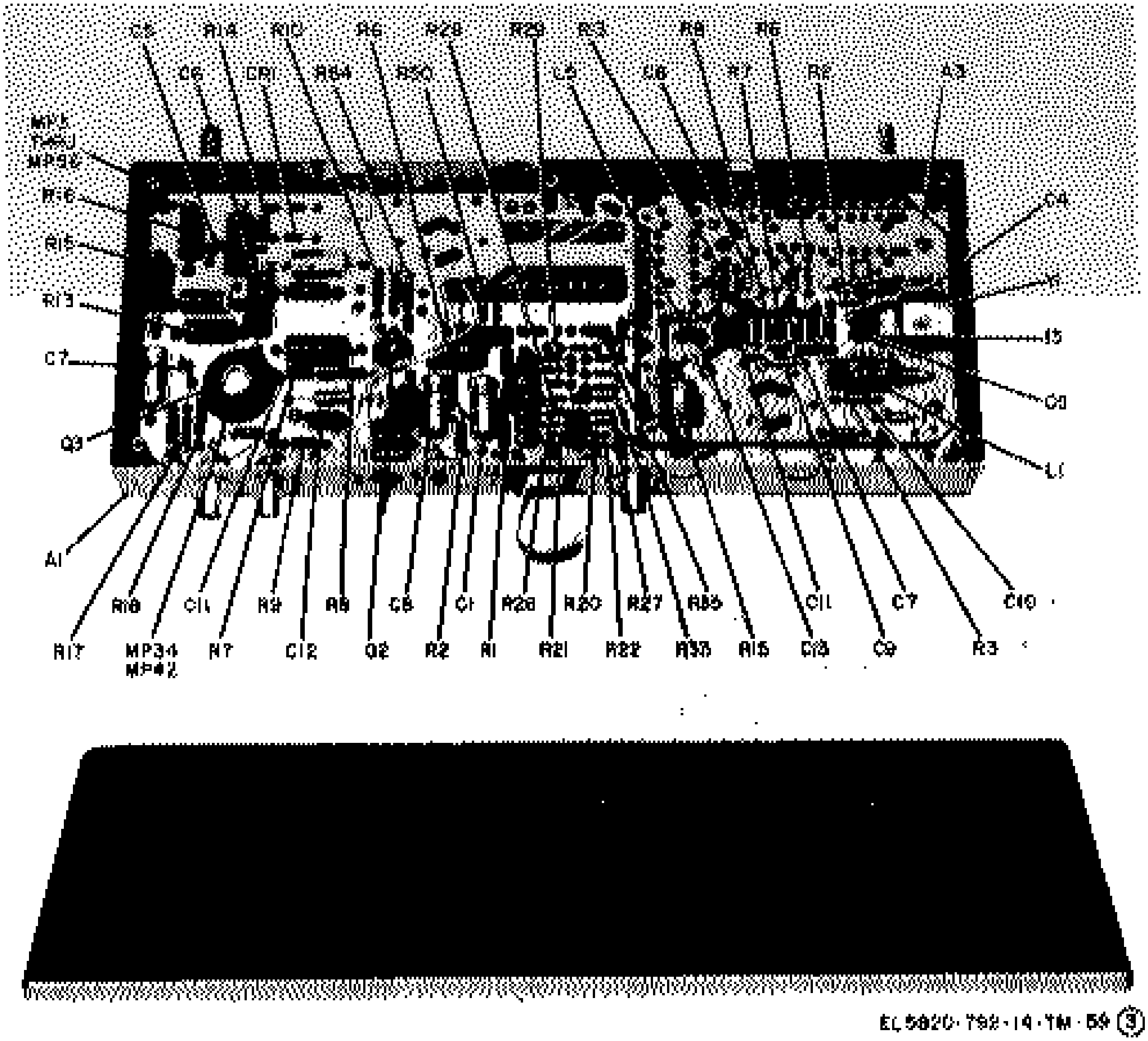
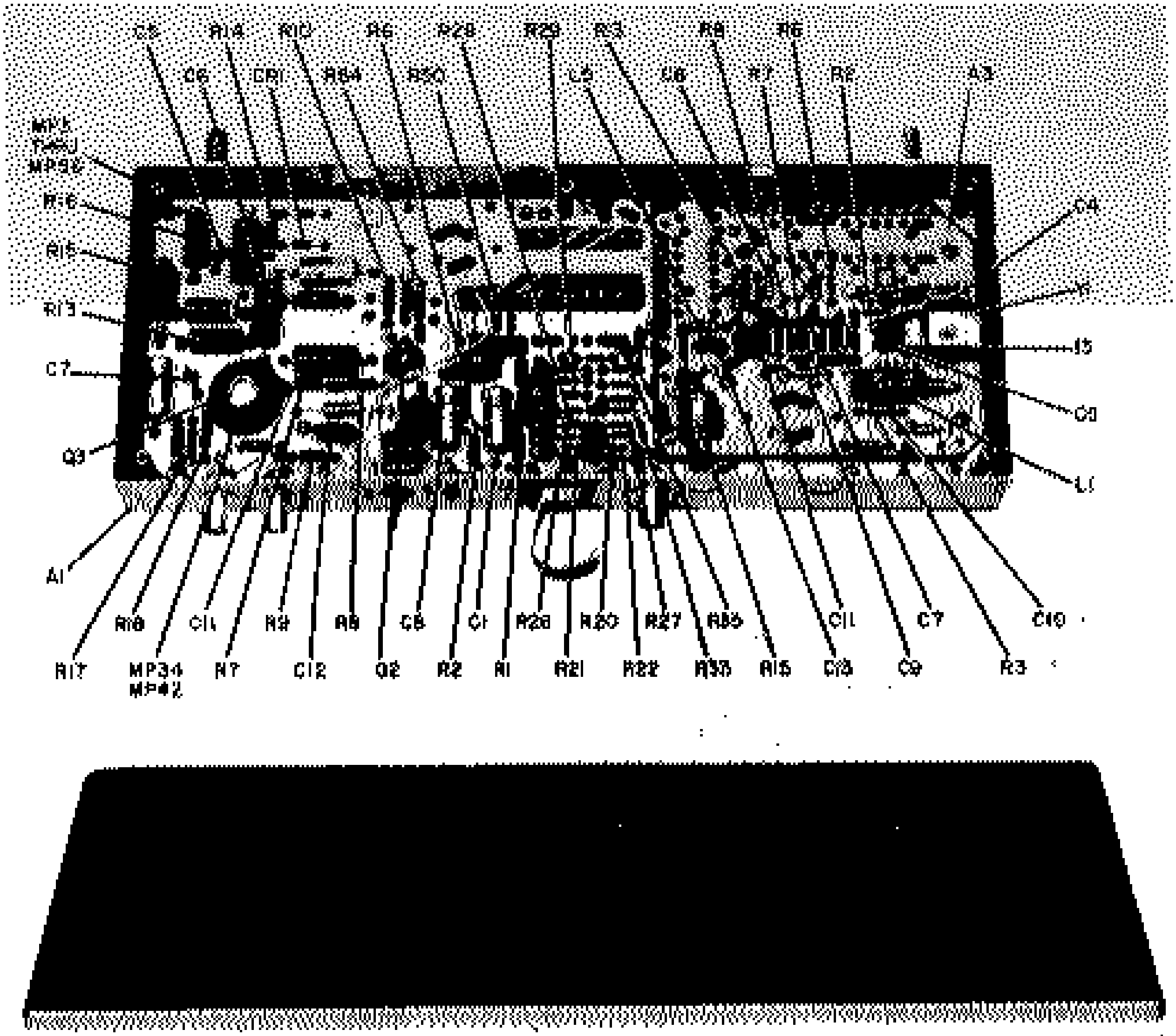


Figure 6-3 2. Adder module, parts location diagram (sheet 2 of 3).



EL5820-792-14-TM-59 (3)

Figure 6-3   3. Adder module, parts location diagram (sheet 3 of 3).

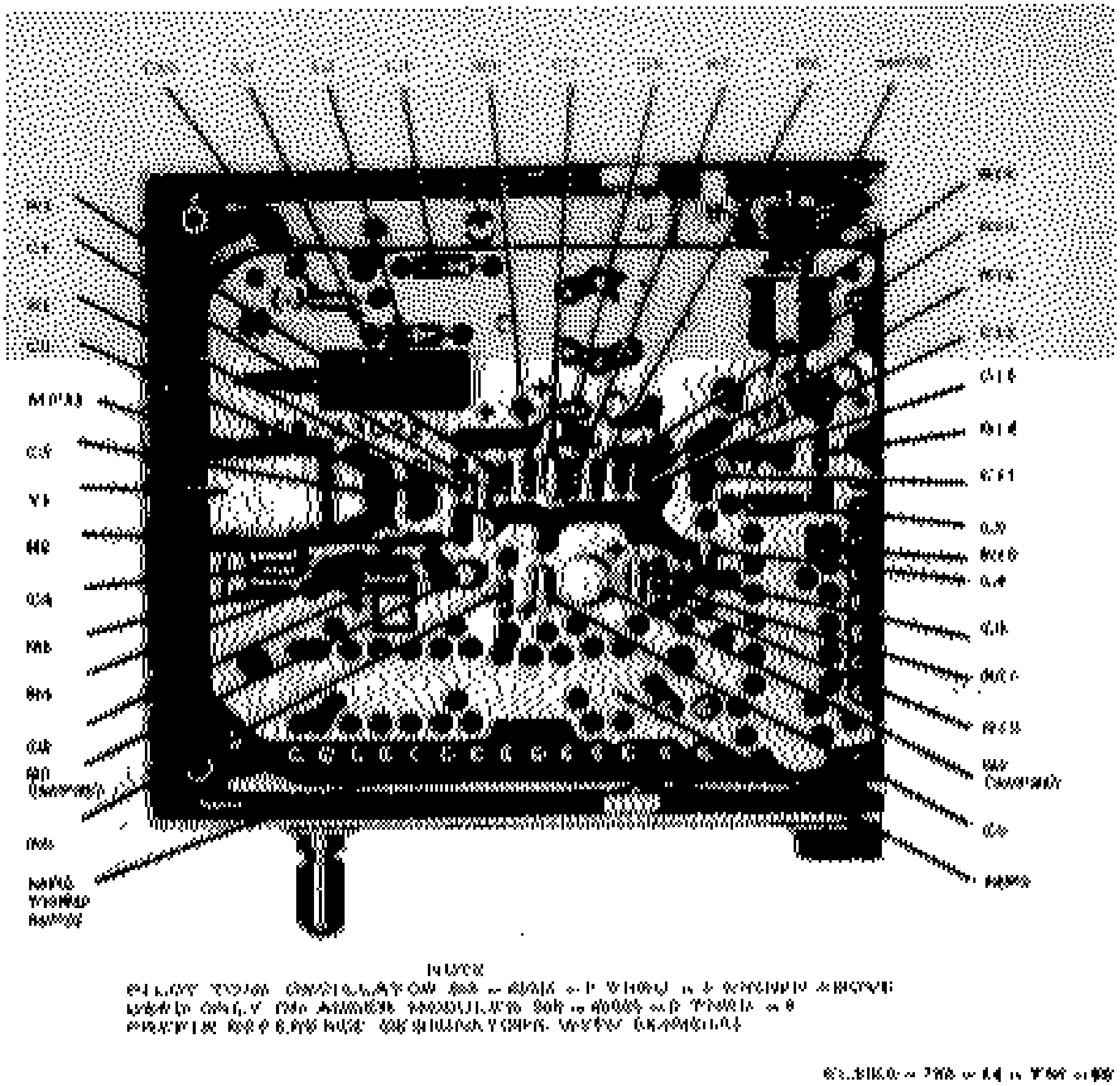


Figure 6-4. Pilot-tone oscillator, parts location diagram.

e. Procedure

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Steering Diode Performance Check		
1.	On the module test set, check to see that the A and B low voltage supplies are adjusted to provide +28± 0.1V dc.			
2.	Connect the adder module under test to one end of the 22-pin point-to-point extender cable and the other end of the extender cable to J5 in the exciter door of the module test set (fig. 6-2).			
3.	Remove both covers from the adder module.			
4.	Locate test points 1, 3, and 5 of the 22-pin extender cable. (Test point 3 and pin 3 are ground).			
5.	Connect the COMMON lead of a multimeter to test point 3.			
6.	On the multimeter, set the FUNCTION switch to +, and the RANGE switch to 30V; connect the DC probe to test point 1.	+28 ±0.5Vdc		
7.	Transfer the DC probe to test point 5.	+28 ± 0.5Vdc		
8.	Transfer the DC probe to the junction of R14, CR1, and CR2.	+27.5 ± 0.5Vdc	Proceed to step 9.	Diode CR1 or CR2 may be shorted causing voltage to rise to +28 Vdc. Replace defective diode after testing.
9.	On the module test set low voltage power supply, set CHANNEL B POWER switch to its OFF position.	+ 27.5 ± 0.5Vdc	Proceed to step 10.	If output is + 28 Vdc, diode is shorted, If output is zero, diode is open. Test and replace diode CR1.
10.	On the module test set low voltage power supply, set CHANNEL B POWER switch to its ON position.			
11.	On the module test set low voltage power supply, set CHANNEL A POWER switch to its OFF position.	+27.5 ± 0.5Vdc	Proceed to step 12.	If output is + 28 Vdc, diode is shorted, If output is zero, diode is open. Test and replace diode CR2.
12.	On the module test set low voltage power supply, set CHANNEL A POWER switch to its ON position.		End of steering diode check.	
		Multiplex Channel Performance Check		

NOTE

Perform the following preliminary adjustments for multiplex channel checking:

(1) On a test oscillator, set the RANGE control to X100K, the OUTPUT ATTENUATOR to -30 dBm, and the FREQUENCY dial to 1.

(2) Connect a 75-ohm termination to one part of a UG-274B/U adapter, then connect this assembly to the INPUT connector of an ac voltmeter. Set the ac voltmeter RANGE control to 40 dB.

(3) Interconnect the ac voltmeter INPUT and the 75-ohm output of the test oscillator.

(4) On the rear of the ac voltmeter, connect a cable to the AC OUTPUT connector; then connect the cable to the AC input of an electronic counter.

(5) Using the COARSE output control of the test oscillator, adjust oscillator output for 40 dBm as indicated by the ac voltmeter.

(6) Check that the test oscillator frequency is 100 kHz as verified by the electronic counter.

(7) Connect the adder module under test to one end of a 22-pin extender cable, and the other end to the ADDER position in the exciter door of the module test set.

(8) Adjust the +28-volt power supply in the module test set to provide +28 ± 0.1 V dc.

(9) Remove the top cover from the adder under test and let the equipment stabilize for 20 minutes.

(10) Proceed to step 14 of the performance test and trouble analysis table below.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
13.	Perform the preliminary adjustments (NOTE above).			
14.	Connect a jumper between test points TP5 and TP6.			
15.	On the adder module, turn the pilot tone switch to OFF.			
16.	Remove cable from test oscillator 75 ohm output (NOTE (3) above). Connect to J1 of the adder module; without disturbing the test oscillator controls, connect the 75-ohm output of the test oscillator through coaxial cable to J3 of adder module (fig. 6-2).			
17.	Connect the oscilloscope through a 10X probe to test point TP1 and common oscilloscope lead to TP3. (fig. 6-2).	120 mV peak-to-peak 100 kHz sinusoidal wave.	Proceed to bandwidth check steps 38 through 56.	Proceed with step 18.
18.	Connect the oscilloscope through 10X probe to Q1 collector (fig. 6-3 **2**)	350 mV peak-to-peak 100 kHz sinusoidal wave.	Proceed to step 19.	Check Q1, Q2, and associated parts.
19.	Connect the oscilloscope probe to Q2 collector (fig. 6-3 **2**).	240 mV peak-to-peak 100 kHz sinusoidal wave.	Proceed to step 20.	Check Q2 and associated parts.
20.	Connect the oscilloscope probe to Q3 emitter (fig. 6-3 **2**).	240 mV peak-to-peak 100 kHz sinusoidal wave.		Check Q3 and associated parts.
21.	Disconnect jumper from test points TP5 and TP6, disconnect test equipment.		End of Multiplex channel test.	
22.	Perform the preliminary adjustments (NOTE above).			
23.	Disconnect the test oscillator cable from the UG-274BIU at the ac voltmeter and connect a 2631 adapter to the free end of the cable.			

Service Channel Performance Test

NOTE

Preliminary Adjustments. Perform the following preliminary adjustments for serv ice channel checking.

(1) On a test oscillator, set the RANGE control to X1K, the OUTPUT ATTENUATOR to 10 dBm, and the FREQUENCY dial to 1.

(2) Connect a 600-ohm termination to one port of UG-274B/U, then connect this assembly to the INPUT connector of an ac voltmeter. Set the ac voltmeter RANGE control to 20 dB.

(3) Interconnect the ac voltmeter INPUT and 600-ohm output of the test oscillator.

(4) Using the COARSE output control of the test oscillator, adjust oscillator output for 25 dBm as indicated by the ac voltmeter.

(5) On the rear of the ac voltmeter, connect a cable to the AC OUTPUT connector; then connect this cable to the AC input of an electronic counter.

(6) Check that the test oscillator frequency is 1 kHz as verified by the electronic counter.

(7) Remove the top cover of the adder module to be tested.

(8) Inspect the attenuator strapping arrangements; unsolder any strapping arrangements, except direct or 0 dB attenuation.

(9) Connect a jumper between E32 and E35; attenuators are now bypassed.

(10) Connect the adder module under test to one end of a 22-pin extender cable, and the other end to the ADDER position in the exciter door of the module test set.

(11) On the transmit terminal filter module, set switch S1 to its OFF position.

(12) Proceed to step 23 of the procedure below.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
24.	Connect the minigator clips of the test oscillator 2631 adapter (step 23 above) to test points 16 and 14 (ground) on the point-to-point extender cable.			
25.	Connect a 2631 adapter to one end of a test cable and the other end of the test cable to the oscilloscope input.			
25.1.	Terminate J1 on adder module with 75 ohms (fig. 6-2).			
26.	Connect the minigator clips of the 2631 adapter (from oscilloscope) between test point TP1 and ground.	60 mV peak-to-peak, 1 kHz sinusoidal wave.	Proceed to step 28.	Proceed to step 27.
27.	Remove the minigator oscilloscope clip from TP1 and connect to Q3 base.	120 mV peak-to-peak, 1 kHz sinusoidal wave.	End of supervisory channel test; disconnect test equipment. If proceeding to step 38, leave attenuators strapped in by-pass.	Check R3 and connections to Q1 base.
		Pilot-Tone Oscillator Performance Test		
28.	Perform the preliminary adjustments of NOTE above.			
29.	Connect a 3221 adapter to a test cable, and connect the other end of the test cable to the INPUT of the ac voltmeter.			
30.	On the adder module, set S1 to the A position to select pilot-tone oscillator A.			
31.	Connect the pin tips of the 3221 adapter between test point TP7 and TP3 (ground).			
32.	Connect a 3221 adapter to a test cable and the other end of the test cable to the vertical input of the oscilloscope.			
33.	Observe the electronic counter.	3.2 MHz ± 20Hz	Proceed to step 34.	Perform pilot-tone oscillator frequency adjustment.
34.	Slowly adjust potentiometer R15 of the pilot-tone oscillator in the counterclockwise direction until the frequency indication fails.	3.2 MHz ± 20Hz.	Proceed to step 35.	If pilot-tone frequency changes as R15 is adjusted, check R15 and/or A3Q2 with associated filter.
35.	Disconnect ac voltmeter 3221 adapter pin tip from TP7 and connect the oscilloscope 3221 adapter pin tips between test points TP7 and ground.			
36.	Set potentiometer R15 fully counterclockwise.	Less than 3V peak-to-peak.	Proceed to step 37.	Check pilot-tone oscillator assembly for proper grounding.

NOTE

Preliminary Adjustments.

Perform the following adjustments for pilot-tone checking:

(1) On the adder module, set potentiometer A3R15 to its maximum clockwise position.

(2) Using a multimeter with FUNCTION switch set to OHMS and the RANGE control set to RX1, check resistance between all ground lugs and mounting plate in the pilot-tone oscillator subassembly. The resistance checks should yield 0 ohm at all points measured. If not resolder or retighten as necessary.

(3) On the rear of an ac voltmeter, connect one end of a test cable to the AC OUTPUT connector, then connect the free end to the AC input of an electronic counter.

(4) Set the RANGE switch of the ac voltmeter to -40 dB.

(5) Connect the adder under test to one end of a 22-pin extender cable, and the other end to the ADDER position in the exciter door of the module test set.

(6) Replace the module cover loosely on top of the module.

(7) Proceed to step 29 of the performance test and trouble analysis table below.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
37.	Set potentiometer R15 fully clockwise.	55 mV peak-to-peak, 3.2 MHz sinusoidal wave.	End of pilot-tone oscillator test. Disconnect all test equipment.	Check C6, C7, C8, LI,. and L2 of pilot-tone oscillator.
		Adder Bandwidth Performance Test		
38.	Perform multiplex channel preliminary adjustments in step 13 above.			
39.	Connect a jumper between TP5 and TP6.			
40.	On the transmit adder, set switch SI to OFF.			
41.	Remove cable from test oscillator 75 Ω output ((13) of step 13) and connect to J1 of adder module.			
42.	Without disturbing the test oscillator control settings, connect 75 Ω output of test oscillator through coaxial cable to J3 of adder module (fig. 6-2).			
43.	Perform multiplex preliminary adjustment in step 13 above.	38 mV to 43 mV. Record reading for reference level.	Proceed to step 44.	Perform multiplex channel test.
	NOTE **The input level to J3 of module for each frequency listed in step 44 must be set to a - 44 dbm as outlined in preliminary adjustment, (step 13 above). This is an amplitude leveling**			
44.	Reset the test oscillator frequency to each of the following frequencies and note the ac voltmeter response at each selection. Repeat steps 41 through 43 for each frequency selected: 12 kHz 50 kHz 500 kHz 1.5 MHz 3.2 MHz	± 1 mV of the reference recorded in step 43 (output flat within ± 1 mV).	Proceed to step 45.	Check capacitors C13 and C14.
45.	Disconnect jumper between TP6 and TP5.			
46.	Replace the 75-ohm termination on the UB-274B/U adapter with a 600-ohm termination. Remove coaxial cable from J1 of adder module.			
47.	Set the RANGE of the ac voltmeter to - 20dB.			
48.	Remove and disconnect other end of coaxial cable from test oscillator.			
49.	On the test oscillator, set the RANGE control to X1K, the OUTPUT ATTENUATOR to - dBm, and the FREQUENCY to 1. Connect the 600-ohm output of test oscillator with coaxial cable removed from J1 above.			
	NOTE **The reference level established at step 50 should be repeated for each frequency selected at step 56. This sets the input level to flat response. The 18 to 27 mv levels are established by bandpass gain of amplifier.**			
50.	Adjust the test oscillator to - 25 dBm as indicated by the ac voltmeter.			
51.	Disconnect the test oscillator from the UG-274BUA and connect a 2631 adapter to the free end of the cable.			
51a	Jump out the pad by connecting a wire from E32 to E35 on the adder module (fig. 7-3 **2**()).			
52.	Connect the minigator clips of the 2631 adapter to pins 16 and 14 (ground) on the point-to-point extender cable.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
53.	Disconnect the UG-274B/U with its 600-ohm termination from the ac voltmeter.			
54.	Connect a 75-ohm through termination to the INPUT of the ac voltmeter.			
55.	Connect the ac voltmeter through termination with coaxial cable to J1 of the adder module.	18 mV to 27 mV. Record reading for reference level in dB.	Proceed to step 56.	Perform service channel test.
56.	Reset the test oscillator frequency to each of the following frequencies and note the ac voltmeter response at each selection. **NOTE** **Perform the level adjustments of steps 45 through 55 for each change in the test frequencies to insure a constant input signal level.** 300 Hz 5 kHz 3 kHz 8 kHz	Reference level with the following variations: 300 Hz, ± 3 dB 3kHz±1 dB 5 kHz. -6 dB 8kHz,-5 dBB	Test complete.	Check capacitors C1, C10, and C11.

f. Disposition of Module. The test procedures of the previous paragraph required that all attenuators be bypassed. This procedure is used to standardize the module so that it may be readily used in the radio terminal without any further adjustments.

(1) Unsolder and remove any connections between E38 and any of the following terminals: E3, ES, E7, or E9.

(2) Unsolder and remove any connections between E33 and any of the following terminals: E4, E6, E8, or E10.

(3) Strap terminals E38 to E33; solder for good electrical connection. This strap provides 0 dB attenuation in the multiplex channel of the ,module.

(4) Strap and solder the required connections in the service channel of the adder module to meet system requirements.

(5) Substitute the adder module under test for the standard adder module in the module test set.

(6) Connect the 75-ohm output of a test oscillator to BASEBAND IN VIDEO of the module test set.

(7) On the module test set, interconnect TERM FLT OUT and ADDER IN.

(8) Connect a 75-ohm feed through termination to the INPUT of an ac voltmeter and set the RANGE control to --30 dB.

(9) Using a test cable, interconnect the 75ohm feed through termination of the ac voltmeter and ADDER OUT of the module test set; verify test equipment using part A of figure 6-5.

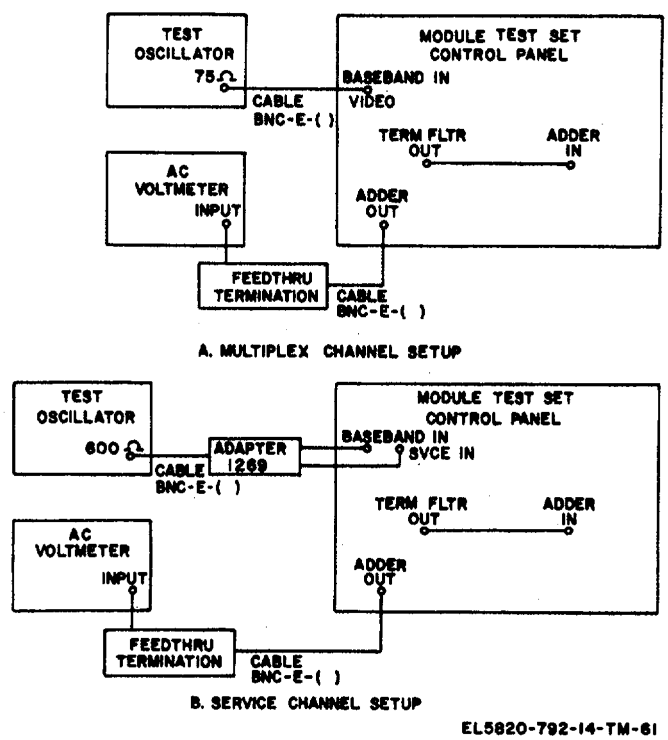


Figure 6-5. Adder module disposition, test equipment setup.

(10) On the transmit terminal filter, set S1 to its OFF position.

(11) Perform steps 38 through 44 of g above, using 1.5 mV/75 ohms (-45 dBm).

(12) The ac voltmeter must indicate 4.8 mV/75 ohms (-35 dBm).

(13) Connect a 1269 adapter to BASEBAND IN SVCE IN.

(14) On the test oscillator, transfer the test cable from 75 to 600 ohms.

(15) On the module test set, transfer the test cable from VIDEO input to the 1269 adapter at SVCE IN; verify the test setup using part B of figure 6-5.

(16) Set the OUTPUT ATTENUATOR of the test oscillator to provide an output signal level in accordance with system requirements for service channel input level.

(17) The ac voltmeter must indicate 4.8 mV/75 ohms (-35 dBm). Disconnect all test equipment.

g. Intermodulation Distortion Test. This procedure is used to evaluate the linearity characteristics, of the adder module. The intermodulation distortion test is the final major performance test of the module. The levels and frequency slots used in this test are based upon 600 channel loading conditions. A discussion of this type of test, and the modifications required for other channel loadings, appears in chapter 5. The test equipment setup is shown in figure 6-6.

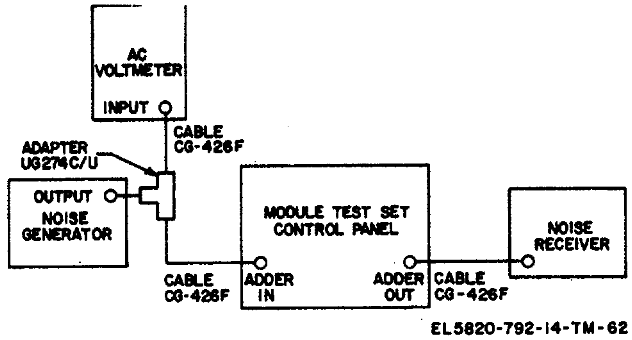


Figure 6-6. Adder module intermodulation distortion, test equipment setup.

(1) Replace test set standard adder module with adder module under test.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the 28-volt power supply in the module test set for 28 ± 0.1 V dc.

(4) Adjust the 6-volt power supply in the module test set for -6 ± 0.1 V dc.

(5) Connect test set cables as shown in figure 6-6.

(6) On the noise generator, set the meter range switch to RED. Set the dial attenuator to 49 dB. Set the noise generator 60 kHz high and the 2540 kHz low-pass filters to their IN positions and all band stop filters to their OUT positions. Set noise generator output level to 8 mV/75 ohms -31 dBm) as read on ac voltmeter.

NOTE

The level provided accounts for the 4 dB (nominal) loss due to the terminal filter, which reduces the SCTT level to --49 dBm/75 ohms. The noise loading for 600 channels is +17.8 dbm0; this loading when added to the SCTT loading is equal to -31.2 dBm.(para 5-33d).

(7) Set the noise receiver frequency selector to 70 kHz, then adjust the attenuator controls to produce a meter reference indication.

(8) Read and record the attenuator setting of the noise generator.

(9) Switch in the 70 kHz bandstop filter on the noise generator.

(10) Set the attenuator controls of the noise receiver to produce the same level as reference 1.

(11) Read and record the attenuator settings of the noise receiver. Label the reading as reference 2.

(12) Subtract reference 1 from reference 2 to obtain the noise power ratio at the 70 kHz slot. The resulting noise power ratio shall not be less than 60 dB (62 dB typical).

(13) Set the 70 kHz bandstop filter switch to its out position.

(14) Repeat (7) through (12) above using 1002 kHz instead of 70 kHz.

(15) Set the 1002 kHz bandstop filter switch to its out position.

(16) Repeat (7) through (12) above using 2438 kHz instead of 70 kHz. Disconnect all test equipment.

h. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, the voltage and resistance data provided in paragraph 646.k, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources. The RX100 scale of the multimeter is used as the standard range unless otherwise stated; the common multimeter lead is connected to J1-3 (ground) during all measurements.

(2) Dc voltage measurements are made with the module connected to the exciter door of the module test set using the appropriate point-to-point extender cable. No signal source is employed.

(3) Ac voltage measurements are made using the 3.2 MHz pilot-tone oscillator as the generator source; for these measurements, adjust R15 to its fully clockwise position for maximum pilot-tone signal output. The adder module is connected to the exciter door of the module test set as for dc .measurements.

i. Voltage and Resistance Data.

Point of measurement	Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
		A2 Adder Assembly Card		
Q1 Base	6.2	Near zero	1.0K	
Emitter	5.5	Near zero	1.2K	
Collector	11.0	15.0 mv	2.6K	
Q2 Base	11.0	15.0 mV	2.6K	
Emitter	10.5	15.7 mV	660	
Collector	21.0	11.0 mV	3.6K	
Q3 Base	14.9	11.0 mV	2.2K	
Emitter	14.7	11.1 mV	200	
Collector	1.9.2	1.46 mV	3.4K	
		A3 Pilot Tone Assembly Card		
Q1 Base	26.0	360 mV	9.5K	RX1K
Emitter	24.1	440 mV	8.0K	RX1K
Collector	26.6	700 mV	10.0K	RX1K
Q2 Base	10.0	630 mV	5.0K	RX1K
Emitter	9.5	660 mV	1.0K	
Collector	18.5	3.5 mV	10.0K	RX1K
TP1	0	11.1 mV	11K	RX1K
TP2	0	11.1 mV	11K	RX1K
TP3	0	0	0	
TP4	0	0	1.1K	
TP5	0	0	1K	
TP6	0	0	1K	
TP7	0	15.5 mV	870	RX10
J1 Pins 1 and 5	28.0		INF	
Pin 16	0		1.2K	
Pin 17	0	3.2 mV	1.35K	
Pin 21	0		900	
Pin 22	28.0		9.5K	RX 1K
Pins 2, 3, 4	0		INF	
Pins 6 through 16	0		INF	
Pins 18, 19, 20	0		INF	

j. Pilot-Tone Oscillator Adjustment. The following procedure is provided for use in adjusting the output level and frequency of the pilot-tone oscillator (fig. FO-13).

(1) On the adder module, set potentiometer A3RL15 to its maximum clockwise position.

(2) On the rear of an ac voltmeter, connect one end of a test cable to the AC OUTPUT connector, then connect the free end of the cable to the AC input of an electronic counter.

(3) Set the RANGE switch of the ac voltmeter to -3-0 dB.

(4) Connect the adder being aligned to one end of a 22-pin extender cable, and the other end to the ADDER position in the exciter door of the module test set. Replace covers on the module.

(5) On the transmit terminal filter module of the test set, operate S1 to its A position.

(6) Connect a 3221 adapter to test points TP7 and TP3 (ground).

(7) Connect a test cable between the 3221 adapter and the INPUT of the ac voltmeter.

(8) Set the electronic counter to provide a convenient display.

(9) Adjust inductor A3L1 until the electronic counter indicates 3.2 MHz ± 20 Hz.

(10) Disconnect the frequency counter.

(11) Connect a 75-ohm through termination to the INPUT of an ac voltmeter.

(12) Connect the ace voltmeter between test points TP3 (ground) and TP1; record the output level indicated.

(13) Set potentiometer R15 to the fully counterclockwise position; record the output level indicated by the ac voltmeter.

(14) The levels recorded in ((12) and (13) above) should cover a range between 10 mV or greater (with R15 fully clockwise) to 1.4 mV or less (with R15 fully counterclockwise).

(15) Adjust potentiometer R15 until the ac voltmeter indicates 2.4 mV/75 ohms (-50 dBm)

(16) Disconnect all test equipment.

Section III. AFC MODULE (368-43686-1)

6-6. Introduction

The AFC module is located in the microwave transmitter. The AFC module compares samples of an internal 70-MHz oscillator signal with a sample of the transmitter output signal (reduced to 70 MHz) and produces an output error voltage that is proportional to the difference in the two frequencies. This error voltage is then used to maintain constant frequency output from the transmitter.

6-7. Functional Description

a. The functional block diagram of the AFC module appears in figure 6-7. A frequency modulated 70-MHz sample of the transmitter output signal is applied to the input of the AFC module. The input signal to the AFC module is obtained from an external mixer. The signal is amplified and sent into the transmitter signal switch circuit. The 70-MHz reference.-oscillator is a crystal-controlled stage that produces the reference signal. After amplification, the reference signal is sent into the reference signal switching circuit.

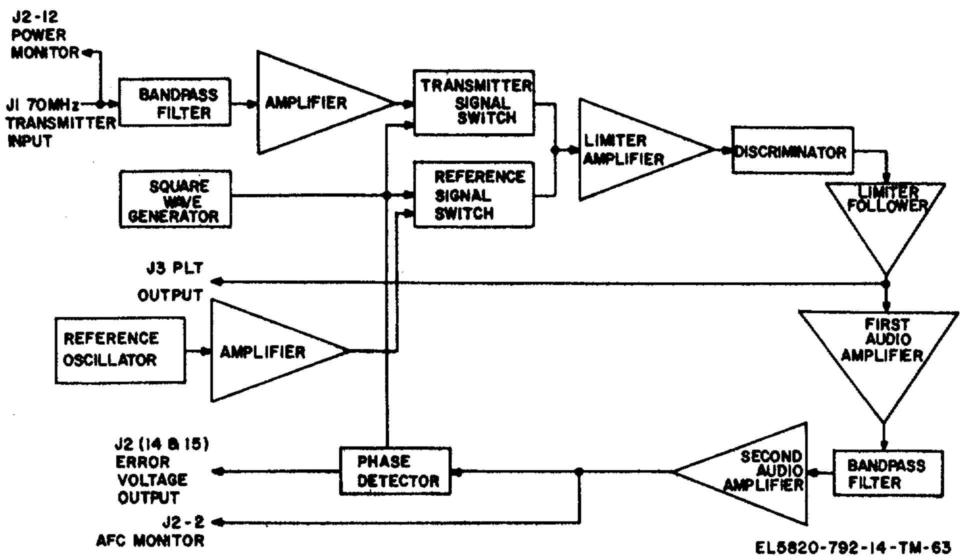


Figure 6-7. AFC module, functional block diagram.

b. The alternate switching between the incoming transmitter signal and the reference signal is accomplished by a 9-kHz square waye generator. Since the output circuits of the two signal switches are connected together, the output signal consists of reference signal samples interlaced with transmitted signal samples of equal time intervals. The output of the signal switches is amplified and limited before application to the discriminator for demodulation.

c. The demodulated signal at the output of the discriminator has a frequency of 9 kHz. Amplitude differences between the interlaced. pulses are proportional to the differences between the reference and transmitter frequencies. Each alternate pulse of the demodulated signal contains baseband components. This baseband, in certain system applications, is sent via connector J3 into a. pilot-tone module to extract the pilot tone from the transmitted baseband. Absence of the transmitted pilot tone implies loss of modulation.

d. Following amplification, the interlaced transmitter and reference signals are sent through a bandpass filter. The bandpass filter passes only the 9-kHz error signal which it converts from square waveform to sinusoidal waveform, and to reject all modulation.

e. The 9-kHz error signal is amplified once more and then sent into a phase detector. The phase detector compares the 9-kHz error signal with the 9-kHz switching signal. The output signal from the phase detector is a dc voltage with an amplitude proportional to transmitter frequency error and whose polarity indicates whether the frequency error is above or below the assigned frequency.

f. At the output of the final audio amplifier, the 9-kHz error signal is detected and a dc signal is passed out of the AFC module at pin 2 of multiple pin connector J2 for purposes of monitoring the frequency drift.

g. Frequency Drift Versus AFC Voltage Amplitude.

Frequency drift	AFC voltage	Frequency drift	AFC voltage
0	± 0.02 V	± 3MHz	± 1.65 V
± 140 kHz	± 0.32 V	± 4 MHz	± 1.69 Y
± 1MHz	± 1.29V	± 5MHz	± 1.71 V
± 2MHz	± 1.58V		

6-8. Circuit Analysis

a. As shown in figure FO-14, a continuous sampling of the transmitter output signal is applied through coaxial connector J1 to the 75-ohm unbalanced input of the AFC module. The network consisting of L15, C17, and R76 in the AFC module is the dc return line for the AFC mixer which translates the transmitter output frequency to 70 MHz. The dc return line is filtered by inductor L16 and capacitor C62 to remove residual 70-MHz signal components before exiting the AFC module at pin 12 of connector J2. This output voltage is eventually applied to an output power monitor and alarm circuit elsewhere in the overall equipment.

b. During transmitter warmup periods, it is possible for AFC circuits to stabilize on the wrong frequency. To prevent this situation, the transmitter signal is sent through a bandpass filter having a narrow-pass characteristic. The band-pass filter consists of inductors L17 and L18, and capacitors C66, C67, and C68. The filter is terminated by resistor R77.

c. Amplifier stage Q16 uses inductor L20 as its collector load; inductors L19 and L22 are RF chokes. The output signal of transistor Q16 is capacitively coupled to the base of common-emitter amplifier Q7. Coupling capacitor, C71, is adjustable to permit matching interstage impedance. The biasing arrangement used for amplifier Q7 is one method of stabilizing gain with temperature variations, but more important, the output impedance of amplifier Q7 is stabilized at a fixed value to properly terminate the transmitter signal switching circuit.

d. The reference oscillator is a Hartley oscillator using transistor .Q4 as the active element and a quartz crystal Y1 as the control element. Resistors R8 and R9 in conjunction with resistor R10 apply base bias to oscillator Q4. Inductors L11 and L12 are used to increase the input impedance of the base circuit; capacitor C5 bypasses resistor R9 at 70 MHz. Inductor L1 and capacitors C6 and C7 are filters to isolate the 70-MHz signal from the dc power line. The resonant circuit consists of transformer T1 and capacitor C9; adjustment of variable capacitor C9 permits a slight amount of tuning to set the oscillator on 70 MHz. Capacitor C11 isolates the dc supply from crystal Y1 while coupling the 70-MHz signal into the control circuit. Inductor L3 and resistor R11 in this feedback control circuit are used to counteract crystal holder effects at 70 MHz. The oscillator output is RC-coupled by C5 and R12 into common base amplifier Q5; resistor R12 is also Q5 emitter resistor. Resistors R13 and R14 set up the dc base voltage for the reference amplifier Q5. Capacitor C12 bypasses R13 to ground, holding Q5 base at ground potential for the 70- MHz reference signal, The filter, made up of L5, C15, and Cr6, prevents the 70-MHz signal from entering the dc power line. Inductor L4 is the collector load which is effectively in parallel with capacitors C13 and C58. Capacitor C13 is adjusted for impedance matching between stages.

Emitter follower Q6 provides isolation and impedance transformation between the 70-MHz amplifier and the reference signal switching circuit.

e. The 9-kHz square-wave generator, which is a free-running stable multivibrator, is made up of transistors Q1 and Q2. Diodes CR1 and CR2 perform the dual functions of insuring transistor cutoff, and providing base-to-emitter protection. Potentiometer R5 is used for frequency adjustment. The 9-kHz switching signal-is applied to emitter follower Q3 which provides impedance matching and isolation. Diode CR3 is used for temperature compensation of Q3. The output of emitter follower Q3 is applied to both sections of the switching circuitry through resistors R4, R25, and R22. Potentiometer R4 is used as a balance control to insure that the amplitude of the switching pulse in each signal switch is the same. Test point TP5 is used to monitor or measure the square-wave output signal into the signal switches.

f. The switching circuits are shown in the simplified schematic diagram of figure 6-8. The transmitter 70-MHz signal present at the output of amplifier Q7 is applied across diodes CR4 and CR6 to ground. The output of emitter follower Q3, which is associated with this portion of the circuit, is applied to the series circuit consisting of capacitor C4, resistor R22, and diode CR6. Diode CR6 is the common element for both the 9-kHz sampling pulse and the 70-MHz transmitter signal.

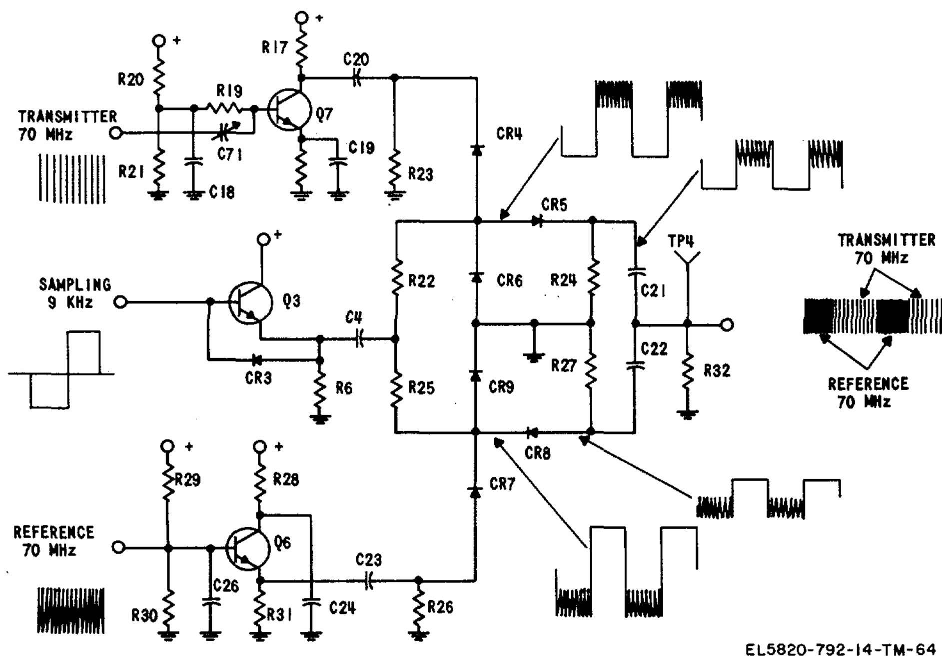


Figure 6-8. Interlacing of transmitter and reference signals, simplified schematic diagram.

g. When the sampling pulse switches positive, diode CR6 is cut off. The voltage at the junction of resistor R22 and diodes CR4, CR5, and CR6 is raised from ground potential to approximately 10 volts positive. Diodes CR4 and CR5 become highly conductive. The 70-MHz transmitter signal is superimposed on the sampling pulse and passed by diode CR5 to load resistor R25. The dc level, arising from the use of the sampling pulse, is blocked by capacitor C21. Only the 70-MHz transmitter signal is present in the output of the switching circuit across resistor R32.

h. During this same time period, the positive sampling pulse present across diode CR9 drives the diode into a highly conductive state. In this case, the voltage at the junction of resistor R25 and diodes CR7, CR8, and CR9 is lowered to essentially ground potential. The 70-MHz reference signal is now shunted to ground. Diode CR8 is, of course, in the nonconductive state and also blocks the passage of the 70-MHz reference signal to the output-channel load resistor, R32.

i. When the sampling pulse switches to its negative valve, the conditions at the two junction points previously discussed are reversed. The net result is that the 70-MHz transmitter signal is shunted to ground, while the 70-MHz reference signal is passed to the output across resistor R32.

j. The signal across resistor R32 consists of samples of the 70-MHz transmitter signal alternately interlaced with samples of the 70-MHz reference signal at a 9-kHz rate. The output of the switching circuit can be measured or monitored at test point TP4. This interlaced signal is sent into common-emitter stage Q8 for amplification. Diodes CR10 and CR11 limit the positive and negative peaks of the interlaced signal. Transformer T2 tends to restore the interlaced signal to its sinusoidal waveform in addition to coupling the signal into common-base amplifier Q9. The signal from amplifier Q9 is limited a second time, then sent into amplifier Q10. The collector load of Q10 is a tuned circuit consisting of L8, R42, and C36; adjustable capacitor C36 is used to obtain maximum signal into the discriminator.

k. The discriminator is a stagger-tuned Travis circuit. The upper leg of the circuit consisting of L9, C59, and C39 is tuned to 60 MHz, while the lower leg of the circuit consisting of L10, C61, and C40 is tuned to 80 MHz. The resonant or center frequency is 70 MHz. Diodes CR14, and CR15 are the detector diodes; these a, poled in opposite directions so that the positive signal detected at 70 MHz by diode CR14 is canceled out by the negative signal detected at 70 MHz by diode CR15 across resistors R3 and R46. Capacitors C41 and C42 bypass the 70-MHz signal in their respective branches to ground. If no modulation is present in the transmitted signal the discriminator output signal will be 0 volt at the 9-kHz switching frequency. If modulation is present in the transmitted signal, this baseband will be present in the discriminator output. Potentiometer R3 is adjusted to produce zero volt at the output of the discriminator when the input signal of the module is 70 MHz. Test point TP3 is used to monitor and measure the discriminator output voltage.

1. The output signal of the discriminator is RC-coupled into emitter follower Q11 which provides impedance matching between discriminator and succeeding audio amplifier stages. Notice that an output signal is developed at the collector of transistor Q11 and passed via coupling capacitor C65 to coaxial connector J3; this is sent into a pilot-tone detector module and is used as a modulator-loss alarm.

m. The output of transistor Q11 is RC-coupled to the base of common-emitter amplifier Q12, which is the first of three audio amplifiers. After the first stage, the audio signal is sent through a dual-purpose bandpass filter FL1. This filter rejects all modulation from the error signal, and converts the error signal from a square wave to a sinusoidal wave. The 3 dB pass-band of the filter ranges between 8.98 kHz and 9.03 kHz. Potentiometer R1 in the emitter circuit of amplifier Q13 is used as a gain adjustment by varying the applied base bias. The overall gain of the audio amplifier is approximately 600.

n. The output of emitter follower Q15 is applied to the primary winding of transformer T4, which is one input signal into the phase detector. This same signal is rectified by diode CR18 and filtered by C72-R82 and passed through pin 2 of printed-circuit connector J2; this error voltage is monitored as AFC at the terminal meter panel. The phase detector is a standard synchronous detector shown in the simplified schematic of figure 6-9. The 9-kHz switching signal is injected by means of T5 secondary into the center strap of T4 secondary; this signal is the standard or synchronizing signal. The 9-kHz error signal developed across the secondary of transformer T4 is mixed with the switching signal also present in T4 secondary. If the transmitter is exactly on frequency, the error and switching signals cancel each other in T4 secondary and the AFC output signal to the transmitter is zero. If the transmitter is not on frequency, the error and switching signals do not completely cancel, so that the difference in signal amplitudes is rectified by diodes CR16 and CR17 and the resulting AFC output voltage is sent into the transmitter to correct transmitter output frequency. During normal operation, the AFC voltage varies between the limits of - 0.5 V, which can be measured between test points TP1 and TP6. Reference to figure FO-14 Q) shows that the AFC module provides a floating (ungrounded) output line at pins 14 and 15 of printed-circuit connector J2. The output line is provided with an ON-OFF switch S1 to enable or disable AFC action as desired.

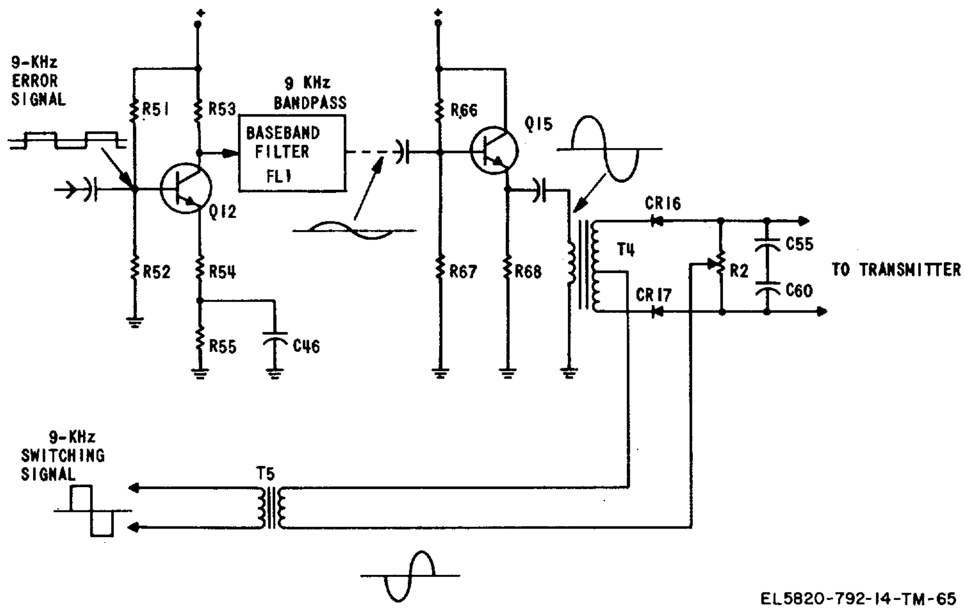


Figure 6-9. AFC phase detector, simplified schematic diagram.

o. Technical Characteristics.

Parameter	Specifications
Pinput impedance	75 ohmns, unbalanced
Output impedance	
Pilot tone output	75 ohmns, unbalanced
Error voltage output	Matched to 75 ohms
Input level	20.0 mV at 70 MHz
Output level	
Pilot tone	5 mV (min) peak-to-peak (variable)
AFC	± 1.0 V for ± 64 kHz
Iower requirements	265 ma at + 28 V dc

6-9. Maintenance Data

a. Performance Test and Trouble Analysis Procedures (General). The following paragraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect the test equipment and test cables to the module as shown in figure 6-10.

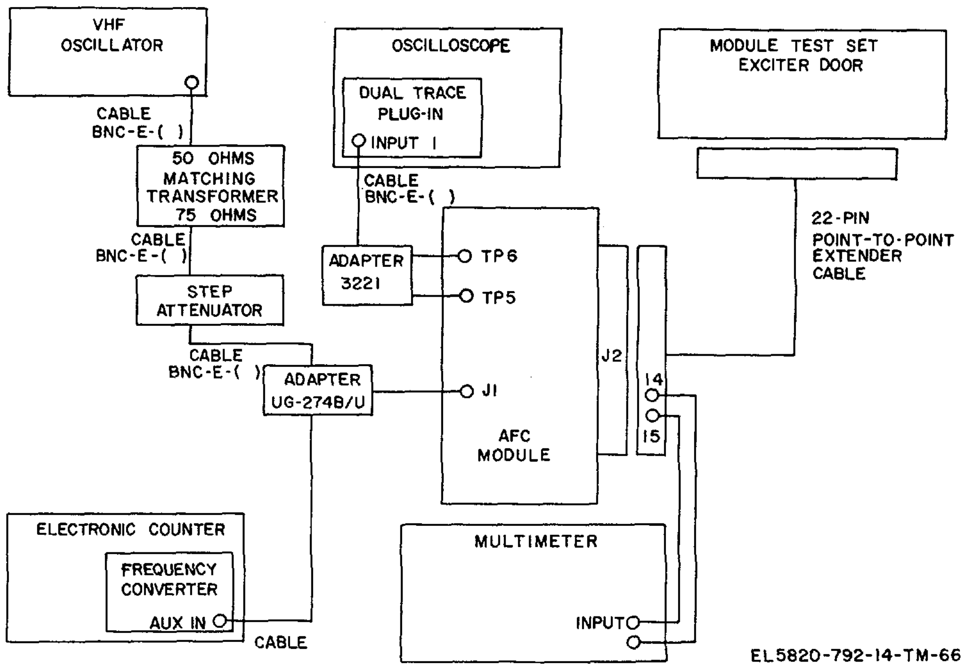


Figure 6-10. AFC module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Insure the top and bottom covers are tightly secured to the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the +28-volt power supply in the module test set to provide +28 ±,0.1 V dc.

(4) Insure that the module test set Klystron power supply is off.

d. Test Procedures. After completing procedures in b and c above, perform the procedures in e.

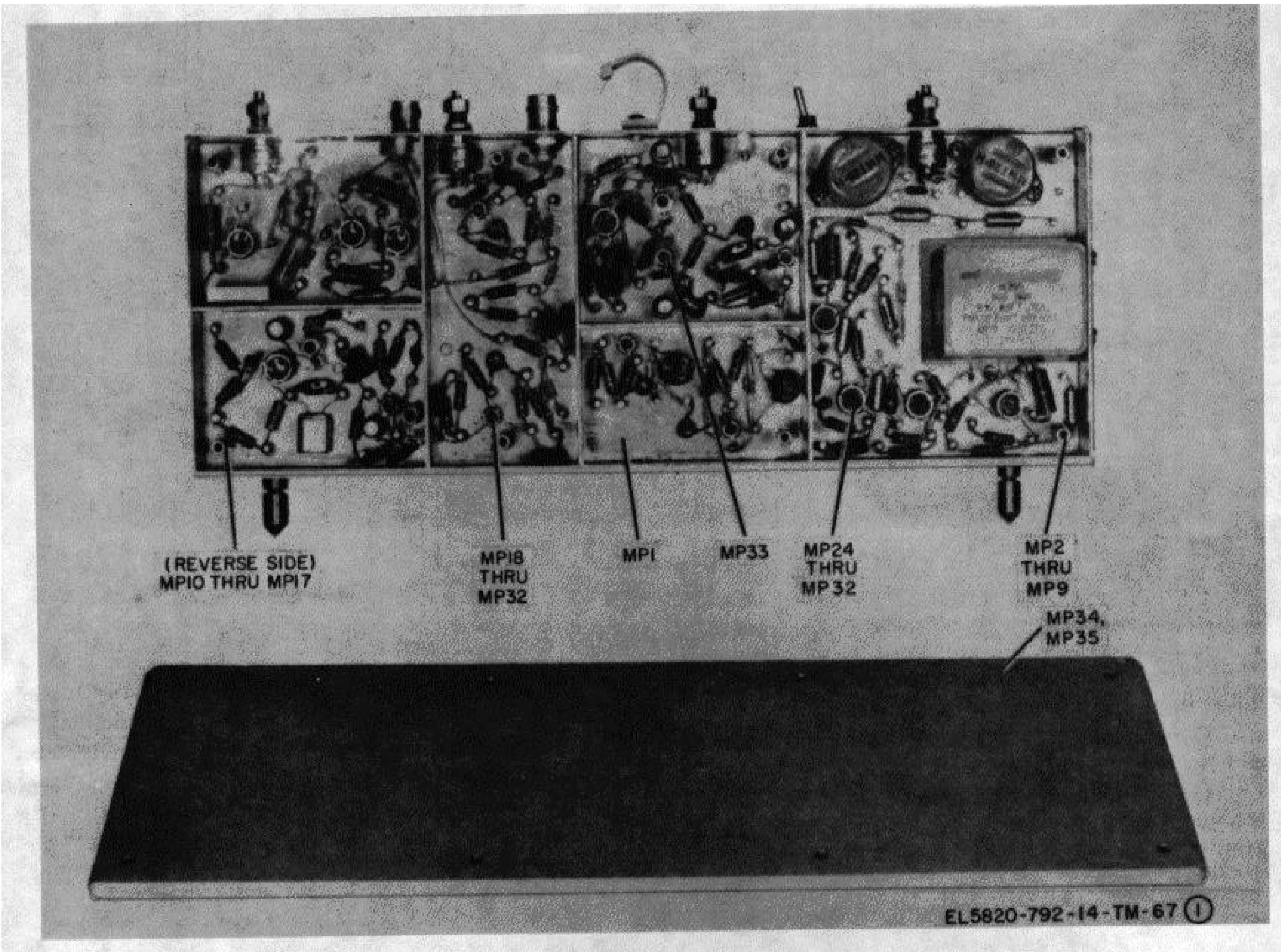


Figure 6-11 (1). AFC module, parts location diagram (sheet 1 of 2).

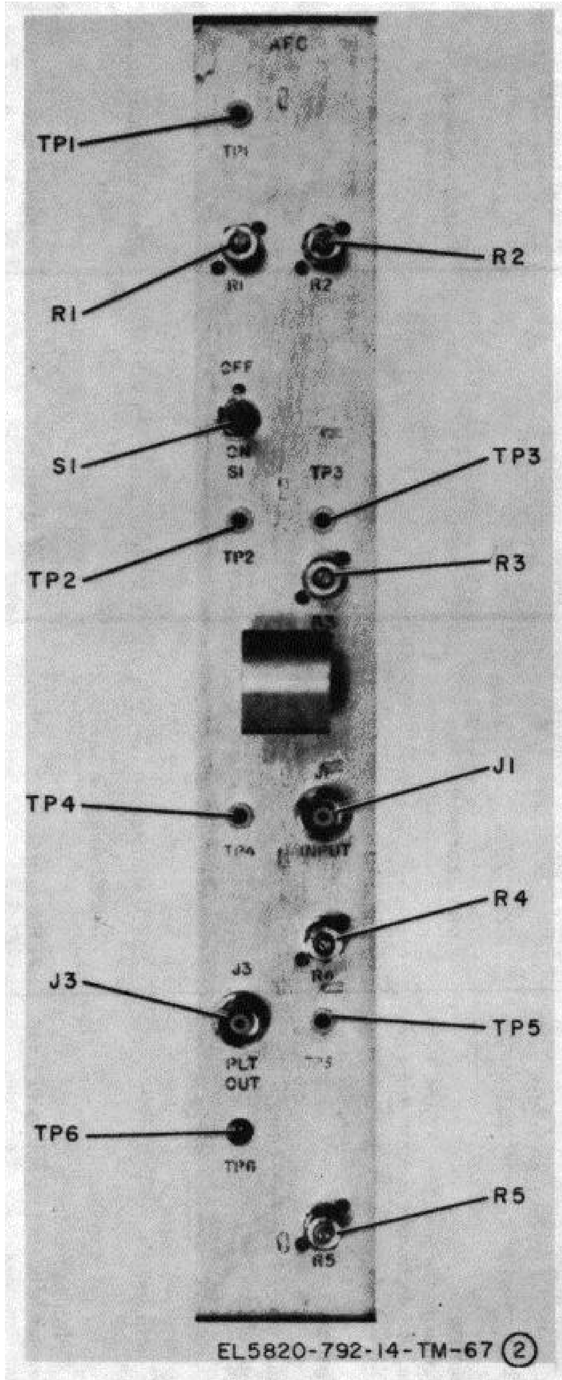


Figure 6-11 (2). AFC module, parts location diagram (sheet 2 of 2).

e. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Sensitivity Performance Check		
1	Set the AFC ON-OFF switch to ON.			
2	Using a VHF oscillator, set its output frequency to 70 - 0.001 MHz in the CW mode. Verify frequency using an electronic counter, then disconnect the counter from the T-connector mounted on J1 of the module.			
3	Connect an RF voltmeter to the free port of the T-connector.			
4	Adjust VHF oscillator output attenuator or external step attenuator to obtain 20 mV on RF voltmeter.			
5	Observe the multimeter indication.	0 ± 0.2 Vdc (mx)	Proceed to step 6.	Proceed to step 15.
6	Reconnect electronic counter to T-connector. Adjust VHF oscillator frequency until electronic counter indicates 70.134 MHz + 10 kHz.			
7	Observe multimeter indication.	+1.8 V dc or greater.	Proceed to step 8.	Proceed to step 15.
8	Reconnect electronic counter to T-connector. Adjust VHF oscillator frequency until electronic counter indicates 69.8666 MHz + 10 KHz. Disconnect electronic counter from the T-connector.			
9	Observe multimeter indication.	- 1.8V dc or greater.	Proceed to step 10.	Proceed to step 15.
		Pilot-Tone Performance Check		
10	Connect the test equipment as shown in figure 6-12.			
11	Adjust the output level of the test oscillator until ac voltmeter 1 indicates 3.7 mV and adjust the test oscillator frequency until the electronic counter indicates 3.2 MHz ± 20 Hz.			
12	Note the indication of ac voltmeter 2.	2.5 mV minimum.	Pilot-tone test is complete.	Check connections toJ3, C65, and Q11.
		Trouble Analysis Checks		
13	Perform steps 1 through 4 of this procedure.			
14	Connect the electronic counter between test points TP5 and TPE (ground).	9kHz - 10 Hz	Proceed to step 15.	Perform squarewave generator frequency adjustment procedure (para 6-10d). d. If normal indication is not obtained with adjustment, check Ql, Q2, and Q3 and associated components.
15	Connect the electronic counter to the junction of C23 and R31. Use an X1 oscilloscope probe.	70 MHz -1 kHz	Proceed to step 18.	Perform reference oscillator alignment procedure (para 6-10c). If normal indication is not obtained with adjustment, proceed to step 18.
16	Connect an RF voltmeter with high impedance probe to Q4 emitter and ground.	1 V minimum	Proceed to step 17.	Check Q4 and associated components.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
17	Connect an RF voltmeter with high impedance probe to Q6 base and ground.	0.8 V minimum	Proceed to step 18.	Check Q5, C14, and associated components.
18	Using an electronic counter, set the frequency of VHF oscillator to 70 MHz ± 1 kHz using the CW mode.			
19	Observe the wave form at test point TP4 on the oscilloscope at the following principal settings: VOLTS/CM to .2. TIME/CM to 50 USEC X10 probe.	Refer to figure 6-13.	Proceed to step 22.	Adjust variable resistor R4 for normal indication. If nor-meal indication is not obtain-ed with adjustment, proceed to step 20.
20	Connect RF voltmeter with a high impedance probe to Q7 collector and ground.	0.8 ± 0.3 V	Proceed to step 21.	Check Q7 and associated com-ponents.
21	Connect RF voltmeter with a high impedance probe to Q6 emitter and ground.	0.8 :± 0.3 V	Proceed to step 22.	Check Q6 and associated com-ponents.
22	Connect RF voltmeter with a high impedance probe to the junction of CR5 and C21.	1 ± 0.5V	Proceed to step 23.	Check CR4, CR5, CR6, C20, R23: R24.
23	Connect RF voltmeter with a high impedance probe to the junction of CR8 and C22.	1 ± 0.5V	Proceed to step 24.	Check CR7, CR8, CR9, C23, R27, and R26.
24	Connect-RF voltmeter with a high impedance probe to Q10 emitter and ground.	0.2 ± 0.4 V	Proceed to step 25.	Check Q8 and Q9 and asso-ciated components.
25	Remove VHF oscillator from input connector J1, connect oscillator to test point TP3 and chassis ground. Set principle oscilloscope controls to: VOLTS/CM to e05 TIME/CM to 20 USEC XI probe.			
26	Observe the waveform on the oscilloscope.	Refer to figure 6-14.	Proceed to step 31.	Perform discriminator balance adjustment procedure (par 6-10g). If normal indication is not obtained with adjust-ment, proceed to step 27.
27	Connect RF voltmeter to junction of C38, R43,.and R44.	2.5 ± 0.5V	Proceedtostep28.	Check Q10 and associated com-ponents.
28	Reconnect test equipment to JI of the AFC module as shown in figure 6-10.			
29	Observe the oscilloscope presentation.	Refer to figure 6-14.		
30	Connect the test equipment as shown in figure 6-15.			
31	On the transmission generator, set the controls as follows: FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 20 SWEEP WIDTH (MHz) FINE to 0 MODE to BB + SWEEP			
32	On the transmission generator, adjust the ATTENUATION (dB) pushbuttons until the RF voltmeter indicates 20 mV.			
33	Set the DISPLAY switch on the demodulator display to IF: then using IF LEVEL pushbuttons, set the IF LEVEL meter to . 0.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
34	Set the DISPLAY switch to EXT.			
35	On the demodulator display unit, set the CALIBRATION (dB) control to its EXT. 50 mV position. On the demodulator display unit, adjust the Y1 gain for 0.5 cm vertical display; then Y2 gain fully counterclockwise and position the Y2 trace to the center graticule on the display.			
36	On the demodulator display unit, set the CALIBRATION (dB) control to OFF.			
37	On the demodulator display, adjust the MARKER OFFSET (MHz) to 8.			
38	Disconnect the input cable from the EXT. INPUT connector on the demodulator display.			
39	Using the Y POSITION control, superimpose the two traces; refer to figure 6-16.			
40	Reconnect the test cable to EXT. INPUT on the demodulator display.			
41	Observe waveform on oscilloscope at TP3 and ground.	Refertofigure6-17.	Proceedtostep42.	Perform discriminator alignment and subsequent alignment. If normal indication cannot be obtained, check components of 70 MHz discriminator.
42	Connect an oscilloscope to test point TP2 and ground.	20 ± 3V peak-to-peak, refer to Figure 6-18.	Proceed to step 43.	Proceed tostep48.
43	Connect oscilloscope between pin I of transformer T5 and ground.	24 ± 1V peak-to-peak.	Proceed to step44.	Check cable from square-wave generator to pin 3 ofT5.
44	Remove +28 V dc from the module, and set a multimeter FUNCTION switch to OHMS and its RANGE switch to X10. Connect the multimeter to pins 14 and 15 on the extender cable.			
45	On the AFC module, adjust variable resistor R2 over the entire range.	Resistance changes from 700 ohms to4k ohms.	Proceedtostep46.	CheckCR16, CRI7, andR2.
46	Connect RF voltmeter with a high impedance probe to Q12 base and ground.	10mV nominal	Proceed to step 47.	Check C45, Q11, and associated components.
47	Connect an oscilloscope to Q13 base and ground.	150mV peak-to-peak min.	Proceed to step 48.	Check Q12, FLI, and associated components.
48	Connect. an oscilloscope to Q14 base and ground.	300mV peak-to-peak min.	Proceed to step 49.	CheckQ13 and associated components.
49	Connect an oscilloscope to Q15 base and ground.	3V peak-to-peak min.	Repeat module qualification as described in steps 1 through 12. Disconnect all test equipment.	Check Q14, Q15, and associated components.

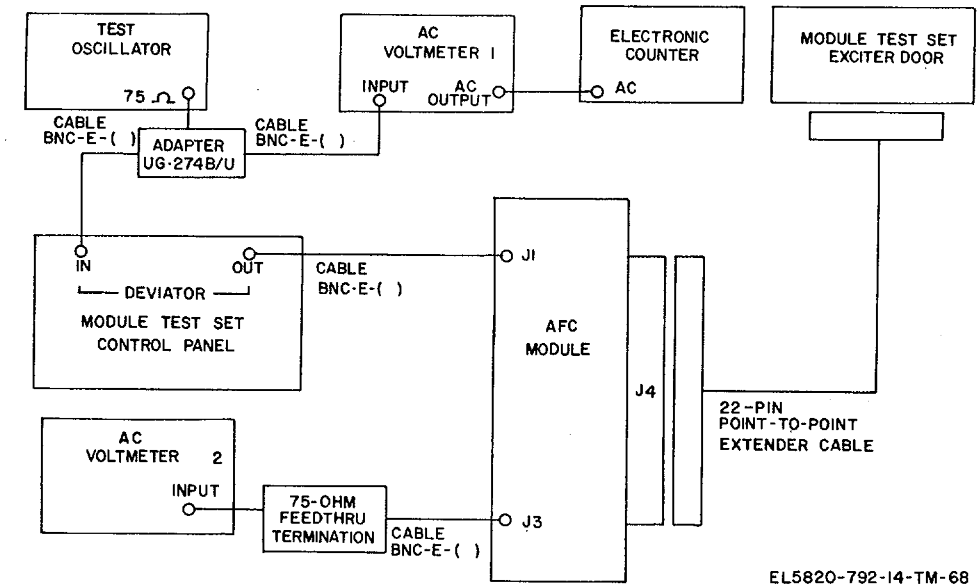


Figure 6-12. AFC module, pilot-tone test equipment setup.

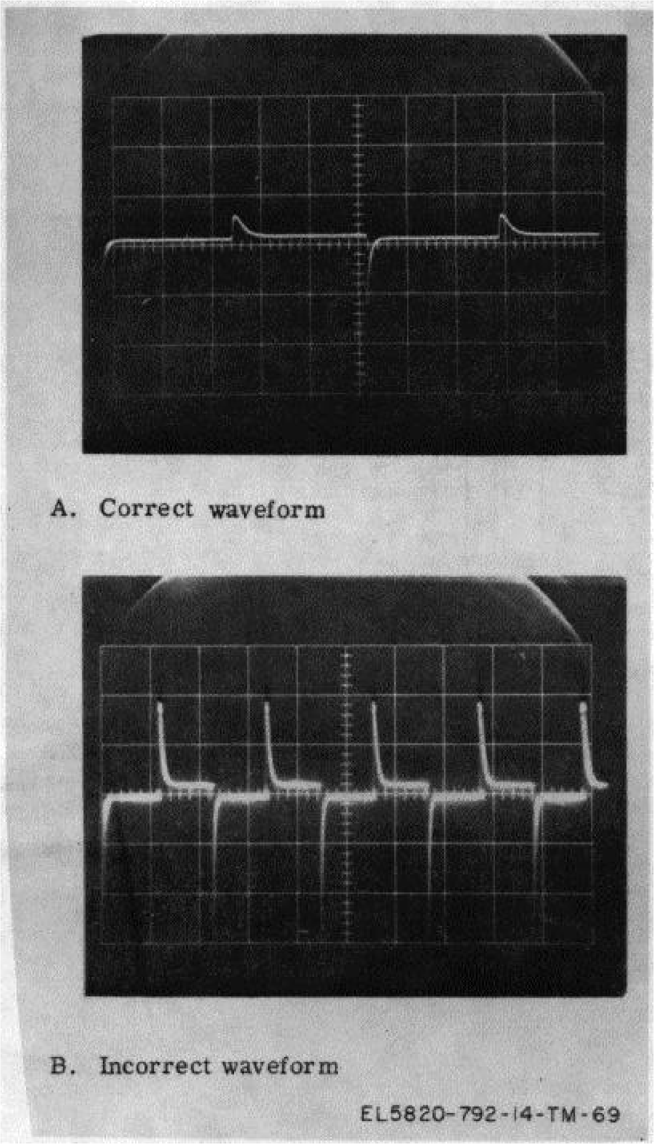


Figure 6-13. AFC switch output waveform at TP4.

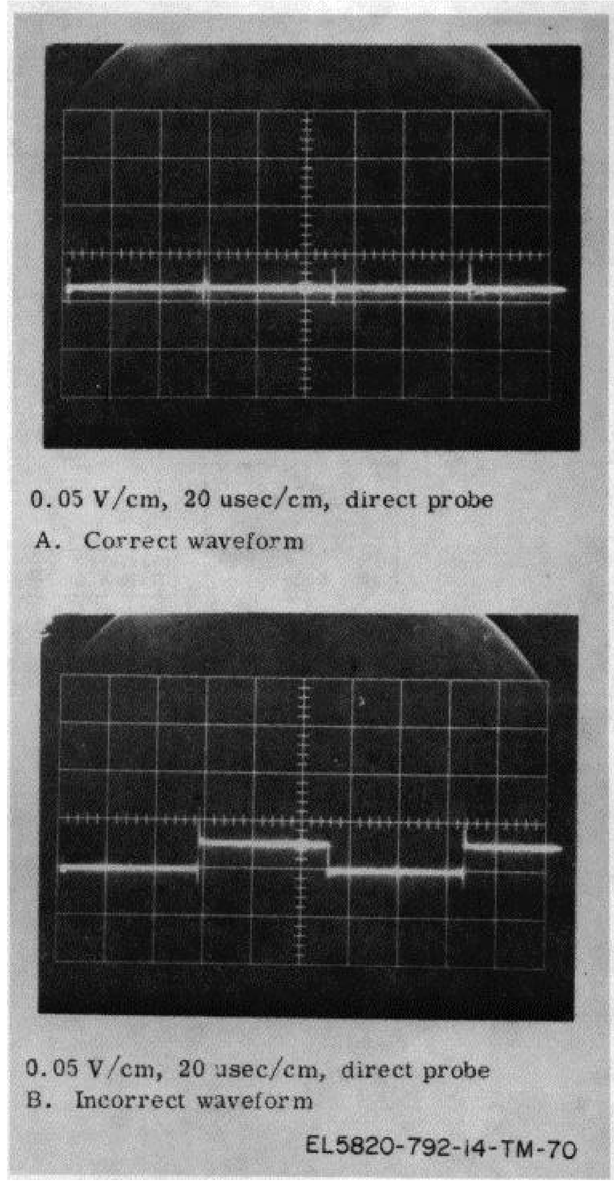


Figure 6-14. AFC discriminator output waveform at TP3, switching signal only.

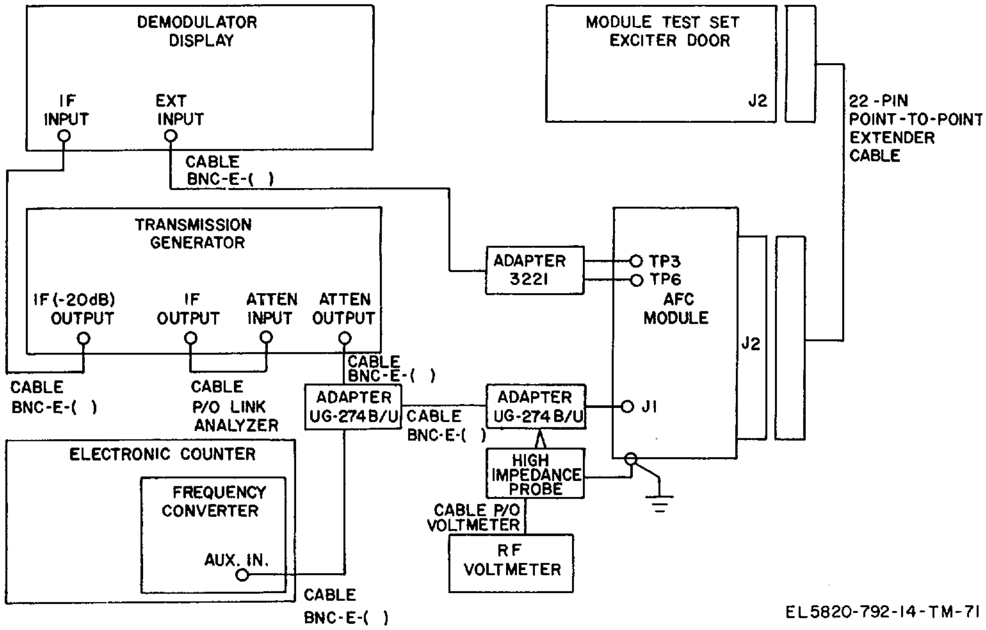


Figure 6-15. AFC module, discriminator test equipment setup.

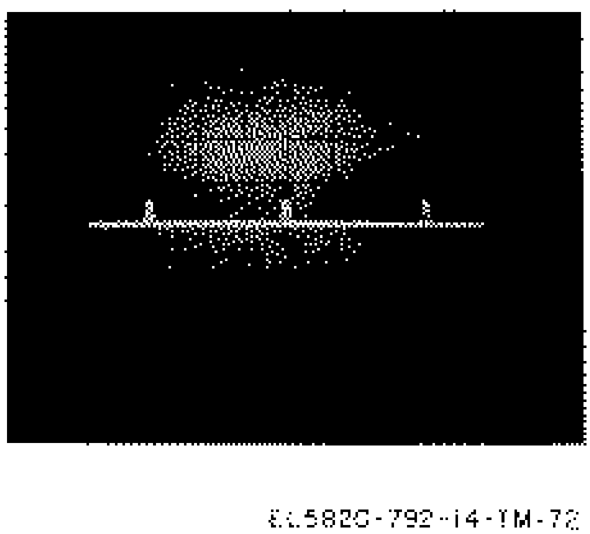


Figure 6-16. Preliminary test equipment calibration waveform.

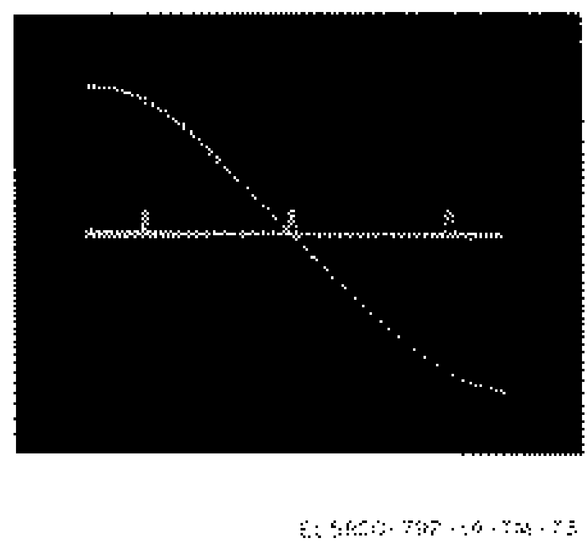


Figure 6-17. Discriminator crossover waveform at TP3, switched signal conditions.

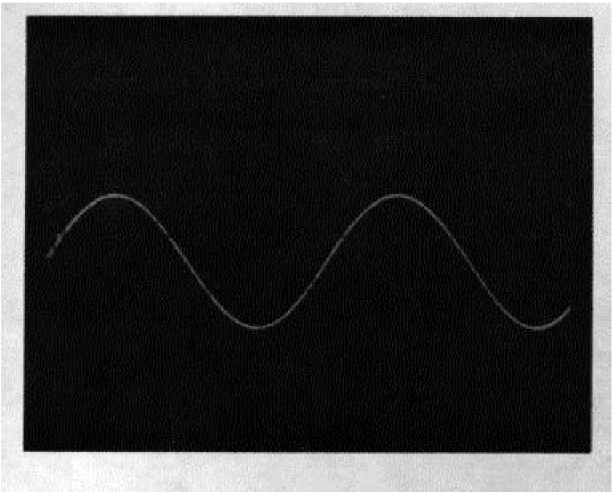


Figure 6-18. Frequency error signal at TP2.

f. Voltage and Resistance Measurements. If performance of the test and(or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in *g* below in, conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources. The RX100 scale of the multimeter is used as the standard range unless otherwise stated; the common multimeter lead is connected to J4-5 (ground) during all except reversed test lead measurements.

(2) Dc voltage measurements are made with the module connected to the receiver door of the module test set using the appropriate point-to-point extender cable. No signal source is employed.

(3) Ac voltage measurements are made using the following procedure:

(a) On a VHF oscillator set the FREQUENCY RANGE (MHz) to 68-130 and set the TUNE control to 70 MHz; verify oscillator frequency using an electronic counter.

(b) Set an IF attenuator to provide 40dB.

(c) Connect the test equipment as shown in figure 6-19.

(d) Set the RF voltmeter to the .03 volt scale, then connect it to the AFC module between the nearest ground post and J1 INPUT.

(e) Add or remove attenuation until the RF voltmeter indicates 20 millivolts.

(f) Perform ac voltage measurements as necessary. Since the module covers are removed, truly accurate ac voltage measurements in this module are difficult to obtain, maneuver the RF voltmeter probe for best meter indication.

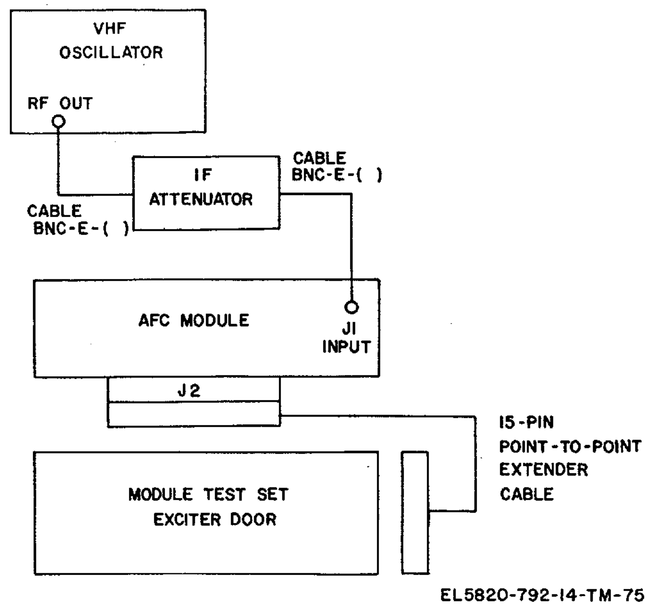


Figure 6-19. Troubleshooting test equipment setup.

g. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)
Q1	Base	0.62		1.5K[c]
	Emitter	0		0
	Collector	12.80		2.3K
Q2	Base	0.64		1.65K
	Emitter	0		0
	Collector	12.60		1.75K
Q3	Base	12.60		1.75K
	Emitter	12.80		1.40K
	Collector	27.00		1.10K
Q4	Base	6.40	115 mV[a]	2.20K
	Emitter	8.50	3.2V	0.81K
	Collector	27.10	3.0V[b]	1.1OK

See footnotes at end of chart.

Point of measurement		Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)
Q5	Base	11.30	390.0 mV	300K
	Emitter	10.70	780.0 mV	0.80K
	Collector	27.10	2.16 V	1.1K
Q6	Base	4.30	530 mV	1.90K
	Emitter	3.60	450 mV	0.63K
	Collector	20.00	68 mV	1.10K
Q7	Base	4.8	17 mV	1.20K
	Emitter	4.0	25 mV	0.66K
	Collector	16.0	160 mV	2.40K
Q8	Base	16.2	390 mV	6.50K
	Emitter	14.6	18.5 mV	2.20K
	Collector	27.8	160 mV	1.1OK
Q9	Base	16.2	20.5 mV a	4.40K
	Emitter	15.5	130 mV	2.40K
	Collector	27.8	530 mV	l.1OK
Q10	Base	16.1	110 mV a	4.60K
	Emitter	16.4	230 mV	2.00K
	Collector	27.8	2.4 V	1.10K
Q11	Base	13.3	l10 mV	2.40KC
	Emitter	12.5	25 mV	1.05K
	Collector	27.8	2.2 V	1.10K
Q12	Base	9.6	20.5 mV	2.80K c
	Emitter	8.9	18.0 mV	0.87K
	Collector	14.6	120.0 mV	2.40K
Q13	Base	11.9	360 mV	7.00KC
	Emitter	11.2	370 mV	3.70K
	Collector	19.6	130 mV	6.00K
Q14	Base	5.1	135 mV	5.50K
	Emitter	4.5	130 mV	0.53K
	Collector	13 9	1.5 V	2.20K
Q15	Base	14.1	1.5 V	2.20K C
	Emitter	14.9	1.5V	0.62K
	Collector	27.2	15.0 mV	1.16K
Q16	Base	20.8	9.4 mV	4.00K
	Emitter	21.2	2.0 mV	3.00K
	Collector	27.8	3.6 mV	1.10K
J2	Pin 1	+28.0		
	Pins 2 through 7	0		
	Pin 8	-12.0		
	Pins 9 through 13	0		
	Pin 14	-12.2		
	Pin 15	-9.7		

[a] Measurement involves a ferrite bead; measure after the bead at the standoff terminal.
[b] Measurement exceeds the value indicated.
[c] Measure resistance by reversing meter leads from standard setup.

6-10. Alignment Data

a. General. The following procedures should be performed after repairs have been made to the module. The AFC module contains many tuned circuits which must be carefully aligned to obtain optimum module performance. The arrangement of the procedures in this paragraph is based on a requirement for complete realignment.

b. Test Equipment Setup. The test equipment setups for the alignment and adjustment of the module are given in the applicable paragraph.

c. 70 MHz Reference Oscillator. The alignment of the reference oscillator consists of tuning the oscillator to the proper frequency and obtaining the correct amplitude. This routine involves a soldering operation which must be followed by an inspection for loose bits of solder and cold solder connections.

(1) Inspect the module for the location of Q1 (fig. FO-6 2).

(2) Ground the base of Q1 with a short clip lead.

(3) On the module test set, set the KLYSTRON . switch of the Klystron power supply to its OFF position.

(4) Connect the AFC module to one end of a

22-pin point-to-point extender cable (368-43546-1) and the other end to the AFC position in the exciter door of the module test set.

(5) Insure that the +28 V power supply of the module test set is adjusted to +28 ± 0.1 V dc.

(6) Connect the high impedance probe of an RF voltmeter to the junction of R31 and C23 (fig. FO-6 (2).

(7) Adjust C9 and C13 for a nominal indication of 650 ± 50 mV on the RF voltmeter.

(8) Disconnect the RF voltmeter and connect an electronic counter through a 10 pF capacitor soldered to the junction of R31 and C23 using a BNC-E-( ) cable and a 2631 adapter.

(9) Adjust C9 (and T1 if provided with a tuning slug) as necessary to obtain an output frequency of 70 MHz + 1,000 Hz, the electronic counter should indicate 699990 to 700010.

(10) Disconnect the frequency counter from the test setup.

(11) Repeat (6) through (10) above to be sure that the output level and frequency are within tolerance.

(12) Remove power from the module and disconnect the test equipment.

(13) Remove the ground from the collector Q1.

(14) Remove the 10 pf capacitor installed in (8) above.

d. Square-Wave Generator Output Frequency. This alignment procedure is used primarily to establish the output frequency of the square-wave generator.

(1) On the module test set, set the KLYSTRON switch of the Klystron power supply to its OFF position.

(2) Connect the AFC module to one end of a 22-pin point-to-point extender cable (368-43546-1) and the other end to the AFC position in the exciter door of the module test set. Preset R5 to its midposition.

(3) Insure that the 28 V power supply of the module test set is adjusted to +28±0.1 V dc.

(4) Connect the test equipment to the module as shown in figure 6-20.

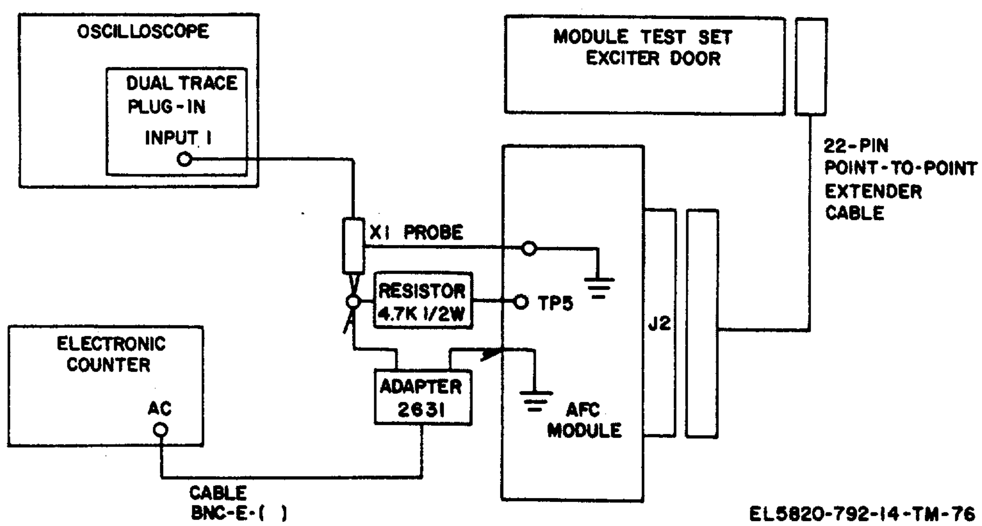


Figure 6-20. AFC module squarewave generator, test equipment setup.

(5) On the oscilloscope, set the principal controls as follows:

(a) TRIGGERING MODE to AUTO.

(b) TRIGGER SLOPE to + INT.

(c) VOLTS/CM to 5 V/cm.

(d) TIME/CM to 20 USEC.

NOTE

Alternate the oscilloscope and counter connection at the 4.7K resistor (fig. 6-20). Simultaneous connection affects the waveform.

(6) Adjust R5 until the electronic counter indicates 9 kHz ± 5 Hz (8095 to 9005); refer to figure 6-21 for waveform diagrams.

(7) Check the peak-to-peak amplitude of the 9 kHz switching signal. Minimum amplitude should be 24 volts peak to peak.

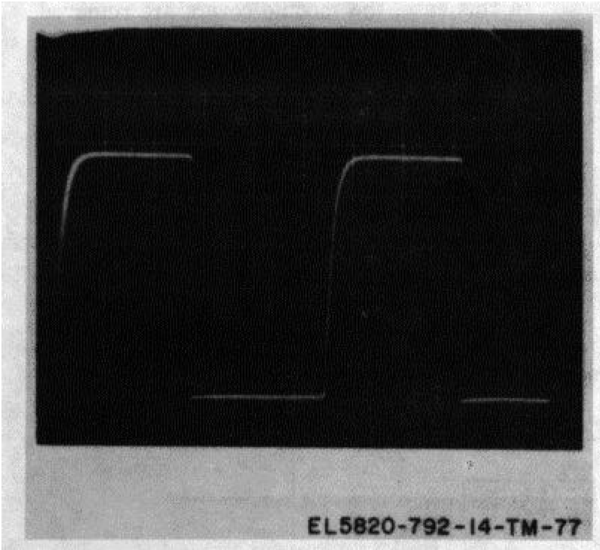


Figure 6-21. AFC module, 9 kHz switching signal waveform.

(8) Disconnect all test equipment.

e. Discriminator Alignment. The alignment of the discriminator consists of tuning the resonant circuits to produce 0 output voltage when the input frequency is 70 MHz. This routine involves a soldering operation which must be followed by an inspection for loose bits of solder and cold solder connections.

(1) On the module test set, set the Klystron power supply KLYSTRON switch to OFF.

(2) Ensure that the +28 V power supply of the module test set is adjusted to +28 ±0.1 V dc.

(3) Inspect figure FO-6 (to ascertain the position of C71 and figure FO-6 (to ascertain the position of R19.

(4) Unsolder C71 from the junction of C71 and R19.

(5) Unsolder the lead from the center conductor of J1 on the module.

(6) Connect an 820 pF capacitor between connector J1 and the junction of resistor R19 and the base Q7.

(7) Temporarily, connect a 4.75K resistor between the junction of diodes CR4, CR5, and CR6 and the free end of R17. Resistor R17 is connected between transistor Q7 and a standoff terminal on the chassis. For this test, the free end of R17 is considered to be that end which is connected to the standoff terminal. This connection places a positive voltage on the diode junction to enable this portion of the switch.

(8) Operate AFC switch S1 to OFF.

(9) Connect the module and test equipment as shown in figure 6-15.

(10) On the transmission generator, set the controls as follows:

FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to O SWEEP WIDTH (MHz) COARSE to 20
SWEEP WIDTH (MHz) FINE to O

(11) On the transmission generator, adjust the ATTENUATION (dB) pushbuttons until the RF voltmeter indicates 20 mV.

(12) Set the DISPLAY switch on the demodulator display to IF. Then using the IF LEVEL attenuator pushbuttons, set the IF LEVEL meter to 0.

(13) Set the DISPLAY switch to EXT.

(14) On the demodulator display unit, set the CALIBRATION (dB) control to its EXT. 50 mV position.

(15) On the demodulator display, adjust the Y1 GAIN for 0.5 cm vertical display. Then Y2 GAIN fully counterclockwise and position the Y2 trace to the center graticule on the display.

(16) On the demodulator display unit, set the 'CALIBRATION (dB) control to OFF.

(17) On the demodulator display, adjust the MARKER OFFSET (MHz) to 8.

(18) Disconnect the input cable from EXT. INPUT connector on the demodulator display.

(19) Using the Y1 POSITION control, superimpose the two traces (fig. 6-16).

(20) Reconnect the test cable to EXT. INPUT on the demodulator display.

(21) On the AFC module, set R3 to its midrange position.

(22) Preset L9 and L10 so that the tuning screws are midrange.

(23) On the AFC module, adjust C36, C39, and C40, with L9 and L10 as follows to produce a linear discriminator waveform as shown in figure 6-17.

(a) Capacitor C36 is used to set the 70 MHz cross-over point and also establishes equal peak excursions of the response curve.

(b) Capacitor C40 and inductor L10 establish the higher frequency portion of the waveform. Capacitor C40 is the primary adjustment, and inductor L10 is used to refine the adjustment.

(c) Capacitor C39 and inductor L9 establish the lower frequency portion of the waveform. Capacitor C39 is the primary adjustment, and inductor L9 is used to refine the adjustment.

(24) Tune the circuit elements so that thel response curve has a minimum spread of 8 MHz at its peak excursion and a minimum peak-to-peak amplitude of 0.6V (6 cm on the display). The 70 MHz crossover point must be within 0.5 cm (50 mV) of the Y2 trace reference line. The controls are tuned to obtain equal peak excursions within 50 mV (0.5 cm).

(25) Disconnect the AFC module from its power source. Disconnect all test equipment.

(26) Remove the 4.75 K resister installed in (3) above.

(27) Remove the 820 pF capacitor installed in (7) above and reconnect the normal lead to the center con-

ductor of J1.

(28) Reconnect C71 to R19.Q7 junction.

NOTE

It is possible that the discriminator is not quite aligned at this time. This misalignment will be apparent when the discriminator balance and phase-detector zero balance adjustment (g and i below, respectively) procedures fail to provide the proper results.

In this case, the module covers are removed and the discriminator controls are readjusted while looking at the waveform at TP3. The potentiometer control is set to midrange and the discriminator controls C39, and C40, are adjusted until a straight line is obtained. Repeat the above alignment (10) through (28) above to refine the discriminator curve.

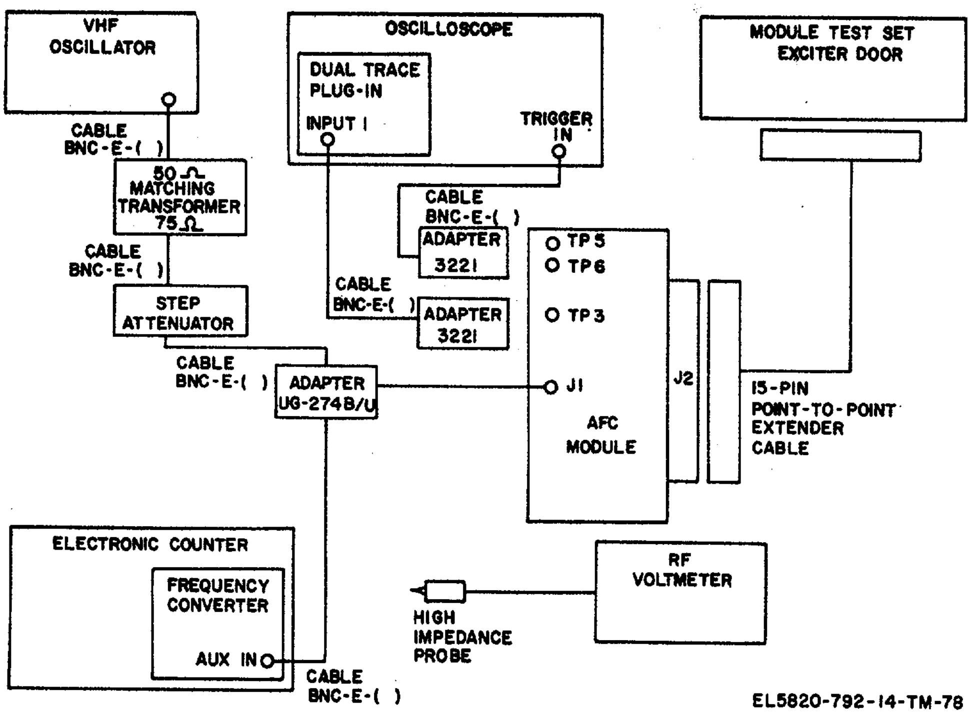


Figure 6-22. AFC module, switch circuit balance test equipment setup.

f. Switch Circuit Balance. This alignment procedure is used to equalize the amplitudes of the switching pulses at the output of the switching circuits. Set up the equipment as in figure 6-22.

(1) Connect an oscilloscope through a 10X probe to the junction of CR4, CR5, and CR6. Note the peak-topeak signal level.

(2) Transfer the oscilloscope probe to the junction of CR7, CR8, and CR9. Adjust R4 to obtain the same peak-to-peak level as noted in step (1).

(3) Repeat (1) and (2) above until the signal levels are identical.

(4) Disconnect all test equipment.

g. Discriminator Balance. This alignment is used to equalize the amplitudes of the switching pulses at the output of the discriminator. No input signals from an external source are required for this procedure. The module covers must be in place and tightly secured to the module.

(1) On the AFC module, set S1 to its OFF position and set R1 to its center position.

(2) On an oscilloscope, set the VOLTS/CM control to .05 and the TIME/CM control to 20 USEC. Set oscilloscope TRIGGERING MODE to AUTO, TRIGGERING SLOPE to EXT.

(3) On the oscilloscope connect the TRIGGERING INPUT to test points TP5 and TP6 using one of the 3221 pin tips. Then connect INPUT 1 of the oscilloscope to test point TP3 on the module using one of the 3221 pin tips, since oscilloscope ground is already established at TP6.

(4) On the AFC module, adjust R3 for a straight-line display on the oscilloscope (fig. 6. 14). If the specification cannot be obtained by adjusting R3 to its midposition, then repeat the alignment of the discriminator components (*e* above).

(5) Disconnect the test equipment, but leave the module connected to the module test set.

h. Input Bandpass Alignment. This alignment procedure sets the input bandpass filter to reject all input frequencies except those ranging between 66 and 74 MHz.

(1) Connect the module and test equipment as shown in figure 6-23. Use an 18 in. piece of coaxial cable between AFC and Demod display unit.

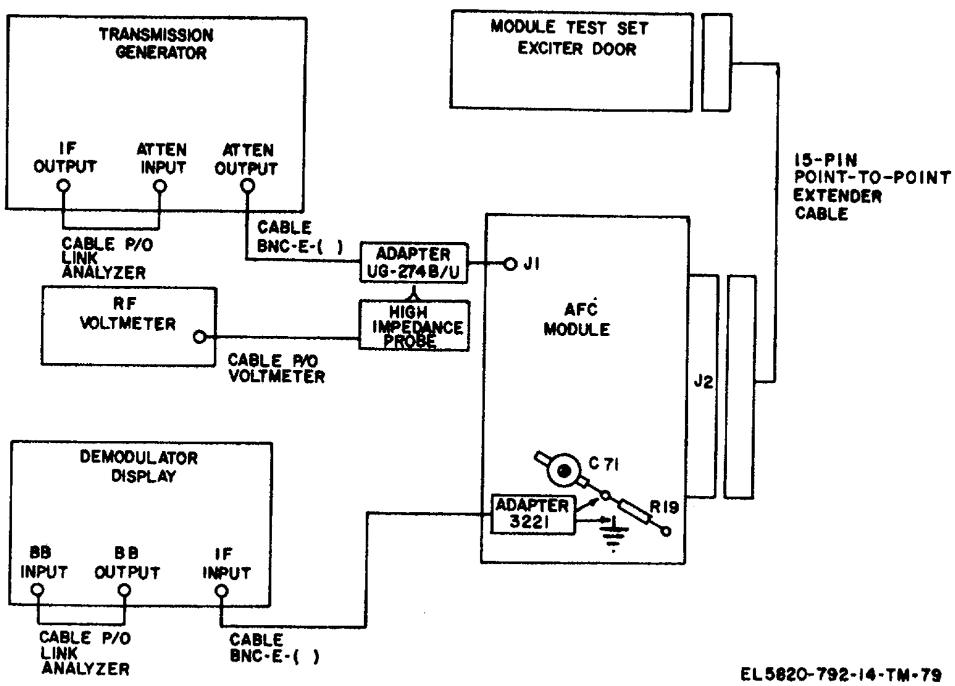


Figure 6-23. AFC module, input bandpass alignment test equipment setup.

(2) Set the controls of the transmission generator as follows:

FREQUENCY (MHz) COARSE	to	70
FREQUENCY (MHz) FINE	to	0
SWEEP WIDTH (MHz) COARSE	to	10
SWEEP WIDTH (MHz) FINE	to	0
MODE	to	BB + SWEEP

(3) Connect a jumper between the base of Q1 and chassis ground.

(4) On the transmission generator, adjust the output level to 170 mV as indicated by the RF voltmeter, using ATTENUATION (dB) pushbuttons.

(5) Set the controls on the demodulator display unit as follows:

DISPLAY	to	IF
MARKER OFFSET (MHz)	to	4

(6) Adjust the IF LEVEL pushbuttons of the demodulator display unit until its IF LEVEL meter indicates 0.

(7) Calibrate the Y1 trace for 1 dB/cm.

(8) On the AFC module, adjust variable capacitors C66, C68, C67, and C71 for the IF bandpass response of 5 dB between * 4 MHz. Make certain that the IF LEVEL meter in-

dication remains on zero during the alignment (fig. 6-24).

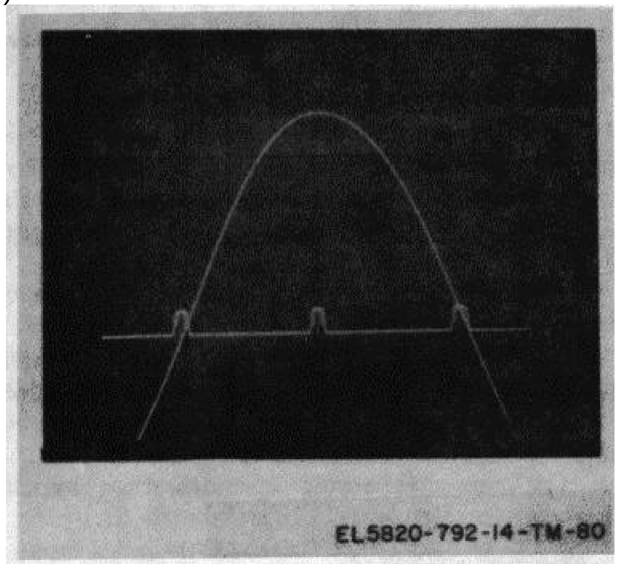


Figure 6-24. AFC module, input bandpass waveform

(9) Disconnect the test adapter from the junction of C71 and R19, then connect the adapter to the junction of R23 and C20.

(10) Readjust the input level into J1 for an indication of 20 mV on the RF voltmeter.

(11) Repeat (8) above to obtain the required bandpass waveform again. Be sure that the IF LEVEL meter indication remains at 0 ± 0.5, by adjusting the ATTENUATION (dB) pushbuttons on the transmission generator. Disconnect the adapter from the junction of R23 and C20.

(12) Set the SWEEP WIDTH (MHz) controls of the transmission generator for zero sweep.

(13) Readjust the output level of the transmission generator to 20 mV as indicated by the RF voltmeter.

(14) Disconnect the RF voltmeter from the UG-274B/U at J1 of the module.

(15) Set the RF voltmeter RANGE to 3V.

(16) Connect the RF voltmeter probe to the junction of R23 and C20. The indication should be 0.7V. If the RF voltmeter indicates less, then disconnect power from the module and remove the ferrite bead (L21) from the emitter of Q16. Reapply power to the module.

(17) Repeat (1) through (16) above if L21 has been removed.

(18) Remove the short form Q1 base to ground.

(19) Disconnect the test equipment from the module.

i. Phase-Detector Zero Adjustment. This alignment procedure is used to adjust the output of the phase detector to zero when the detector input signal is 70 MHz. This alignment must be accomplished with the top and bottom module covers in place.

(1) Connect the test equipment as shown in figure 6-10.

(2) Adjust the output level of the VHF oscillator to zero.

(3) Display the waveform at TP5 on the oscilloscope.

(4) Preset R2 to obtain the waveform shown in figure 6-25. Notice the small ripple, or irregularity during the rise time of the squarewave. This ripple must be aligned midway between the top and bottom of the squarewave using R2.

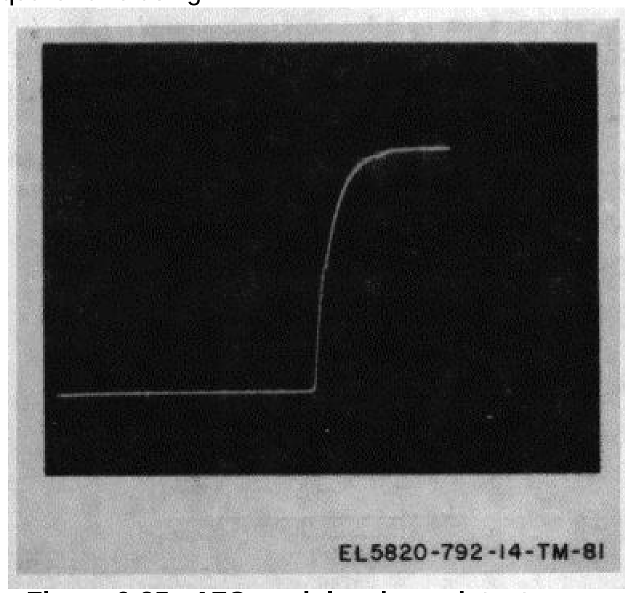


Figure 6-25. AFC module, phase detector zero waveform.

(*a*) Set up and connect test equipment as shown in figure 6-25.1 by removal of AFC module from the set up of figure 6-22.

(*b*) Set the oscilloscope controls as follows:

1. Chan 1 V/CM .5V (calibrated).
2. Chan 2 V/CM .5V (calibrated).
3. Adjust the oscilloscope to trigger on the channel 1 signal (square wave).

(*c*) A display like the ones shown in figure 6-25.2 should be obtained.

(*d*) Adjust the 9 kHz frequency control, R5 to obtain one of the two correct waveforms shown in figure 6-25.2.

(*e*) Disconnect the test equipment and restore to that of the figure 6-22 set-up.

(5) Adjust the frequency controls of the VHF oscillator until the electronic counter indicates 70 MHz ± 1 kHz. Disconnect the electronic counter.

(6) Connect the RF voltmeter to the vacant port of the UG-274B/U and adjust the attenuators and output level of the VHF oscillator to obtain 20 mV; then disconnect the RF voltmeter. Place S1 to the ON position.[(7) Adjust R2 very slowly to produce a zero indication on the multimeter.

(8) Set the multimeter range switch to progressively more sensitive voltage scales, and readjust R2, as necessary to obtain a voltmeter indication of 0 ± 0.2V.

(9) Reconnect the electronic counter to the UG-274B/U vacant port.

(10) Adjust the VHF oscillator for 70.134. MHz ± 1 kHz as indicated by the electronic

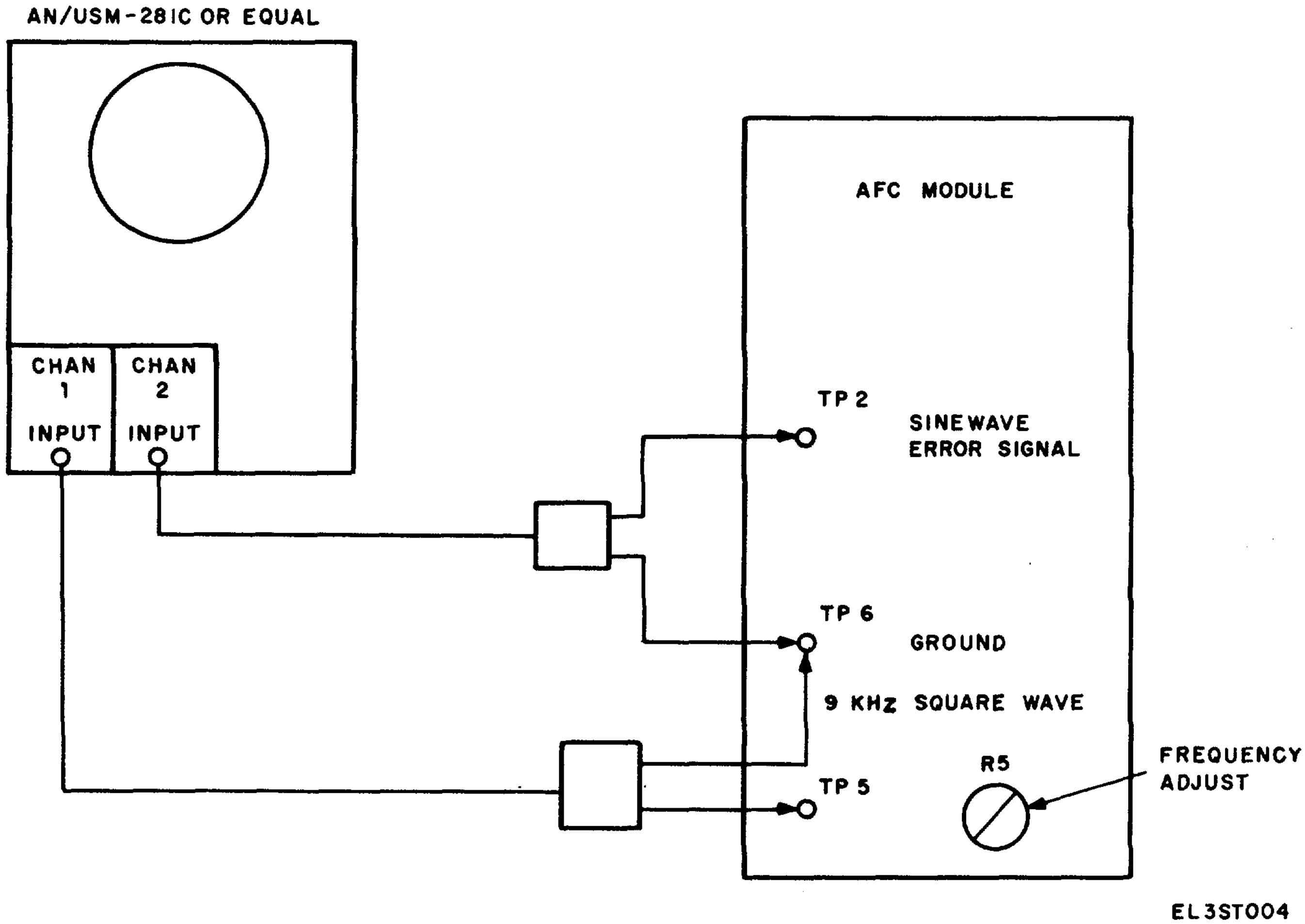
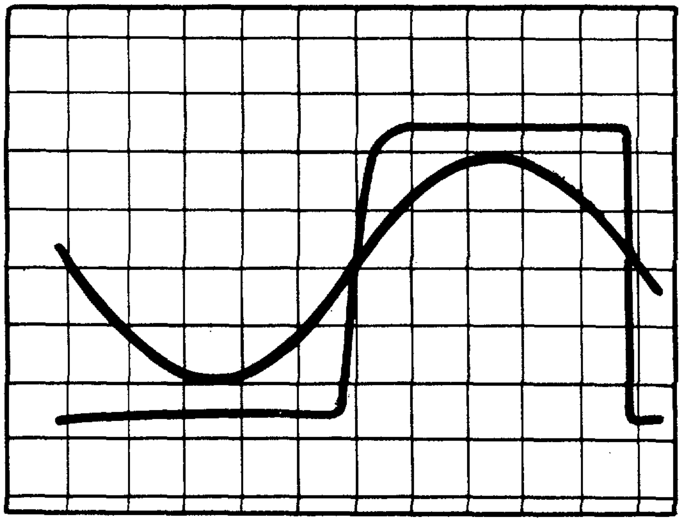
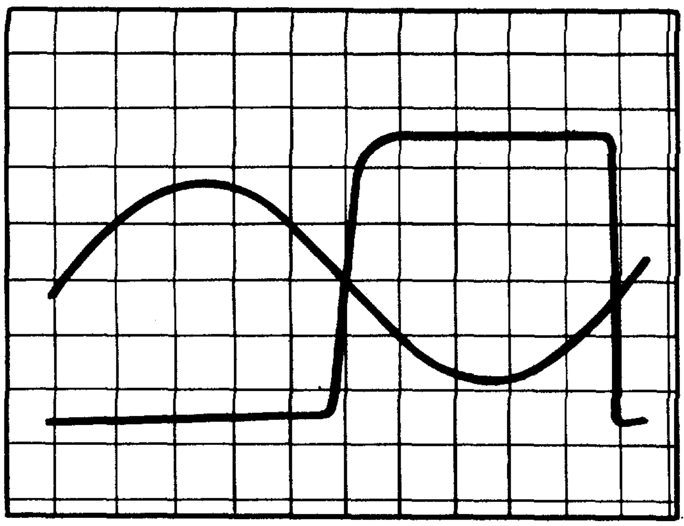


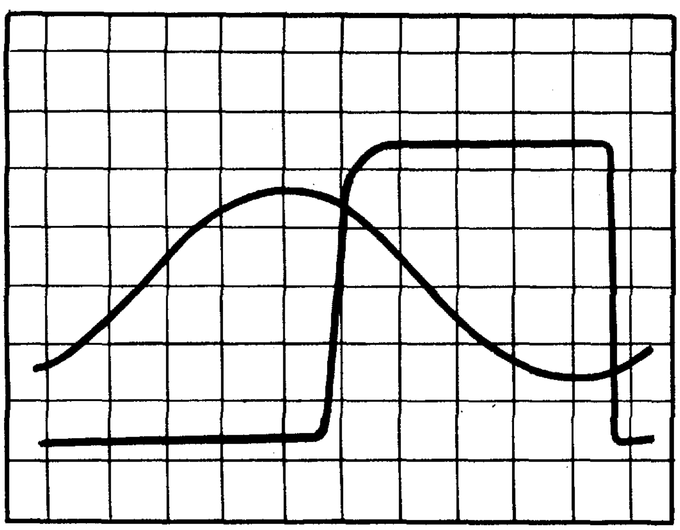
Figure 6-25.1. Test equipment set up for 9 kHz phase calibration. I



1. CORRECT WAVEFORM NOTE THAT WAVEFORMS ARE EXACTLY IN PHASE.



2. CORRECT WAVEFORM NOTE THAT WAVEFORMS ARE EXACTLY 180 DEGREES OUT OF PHASE.



3. INCORRECT WAVEFORM NOTE THAT WAVEFORMS ARE OTHER THAN ZERO OR 180 DEGREES PHASE RELATIONSHIP.

EL3STOO05

Figure 6-25.2. Oscilloscope waveforms for 9 kHz phase calibration.

counter; then disconnect the electronic counter from the test setup.

(11) Observe and record the multimeter indication.

(12) Repeat (10) and (11) above for 69.866 J MHz ± 1 kHz.

(13) The minimum voltages obtained in steps (10) through (12) above must be +1.8 V dc for the 70.134 MHz input and --1.8 V dc for the 69.866 MHz input signal. Disconnect the VHF oscillator from J1; observe a 0 + 0.5 V dc indication on the multimeter. If all three requirements are not obtained, proceed to (14) below. If the requirement is obtained disconnect the test equipment, the alignment is complete.

(14) Set the VHF oscillator to 70.064MHz + 1 kHz using an electronic counter verification.

(15) Adjust R1 of the module to obtain a 1 + 0.1 V dc as indicated by the multimeter. Do not overadjust.

(16) Repeat (10) through (13) above, until the required indications are met.

NOTE

If the+1.8 V dc resulting from 70.134MHz is obtained and also 0 * 0.2 V dc is obtained at 70 MHz ±lkHz, but the ¾ 1.8 V dc resulting from 69.866 MHz is NOT obtained AND is within 0.3 V dc, set the VHF oscillator for 69.866 kHz and slightly readjust R1 until -1.8 V dc is obtained. Do not overadjust R1. The same argument may be used if --1.8 V dc is obtained, but +1.8 Vdc is not; that is. if the situation is reversed. If all three requirements cannot be met, align the discriminator again.

(17) Disconnect all test equipment; this step completes the alignment of the entire module,

Section IV. BASEBAND COMBINER MODULE (398-12040-1)

6-11. Introduction

a. The baseband combiner is a module belonging to the microwave receiver. In frequency-modulated dual diversity systems, the baseband information from the receivers is the same (coherent) while the noise output is noncoherent and its magnitude varies as a function of the received RF level. The output signals resulting from the demodulation of the two receiver channels are essentially constant and equal in magnitude. The noise output of these channels may be used as a measure of the signal to-noise ratio of each diversity receiver. The noise products of each receiver channel can be used to control the relative baseband contribution of each receiver channel to the combined output signal.

b. The combiner circuitry uses redundant elements in all circuits common to the received signal paths. When equal signal levels are present in each radio receiver, their paralleled outputs are combined for an improvement in the signal-to noise ratio so that the combiner output is no worse than the signal-to-noise ratio of the better of the input signals. The output of either receiver is muted when the continuity pilot-tone is lost or when the per channel noise exceeds a selectable level resulting in a signal-to-noise ratio in the range from 25 to 40 dB. However, a failure of the incoming continuity pilot in all the associated receivers while the noise level is not excessive does not cause the combiner to mute or otherwise affect its combining operation. There is no baseband signal interruption due to fading in one signal path or to manual selection of one receiver output for maintenance purposes. The dual baseband combiner module consists of a single printed wiring card (A2) mounted in a metal module chassis (A1). All components, with the exception of controls, test jacks, and connectors, are mounted on the printed-wiring card. The latter components are mounted on the front flange of the metal chassis.

6-12. Functional Description

a. As shown in figure 6-26, the baseband combiner module accepts baseband input signals directly from the demodulator of its associated receiver. The baseband signals pass through a roofing filter to attenuate noise above the in; formation band. The filtered signal is then applied to two independent paths; one path is sent out of the combiner to the noise amplifier module, and the remaining path is sent into the baseband combiner stage.

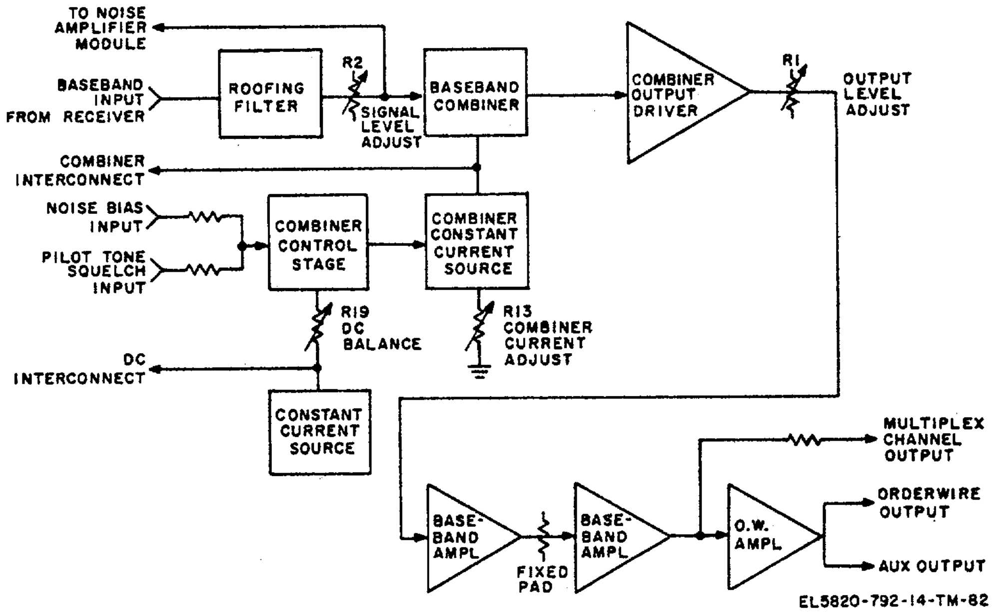


Figure 6-26. Baseband combiner module, functional block diagram.

b. The baseband combiner stage controls the combing action of its associated receiver. Since, the bias voltage is a variable control voltage, the stage gain varies directly with the applied control voltage. Under conditions of excessive noise, combiner stage gain is redued to near-zero levels.

c. The output signal of the baseband combiner stage is connected to the combiner output driver stage. The baseband output level is adjusted and applied to two 3-stage amplifiers in cascade. The baseband signal is applied to two paths. One path is sent out of the combiner module through J3 and eventually becomes the orderwire line, and the auxiliary output or baseband pilot tone output lines.

d. A low or absent signal at the input to the receiver produces excessive noise in that particular receiver channel. Since excessive noise degrades system quality if propagated through the system, a muting feature is incorporated to remove the baseband signal from the input to the baseband combiner stage. The detection of excessive noise levels is accomplished in the noise amplifier module associated with the individual receiver channel; if the noise level in a particular receiver channel increases beyond an arbitrary threshold, the muting relay is deenergized to remove the baseband signal from the input to the baseband combiner stage. When the. excess noise condition is corrected, the muting relay is energized and the combiner is restored to normal operation.

e. The noise bias input from the noise amplifier is applied to the combiner control stage; pilot; tone squelch voltage from the pilot-tone detector module is also applied to the combiner control stage. The noise bias controls the operating point of the combinert in accordance with the instantaneous noise level. The pilot-tone squelch' overrides the noise amplifier bias and squelches the combiner upon the loss of pilot tone.

f. To insure uninterrupted system operation, the operating power for the baseband combiner module is provided by two positive and two negative power supplies which are connected to the module through diodes mounted directly on each baseband combiner printed-wiring card. If one of the positive or the negative power supplies fails, the defective power supply is automatically isolated from its companion power supply through the action of the steering diodes; the remaining power supply will continue to provide operating power for the module circuits.

6-13. Circuit Analysis

a. The schematic diagram for the dual combiner is shown in figure FO-16. The baseband signal output of the demodulator for each diversity channel is sent into its roofing filter via connector J6. The roofing filter is a low-pass network consisting of L7, L8, and C45 through C47, used to attenuate the noise above the information band.

b. Potentiometer R2 compensates for variations in demodulator sensitivity into the combiner stage and into the associated noise amplifier module via connector J5.

c. Transistor Q3 is a constant current source which supplies emitter current to the differential amplifier. The schematic circuit shown in figure FO-16 must work in conjunction with a companion combiner circuit which has the same schematic diagram as that shown in figure FO-16; otherwise, combiner action does not occur. On this basis, observe that constant current generator Q3 has a combiner interconnect leaving the combiner card at coaxial connector J4 that is routed into connector J4 of the companion combiner card. This interconnect serves two purposes. First, it places the constant current source (Q3) on each combiner board in parallel for greater reliability through redundancy. Second, it interconnects the emitter circuits of transistor Q1 on each .combiner board to form a differential amplifier.

d. The basic combining operation is performed by the differential amplifier comprised of Q1 on each card. These stages have their emitters connected to a common output line via diode CR1 in each emitter circuit. If the base of Q1 in the right channel becomes more negative than the base of Q1 in the left: channel, then emitter current of right channel's Q1 decreases while the emitter current of Q1 in the left channel increases by a corresponding amount. Under these circumstances, less of the available right channel baseband signal present at Q1 base is gated through to the output of the corresponding side of the differential amplifier. On the other hand, a corresponding increase of the available left baseband signal present at companion Q1 base, is gated through to the output of that side of the differential amplifier. The decrease in right channel baseband is exactly compensated by the corresponding increase in the left channel baseband at the output of the differential amplifier. The result is that the output level of the differential amplifier remains constant, but the ratio of one channel to the other channel contribution in the output level changes continuously. This same explanation holds when the bias levels of the differential amplifier are reversed.

e. The method of changing and controlling the ratios of the baseband in the combined output must now be discussed. Transistor Q5 is a constant current source, used in dual baseband combiner applications only, supplying emitter current to the combiner stages; refer to figure 627. Observe that transistor Q5 has a dc interconnect line leaving the combiner card at printed circuit connector A2J1-16 that is routed into connector A2J1-16 of its companion combiner card. The interconnect line, therefore, places two Q5 stages in parallel to form a complete constant current source. The purpose of the constant current source is to supply the total emitter current to the combiner control stage, Q4 which is part of a differential amplifier.

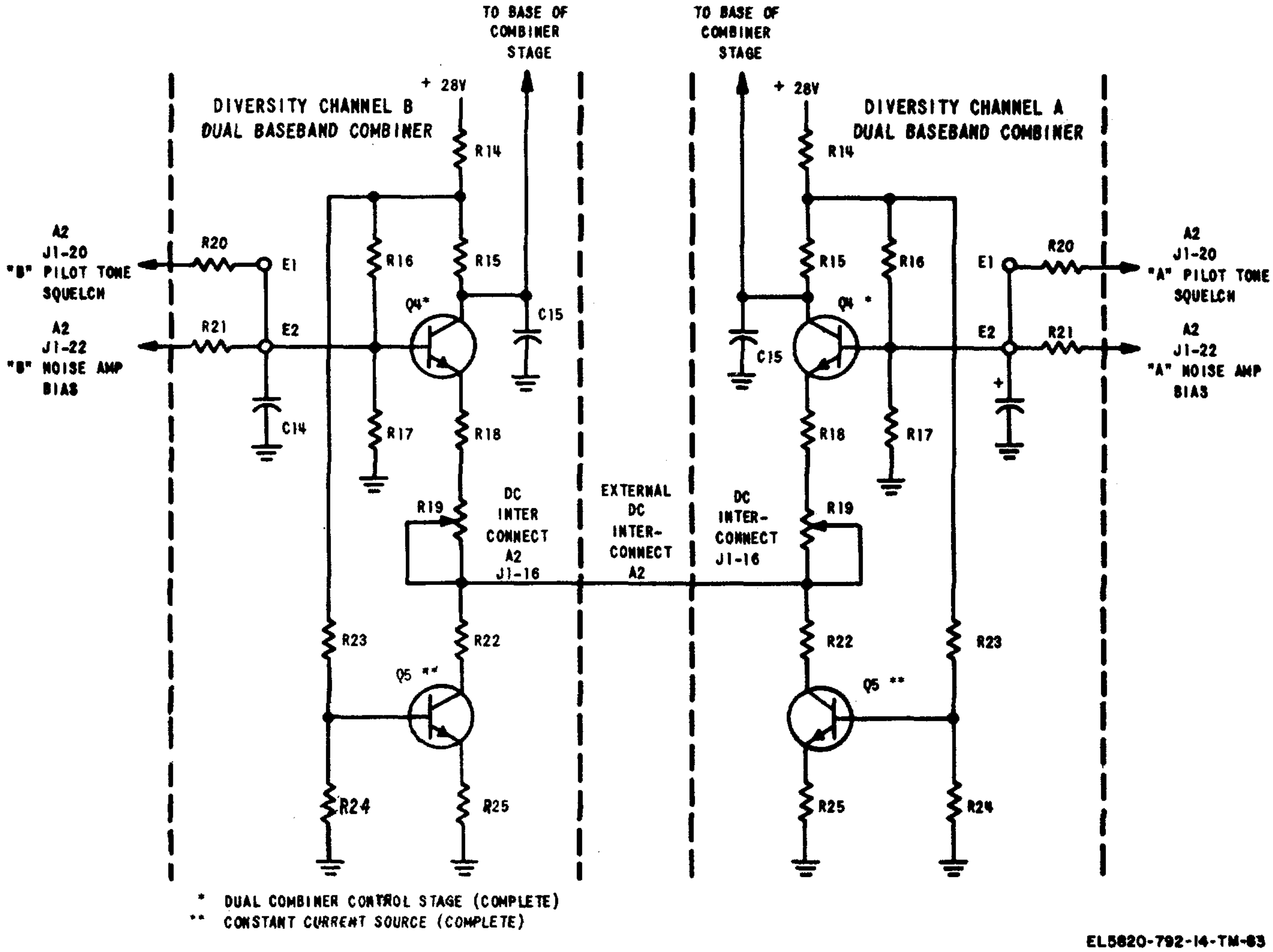


Figure 6-27. Baseband combiner, interconnection of control stages.

f. The noise amplifier output voltage which provides the combiner control voltage, is positive. An increase in noise level causes the control voltage to become more positive. Suppose that right channel noise level increases, with no increase in the other channel noise level. Emitter current through Q4 of the right channel increases while emitter current through Q4 to the left channel decreases by a corresponding amount. The collector voltage for transistor Q4 in the right channel is now more negative while its companion Q4 in the left channel is now more positive. The reverse situation merely interchanges the balancing conditions of the combiner control stage.

g. It is interesting to note two operational facets of the combiner. First, the amplitude of the combiner output signal in each emitter of the combiner differential amplifier, Q1, has no relationship to the amplitude of the baseband signal present at each of the Q1 bases once a minimum threshold level is reached. The output level of the combiner differential amplifier, Q1, is dependent upon the instantaneous balance of the combiner control differential amplifier, Q4, which is, in turn, dependent upon instantaneous noise levels in each diversity channel. Hence, the combiner output level is inversely proportional to the instantaneous noise level. The second point is that while one channel's noise level has been permitted to vary for purposes of explanation, it is nevertheless true that by differential amplifier action, the noise level may be varying simultaneously in both channels. As the noise bias is increased in one channel, it is reduced by the corresponding amount in the other channel. Thus, the combiner changes the ratio of the baseband signals, so that the baseband signal containing the least noise is increased while the noisy baseband signal is suppressed, and the overall output signal amplitude remains constant.

h. On those occasions when the continuity pilot tone is lost, a squelch bias is applied from an associated pilot-tone detector module, across resistor R20, to the base of transistor Q4. The squelch Ibias of +28 volts drives transistor Q4 into saturation to drive the combiner stage Q1 into cutoff. This defective diversity channel is squelched. The combiner output then consists of baseband signals obtained from the remaining unaffected diversity channel. If the pilottone signal is simultaneously lost in both diversity receivers, then a squelch bias of + 28 volts is applied to each combined board through printed-circuit connector A2J1-20. The combiner control differential amplifier, having 28 volts applied to its base inputs, is balanced with respect to the pilot tone; in this case neither baseband channel is squelched out. The combiner control differential amplifier, now in a balanced condition as far as pilot-tone squelch bias is concerned, continues to respond to the noise amplifier control signal as previously explained.

i. Certain occasions may arise where one of the baseband combiner modules must be removed from service. When this is done, the differential amplifier interconnects are broken. Looking at the combiner control stage Q4, its emitter current is determined by transistor Q5. At the same time, Q1 emitter current is determined by transistor Q3. The bias applied to the combiner stage, Q1, therefore, is unchanged. Since Q1's dc operating point is unchanged, then the baseband output level from Q1 remains the same as before the module was removed. The incoming noise amplifier bias, applied to the base of Q4, has little effect on the combiner stage, Q1, so that the baseband output signal depends only on the baseband input signal. It would be undesirable to reduce baseband output to near zero without being able to compensate with the other baseband combiner module.

j. The output of the combiner stage is passed through an output driver which is an emitter follower stage (Q2) with feedback through capacitors C17 and C18. The output level of the combiner stage is adjusted by means of potentiometer R1 to drive the baseband combiner to the desired output level.

k. The emitter follower is followed by a three-stage feedback amplifier consisting of transistors Q6, Q7, and Q8. The amplifier employs feedback from the emitter of Q8 to the emitter of Q6, via the parallel combination of C25 and C26, and the resistor feedback network made up of R40 and R41. This method of feedback stabilizes the gain of the amplifier, increases the bandwidth, and improves the linearity, as well as reducing the amplifier output impedance at the emitter of Q8.

l. The baseband signal then passes through a second ultralinear, broadband, three-stage feedback amplifier, made up of transistors Q9, Q10, and Q11. The output line, which eventually is used for multiplex output, is taken directly from the amplifier triplet through coaxial connector J3. The baseband pilot output can be taken from this same line through coaxial connector J2. The triplet amplifier output signal is then passed through a driver stage to derive the orderwire output line at connector J1.

m. Figure FO-16 shows that A2J1-15 and A2J1-4 are both labeled with auto-level adjust. Note that A2J1-4 is the dc supply line for the baseband combiner module. An external line is connected from A2J1-4 of one baseband combiner module. An external line is connected from A2J1-4 of one baseband combiner to A2J1-15 of a companion baseband combiner. When one of the combiner cards is removed from the combiner door, relay K2 deenergizes to connect resistors R57 and R58 in parallel. The output impedance of the multiplex line, for the operating combiner card is then automatically adjusted to maintain the proper output level.

n. Diodes CR10 and CR11 are part of a muting feature supplied in the overall terminal. The line entering the baseband combiner at A2J1-18 is interconnected with the excess noise alarm in the associated noise amplifier module. When excess noise is detected on a given diversity channel, the noise detector interrupts 28 volts dc to muting diodes CR10 and CR11. The positive 28 volts dc which switches CR11 on and CR10 off is removed and a negative 6 volts dc is applied through resistor R76. Diode CR10 is switched on and resistor R4 is placed across the input of the combiner balance stage. This action disconnects the baseband signal from combiner stage Q1 and prevents the excess noise from being sent through the remainder of the combiner.

o. The two + 28-volt supplies are connected together by diode rectifiers. CR2 and CR3; the two 6-volt supplies are connected together by diode rectifiers CR4 and CR5. These rectifiers act as steering diodes to isolate a defective power supply from the module. This way, the module automatically receives its power form the remaining supply in the event of a power supply failure.

p. Technical Characteristics.

Parameter	Specifications
Input impedance	75 ohms, unbalanced
Output impedance:	
Multiplex (J3)	75 ohms, unbalanced
Orderwire (J1)	75 ohms, unbalanced
Input signals levels:	
Demodulated input	- 20 dBm SCTT (200 kHz rms deviation)
Noise amplifier bias input	+ 7 to + 18 V dc, nominal

Parameter	Specifications
Pilot tone squelch input	0 V dc (pilot present)
Output levels: *	
Multiplex	-12 dBm SCTT (70 mV)
Orderwire	-8 dBm SCTT (110 mV)
Frequency response:	
Multiplex	12 KHz to 2.6 MHz ± 0.5 dB
Order wire	200 Hz to 12 kHz ± 0.7 dB
Power requirements	500 ma at + 28 V dc; 15 mA at -6 V dc

* Based on 200 kHz rms deviation but are adjustable as per system requirements.

6-14. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The baseband combiner module presents two choices in test methods. One method is to test two interoperating baseband combiners to obtain functional operation in the module test set similar to that obtained in a fully operating terminal. The other method is to test a single module, on its own merits and without reference to companion modules, to isolate a malfunctioning stage in a particular module. The following paragraphs contain both types of procedures. Tests for the single module are present in chart form, while tests for interoperating modules are given in procedural steps form.

b. Single-Module Test Equipment Setup. Connect the test equipment to the module as shown in figure 6-28.

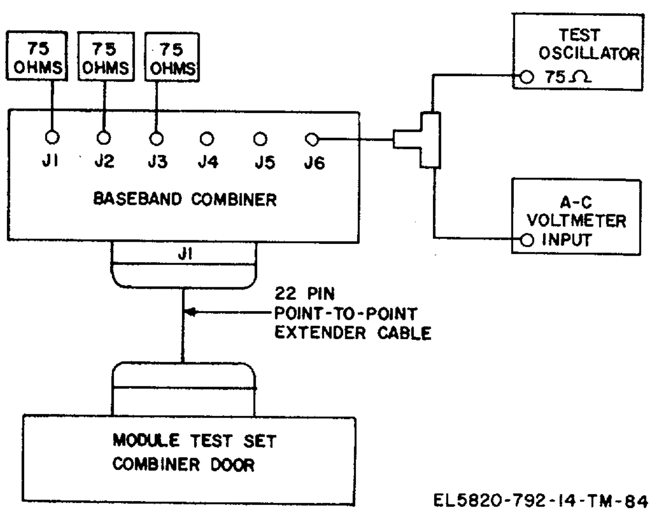


Figure 6-28. Bnqehalnd combiner module, initial test equipment setup

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove the top and bottom covers from the module.

(2) Set all test equipment power switches to the ON position; allow' the test equipment to stabilize for 20 minutes.

(3) Adjust the +28-volt power supply for ±0.1 Vdc.

(4) Adjust the 6-volt power supply for 6 ±0.06 Vdc.

d. Single-Module Test Procedures. After completing the test equipment hookup and preliminary adjustments of b and c above, perform the test procedures in chart e below using figure 6-29 (1) and (2) for parts location purposes. Voltages shown in the following performance test chart are permitted variations on the order of ±10 percent.

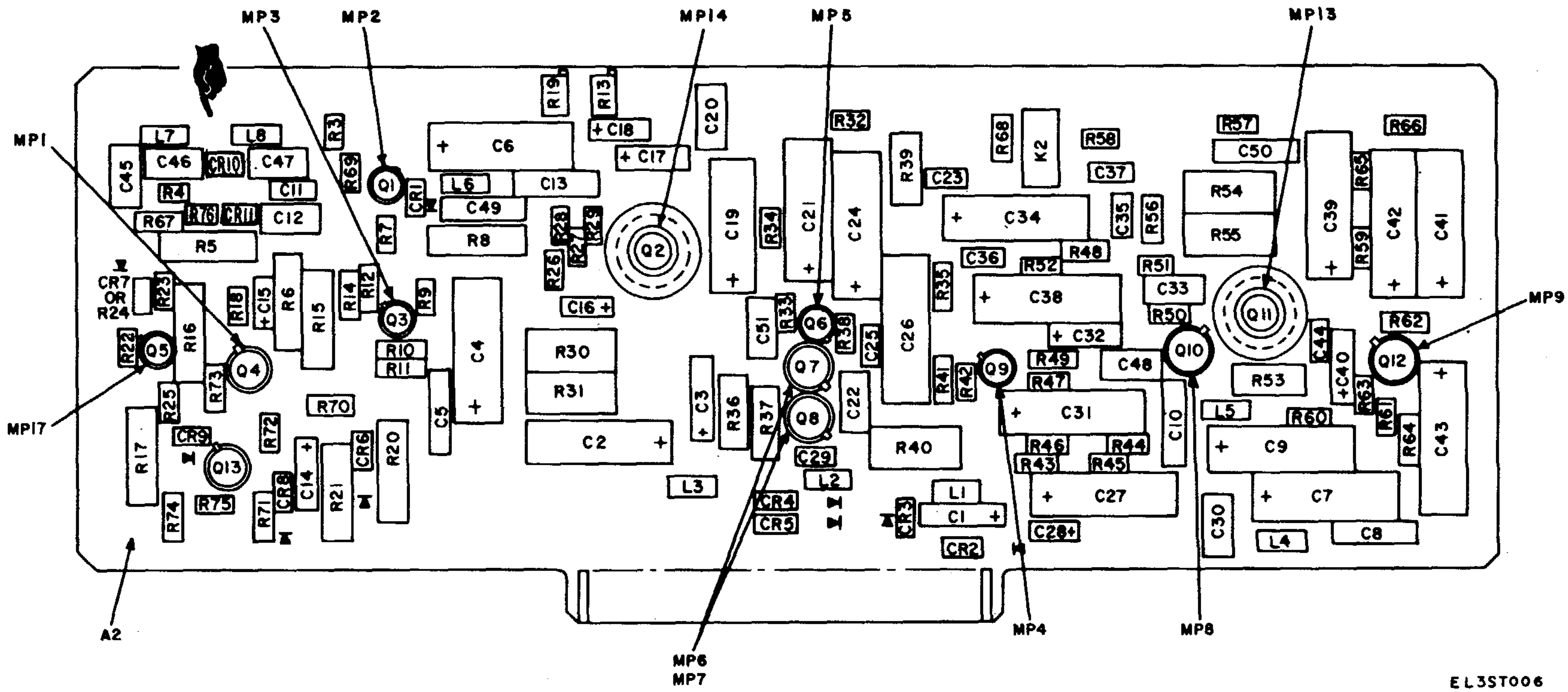


Figure 6-29 (1). Baseband combiner, parts location diagram (sheet 1 of 2).

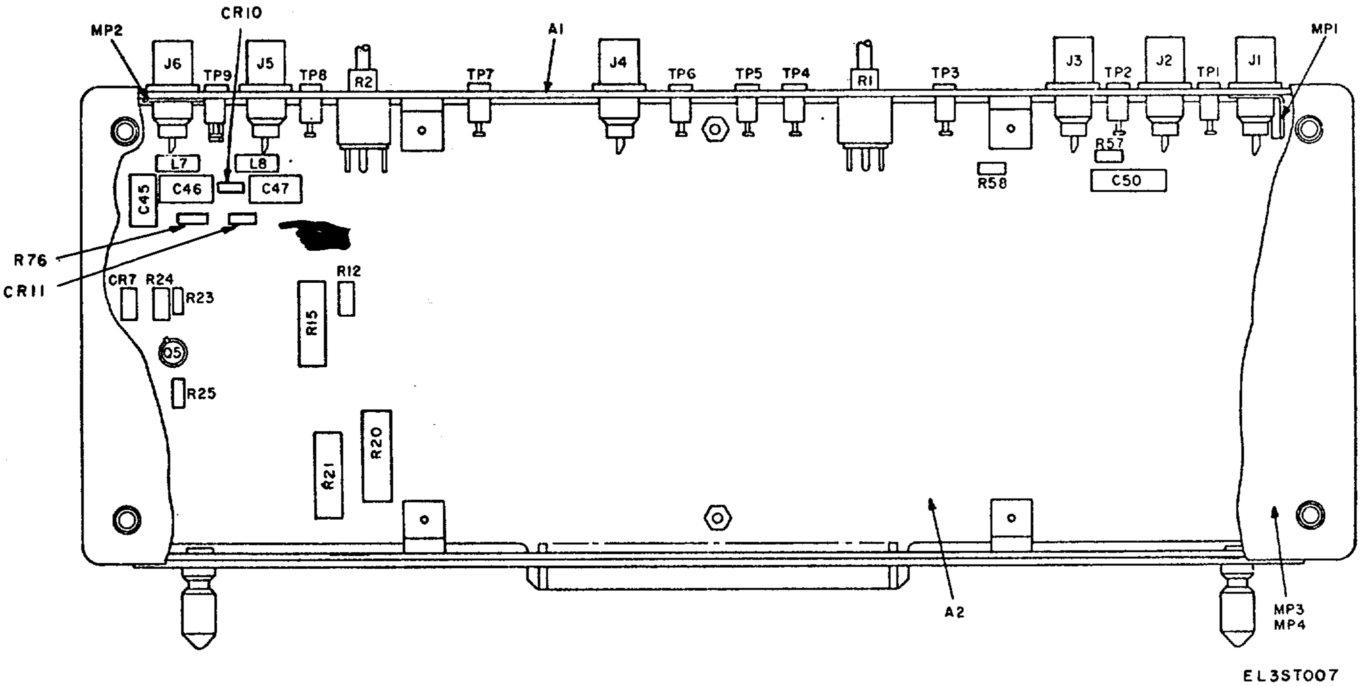


Figure 6-29 (2). Baseband combiner, parts location diagram (sheet 2 of 2).

e. Procedures.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Steering Diode Performance Check		
1	On the module test set, check that the A and B low voltage power supplies provide +28 ± 0.1 and -6 ± 0.1 V dc.			
2	Connect the baseband combiner module to one end of a 22-pin extender cable and the other end to the BASEBAND COMBINER position in the combiner door of the module test set.			
3	Connect the COMMON lead of a multimeter to test point TP6 on the module. **NOTE** In order to prevent repetition of this procedure for +28 V diodes: and for -6 V diodes. The following test is arranged for either check. Operations and numbers given inside the parentheses apply to -6 V diodes, while operations and numbers outside the parentheses apply to +28 V diodes.			
4	On a multimeter, set the FUNCTION switch to + (-), the RANGE switch to 30 V (10 V) then connect the DC probe to test point TP1 (TP4).	+27.5Vdc(-5.5Vdc) nominal		Check LI
5	On the module test set low-voltage power supply, set CHANNEL B POWER switch to its OFF position.	+27.5Vdc(-5.5Vdc)	Proceed to step 6.	ReplaceCR2(CR4).
6	On the module test set low-voltage power supply, set CHANNEL B POWER switch to its ON position.			
7	On the module test set low-voltage power supply, set CHANNEL A POWER switch to its OFF position.	+27.5Vdc(-5.5Vdc) nominal	Proceed to step 8.	ReplaceCR3 (CR5).
8	On the module test set low-voltage power supply, set CHANNE;L A POWER switch to its ON position.		End of steering diode test.	
		Mute and Auto-Level Performance Check		
9	Set test oscillator RANGE to X1M, FREQUENCY dial to 1, and OUTPUT ATTENUATOR to -20 dBm. Adjust its COARSE control to provide 15 mV into 75 ofins using an ac voltmeter. Connect the test oscillator to J6 of the module under test.			
10	Connect an oscilloscope to test point TP8 and ground.	40 mV peak-to-peak.	Proceed to step 11.	Proceed to step 27.
11	On the combiner door of the module test set, check whether the -com-under test is plugged into channel A slot or channel B slot of the door. For example of this test, assume the module under test belongs in channel A slot.	'		
12	On the combiner door of the module test set, remove the corresponding noise amplifier module. In this example, remove channel A noise amplifier.	Oscilloscope indicates complete loss of signal.	Proceedtostepl3.	Replace diodes CR10 and/or CR11, resistors R67, R76, or R4.
13	Replace noise amplifier in combiner door of module test set.	Oscilloscope indicates complete restoration of signal.	Proceed to step 14.	Same as above

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
14	Set the RANGE of an ac voltmeter to .3 V. Connect a UG-274B/U adapter with 75-ohm termination to J3 of the module under test and ac voltmeter INPUT at the adapter.			
15	Adjust R1 of the module under test until the ac voltmeter indicates 71 mV. Change ac voltmeter ranges as necessary to get a good indication.			
16	On the combiner door of the module test set, remove the remaining baseband combiner module. Observe the ac voltmeter indication.	106 ±3mV	Proceed tostep 17.	If ac voltmeter indicates 71 ± 3 mV, replace auto-level relay K2.
17	Replace combiner module, removed in step 16, in the combiner door of the module test set. Observe the ac voltmeter.	71 -3mV	Proceedtostep18, end of mute and auto-level performance test.	If ac voltmeter indicates 106 ± 3 mV replace K2.
		Trouble Analysis Checks		
18	Set the multimeter RANGE to 30 V, and the FUNCTION switch to +.			
19	Connect the multimeter between TP7 and TP6 (ground).	+23.5Vdc	Proceedto step20.	Adjust R13 (para 6-15b). If unobtainable, check Q1, Q3 and associated components.
20	Connect the multimeter between TP8 and TP6 (ground).	+13 +0.5Vdc	Proceed to step 21.	Adjust R19 (para6-15b). If unobtainable, check Q1, Q5, and Q4 with associated components. If R19 variation produces no voltage variation atTP8, that is, the multimeter indicates the same voltage, replace Q1. Do not proceed to further testing unless steps 10 and 11 are satisfactory.
21	Connect the multimeter between Q2 collector and ground.	+26.2 V dc nominal.	Proceed to step 22.	Check Q2 and associated components.
22	Connect the multimeter between Q8 emitter and ground. the dc coupling between stages, a defective transistor will unbalance the remaining transistor voltages.	15.8Vdc	Proceed to step 23.	Check Q6, Q7, and Q8. Note
23	Connect the multimeter between Q11 emitter and ground.	16.5 V dc nominal.	Proceed to step 24.	Check Q9, Q10, and Q11. Note the dc coupling between stages, a defective transistor will unbalance the remaining stages.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
24	Set test oscillator RANGE to X1M FREQUENCY dial to 1, and OUTPUT ATTENUATOR to -20 dBm Adjust its COARSE control to provide !5 mV into 15 ohms using ac voltmeter.			
25	On the module, set potentiometers R1 and R2 fully clockwise.			
26	Connect oscilloscope to test points TP9 and ground.	41 mV peak-to-peak.	Proceed to step 27.	Check R2, R3, and roofing filter consisting C45, C46, C47, L7 and L8.
27	Connect the oscilloscope to test point TP8 and ground.	40 mV peak-to-peak.	Proceed to step 28.	Check whether R2 is set for maximum gain. If signal is absent or drastically reduced from the level specified in step26, check CR10 and CR11. Otherwise Check C11, C12, and Q1.
28	Connect the oscilloscope to test point TP5 and ground.	37 mV peak-to-peak.	Proceed to step 29.	Check whether R1 is set for maximum gain. Check RI. Q2 and associated components.
29	Connect the oscilloscope to test point TP3 and ground.	310 mV peak-to-peak.	Proceed to step 34.	Proceed to step 30.
30	Connect the oscilloscope to Q6 collector and ground.	20 mV peak-to-peak.	Proceed to step 31.	Check Q6, C21. C25, C26, and other associated components.
31	Connect the oscilloscope to Q7 collector and ground.	310 mV peak-to-peak.	Proceed to step 32.	Check Q7 and associated components.
32	Connect the oscilloscope to Q8 emitter.	310 mV peak-to-peak.	Proceed to step 33.	Check Q8 and associated components.
33	Reconnect oscilloscope to test point TP3 and ground.	310 mV peak-to-peak.	Proceed to step 34.	Set test oscillator output level to provide 13 mV, and connect to test point TPS and ground: readjust test oscillator output for the 13 mV. if necessary. If310 mV is measured at TP3: recheck Q2 and associated components Otherwise check C27, C28. and R42. Return test oscillator to 15 mV output and reconnect it to J6.
34	Connect oscilloscope to Q11 emitter and ground.	1.7 V nominal (peak-to-peak).	Prceedtostep38.	Proceed to step35.
35	Connect oscilloscope to Q9 collector and ground.	230 mV peak-to-peak.	Proceed to step 36.	Check Q9, C31, C37, C38, associated other components.
36	Connect oscilloscope to QIO collector and ground.	1.7 V peak-to-peak.	Proceed tostep37.	Check QI0. C32. and associated other components.
37	Connect oscilloscope to Q11 emitter and ground.	4.7 V peak-to-peak.	Proceed to step 38.	Check Q11 and associated comporents.
38	Connect the oscilloscope to J2 and ground.	420 mV peak-to-peak.	Check components between J2 and Q11 emitter, except for Q12 and its associated cor- Proceed to step 39.	Check K2, R57, and R58,

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
39	Set the test oscillator RANGE to X1K, maintain its 15 mV output level.			
40	Connect the oscilloscope to J1 and ground.	600 mV peak-to-peak.	End of trouble analysis. Disconnect test equipment.	Check Q12 and associated components.
		Frequency Response Performance Test		,
41	Set a test oscillator RANGE control to X1M, the FREQUENCY dial to 1, and OUTPUT ATTENUATOR to 0 dBm.			
42	Set the RANGE of ac voltmeter 1 to .3 VOLTS, and the RANGE of ac voltmeter 2 to 1 VOLTS.			
43	Set an IF attenuator to provide 20 dB attenuation. Then connect the test equipment to the baseband combiner as shown in figure 6-30.			
44	Adjust the test oscillator COARSE and FINE attenuators until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
45	On the 'baseband combiner module, adjust R2 until ac voltmeter 2 indicates 8 mV.			
46	Disconnect the 3221 adapter from the baseband combiner module. Change voltmeter #2 to .3 V Scale.			
47	Transfer the 75-ohm termination from J3 of the module to the open port of adapter UG-274B/U at ac voltmeter 2.			
48	Disconnect the 3221 adapter from ac voltmeter 2 and connect the voltmeter cable to J3 of the module test.			
49	Adjust RI of the module until ac voltmeter 2 indicates less than 100 mV, then shift the voltmeter RANGE to .1 VOLT and carefully adjust R1 to obtain 71 mV/75 ohms (-11.7 dBm).	71 mV/75 ohms (-11.7dBm)		
50	On the test oscillator, set the RANGE to X1OK, the FREQUENCY dial to 1.2, then adjust the output level of the test oscillator until ac voltmeter 1 indicates 200 mm75 ohms (-2.7dBm).			
51	Observe voltmeter 2 indication.	71 + 2mV/75 ohms (-11.7 + 0.5 dBm)		Check roofing filter if any frequency is out of specification.
52	On the test oscillator, set the FREQUENCY dial to 5, then adjust the output level of the test oscillator until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
53	Observe voltmeter 2 indication.	71 1- 2 mV/75 ohms (-11.7 I- 0;5 dBm)		
54	On the test oscillator, set RANGE control to X100K, FREQUENCY dial to 1, then adjust the output level COARSE and FIN'E, controls until ae volteteor 1 indicates 200 mV/75 ohms (-2.7 dBm).			
55	Observe voltmeter 2 indication.	71 + 2 mV/75 ohms (-11.7 + 0.5 dBm)		

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
56	On the test oscillator, set FREQUENCY dial to 5, then adjust the output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
57	Observe voltmeter 2 indication.	71 ± 2 mV/75 ohms (-11.7 ± 0.5dBm)		
58	On the test oscillator, set RANGE to X1M, FREQUENCY dial to 1.5, then adjust the output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
59	Observe voltmeter 2 indication.	71 +-2 mV/75 ohms (-11.7 ± 0.5dBm)		
60	On the test oscillator, set the FREQUENCY dial to 2, then adjust the output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm.).			
61	Observe voltmeter 2 indication.	71 + 2 mV/75 ohms (-11.7± 0.5dBm)		
62	On the test oscillator, set the FREQUENCY dial to 2.6, then adjust the output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
63	Observe voltmeter 2 indication.	71 2 mV/75 ohms (-11.7 ± 0.5dBm)		
64	The test oscillator input level is -2.7 dBm and including - the 20 dB from the IF attenuator provides -22.7 - dBm into the combiner module at J6. Subtracting the input level from the output level provides combiner gain.	9dB (min) for the multiplex channel.		
65	Remove the 75-ohm termination from J1 of the combiner module.			
66	On ac voltmeter 2, change RANGE to .3 VOLT, then transfer the meter cable from J3 to J1.			
67	Connect a 75-ohm termination to J3 of the module under test.			
68	On the test oscillator, set Line frequency dial to 2, then RANGE control to X1K, then adjust output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV (-2.7 dB/75 ohms).			
69	Observe ac voltmeter 2 indication. Record this value as reference level.	102 ± 4 mV/75 ohms (-8.6 ± 0.7 dBm)		
70	On the test oscillator, set the RANGE control to X100, then adjust output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm.)			
71	Observe voltmeter 2 indication.	02 ± 4 mV/75 ohms (-8.6 ± 0.7 dBm).		
72	On the test oscillator, set the FREQUENCY dial to 4, then adjust output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			' Check R59, R60, R61, C44 and C40 if any frequency is out of specification.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
73	Observe ac voltmeter 2 indication.	102 - 4 mV/75 ohms (-8.6± .0.7dBm)		
74	On the test oscillator, set the FREQUENCY dial to 1, the RANGE control to X1K, then adjust output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
75	Observe voltmeter 2 indication.	102 4 mV/75 ohms (8.6 ± 0.7 dBm)		
76	On the test oscillator, set the FREQUENCY dial to 4, then adjust output level COARSE and FINE controls until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
77	Observe voltmeter 2 indication.	102 + 4 mV/75 ohms (-8.6 ± 0.7dBm)		
78	On the test oscillator, set the FREQUENCY dial to 1, the RANGE control to X1OK, then adjust output level controls COARSE and FINE until ac voltmeter 1 indicates 200 mV/75 ohms (-2.7 dBm).			
79	Observe voltmeter 2 indication.	102 + 4 mV/75 ohms (-8.6 ± 0.7 dBm)		
80	Reference to step 64 shows that the input level to the baseband combiner module is -22.7 dBm. Subtracting the input level from the output level provides the combiner gain.	14dB (min) for the service channel.	End of frequency response test. Disconnect all test equipment.	

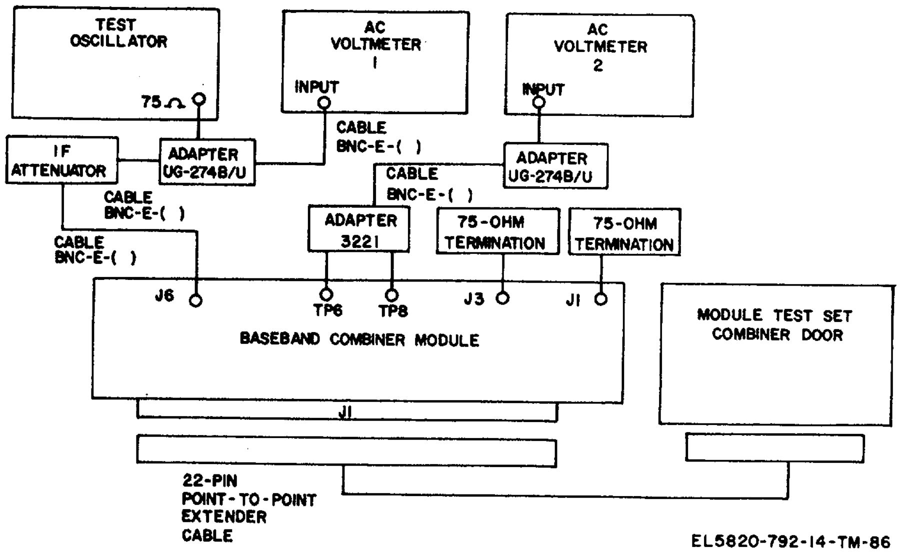


Figure 6-30. Baseband combiner, frequency response, test equipment setup.

f. Interoperating Combiner Preliminary Adjustments. It is important to read and observe the following caution before making any preliminary test setup.

CAUTION

Before interconnecting J4 of both modules, be sure that the two combiner modules are balanced with respect to each other, because the interconnection of J4 of both modules without balancing usually results in DESTRUCTION of transistor Q1. These procedures provide good balance if properly performed, but cannot be used as a balancing procedure for final disposition of the module where module interchangeability is required.

(1) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(2) Check the +28-volt power supplies for +28-0.1 V dc.

(3) Check the -6 volt power supplies for -6 ±0.1 V dc.

NOTE

The module test set contains two interconnected and balanced baseband combiner modules and they are termed the standard combiner modules. When performance testing interoperating combiners, remove the A baseband combiner as a matter of convenience and consistency; in this way the B combiner will always be the standard test module and eliminate much confusion during the test.

(4) In the module test set, remove the A baseband combiner module.

(5) Install the baseband combiner to be tested in the BASEBAND COMBINER slot of the module test set combiner door. Do not connect combiner interconnect cable.

(6) On the standard combiner module, remove the cables from J6 s J5, and J4.

(7) Set a multimeter RANGE to 30 V and its FUNCTION switch to +, connect the No. 2 meter between TP8 and TP6 of the module under test; the multimeter must indicate at least +13.0 V dc. If it does not, adjust R19 until the requirement is obtained. The adjustment of R19, under these circumstances, produces a very slow change in voltage. If this. voltage cannot be changed with full R19 adjustment, troubleshoot the module.

NOTE

If the multimeter, connected between TP8 and TP6, indicates over 14 V dc on one combiner and less than 12 V dc on the other combiner, and adjustment of R19 produces no effect whatever, set BOTH switches S2 and S3 of the pilot-tone detector module to the PLT BYP or PLT NORM position. If the combiner voltages return to normal, one of the noise amplifier modules is defective; remove both noise amplifier modules from the door and continue to balance the combiners. If this maneuver has no effect on the indicated

voltage, remove and troubleshoot both combiners.

(8) Transfer the multimeter DC probe to TP7 of the module under test; the multimeter must indicate +23.5 V dc. If it does not, adjust R13 until the requirement is obtained. The adjustment of R13, under these circumstances, produces a relatively fast change in voltage.

(9) Repeat (7) and (8) above, because of control interaction.

(10) On a ME-70C/PSM-6B multimeter, set the FUNCTION SWITCH to DC 20 K-ohm/V and the RANGE switch to 2.5.

(11) Connect the multimeter leads to TP8 on both combiner modules. The multimeter must indicate zero volt. Adjust R19 on the module under test until the multimeter does indicate zero; if zero is obtained, shift multimeter RANGE control to .5 and check again. If zero is obtained, reverse the meter leads and check once more. Set multimeter RANGE to 2.5.

(12) Connect the multimeter leads to TP7 on both combiner modules. The multimeter must indicate zero volt. Adjust R13 on the module under test until the multimeter does indicate zero; if zero is obtained, shift multimeter RANGE control to .5 and check again. If zero is obtained, reverse the meter leads and check once more. Set the multimeter RANGE to 2.5.

(13) Repeat (11) and (12) above because of control interoperation. Leave the multimeter leads connected to TP7 of each combiner module using the proper coaxial cable from the module test set.

(14) Interconnect J4 of each combiner module using the proper coaxial cable from the module test set.

(15) Observe the multimeter indication. If the multimeter indicates 0 ± 0.1 Vdc, combining action will be satisfactory for this test.

NOTE

Do not attempt to obtain a meter zero indication while the coaxial cable is connected between J4 of the modules. Much time is wasted and the danger of damaging transistor Q1 increases. Instead, disconnect the cable between J4 of the modules, and refine the adjustments made in (10) through (15) above.

(16) Disconnect the cables from J1, and J3 of the standard baseband combiner module.

(17) Proceed to the 'squelch rejection test.

g. Squelch Rejection Test. This procedure is used to check the response of the interoperating baseband combiners, when the pilot-tone squelch is applied in various combinations.

(1) On the ac voltmeter 1 set the RANGE switch to .03 VOLT and on ac voltmeter 2 set the RANGE switch to .01 VOLT.

(2) On the test oscillator, set the RANGE control to X100K, the FREQUENCY dial to 1, and the OUTPUT ATTENUATOR to -60 dBm.

(3) Connect the test equipment as shown in figure 6-31.

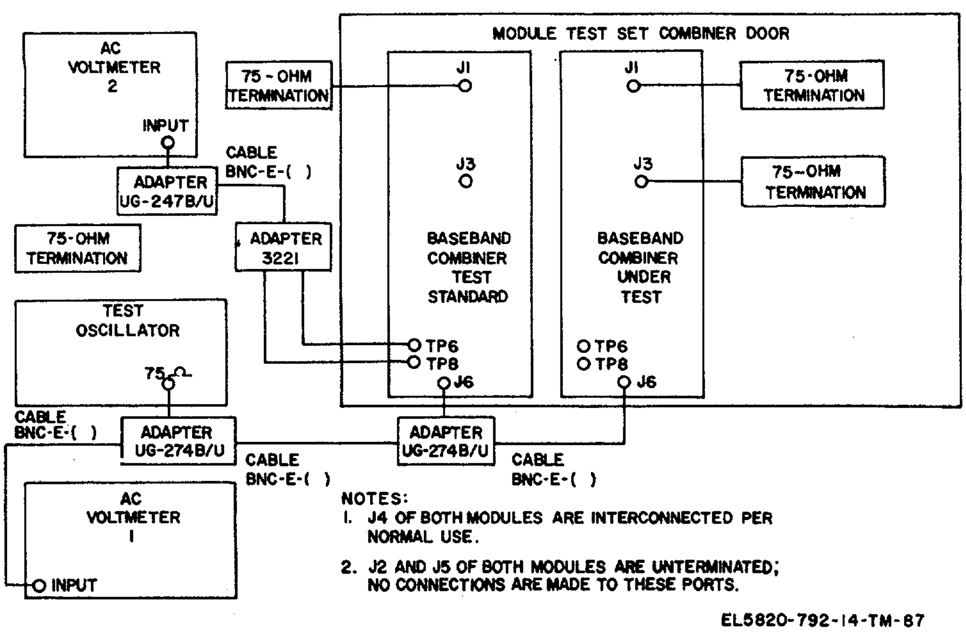


Figure 6-31. Baseboard combiner squelch rejection, test equipment setup.

(4) Adjust the OUTPUT ATTENUATOR with COARSE and FINE controls, to obtain 15 mV on ac voltmeter 1.

(5) Adjust R2 until ac voltmeter 2 indicates 8 mV.

(6) Transfer the 3221 adapter leads to test points TP8 and TP6 (ground) of the module under test.

(7) Adjust R2 on baseband combiner under test until voltmeter 2 indicates 8 mv.

(8) Disconnect the 3221 adapter from the test setup. Set ac voltmeter RANGE to .1 VOLT.

(9) Connect the 75-ohm termination to adapter UG-274B/U on ac voltmeter 2 and then hook its free end to J3 of the test standard combiner.

(10) On the dual pilot-tone detector, set switches S2 and S3 to their PLT NORM positions.

(11) Adjust R1 of baseband combiner test standard until ac voltmeter 2 indicates 71 mV.

(12) Disconnect the 75-ohm termination from J3 of the combiner under test.

(13) Transfer the test cable from J3 of the test standard module to J3 of the module under test.

(14) Adjust R1 of baseband combiner under test until ac voltmeter 2 indicates 71 mV.

(15) Set the RANGE of an electronic multimeter to 30V and the FUNCTION switch to +. Connect the electronic multimeter between TP8 of the test standard module and ground.

(16) Observe the squelch rejection chart of step (17). Prepare a similar chart, omitting the voltage indications. Notice that the voltages shown may vary from module to module, but are normally the same. In any event, the pattern is the primary consideration and that the signal output from either module be essentially the same (within 4 mV). If levels obtained are not consistent with the pattern shown, recheck the balancing (*f* above) and/or troubleshoot the module under (e above)

(17) Squelch Rejection Chart.

Dual pilot-tone detector module		**Baseband combiner under test**			**Baseband combiner standard unit**		
S2	S3	TP7	TP8	J3	TP7	TP8	J3
PLT NORM	PLT NORM	23.5 v dc	13.5 V dc	71 mV	23.5 V dc	13.5 V dc	71 mV
PLT NORM	PLT BYP	26.0 V dc	11.0 V dc	73 mV	21.0 V dc	19.0 V dc	73 mV
PLT BYP	PLT NORM	21.0 V dc	19.0 V dc	68 mV	26.0 V dc	11.0 V dc	68 mV
PLT BYP-	PLT BYP	23.5 V dc	13.5 V dc	71 mV	23.5 V dc	13.5 V dc	71 mV

(18) Record all voltages indicated at the specified test points in step (17).

(19) Set dual pilot-tone detector module switches S2 and S3 to the positions shown in the chart of (17) above. Record all voltages at the specified test points.

(20) Repeat (19) above until all data is taken.

(21) Use the data as explained in (16) above.

h. Intermodulation Distortion Test. This procedure is used to evaluate the linearity characteristics of the baseband combiner module. The intermodulation distortion test is used as the concluding major performance test of the baseband combiner module. The levels and frequency slots used in this test are based upon 600-channel loading; for a discussion of this type of test and its modification to other channel loading factors (chap. 5). The test equipment setup is shown in figure 6-32.

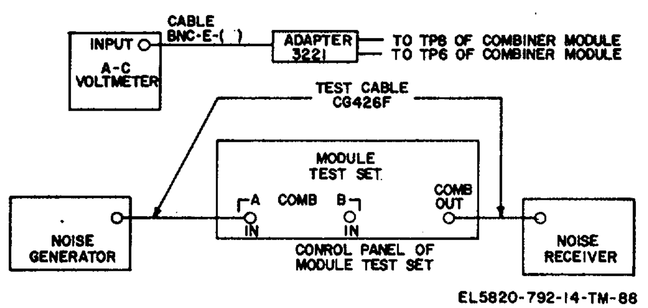


Figure 6-32. Baseband combiner inter-modulation distortion, test equipment setup.

(1) Perform the preliminary adjustments given in *f* above.

(2) Set the noise generator high-and low-pass filters to their IN positions, and all bandstop

filters to their OUT positions. Adjust the output level of the noise generator to 61 mV (-13.2 dBm/75 ohms) as indicated by the ac voltmeter.

(3) Set the noise receiver frequency selector to 70 kHz, then adjust the attenuator controls to produce a meter reference indication.

(4) Read and record the attenuator setting of the noise receiver. Label the reading as reference 1.

(5) On the noise generator, switch in the 70 kHz bandstop filter.

(6) Set the attenuator controls of noise receiver to produce the same reference level as reference 1.

(7) Read and record the attenuator settings of the noise receiver. Label the reading as reference 2.

(8) Subtract reference 1 from reference 2 to obtain the noise-power ratio at the 70 kHz slot. The resulting noise-power ratio for this slot shall not be less than 60 dB. Typical results are in the order of 62 dB.

(9) Set the 70 kHz bandstop filter switch to its out position.

(10) Repeat (3) through (8) above using 1002 kHz instead of 70 kHz.

(11) Set the 1002 kHz bandstop filter switch to its out position.

(12) Repeat (3) through (8) above using 2438 kHz instead of 70 kHz.

(13) Disconnect all test equipment from the module test set.

(14) Remove the module under test from the module test set.

(15) Replace the standard baseband combiner module in the module test set. This step completes this procedure.

i. Voltage and Resistance Measurements. If 6.54 performance of the test and/or alignment procedures does not result in acceptable module operation, the voltage and resistance data provided in paragraph 6-18j, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources, but only after making preliminary settings of the module controls. Preliminary control settings are the same as for ac voltage measurements. The RX100 scale of the multimeter is used as the standard range unless otherwise stated; the common multimeter lead is connected to J1-3 (ground) during all measurements.

(2) Dc voltage measurements are made with the module connected to the receiver door of the module test set using the appropriate point-to-point extender cable. No signal source is employed. Prior to performing dc voltage measurements, perform the preliminary adjustments as for ac voltage measurements.

(3) Ac voltage measurements are made using the following preliminary procedure:

(a) Set the RANGE control of a multimeter to 30V; set its FUNCTION switch to +.

(b) Set the RANGE control of a test oscillator to X100K and its FREQUENCY dial to 1; place the OUTPUT ATTENUATOR to .3 VOLT.

(c) Set the RANGE control of an ac voltmeter to .003 VOLT.

(d) Preset an IF attenuator for 16 dB.

(e) Connect the test equipment to the baseband combiner module as shown in figure 6-33.

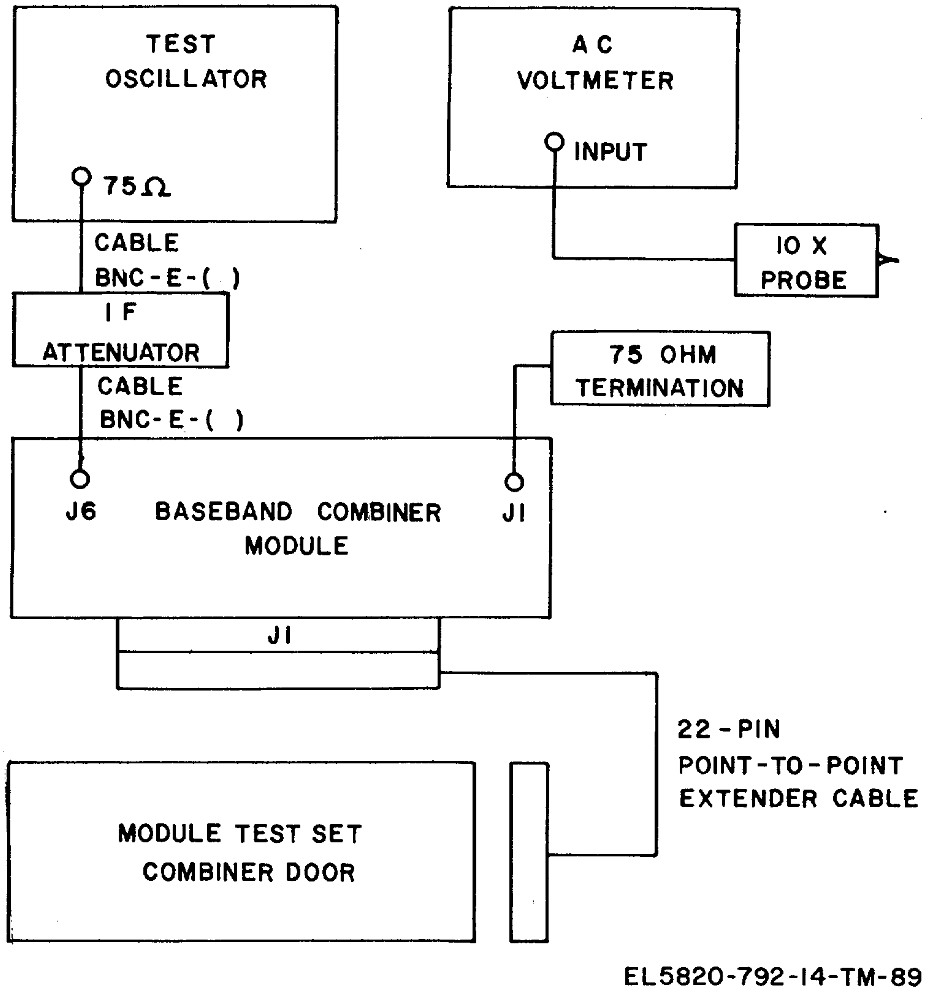


Figure 6-33. Troubleshooting test equipment setup, baseband combiner modules.

(f) Connect a multimeter COMMON to J1 pin 3 of the point-to-point extender cable; connect its DC probe to module test point TP8.

(g) Adjust R19 of the module for 13.5 to 14 volts as indicated by the multimeter.

(h) Transfer the DC probe of the multimeter to test point TP7 of the module.

(i) Adjust R13 of the module for 23.5 volts as indicated by the multimeter, then disconnect the multimeter.

(j) Connect the IOX probe of the ac voltmeter between J6 and ground.

(k) Add or remove attenuation as required to obtain an ac voltmeter indication of 1.4 mV, which is equivalent to 14 mV.

(l) Transfer the 10OX probe to module test point TP9.

(m) Adjust R2 of the module until the ac voltmeter indicates 0.9 mV, which is equivalent to 9 mV.

(n) Transfer the 10OX probe to module test point TP2.

(o) Set the ac voltmeter RANGE to 01.VOLT.

(p) Adjust R1 of the module until the ac voltmeter indicates 7.1 mV which is equivalent to 71 mV.

(q) Perform ac voltage measurements as necessary. Note that all measurements provided in the chart have been multiplied by 10 to account for the 10X probe.

(r) To perform dc voltage measurements, disconnect the signal source and measure as necessary.

(s) To perform resistance measurements, disconnect the signal source and also disconnect the point-to-point extender cable from the module test set.

j. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
Q1	Base	13.5	9.0 mV	7.4K	RX1K
	Emitter	12.8	8.8 mV	18.5K	RX1K
	Collector	23.5	0	4.1K	RX1K
Q2	Base	18.6	8.4 mV	4.5K	RX1K
	Emitter	17.0	8.3 mV	410	
	Collector	26.2	0	1.3K	
Q3	Base	7.5	1.25K		
	Emitter	6.9	6.0K		RX1K
	Collector	12.1	11.8K RX1K		
Q4	Base	7.5	1.75K		
	Emitter	6.8	11.5K		RX1K
	Collector	15.5	6.0K RX1K		
Q5	Base	3.9	1.9K		
	Emitter	3.2	1.75K		
	Collector	5.1	11.1K RX1K		
Q6	Base	3.2	1.5 mV 1.4K		
	Emitter	2.6	1.5 mV	480	
	Collector	8.3	1.Q mV	2.2K	
Q7	Base	8.3	1.0 mV	2.2K	
	Emitter	7.7	0	51C	
	Collector	16.5	15.0 mV	1.8K	
Q8	Base	16.5	15.0 mV	1.8K	
	Emitter	15.8	14.8 mV	440	
	Collector	26.5	0	1.3K	
Q9	Base	6.6	12.5 mV	3.6K	
	Emitter	6.0	10.0 mV	1.4K	
	Collector	13.8	12.3 mV	2.9K	
Q10	Base	-0.30	12.3 mV	6.0K	RX1K
	Emitter	-0.86	0	2.1K	
	Collector	+17.30	71.0 mV	1.8K	
Q11	Base	17.30	71.0 mV 1.8K		
	Emitter	16.50	71.0 mV	230	
	Collector	26.50	0	1.3K	
Q12	Base	4.9	11.2 mV	4.6K	RX1K
	Emitter	4.1	11.0 mV	200	
	Collector	23.2	11.1 mV	1.4K	
J1		0	9mV[a] 28.5mv [b]	INF	
J2		0	1.3mV[a] 71lmV[b]	INF	
J3		0	2.3mV[a] 7lmV[b]	INF	
J4		12.0	0	12K	RX1K
J5		0	9 mV	56	RX1K
J6		0	14 mV	76	RX1K
TP1	27.0	0	1.3K		
TP2		0	71 mV	INF	
TP3		0	14.6 mV	370	
TP4		-5.4	0	2.7K	
TP5		0	1.8 mV	27	RX10
TP6		0	0	0	
TP7		23.5	0	4.2K	RX1K
TP8		13.5	9 mV	7.7K	RX1K
TP9		0	9 mV	55	RX10
J1	Pin 1	28.0	0	INF	
	Pin 3	0	0	0	
	Pin 4	27.5	0	1.3K	
	Pin 5	28.0	0	INF	
	Pin 7	0	0	0	
	Pin 9	-6.0	0	360K	RX10K
	Pin 10	-6.0	0	320K	RX10K
	Pin 13[c]	0	0	INF	
	Pin 14[c]	0	0	INF	
	Pin 15	28.0	0	1.35K	

See footnotes at end of chart.

Point of measurement	Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
Pin 16	5.3	0	3.4K	
Pin 17	0	0	INF	
Pin 18	0	0	1.35K	
Pin 20	7.6	0	5.6K	RX1K
Pin 22	6.6	0	7.4K	RX1K

[a] Terminated in 75 ohms.
[b] Unterminated
[c] Interconnected pins.

6-15. Alignment Data

a. General. Alignment of the baseband combiner module consists of balancing the voltage and current sources and setting signal levels through the module. Alignment given in b and c below are given only to demonstrate the capability of the module to meet the required electrical specifications. Setting signal levels through the baseband combiner must be accomplished in an operating terminal, because combining action is determined by system noise levels. Voltage and current source balancing as given in the paragraph cited, while providing reasonable accuracy, does not insure interchangeability in the system. The method given in this paragraph does provide module interchangeability in terms of current and voltage balancing. Use figure 6-34 for the test equipment setup.

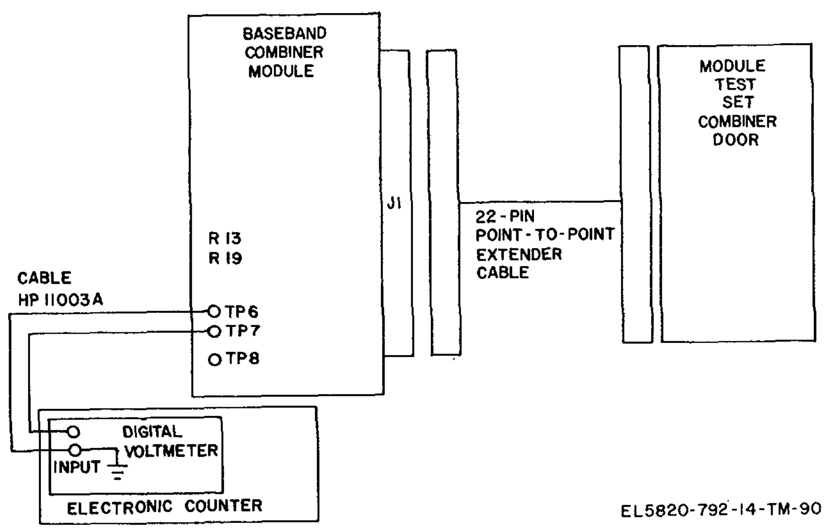


Figure 6-34. Baseband combiner balance adjustment, test equipment setup.

b. Preliminary. The procedure used to assure module interchangeability is based on comparison of the module under test with a standard module, designated as the master module. To assure continuity of module interchangeability throughout the system in the event of failure of the master module, a second module having characteristics matched to those of the master module should be retained in reserve at all times. The procedure for selecting and adjusting a master module follows.

(1) Obtain four to six operational baseband combiner modules.

(2) Preset R19 on each module using the procedure outlined in c (1) through (4) below.

(3) Perform the procedure in c (5) and (6) below.

(4) Insert two of the preadjusted modules in the A and B baseband combiner positions on the test set door.

(5) Connect a digital voltmeter probe in turn to 7P7 on each module and adjust R13 for 23.500

± 0.010 volts. Repeat to assure no interaction or drift.

(6) Transfer the digital voltmeter probe to TP8 of each module in turn and record voltage indicated to the nearest millivolt: also record the serial number of each module.

CAUTION

Do not adjust R19 on either module or attempt to balance modules at this time.

(7) Remove one of the modules from the test set door. Then repeat (4), (5), and (6) above, comparing another preadjusted module with the module remaining in the test set door.

(8) Repeat (7) above until each preadjusted module has been compared with every other module; that is, until all possible pair combinations of modules have been tested.

(9) Review acquired data. Select the pair of modules having the best balance (the smallest indicated difference in voltage readings at TP8) for use as master modules, and place the two selected modules in the test set door.

(10) Connect the digital voltmeter probe to TP7 of each module in turn, and adjust R13 for 23.500 volts + 10 millivolts AND for a difference between the two test points of not more than 10 millivolts.

(11) Transfer the digital voltmeter probe to TP8 of each module in turn and record indicated voltage.

(12) Adjust R19 of the module having the lower voltage at TP8 until the voltage difference between modules is 3 millivolts or less. Note that the voltage at TP8 of one module decreases as the voltage at TP8 of the other module increases.

(13) Seal the holes covering R19 on each module with tape to prevent accidental adjustment. Retain one of the modules in the test set door as the master module, and retain the other module for use as the reserve master module. Record serial numbers of both modules, together with final voltage recorded at TP8 of each module, for future reference.

(14) At regular intervals, reverify that the master module is maintaining long-term stability by inserting the reserve master module into the test set door with the master module and recording the voltage at TP8 of each module. Note that R13 of each module may require readjustment as described in step (10) above. If the voltage differential at TP8 is less than 10 millivolts, continue to use the master module without further adjustment; if the voltage differential is greater than 10 millivolts but less than 100 millivolts, readjust R19 of each module as required to achieve balance at the voltage closest to that recorded originally. If the voltage differential is greater than 100 millivolts, no adjustments should be made until the reason is determined. One of the modules (probably the master module in use) has changed characteristics and must be replaced; attempt to verify, possibly through use of a spare module previously aligned with the master module, which of the modules has changed in performance. Replace the module which has changed, following the procedures in (15) and (16) below.

(15) If the master module fails, insert the reserve master module in the B position and match another module to it, using the basic procedure described in (1) through (11) above, except that each new module must be tested ONLY against the reserve master module and the best module selected.

(16) Adjust R19 of the newly selected module to balance within 3 millivolts of the master module, record data on the two modules as in (13) above, and retain the newly aligned module as the new reserve master module.

c. Procedure. Perform the following steps:

(1) Remove the top cover of the module under test.

(2) Locate transistors Q4 and Q5 and resistors R18 and R22 (fig. 6-29 (1)).

(3) Set a universal bridge to indicate balance at 870 ohms. Then connect the bridge test leads to (a) the junction of R18 and Q4 emitter, and (b) the end of R22 NOT connected to Q5 collector.

(4) Adjust R19 until the bridge indicates balance. Disconnect test leads and replace module top cover.

(5) Remove both noise amplifier modules from the test set door for the remainder of this test.

(6) Place both switches S2 and S3 of the dual pilot tone detector module in the PLT BYP position for the remainder of the test.

(7) Insert the module under test in the A baseband combiner position on the test set door.

(8) Using a digital voltmeter, measure the voltage at TP7 of the module under test. Adjust R13 to obtain 23.500 volts ±10 millivolts at TP7.

(9) Transfer the digital voltmeter probe to RP7 of the master module and adjust R13 for 23.500 volts ± 10 millivolts.

(10) Transfer the digital voltmeter probe to TP8 of the module under test. Note voltage to the nearest millivolt.

(11) Transfer the digital voltmeter probe to TP8 of the master module and record voltage to the nearest millivolt.

(12) Adjust R19 of the module under test

until the voltages at TP8 of both modules are matched within 3 millivolts. Note that the voltage at TP8 of one module will decrease as the voltage at TP8 of the other module increases; it will be necessary to transfer the digital voltmeter probe back and forth between modules to obtain required balance.

(13) Interconnect J4 of both combiners with a short coaxial cable, then repeat (10) through (12) above until balance at TP8 is again within 3 millivolts.

(14) Disconnect one end of the coaxial cable and recheck balance; combiners should still be in balance.

d. Disposition of Module. Place a tape on the module to cover access holes to R13 and R19. Set R1 and R2 fully clockwise. This completes alignment of the module.

Section V. DUAL PILOT TONE DETECTOR (368-43035-1)

6-16. Introduction

The pilot-tone detector module is a module that can be used equally well in radio transmitter or receiver applications. The pilot-tone detector module amplifies, detects, and provides pilot-tone squelch and pilot-tone alarms in the event that pilot tones are missing in the baseband signals. The pilot-tone detector module consists of a single -printed-wiring card on which all components, with the exception of controls, test jacks, and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis (A1).

a. The functional block diagram of the pilot-tone detector appears in figure 6-35. Pilot-tone detector modules have two major applications. The first application is their use with dual receivers to detect pilot-tone continuity over the radio path from distant to local stations. The second application is their use with dual transmitters to detect pilot-tone continuity through the transmitter modules; loss of pilot tone in this application is interpreted as loss of modulation.

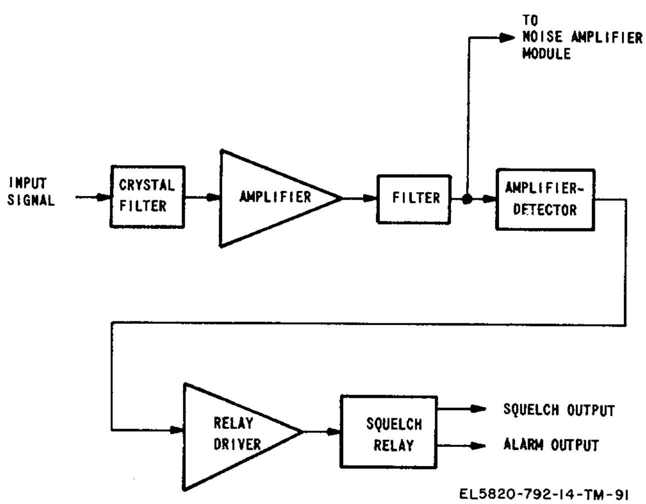


Figure 6-35. Pilot-tone detector module, functional block diagram.

b. In the dual pilot-tone detector modules, two independent pilot-tone detectors are placed on the same printed-wiring assembly; one is used for diversity channel A detection and one is used for diversity channel B detection.

c. The pilot-tone detector module receives its input signal from the noise amplifier module associated with that transmission path; this signal contains all components of the baseband. The TEST-NORMAL switch is used, at the desire of the maintenance personnel, to provide a simulated loss of pilot tone for test purposes. The multiplex and service-channel signals are rejected by the crystal filter, while the pilot-tone signal is passed through into the first stage of amplification.

6-17. Pilot-Tone Paths

After amplification, the pilot-tone is passed through another filter which eliminates transistor noise. The pilot-tone signal is split into two paths; one path attenuates the signal and routes it out of the pilot-tone detector module to a noise amplifier module, and the second path passes the pilot tone into a final amplifier prior to the detector. The pilot tone is detected by means of a voltage-doubling detector circuit, and the output is used to bias off the Schmitt trigger (the relay driver). With the Schmitt trigger biased off, the relay driver keeps the relay energized. A loss of pilot tone or the loss of +28 V dc causes the relay driver to deenergize the relay. When the relay is deenergized in receiver pilot tone applications, squelch bias is applied to the combiner module to suppress the failing channel, and to both the local and remote alarms of its associated receiver channel. In transmitter pilot-tone applications, both local and remote alarms of the associated transmitter channel are activated; the squelch output is unused. Dc power for the pilot-tone detector module is supplied from dual low-voltage power supplies external to the module. Steering diodes in the module are connected so that either supply can operate the squelch circuit. In normal operation, however, supply A is used only for channel A, and supply B is used only for channel B.

6-18. Circuit Analysis

a. The schematic diagram of the dual pilottone detector module is shown in' figure FO-17. The circuits for the A and B pilot-tone channels are the. same, except for circuit reference designators, so that the discussion which follows for channel A pilot-tone channel is also applicable to channel B circuits using the corresponding reference designators. The baseband signal received at the input connector is applied to PLT/NORM/TEST switch S1. If connection is made in the NORM position of switch S1, the pilot-tone signal is passed into crystal filter FL2 without attenuation. If connection is made in the TEST position of switch S1, the pilot-tone signal is attenuated by 6 dB and T-pad consisting of R62, R63, and R64. Following this, provisions are made for additional attenuation, as desired, by strapping in a T-pad consisting of R34, R35, and R36.

b. The input signal applied to crystal filter FL2 is processed to reject the multiplex and supervisory-channel signals while the pilot-tone signal is passed into integrated circuit MD2. The bias supply for module MD2 is taken from the 28-volt supply at the junction of resistors R37 and R38. Bias current is passed from this junction through R40 to the inverting input pin 2 of MD2; similarly, the bias current is passed through R41 into the noninverting pin 3 input of MD2. Any baseband signals reaching pin 3 of MD2 are passed to ground via C47 and C26. Capacitor C28 is connected across the frequency-compensation terminals of the integrated circuit module. Resistor R42 is a feedback resistor. Pin 8 of the integrated circuit supplies the dc operating voltage to the module.

c. The output signal from MD2 is RC-coupled into a second filter stage consisting of inductor L10 and capacitors C32 and C33. This filter is resonant at the pilot-tone frequency and presents an infinite impedance to the pilot-tone frequency only; other frequencies are shunted to ground. Since E10 is strapped to E9, the pilot-tone frequency is attenuated by voltage divider R45 and R46, then sent out of the pilot-tone detector module through shielded wire into the noise amplifier module via J1 pin 9. The setting of potentiometer R1 determines the specific level at which the loss-of-pilot alarm and squelch circuits are activated.

d. The amplified continuity pilot tone is detected by diodes CR11 and CR12 in a voltage-doubler circuit configuration arranged to provide a negative output voltage. This negative dc voltage is used to oppose the quiescent positive bias at the base of Schmitt trigger Q6 to maintain the input stage at cutoff, causing the relay driver to keep the squelch relay energized. A loss of pilot tone drives the Schmitt trigger into conduction, and causes the relay driver to deenergize relay K2. The reaction time of the pilot-tone detector is 200 milliseconds after the loss of the pilottone signal. The recovery time, that is, the time from the initial receipt of the continuity pilot tone until the alarms are deactivated, is 20 milliseconds. Diode CR14 is used to protect driver stage Q6 from base-to-emitter voltage breakdown, which could result from the negative detected pilot-tone signal.

e. Switch S2 is open in the PLT NORM position; closing the switch (PLT BYPASS position) grounds the base of Schmitt trigger Q6. The input stage of the relay driver (the Schmitt trigger) is forced into cutoff, and the relay driver energizes relay K2, thus simulating the presence of the pilot tone. Switch S1 is a manual switch which introduces 6 dB attenuation into the input of the dual pilot-tone detector. This simulates a 6dB drop in pilot tone which causes operation of the pilot-tone squelch and fault signal circuits for test purposes.

f. The +28-volt dc power for this module is obtained from the dual low-voltage power supplies; channel A supply powers channel A and channel B supply powers channel B. Diode steering of these supplies is employed within the module in such a way that both supplies are applied to the squelch circuits of both channels. Consequently, if one of the supplies fails, the squelch circuit of that channel still operates.

g. *Technical Characteristics*

Parameter	Specifications
Input Impedance	75 ohms, unbalanced
Input Level	5 mV minimum
Outputs	0 or +28 V dc for combiner squelch O or +28 V dc for alarm indication Form C dry contacts for external alarm
Gain	55 dB at pilot-tone frequency
Frequency Response	3.2 MHz ± 600 Hz
Reaction Time	
Alarm ON	200 milliseconds (activation)
Alarm OFF	20 milliseconds
Power Requirements	
Dual Units	90 mA at +28 V dc

6-19. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following paragraphs contain procedures for testing the performance of the overall module and its major circuits, and gives probable causes of abnormal indication.

b. Test Equipment Setup. Connect the test equipment and module test set to the module as shown in figure 6-36 when directed to do so in the procedure.

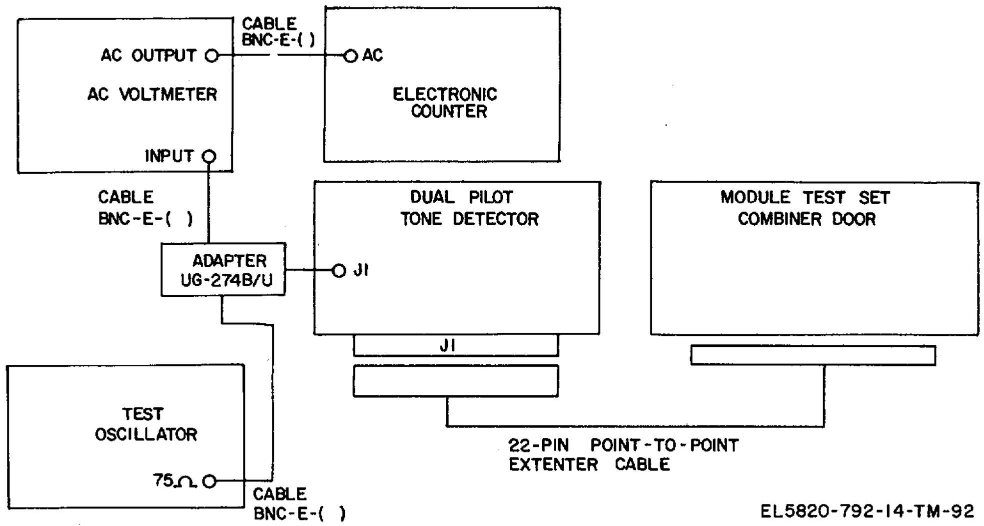


Figure 6-36. Pilot-tone detector module. initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

NOTE

Strapping of attenuator pads of the module is based on a standard configuration, that is, E2 to El and E4 to E6 for channel B and also Ell to E13 and E14 to E16 for channel A. These straps provide zero attenuation into the respective filters. If the strapping of these pads are not standard when received for maintenance, perform the necessary soldering operations to restore the module to standard configuration.

(1) Remove the top and bottom covers from the module.

(2) Set all test equipment power switches to their ON positions; allow the test equipment to stabilize for 20 minutes.

(3) Check that the +28-volt power supply in the module test set is +28 + 0.1 V dc.

d. Test Procedures. After completing the procedures in b and c above, perform the procedures provided in e below. Figure 6-37 contains parts location data.

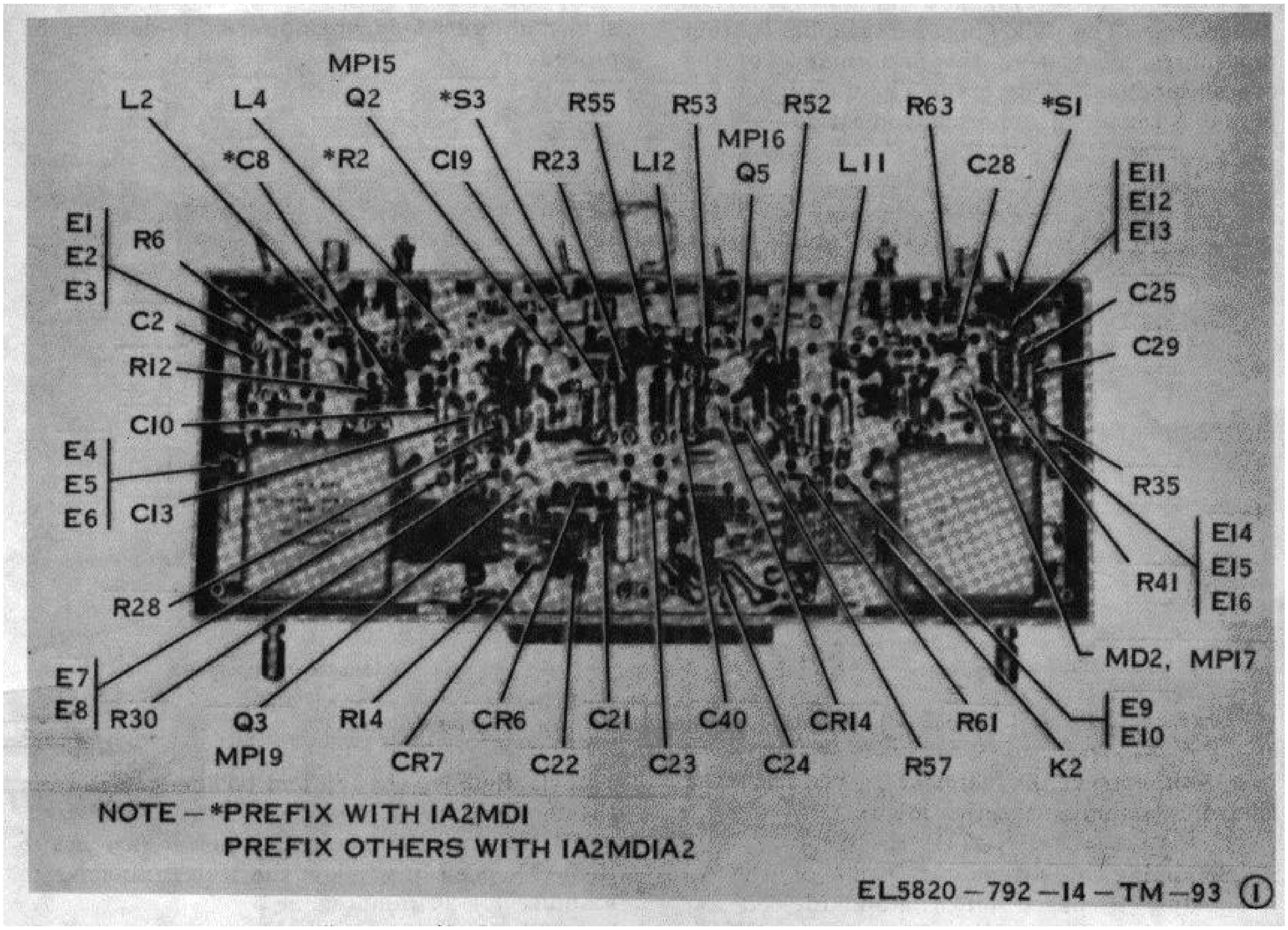


Figure 6-37 (1). Pilot-tone detector module, parts location diagram (sheet 1 of 4).

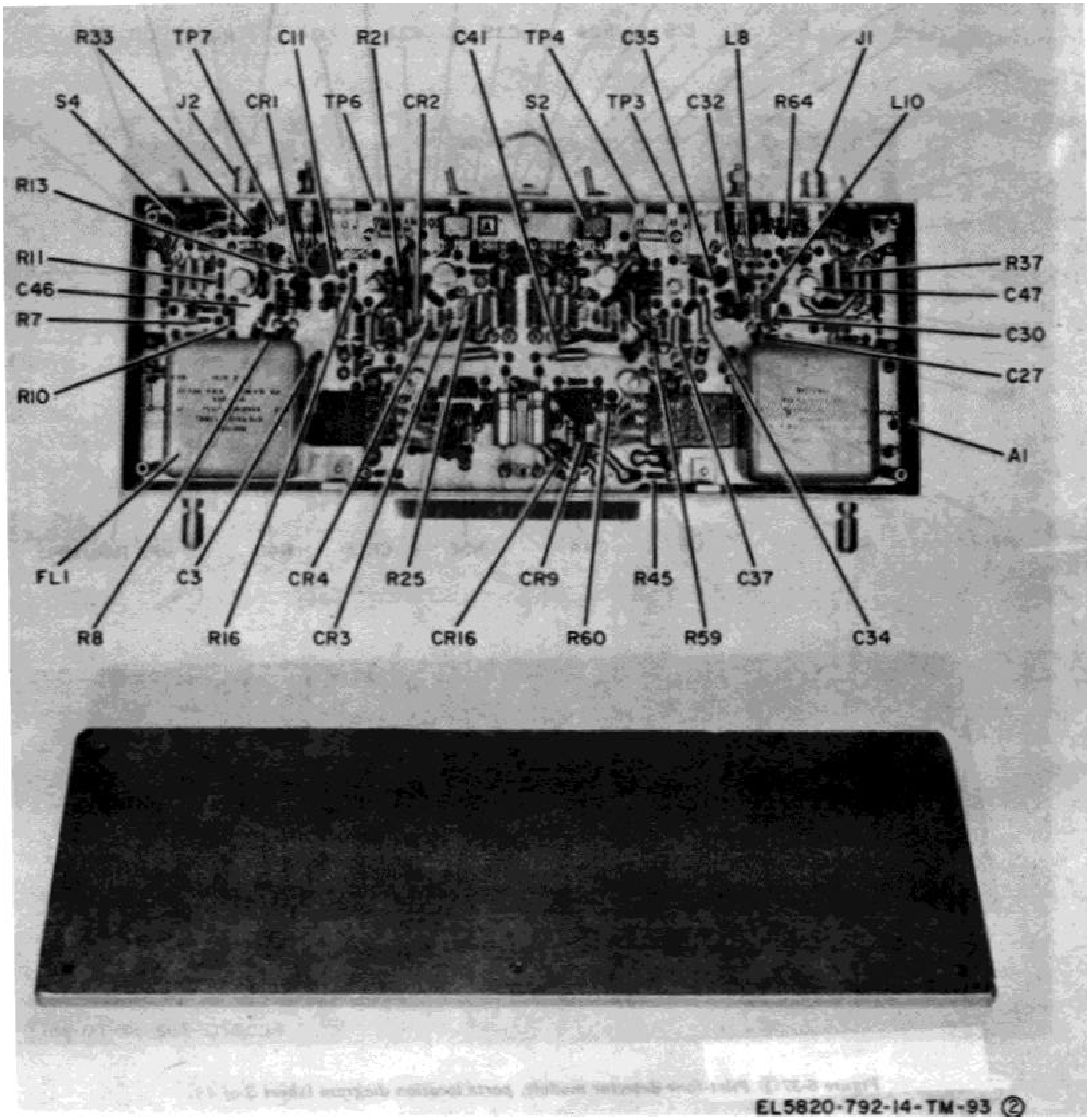


Figure 6-37 (2). Pilot-tone detector module, parts location diagram (sheet 2 of 4).

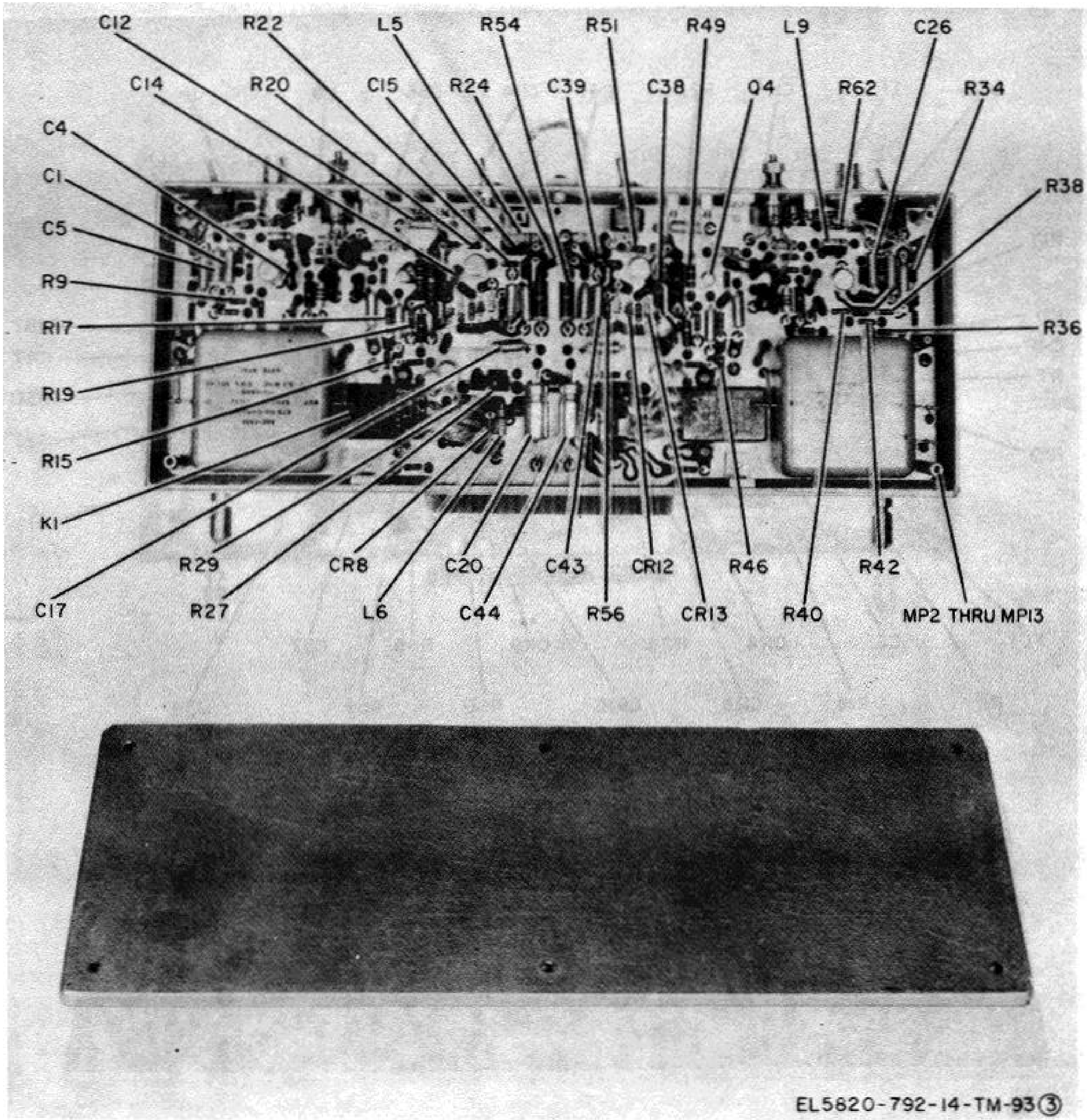


Figure 6-37 (3). Pilot-tone detector module, parts location diagram (sheet 3 of 4).

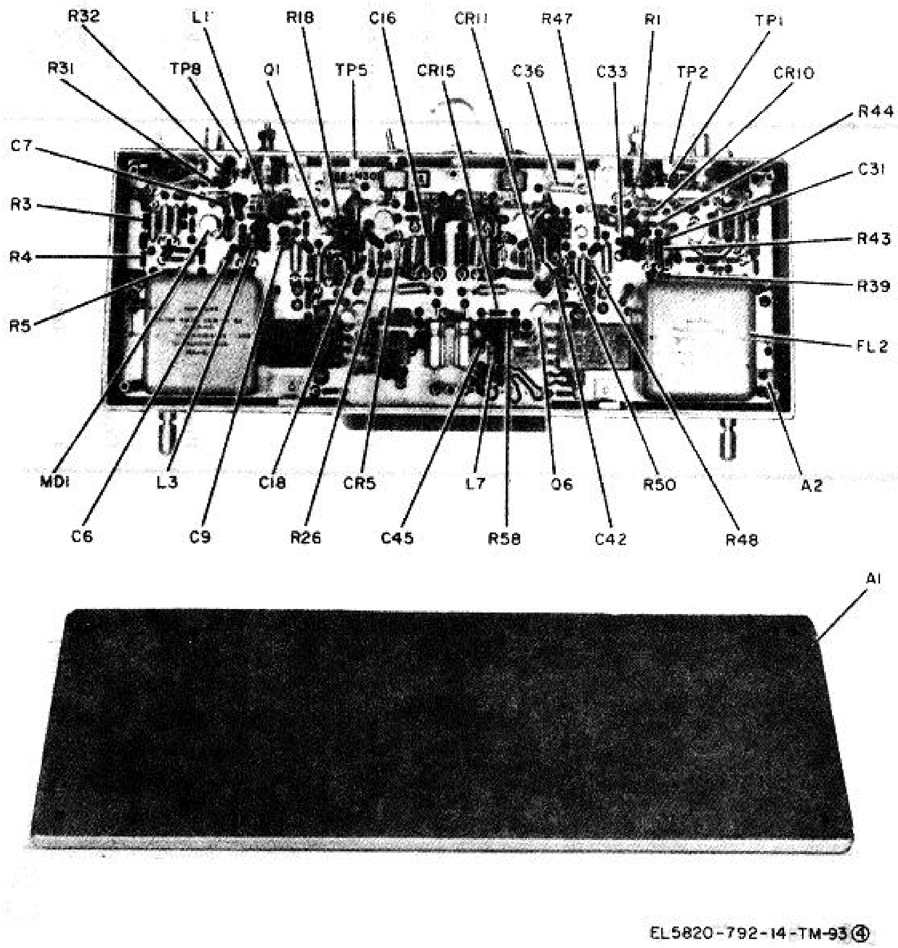


Figure 6-37 (4). Pilot-tone detector module, parts location diagram (sheet 4 of 4).

e. Procedure

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Channel A Performance Check		
	On the test oscillator, set the RANGE to X1M, FREQUENCY dial to 3.2, and the OUTPUT ATTENUATOR to --30 dBm.			
3	Connect the test equipment to the module as shown in figure 6-36.			
4	On the pilot-tone detector module, set switches S1 and S4 to their NORM positions, and switches S2 and S3 to their PLT NORM positions.			
5	On the test oscillator, adjust the COARSE and FINE us attenuators until the ac voltmeter indicates 6 mV.			
6	On the test oscillator, adjust the FREQUENCY dial until the electronic counter indicates 3.2 MHz ±100 Hz.			
7	On the dual pilot-tone detector module, adjust R' to its fully clockwise position. Notice that the A PILOT TONE indicator on the module test set is not lighted.			
8	On a multimeter, set the FUNCTION switch to + and the RANGE control to 30 V. Connect the COMMON lead of the multimeter to test point 3 on the 22-pin point-to-point extender cable.			
9	Connect the DC test probe of the multimeter to pin 13 of J1.	0 V dc	Proceed to step 10.	Proceed to step 12.
10	On the dual pilot-tone detector module, set switch SI to its TEST position, while observing the multimeter. Then return the switch to its NORMAL position. Disconnect the multimeter.	+ 28 V dc	Proceed to step 16.	Proceed to step 11.
11	Disconnect the ac voltmeter cable from the UG-274B/U adapter and attach a 3221 adapter to the free end of the cable. Set meter RANGE to .1 VOLT.			
12	Connect the ac voltmeter between test points TP3 and TP1 on the dual pilot-tone detector module; then disconnect ac voltmeter from the module.	60 mV (nominal)	Proceed to step 13.	Check MD2 and associated components, then check FL2.
13	Set ac voltmeter RANGE to 10 V, then connect the ac voltmeter between Q5 collector and ground.	3V (nominal)	Proceed to step 14.	Check transistors Q4, Q5, and associated components.
14	Connect the ac voltmeter cable to test points 9 and 10 of the extender cable. and K2.	5.3 mV (nominal)	Proceed to step 5.	Check transistor Q6 and associated components.
		Channel B Performance Check		
15	On the test oscillator, set the RANGE to X1M, FREQUENCY dial to 3.2 and the OUTPUT ATTENUATOR to --40 dBm.			
16	On the ac voltmeter, set the RANGE control to .01 VOLT.			
17	Connect the test equipment to the module as shown in figure 6-36, except that the test equipment is connected to J2 instead of J1.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
18	On the pilot-tone detector module, set switches S1 and S4 to their NORM positions, and switches S2 and S3 to their PLT NORM positions.			
19	On the test oscillator, adjust the COARSE and FINE attenuators until the ac voltmeter indicates 6 mV.			
20	On the test oscillator, adjust the FREQUENCY dial until the electronic counter indicates 3.2 MHz ±100 Hz.			
21	On the dual pilot-tone detector module, adjust R2 to its fully clockwise position. Notice that the B PILOT TONE indicator on the module test set is not lighted.			
22	On a multimeter, set the FUNCTION switch to + and the RANGE control to 30 V. Connect the COMMON lead of the multimeter to test point 3 on the 22-pin extender cable.			
23	Connect the DC test probe of the multimeter to pin 16 of J1.	0 V dc	Proceed to step 24.	Proceed to step 26.
24	On the dual pilot-tone detector module, set switch S4 to its TEST position while observing the multimeter. Then return the switch to its NORMAL position. Disconnect the multimeter.	+28 Vdc	Proceed to step 30.	Proceed to step 25.
25	Disconnect the ac voltmeter cable from the UG-274B/U adapter and attach a 3221 adapter to the free end of the cable. Set meter range for .1 VOLTS.			
26	Connect the ac voltmeter between test points TP6 and TP7 on the dual pilot-tone detector module; then disconnect ac voltmeter from the module.	60 mV (nominal)	Proceed to step 27.	Check MD1 and associated components, then check FL1.
27	Set ac voltmeter RANGE to 10 V, then connect the ac voltmeter between Q2 collector and ground.	3 V (nominal)	Proceed to step 28.	Check transistors Q1, Q2, and associated components.
28	Connect the ac voltmeter cable to test points 22 and 21 of the extender.	5.3 mV (nominal)	Proceed to step 29.	Check R14, R15, and the strapping between E7 and E8.
29	Set a multimeter RANGE to 10 V. Connect the DC probe to test point TP5. The COMMON lead is still connected to pin 3 of the extender cable.	Less than 2 V dc	Proceed to step 30.	Check CR2, CR3, and associated components
30	Transfer the DC probe of the multimeter to the anode of CR6. CR6 and K1.	Less than 6 Vdc	Proceed to step 31.	Check transistor Q3 and associated components. Then check
		Steering Diode Performance Check		
31	Of the module test set, check that the A and B low-voltage power supplies are adjusted to provide +28 ± 0.1 V dc.			
32	Connect the dual pilot-tone detector module to one end of a 22-pin extender cable, and the other end to the DUAL PLT TONE DET position in the combiner door of the module test set.			
33	On the dual pilot-tone detector module, set S2 and S3 to their PLT BYP positions.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
34	Locate test points 1, 3, 5, 6, and 8 of the extender cable.			
35	Connect the COMMON lead of a multimeter to test point 3 of the extender cable.			
36	On the multimeter, set the FUNCTION switch to +, the RANGE switch to 30 V, then connect the DC probe to pin of the extender cable.	+28 ±0.1 Vdc		
37	Transfer the DC probe to pin 5 of the extender cable.	+28 ± 0.1 Vdc d		
38	Connect the DC probe to pin 6 of relays K1 or K2.	+ ± 0.5 Vdc	Proceed to step 39.	Replace CR8 and CR9.
39	On the module test set low voltage power supply, set CHANNEL B POWER switch to its OFF position.	'		
40	Connect the DC probe to pin 6 of relays K1 or K2.	+27 ± 0.5 Vdc	Proceed to step 41.	Replace CR9.
41	Transfer the DC probe to pin 8 of the extender cable.	0 Vdc	Proceed to step 42.	Replace K1
42	Transfer the DC probe to pin 6 of the extender cable.	+27 ± 0.5 Vdc	Proceed to step 43.	Replace K2.
43	On the module test set low voltage power supply set CHANNEL B POWER switch to its ON position.			
44	On the module test set low voltage power supply, set CHANNEL A POWER switch to its OFF position.			
45	Connect the DC probe to pin 6 of relays K1 or K2.	+27 ± 0.5 Vdc	Proceed to step 46.	Replace CR8.
46	Transfer the DC probe to pin 8 of the extender cable.	+27 ± 0.5 V dc	Proceed to step 47.	Replace K1.
47	Transfer the DC probe to pin 6 of the extender cable.	0 V dc	Test complete. Disconnect all test equipment.	Replace K2.

f. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, the voltage and resistance data provided in g below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources. Preset switches S1 and S4 to their NORM positions, S2 and S3 to their PLT NORM positions, and potentiometers R1 and R2 fully clockwise.

(2) Dc voltage measurements are made with the module connected to the combiner door of the module test set using the appropriate point-to-point extender cable. No signal source is employed. Preset module controls as indicated under resistance checks.

(3) Ac voltage measurements are made using the following preliminary procedure:

(a) Preset switches and potentiometers as per resistance measurement.

(b) Insert 6 dB into IF attenuator.

(c) Connect the test equipment as shown in figure 6-38, except for the actual connection to J1 or J2 of the module, and the 10X probe on the ac voltmeter.

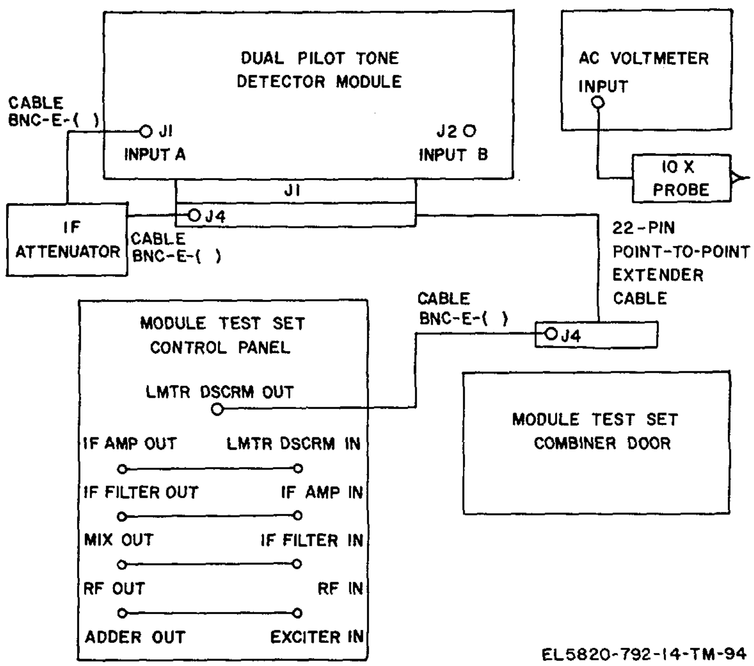


Figure 6-38. Troubleshooting test equipment setup, dual pilot-tone detector module.

(d) Set the ac voltmeter RANGE to .01 VOLTS.

(e) Connect an UG-274B/U to the ac voltmeter, then connect the free end of the IF attenuator cable to the UG-274B/U adapter.

(f) Connect a 75-ohm termination to the remaining port of the UG-274B/U adapter.

(g) Add or remove attenuation from the IF attenuator until the ac voltmeter indicates 5 mV.

(h) Disconnect the UG-274B/U adapter from the ac voltmeter and the free end of the IF attenuator cable.

(i) Connect the IF attenuator cable to J1 INPUT A or J2 INPUT B as desired.

(j) Connect the 10X probe to the ac voltmeter INPUT.

(k) Perform ac voltage measurements as desired.

NOTE

Stages Q3 and Q6 are dual transistors. When viewing foil-side connections, count the pins in a clockwise direction, using the casing tab of the stage as an indexing or starting point.

g. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
Q1	Base	3.40	7.8 mV	2.1K	
	Emitter	2.70	0	550	
	Collector	9.20	770 mV	3.0K	
Q2	Base	9.20	770 mV	3.0K	
	Emitter	8.60	765 mV	550	
	Collector	19.20	4.7 mV	3.3K	
Q3	Pin 1	5.9[a]20.5[b]		1.7K	
	Pin 2	6.3[a]0[b]		3.20	
	Pin 3	5.6 [a] 3.4 [b]		580	
	Pin 4	5.6[a] 3.4 [b]		580	
	Pin 5	1.65 [a] 4.2 [b]		1.4K	
	Pin 6	28.0[a] 3.5 [b]		2.1K	
Q4	Base	3.40	10.5 mV	2.1K	
	Emitter	2.70	0	560	
	Collector	9.85	950 mV	3.4K	
Q5	Base	9.85	950 mV	3.4K	
	Emitter	9.20	940 mV	540	
	Collector	18.30	4.7 mV	3.3K	
Q6	Pin 1	28.0[a] 3.6[b]		3.4K	
	Pin 2	20.5[a] 4.2[b]		1.35K	
	Pin 3	5.1 [a] 3.4 [b]		560	
	Pin 4	5.1[a] 3.4[b]		560	
	Pin 5	5.8[a]0[b]		310	
	Pin 6	7.5[a] 20.5[b]		2.1K	
MD1	Pin 1	7.2	0.6 mV	3.4K	RX1K
	Pin 2	7.2	1.4 mV	6.0K	RX1K
	Pin 3	7.2	1.1 mV	4.5K	RX1K
	Pin 4	0	0	0	
	Pin 5	12.0	660 mV	15.5K	RX1K
	Pin 6	7.9	600 mV	10.9K	RX1K
	Pin 7	7.2	585 mV	3.6K	RX1K
	Pin 8	19.0	0.8 mV	1.0K	
MD2	Pin 1	7.2	1.3 mV	3.0K	RX1K
	Pin 2	7.2	1.9 mV	5.6K	RX11K
	Pin 3	7.2	1.1 mV	6.2K	RX1K
	Pin 4	0	0	0	
	Pin 5	11.5	1.0 V	15.0K	RX1K
	Pin 6	7.6	900 mV	11.1K	RX1K
	Pin 7	7.0	860 mV	2.8K	RX1K
	Pin 8	18.7	1.3 mV	1.2K	
J1	Pin 1	28.0	2.4K		
	Pin 3	0		0	
	Pin 5	28.0		2.41	
	Pin 6	0 [a] 28.0 b		INF	
	Pin 7	0		0	
	Pin 8	0 [a] 28.0 b		INF	
	Pin 9	0		1.2K	
	Pin 10	0		0	
	Pin 11	27.0[a] 7.6[b]		200K	RX10K
	Pin 12	18.0[a]0b		INF	
	Pin 13	28.0[a]0b		60K	RX10K
	Pin 14	0		INF	
	Pin 15	18.5[a] 0 [b]		INF	
	Pin 16	28.0[a] 0[b]		60K	RX10K
	Pin 17	0		INF	
	Pin 18	0		INF	
	Pin 19	28.0[a]0[b]		200K	RX10K
	Pin 20	0		INF	
	Pin 21	0		0	
	Pin 22	0		1.2K	
TP1		0		0	
TP2		0		0.4	RX1[C]
TP3		0		3.2	RX1

See footnotes at end of chart.

Point of measurement	Dc voltage (nominal)	Ac voltage (rims nominal)	Resistance (ohms nominal)
TP4	6.0[a]0[b]		5.0K RX1K[a]
TP5	6.4[a]0[b]		4.8K RX1K[a]
TP6	0		32 RX1
TP7	0		0
TP8	0		38 RX1[d]

[a] Switches S2 and/or S3 in the PLT NORM position.
[b] Switches S2 and/or S3 in the PLT BYP position.
[c] Strapping option E2 to E1 and E6 to E4.
[d] Strapping option E2 to E3 and E6 to E5.

6-20. Alignment Data

The pilot-tone detector does not require alignment at the test bench location; however, when the module is installed in an operational terminal it must be aligned to meet system specifications. The pilot-tone detector uses potentiometers R1 and R2 in addition to an attenuator pad to set the threshold for the pilot-tone alarms; refer to chapter 5.

Section VI. IF AMPLIFIER MODULE (368-43488-1)

6-21. Introduction

The IF amplifier module is used in the microwave receiver. The function of the IF amplifier module is to receive the 70-MHz receiver IF signal from the IF filter module, amplify this frequency-modulated signal, and deliver it to a limiter-discriminator module. The amplifier has a 50 MHz bandwidth with a gain of approximately +80 dB, subject to AGC control over a dynamic range of 60 dB. The IF amplifier module consists of a single printed-wiring card on which all components, with the exception of test jacks and connectors, are mounted. The latter components are mounted on the front face of the metal module chassis.

6-22. Functional Description

a. The functional block diagram of the IF amplifier appears in figure 6-39. The 70-MHz FM input signal, ranging between -70 dBm and -10 dBm, enters the IF amplifier module through coaxial connector J1. This signal is first passed through a varilosser circuit which operates to maintain a constant output signal despite input signal amplitude fluctuations. The IF signal is then amplified by a two-stage transistor amplifier prior to its application to the second varilosser stage. The second varilosser stage is followed by another two stage amplifier which has a bandwidth of 100 MHz and a signal gain of approximately +22 dB.

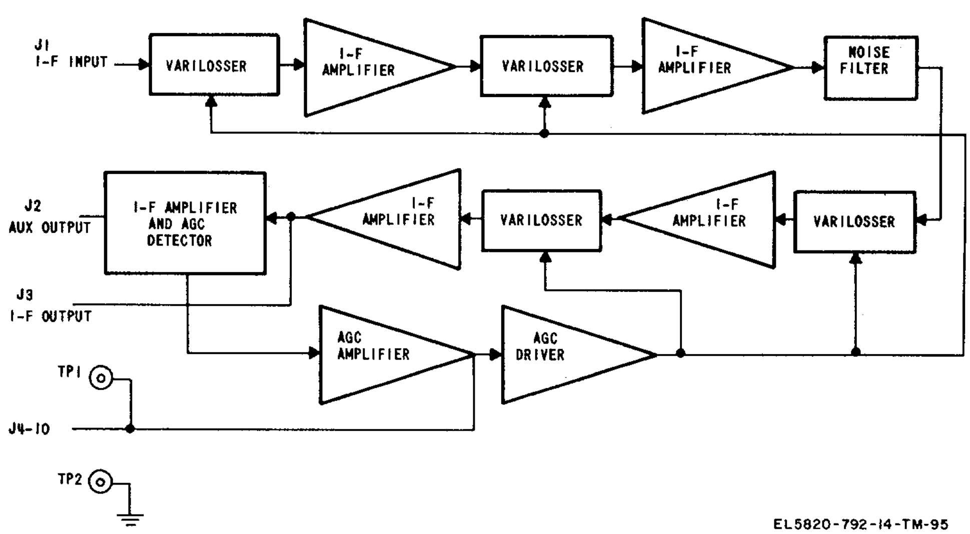


Figure 6-39. IF amplifier module, functional block diagram.

b. The 70-MHz IF signal is then sent into a bandpass filter which reduces receiver noise products and limits the module output bandwidth to 50 MHz. Following the filter, another varilosser stage is used to control signal gain. Two more two-stage amplifiers are used, with a final varilosser between them, to produce the final IF output signal at coaxial connector J3. The final output level of the 70-MHz IF signal at J3 is approximately +5 dBm across 75 ohms.

c. The 70-MHz output signal is amplified prior to the AGC detector. The IF signal level available at auxiliary output J2 ranges between -5 and +7 dBm across 75 ohms. The IF signal is passed into a voltage-doubling rectifier which is referenced to -6 V dc. The AGC voltage is amplified by an operational amplifier and applied to an AGC driver stage which supplies AGC control voltage to all varilosser stages. The output of the operational amplifier is also available for external meter monitoring.

6-23. Circuit Analysis

a. The schematic diagram of the module is shown in figure FO-19. The 70-MHz IF signal is brought into the module at coaxial connector J1. Depending upon path performance, this level ranges between -8 dBm and -68 dBm. From J1, the IF signal is sent to the first of four bridged-T varilosser networks driven by the AGC circuits.

b. Resistor R6 is used in conjunction with Zener diode CR1 to reduce the 28-volt supply to 18 volts and to regulate one end of the varilosser control line. Capacitors C107 and C1 bypass the IF signal at the Zener diode. Inductor L1 prevents the IF signal from reaching the Zener diode. The path for the varilosser control circuit is through diodes CR2, CR4, CR6, and CR8, then through inductor L33 and diodes CR9, CR7, CR5, and CR3 to the collector of varilosser driver Q10. A resistor is connected across each diode in this series circuit to restrict the impedance range within proper limits as the varilosser operates. Bypass capacitors and RF chokes are used at the terminals of each varilosser diode to provide RF isolation at each point.

c. Each varilosser is a bridged-T network. The T-portion of the first varilosser network consists of resistors R4 and R8, with the network CR3, R5, and C4 acting as the common leg of the T. Capacitor C4 provides signal ground for the common leg to the dc operated T circuit. Capacitors C2 and C71, in addition to passing the IF signal input, also block the dc voltage of the T network; capacitors performing this same function are used at each varilosser. Inductor L2, capacitors C3 and C5, and network CR2-R7 form the bridging portion of the bridged-T network. Inductors are not used in all varilossers, but the two capacitors are used to isolate the T-network from its associated bridging network because of dc circuit requirements.

d. In order to explain its operation, assume that the input varilosser control voltage has increased in the positive direction. The forward bias across diode CR3 decreases, with a resulting increase in diode impedance. The impedance of the R5-CR3 combination increases. At the same time, the forward bias across diode CR2 increases, with a resulting decrease in diode impedance. The impedance of the bridging network, R7-CR2 Decreases. Although the impedance of the separate bridged-T components act in opposite directions, the amplitude of the change is the same in each component because it is the series collector current of transistor Q10 which drives them both. From an overall circuit standpoint, the decreased bridging impedance is canceled out by the increased T impedance, resulting in a constant impedance looking through the input and output terminals of the bridged-T. Internally, however, decreased bridging impedance means that a greater portion of the IF input signal is shunted across the T into the amplifier input.

e. Resistor R9 is part of the termination for the input varilosser network, and from here the IF input signal is RC-coupled into amplifier Q1. Resistor R13 and capacitor C9 are the elements of a decoupling filter network. The emitter circuit of transistor Q1 uses a variable peaking capacitor which varies the amplifier gain and bandwidth by varying the amount of degenerative feedback in the stage.

f. The IF signal is coupled into amplifier Q2 by means of capacitor C16. The RC circuit, R18 and C18, is a decoupling filter. Resistors R15, R16, and R17 set the base bias for the amplifier. Signal feedback occurs through network C17 and R16.

g. In regard to amplifier stage Q3, observe that resistor R24 is used for high frequency peaking. Resistor R58 or only the inductor is used for high-frequency peaking, in the base circuit of amplifier Q7.

h. The output signal from amplifier Q4 is sent through a 50-MHz bandpass filter consisting of inductors L18 and L21, capacitors C38, C42, and C44. This filter reduces the noise content of the 70-MHz IF signal. The filter is terminated at either end by a T-pad.

i. Amplifier Q8, the final IF amplifier stage, has two output signal paths. The primary signal path is terminated in coaxial connector J3; the output level at this point is approximately +5 dBm. The secondary signal path is used to develop an AGC signal.

j. Inductor L48 is the collector load for amplifier Q9. This inductive load is used to obtain a very high impedance at the collector of Q9 to operate the AGC detector rectifiers. Two RF filter sections, L40-C86 and L41-C89, are used to prevent passage of IF signals to the power supply line. The IF signal output from amplifier Q9 is sent to output transformer T1 and capacitively coupled to coaxial connector J2 (AUX OUTPUT). The auxiliary output is unused because IF heterodyne repeater service is not required.

k. Negative 6 volts dc, taken from the power supply at pin 3 of printed-circuit connector J4, is filtered by the twin-section filters consisting of inductors L42 and L43 and capacitors C95 through C99. The dc output from the filter is connected to resistors R80 and R81. Potentiometer R80 is used as a balance control for setting the dc output level of amplifier MD1. This balance voltage is connected through resistor R82 to the non-inverting input of MD1. After an additional filter stage L44 and C101, the negative (6-volt) power supply output in used as one of the operating voltages for the integrated operational amplifier module MD1 at pin 4. Finally, this negative 6 volts supply is decoupled by R77-C91 and applied to the network R75, CR11, and CR12. Diodes CR11 and CR12 are temperature compensating circuit elements for the AGC detector.

l. The AGC detector is a voltage-doubler network consisting of coupling capacitor C88 and rectifier CR10 during the positive half-cycles and capacitor C94 and diode CR13 during the negative half-cycles. The output from the detector is a dc voltage which is proportional to the average IF signal amplitude. The detector voltage rides on the negative 6 volts present at the junction of CR10, R75, C91, and R77. If the IF signal is removed from the input to the module at J1, the IF signal input to the detector drops to zero. Under these conditions, the negative 6 volts sends current through diodes CR10 and CR13 to resistor R79 and then to ground. The voltage, developed across R79, is present at the inverting input to operational amplifier MD1 and causes a positive dc voltage at the output. When the IF signal is present at the input, J1, a positive dc voltage is developed by rectifiers CR10 and CR13, which reduces the negative bias sent into the inverting input of MD1. Thus, the positive dc output voltage from pin 7 of MD1 has its maximum value during no-signal conditions and minimum value during maximum signal amplitude.

m. Capacitor C100 is connected to the pin 6 terminal of MD1 to complete the frequency compensation circuit of the operational amplifier. The 28-volt dc line is reduced -to 12 volts by resistor R84 and Zener diode CR14, this voltage is used as the positive operating potential for MD1 at pin 8. Capacitors C92, R83, and C102 affect-the AGC response line.

n. The output signal from integrated operational module MD1 is split into two paths. The secondary path exists through inductor L45 and or inductor L47 to pin 10 of the printed circuit connector J4 and to test point TP1; bypassing is accomplished by capacitors C104 and C106. The primary path exists through L46 into the base of AGC control Q10. Suppose that the IF signal amplitude decreased through the module; then the positive base drive into AGC control Q10 decreases. Collector current through Q10 decreases, permitting the AGC voltage to rise in the positive direction. The remaining circuit action of the AGC loop has already been described.

o. Technical Characteristics.

Parameter	Specifications
Input impedance	75 ohms, unbalanced
Output impedance	75 ohms, unbalanced
Input level	-8 to -68 dBm
Output level	
Main output (J3)	+5 dBm
Auxiliary output (J2)	--5 to +7 dBm
Maximum available gain	80 dB (without AGC)
AGC response time	5 milliseconds
AGC control range	60 dB
IF bandwidth	
3 dB points	40 MHz (minimum)
	50 MHz (maximum)
Flat within 0.5 dB	60 MHz to 80 MHz
Flat within 0.2 dB	65 MHz to 75 MHz
Power requirements:	
+28 volt source	150 mA
- 6 volt source	25 mA

6-24. Maintenance Data.

a. Performance Test and Trouble Analysis Procedures. The following subparagraphs contain procedures to test the performance of the overall module and its major circuits and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect test equipment and test cable to the module as shown in figure 6-40.

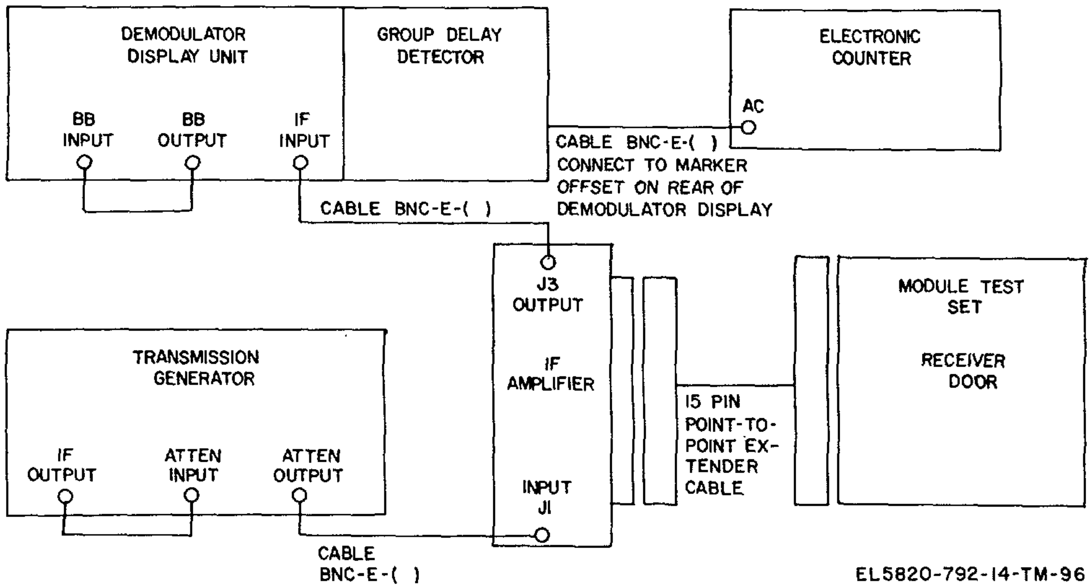


Figure 6-40. IF amplifier module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments. Performance tests should be accomplished with top and bottom covers in place on the module, both covers are removed from the module only when required for trouble analysis.

(1) Set all test equipment POWER switches to their ON positions; allow the test equipment to stabilize for 30 minutes.

(2) Adjust the 28 and 6-volt power supplies to provide +28 ± 0.1 V dc and --6 ±-0.06 V dc, respectively.

(3) On a multimeter, set the RANGE control to 6 V, and its FUNCTION switch to negative (-).

(4) Connect the multimeter between test points TP1 and TP2 on the IF amplifier module.

(5) On the module test set, adjust the AGC/MNL control until the multimeter indicates less than 1 volt.

(6) Change the multimeter RANGE switch to 1 V, then carefully adjust the AGC/MNL control until the multimeter indicates 0.5 V dc.

d. Test Procedures. After completing procedures indicated in *b* and *c* above, perform the procedures in *e* below. Figures 6-41 and FO-34 contains parts location data.

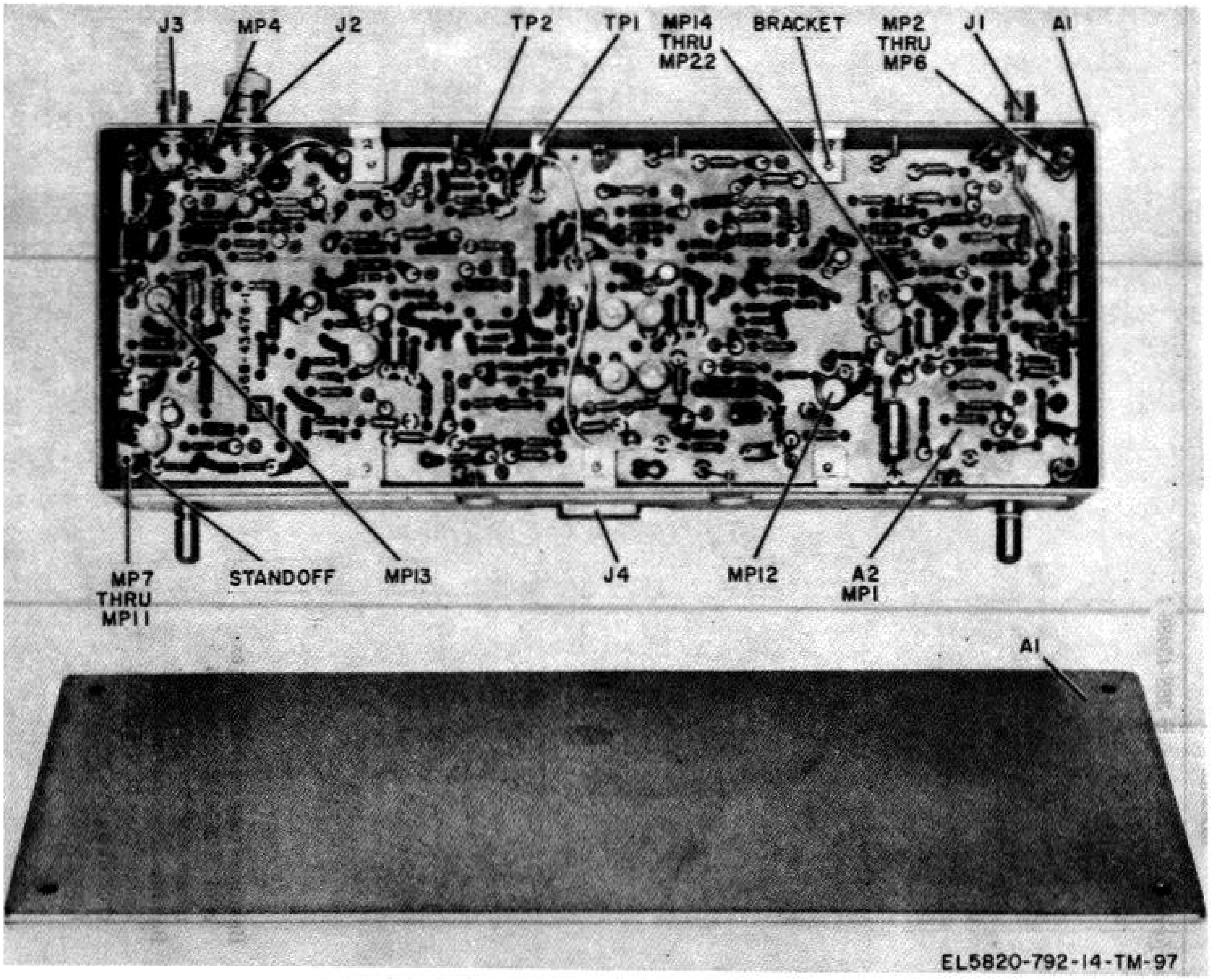


Figure 6-41. IF amplifier, parts location diagram.

e. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Bandpass performance check module 368-43488-1		
1	Connect the test equipment as shown in figure 6-40 then on the transmission generator, set the following controls: FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 40 SWEEP WIDTH (MHz) FINE to 10 BB FREQUENCY (kHz) to 500 BB DEVIATION (kHz RMS) to 140 MODE to BB + SWEEP			
2	On the transmission generator, insert 20 db using the ATTENUATION (db) pushbuttons.			
3	On the demodulator display unit, set DISPLAY switch to IF, then depress the IF LEVEL pushbuttons to obtain an on-scale indication of the IF/BB LEVEL meter.			
4	On the rear apron of the demodulator display unit, set the Y2 switch to DELAY.			
5	Adjust the MARKER OFFSET (MHz) control of demodulator display unit until electronic counter indicates 25 MHz - 50 kHz.			
6	On the demodulator display unit, set the Y2 GAIN control to its maximum counterclockwise position.			
7	Using the X PHASE SHIFT and X GAIN controls of the demodulator display unit, and FREQUENCY (MHz) FINE control of transmission generator, set the 70 MHz marker to center graticule and 25 MHz markers to the - 4 cm graticule.			
8	Set the reference line 1 cm below center graticule using the REF LINE control of the demodulator display.			
9	Set DISPLAY switch to its BB position, adjust the BB POWER (-dbm) control until IF/BB LEVEL meter indicates zero. Return DISPLAY switch to IF position.			
10	Set CALIBRATION (db)% switch to 1.0 dB adjust Y1 GAIN control for a 1 cm separation between chopped traces, turn CALIBRATION (db)% to its OFF position.			
11	Using the Y1 POSITION control, set the Y1 trace 3 cm above the reference line.	Bandpass response must not exceed ± 25 MHz at the 3 db points, refer to figure 6-42.		Align the IF amplifier.
12	Adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 20 MHz ± 50 kHz.	Bandpass response m ust be greater than ± 20 MHz at the 3 db points, refer to figure 6-43.		Align the IF amplifier.
13	Adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 10 MHz ± 50 kHz.			
14	On the transmission generator, set SWEEP WIDTH (MHz) COARSE to 10 and SWEEP WIDTH (MHz) FINE to 5.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
15	On the demodulator display unit, depress the IF LEVEI, pushbuttons until the IF/BB LEVEL meter indicates on-scale.			
16	Using the X PHASE SHIFT and X GAIN controls of the demodulator display unit, and FREQUENCY (MHz) FINE control of the transmission generator, set the 70 MHz marker to center graticule and 10 MHz markers to the t 4 cm graticules.			
17	Using the Y1 POSITION control set the upper part of the Y1 trace 3 cm above the reference line. 0.5 cm; refer to fig 6-44.	Bandpass response at the ± 10 MHz markers must not exceed		Align the IF amplifier.
18	Adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 5 MHz ± 50 kHz.			
19	On the transmission generator, set SWEEP WIDTH (MHz) FINE control until the trace is just slightly greater than the marker points.			
20	On the demodulator display unit, depress the IF LEVEL pushbuttons until the IF/BB LEVEL meter indicates on-scale.			
21	Using the X PHASE SHIFT and X GAIN controls of the demodulator display unit, and the FREQUENCY (MHz) FINE control of the transmission generator, set the 70 MHz marker to center graticule and 5 MHz markers to the t 4 cm graticules.			
22	Set the CALIBRATION (db)% control to 0.1, adjust the Y1 GAIN control for a 1 cm separation between chopped traces then set CALIBRATION (db)% control to its OFF position.			
23	Using the Y1 POSITION control, set the response curve 3 cm above the reference line.	Bandpass response at the + 5 MHz markers must not exceed 2.0 cm; refer to figure 6-45.		Align the IF amplifier.
	Group delay performance check module 368-43488-1			
24	On the transmission generator, set the following controls, FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 10 SWEEP WIDTH (MHz) FINE to 0 BB FREQUENCY (kHz) to 500 BB Deviation (kHz RMS) to 140 MODE to BB + SWEEP			
25	On the transmission generator, insert 20 db using the ATTENUATION (db) pushbuttons.			
26	On the demodulator display unit, set DISPLAY switch to IF, then depress the IF LEVEL pushbuttons to obtain an on-scale indication of the IF/BB LEVEL meter.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
27	On the rear apron of the demodulator display unit, set Y2, switch to DELAY.			
28	Adjust the MARKER OFFSET (MHz) control of the demodulator display unit until the electronic counter indicates 5 MHz '* 50 kHz.			
29	On the demodulator display unit, set the Y2 GAIN control to its maximum counterclockwise position.			
30	Using the X PHASE SHIFT and X GAIN controls of the demodulator display unit, and FREQUENCY (MHz) FINE control of the transmission generator, set the 70 MHz marker to center graticule and the 5 MHz markers to the- 4 cm graticules.			
31	Set the reference line 1 cm below center graticule using the 1u REF LINE control of the demodulator display.			
32	Set the DISPLAY switch to its BB position, adjust the BB POWER (-dbm) control until IF/BB LEVEL meter indicates zero. Return DISPLAY switch to its IF position.			
33	Set the CALIBRATION (db)% switch to 0.1, adjust Y1 GAIN control for a 1 cm separation between chopped traces, then turn CALIBRATION (db)% to its OFF position.			
34	Using the Y1 POSITION control, move the Y1 trace to the 2nd or 3rd graticule.			
35	On the group delay detector, set the BB FREQUENCY (kHz) control to 500 and the DEMOD INPUT switch to INT.			
36	On the group delay detector, adjust the SET LEVEL control until the PHASE LOCK/LEVEL meter indicates in the green zone.			
37	On the group delay detector set the DELAY CALIBRATION (ns) control to 1.0, then adjust the Y2 GAIN control for a I cm separation between chopped traces, then set DELAY CALIBRATION (ns) control to OFF.	Group delay of the IF ampli-fier is 0.5 ns to 1.5 ns.		Realign the IF amplifier.
		A GC level performance check		
38	On the transmission generator, set the following controls: FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 0 SWEEP WIDTH (MHz) FINE to 0 BB FREQUENCY (kHz) to 500 BB DEVIATION (kHz RMS) to 140 MODE to BB + SWEEP			
39	On the transmission ATTENUATION (db) pushbuttons.	generator, insert 32 db using the		

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
40	On J1 of the IF amplifier module, disconnect the test cable, connect a UG-274B/U adapter to J1, then reconnect the test cable.			
41	On an RF voltmeter, set VOLTS-FULL SCALE control to .03 VOLTS.			
42	Connect the RF voltmeter between ground and center conductor of the UG-274B/U.			
43	Depress ATTENUATION (db) pushbuttons of transmission generator until the RF voltmeter indicates 20 + 2 mV. Disconnect meter.			
44	Remove the probe tip of the RF voltmeter probe and substitute the 75 ohm adapter of the meter.			
45	On the module test set, set the AGC/MNL control to AGC position.			
46	On the RF voltmeter, set the VOLTS-FULL SCALE RF voltmeter shall indicate control to 1, then connect the probe to J3 of the IF amplifier module.	500 + 5 mV.		Adjustment of R80 in final disposition of module.
		AGC control range performance check module 368-43481-1		
47	On the transmission generator, set the following controls: FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 0 SWEEP WIDTH (MHz) FINE to 0 BB FREQUENCY (kHz) to 500 BB FREQUENCY (kHz RMS) to 140 MODE to BB + SWEEP			
48	On the transmission generator, insert 15 db using ATTENUATION (db) pushbuttons.			
49	Check that the test equipment is connected as shown in figure 6-40.			
50	On the demodulator display unit, set DISPLAY to IF position, then depress IF LEVEL pushbuttons until the IF/BB LEVEL meter indicates on-scale. Observe this meter indication carefully and record it for reference.	IF LEVEL pushbuttons indicate 15db plus meter indication.		Check AGC circuits.
51	On the transmission generator, depress the 20 pushbutton of the ATTENUATION (db) control, and then remove all other attenuation. The input to the IF amplifier is now -10 dbm.	As in step 50.		Check AGC circuits.
52	On the transmission generator, depress only the 10 and 20 Pushbuttons of the ATTENUATION (db) control; the input level is now -20 dbm.	As in step 50.		Check AGC circuits.
53	On the transmission generator, depress only a 30 pushbutton and the 10 pushbutton of the ATTENUATION (db) control; the input level is now -30	As in step 50.		Check AGC circuits.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
54	On the transmission generator, depress only a 20 push-button and a 30 push-button of the ATTENUATION (db) control; the input level is now -40 dbm.	Asinstep50.		Check AGC circuits.
	55 On the transmission generator, depress only two 30 push-buttons; the input level is now -50 dbm.	As in step 50.		Check AGC circuits.
56	On the transmission generator, depress both 30 push-buttons. and a 10 push-button; the input level is now -60 dbm.	As in step 50.		Check AGC circuits.
57	On the transmission generator , depress both 30 push-buttons and a 20 push-button. The input level is now -70 dbm.	As in step 50 within 1.0. db.	Check AGC circuits.	
		If amplifier trouble analysis module 368-4848-1		
58	Connect the equipment as shown in figure 6-46.			
59	On the VHF oscillator, set the FREQUENCY RANGE (MHz) to 68-130 and the TUNE control to 70 MHz; verify frequency using an electronic counter.			
60	Connect an RF voltmeter to the remaining port of the T-connector at J1 of the IF module.			
61	Adjust the output level of the VHF oscillator until the RF voltmeter indicates 30 mV. Disconnect RF voltmeter from J1;			
62	Set a multimeter to measure -1 V dc, and connect it between test poins TP1 and TP2.			
63	Adjust R80 until the multimeter indicates -0.5 V dc.			Troubleshoot the AGC network beginning with step 74.
64	Connect the RF voltmeter between Q1 base and ground.	7.3 mV	Proceed to step 65.	If 30 mV appears at Q1 base, .proceed to step 65.
65	Connect the RF voltmeter between Q2 base and ground.	14.5 mV	Proceed to step 66.	Check Q1 and associated.
66	Connect the RF voltmeter between Q3 base and ground.	8.7 mV	Proceed to step 67.	Check Q2 and associated circuits if reading is low.
67	Connect the RF voltmeter between Q4 base and ground.	17.7 mV	Proceed to step 68.	Check Q3 and associated circuits
68	Connect the RF voltmeter between Q4 collector and ground.	130mV	Proceed to step 69.	Check Q4 and associated circuits.
69	Connect the RF voltmeter between Q5 base and ground.	5.8 mV	Proceed to step 70.	Check filter network. If reading is high, check associated varilosser circuit.
70	Connect the RF voltmeter between Q6 base and ground.	11.0 mV	Proceed to step 71.	Check Q5 and associated circuits
71	Connect the RF voltmeter between Q7 base and ground.	11.5 mV	Proceed to step 72.	If reading is low, checkQ6 and associated circuits; if read-ing is too high, check the associated varilosser net-work.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
72	Connect the RF voltmeter between Q8 base and ground.	5.3 mV	Check Q8 output circuit.	Check Q7 and associated circuit.
73	Connect the RF voltmeter between Q9 collector and ground.	94 mV	Check Q9 output circuit.	Check Q9 and input coupling network.
		AGC circuit check		
74	Connect a multimeter between test point TP1 and TP2 (ground).	-0.5Vdc	Proceed to step 75.	Check the setting of AGC/MNL control on test set control panel.
75	Set a multimeter RANGE control to 30 V, and its FUNCTION switch to +.			
76	Connect the multimeter between Q10 collector and ground.	+ 14.5 V dc	Proceed to step 77.	Check Q10 and associated circuits.
77	Connect multimeter probe to the junction C5, C7, R8, and L2.	15Vdc	Proceed to step 78.	Check L2, R4, R5, R8, C4, C8, L3, and CR3.
78	Connect multimeter probe to the junction C24, C26, and R23.	15.2Vdc	Proceed to step 79.	Check R20, R21, R23, CR5, L9, L12, C22, and C25.
79	Connect multimeter probe to the junction C49, C51. and R41.	15.8Vdc	Proceed to step 80.	Check R38, R40, R41, CR7, L22, L25, L26, C48, C50 and C55.
80	Connect multimeter probe to the junction C68, C69, and R57.	16.2Vdc	Proceed to step81.	Check R54, R55, R57, CR9, and C67.
81	Connect multimeter probe to the cathode of CR8.	16.6 V dc	Proceed to step 82.	Check L33, R53, R56, C66, C68, and CR8.
82	Connect the multimeter probe to the Cathode of CR6.	17.2 V dc	Proceed to step 83.	Check L27, L24, C54, C56, C47, C49, R39, and CR6.
83	Connect the multimeter probe to the cathode of CR4.	18.0Vdc	Proceed to step 84.	Check L15, L19, C20, C24, C34, C37, R22, and CR4.
84	Connect the multimeter probe to the cathode of CR2.	18.2Vdc	Proceed to step 85.	Check L4, L10, C3, C5, C11, C13, R7, and CR2.
85	Connect the multimeter probe to the cathode of CR1.	18.5Vdc	Proceed to step 86.	Check L C1, C107 R6, and CR1.
86	Connect the multimeter probe to MD1 pin 2.	-1.1 Vdc	Proceed to step 87.	Check MD1 and associated circuits.
87	Connect the multimeter probe to MD1 pin 3.	-2.3 V dc	Proceed to step 88.	Check MD 1 and associated circuits.
88	Connect the multimeter probe to MD1 pin 7.	-1.4 V dc	End of test. Disconnect all test equipment.	Check MD1, R85, C102, L45, and associated circuits.

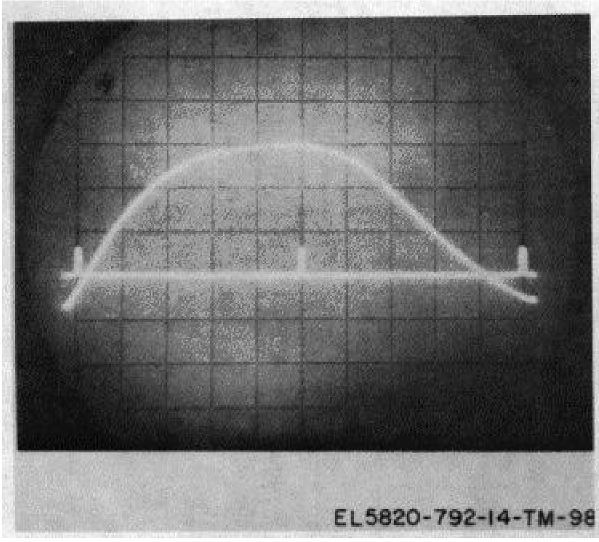


Figure 6-42. IF bandpass response relative to 50 MHz.

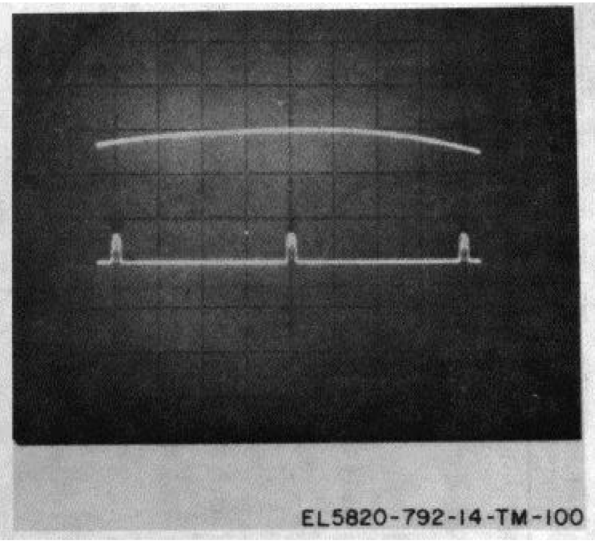


Figure 6-44. IF bandpass response waveform 60 to 80 MHz

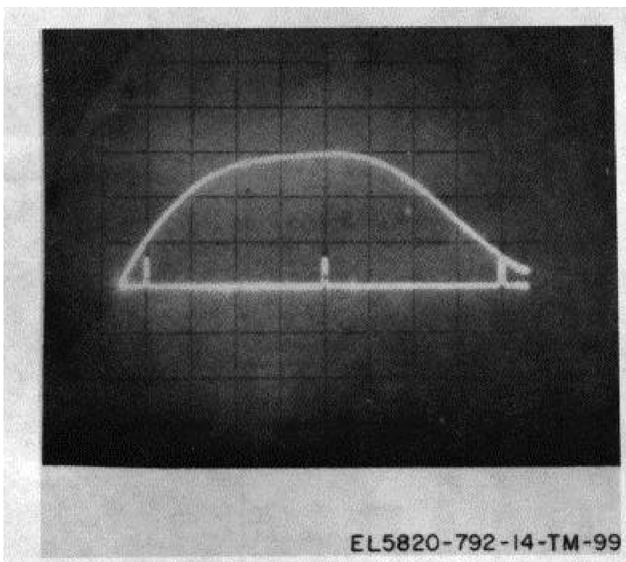


Figure 6-43. IF bandpass response relative to 40 MHz.

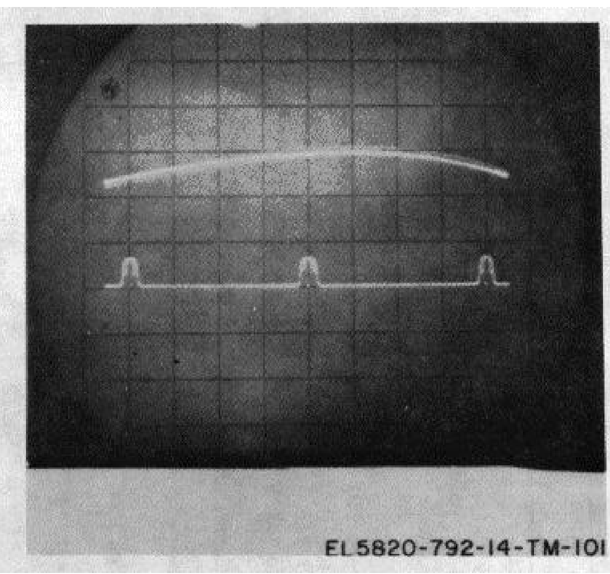


Figure 6-45. IF bandpass response waveform 65 to 75 MHz.

f. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, the voltage and resistance data provided in g below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources. The RX100 scale of the multimeter is used as the standard range unless otherwise stated; the common multimeter lead is connected to J4-5 (ground) during all measurements.

(2) Dc voltage measurements are made with the module connected to the receiver door of the module test set using the appropriate point-to-point extender cable. No signal source is employed.

(3) Ac voltage measurements are made using the following preliminary procedure:

(a) On a VHF oscillator set the FREQUENCY RANGE (MHz) to 68-130 and set the TUNE control to 70 MHz; verify oscillator frequency using an electronic counter.

(b) Set an IF attenuator to provide 40 dB.

(c) Connect the test equipment as shown in figure 6-46.

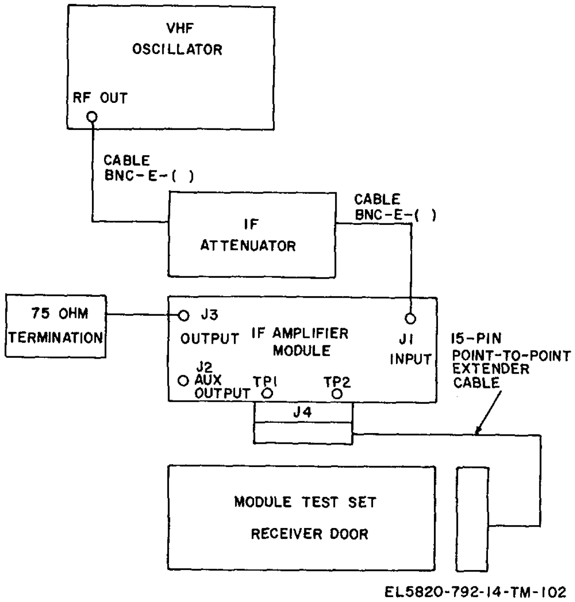


Figure 6-46. Troubleshooting test equipment setup, IF amplifier module.

(d) Set the RF voltmeter to the .03 volt scale, then connect it to the IF amplifier module between the nearest ground lug and INPUT J1.

(e) Add or remove attenuation until the RF voltmeter indicates 30 millivolts.

(f) Connect a multimeter set to measure 1 V 'dc between test points TP1 and TP2.

(g) Adjust R80 until the multimeter indicates -0.5 V dc. Leave the multimeter connected during voltage measurements, but disregard its indication while connecting the RF voltmeter.

(h) Perform ac voltage measurements as necessary.

NOTE

The AGC voltages corresponding to the applied signal are provided in the following list:

Q10 Base	-0.48 V dc	MD1Pin 1	0
Emitter	-1.2 V dc	Pin 2	-0.82 V dc
Collector	+14 V dc	Pin 3	-0.82 V dc
		Pin 4	-5.9 V dc
TP1	-0.5 V dc	Pin 6	+4.2 V dc
J4-10	-0.5 V dc	Pin 7	+3.4 V dc
		Pin 8	+11.5 V dc

g. Voltage and Resistance Data.

Point of measurement	Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
Q1 Base	0.80	7.3 mV	850	RX1
Emitter	0.64	4.8 mV	17	
Collector	6.00	14.5 mV	2.8K	
Q2 Base	0.79	15.0 mV	330	
Emitter		0	0	
Collector	5.10	105.0 mV	1.6K	
Q3 Base	0.78	8.7 mV	820	RX1
Emitter	0.04	5.9 mV	18	
Collector	5.60	16.0 mV	2.6K	
Q4 Base	0.75	17.7 mV	320	
Emitter	0	0	0	
Collector	4.80	130.0 mV	1.6K	
Q5 Base	0.79	5.8 mV	830	
Emitter	0.04	3.9 mV	17	RX1
Collector	6.00	11.4 mV	2.8K	
Q6 Base	0.76	11.0 mV	330	
Emitter	0	0	0	
Collector	4.60	205.0 mV	1.8K	
Q7 Base	0.85	11.5 mV	830	
Emitter	0.08	8.4 mV	17	RX1
Collector	4.30	7.5 mV	2.6K	
Q8 Base	13.10	5.3 mV	930	
Emitter	12.50	9.8 mV	390	
Collector	28.00	200.0 mV	1.6K	

Point of measurement	Dc voltage (nominal)	Ac.voltage (rms nominal)	Resistance (ohms nominal)
Q9 Base	22.50	59.0 mV	3.0K
Emitter	21.70	61.0 mV	1.6K
Collector	27.50	94.0 mV	930
Q10 Base	-5.60		1.6K
Emitter	-5.60		2.4Kv
Collector	-5.90		2.2K
MD1 Pin 1	0		0
Pin 2	-9.1		2.8K
Pin 3	-2.2		1.3K
Pin 4	-5.8		600
Pin 5	--0.58		5.0K
Pin 6	--5.1		2.6K
Pin 7	-5.6		1.9K
Pin 8	+11.8		1.3K
J4 Pin 1	+28.0		930
Pin 2	0		INF
Pin 3	-5.9		610
Pin 4	0		INF
Pin 5	0		0
Pin 6	0		0
Pin 7	0		INF
Pin 8	0		INF
Pin 9	0		1.6K
Pin 10	-5.8		INF
Pin 11	0		INF
Pin 12	0		INF
Pin 13	0		INF
Pin 14	0		INF
Pin 15	0		INF

6-25. Alignment Data

a. General. The following procedures should be performed after repairs have been made to the module. The IF amplifier module contains many tuned circuits which must be carefully aligned to obtain optimum module performance. The arrangement of the procedures in -this section is based on a requirement for a complete realignment.

b. Test Equipment Setup. The test equipment setup used for the alignment and adjustment procedures is the same as that described in paragraph 6-24, unless otherwise indicated in the procedure.

c. Preliminary Adjustments. Perform the following preliminary adjustments.

(1) Set all test equipment LINE and POWER switches to their ON positions; allow test equipment to stabilize for 30 minutes.

(2) Adjust the 28and 6-volt power supplies to provide +28 ±0.1 V dc and -6 +0.06 V dc, respectively.

(3) On the transmission generator, insert 20 dB using the ATTENUATION (dB) pushbuttons, then complete the following settings:

FREQUENCY (MHz) COARSE	to	70
FREQUENCY (MHz) FINE	to	0
SWEEP WIDTH (MHz) COARSE	to	40
SWEEP WIDTH (MHz) FINE	to	10
BB FREQUENCY (kHz)	to	500 BB
DEVIATION (kHz RMS)	to	140
MODE	to BB + SWEEP	

(4) On a multimeter, set the FUNCTION switch to-, and its RANGE CONTROL TO 6 V.

(5) Connect the IF amplifier under alignment to the module test set.

(6) Connect the multimeter between test points TP1 of the IF amplifier module.

(7) On the module test set, adjust the AGC/MNL control until the multimeter indicates less than 1 volt.

(8) Change the RANGE of the multimeter to 1 V, then carefully adjust the AGC/MNL control until the multimeter indicates 0.5 V dc. Disconnect multimeter.

(9) Connect the-test equipment as shown in figure 6-40.

(10) On the demodulator display unit, set the display switch -to IF, -then depress the IF LEVEL pushbuttons -to obtain an on-scale indication of the IF/BB LEVEL meter.

(11) On the rear apron of the demodulator display unit, set the Y2 switch to DELAY.

(12) Adjust the MARKER OFFSET (MHz) control of the demodulator display unit until the electronic counter indicates 25 MHz 50 kHz.

(13) On the display unit, set the Y2 GAIN control to its maximum counterclockwise position, then adjust the X GAIN control to spread the display to a convenient width.

(14) Using the X PHASE SHIFT and X GAIN control of the demodulator display unit, and the FREQUENCY (MHz) FINE control of the transmission generator, set the 70 MHz marker to the center graticule and -the 25 MHz markers to the + 4 cm graticules.

(15) Using the RED LINE control of the demodulator display, move the reference line 1 cm below center graticule.

(16) Set the DISPLAY switch to its BB position, adjust the BB POWER (--dBm) control to produce a zero indication on the IF/BB LEVEL meter. Return the DISPLAY switch to its IF position.

(17) Set the CALIBRATION (dB) % switch to 1.0, adjust the Y1 GAIN control for a 1 cm separation between chopped traces, then set CALIBRATION (dB) % to its OFF position.

(18) Using the Y1 POSITION control, position the Y1 trace 3 cm above the reference line.

d. Bandpass Alignment. Perform the following bandpass alignment.

(1) Adjust C38, C42, and C44 for a smooth symmetrical flat-topped curve with the skirts of the response curve crossing the reference line between the 25 MHz markers; refer to figure 6-42. During adjustment of a tuning element, also observe the IF/BB LEVEL meter. Whenever the meter indication moves off-scale during adjustment, reset the IF LEVEL pushbuttons to reset the meter on-scale. In addition, adjustment of the tuning controls of the IF amplifier will shift the Y1 trace up or down with respect to the reference line; use the Y1 POSITION control to maintain the top of the trace 3 cm above the reference line.

NOTE

Do not adjust the response curve for a greater frequency response than + 25 MHz, even though the module seems capable of broader tuning. In general, however, the closer the markers are approached, the better the linearity over the passband.

NOTE

Tuning elements C38, C42, and C44 are tuned for a maximum peak in the response curve when the displayed bandwidth is less than + 25 MHz; not only does the trace amplitude increase, but the IF/BB LEVEL meter also shows an amplitude increase along with the trace. Capacitor C38 primarily effects the low-frequency region of the response curve, while C42 primarily affects the high-frequency region. Capacitor C44 is useful to control the symmetry and tilt of the response curve with respect to the reference line.

(2) After obtaining the best response in the previous step, adjust capacitors C14, C29, C57, and C77 to obtain the flattest response possible.

(3) Adjust the MARKER OFFSET (MHz) control to 20 using dial calibrations; refer to figure 6-43. As long as the markers are inside the response curve, as shown, the alignment is satisfactory for the moment, because the bandwidth specification is at least 40 MHz between the 3 dB points.

NOTE

Tuning elements C14, C29, C57, and C77 are tuned initially to flatten the response curves, therefore, when these elements are first tuned, adjust them so that the IF/BB LEVEL meter indicates a decrease in amplitude level. Whenever, the display begins to appear unsymmetrical during adjustment, readjust for best symmetry.

(4) On the demodulator display unit, adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 10 MHz 'f 50 kHz.

(5) On the transmission generator, set the SWEEP WIDTH (MHz) COARSE control to 10. If the 10 MHz markers are not present, adjust the SWEEP WIDTH (MHz) FINE control until the markers are present and complete.

(6) Use the X GAIN control to spread the trace out so that the 70 MHz marker is centered and the 10 MHz markers are located on the t: 4 cm graticules.

(7) Depress the IF LEVEL pushbuttons until the IF/BB LEVEL meter indicates on-scale and the AFC LOCK indicator is lighted.

(8) Use the Y1 POSITION control to set the bandpass response curve 3 cm above the reference line. Inspect the display, the bandpass must be flat within 0.5 dB between the 10 MHz markers; refer to figure 6-44. Since the display is calibrated for 1 dB/cm, the curve may vary by 0.5 cm between markers. If the specification is not obtained, refine the adjustments of C14, C57, and C77 if necessary. If the specification still is not obtained, use C38, C42, and C44 to slightly tune the curve, but when doing so, return to (1) above and recheck all -steps before continuing -this alignment.

(9) Adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 5 MHz 50 kHz.

(10) On the transmission generator, adjust the SWEEP WIDTH (MHz) FINE control until all markers are present and complete.

(11) Use the X-GAIN control to spread the trace out so that the 70 MHz marker is centered and the ± 5 MHz markers are located on the ± 4 cm graticules.

(12) Depress the IF LEVEL pushbuttons until the IF/BB LEVEL meter indicates on-scale and the AFC LOCK indicator is lighted.

(13) Set the CALIBRATION (dB) % switch to 0.1, adjust the Y1 GAIN control for a 1 cm separation between chopped traces, then set CALIBRATION (dB) % switch to OFF.

(14) Use the Y1 POSITION control to set the bandpass response to some convenient graticule. Inspect the display, the bandpass must be flat within 0.2 dB between + 5 MHz markers, refer to figure 6-45. Since the curve is calibrated at 0.1 dB/cm, the curve may vary by 2 cm between markers. If the requirement is not met, repeat (4) through (7) above. Carefully adjust C14, C29, C57, and C77 as necessary.

(15) Repeat steps as necessary to check that the 3 dB response curve is greater than 40 MHz and less than 50 MHz.

(16) Alignment is complete and ready for final disposition.

e. Disposition of Module. The final procedure for the IF amplifier consists in setting the output signal level per given input signal level. Remove the top cover of the IF amplifier.

(1) On the transmission generator, set the controls as follows:

FREQUENCY (MHz) COARSE	to	70
FREQUENCY (MHz) FINE	to	0
SWEEP WIDTH (MHz) COARSE	to	0
SWI:EEP WIDTH (MHz) FINE	to	0
BB FREQUENCY (kHz)	to	500
BB FREQUENCY (kHz RMS)	to	140

(2) On the transmission generator insert 33 dB using the ATTENUATION (dB) pushbuttons.

(3) Connect a cable between IF OUTPUT and ATTEN INPUT.

(4) Connect an UG-274B/U adapter to J1 of the IF amplifier.

(5) Connect a test cable between UGC274B/U on the IF amplifier module and ATTEN OUTPUT on the transmission generator.

(6) Set the VOLTS-FULL SCALE control of a RF voltmeter to the .03 range.

(7) Connect the RF voltmeter probe tip to the center conductor of the UG-274B/U.

(8) Change the ATTENUATION (dB) pushbuttons of the transmission generator as necessary to obtain an RF voltmeter indication of 20 mV.

(9) Disconnect the RF voltmeter from the test setup.

(10) Remove the tip from the RF voltmeter probe and substitute the 75-ohm adapter which is also part of the RF voltmeter.

(11) Connect an adapter UG-491A/U to the RF voltmeter probe.

(12) On the RF voltmeter, set the VOLTSFULL SCALE control to 1. On the module test set, set the AGC/MNL control full counterclockwise to its detent position.

(13) Connect the RF voltmeter probe with adapter to J3 of the IF amplifier module.

(14) Adjust R80 of the IF amplifier until the RF voltmeter indicates 500 mV.

(15) Disconnect the test setup.

(16) Replace the module cover.

(17) Complete module performance tests in accordance with paragraph 6-24 a through e, (1) through (57).

Section VII. IF BANDPASS FILTER (398-12067-3)

6-26. Introduction

The IF bandpass filter module belongs to the receiver of the microwave radio set. The function of the IF bandpass filter module is to establish the overall bandwidth of the receiver and to provide delay equalization for the filter and for the microwave link. The IF bandpass filter consists of a printed circuit filter board and a maximum of four printed circuit equalizer cards. All Components, with the exception of its input and output connectors, are mounted on the printed wiring cards. The latter components are mounted on the front flange of the metal module chassis.

6-27. Functional Description

The functional block diagram of the IF bandpass filter module is shown in figure FO-20. The IF filter printed circuit card contains an input termination, a 3-stage filter and an output pad. The associated delay equalizer compensates for the group delay characteristics of the IF filter.

6-28. Circuit Analysis

a. The schematic diagram for the IF bandpass filter card is shown in figure FO-21. It consists of a three-pole Butterworth filter with input and output pads. Resistors R1 through R6 are matching pads to obtain the 75-ohm input and output impedances of the filter. There is approximately 11 dB attenuation in the filter network.

b. The time delay equalizers are lossless, all-pass, bridged-T networks as shown in figure FO22. The equalizers match the input and output ports to 75 ohms.

c. Technical Characteristics

Parameter	Specification
Filter card assembly	
Bandpass (3 dB points)	25 MHz (min), 30 MHz (max)
Return loss	30 dB over 10 MHz bandwidth (minimum)
Equalizer card assembly	
398-12222-3 Return loss	27 dB over 15 MHz bandwidth
398-12222-4 Return loss	24 dB over 10 MHz bandwidth
Filter and equalizer (-3)	
Bandpass (:3 dB points)	30 MHz (maximum)
Bandpass tilt	0.4 dB over 10 MHz bandwidth
(Group delay	0.5 ns over 10 MHz bandwidth 2.0 ns over 14 MHz bandwidth
Return loss	30 dB over 10 MHz bandwidth
Complete module	
Bandpass (3 dB points)	30 MHz (maximum)
Return loss	27 dB over 10 MHz bandwidth (nominal)
Insertion loss	11 ± dB

6-29. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. This paragraph contains procedures to test the performance of the IF bandpass filter module and its major circuits, and give probable causes of abnormal indication. The characteristics of this module are predicated on the basis of a back-to-back terminal or an over-the-link terminal. Performance testing the overall module with Al filter card, A2 filter equalizer card, and A3 system equalizer cards installed, cannot provide standardized group delay and linearity characteristics, since the A3 card is aligned to optimize the system characteristics. On this basis, performance tests are made with only the Al filter card and A2 equalizer cards installed, except in the case of testing for insertion loss.

b. Test Equipment Setup. Connect the test equipment as shown in figure 6-47 for all setups, except return loss test setups. The return loss test equipment setup is shown in figure 6-48.

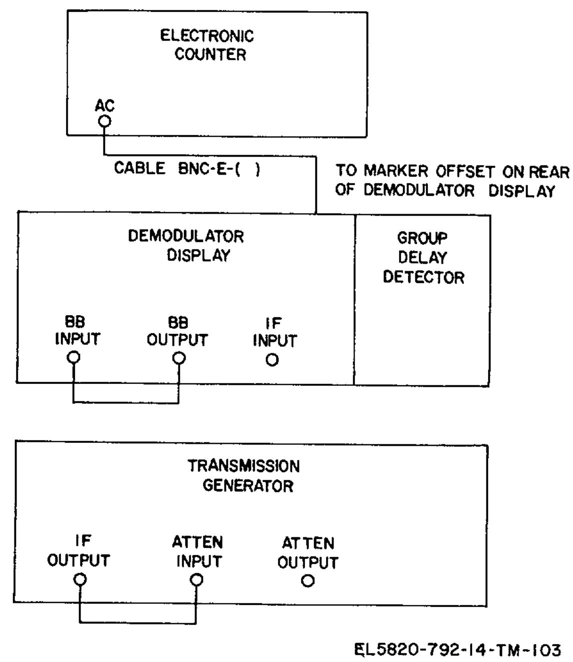


Figure 6-47. IF bandpass filter, general test equipment setup.

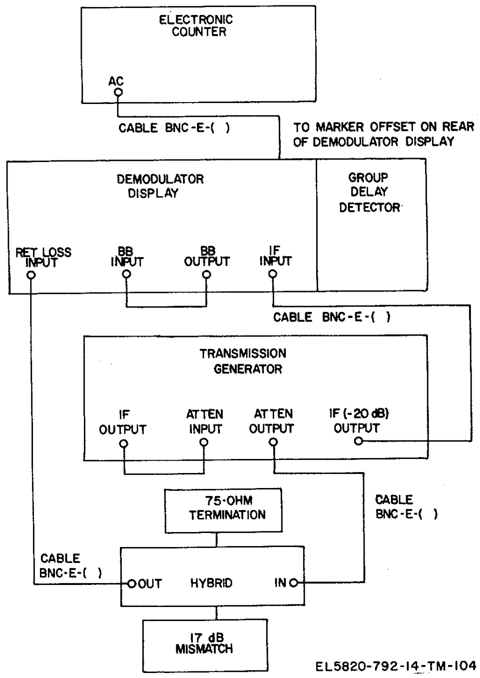


Figure 6-48. IF bandpass filter, return loss test equipment setup.

c. Preliminary Adjustments. For all performance tests, except the insertion loss test, remove both covers from the module, remove the A3 equalizer card and substitute the dummy equalizer card (fig. 6-49) and replace both module .covers. For the insertion loss test, insure that the Al, A2, and A3 cards are installed in the module. Figure 6-50 gives parts location data.

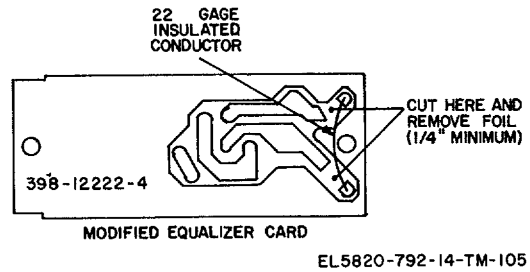


Figure 6-49. Dummy equalizer card.

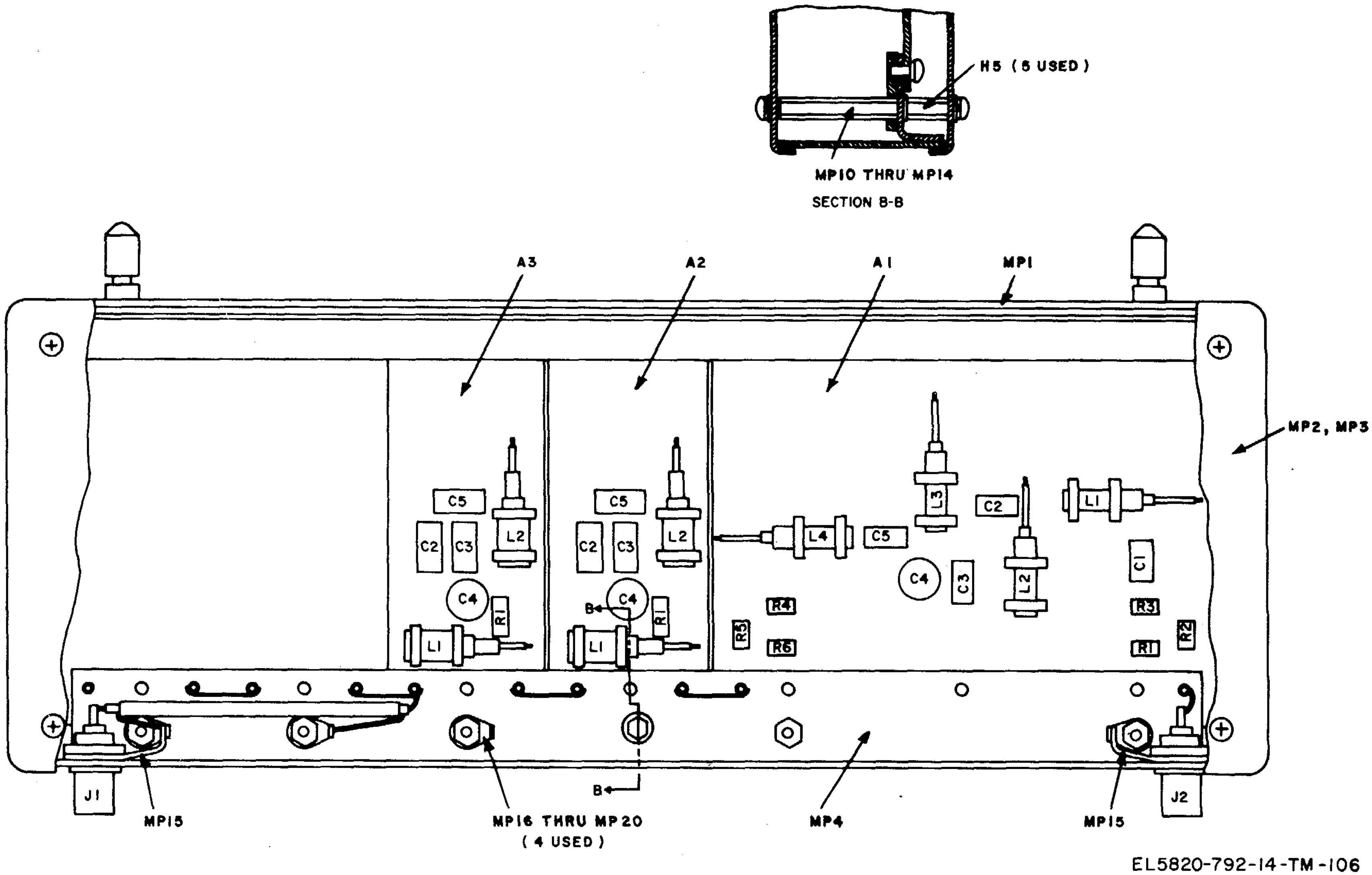


Figure 6-50. IF bandpass filter module, parts location data.

d. *Test Procedure.* After completing the procedures in b and c above, perform the procedures given in the following chart.

e. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
	Filter on Filter Equalizer Return Loss Check			
1	On the transmission generator, insert 5 dB using ATTENUATOR (dB).			
2	On the transmission generator, set the controls as follows: IF FREQUENCY (MHz) COARSE to 70; IF FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 30 SWEEP WIDTH (MHz) FINE to 0 BB DEVIATION (kHz RMS) to 140 BB FREQUENCY (kHz) to 500 MODE to BB + SWEEP			
3	On the rear apron of the demodulator display unit, set the Y2 switch to RET LOSS.			
4	On the demodulator display unit, set DISPLAY switch to IF and the SENSITIVITY switch to X1.			
5	Operate the IF LEVEL push buttons to obtain an on-scale IF/BB level meter.			
6	On the demodulator display unit, set the display switch to RET LOSS position, then set the coarse and fine RETURN LOSS (dB) control to 17.			
7	Adjust the RETURN LOSS SET control until the RETURN LOSS meter indicates zero.			
8	Place the SENSITIVITY control to XO.1, the Y1 GAIN to its maximum counterclockwise position, and move the trace to a convenient location using the Y1 POSITION control.			
9	On the demodulator display unit, set the CALIBRATION (dB)% control to 1.0, adjust Y2 GAIN to obtain a 1 cm separation between the chopped trace, then set the CALIBRATION (dB)% control to OFF.			
10	Using the Y1 POSITION control, move the reference line to the 2 cm graticule (from top of display); then adjust Y2 trace to coincide with the Y1 trace using the REF LINE control.			
11	On the demodulator display unit, adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 5 MHz +-50 kHz. °			
12	Using the X GAIN control, spread the display to fill up the display area (+5 cm).			
13	Remove the 17 -dB mismatch from the hybrid, and connect an UG-491 A/U to the hybrid			
14	Connect the INPUT of the module under test to the UG-491A/U adapter on the hybrid.			
15	Connect a termination to the OUTPUT of the test fixture.			
16	On the demodulator display unit, adjust the RETURN LOSS (dB) control until one of the return loss trace markers first coincides with the reference line.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
17	Read the return loss directly from the RETURN LOSS (dB) dial. figure 6-51.	30 dB return loss over 10 MHz bandwidth; refer to 6-30h (1)).		Perform module alignment for the equalizer card (para
		Filter and Filter Equalizer Group Delay Check		
18	Reconfigure the test equipment setup as shown in figure 6-47.			
19	Connect test cable between ATTEN OUTPUT of transmission generator and the INPUT of the test fixture.			
20	Connect a test cable between IF INPUT of the demodulator display and the OUTPUT of the Fixture.			
21	On the transmission generator insert 5 dB using ATTENUATOR (dB) pushbuttons.			
22	On the transmission generator set the controls as follows: IF FREQUENCY (MHz) COARSE to 70 IF FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 10 SWEEP WIDTH (MHz) FINE to 0 BB DEVIATION (kHz RMS) to 140 BB FREQUENCY (kHz) to 500 MODE to BB + SWEEP			
23	On the demodulator display, set the DISPLAY switch to IF, then operate IF LEVEL pushbuttons until the IF/BB LEVEL meter indicates on scale.			
24	Adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 5 MHz - 50 kHz.			
25	Reposition the trace for convenience.			
26	Using IF FREQUENCY (MHz) FINE on the transmission generator and X PHASE SHIFT and X GAIN controls of the demodulator display unit, position the 70 MHz marker on the center graticule, and the 5 MHz markers on the +4 cm graticules.			
27	On the demodulator display unit, set SENSITIVITY control to X1.			
28	On the demodulator display unit, set CALIBRATION (dB)% to 1.0, adjust the Y1 GAIN control for 1 cm between chopped traces, then set the CALIBRATION (dB)% control to OFF.			
29	On the rear apron of the demodulator display, set the Y2 switch to DELAY.			
30	On the group delay detector, adjust the SET LEVEL control until the PHASE LOCK/LEVEL meter indicates in the green zone.			
31	Adjust the REF LINE control to move the Y1 trace into the display area.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
	Filter and Filter Equalizer Group Delay Check-Continued			
32	On the group delay detector, set the DELAY CALIBRATION (ns) control to 10.			
33	Using the REF LINE and Y2 GAIN controls of the demodulator display unit, spread the chopped display 10 cm apart, then set DELAY CALIBRATION (ns) control to OFF.			
34	Observe the oscilloscope display.	Delay shall not exceed 0.5 ns over a 10 MHz bandwidth Observe the Y1 trace for tilt which shall not exceed 0.4 dB over 10 MHz bandwidth Refer to figure 6-52.	a. Align equalizer card (para 6-30h (3)) if delay is excessive. b. Align filter card (para 6-.30h) if tilt exceeds require-ments.	
35	On the demodulator display unit, adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 7 MHz + 50 kHz.			
36	On the transmission generator, adjust the SWEEP WIDTH (MHz) FINE control to 5.	Delay shall not exceed 2 ns over a 14 MHz bandwidth. The amount of tilt in this measurement is disregarded. Refer to figure 6-53.	Align equalizer card (para 6-30h (5) through (8)).	
	Filter and Filter Equalizer Bandpass Check			
37	Configure the test equipment setup per figure 6-47.			
38	Connect a test cable between ATTEN OUTPUT of the transmission generator and the INPUT of the test fixture.			
39	Connect a test cable between IF INPUT of the demodulator display and the OUTPUT of the test fixture.			
40	On the transmission generator, insert 5 dB using ATTENUATOR (dB) pushbuttons.			
41	On the transmission generator set the controls as follows: IF FREQUENCY (MHz) COARSE to 70 IF FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 30 SWEEP WIDTH (MHz) FINE to 0 BB DEVIATION (kHz RMS) to 140 BB FREQUENCY (kHz) to 500 MODE to BB + SWEEP			
42	On the rear apron of the demodulator display unit, set the Y2 switch to REF position.			
43	On the demodulator display, set the DISPLAY switch to X IF, then operate IF LEVEL pushbuttons until the IF/BB LEVEL meter indicates on-scale.			
44	Using the REF LINE control, center the display; set SENSITIVITY control to X1.			
45	On the demodulator display unit, set CALIBRATION (dB)% to 1.0, adjust the Y1 GAIN control for 1 cm between chopped traces, then set CALIBRATION (dB)% switch to OFF.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
	Filter and Filter Equalizer Bandpass Check - Continued			
46	Position the Y1 trace 3 cm above the reference line.			
47	Using the MARKER OFFSET (MHz) control, adjust the markers to 14 ±0.1 MHz.			
48	Adjust IF FREQUENCY (MHz) FINE of the transmission generator, and the X PHASE SHIFT control of the demodulator display unit to position the 70 MHz marker in the center of the display and the 14 MHz markers on the ± 4 cm graticule.	Bandpass must be 30 MHz maximum between 3 dB points, refer to figure 6-54.		
	IF Bandpass Filter Insertion Loss Check		k	
49	Configure the test equipment per figure 6-47.			
50	Ascertain that the IF bandpass module contains the filter card, and the 398-12222-3 and 398-12222-4 equalizer cards.			
51	On the transmission generator, set the controls as follows: IF FREQUENCY (MHz) COARSE to 70 IF FREQUENCY (MHz) FINE to 0 SWEEP WIDTH (MHz) COARSE to 0 SWEEP WIDTH (MHz) FINE to 0 BB DEVIATION (kHz RMS) to 140 BB FREQUENCY (kHz) to 500 MODE to BB + SWEEP			
52	On the demodulator display unit, set DISPLAY switch to IF, and the MARKER OFFSET (MHz) to OFF, and IF LEVEL attenuators to zero.			
53	Connect a test cable between ATTEN OUTPUT of the transmission generator and the INPUT J2 of the IF bandpass filter module.			
54	Connect a test cable between IF INPUT of the demodulator display unit and the OUTPUT J1 of the IF bandpass filter module.			
55	On the transmission generator operate the ATTENUATOR (dB) pushbuttons until the IF/BB LEVEL meter on the demodulator display indicates on-scale. AFC LOCK indicator should be lighted.			
56	Disconnect the module from the test equipment setup.			
57	Connect a test cable between IF INPUT of the demodulator display unit and the ATTEN OUTPUT of the transmission generator.			
58	On the demodulator display unit, operate the IF LEVEL pushbuttons until the IF/BB LEVEL meter indicates on-scale again. The setting of the IF LEVEL pushbuttons is the insertion loss of the bandpass filter. End of test. Disconnect all test equipment.	Insertion loss shall be 11 dB ± 1 dB.		Check filter components per voltage and resistance measurements data.

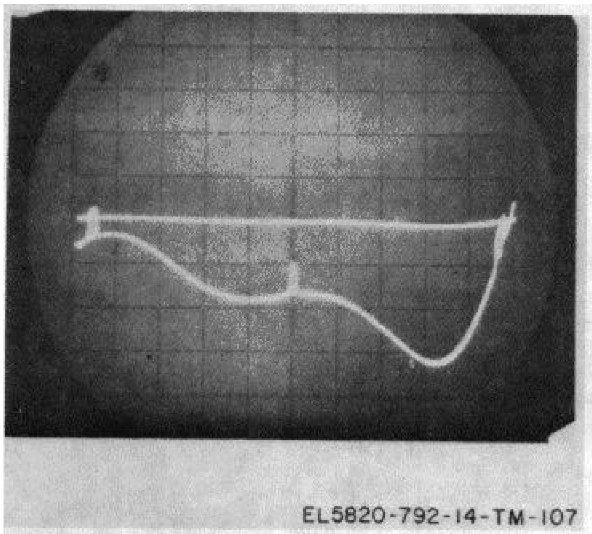


Figure 6-51. IF bandpass filter and A2 equalizer card, return loss waveform.

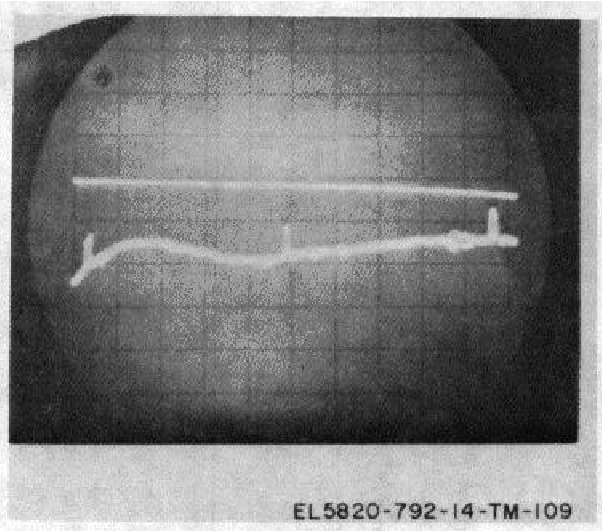


Figure 6-53. IF bandpass filter and A2 equalizer card, 2 ns group delay waveform.

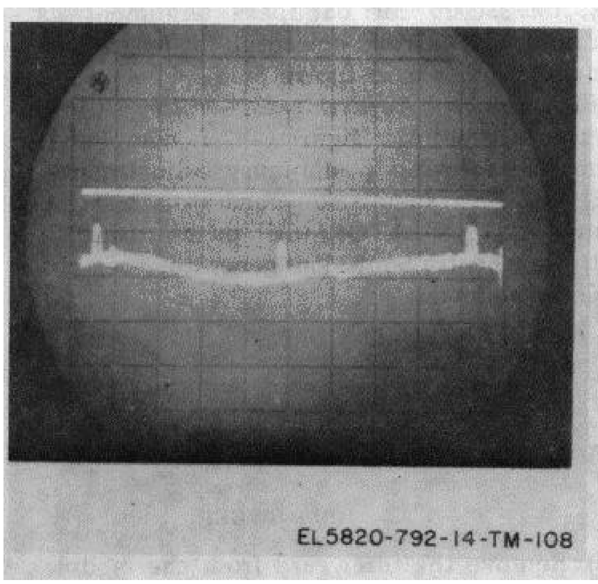


Figure 6-52. IF bandpass filter and A2 equalizer card, 0.5 ns group delay waveform.

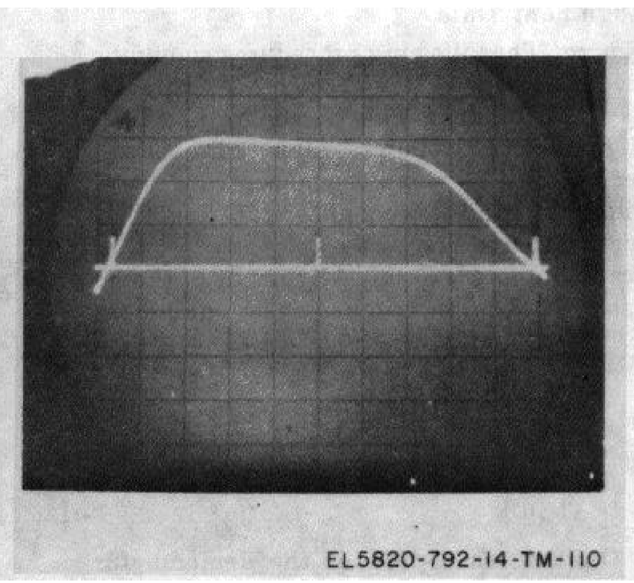


Figure 6-54. IF bandpass filter and A2 equalizer card, bandpass waveform.

f. Voltage and Resistance Measurements. If performance of the test and/or alignment Procedures does not result in acceptable assembly oration, use of the resistance data provided in g below, in conjunction with -standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the module disconnected from all external components using the multimeter.

g. Voltage and Resistance Data.

Point of measurement	Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100scale unless otherwise specified
	Filter card		
Junction:			
J2, R2	0		260 ohms
R2, R3	0		240 ohms
L1, C1	0		0
L1, L2, C2	0		0
C2, L3			INF
L3, C3, C4, C5	0		INF
C5, L4	0		150 ohms
L4, R4, R5	0		150 ohms
R5, R6	0		140 ohms
	Equalizer card		
L1, C2	0		140 ohms
C2.C3,C4 L2	0		INF
L2, C5	0		INF
L1, C3, C4	0		140 ohms

6-30. Alignment Data

a. General. The following procedures should be performed after repairs have been made to the IF bandpass filter module. This procedure is a five-part alignment as follows: filter card alone; equalizer card (-3) alone; equalizer card (-4) alone; filter card and --3 equalizer card together, and overall module.

b. Test Equipment Setup. Alignment of the IF bandpass filter requires two basic test equipment setups, one setup for bandpass alignment as shown in figure 6-47 and one setup for return loss alignment as shown in figure 6-48.

c. Preliminary Adjustments, Filter Card. When the test setup of figure 6-47 is completed, perform the following preliminary adjustments:

(1) On the transmission generator, insert 5 dB using ATTENUATOR (dB) pushbuttons.

(2) On the transmission generator, set the controls as follows:

IF FREQUENCY (MHz) COARSE	to	70
IF FREQUENCY (MHz) FINE	to	0
SWEEP WIDTH (MHz) COARSE	to	30
SWEEP WIDTH (MHz) FINE	to	0
BB DEVIATION (kHz RMS)	to	140
BB FREQUENCY (kHz)	to	500
MODE	to	BB + SWEEP

(3) On the rear apron of the demodulator display unit, set the Y2 switch to REF.

(4) On the demodulator display unit, set DISPLAY switch to IF and the SENSITIVITY switch to X1.

(5) Remove both covers from the module to be aligned.

(6) Remove the filter card from the module to be aligned and place it in the test fixture shown in figure 6-55. Fasten it with appropriate screws. The mounting screws provide ground contact for the assembly and must be tight to insure correct alignment of the filter circuit.

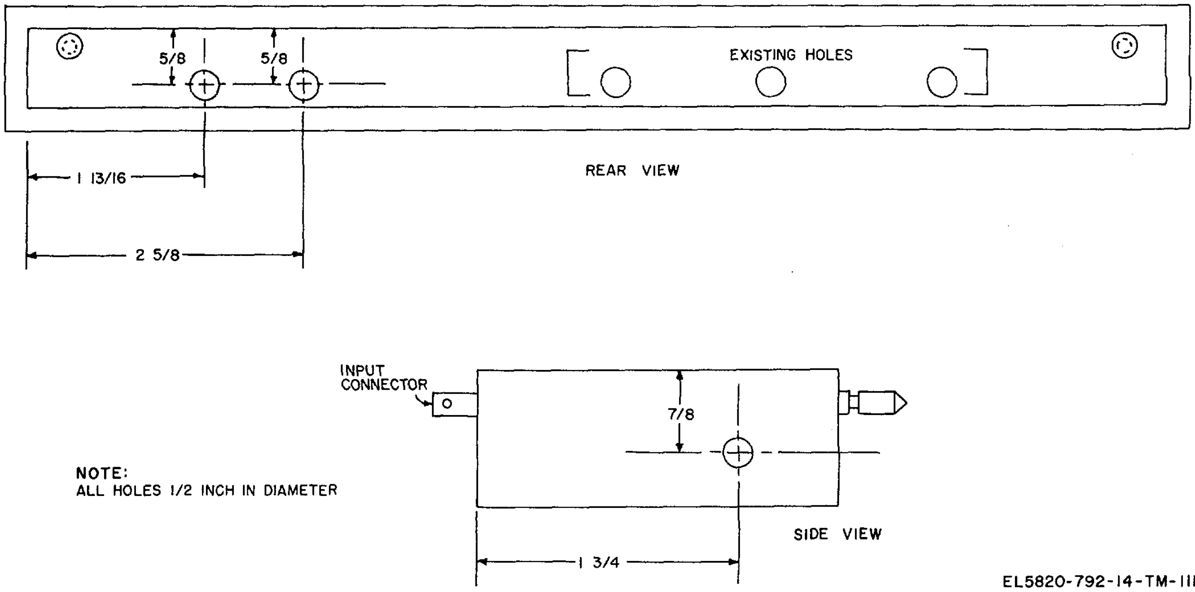


Figure 6-55. IF bandpass filter, test fixture.

(7) Insure that the two dummy equalizer cards are inserted in the test fixture.

(8) Place bottom covers on the test fixture and secure it with all screws in place.

d. Filter Card Alignment. The following procedure is provided to align the bandpass and return loss characteristics of the filter card alone.

(1) Perform preliminary steps in c above.

(2) Connect a test cable between the INPUT of the test fixture and ATTEN OUTPUT of the transmission generator, then connect another test cable between OUPPUT of the test fixture and IF INPUT of the demodulator display.

(3) On the demodulator display unit, operate IF LEVEL pushbuttons until the IF/BB LEVEL meter provides an on-scale indication.

(4) On the group delay detector, set the controls as follows:

BB FREQUENCY (kHz)	to	500
DEMOD INPUT	to	INT
DELAY OUTPUT	to	NORMAL

(5) On demodulator display unit, adjust the REF LINE control to place the trace on the center graticule, then adjust the Y1 trace near the center of the display using the U1 POSITION control.

(6) Spread the traces to occupy the full width of the graticule (± 5 cm) using the X GAIN control of the demodulator display unit.

(7) On the demodulator display, set the CALIBRATION (dB) % to 1.0, spread the chopped Y1 trace apart by 1 cm using the Y1 GAIN control, then turn the CALIBRATION (dB) % control to its OFF position.

(8) Using the Y1 POSITION control of the demodulator display unit, position the Y1 trace 3 cm above the reference line.

(9) On the electronic counter, set the SENSITIVITY (VOLTS RMS) control to .1, TIME BASE control to .1 ms, and the FUNCTION to FREQUENCY.

(10) On the demodulator display unit, adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 14 ± 0.1 MHz.

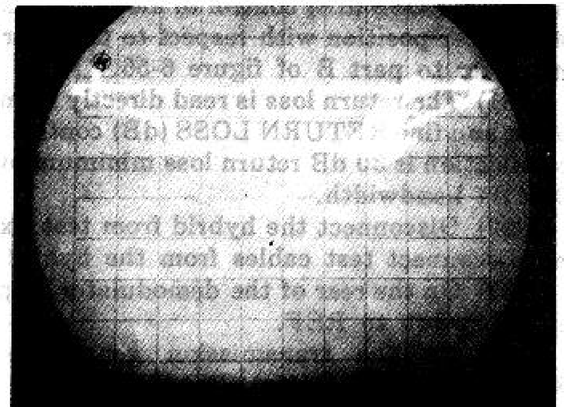
(11) Using the IF FREQUENCY (MHz) FINE control on the transmission generator and the X PHASE SHIFT control on the demodulator, center the 70 MHz marker with the 14 MHz markers positioned on the ± 4 cm graticules.

(12) Adjust inductors L1 through L4 and capacitor C4 on the filter card. The passband at the 3 dB points must be 14 0.1 MHz, (A, fig. 6-56). Using tuning tools with flexible shafts to align the inductors.

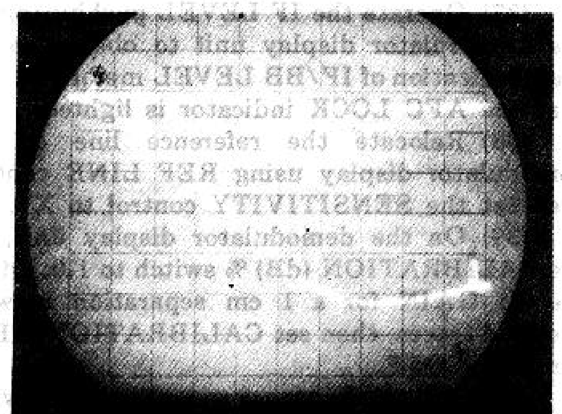
NOTE

While tuning components, observe the IF/BB LEVEL meter as well as the Y1 trace. Maintain the IF/BB LEVEL meter indication as near zero as possible using the IF LEVEL pushbuttons. The Y1

trace will tend to move vertically, return the Y1 trace to 3 cm graticule above reference line using the Y1 POSITION control.



A. 398-12222-3 Equalizer forward return loss



B. 398-12222-3 Equalizer reverse return loss

EL5820-792-14-TM-113 (1)

Figure 6-56. Filter card, alignment waveforms.

(13) Disconnect the test fixture from the test equipment setup.

(14) Reconfigure the test equipment setup as shown in figure 6-48.

(15) On the transmission generator, set SWEEP WIDTH (MHz) COARSE control to 10.

(16) On the demodulator display unit, operate IF level pushbuttons to set IF/BB LEVEL meter as close as possible to zero.

(17) Set DISPLAY switch of the demodulator display to RET LOSS and adjust RETURN LOSS (dB) control to 17.

(18) On the electronic counter, set Sensitivity (VOLTS RMS) to 1.

(19) Adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 5 ± 0.1 MHz.

(20) On the rear apron on the demodulator display unit, set Y2 switch to RET LOSS.

(21) On the demodulator display unit, set SENSITIVITY control to X0.1, Y1 GAIN control to its maximum counterclockwise position, then spread the display to full width (±5 cm) using the X GAIN control.

(22) Carefully and accurately adjust the RETURN LOSS SET control to obtain zero indication on the RETURN LOSS meter.

(23) On the demodulator display unit, set the CALIBRATION (dB) % control to 1.0, and adjust the Y2 GAIN control to obtain a 1 cm separation between the chopped Y2 traces, then set the CALIBRATION (dB) % control to its OFF position.

(24) Using the Y1 POSITION control, move the reference line to the 2 cm graticule (from the top of the display); then adjust the Y2 trace to coincide with the Y1 trace using the REF LINE control.

NOTE

Y1 GAIN, Y1 POSITION, REF LINE, and Y2 GAIN controls are now calibrated and MUST NOT be readjusted again until directed in the procedure. Furthermore, removal of the 17-dB mismatch in a subsequent step causes the RETURN LOSS meter indicator to move off-scale, DO NOT disturb the RETURN LOSS SET control-let the meter continue to indicate off-scale.

(25) Disconnect the 17-dB mismatch.

(26) Connect an UG-491A/U adapter to the hyb rid.

(27) Connect the INPUT of the test fixture to the open port of the UG-491A/U.

(28) Connect a 75-ohm termination to the OUTPUT connector of the test fixture.

(29) Adjust the RETURN LOSS (dB) control so that the return loss trace is as close as possible to the lower side of the reference line.

(30) The adjustment for return loss involves the adjustment of L1 and L4 primarily, however, there is interaction so that L2, L3 and C4 may

require some slight touchup to achieve optimum loss. Each time an adjustment is made, reset the RETURN LOSS (dB) control to move the display into proper position with respect to the reference line, refer to part B of figure 6-56.

(31) The return loss is read directly from the coarse and fine RETURN LOSS (dB) control. The specification is 30 dB return loss minimum over a 10 MHz bandwidth.

(32) Disconnect the hybrid from test fixture and disconnect test cables from the hybrid.

(33) On the rear of the demodulator display, set Y2 switch to REF.

(34) On the transmission generator, set SWEEP WIDTH (MHz) COARSE to 30.

(35) Return the test equipment setup to the configuration as shown in figure 6-47.

(36) On the demodulator display unit, set DISPLAY switch to its IF position.

(37) Operate the IF LEVEL pushbuttons of the demodulator display unit to obtain an on-scale indication of IF/BB LEVEL meter and note that the AFC LOCK indicator is lighted.

(38) Relocate the reference line on the demodulator display using REF LINE control, then set the SENSITIVITY control to X1.

(39) On the demodulator display unit, set the CALIBRATION (dB) % switch to 1.0, adjust the Y1 GAIN for a 1 cm separation between chopped traces, then set CALIBRATION (dB) % control to OFF.

(40) Adjust the traces to a convenient width using the X GAIN control and then position the Y1 trace 3 cm above the reference line using the Y1 POSITION control.

(41) On the electronic counter, set the SENSITIVITY (VOLTS RMS) control to .1.

(42) Adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 14 ±0.1 MHz.

(43) Using the IF FREQUENCY (MHz) FINE control of the transmission generator, and the X PHASE SHIFT control of the demodulator display unit, adjust the markers on the reference line so that the 70 MHz marker is centered and the 14 MHz markers are at the ±4 cm graticule.

(44) Refer to (12) above and refine the bandpass response as necessary: tune for best bandwidth response.

NOTE

Careful comparison of parts A and C of figure 6-56 shows a decided tilt along the top of the response curve. As long as the tilt is flat, do not try to remove the tilt, because it is produced by the return loss adjustment.

(45) The bandpass and return loss specifications in (12) and (31) above must be obtained together. Do not relax the specifications because of the seeming difficulty during adjustment; it is possible that several tries must be made before satisfactory results are obtained. Repeat steps as necessary.

e. Preliminary Adjustments, Equalizer Cards. When the test setup of figure 6-48 is completed, perform the following preliminary adjustments:

(1) On the transmission generator, insert 5 dB using ATTENUATOR (dB) pushbuttons.

(2) On the transmission generator, set the controls as follows:

IF FREQUENCY (MHz) COARSE	to	70
IF FREQUENCY (MHz) FINE	to	0
SWEEP WIDTH (MHz) COARSE	to	10
SWEEP WIDTH (MHz) FINE	to	6
BB DEVIATION (kHz RMS)	to	140
BB FREQUENCY (kHz)	to	500
MODE	to	BB SWEEP

(3) On the rear apron of the demodulator display unit, set the Y2 switch to RET LOSS.

(4) On the demodulator display unit, set DISPLAY switch to IF and the SENSITIVITY to X1.

(5) Operate the IF LEVEL pushbuttons to obtain an on-scale indication on the IF/BB LEVEL meter with the AFC LOCK lamp lighted.

(6) On the demodulator display unit, set the DISPLAY switch to RET LOSS position, and set the coarse and fine RETURN LOSS (dB) control to 17. Adjust the RETURN LOSS SET control until the RETURN LOSS meter indicates zero.

(7) Place the SENSITIVITY control to X0.1, the Y1 GAIN to its maximum counterclockwise position, and move the trace to a convenient location using the Y1 POSITION control.

(8) On the demodulator display unit, set the CALIBRATION (dB) % control to 1.0, adjust the Y2 GAIN to obtain a 1 cm separation of the chopped trace, then set the CALIBRATION (dB) % control to its OFF position.

(9) Using the Y1 POSITION control, move the reference line to the 2 cm graticule (from the top of the display); then adjust the Y2 trace to coincide with the Y1 trace using the REF LINE control.

NOTE

Y1 GAIN, Y1 POSITION, REF LINE,

and Y2 GAIN controls are now calibrated and MUST NOT be readjusted again until directed in the procedure. Furthermore, removal of the 17-dB mismatch in a subsequent step causes the RETURN LOSS meter indicator to move off-scale, DO NOT disturb the RETURN LOSS SET control--let the meter continue to indicate off-scale.

f. Equalizer Card Alignment. The following procedure is provided to align the return loss characteristics of the 398-12222-3 and 398-122224 equalizer cards alone.

(1) Perform preliminary steps in e above.

(2) On the demodulator display unit, adjust the MARKER OFFSET (MHz) control until the electronic counter indicates:

7.5 MHz + 50 kHz for the 398-12222-3 card.
5.0 MHz + 50 kHz for the 398-12222,-4 card.

(3) Remove the appropriate equalizer card (-3 or -4) from the module to be aligned, then mount it on the 398-13085-1 test fixture which is part of the module test set. Insure that mounting screws are tight to provide for good contact.

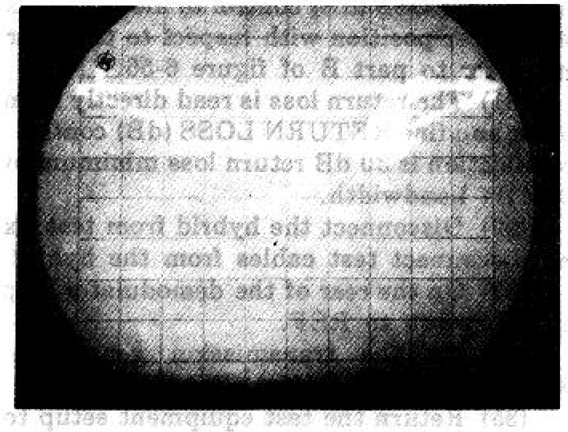
(4) Remove the 17-dB mismatch from the hybrid, then substitute an UG-491A/U adapter for the mismatch.

(5) Turn the equalizer card/test fixture assembly so that the part number of the fixture is correctly oriented for reading. The left-hand connector is J1 and the right-hand connector is J2.

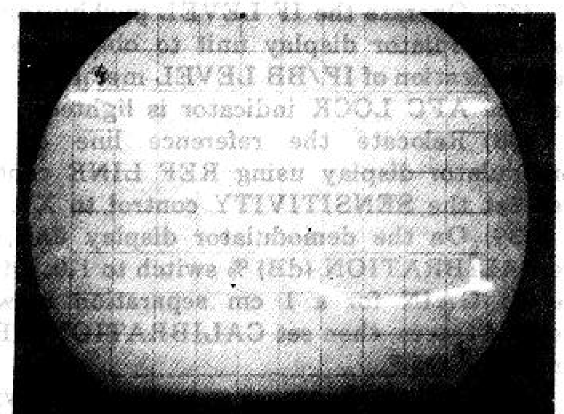
(6) Connect J1 of the test fixture to the UG491A/U adapter on the hybrid, then attach a 75ohm termination to J2 of the test fixture.

(7) Adjust L1, L2 and C4 to obtain a minimum forward return loss of:

27 dB over a 15 MHz bandwidth for 398-12222-3
24 dB over a 10 MHz bandwidth for 398-12222-4
Maintain the 70 MHz marker in the center of the Y2 response curve; refer to part A of figure 6-57.



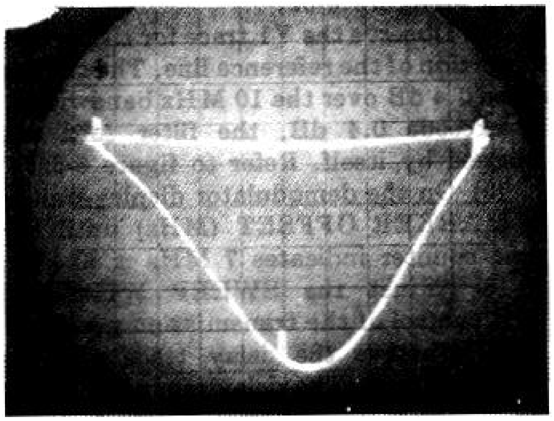
A. 398-12222-3 Equalizer forward return loss



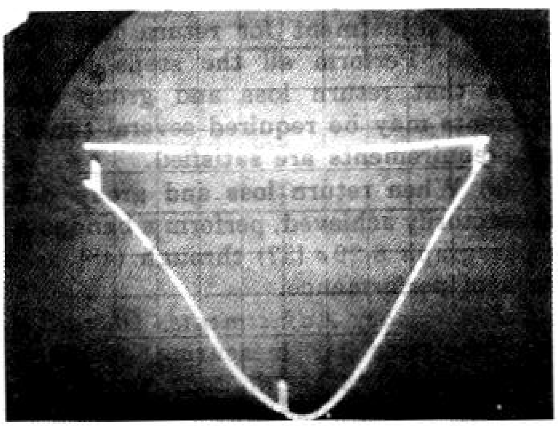
B. 398-12222-3 Equalizer reverse return loss

EL5820-792-14-TM-113(1)

Figure 6-57 (1). Equalizer card, alignment waveforms (sheet 1 of 2).



A. 398-12222-4 equalizer forward return loss



B. 398-12222-4 equalizer reverse return loss

EL5820-792-14-TM-113 (2)

Figure 6-57 (2). Equalizer card, alignment waveforms (sheet 2 of 2).

(8) Interchange the hybrid and 75-ohm termination on the equalizer -test fixture. Then adjust the RETURN LOSS (dB) coarse and fine controls of the demodulator display so that-the response marker nearest-the reference line is merged with the reference line. The equalizer response curve should now be similar to that shown in part B of figure 6-57.

The reverse return loss must be a minimum of

27 dB over 15 MHz bandwidth for 398-12222-3

24 dB over 10 MHZ bandwidth for 398-12222-4

If the specification is not obtained, adjust C4 only to meet the specification.

(9) Interchange the hybrid and 75-ohm termination to recheck the return loss in the forward direction again.

(10) Repeat steps (7), (8), and (9) above as necessary to meet the return loss requirements. Do not relax the specification because of the seeming difficulty in adjustment, since the alignment of the IF bandpass filter module is critical to the proper response of the overall radio terminal.

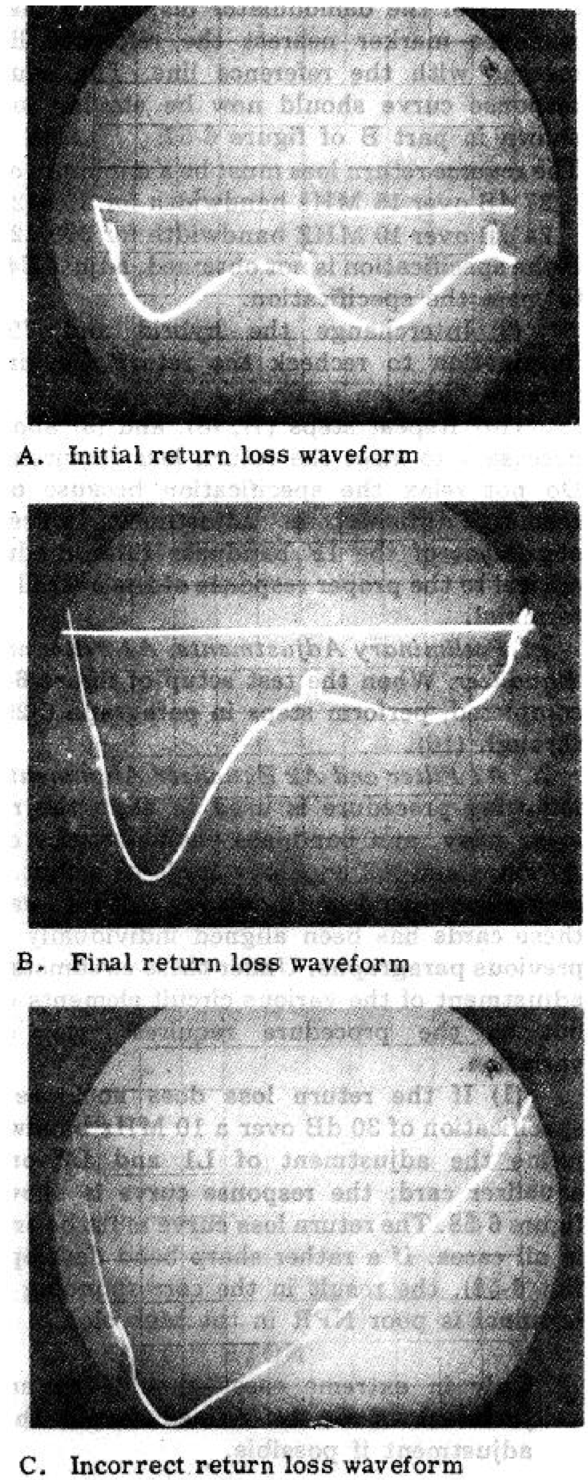
g. Preliminary Adjustments, A1 Filter and A2 Equalizer. When the test setup of figure 6-48 is completed, perform steps in paragraph 6-29e (1) through (16).

h. A1 Filter and A2 Equalizer Alignment. The following procedure is used to align the return loss, delay, and bandpass characteristics of the Al filter and A2 equalizer cards as a unit. This alignment should not be attempted until each of these cards has been aligned individually as in previous paragraphs. Under these circumstances, adjustment of the various circuit elements called out in the procedure requires very slight variation.

(1) If the return loss does not meet the specification of 30 dB over a 10 MHz bandwidth, refine the adjustment of L1 and L2 on the equalizer card; the response curve is shown in figure 6-58. The return loss curve must be smooth in all cases. If a rather sharp bend develops (C, fig. 6-58), the result in the corresponding radio terminal is poor NPR in the high slot.

NOTE

Only in extreme cases should the adjustment of C4 be refined; avoid this adjustment if possible.



A. Initial return loss waveform

B. Final return loss waveform

C. Incorrect return loss waveform

EL5820-792-14-TM-114

Figure 6-58. IF bandpass filter and A2 equalizer cord, initial return loss waveform

(2) Perform steps in paragraph 6-29e (18) through (37).

(3) The delay must not exceed 0.5 ns over a 10 MHz bandwidth. If not, adjust L1 and L2 of the equalizer only; do not refine the adjustment of C4. The waveform should appear similar to that shown in figure 6-52.

(4) Observe the Y1 trace for tilting along the flat portion of the reference line. The tilt must not exceed 0.4 dB over the 10 MHz bandwidth. If the tilt exceeds 0.4 dB, the filter card must be realigned by itself. Refer to figure 6-52.

(5) On the demodulator display unit, adjust the MARKER OFFSET (MHz) until the electronic counter indicates 7 MHz ± 50 kHz.

(6) Adjust the SWEEP WIDTH (MHz) FINE control of the transmission generator to 5.

(7) Observe the delay trace and compare with figure 6-53. The delay must not exceed 2 ns over a 14 MHz bandwidth. If it does, very carefully readjust L1 and L2 of the equalizer card. Disregard the tilting of the reference line.

(8) If adjustments had to be performed in the previous step, it is very likely that the previous adjustment for return loss has been disturbed. Perform all the steps in g above. Notice that return loss and group delay adjustments may be required several times before both requirements are satisfied.

(9) When return loss and group delay are satisfactorily achieved, perform a bandpass check in paragraph 6-29e (37) through (48) as a final check of performance.

i. Preliminary Adjustments, Overall Module. The conditions for measuring overall module parameters are rather limited. An entire module that is in use in a radio system contains an A3 equalizer assembly which has been adjusted for group delay or NPR over the path and is no longer suitable for use in this alignment. Any overall module which has been recently aligned and not modified by installation in the radio set is suitable for this check.

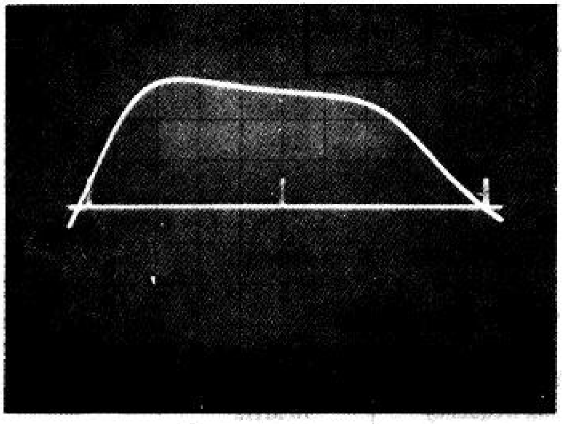
(1) Perform steps in paragraph 6-29e (1) through (16).

j. Overall Module Alignment. Only the return loss and bandpass characteristics of the module need be set in this procedure; group delay is not important since it is set when the module is installed in the radio set.

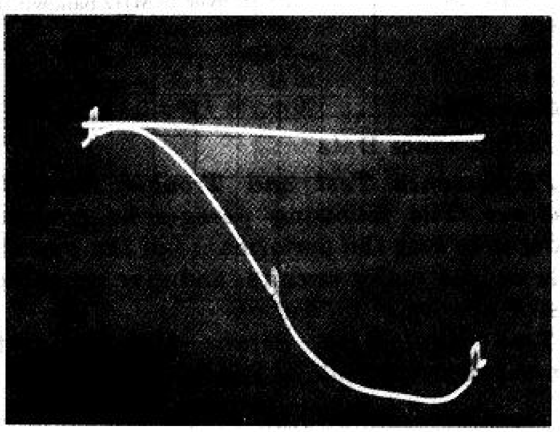
(1) If the module does not meet the specification of 27 dB over a 10 MHz bandwidth, refine the adjustment of L1 and L2 on the A3 equalizer card; the response curve is shown in part A of figure 6-59.

NOTE

Only in extreme cases should the adjustment of C4 on the A3 card be attempted; avoid this adjustment if possible.



A. Bandpass response



B. Return loss response

EL5820-792-14-TM-115

Figure 6-59. Overall IF filter module response waveforms.

(2) Perform steps in paragraph 6-29e (37) through (47), except in (47), set the markers to 15 ± 0.1 MHz. Refer to figure 6-59 for the final waveform.

Section VIII. IF PREAMPLIFIER MODULE (398-12215-1)

6-31. Introduction

The IF preamplifier module largely determines the noise figure of the microwave receiver. The input signal to the IF preamplifier is-taken from the receiver mixer. After amplification, the output signal from the preamplifier is passed into an IF bandpass filter. The IF preamplifier consists of a printed-wiring card on which all components are mounted. Interconnections between the interior of the module and the dc input connector are made by a 9-pin point-to-point wiring connector. The IF connections is made by a test point type connector or probe on one end of the chassis that mates with a pin on the mixer output port. A coaxial connector is used at the output of the preamplifier module.

6-32. Functional Description

The functional block diagram of the IF preamplifier module is shown in figure 6-60. The input signal to the IF preamplifier module is a 70-MHz signal from the output port of the receiver mixer. Signal amplification is provided by hybrid plug-in amplifier. A fixed attenuator pad on the preamplifier output line maintains a constant output impedance over the operating bandpass.

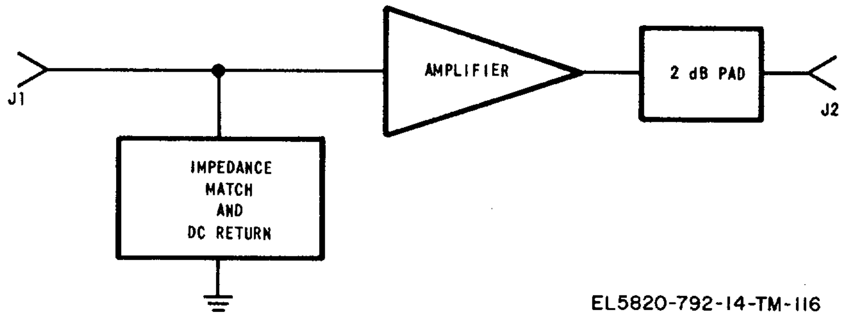


Figure 6-60. IF preamplifier module, functional block diagram.

6-33. Circuit Analysis

a. The schematic diagram of the IF preamplifier is shown in figure FO-23. The input signal is received at J1 and is coupled directly to the input of the hybrid amplifier MD1. Inductor L1 is used to match the input of the hybrid amplifier to the output of the receiver mixer and also to provide a dc bias return path for the mixer diodes. The hybrid output signal is coupled through a 2dB T-pad to the output coaxial connector, J2. The 2-dB pad is used to maintain a more constant output impedance over the preamplifier bandpass characteristic. Resistor R4 and Zener diode CR1, together with filter components L2, L3, and C2 through C5, provide a fixed +12 V dc bias for the hybrid amplifier. The dc input voltage at pin 1 of J3 is +28 V dc.

b. Technical Characteristics.

Parameter	Specifications
Operating frequency	70 MHz
Input impedance	Matched in system (Drive from 50 ohms in unit test)
Output impedance	75 ohms
Output return loss	20 dB over 40 MHz bandwidth
Input level	-40 dBm (maximum)
Output level	-2 dBm
Bandwidth	40 MHz at 1 dB points
Power requirements	70 mA at + 28 ± 0.5 V dc

6-34. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following paragraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect test equipment to the module as shown in figure 6-61.

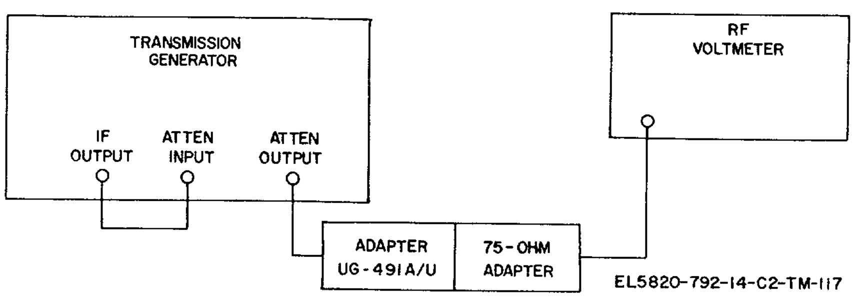


Figure 6-61. IF preamplifier module, input level test equipment setup.

NOTE

Connector J1 is a test-point type probe, and requires an 0.080 ± 0.003-inch diameter probe to permit interconnection with test equipment.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

NOTE

The holddown bracket for the hybrid amplifier must be in place -to assure proper grounding.

(1) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(2) Adjust the +28-volt power supply in the test set for 28 ± 0.1 V dc, using the digital voltmeter.

d. Test Procedures. After completing the procedures in b and c above, perform the procedures in e below.

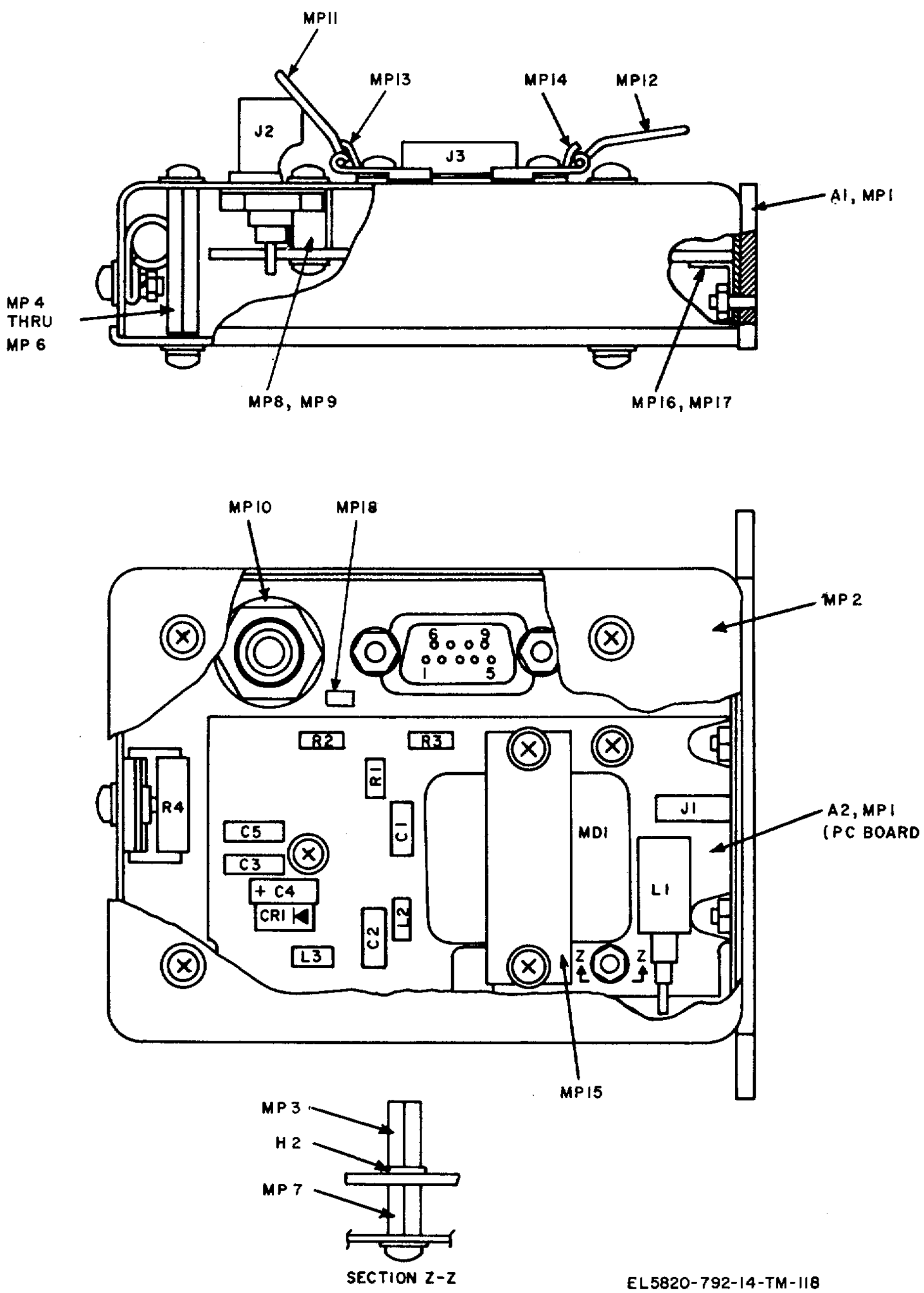


Figure 6-62. IF preamplifier module; parts location diagram.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
1	Set the RANGE-VOLTS FULL SCALE control of a RF voltmeter to its .003 VOLTS position.			
2	On the transmission generator, set controls as follows: FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to 0 SWEEPWIDTH (MHz) COARSE to 0 SWEEPWIDTH (MHz) FINE to 0 BB FREQUENCY (kHz) to 500 BB DEVIATION (kHz RMS) to 140 MODE to BB + SWEEP.			
3	On the transmission generator, depress the ATTENUATION (dB) pushbuttons to insert 50 dB. This provides a -40 dB output level.			
4	Connect the test equipment as shown in figure 6-61.			
5	On the transmission generator, depress additional ATTENUATION (dB) pushbuttons until RF voltmeter indicates 2.5 mV.			
6	Disconnect the UG-491A/U adapter and probe from ATTEN OUTPUT of the transmission generator.			
7	On the demodulator display unit insert 10 dB using the IF LEVEL pushbuttons.			
8	Connect the test equipment as shown in figure 6-63. **NOTE** **When connecting the 3221 adapter pin tips to the module input twist the leads loosely (3 turns approximately) to eliminate undesired reflections as much as possible.**			
9	Observe IF/BB LEVEL meter and AFC LOCK indicator. Depress IF LEVEL pushbuttons to obtain an on-scale indication with AFC LOCK indicator lighted.			
10	Observe IF LEVEL pushbuttons to obtain the number of dB inserted or removed.	If dB inserted is 10, then the preamplifier gain is 40 dB. If dB inserted is greater than 10 then preamplifier gain exceeds 40 dB.		
11	Set RANGE-FUI,L SCALE control of a RF voltmeter to .3 VOLTS.			
12	Connect the high impedance probe of the RF voltmeter to the UG-274B/U adapter.	290 mV minimum.		Check 28 V dc at C5 and 12 V dc at CR1. If bias is satisfactory, check voltage at R1C1 junction for 265 mV. If satisfactory replace A1.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
13	Connect a test cable between MARKER OFFSET on the rear apron of the demodulator display and the input of an electronic counter, if desired.			
14	On the demodulator display unit, adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 20 MHz 50 kHz.			
15	On the transmission generator, set the SWEEP WIDTH (MHz) COARSE control to 40, then adjust SWEEPWIDTH (MHz) FINE as necessary to obtain complete markers.			
16	On the demodulator display unit, adjust the X PHASE SHIFT and X GAIN control, and on the transmission generator adjust the FREQUENCY (MHz) FINE control until the 70MHz marker is centered and the 20 MHz markers are located at ±4 cm graticule.			
17	On the demodulator display unit, set the CALIBRATION (dB) % control to 1.0, adjust the Y1 GAIN control for a 1 cm separation between chopped traces, then set CALIBRATION (dB)% control to OFF.			
18	Using the REF LINE control, move the trace 1 cm below center graticule			
19	Using the Y1 POSITION control, move the response curve until at least one point of the curve passes through the reference line at the 20 MHz marker. bandwidth. **NOTE** **To obtain a smoother waveform, hold the BNC fitting of the 3221 adapter in contact with the preamplifier module casing. Hand capacitance has negligible effect.**	The bandpass response shall be within 1 dB (±0.5 dB) across the 40 MHz	End of test. Disconnect test equipment.	Align the module, (chapter 5).

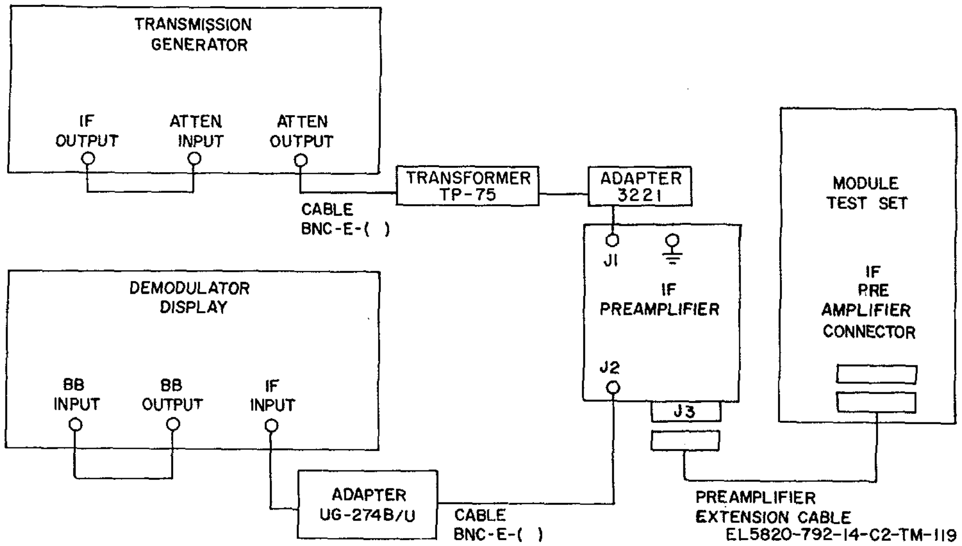


Figure 6-63. IF preamplifier bandpass test equipment.

f. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage data provided in g below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. All voltages are measured using a multimeter.

g. Voltage and Resistance Data.

Point of measurement	Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unless otherwise specified
Power connector L2 (terminal connected to the positive supply voltage for MD1)	+28 +12		

6-35. Alignment Data

a. General. The following procedure should be performed after repairs have been made to the module.

b. Test Equipment Setup. The test equipment setup used for the alignment and adjustment procedure is the same as that described in paragraph 6-34, unless otherwise indicated in the procedure.

c. Preliminary Adjustments. Perform the following preliminary adjustments.

(1) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(2) Adjust the +28-volt power supply in the module test set for 28 ± 0.1 V dc, using-the digital voltmeter.

(3) Set the RANGE-VOLTS FULL SCALE control of a RF voltmeter to its .003 VOLTS position.

(4) On the transmission generator, set the controls as follows:

FREQUENCY (MHz) COARSE	to	70
FREQUENCY (MHz) FINE	to	0
SWEEPWIDTH (MHz) COARSE	to	0
SWEEPWIDTH (MHz) FINE	to	0
BB FREQUENCY (kHz)	to	500
BB DEVIATION (kHz RMS)	to	140
MODE	to	BB + SWEEP

(5) On the transmission generator, depress the ATTENUATOR (dB) pushbuttons to insert 50 dB.

(6) Connect the test equipment as shown in figure 6-61.

(7) On the transmission generator, depress additional ATTENUATION (dB) pushbuttons until the RF voltmeter indicates 2.5 mV.

(8) Disconnect the UG-491A/U adapter and probe from ATTEN OUTPUT of the transmission generator (fig. 6-63).

(9) On the demodulator display unit, insert 10 dB using the IF LEVEL pushbuttons.

(10) Observe IF/BB LEVEL meter and AFC LOCK indicator. Depress additional IF LEVEL pushbuttons as necessary to obtain an on-scale indication with AFC LOCK indicator lighted.

(11) On the demodulator display unit, adjust the MARKER OFFSET (MHz) control until the electronic counter indicates 20 MHz 50 kHz.

(12) On the transmission generator, set the SWEEPWIDTH (MHz) COARSE control to 40 then adjust the SWEEPWIDTH (MHz) FINE, as necessary, to obtain a complete set of markers.

(13) On the demodulator display unit, adjust the X PHASE SHIFT and X GAIN control, and on the transmission generator, adjust FREQUENCY (MHz) FINE control until the 70 MHz marker is centered and the 20 MHz markers are located at the ± 5 cm graticule.

(14) On the demodulator display unit, set the CALIBRATION (db) % control to 1.0 dB, and adjust the Y1 GAIN control for a 1 cm separation between chopped traces, then set CALIBRATION (dB) % control to OFF.

(15) Using the REF LINE control, move the trace 1 cm below center graticule.

(16) Using the Y1 POSITION control, move the response curve until at least one point of the curve passes through the reference line at the 20 MHz marker.

(17) On the IF preamplifier, adjust inductor L1 until the curve is symmetrical and both ends of the response curve pass through the band edge markers. The bandpass response shall also be within 1 dB (-0.5 dB) across the 40 MHz bandwidth. Refer to figure 6-64.

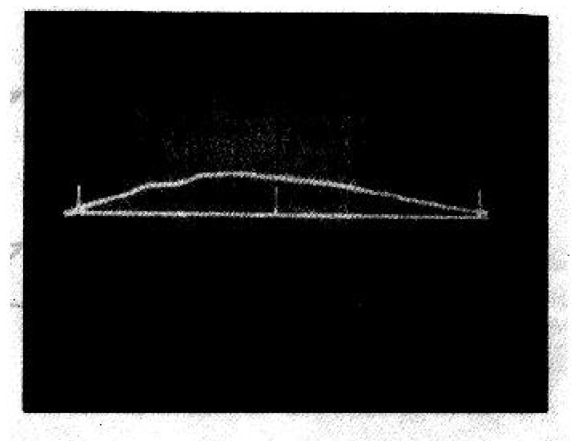


Figure 6-64. IF preamplifier bandpass alignment waveform.

Section IX. KLYSTRON DRIVER MODULE (368-43490-1, -2 and -6)

6-36. Introduction

The Klystron driver module is a module belonging to the microwave transmitter which performs the functions of signal amplification, preemphasis processing, and signal injection into the modulator unit.

6-37. Module Configuration

a. The Klystron driver module consists of a single printed-wiring card on which all components are mounted, with the exception of controls, test jacks, and connectors. The latter components are mounted on-the front flange of the metal module chassis.

b. The module can be equipped with a telephony preemphasis network; this is mounted on a separate printed-wiring card and is secured to the main printed-wiring card. Three different preemphasis networks having different frequency characteristics are available for use with the Klystron driver module. The network used in a given application depends upon the channel loading of the particular system.

c. Module Configuration Data.

Klystron driver module part No.	Preemphasis network part No.	Channel capacity	f max kHz
368-43490-1	Not used	Any	Any
368-43490-2	368-41959-8	600	2540
368-43490-6	368-41959-6	240	1024

6-38. Functional Description

a. A functional block diagram of the Klystron driver is shown in figure 6-65. The multiplex path uses a three-stage feedback amplifier at the input to provide gain of approximately 13 dB. Following amplification, the multiplex baseband is sent into a preemphasis network, which introduces a 5-dB loss at pivot frequency. The preemphasis network is used -to shape the transmit baseband signal so-that-the high end of the baseband frequencies is amplified more-than the low end. The selection of -the -type of preemphasis network used in a system depends upon the channel capacity required.

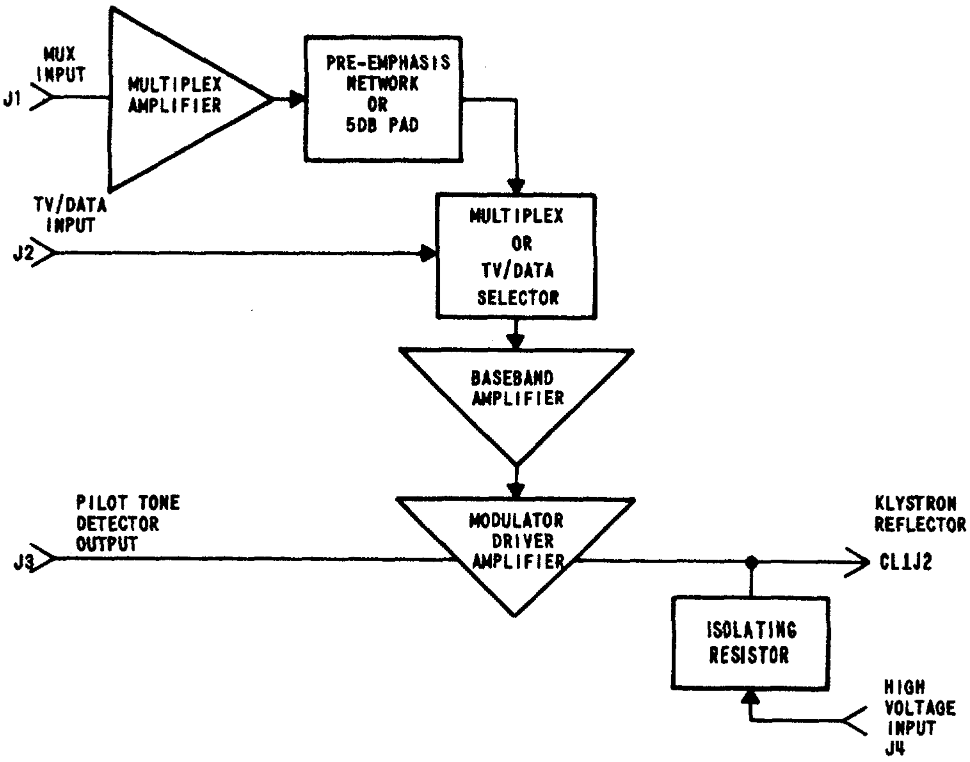


Figure 6-65. Klystron driver module, functional block diagram.

b. Two modes of operation can be selected by means of a switch on the Klystron driver. The first mode is the multiplex baseband mode. The baseband signal is amplified and processed by the preemphasis network prior to insertion into the high-level output amplifier stages. The second mode is the television /data mode. In this mode, the television/data signal is sent directly into the high-level output amplifier stages; the multiplex amplifier and the preemphasis network are automatically terminated in this mode. The termination of the multiplex path permits the television/data signal to enter the high-level amplifier chain without interference from the multiplex path, even though the baseband signal may still be present at the input of the module. The overall gain of the high level amplifiers is 44 dB.

6-39. Circuit Analysis

a. The schematic diagram of the module appears in figure FO-24. Resistor R3 is the 75-ohm input termination for the multiplex amplifiers. Resistors R6 and R7 in conjunction with R8 are base-biasing resistors for Q1. Resistor R6 also provides degenerative feedback to stabilize the gain of amplifier Q1. Direct coupling is used to couple the baseband signal from amplifier Q1 into amplifier Q2. Resistors R11 and R12 are emitter resistors for the second amplifier stage; the voltage gain of this amplifier is heavily dependent upon the value of resistor R11. Capacitors C4 and C6 bypass resistor R12 to ground. Direct coupling is also used to couple the baseband signal into emitter-follower Q3. Direct coupling in these cases provides excellent low-frequency response and eliminates undesired phase shifts. A portion of the baseband signal developed in the output of emitter-follower Q3 is taken across resistor R15 and injected via capacitor C5 into the emitter circuit of input amplifier Q1. The signals at the emitters of Q1 and Q3 are in phase and provide degenerative feedback to increase bandwidth and stabilize amplifier gain.

b. The A3 assembly is the preemphasis network. The preemphasis network is made up of two fixed resistors, R1 and R2, two AR (as required) capacitors, C1 and C2, and one AR adjustable inductor. The values of the as-required circuit elements are listed in figure FO-24. During module alignment, inductor L1 is adjusted for a peak response at its resonant frequency. In some cases such as module -test sets, preemphasis networks are not required; when this situation prevails, resistor R18 is used in place of the preemphasis network to introduce the 5-dB signal loss without baseband shaping.

c. Single-pole double-throw switch S1 is the mode-selecting switch of the Klystron driver module. When the switch is placed in the MUX position, the multiplex amplifiers and the preemphasis network are connected to the highlevel modulator driver amplifiers. Potentiometer R1 and resistor R4, connected in parallel, terminate the preemphasis network in 75 ohms. The multiplex level into the high level amplifiers is adjusted by use of potentiometer R1, and can be measured at test point TP3. Notice that TV/DATA coaxial connector J2 is always connect to 75-ohm input terminating resistors R1 and R4. When the switch is placed in the TV/DATA position, the multiplex amplifier chain is disconnected from the high-level driver amplifiers and is transferred into 75-ohm termination resistor R20.

d. The high-level amplifier chain receives its dc operating potentials from a 120-volt dc source in the Klystron power supply via connector J4-K.

e. The baseband signal is sent through its coupling circuit into the base of amplifier Q4. Resistor R21 serves the dual purpose of biasing and baseband voltage feedback from collector to base. The output signal is coupled from the output of transistor Q4 to the input of transistor Q5 by capacitor C10. Transistor Q6 is direct-coupled to amplifier Q5 collector. Transistor Q6 is an emitter-follower which shares a portion of its emitter resistance with transistor Q4 for degenerative feedback purposes to stabilize amplifier gain and to obtain a wide bandpass characteristic. Capacitor C11 bypasses resistor R30 to eliminate high frequency peaking. The output level and gain of this first high-level triplet amplifier can be measured between test points TP5 and TP6 (ground); the gain of this unit should be 18 dB, but the output level depends upon the amount of deviation required.

f. Capacitor C13 and resistors R32 couple the baseband signal into the second high-level amplifier triplet. This amplifier is similar to the previously explained triplet. Diode CR1 is a protective element. If a short circuit, for instance, were to develop in the Klystron reflector circuit, diode CR1 would become reverse-biased into cutoff to isolate amplifier Q7 from the highvoltage discharge of capacitor C20 through resistors R50, R45, R44, R40, and R37. Diode CR2 is a Zener diode, which sets the proper quiescent current flow through transistor Q8. This eliminates the need for the use of a resistor and bypass capacitor combination, which would degrade the low-frequency response. Inductor L1 is a peaking coil used to flatten the bandwidth response of the amplifier. Recall that for low frequencies, inductor L1 has a negligible effect, while resistors R41 and R42 constitute the basic load impedance; for high frequencies, inductor L1 interoperates with collector capacitance to boost the high-frequency response. The two transistors, Q9 and Q10, are used to provide better current handling capabilities than is obtained by a single unit operating at the same temperature. Diode CR3 protects the final amplifiers Q9 and Q10, from troubles likely to develop in the Klystron circuit. Most troubles would cause capacitor C20 to reflect a positive voltage back toward Q9 and Q10. In such cases, CR2 becomes reverse-biased to cutoff to isolate the final amplifier from the discharge path. In addition, diode CR4 becomes forward-biased for such emergencies and provides a safe discharge path for capacitor C20 through capacitor C18.

g. Figure 6-66 shows how the Klystron tube and Klystron power supplies are interconnected as far as their effect on the Klystron driver module is concerned. Klystron reflector current is passed through resistor R55 (as shown in figure FO-24) which is connected in series with the Klystron reflector and the negative line of the 450-volt Klystron supply. Capacitor C21 establishes an ac ground between the Klystron driver signal circuits and the high-voltage dc supply. Capacitor C20 feeds the modulating baseband to the reflector of the Klystron. Diode CR5 insures that the Klystron reflector never goes positive at any time. Resistor R54, in series with diode CR5, limits the maximum circuit current through CR5 whenever conduction occurs.

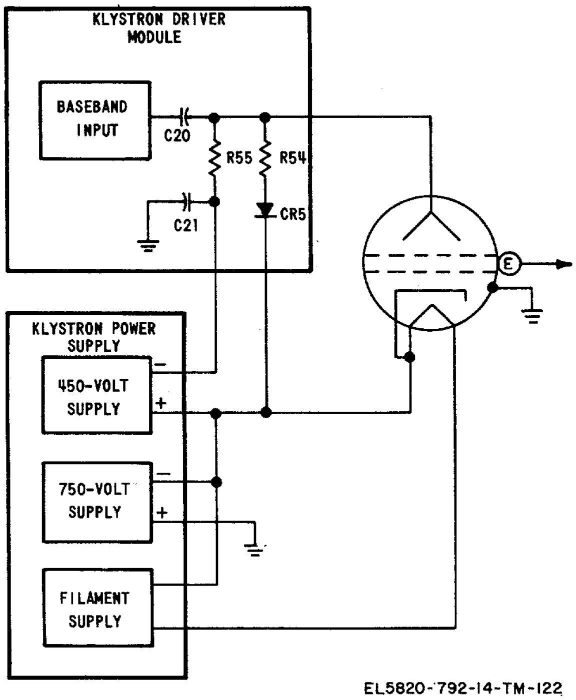


Figure 6-66. Klystron driver output circuit in relation to the Klystron and the Klystron power supply.

h. Depending upon system requirements, the final modulating signal is monitored for pilot-tone continuity. When required, the baseband is coupled from collector load resistor R47 through resistor R48 and capacitor C19 to an external connector, J3. Resistor R53 terminates this output line. The frequency response on this line is only intended to be sufficient to pass the pilot-tone signal.

i. Technical Characteristics.

Parameter	Specifications
MU X input impedance	75 ohms unbalanced
Output impedance	Low impedance to drive Klystron
MU X input level	-40 dBm
Output level	800 mV SCTT
MUX gain	40 dB
MU X frequency response	12 kHz to 2.8 MHz ± 0.2 dB
	200 Hz to 12 kHz ± 0.5 dB
lower requirements	140 mA at 120 V dc
	50 mA at 28 V dc

6-40. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following paragraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. The initial test equipment setup for the Klystron driver module appears in figure 6-67.

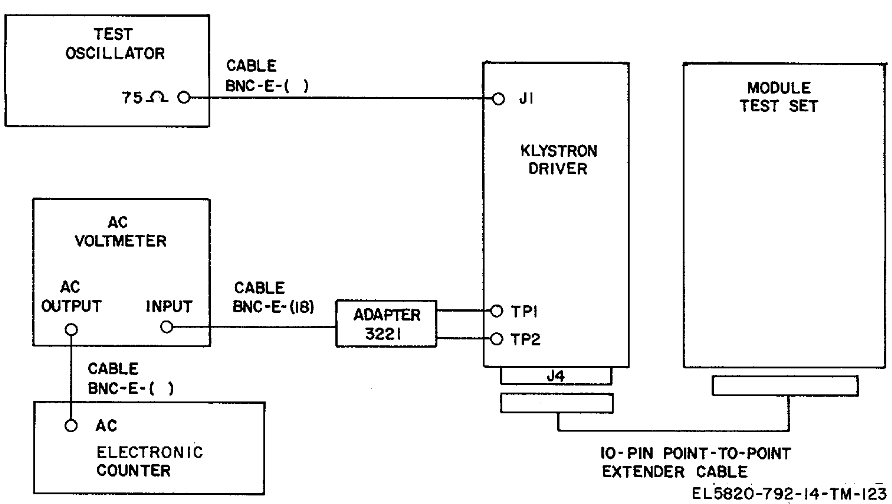


Figure 6-67. Klystron driver module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

WARNING

Dangerous voltages exist in this equipment. Be careful when working on the +120 V dc section of -the module; refer to FO-24 and figure 6-68. Observe the necessary safety precautions.

(1) Remove the bottom cover of the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Check that the +28 V dc and +120-volt power supplies in the module test set are set to +28 ± 0.1 V dc and +120 ± 0.5 V dc, respectively.

(4) Prior to connecting the module to the test equipment, check resistance between each ground lug on the printed wiring assembly and the module chassis, using a multimeter on the RX1 range. Repair any faulty connections before proceeding with further tests.

(5) On a test oscillator, set the FREQUENCY dial to 1, the RANGE control to X1OOK, and the OUTPUT ATTENTUATOR to minimum output.

(6) On an ac voltmeter, set the RANGE control to its .01 VOLTS position.

(7) On the Klvstron driver module. Unsolder the lead from terminal 2 on the preemphasis network.

(8) Using short clipleads, connect a 110-ohm resistor between terminal 1 of the preemphasis network and the wire lead removed from terminal 2 in the previous step.

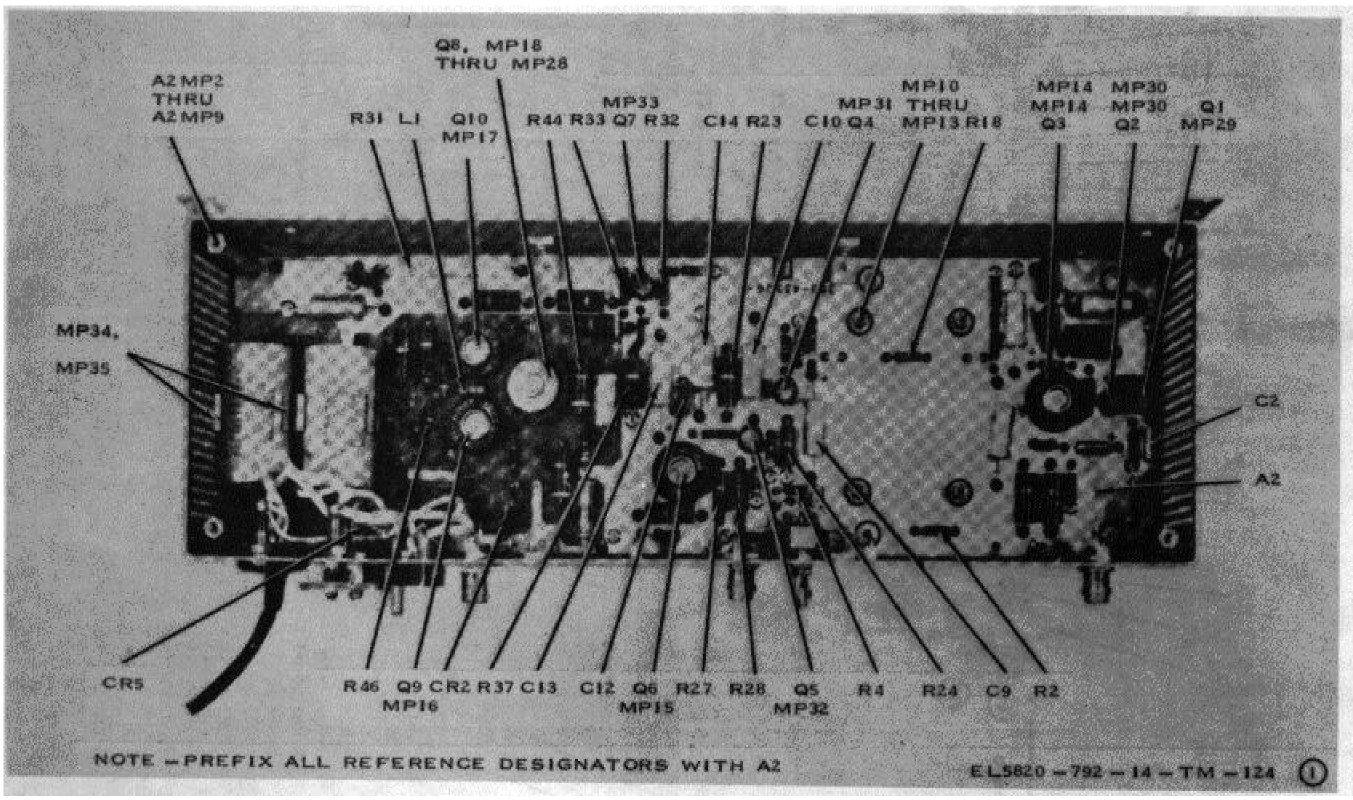


Figure 6-68 (1). Klystron driver module, parts location diagram (sheet 1 of 3) .

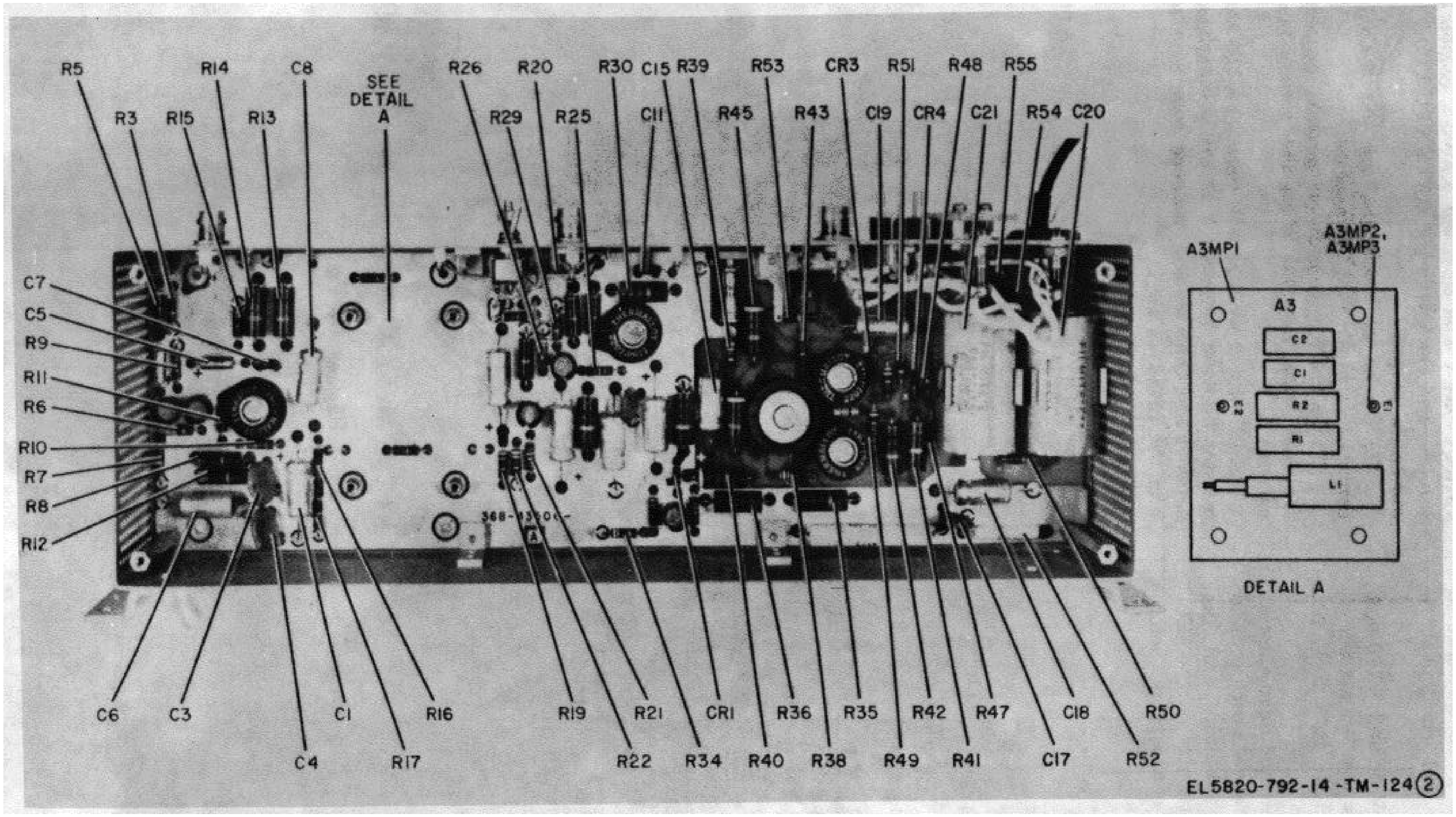


Figure 6-68(2) . Klystron driver module, parts location diagram (sheet 2 of 3).

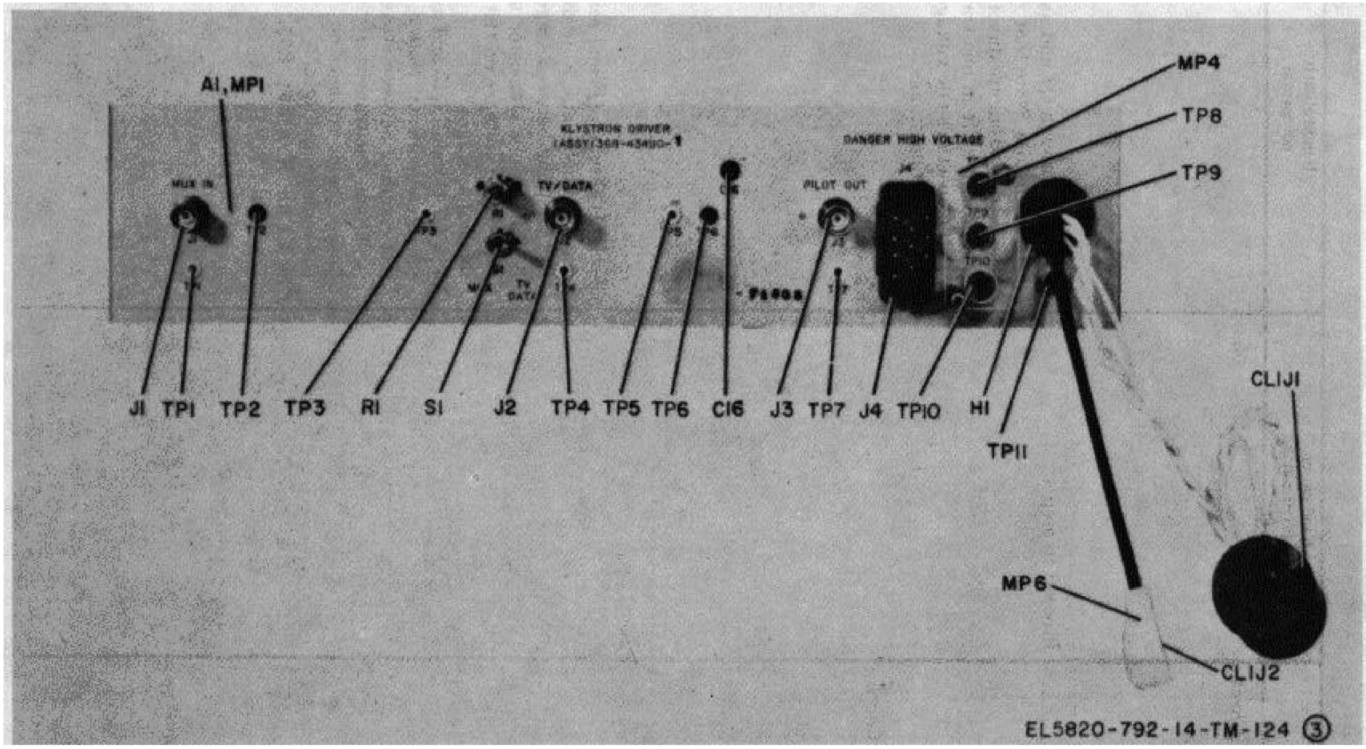


Figure 6-68 (3) Klystron driver module, parts location diagram (sheet 3 of 3)

(9) Set a multimeter FUNCTION control to OHMS, its RANGE control to X10000.

(10) Connect the multimeter between test points TP8 and TP9. Note the approximate meter indication. Reverse the meter leads and note the approximate meter indication. The approximate indications are 680 k in the forward direction and INF in the reverse direction. Where these indications are not obtained, replace CR5.

(11) Connect the test equipment as shown in figure 6-67.

d. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Low Level Amplifier Gain Check		
1	On the test oscillator, adjust the OUTPUT ATTENUATOR, COARSE, and FINE controls until the ac voltmeter indicates 7.8 mV/75 ohm (-31 dBm).			
2	On the Klystron driver module, place switch S1 in its MUX position and R1 to its maximum clockwise position (maximum gain).			
3	Disconnect the test lead from test point TP1, change the ac voltmeter RANGE control to .03 VOLTS, then connect the test lead to TP3.	19.5 ± 0.2 mV/75 ohms -23 dBm)	Proceed to step 4.	Check Q1 through Q3 and associated circuits. Note that these transistors are direct coupled, a shift in one transistor upsets the dc voltages on remaining stages.
		High Level Amplifier Gain Check		
4	On the Klystron driver module. set S1 to its TV/DATA position.			
5	Transfer the test oscillator cable from J1 to J2. Set OUTPUT ATTENUATOR to -70 dB position.			
6	Transfer the ac voltmeter leads to test points TP4 and TP6 (ground).			
7	On the test oscillator, adjust the OUTPUT ATTENUATOR, COARSE -and FINE controls until the ac voltmeter indicates 19.5 mV/75 ohm (-23 dBm).			
8	Disconnect the test lead from TP4, change the ac voltmeter to range .3 VOLTS, then connect the voltmeter lead to TP5.	144 ± 5 mV		Check Q4 through Q6 and associated components. Note direct coupling between stages. A shift in one transistor upsets the dc voltages on the remaining stages.
9	Disconnect the test lead from TP5, change the ac voltmeter range to 3 VOLTS, then connect the voltmeter lead to TP7.	980 mV minimum		Check Q7 through Q10 and asciated components. Note direct coupling between stages. A shift in one transistor upsets the dc voltages on the remaining stages.
10	Transfer the ac voltmeter leads to test points TP8 and TP9.	44 mV min		Check CR5, R50, R54, R55, C20, and C21.
		Bandwidth Check Without Preemphasis		
11	Transfer the ac voltmeter to test points TP1 and TP2 (ground).			
12	Transfer the test oscillator from J2 to J1 MUX input.			

k,

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
13	On the klystron driver module, set switch S1 to its MUX position.			
14	On the test oscillator, set the FREQUENCY dial to 1, the RANGE control to X100K, and adjust the OUTPUT ATTENUATOR COARSE, and FINE controls to minimum.			
15	On the ac voltmeter, set its RANGE to .01 VOLTS.			
16	On the test oscillator,' adjust OUTPUT ATTENUATOR, COARSE, and FINE controls until the ac voltmeter indicates 7.8 mV/75 ohm (-31 dBm).			
17	On the ac voltmeter, change the RANGE control to 1 VOLTS, then transfer the ac voltmeter leads to test points TP7 and TP6 (ground).			
18	On the klystron driver module, adjust R1 until the ac voltmeter indicates 775 mV. The klystron driver is now set for a 40-dB gain.	Reference level is 775 mV.		
19	Transfer the ac voltmeter to test points TP1 and TP2. Set RANGE for .01 VOLTS.			
20	On the test oscillator, set the FREQUENCY dial to 2, the RANGE control to X100, adjust COARSE and FINE output level controls until ac voltmeter indicates 7.8 mV/75 ohm (-31 dBm).			
21	On the ac voltmeter, change the RANGE control to 1 VOLTS, then transfer the ac voltmeter leads to test points TP7 and TP6 (ground).	Reference level 775 mV ± 50 mV.		Check C2, C5, C6, C8, C9, C10, C13 and C15.
22	On the test oscillator, set the FREQUENCY dial to 1, and the RANGE control to XIK.			
23	Transfer the ac voltmeter to TP1 and TP2. Change RANGE control to .01 VOLTS.			
24	Adjust the COARSE and FINE output level controls of the test oscillator until the ac voltmeter indicates 7.8 mV.			
25	Change ac voltmeter RANGE to 1 VOLTS, then transfer the ac voltmeter to TP7 and TP6.	Reference level 775 mV ± 50 mV.		Repeat steps 1 through 21.
26	On the test oscillator, set the RANGE control to X1OK.			
27	Transfer the ac voltmeter to TP1 and TP2. Change Range control to .01 VOLTS.			
28	Adjust the COARSE and FINE output level controls of the test oscillator until the ac voltmeter indicates 7.8 mV.			
29	Change the ac voltmeter RANGE to 1 VOLTS, then transfer the ac voltmeter to TP7 and TP6 (ground).	Reference level 775 mV ± 20 mV.		Repeat steps 1 through 29.
30	On the test oscillator, set the FREQUENCY dial to 2.8, and the RANGE control to X1M.			
31	Transfer the ac voltmeter to TP1 and TP2. Change the RANGE control to .01 VOLTS.			
32	Adjust the COARSE and FINE output level controls of the test oscillator until the ac voltmeter indicates 7.8 mV.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
33	Change the ac voltmeter RANGE to 1 VOLTS, then transfer the ac voltmeter to TP7 and TP6.	Reference level 775 ± 20 mV.		Adjust high frequency peaking capacitor C16 for reference level.
		Bandwidth Check With Preemphasis		
34	Remove the 110-ohm resistor inserted in step 7 of the previous paragraph; restore the original connection and resolder.			
35	If the Klystron driver is a 368-43490-1 module, this performance check is not applicable. Select the pivot frequency of the preemphasis network per Klystron driver part number. 368-43490-2 1544 kHz 368-43490-6 640 kHz			
36	Change the ac voltmeter RANGE to .01 VOLTS, then transfer the ac voltmeter to TP1 and TP2.			
37	On the test oscillator, set the FREQUENCY dial to 1.5 or 6.4, as applicable, set the RANGE control to X1M, or X100K and output level to minimum.			
38	Transfer the test oscillator cable from J2 to J1.			
39	On the test oscillator, adjust OUTPUT ATTENUATOR, COARSE, and FINE output level controls until the ac voltmeter indicates 5.5 mV/75 ohm (-34 dBm).			
40	On the test oscillator, adjust the FREQUENCY dial until the electronic counter indicates 1544 ±1 kHz or 640 1 kHz as appropriate for the Klystron driver under test.			
41	Change the ac voltmeter RANGE to 1 VOLTS, then transfer the ac voltmeter to TP7 and TP6. Read and record the output level in dB for reference.	-3 ± 0.2 dB	Proceed to step 42	Preemphasis alignment is required (para 6-41e).
42	Transfer the ac voltmeter to test points TP1 and TP2. Change the RANGE to -40 dB.			
43	Select the resonant frequency of the preemphasis network per Klystron driver part number. 368-43490-2 3175 kHz 368-43490-6 1315 kHz			
44	On the test oscillator, set the FREQUENCY dial to 3.1 or 1.3 as applicable, set the RANGE control to X1M, and output level to minimum output.			
45	Transfer the ac voltmeter to TP1 and TP2. Set its RANGE to -40 dB.			
46	On the test oscillator, adjust OUTPUT ATTENUATOR, COARSE, and FINE output level controls until the ac voltmeter indicates 5.5 mV/75 ohm (-34 dBm).			
47	On the test oscillator, adjust the FREQUENCY dial until the electronic counter indicates 3175 ± 1 kHz or 1315 ± 1 kHz-as appropriate.			
48	On the ac voltmeter, set its RANGE to 0 dB, then transfer it to test points TP7 and TP6.	Reference level +5 dB ± 0.2 dB.	Proceed to step 49.	Preemphasis alignment is required (para 6-41e).

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
49	Select the maximum frequency of the preemphasis network per Klystron driver part number. 368-43490-2 2540 kHz 368-43490-6 1052 kHz			
50	On the test oscillator, set the FREQUENCY dial to 2.5 or 1.0 as applicable.			
51	Transfer the ac voltmeter to TP1 and TP2. Set its RANGE to -40 dB.			
52	On the test oscillator, adjust the FREQUENCY dial until the electronic counter indicates 2540 ± 1 kHz or 1052 1 kHz as appropriate.			
53	On the test oscillator, adjust the COARSE and FINE controls until the ac voltmeter indicates 5.5 mV/75 ohms (-34 dBm).			
54	On the ac voltmeter, set its RANGE control to 0 dB, then transfer it to test points TP7 and TP6.	Reference level +4 dB ± 0.2 dB.	Proceed to step 55.	Preemphasis alignment is required (para 6-41e).
55	Select the minimum frequency of the preemphasis network per Klystron driver part number. 368-43490-2 254 kHz 368-43490-6 105 kHz			
56	On the test oscillator, set the RANGE control to X1OOK.			
57	Transfer the ac voltmeter to TP1 and TP2. Set its RANGE to -40 dB.			
58	On the test oscillator, adjust the COARSE and FINE controls until the ac voltmeter indicates 5.5 mV/75 ohms (-34 dBm).			
59	On the ac voltmeter, set its RANGE control to 0 dB, then transfer it to test points TP7 and TP6.	Reference level -3.8 dB ± 0.3 dB.	End of test. Disconnect all test equipment.	Preemphasis alignment is required.
		Diode Check		
60	On the module test set, set the Klystron power supply to its OFF position.			
61	Remove all cabling from the Klystron driver in the module test set. Then remove the Klystron driver.			
62	Install the Klystron driver to be tested in the module test set. Connect normal cabling to the module.			
63	On the module test set control panel, set the meter function switch to its OUTPUT POWER position.,			
64	On the module test set, set the Klystron power supply to its ON position.			
65	Observe the module test set control panel meter.	Meter indicates in red-line zone.	Test complete. Remove tested module and reinstall normal test set Klystron driver. Disconnect test equipment.	Replace CR5. u

e. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, the voltage and resistance data provided in *f* above, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources. The RX1K scale of the multimeter is used as the standard range unless otherwise stated; the common multimeter lead is connected to the module casing (ground) during all measurements.

(2) Dc voltage measurements are made with the module connected to the RF panel using the appropriate 10-pin point-to-point extender cable. No connections are made to the Klystron and the high voltages associated with the Klystron are not present. No signal source is employed.

WARNING

Dangerous voltages exist in this module. Be careful when working on the +120- volt sections. Observe the necessary safety precautions.

(3) Ac voltage measurements are made using the following procedure:

(a) In the Klystron driver, disconnect whatever preemphasis circuit may exist in the module between standoff terminals 1 and 2.

(b) Strap-in the 110-ohm resistor (5 dB pad) between standoff terminals 1 and 2.

(c) Set potentiometer R1 to its fully clockwise position.

(d) Set the FREQUENCY control of a test oscillator to 1.2, set its RANGE control to X10K, and its OUTPUT ATTENUATOR to the .3 VOLT range, then set the COARSE adjustment to minimum output level.

(e) Set and ac voltmeter to its .003 VOLT range, and connect a 10OX probe to the ac voltmeter.

(f) Connect the 10-pin point-to-point extender cable between the Klystron driver receptacle on the RF panel of the test set and J4 of the Klystron driver module.

(g) On the Klystron power supply, operate the ON-OFF switch to its ON position. High voltages are now applied to the module, take necessary safety precautions.

(h) Connect the 10X probe at the rear of J1 of the Klystron driver module.

(i) Adjust the test oscillator COARSE output level until the ac voltmeter indicates 1.4 millivolts, which is 14 millivolts taking into account the 10X probe.

(j) Set switch S1 of the module to its MUX position and perform ac voltage measurements as necessary.

f. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
Q1	Base	3.4	13.5 mV	1.2K	RX100
	Emitter	2.7	12.6 mV	300	RX100
	Collector	13.5	7.3 mV	3.0K	RX100
Q2	Base	13.5	7.3 mV	3.0K	RX100
	Emitter	12.8	6.5 mV	1.25K	RX100
	Collector	21.2	128.0 mV	6.5K	
Q3	Base	21.2	128.0 mV	6.5K	
	Emitter	20.5	126.0 mV	270	RX100
	Collector	27.0	0	6.0K	
Q4	Base	3.9	32.0 mV	4.0K	
	Emitter	3.2	32.2 mV	87	RX10
	Collector	18.3	56.5 mV	7.1K	
Q5	Base	5.4	56.5 mV	4.3K	
	Emitter	4.1	56.0 mV	300	RX100
	Collector	19.5	256.0 mV	7.8K	
Q6	Base	19.5	256.0 mV	7.8K	
	Emitter	18.9	255.0 mV	780	RX100
	Collector	42.0	0	7.8K	
Q7	Base	9.4	226 mV	4.0K	
	Emitter	8.8	226 mV	15K	
	Collector	42.0	270 mV	8.2K	
Q8	Base	11.7	270 mV	4.3K	
	Emitter	11.2	267 mV	11K	
	Collector	70.0	2.15 mV	8.2K	
Q9	Base	70.0	2.15 mV	8.2K	
	Emitter	70.0	2.14 mV	24K	
	Collector	108.0	94 mV	5.7K	

Point of measurement		Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
Q10	Base	70.0	2.15 mV	8.2K	
	Emitter	70.0	2.14 V	24K	
	Collector	108.0	94 mV	5.7K	
TP1		0	14 mV	78	RX10
TP2		0	0	0	
TP3		0	33.0 mV	78	RX10
TP4		0	34.0 mV	76	RX100
TP5		19.2	255 mV	780	RX100
TP6		0	0	0	
TP7		70.0	2.1 V	24K	
TP8		0	0	INF	
TP9		0	750 mV	INF	
TP10		0	0	INF	
TP11		0	0	INF	
J1		0	14.0 mV	80	RX10
J2		0	34.0 mV	78	RX10
J3		0	94.0 mV	10K	
J4	pin K	120		7.6K	
J4	pin L	28		5.9K	
J4 pin J		0		0	

6-41. Alignment Data

a. General. The following procedures should be performed after repairs have been made to the module. Certain system parameters are imposed on the microwave radio terminal which dictate the setting of R1 to control transmitter deviation sensitivity. During the following module alignment, R1 is set as a part of the procedure, but is later set to provide a 40 dB gain through the module.

b. Test Equipment Setup. The test equipment setup for this alignment is the same as that shown in figure 6-67, unless otherwise indicated in the procedure.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

WARNING

Dangerous voltages exist in this equipment. Be careful when working on the +120 V dc section of the module; refer to FO-24 and figure 6-68. Observe the necessary safety precautions.

(1) Remove the bottom cover of the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Check that the +28-volt and +120-volt power supplies in the module test are +28 ± 0.1 V dc and ± 120 ± 0.5 V dc, respectively.

d. Gain Adjustment. Perform the following procedure:

(1) On the Klystron driver module, set S1 to its TV/DATA position.

(2) Transfer the test oscillator cable from J1 to J2 of the module.

(3) Set the RANGE control of the ac voltmeter to - 30 dB, then transfer the ac voltmeter to test points TP4 and TP6 (ground).

(4) On the test oscillator, set the RANGE control to X1OOK, the FREQUENCY dial to 5, and the OUTPUT ATTENUATOR to -20 dBm, then adjust the COARSE and FINE controls until the ac voltmeter indicates 19.5 mV/75 oms (-23 dBm).

(5) Disconnect the test lead from TP4, reset the ac voltmeter RANGE to 1 VOLTS, then connect the ac voltmeter lead to TP7.

(6) Adjust potentiometer R1 until the ac voltmeter indicates 550 mV.

(7) Transfer the ac voltmeter lead from TP7 to TP4.

(8) On the test oscillator, set the RANGE control to X1M, the FREQUENCY dial to 7.5, and the OUTPUT ATTENUATOR to -20 dBm.

(9) On the ac voltmeter, set the RANGE control to --30 dB.

(10) On the test oscillator, adjust the FREQUENCY dial until the electronic counter

indicates 7.5 ± 0.1 MHz, then adjust the COARSE and FINE controls until the ac volt- meter indicates 19.5 mV/75 ohms (-23 dBm).

(11) Disconnect the test lead from TP4, reset the ac voltmeter RANGE to 1 VOLTS, then connect the ac voltmeter lead to TP7.

(12) Adjust capacitor C16 until the ac voltmeter indicates 550 mV.

(13) This step completes the gain adjustment.

e. Preemphasis Network Alignment. There are two different preemphasis networks that may be used in the Klystron driver (as shown in figure FO-24). The following procedure is applicable for aligning any of the standard' networks.

(1) Perform steps in d (1) through (5) above.

(2) Adjust potentiometer R1 until the ac voltmeter indicates 770 mV.

(3) On the Klystron driver set S1 to its MUX position.

(4) Transfer the ac voltmeter test leads to TP1 and TP2 (ground). Set RANGE to -30 dB.

(5) On the test oscillator, set the OUTPUT ATTENUATOR to -40 dBm, the RANGE control to X1M, and the FREQUENCY dial to 1.3 for the 368-43490-6 driver module or to 3.1 for the 368.43490-2 module.

(6) Transfer the test oscillator test cable to J1 of the Klystron driver module.

(7) On the test oscillator, adjust the COARSE and FINE controls until the ac voltmeter indicates 15.5 mV/75 ohms (-25 dBm).

(8) On the test oscillator, adjust the FREQUENCY dial until the electronic counter indicates 1315 ±1 kHz for the 368-43490-6 driver module or 3175 - 1 kHz for the 368-43490-2 driver module.

(9) Disconnect the meter lead from TP1, reset the ac voltmeter RANGE to 0 dB, then connect the meter lead to TP7.

(10) On the preemphasis assembly, adjust inductor L1 for a peak ac voltmeter indication.

(11) Disconnect all test equipment, alignment is complete.

Section X. KLYSTRON POWER SUPPLY (368-43580)

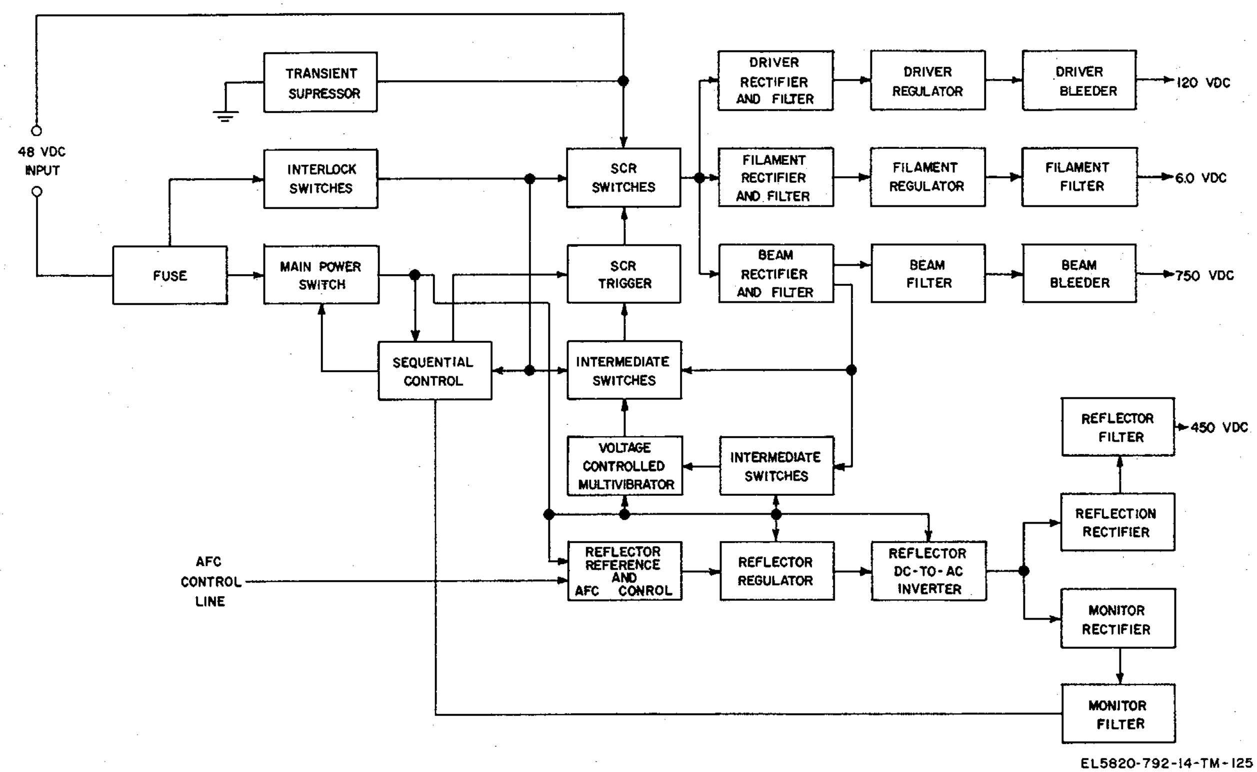
6-42. Introduction

The Klystron power supply furnishes all operating potentials to drive a reflex Klystron. All output potentials are fixed -except for the 450-volt section which is under direct control of an AFC circuit. The Klystron power supply consists of six printed-wiring card assemblies and the main chassis. Only the fuse, Fl, and the main power switch, S4, are accessible from the front panel. Test points, that are accessible from the top of the supply, are provided for monitoring output voltages.

6-43. Functional Description

a. Each Klystron power supply provides three supply voltages for its associated Klystron and one supply voltage to drive the high level amplifiers of the Klystron driver module. The Klystron supply voltages are a 6.0 V dc filament supply, a - 450 V dc reflector supply, and a - 750 V dc beam supply. The high-level amplifier voltage required for the Klystron driver is the 120 V driver supply.

b. As shown in figure 6-69, the 48-volt battery power is always applied to the SCR (silicon-controlled rectifier) switches, intermediate switches, and sequential control circuits through an ultrafast-blow 10-ampere fuse and the interlock switches. When the main power switch is turned on, battery power is applied through the fuse and main power switch to the sequential control, voltage controlled multivibrator, amplifier-comparator, and reflector power supply circuits.



Figure, 6-69. Klystron power supply, functional block diagram.

c. Depending upon the interaction of the reference and AFC control circuit, the reflector regulator applies a regulated drive voltage to the reflector dc-to-ac inverter. The inverter output signal is stepped up to 450 volts and rectified. After suitable filtering the negative output of the 450-volt supply is used to drive the Klystron reflector. The inverter output is also applied to a monitor circuit where it is stepped down to approximately 10 volts, rectified, filtered, and then applied to the sequential control circuits.

d. The first part of sequential control action occurs when the current from the 10-volt monitor supply initiates operation of an electromechanical relay. A pair of relay contacts close, thereby paralleling the contacts of the main power switch, and another set of contacts completes the path to the second stage of the sequential control circuit. Recall that power has been applied to the voltage-controlled multivibrator and intermediate switches during the first part of the sequential control interval. The second stage of the sequence occurs when a timing circuit fires and completes a power path to the SCR trigger circuits.

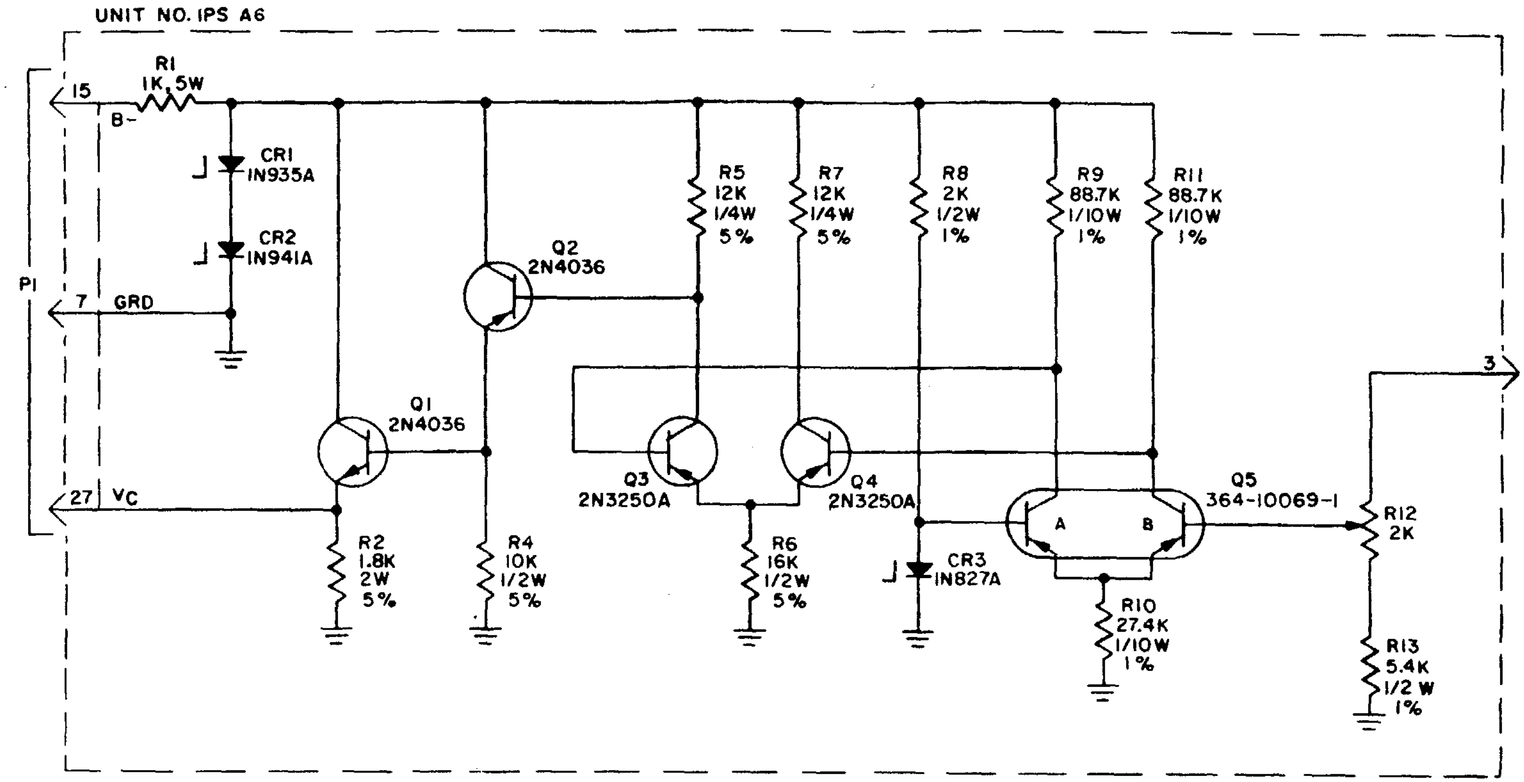
e. The silicon-controlled rectifier circuits, driven by the voltage-controlled multivibrator at minimum duty cycle, are now set into operation. The output power from the silicon controlled rectifiers is transformer-coupled into the driver, filament and beam sections of the power supply. The filament voltage rises to full output, and the filament regulator stabilizes at 6.0 V dc. Following this, the beam rectifier output voltage reaches approximately 80 volts. At this time, the amplifier-comparator drives the voltage-controlled multivibrator to maximum duty cycle. The output power delivered by the silicon- controlled rectifiers increases sharply, and the voltage delivered to the driver and beam rectifiers also increases sharply. The driver regulator stabilizes its output at 120 volts. The Klystron tube itself now reaches stable operation, whereupon the power supply demand is reduced slightly. The amplifier-comparator then reduces the duty cycle of the voltage-controlled multivibrator to normal value.

f. When the power supply has stabilized, the output voltages of the Klystron power supply reaches the values stated in para 6-44 v. When the power supply is turned off, the sequential control circuits immediately remove power from the SCR trigger and halt SCR switching action. The reflector supply is the slowest to discharge so that all other power is removed from the Klystron by the time the reflector supply is ready to be shut down. The monitor voltage falls below 10 volts permitting the sequential control relay to deenergize. The relay contacts bridging the main power switch open and all power except that noted in paragraph 6-46 b is removed.

6-44. Circuit Analysis.

a. General. The basic power supply circuit appears in figure FO-31. Specific circuits within the power supply appear in the indicated figures. The negative output of the 750-volt rectifier, taken from terminal 1 of filter choke L3A, is passed to feed-through capacitor C12 and resistor R25 into the amplifier-comparator card. At the input of the amplifier-comparator, the 750 volts has been reduced to approximately 7 to 7.5 volts.

b. Amplifier-Comparator. The schematic diagram of the amplifier-comparator (A6) appears in figure 6-70. Variations in the 750-volt supply are sensed across the input circuit consisting of potentiometer R12 and resistor R13. Differential amplifier Q5 is an integrated circuit device. Notice that differential amplifier load resistors R9 and R11 have the same value and are used as the arms of a bridge circuit. Resistor R8 and reference diode CR3 form the voltage reference circuit for the comparator and sets the constant current characteristic of the differential amplifier. Potentiometer R12 is adjusted so the base-to-ground voltage of the 750-volt power supply is equal to the reference voltage across diode CR3. In this situation, the collector current through load resistor R9 is equal to the collector current through load resistor R11. There is no potential difference between the collectors of Q5, so the bridge is balanced. If the output voltage of the 750-volt supply tends to decrease, base current and collector current through the sensing side of Q5 would also decrease. Collector current through the reference side of Q5 would increase correspondingly to maintain constant emitter current. The result is that the collector-to-ground voltage of the sensing side of Q5 increases by the same amount as the collector-to-ground voltage of the reference side of Q5 decreases. The differential amplifier, consisting of transistors Q3 and Q4, is used as the bridging device between the sensing and reference arms of Q5. As the base-to-ground voltage of transistor Q4 decreases, its collector and base currents also decrease. Simultaneously, as the base-to-ground voltage of transistor Q3 increases, its collector and base currents increase by the same amount as the decreasing base/collector 'currents in Q4. Emitter current through resistor R6 is constant. The output of transistor Q3 is used to drive two emitter-followers, Q2 and Q1. The purpose of using two emitter-followers is to increase the input impedance of transistor Q2 to avoid loading effects on the output of transistor Q3. Resistor R2 is the line dropping resistance, working in conjunction with Zener diodes CR1 and CR3 to produce the operating supply voltage for the amplifier-comparator circuits.



HIGHEST REFERENCE DESIGNATION		
Q5	CR3	
R13		
REFERENCE DESIGNATIONS NOT USED		
R3		

NOTE:
UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS

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Figure 6-70. Amplifier-comparator, A6, schematic diagram.

c. Voltage-Controlled Multivibrator. The basic multivibrator used in this circuit is the emitter coupled a stable multivibrator. This unit, (A5) as shown in figure 6-71 consists of transistors Q4 and Q5, load resistors R1 and R8, and capacitors C2 and C3. The emitter resistor, R14, and the base resistors, which are a part of the basic multivibrator, are replaced by complex circuits performing specific functions. The complex circuit performing the function of resistors RB 1 and RB 2 is shown in figure 6-72. The circuits including transistors Q1 and Q2 form a constant current generator to force the timing capacitors to charge linearly with time. Assume that multivibrator transistor Q4 is saturated, and that transistor Q5 is cutoff. Capacitor C2 is forced to discharge along the path of emitter resistance R14, emitter-to-base junction of Q4, and resistor R8. The collector-to-emitter voltage across transistor Q1 drops to a very low value, but does not affect the collector current of Q1, since the unchanged base current through transistor Q1 fixes its collector current. The collector current of transistor Q1 fixes its collector current. The collector current of transistor Q1 passes into the base-to-collector circuit of the saturated multivibrator transistor Q4 and out through collector resistor R1. Capacitor C3 is forced to charge along the path of resistor R7, transistor Q2, and load resistor R1; transistor Q5 is cutoff and charging current cannot take that path. Recall that the nature of a capacitor is to draw the greatest charging current initially and the least current at the termination of the charging period, which results in an exponential charge curve. Capacitor C3 is not permitted to charge in this manner; instead., it must charge by using whatever current is made available to it from the constant current source, Q2. Thus, capacitor C3 charges linearly with time, instead of exponentially. As shown in figure 6-73 and FO-32, potentiometer R4, and base resistors R3 and R6 form a T-network between the bases of transistors Q1 and Q2 and ground. Both base circuits are completed through potentiometer R5 to the negative source. Adjustment of potentiometer R4 establishes the desired value of collector current for both transistors Q1 and Q2. The dc output voltage of the 750-volt section of the power supply is injected into Darlington connected emitter-follower transistors Q11 and Q10 through feedthrough capacitor C12 and resistor R25. The Darlington connected emitter-follower is used to prevent loading of the amplifier-comparator input circuit. The output current from emitter follower Q10/Q11 is taken from the movable arm of potentiometer R20 and fed through pin A27 of the voltage controlled multivibrator card to the base circuit of transistor Q3.

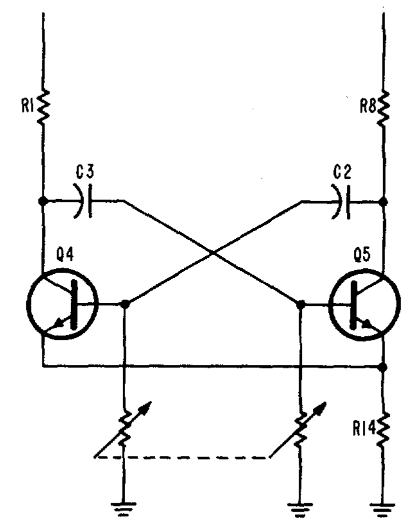

Figure 6-71. Basic emitter-coupled multivibrator.

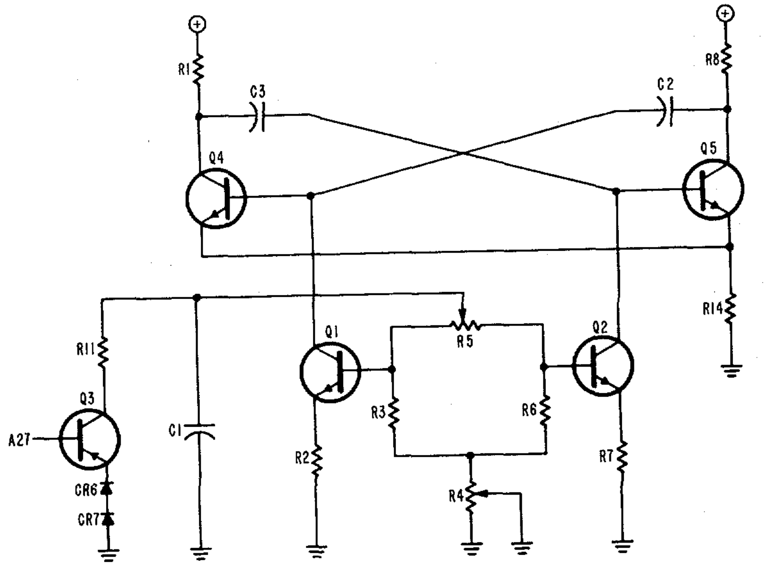

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Figure 6-72. Basic voltage-controlled multivibrator.

d. Initial Conditions. When the Klystron power supply is initially energized, all output voltages are zero; therefore, the base current into the emitter-follower transistors is zero. The emitter current of transistors Q10 and Q11 is zero also, with the result that voltage-controlled multivibrator transistor Q3 is cutoff because its base current is zero. Observe that the collector-to-emitter circuits of transistor Q3 are essentially connected in parallel with the base-to-ground circuits of transistors Q1 and Q2. When the supply is initially turned-on, capacitor C1 is at zero charge, which holds the constant current of transistors Q1 and Q2 to a very low value. The duty cycle of the voltage-controlled multivibrator is held to its minimum value. When the output voltage of the 750-volt supply reaches 800 volts, emitter current through potentiometer R4 increases to the point where transistor Q3 draws base and collector current. The voltage divider network shown in figure FO-33 consisting of resistor R10 in one branch, and resistor R11, transistor Q3, and diodes CR6/CR7 in the other branch, changes resistance due to transistor Q3. The supply voltage across capacitor C1 rises, and transistors Q1 and Q2 draw an increased amount of base drive. Collector current through the constant current generators Q1 and Q2 rises to normal value. The output voltage of the amplifier comparator is fed through pin B19 of the voltage controlled multivibrator. Assuming a decreased output voltage from the amplifier comparator, as occurs when the power supply is reaching its 6-128 stable operating condition, the voltage at B19 becomes more positive. The charge requirements of capacitors C2 and C3 through resistors R13 and R12, respectively, are reduced. Since the charge current is constant, reduced charge yields reduced charge voltage with respect to time. Capacitors C2 and C3 reach charged condition earlier than under previous conditions; this results in an increase in multivibrator output frequency. The output signal from the voltage-controlled multivibrator is taken from the collectors of transistors Q4 and Q5. Diodes CR2 and CR3 are clamping diodes.

e. Voltage Regulator. The voltage regulator circuit, consisting of transistors Q6 and Q7, is included as a part of the voltage controlled multivibrator to prevent supply line variations from affecting the output frequency of the multivibrator. The regulator consists of a series transistor Q6, which is driven by a difference sensing amplifier Q7 across the arms of a bridge circuit. The bridge circuit includes the sensing arm consisting of resistances R18 through R20, and the standard arm consisting of voltage reference diode CR5 and resistor R18. Capacitor C4 is a bypass capacitor. Potentiometer R19 is used to set the regulated output voltage to a negative 36 volts. When the bridge is unbalanced, assume a decrease in regulator output voltage; the base current through transistor Q7 is reduced as well as is the collector current through load resistor R16. The base of transistor Q6 becomes more negative, thus increasing base and collector currents through Q6. The increased collector current obtained through transistor Q6 decreases the Q6 collector-to-emitter voltage with a corresponding increase in the supply voltage dropped across load resistor R16.

f. Intermediate Switches. The output of the voltage controlled multivibrator, taken from the collectors of transistors Q4 and Q5, is passed out of the card through terminals B7 and B11, respectively. The signals leaving the card are passed into the bases of two switching transistors, Q4 and Q9, shown in figure FO-31. These switches are standard switching circuits which provide a degree of isolation between the voltage controlled multivibrator circuits and the silicon controlled rectifier trigger circuits. Resistor R16 and capacitor C6 are decoupling elements for the intermediate switches and the SCR trigger circuits. Battery power is supplied through interlock switches S1 through S3 when the main power switch is turned on. No time delays are provided.

g. SCR Trigger. Operating supply potentials are furnished to the SCR trigger circuits through pins A23 and A27. Pin A27 is the ground return line through decoupling network R13 and C4, time delay relay K1, time delay circuit involving Q2, and main power switch S4. This ground return line is passed through the time delay relay to insure that pulses from the voltage-controlled multivibrator are present at the SCR trigger input before the trigger circuit is permitted to function. The SCR trigger circuits (A3) are shown in figure FO-35. Notice that there are two identical trigger circuits on this card; therefore, only one need be described in detail. The output of the intermediate switches is capacitively coupled into transistor Q1 through card pin A3. The input square-wave pulses are passed through capacitor C1 and resistor R2 to produce a differentiated bipolar waveform at the base of transistor Q1. The bipolar differentiated wave appearing at the emitter of Q1 is capacitively coupled into the trigger driver transistor Q2. Inspection of the schematic diagram shows that in the presence of the positive portion of the output of transistor Q1, the emitter circuit of transistor Q2, consisting of resistor R4 and diode CR1, is completed. Diode CR2 is reverse-biased and acts as an open circuit. During reset, CR2 acts as a shunt to ground for any negative excursions. In the presence of the negative portion of transistor Q1 output, diode CR1 is reverse-biased; the emitter circuit of transistor Q2 is effectively open-circuited. Positive triggers are used to drive transistor Q2. Resistor R5, in conjunction with resistor R4, is the bias network for diode CR1, thus it sets the trigger level for Q2. Resistors R4 and R5 have been selected so that circuit operation is not initiated by noise pulses. The positive output trigger from common-base amplifier Q2 is passed into the 1-2 primary winding of pulse transformer T1. The 3-4 secondary winding of transformer T1 is poled to produce a positive-going trigger that is fed back to the emitter of transistor Q2. Transistor Q2 is driven into saturation. The core of transformer T1 saturates, at which time increasing the primary current only produces a constant magnetic field. As the magnetic flux collapses, a negative-going pulse is generated in the 3-4 secondary winding of transformer T1. This negative pulse now reverse-biases Q2, thus driving it into cutoff. Diode CR2 is forward biased in the presence of this negative-going pulse. Diode CR2 aids in decreasing the reset time of transistor Q2 and also prevents negative pulses from being conducted back into transistor Q1. Transistor Q2 is immediately driven into cutoff. The magnetic field of transformer T1 is reversed; however, diode CR3 now becomes forward-biased, thus connecting resistor R6 across the primary winding of transformer T1. Resistor R6, diode CR3, and capacitor C9 act together to suppress any tendency to produce negative-going transients and increase circuit operate time. The pi network consisting of resistors and diodes across the 5-6 and 7-8 secondary windings is also a negative transient suppression circuit. Capacitor C4 and resistor R8 forms a filter network and an ac return for the 3-4 secondary winding of transformer T1. Resistor R7 provides the path for the dc return circuit at this point.

h. SCR Inverter. The input power from the battery or other dc source is applied to the Klystron power supply at terminal 5 (negative) and terminal 4 (positive ground). The positive ground line is passed through reactor L2 to the anode of silicon-controlled rectifiers Q5 and Q6. The negative line is passed through inductor L6, fuse F1, and interlock switches S1 through S3 to the cathodes of silicon-controlled rectifiers Q7 and Q8. As shown in figure 6-73, silicon-controlled rectifiers Q5 through Q8 are connected in a bridge arrangement. Transformer winding A3T1 and A3T2 are the 5-6 and 7-8 secondary windings of transformers T1 and T2 on the SCR trigger card (figure 6-73). When a trigger is developed in transformer T1, the 5-6 winding delivers a trigger pulse to rectifier Q5 while the 7-8 winding delivers a trigger pulse to rectifier Q8.

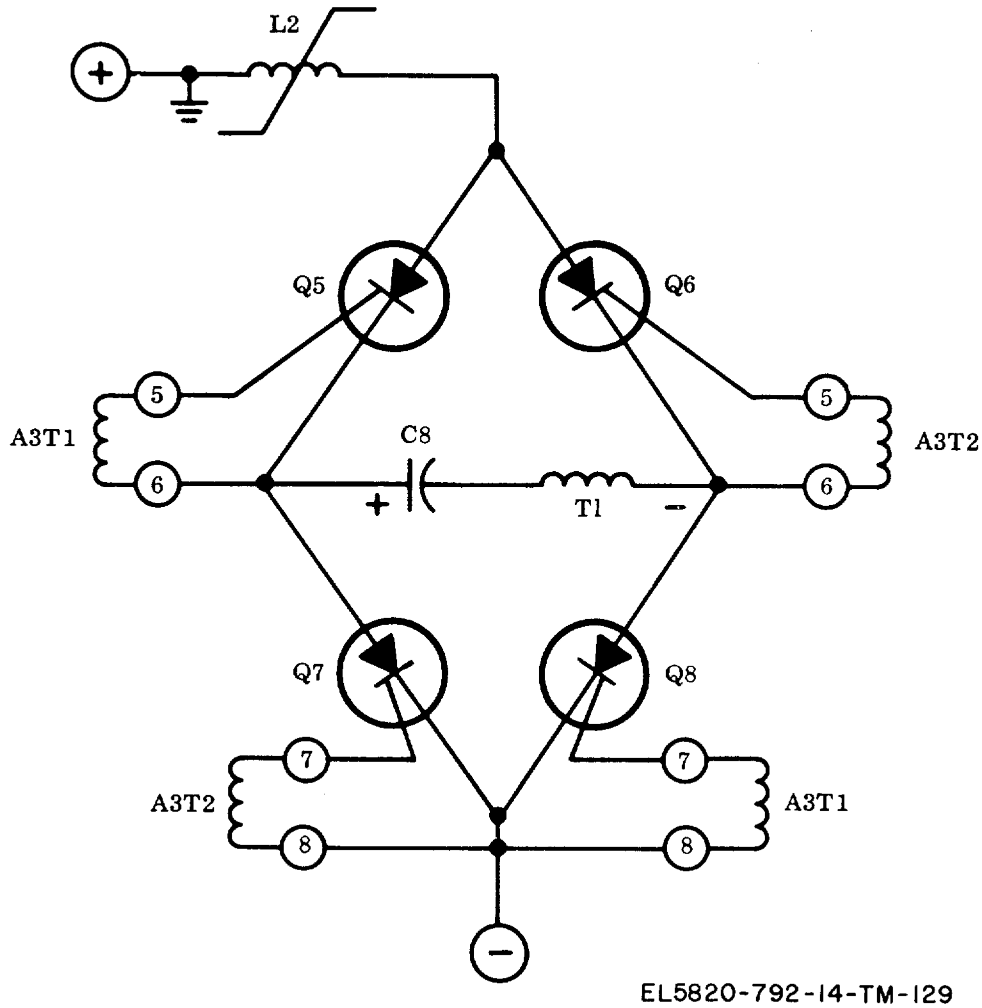


Figure 6-73. Silicon-controlled rectifier bridge, simplified schematic diagram.

i. Triggering. The trigger pulse drives rectifiers Q8 and Q5 into conduction, completing the dc path through the circuit, with the exception of capacitor C8. The bridge therefore does not direct current; only the trigger current is used to energize transformer T1. The problem of turning the silicon-controlled rectifiers off is accomplished by saturable reactor L2. As the charging current of capacitor C8 increases, circuit current through inductor L2 increases until the core is driven into saturation. At this time, further increases in inductor current no longer produce any change in voltage across the inductor. As the magnetic flux collapses, it produces a voltage of opposite polarity across the inductor. At this time, a negative pulse is generated in L2 which reverse biases the anode of Q5. Silicon-controlled rectifiers Q5 and Q8 are now turned off. Transistors Q5 and Q8 must be turned off before receipt of a new trigger pulse turning silicon-controlled rectifiers Q6 and Q7 on; otherwise, all rectifiers are turned on at the same time, creating a short circuit condition which will destroy the rectifier units. The next trigger pulse, which is developed in the 5-6 and 7-8 windings of trigger transformer A3T2, turns rectifiers Q6 and Q7 on. The charging path through capacitor C8 is now reversed. Turn-off of rectifiers Q6 and Q7 is accomplished in the same fashion as previously described. The action of the inverter, is to produce a square-wave signal in the primary winding 1-2 of inverter transformer T1. This ac signal is transferred into the secondary windings of T1 to drive the output converters, that is, the 750 volt, 120-volt, and 6.0 volt sections of the Klystron power supply.

j. Beam Section. The square wave signal present in the primary of transformer T1 is coupled into the 3-4 secondary winding, and is rectified by full-wave bridge rectifiers CR16 through CR19. The pulsating dc voltage is passed into a two-section capacitor-input filter consisting of C15, C16, and L3A in one section and C17-L3B in the second section. Note that the dc output of the 750-volt section is tapped off at the junction of C15, C16, and L3A for the control of the amplifier-comparator and voltage-controlled multivibrator circuits. The high voltage output of this section is passed through another inductor, L5, before delivery to the TB2-3 (negative) and TB2-8 (positive) output terminals of the Klystron power supply. A high-voltage bleeder network is connected across the 750-volt section from the junction of L3B and L5 to the positive side of the line. At the junction of bleeder resistors R33 and R32, a tap is provided to TB1-8 which is terminated in a meter panel to monitor the output of the 750-volt section.

k. 120 V Section. The square wave signal present in the primary of transformer T1 is coupled into the 7-8 secondary winding, and is rectified by full-wave bridge rectifiers CR8 through CR11. Capacitor CR13 performs the initial filtering of the pulsating dc output. Reference to figure 6-75 shows that differential amplifier Q3 performs the comparison between the regulator output voltage and the reference supply. Transistor Q2 and associated circuits provide overcurrent protection for the 120-volt regulator. Transistor Q1 and external transistor Q12 are the control and series transistors, respectively. Capacitor C3 is an output bypass unit performing final filtering of the 120-volt section. Variations in regulator output voltage are sensed across the resistor network consisting of R9 through R11. Potentiometer R10 is used to adjust the regulator output voltage to the desired value. Resistor R9 limits the high voltage adjustment of potentiometer R10, and resistor R11 limits the low voltage adjustment.

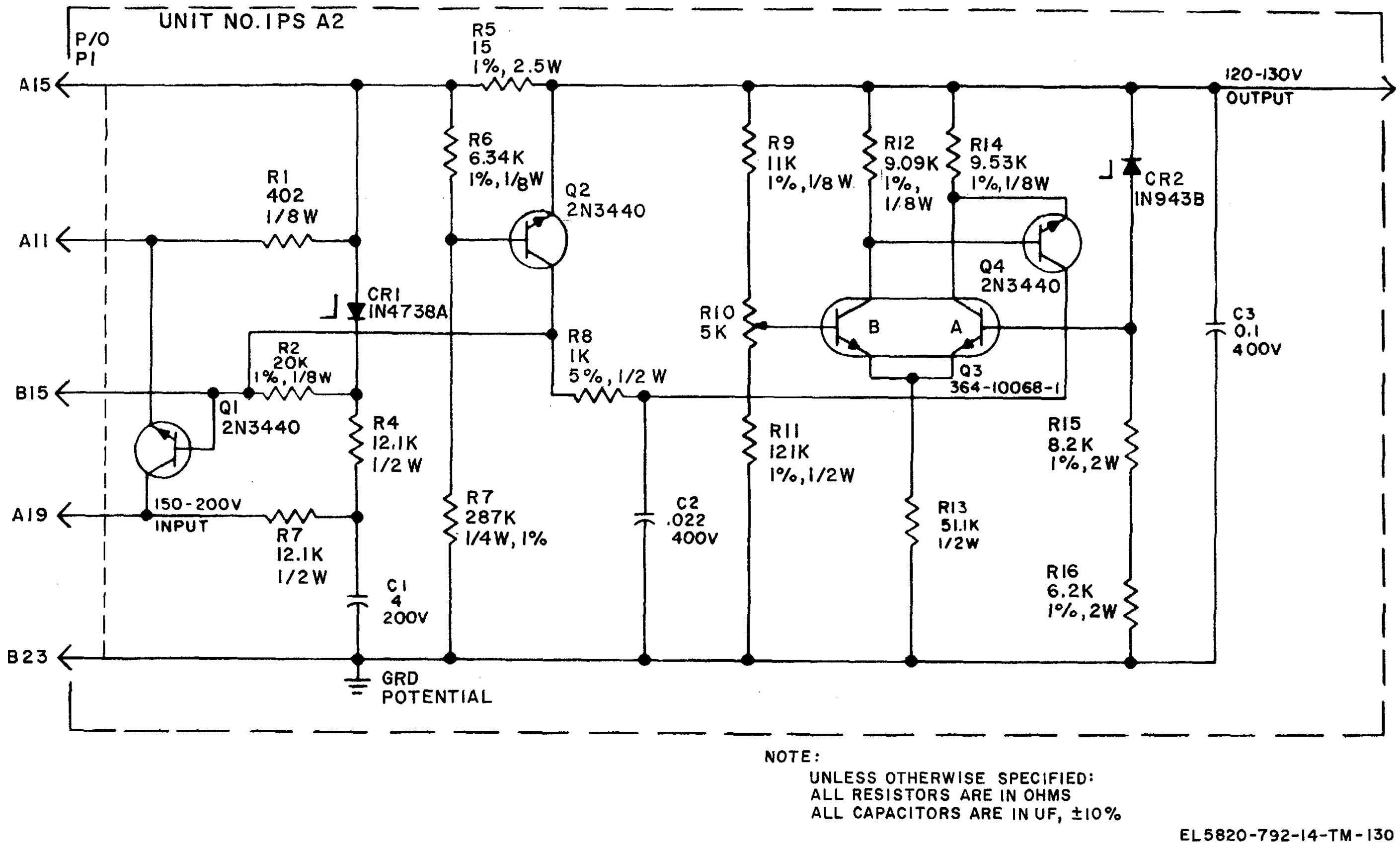


Figure 6-74. 120 V regulator, A2, schematic diagram.

i. Reference Circuit. The reference circuit in the 120 V regulator (A2) consists of Zener diode CR2 and resistors R15 and R16; the drop across diode CR2 is 11.2 volts. Investigation of the differential load resistors R12 and R14 shows that their resistances are not .equal; however, the emitter current through resistor R13 is constant. If the regulated output voltage has a tendency to decrease, base and emitter currents through the sensing side of transistor Q3 decreases. Emitter current through the reference side of transistor Q3 increases correspondingly. Accounting for collector currents through load resistors R12 and R14 under these conditions shows that the base current through bridging transistor Q4 decreases. Decreasing collector current through transistor Q4 is passed through resistor R8 into the base circuit of series control transistor Q1. The base circuit of transistor Q1 receives two input signals. The first input signal is received from the differential amplifier Q3 and Q4. Decreasing collector current from transistor Q4 yields a decreasing base current into control transistor Q1. Emitter current flowing into control transistor Q1 decreases with decreasing base current; the decreasing voltage drop across resistor R1 means that the base voltage of series transistor Q12 becomes more positive. Base current and collector current through transistor Q12 increases to produce a corresponding decrease in collector-to-emitter resistance. The collector-to-emitter voltage decreases and the redistribution of voltage drops around the circuit places an increasing voltage across the load. Resistor R5 is a current sensing circuit element used to drive the overcurrent protection circuit. Resistors R6 and R7 make up the base bias circuit for transistor Q2. Under normal operating conditions, a difference of potential exists across resistor R5; however, the junction of resistors R5 and R6 is held at a constant voltage by the action of the voltage regulator. Hence, the emitter of transistor Q2 is held negative with respect to its base so that a certain amount of collector current passes through Q2; this current is passed directly into the base of control transistor Q1. A balanced condition is established between the voltage regulator and overcurrent protection circuit to provide normal regulated output voltage. When load current becomes excessive, the emitter of transistor Q2 becomes highly negative. Increased base and collector current flows through transistor Q2. Base and emitter currents through transistor Q1 increase. The voltage drops across resistor R1 increases, thereby driving the base of transistor Q12 more negative. The collector-to emitter voltage across series transistor Q12 increases with a resulting decrease in regulator output voltage. At the same time, the increased collector current through transistor Q2 produces an increased current flow through resistors R2, R3, and R4. The result is that the anode voltage of Zener diode CR1 is going in the negative direction while its cathode voltage is becoming more positive. If the overload condition persists beyond the charge time of capacitor C1 and resistor R3, diode CR1 goes out of regulation. When this happens, the base of transistor Q1: becomes positive enough to reach saturation. The increasing voltage across resistor R1 drives the base of series-pass transistor Q12 into cutoff, whereupon both load voltage and load current are reduced to near zero until the excessive load condition is cleared. This circuit is self-resetting. Resistors R26 and R27 form a bleeder network across the output of the 120-volt section (fig. FO-31). The junction of R26 and R27 is brought out to external terminal TB1-6 which is terminated in a meter panel to monitor the output of the 120-volt section.

m. Filament Section. The square wave signal present in the primary of transformer T1 is transferred into the 5-6 secondary winding, and is rectified by full-wave bridge rectifiers CR12 through CR15. Capacitor C14 performs the initial filtering of the pulsating dc output. Figure 6-75 shows the voltage regulator (A4) and overcurrent protection circuit of the regulator card. The voltage regulator circuit uses a differential amplifier with Q5 as the voltage reference unit and Q4 as the regulator sensing unit. Potentiometer R6 is adjusted to provide the correct output level. Assuming a decrease in regulator output voltage, the base voltage of transistor Q4 becomes more negative. The emitter voltage of transistor Q4 cannot change, however, since a constant current is drawn through resistor R9. Base and collector current through transistor Q4 increases, thereby causing the voltage drop across load resistor R8 to become more positive. Base current drawn through emitter resistor R2, the emitter-to-base junction of transistor Q2, and resistor R3 increases to produce a larger collector current through transistor Q2. The collector current of Q2 becomes the base current of transistor Q1. Transistor Q1 mounted on the 6.0 volt regulator card and externally mounted transistor Q13 are Darlington connected series transistors. Increasing the base current into transistor Q1 increases collector current through series transistor Q13, and effectively reduces its collector-to-emitter resistance. The output load voltage is increased by the same amount as the decrease in collector-to-emitter voltage across transistor Q13. Overcurrent protection is provided by transistor Q3. Resistor R3 is in series with the load. The end of resistor R3 connected to the base of transistor Q3 is held at a fixed voltage because of the voltage regulator circuit; therefore, excessive load current drives the emitter of transistor Q3 negative with respect to its base. Collector current through transistor Q3 and its load resistance, R1, rises. The collector of transistor Q3 is directly connected to the base of transistor Q1. The junction of R1, Q1, and Q3 becomes more negative with rising collector current through resistor R2 so that base current normally fed into transistor Q1 is diverted through resistor R1. Decreasing base current into transistor Q1 yields an increasing collector-to-emitter voltage across transistor Q13, with a corresponding decrease in output load voltage. The voltage regulator will act to counteract this effect, but if the output load current is great enough, output voltage of the 6-volt section is reduced as long as the excessive current condition persists.

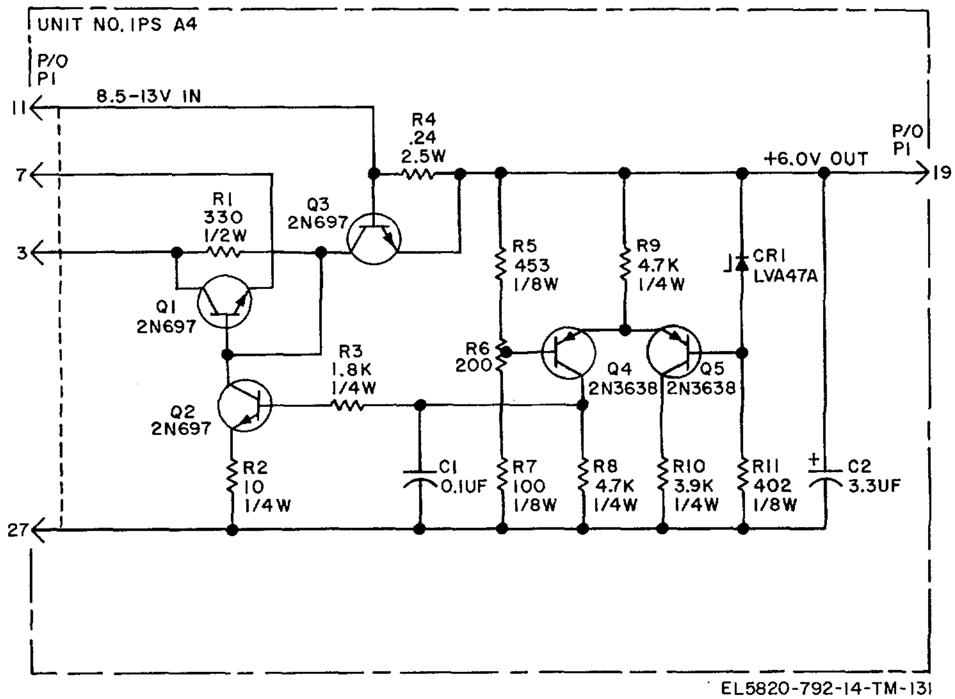


Figure 6-75. 6-volt regulator, A4, schematic diagram.

n. Reflector Section. The reflector section (Al) of the power supply includes a voltage regulator which is subject to AFC requirements, a dc-to-ac inverter, a 450-volt output supply, and a 10-volt output control supply. A simplified schematic diagram of interrelationship between the regulated output circuit and the AFC circuit is shown in figure 6-76; the complete schematic diagram of the 450-volt section is shown in figure FO-33. Operating potentials placed on the integrated circuit module MD1 are considered first. Pin 8 of the module is connected directly to the positive ground of the 48-volt battery. Pin 4 of the module is returned through resistor R11 to the negative side of the 48-volt battery to provide a maximum of 18 volts for module operation. (Note that the module is connected across the 48-volt source ahead of the regulator circuits.) Pin 1 of the module is the return pin of the integrated circuit. Capacitor C5 is used to bypass undesirable noise of the 48-volt power source so that it will not affect MD1 performance. The automatic frequency control voltage is essentially a dc voltage which can assume polar characteristics. It is because of the polar excursions of the AFC voltage that the AFC line cannot be connected in common with one side with the 48-volt source by means of a voltage divider consisting of resistor R11 and Zener diodes CR2 and CR3. Capacitor C3 is a noise bypass unit.

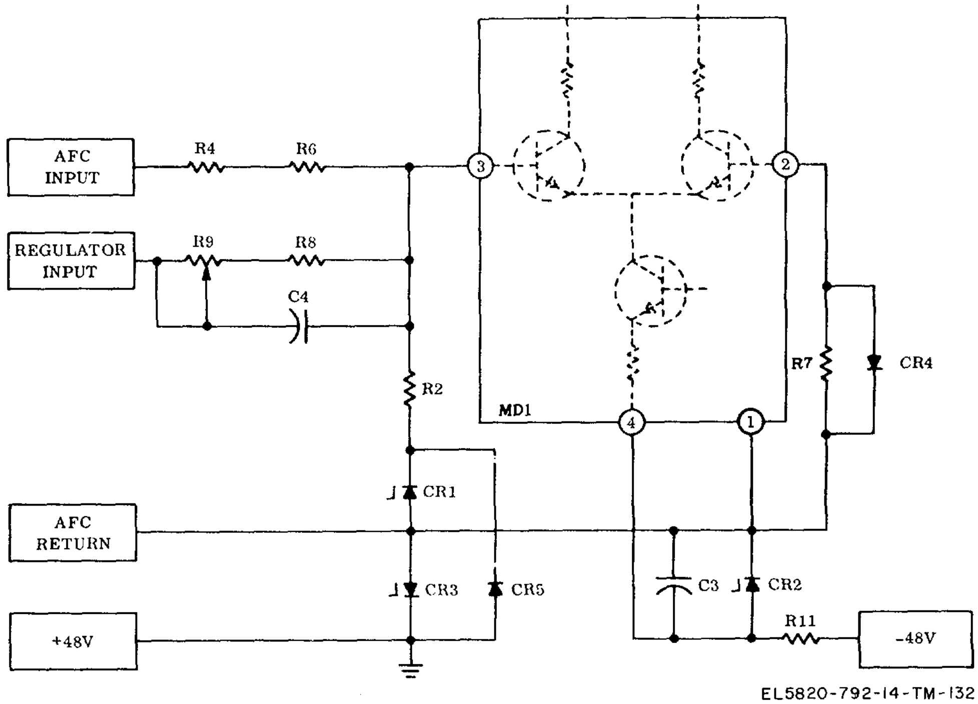


Figure 6-76. Voltage regulator AFC control, simplified schematic diagram.

o. Voltage Divider. A voltage divider across the regulated voltage output is shown in figure 6-76. This divider is connected from the negative output of the regulator through potentiometer R9, resistors R8 and R2, and diode CR5 to the positive ground of the battery source. However, the output of the regulator must be modulated by the AFC voltage, so the regulator output line is connected to the AFC return line through Zener diode CR1. A voltage divider across the AFC line is also shown in figure 6-76. This divider consists of resistors R4, R6, and R2, and Zener diode CR1. The AFC circuit shares resistor R2 in common with the regulator output circuit. The more rapid variations occurring in the regulated output voltage are routed around resistor R8 to the junction of resistors R6, R8, and R2 by capacitor C4; this junction, then, is the input circuit at pin 3 to one side of a differential amplifier within module MD1. The purpose of diode CR4 is to prevent latching of the amplifier if it becomes saturated in a positive or a negative direction (figure 6-77). Resistor R7 is a balancing resistor which adjusts zero current into pin 3 by unbalancing pin 2 circuits. The series network consisting of capacitor C6 and resistor R12 is connected to the lag terminal 6 of module MD1 for frequency response compensation; the lead terminal 5 is not used.

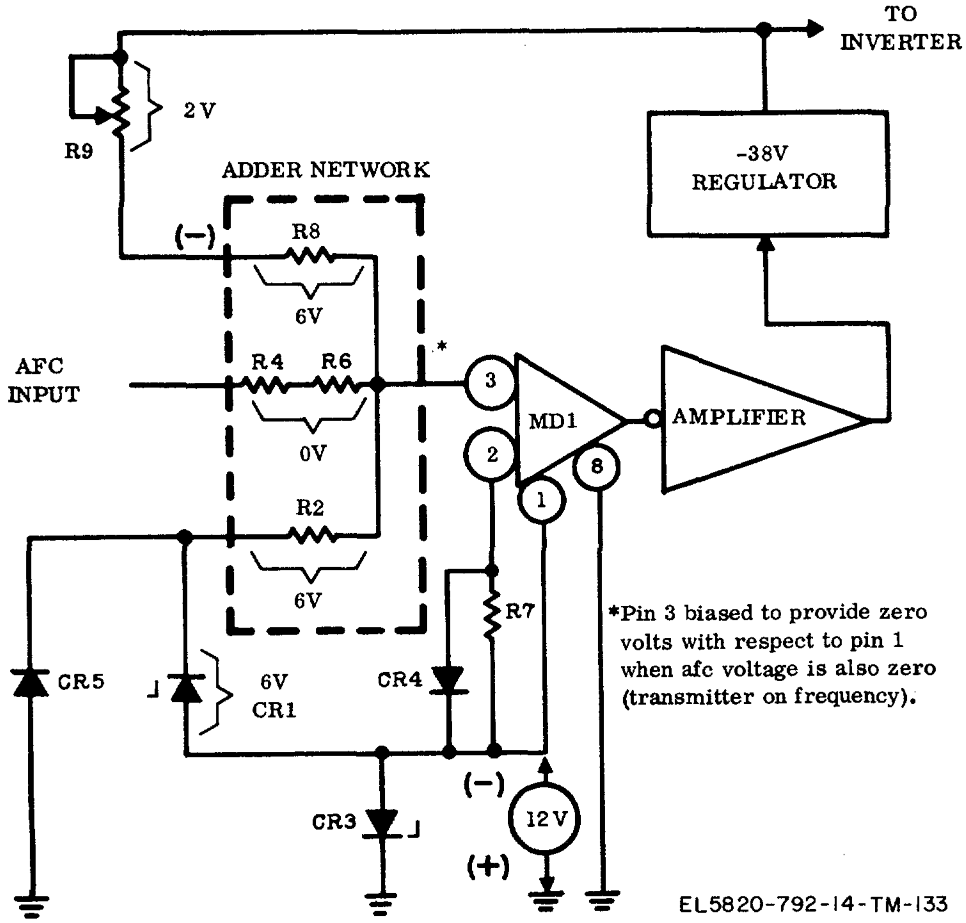


Figure 6-77. AFC control, simplified schematic diagram.

p. AFC Voltage. Assume that the AFC input voltage to the 450-volt section is zero. A positive reference voltage is developed by CR1 and applied to the noninverting input terminal 3 through resistor R2. The negative output voltage of the regulator is also applied to the noninverting input terminal 3 through resistors R8 and the voltage output adjustment potentiometer R9. The differential amplifier in MD1 responds to the voltage that is applied between terminal 3 and terminal 1. The amplifier drives the -38 volt regulator until the feedback voltage causes the voltage between terminal 3 and 1 to go to zero. The output voltage of the regulator is modulated by introducing another voltage between terminal 3 and 1 of MD1 through resistors R4 and R6. Pin 3 is the noninverting connection into the integrated circuit module MD1, which means that a decreasing regulator current produces a decreasing module output current into the base of transistor Q3. If the AFC voltage increases in the positive direction, the AFC current through resistor R2 opposes regulator current through the 6-136 same resistor. A more positive voltage exists at pin 3 of the module, MD1. The output current from module pin 7 increases the base drive into transistor Q3 above the value when the AFC voltage is zero. If the AFC voltage increases in the negative direction, the AFC current through resistor R2 aids the regulator current. The output current from module pin 7 decreases the base drive into transistor Q3 below the value when the AFC voltage is zero. Inspection of the schematic diagram (fig. FO-33) shows that base bias current is pulled through the emitter-to-base junction of transistor Q4 by means of field-effect transistor Q2 arranged as a constant current generator. Resistor R10 sets the current level through transistor Q2 Transistor Q3 and its associated circuit acts as the remaining leg of the Q4 biasing network. Note that the emitter of transistor Q3 is returned to the AFC return line. Assume that the output current from the integrated circuit module has decreased. Collector current through transistor Q3 decreases and transistor Q2 is forced to pull a larger amount of its constant current through-the emitter-to-base junction of transistor Q4. Collector as well as emitter currents through Q4 must also increase. The rise in emitter current through resistor R16 drives the base of transistor Q1 more negative. Transistor Q1 also passes more collector current. The collector-to-emitter resistances of transistors Q1 and Q4 decreases, thus permitting an increased output voltage at the output of the regulator to be taken from the battery source. The overall reaction of the regulator acts to increase the output voltage to maintain a constant output voltage. Conversely, if the regulated output voltage tends to increase, the regulator acts to decrease the output voltage to maintain a constant output voltage. If the AFC voltage is zero volts, the action of the regulator is unchanged from the previous discussion. When the AFC voltage becomes negative, the regulator acts to increase the output voltage; and, conversely, when the AFC voltage becomes positive, the regulator acts to decrease the output voltage. Interaction between the AFC and regulator input voltages is continually balancing the 450-volt supply; the reaction time of the supply to either of these inputs is very slow. Capacitors AiC12 and A1C13, and resistor A1R8 control regulator phase response time. Resistor R7 controls the attenuation of signal amplitude to compensate for high gain in the AFC loop. Capacitor C7 provides oscillator suppression of the regulator.

q. Overcurrent Protection. Overcurrent protection is provided by transistor Q5 and its associated circuitry. Assuming that excessive current is taken from the regulator, the voltage drop across resistor R17 biases transistor Q5 into conduction. Collector current through transistor Q5 passes through resistor R14 into the base-to-emitter junction of Q3. Increasing collector current through Q3 pulls more of the available current from constant-current generator Q3, resulting in decreasing base current into transistor Q4. The collector-to-emitter resistance of transistors Q4 and Q1 increases to lower the regulated output voltage. If an excessive current persists, which is greater than the capability of the voltage regulator, the overcurrent protection circuit prevails, and the regulator output voltage is reduced to a very low value. Capacitor C2 is a feed-through unit which permits the passage of the dc supply current into the 450-volt section through a chassis compartment wall, while suppressing high frequency transients from the SCR switching circuits. Resistor R1 and capacitor C1 form a decoupling network across the battery supply. Capacitors C1 and C11, associated with the AFC input line, are also feed-through capacitors; these units pass the low frequency signals while preventing high frequency transients from entering the AFC module. Capacitors C12 and C13, with resistor R8, form a filter network across the AFC input line; notice the polarity of the two capacitive units to maintain constant impedance despite polarity reversals of the AFC signal. The output of the 450-volt regulator is passed through feed-through capacitor C10 to A1TBi-3 of the 450-volt section and TB2-1 of the Klystron power supply to an external meter. The dc level, at this point, ranges from --38 to --47 volts, depending upon the AFC level and polarity. This dc voltage, then, is an indirect measure of transmitter output frequency. The output voltage of the 450-volt regulator is passed through inductor L1 and capacitor C1 to prevent switching transients of the dc-to-ac inverter from entering the regulator circuits.

r. Saturable Core Transformer. Transformer T1 is a saturable core device having one primary winding and two secondary windings. Notice that the transistor and transformer circuits are the same for transistors Q2 and Q3; therefore, only one transistor circuit, Q2, is described in detail. When the inverter is initially energized, the applied dc voltage is dropped across -the 3-2-1 winding of transformer T1 and resistors R2 and R1. A second path is established across the 3-2 winding of transformer T1, the emitter-to-base junction of transistor Q2, and the resistor. These two dc paths establish the dc bias for transistor Q2. As collector current through -transistor Q2 increases, the magnet flux linking expanding in the 3-2 winding induces an increasing voltage across the 2-1 winding of T1. The increasing voltage across winding 2-1 is shunted around resistor R2 and directly into the base of-transistor Q2, driving this amplifier deeper into conduction. Primary current flows from terminal 5-to-terminal 1, resulting in transistor Q3 being driven-toward its cutoff point. When-the core of-transformer T1 saturates, core magnetization remains constant, and the magnetic flux collapses. The collapsing field across the 2-1 transformer winding reverses polarity which, coupled through capacitor C3 to the base of transistor Q2, reduces collector current through Q2. Transistor Q3 begins conduction, with the end result that transistor Q2 is operating near cutoff, and primary current flows from terminal 1 to terminal 5. The cycle repeats itself as long as the dc input voltage is applied. The square-wave voltage across-the 6-7 winding of transformer T1 is shaped by the network consisting of resistor R5 and capacitor C6, and is then rectified by diodes CR1 through CR4. After filtering, the 450-volt output is passed along feedthrough capacitors C8 and C9 to external Klystron power supply terminals TB2-2 and TB23. The square-wave voltage across the 6-8 winding of transformer T1 is rectified by full-wave bridge rectifier diodes CR1 through CR4. The output voltage of this rectifier is regulated at 10 volts by Zener diode CR5 and capacitor C7, current limited to 2 milliamperes by resistor R6, and sent via A1TB1-4 and A1TB1-5 to the time delay relay circuits.

s. Sequential Control Turn On. The following discussion is based on the overall schematic diagram (fig. FO-31). Direct current from the 48volt battery or other suitable source at TB1-5 flows through the circuit consisting of inductor L6, fuse Fl, interlock switches S1, S2, and S3, and main power switch S4 to A1TB1-1 of the reflector section. The dc return circuit is made from A1TBI-6 of the reflector section to ground, and from ground through power supply terminal TB1-4 to the 48-volt battery. When the main power switch is set to its on position, switch contacts S4-1 and S4-3 are broken while switch contacts S4-4 and S4-5 are made. Battery power is immediately applied directly to the reflector section. Battery power applied through feedthrough capacitor C5, diode CR20, and resistor R7 is applied to the voltage-controlled multivibrator. Diode CR20 insures that positive going spikes do not pass into the voltage controlled multivibrator. The battery voltage is further reduced and regulated by the network consisting of capacitor C7, resistor R21, and Zener diode CR7. When-the reflector section reaches stable operation, 10 volts obtained from A1TB1-4 and A1TB1-5 are applied to time delay transistor Q3. The initial charge on capacitor C3 is zero, so most of the 10-volt output is used to charge capacitor C3 through resistor R9. Control transistor Q3 remains near cutoff. After a time interval of about 0.6 second, capacitor C3 is sufficiently charged to pass base current into transistor Q3. Collector current of Q3 flows through the coil of relay K1 and resistor R11 to the negative side of the battery. Contacts K1-3 and K1-1 are made when relay K1 is energized; these contacts are made in parallel with the 4 and 5 contacts of the main power switch. Contacts K1-4 and K1-6 are also made when relay K1 is energized. Recall that the amplifier-comparator and voltage-controlled multivibrator are energized. Since silicon-controlled rectifiers Q5 through Q8 are in-the blocked condition, the input 6-138 voltage to the amplifier-comparator is zero. The voltage-controlled multivibrator is operating at minimum duty-cycle at this time. The intermediated switches Q4 and Q9 are processing this signal into the SCR trigger assembly. It is very important that all of these units be operating properly before the end of the 100 ms additional time delay initiates conduction. After the contacts of relay K1 close, the capacitor, at zero charge, effectively shorts out resistors R2 and R3, and snap diode CR4 as it charges through resistors R4. When the capacitor reaches its charge level, the current through the diode suddenly switches on, pulling trigger current through resistor R3. Silicon-controlled rectifier Q2 conducts to turn on the SCR trigger circuits. Diode CR5 shunts any negative-going transients away from the silicon-controlled rectifier gate to prevent damage to Q2. The silicon-controlled rectifiers Q5 through Q8 are set into operation; however, they are being operated at a low duty cycle. During this time, the Klystron filament is permitted to reach its stable operating temperature. When the input voltage to the amplifier comparator reaches 800 volts, the voltage controlled multivibrator shifts to its operating duty cycle and acts to reduce the high-voltage output to 750 volts. The Klystron power supply is now fully operative.

t. Sequential Control Turn Off. When the main power switch is moved to the off position, the S4-4 and S4-5 switch contacts are opened. Relay contacts K1-1 and K1-3 remain closed at this time to insure that the Klystron beam in dissipated prior to removal of the reflector voltage. In addition, turn-off breaks the S4-1 and S4-2 contacts, immediately removing power from the SCR trigger circuits. Silicon-controlled rectifiers Q5 through Q8 become blocked, and power is removed from the 120-volt section, 6.0volt section, and 750-volt section. When switch S4 is turned-off, contacts 1 and 3 switch S4 are made; resistor R12 is connected in parallel with resistor R9 to hasten the decay of the 450-volt section. When capacitor C3 is discharged, transistor Q3 goes into cutoff, forcing relay K1 to deenergize. The contacts, K1-1 and K1-3, are broken to remove all power from the supply. The Klystron power supply is now completely shut down.

u. Transient Suppression. Most turn-on and turn-off transients are short-duration, high-power impulses. When silicon-controlled rectifiers Q5 through Q8 are switched off, the collapsing magnetic field around inductor L1 produces a positive-going transient which may have sufficient energy to destroy the rectifiers. This positive-going transient forward-biases diodes CR1 and CR3, and snap diode CR2. If the transient pulls enough current through snap diode CR2, the diode triggers on to pull gate current through the silicon-controlled rectifier Q1. Rectifier Q1 conducts, effectively placing resistor R6 in parallel with inductor L1. The transient is now bypassed around the choke.

v. Technical Characteristics.

Parameter	Specification
Primary power	43-56 V dc
450-volt section	
Adjustable minimum range	275 to 475 V dc
Load current	5µa at 450 V dc
Regulation (line)	±1 V dc
AFC gain (minimum)	20±5 volts per volt
120-volt section	
Adjustable range	110 to 130 V dc
Load current	160 ± 10 mA
Regulation (line and load)	± 1.2 V dc
6.0-volt section	
Adjustable range	5.5 to 7.0 V dc
Load current :	0.60 to 0.90 A
Regulation (line and load)	0.2 V dc
750-volt section	
Dc output voltage	700 to 800 V dc
Load current	75 mA
Regulation (line and load)	±5 V dc

6-45. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following subparagraphs contain procedures to test the performance of the major circuits and give probable causes of abnormal indications.

b. Test Equipment Setup. Connect test equipment to the Klystron power supply as shown in figure 6-78 *a*.

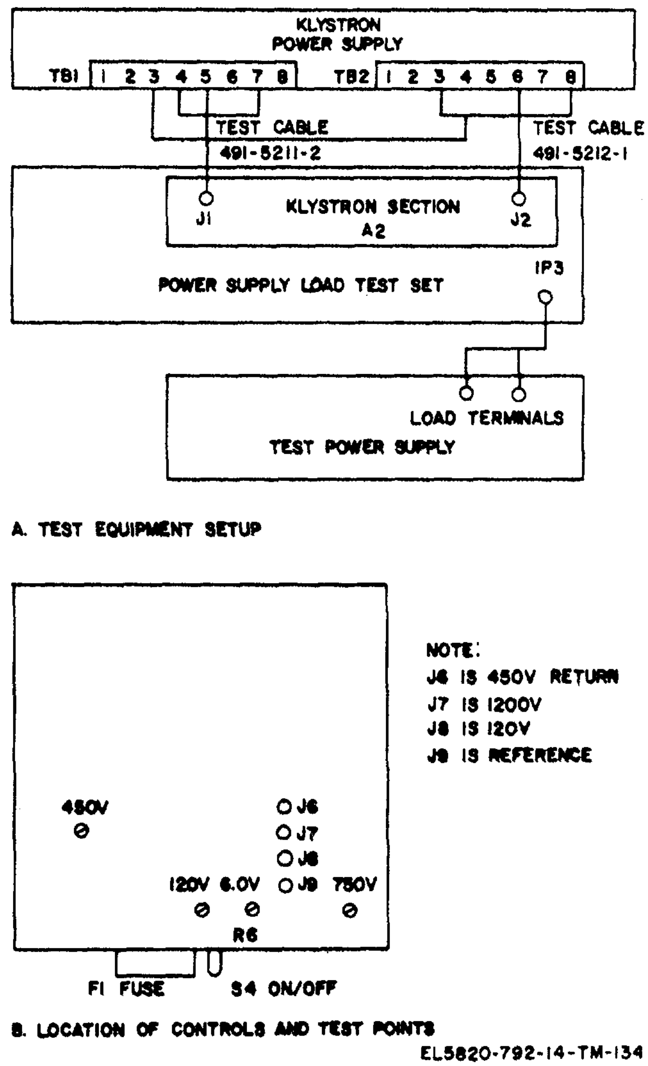


Figure 6-78. Klystron power supply, initial test equipment setup with control locations.

c. Preliminary Adjustments. Perform the following preliminary adjustments (fig. 6-79 through 6-94):

(1) Remove top cover and front panel from unit under test.

(2) Turn the ON-OFF switch to OFF, if not already in that position.

(3) Disconnect one of the two wires connected to the terminal mounted in the support bracket in back of the front panel.

(4) Connect a clip lead from one side of the fuse post to terminal 4 of the ON-OFF switch. This defeats the interlock switches to enable maintenance.

(5) Connect a clip lead between TB1-3 and TB2-8 to ground the positive side of the 750-volt supply.

(6) Turn on the power supply load test set and adjust the test power supply until the meter on the power supply load test set indicates 48V dc.

WARNING

Be extremely careful when measuring the 6-volt and 450-volt supplies as these voltages are referenced to 750-volts.

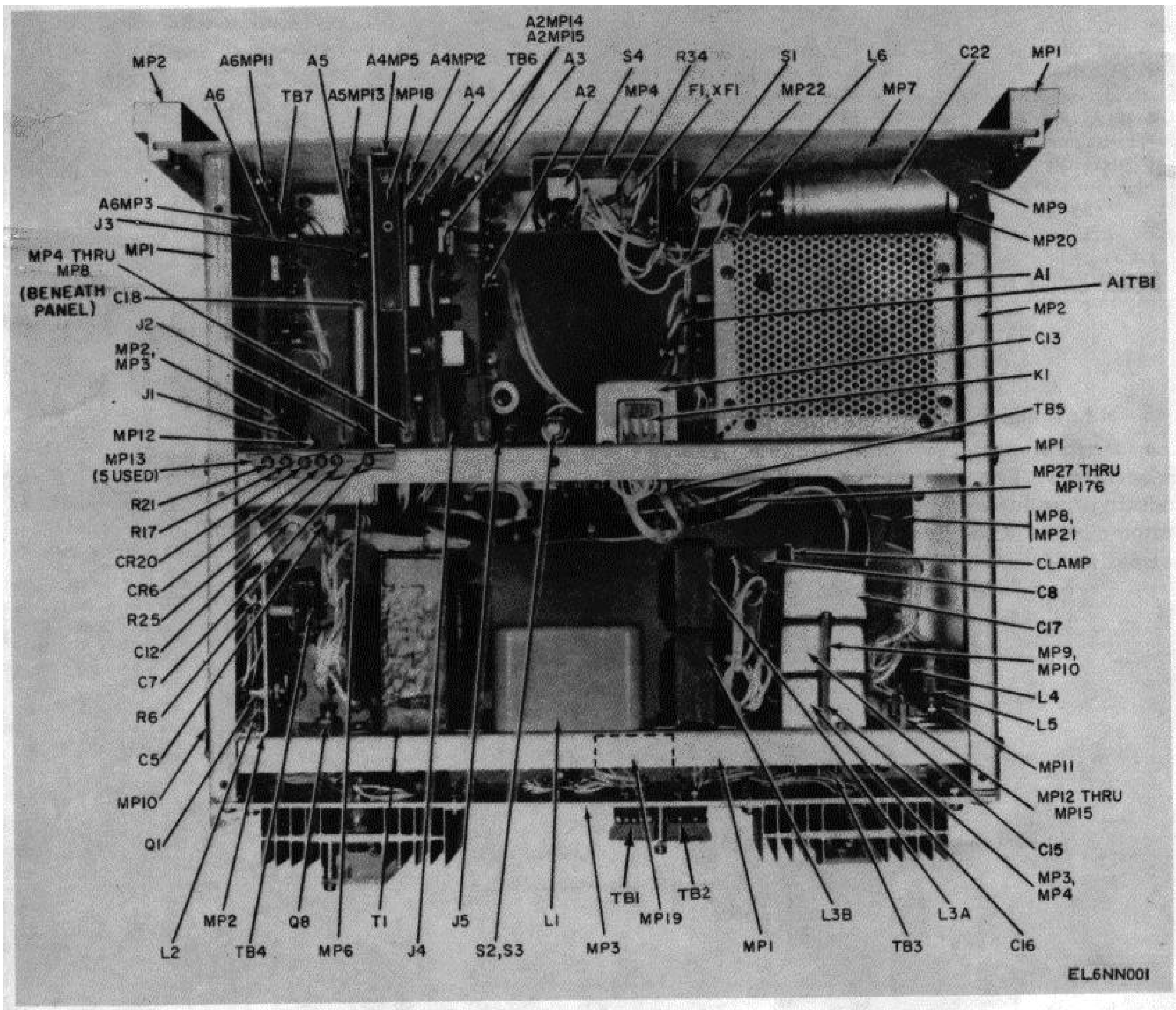


Figure 6-79. Klystron power supply, parts location diagram.

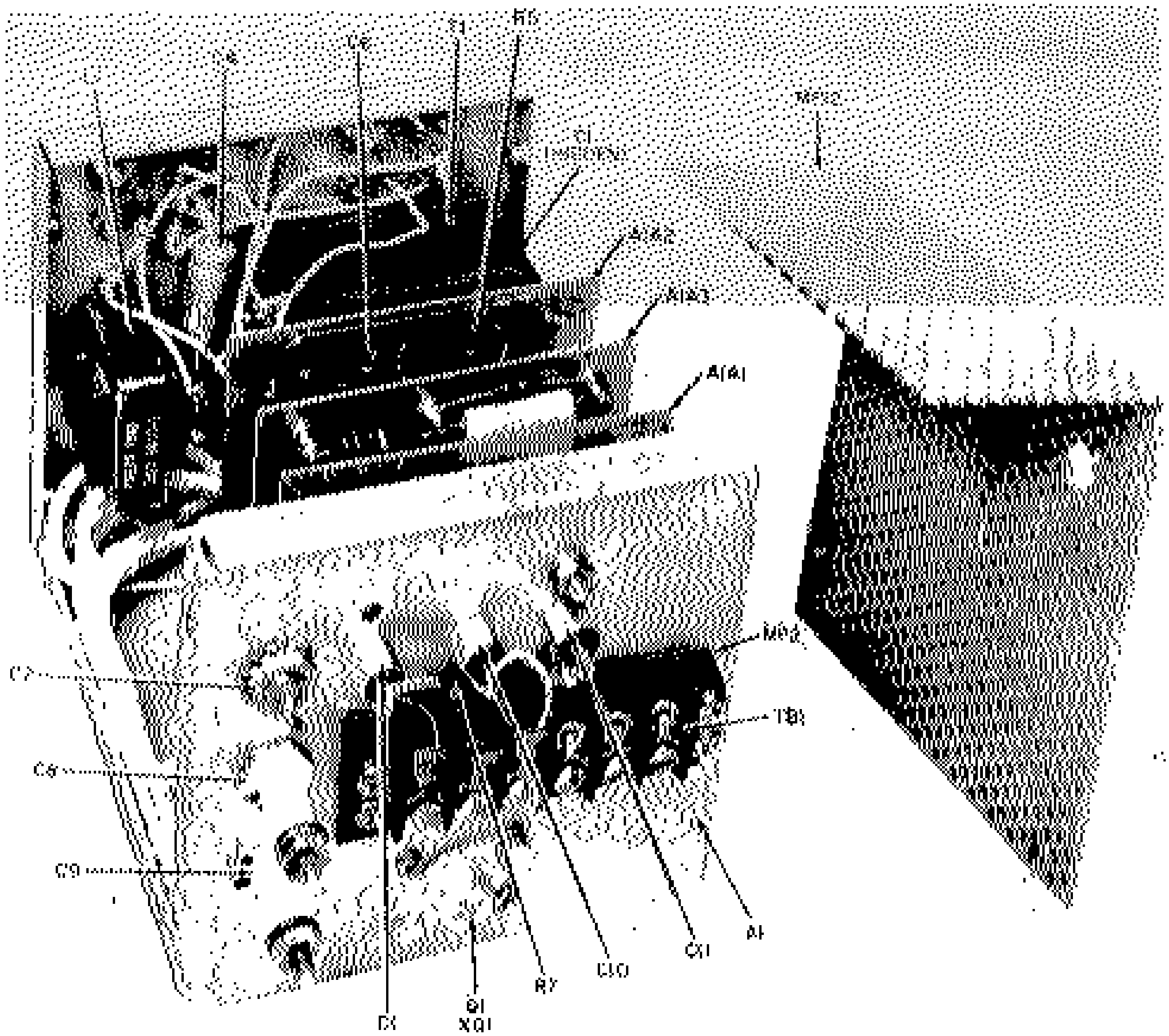


Figure 6-80(1). Reflector section (A1), parts location diagram (sheet 1 of 2).

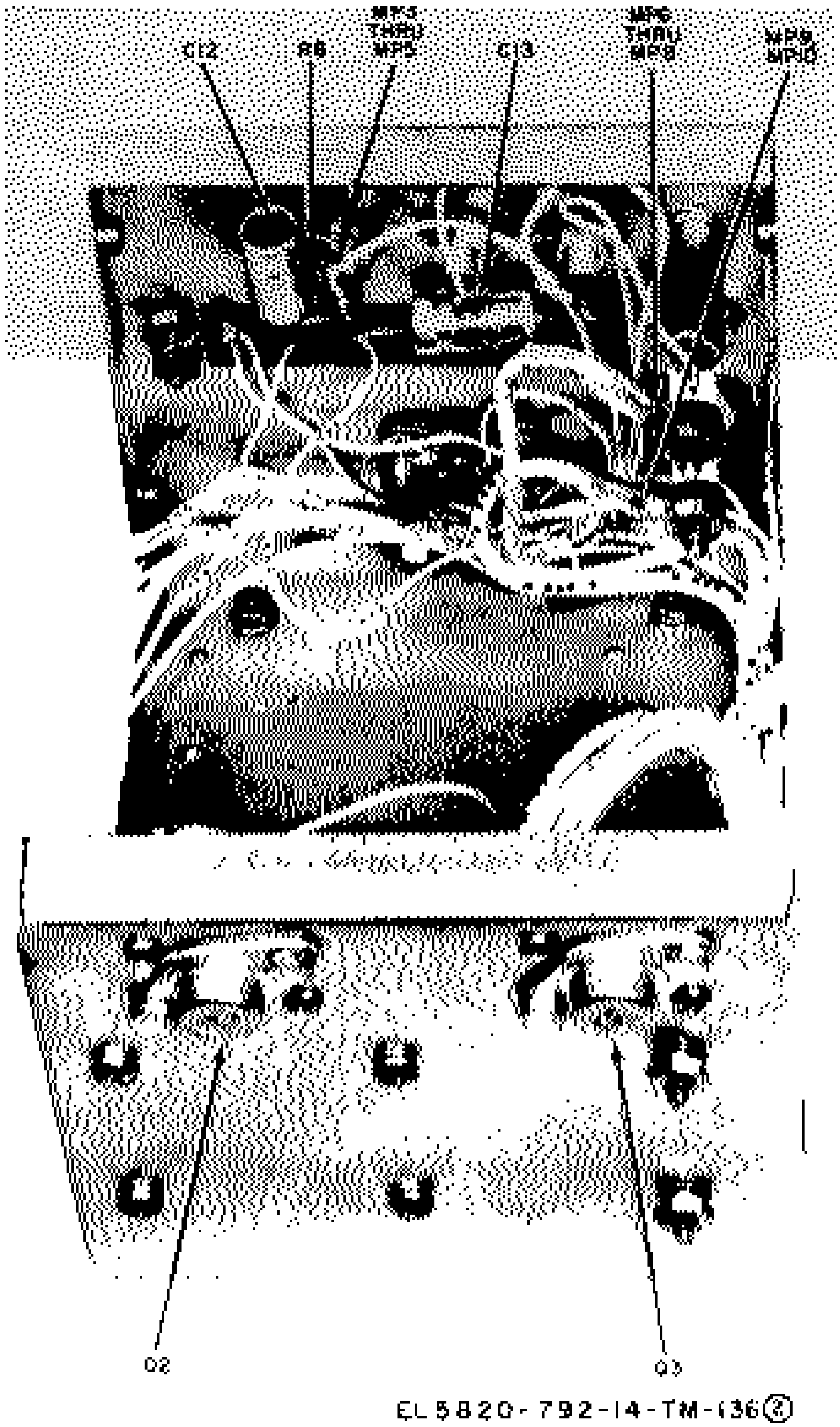


Figure 6-80(2). Reflector section (A1), parts location diagram (sheet 2 of 2).

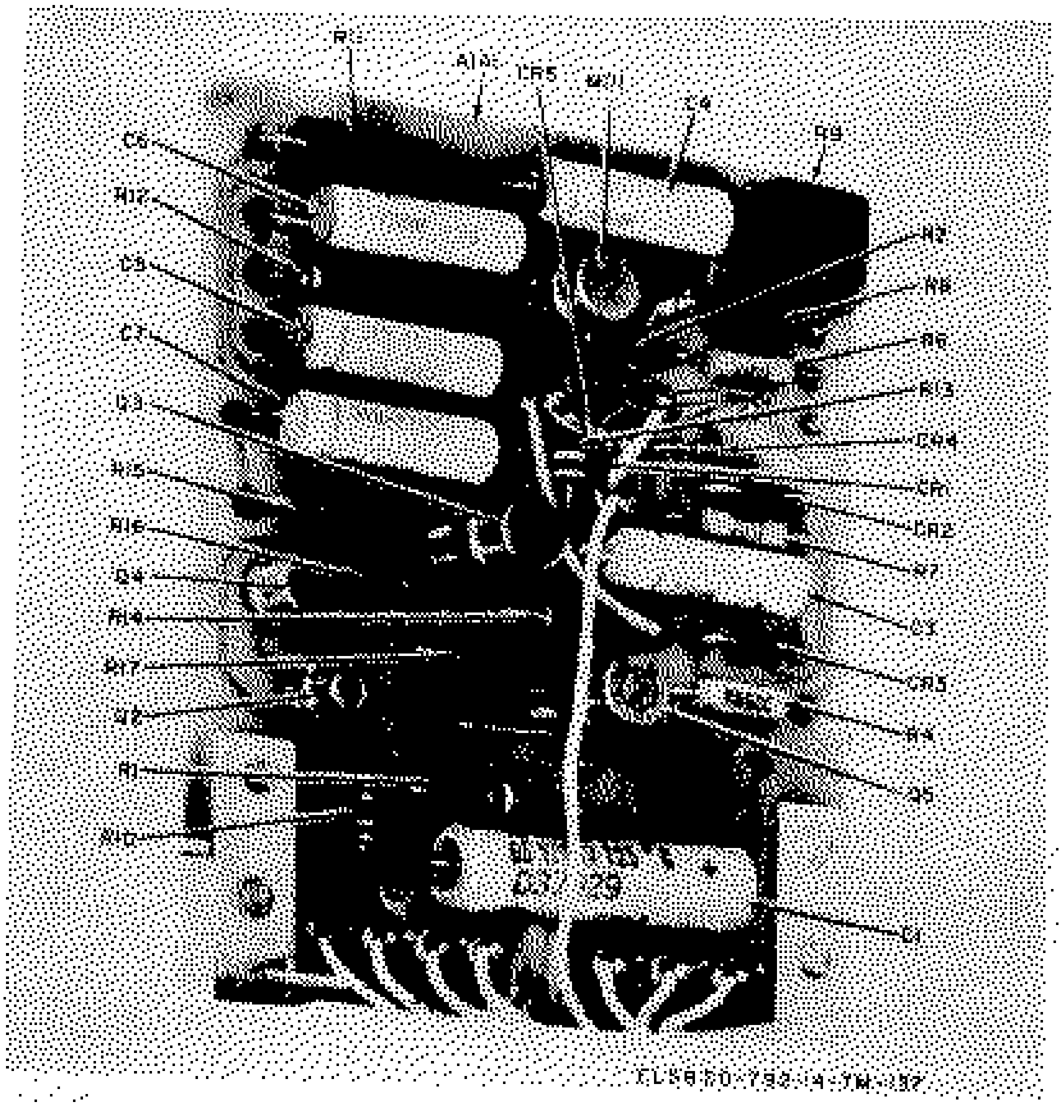


Figure 6-81. Printed circuit assembly (A1A1), parts location diagram.

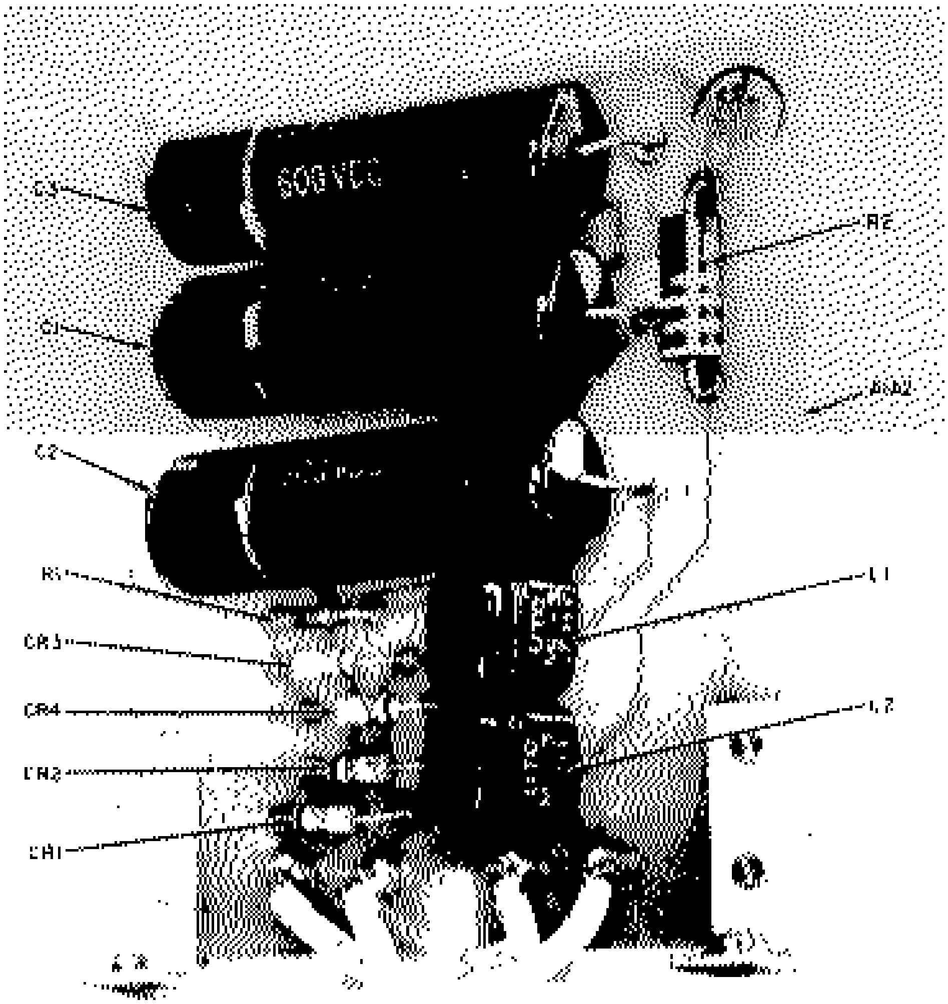


Figure 6-82. Printed circuit assembly (A1A2), parts location diagram.

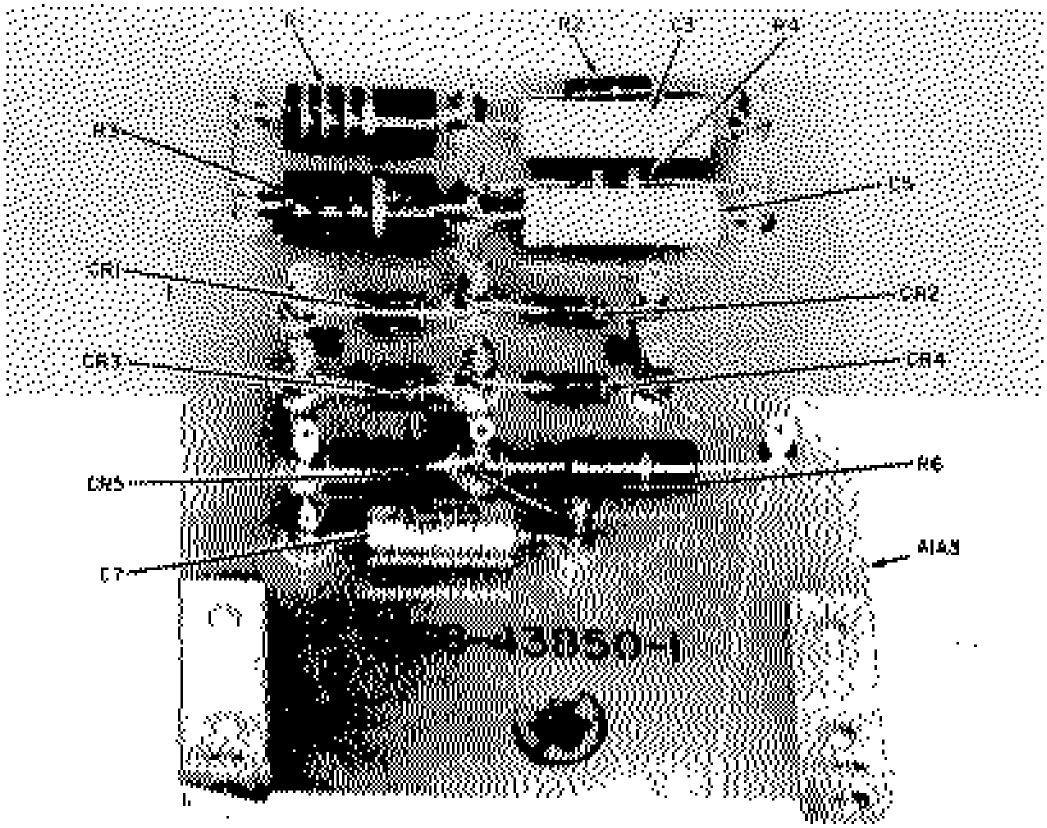


Figure 6-83. Terminal board assembly (A1A3), parts location diagram.

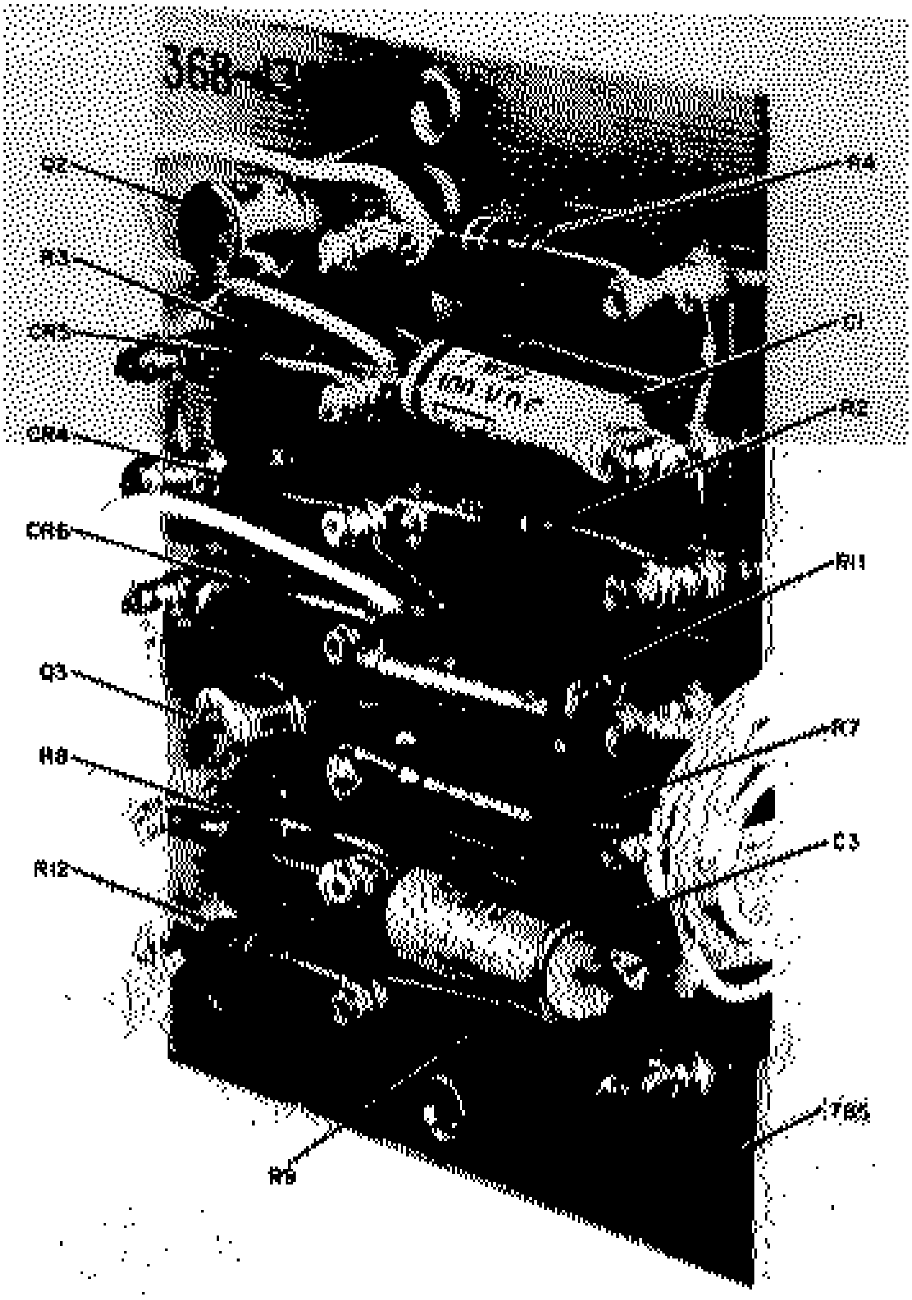


Figure 6-84. Terminal board assembly (TB5), parts location diagram.

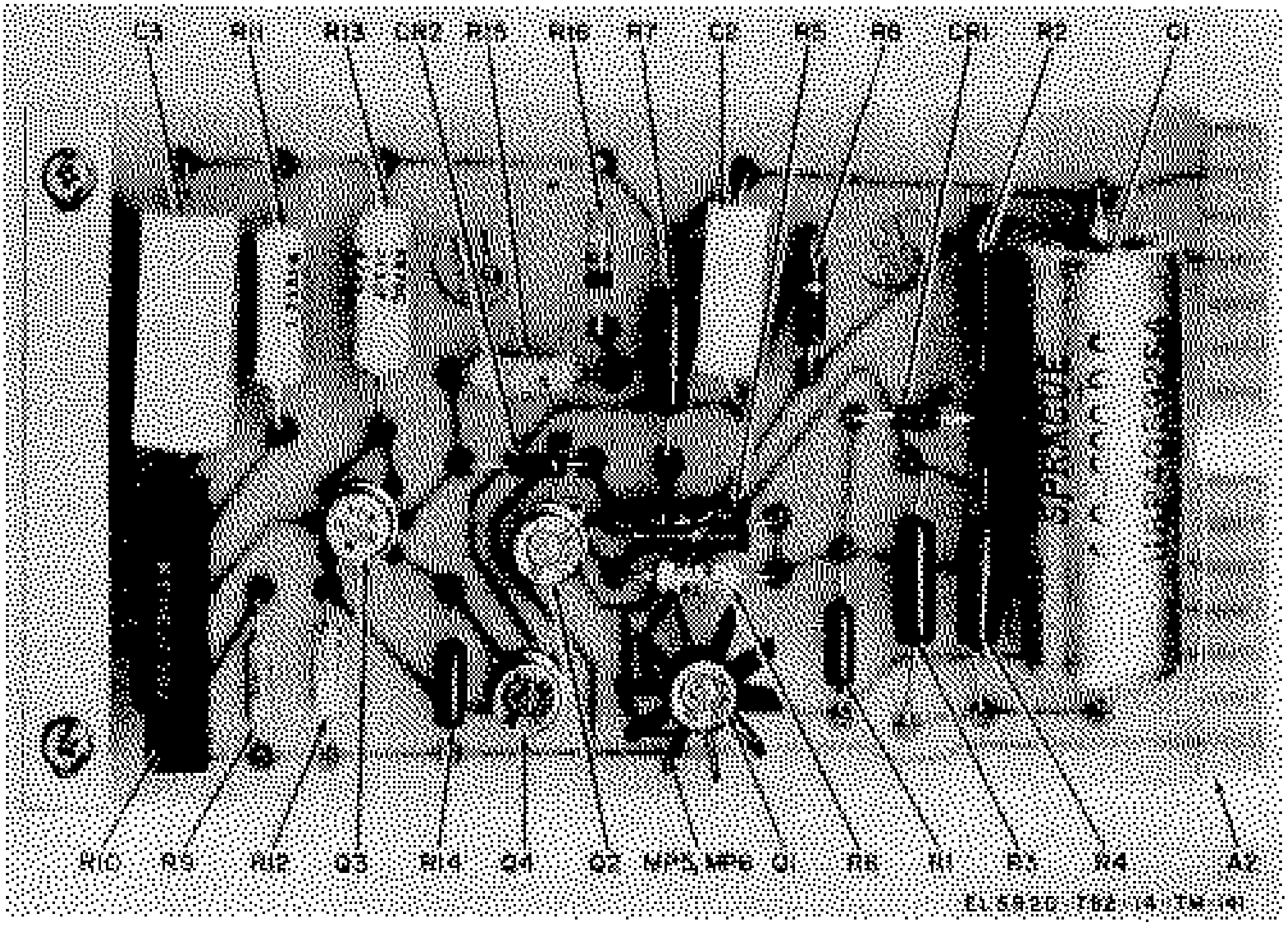


Figure 6-85. 120 V regulator assembly (A2), parts location diagram.

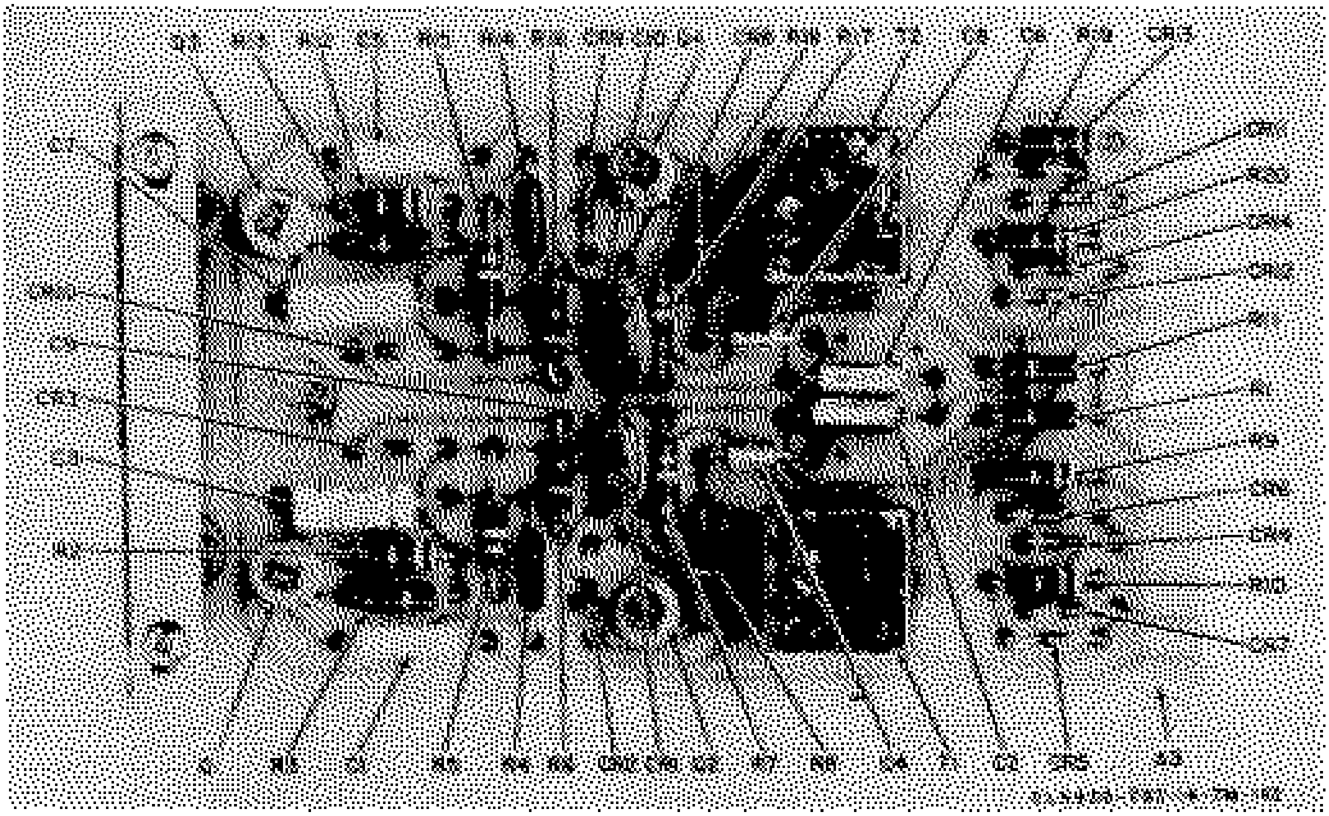


Figure 6-86. SCR trigger assembly (A3), parts location diagram.

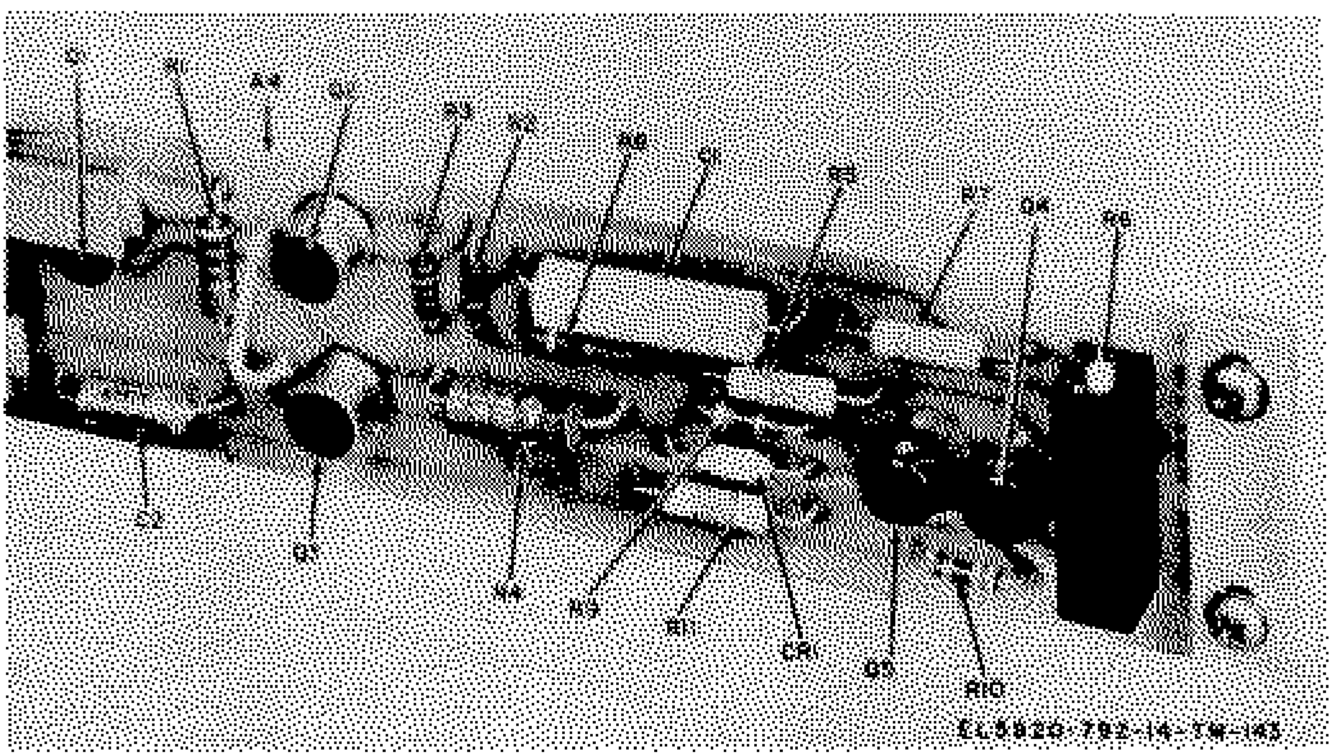


Figure 6-87. 6 V regulator assembly (A4), parts location diagram.

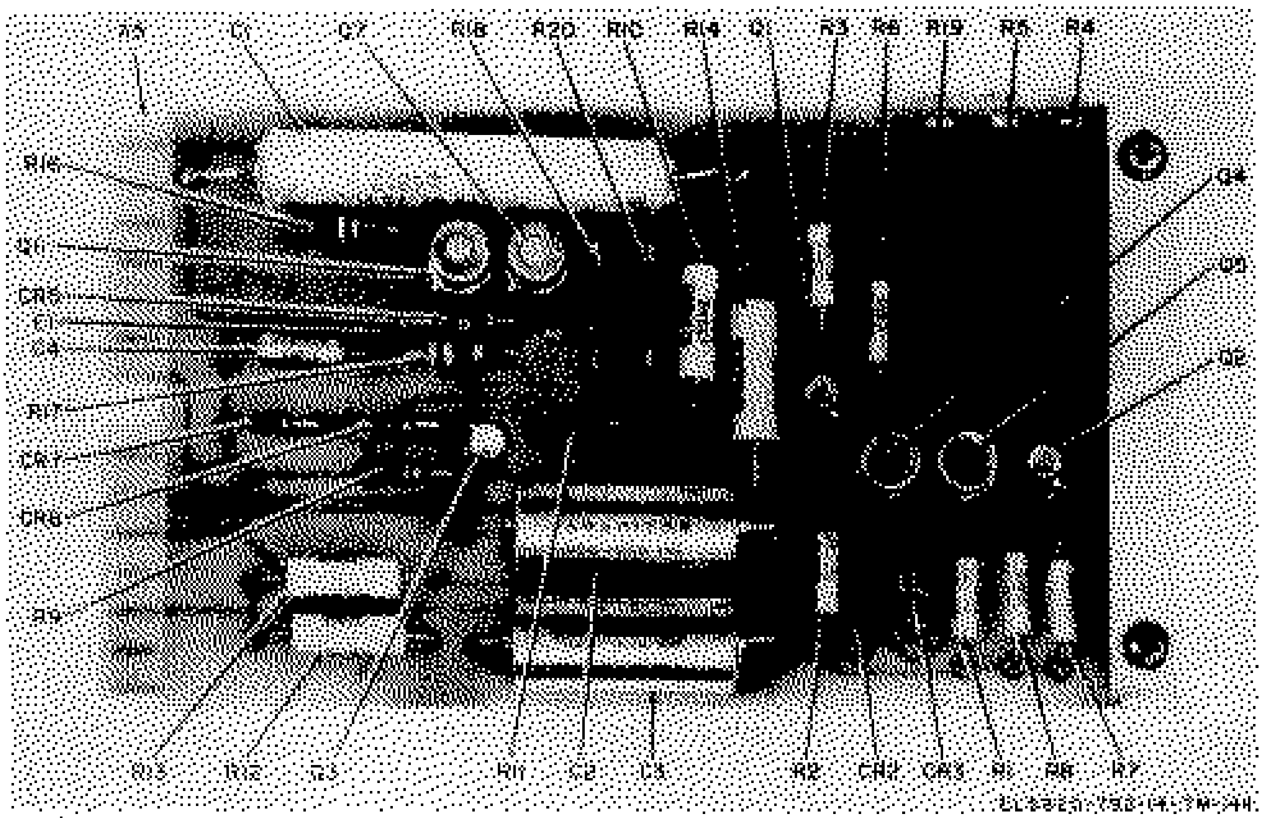


Figure 6-88. Voltage-controlled multi-vibrator (A5), parts location diagram.

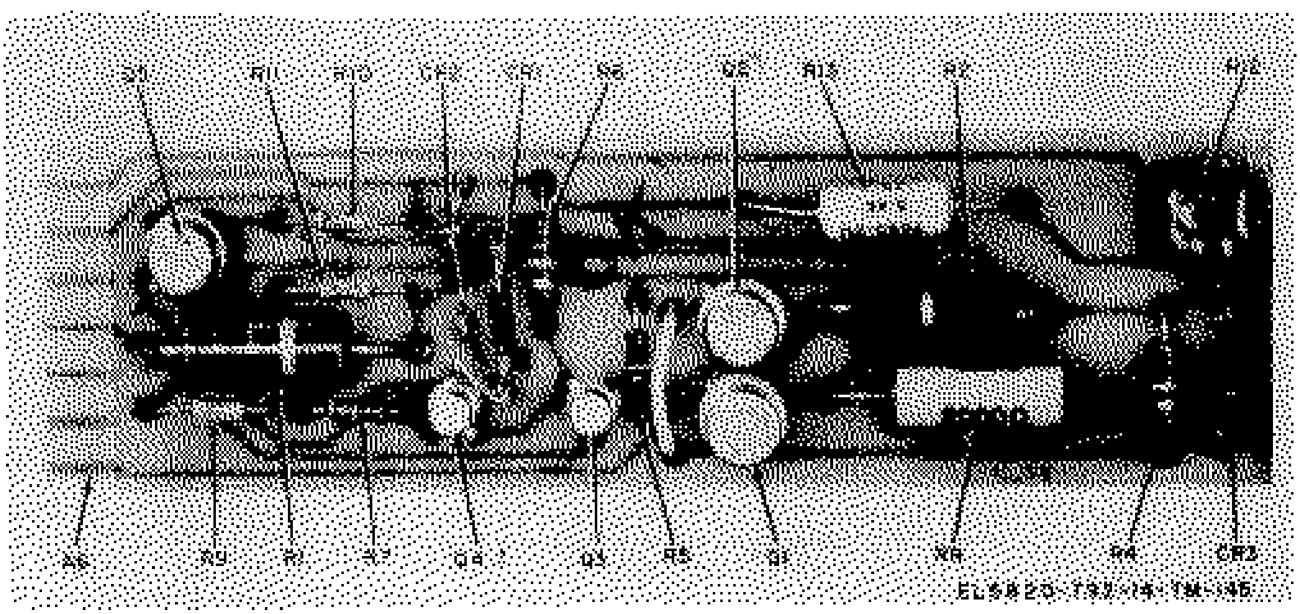


Figure 6-89. Amplifier-comparator (A6), parts location diagram.

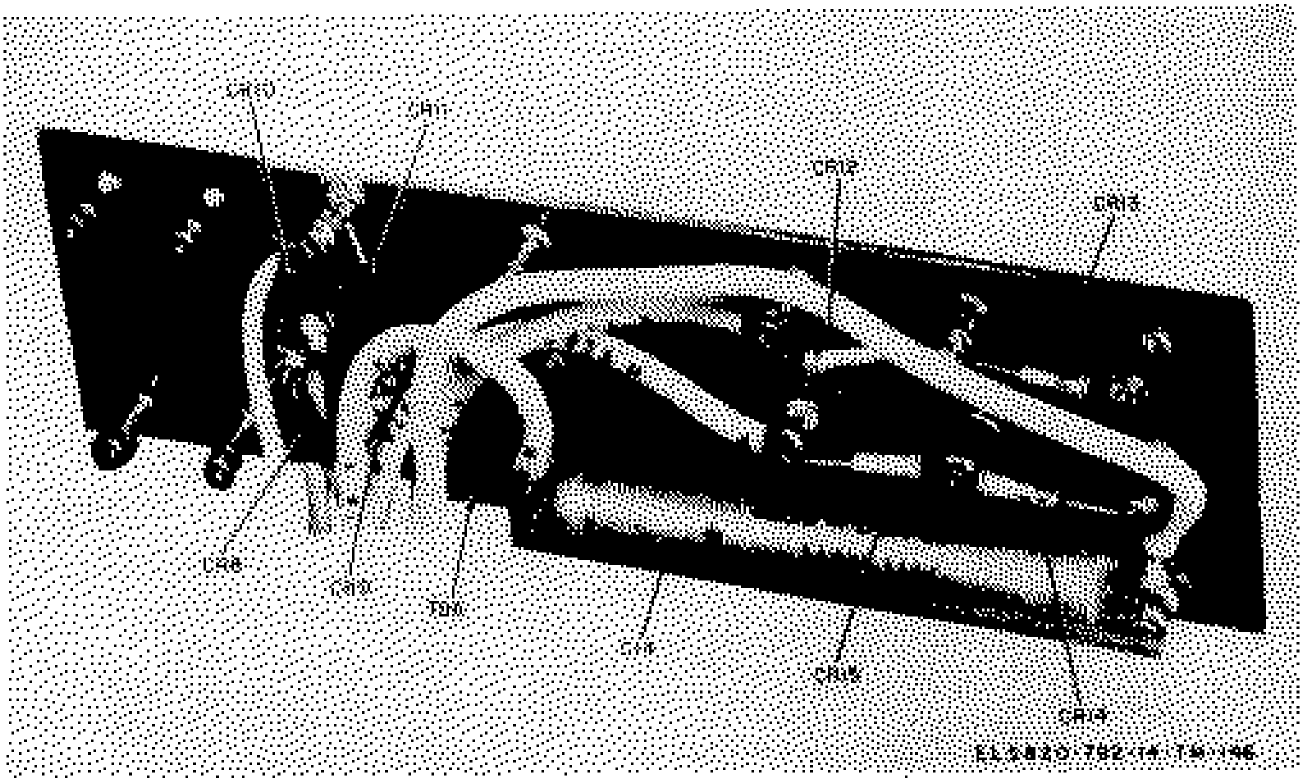


Figure 6-90. Terminal board assembly (TB6), parts location diagram.

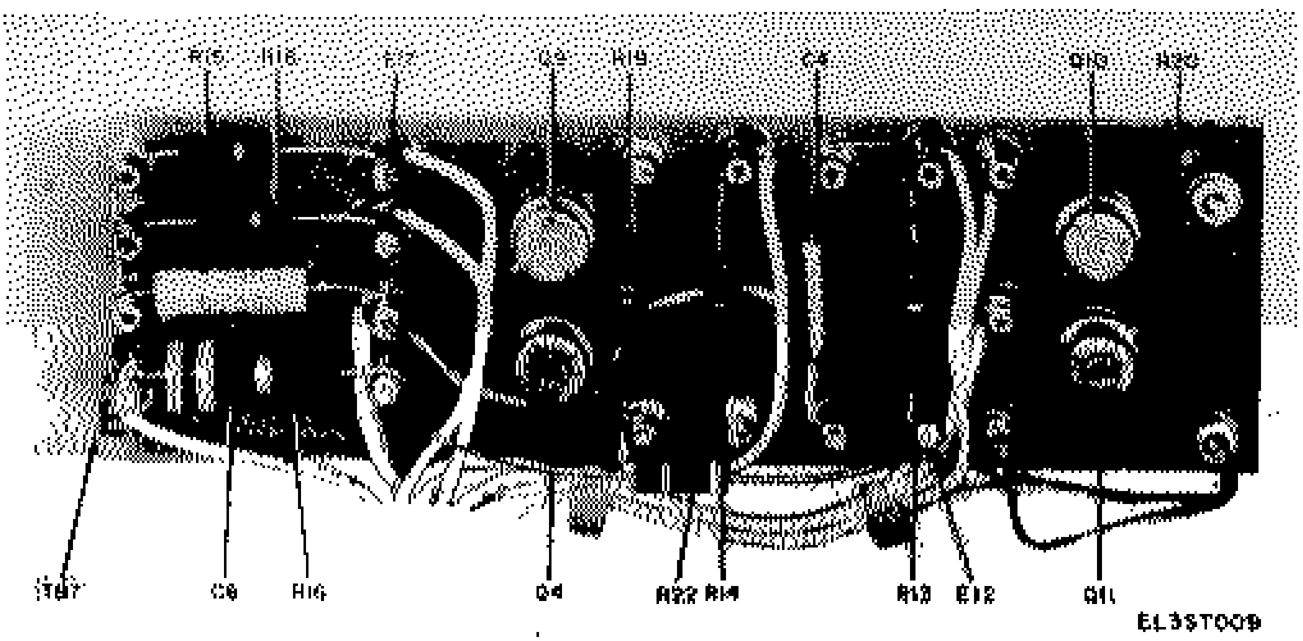


Figure 6-91. Terminal board assembly (TB7), parts location diagram.

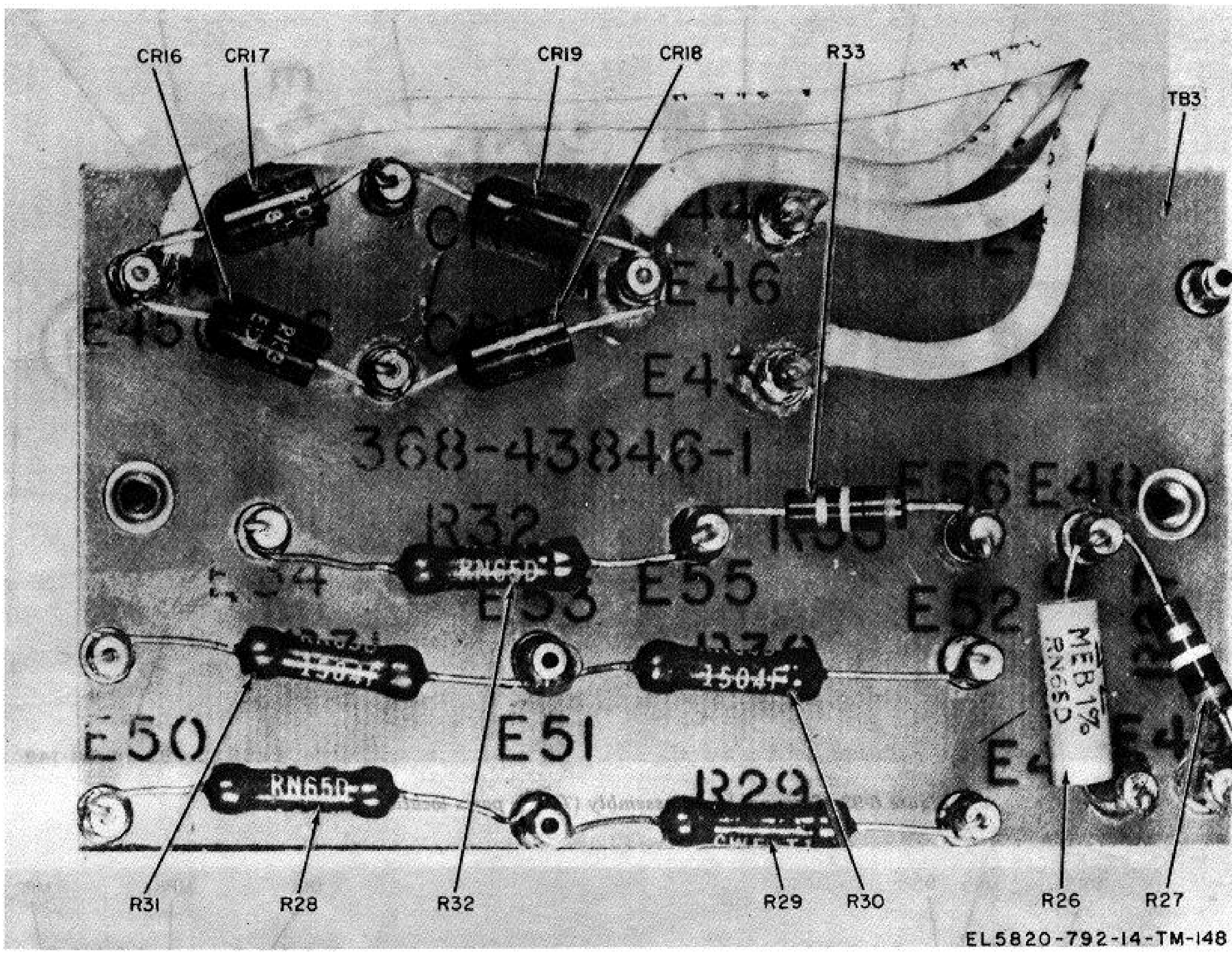


Figure 6-92. Terminal board assembly (TB3), parts location diagram.

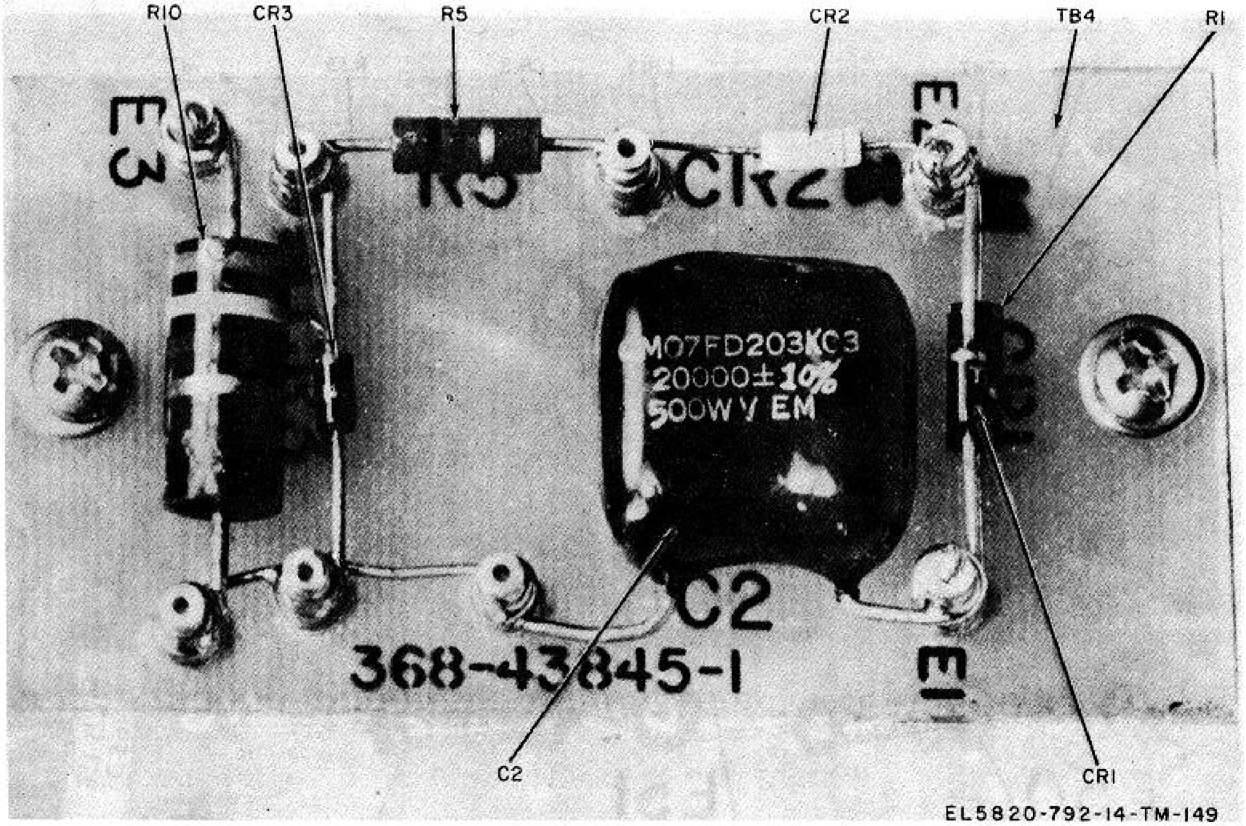


Figure 6-93. Terminal board assembly (TB4), parts location diagram.

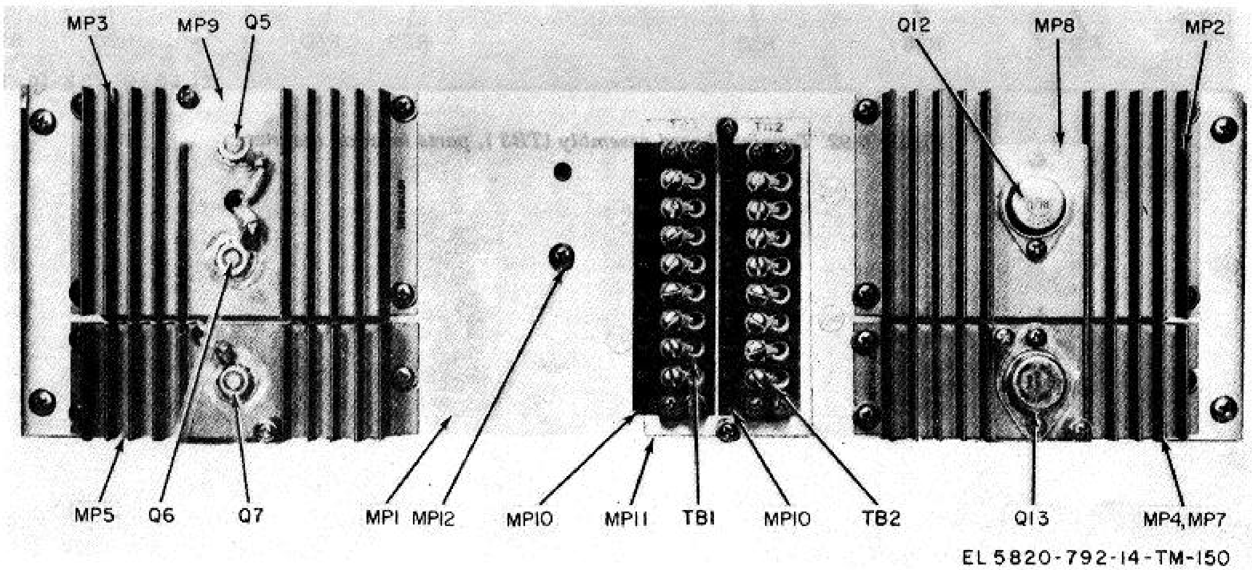


Figure 6-94. Rear plate assembly, parts location diagram.

d. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Time Delay Performance Check		
1	On the Klystron power supply, set the MAIN POWER switch to its OFF position.			
2	On an oscilloscope, set the following controls: HORIZONTAL DISPLAY to A TM/CM to 10 msec TRIGGER SLOPE to NEGATIVE EXT TRIGGERING MODE to DC INPUT SELECTOR to DC VOLT/CM to 1 V			
3	Connect a 10X probe to the oscilloscope, then connect the probe between Klystron power supply chassis and terminal post E12 located on TB7. See figure 6-91 for exact location.			
4	Connect a test lead between TRIGGER INPUT of the oscilloscope and A1TB1-5 (fig. FO-31, 6-79, and 6-80 (0) of the klystron power supply (reflector section). **NOTE** **In the followin g step, the power supply should not be left in the MAIN POWER ON position long enough to warmup. This portion of the procedure depends on a cold condition.**			
5	Set the MAIN POWER switch to its ON position. Observe the oscilloscope for delayed turn-on. Several attempts may be re-quired in order to adjust the oscilloscope TRIGGERING LEVEL and STABILITY controls to obtain the proper display.	600 to 100 msecs as shown in figure 6-95.	Proceed to step 6.	Check CR3, R9, Q3 and associated components. If sawtooth waveform is noted, check Q2 and K1 circuitry.
6	Disconnect the oscilloscope from the test setup.			
		750-volt Performance Check		
7	Set the MAIN POWER switch of the klystron power supply to its OFF position.			
8	On the support bracket of the rear side of the power supply front panel, resolder the wire to its normal terminal. 4			
9	On the klystron power supply, set the MAIN POWER switch to the ON position. Allow the power supply to warm up for 15 minutes.			
10	Connect the ground terminal of a digital voltmeter to J9 and the positive terminal to J6.			
11	Observe the voltmeter indication. Record the voltage for reference. and associated components.	-750 V dc (nominal)	Proceed to step 12.	Check CR16, CR17, CR18, CR19,

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
12	Adjust the test power supply until the load test set meter indicates 43 V de.	Reference voltage ± 0.5 Vdc	Proceed to step 13	Check amplifier-comparator, A6, voltage controlled multivibrator A5, SCR trigger A3, and associated components.
13	Adjust the test power supply until the load test set meter indicates 56 V dc.	Reference voltage ± 0.5 Vdc.	Proceed to step 14.	Check same components as in step 12 above.
14	Set A6R12 to its maximum clockwise position, note the digital voltmeter indication, then adjust A6R12 to its maximum counterclockwise position and note digital voltmeter indication.	The adjustment range should be a minimum of 700 to 800 V dc.	Proceed to step 15.	Check same components as in step 12 above.
		120-Volt Performance Check		
15	Adjust the test power supply until the load test indicates 46 V dc.			
16	Connect the digital voltmeter ground lead to J9 and the positive lead to J8.			
17	On the load test set, set the 120 V LOAD switch to its MAX position.			
18	Observe and record the voltmeter indication for reference.	120 V dc (nominal	Proceed to step 19.	Check CR8, CR9, CR10, CR11, and associated components.
19	Adjust the test power supply until the load test set indicates 43 V dc.	Reference voltage ± 1.2 V dc.	Proceed to step 20.	Check the 120 V regulator card assembly (A2).
20	Adjust- the test power supply until the load test set indicates 56 V dc.	Reference voltage ± 1.2 V dc.	Proceed to step 21.	Check the 120 V regulator card assembly (A2).
21	Set.A2R10 to its maximum clockwise position, note the digital voltmeter indication, then adjust A2R10 to its maximum counterclockwise position and note the digital voltmeter indication.	The adjustment range should be a minimum of 110 to 130 V dc.		
		6-Volt Performance Check		
22	Adjust the test power supply until the load test set meter indicates 48 V dc. **CAUTION** **In the following steps, the digital voltmeter chassis will be 750 volts above ground. Use extreme caution.**			
23	Isolate the digital voltmeter from station ground by using a 3-prong-to-2-prong adapter.			
24	Connect the ground lead of the digital voltmeter to J6 (-750 V dc) and positive lead to TB2-6 of Klystron power supply.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
25	Observe and record the digital voltmeter indication for reference.	6 V dc (nominal)	Proceed to step 26.	Check CR12, CR13, CR14, CR15, and associate components.
26	Adjust the test power supply until the load test set meter indicates 43 volts.	Reference voltage ± 0.2 V dc.	Proceed to step 27.	Check the 6 V regulator card assembly (A4).
27	Adjust the test power supply until the load test set meter indicates 56 volts.	Reference voltage ± 0.2 V dc.	Proceed to step 28.	Check the 6 V regulator card assembly (A4).
28	Set A4R6 to its maximum clockwise position, note the digital voltmeter indication, then adjust A4R6 to its maximum counterclockwise position, and note the digital voltmeter indication.	The adjustment range should be a minimum of 5.5 to 7.0 V de.		
	WARNING **In the following steps, the digital voltmeter authorized for use to make the following tests will have its chassis 750 volts above ground. Use extreme caution since ground loops may exist during measurement. If available, use a digital multimeter which is isolated from ac power, or use a Multimeter TS-352B/U.**			
	450- Volt Performance Check			
29	Adjust the test power supply until the load test set indicates 48 volts.			
30	Deleted			
31	Connect the ground lead of the digital voltmeter to J6 (- 750 V dc) and the positive lead to J7.			
32	Observe and record the digital voltmeter indication for reference.	-275 to -475 Vdc. (minimum range).	Proceed to step 33.	Check the reflector section assembly (A1).
33	Adjust the test power supply until the load test set meter indicates 43 volts.	Reference voltage ± 1 V dc.	Proceed to step 34.	Check the reflector section assembly (A1).
34	Adjust the test power supply until the load test set meter indicates 56 volts.	Reference voltage ± 1 V dc.	Proceed to step 35.	Check the reflector section assembly (Al).
35	Adjust the test power supply until the load test set meter indicates 48 volts.			
36	On the power supply load test set, place the AFC ADJ control to its OFF position. Set the control to its maximum clockwise position.			
37	On the A1 card in the reflector section assembly (A1) of the Klystron power supply under test, adjust R9 (450 V control) for an indication of - 350 volts on the digital voltmeter. See figures 6-80 and 6-81 for the location of this control.		Proceed to step 38.	Check the A1A1 card assembly.
38	On the power supply load test set, place the AFC switch to its + position. Read and record the output voltage on the digital voltmeter.	- 275 V dc or less.	Proceed to step 39.	Check the A1A1 card assembly.
39	On the power supply load test set, place the AFC switch to its - position. Read and record the output voltage on the digital voltmeter.	- 425 V dc or greater.	Test complete. Disconnect all test equipment.	Check the A1A1 card assembly.
	<u>Power Supply Ripple Test</u>			
40	Connect a .01 mfd 1000 Vdc ceramic blocking capacitor to red lead of the ME-30 3223 adapter, and connect other end of blocking capacitor to	No more than 30 millivolts.	Proceed to step 41.	Troubleshoot 1200 volt power supply filters.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
	TB2 Pin-2. Connect the 3223 adapter black lead to TB-2, Pin-8. Turn the power supply on (if it is not already on), and give the ME-30/U time to stabilize.			
41	Turn the power supply off. Move the capacitor lead from TB2 Pin-2 and connect to TB2, Pin-3. Turn the power supply on, and give the ME-30/U time to stabilize.	No more than 40 millivolts.	Proceed to step 42.	Troubleshoot 750 volt power supply filters.
42	Turn the power supply off. Move the capacitor lead from TB2 Pin-3 and connect to TB1, Pin-7, Turn the power supply on and give the ME-30/U time to stabilize.	It should read 3 millivolts or less.	Test complete. Disconnect ac voltmeter ME-30 and restore power supply to normal service.	Troubleshoot 120 volt power supply filters.

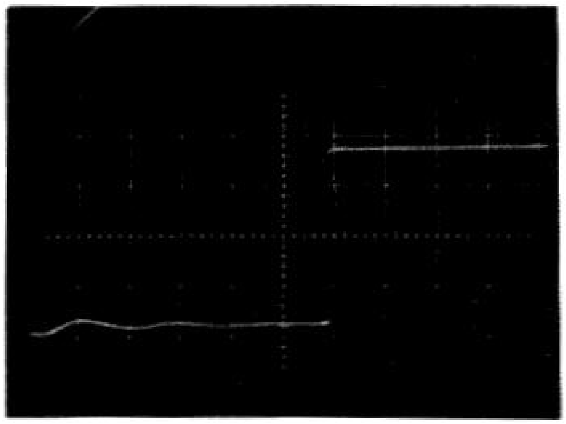


Figure 6-95. Klystron power supply, turn-on time delay waveform.

e. Voltage and Resistance Measurements. If performance of the test and alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in paragraph f below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the power supply disconnected from all external components using the resistance ranges of the electronic voltmeter. All voltages are measured using the test setup of *a* above. Use the electronic voltmeter for dc voltage measurement and the ac voltmeter for ac voltage measurement. Resistance and voltage measurements are made with respect to the common input terminal TB1-3, and the common output terminal TB2-8 which must be jumpered together. On the load test set, place the AFC switch to its OFF position, and the 120 V LOAD switch to its MAX position.

f. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Resistance (nominal) RX100 scale unless otherwise specified	
Q1	Anode	-0.1V	15	
Q1	Cathode	0V	0	
Q1	Gate	0V	17	
Q2	Anode	0V		
Q2	Cathode	-0.6 V		
Q2	Gate	0 V		
Q3	Emitter	-4.9 V	70	(RX100)
Q3	Base	-5.6 V	360	(RX100)
Q3	Collector	-5.3 V	640	(RX100)
Q4	Emitter	0 V	0	(RX1)
Q4	Base	-0.4 V	17.5K	(RX10 k)
Q4	Collector	-19 V	8K	
Q5	Anode		0	(RX11
Q5	Collector		10 M	(RX100 k)
Q5	Gate		10 M	(RX100 k)
Q6	Anode		0	(RX1)
Q6	Collector		10 M	(RX100 k)
Q6	Gate		10 M	(RX100 k)
Q7	Anode		10 M	(RX100 k)
Q7	Collector		2.5K	(RX1 k)
Q7	Gate		2.5K	(RX1 k)
Q8	Anode		10 M	(RX100 k)
Q8	Collector		2.5K	(RX1 k)
Q8	Gate		2.5K	(RX1 k)
Q9	Emitter	0 V	0	
Q9	Base	-0.35 V	15K	(RX10 k)
Q9	Collector	-20 V	8K	(RX1 k)
Q10	Emitter	-6 V	3.8K	(RX1 k)
Q10	Base	-6.6 V	3.6K	(RX1 k)
Q10	Collector	-26 V	2.5K	(RX1 k)
Q11	Emitter	-6.6 V	3.6K	
Q11	Base	-7.2 V	7K	
Q11	Collector	-26 V	2.5K	
Q12	Emitter	+123 V	22K	(RX10 k)
Q12	Base	+124 V	23K	(RX10 k)
Q12	Collector	+220 V	25K	(RX10 k)
Q13	Emitter	-750 V	9K	(RX10 k)
Q13	Base	-750 V	10K	(RX10 k)
Q13	Collector	-740 V	11K	(RX10 k)
A1W1	Emitter	-34.3 V	1K	
A1Q1	Base	-35.2 V	1.1K	
A1Q1	Collector	-45 V	2.8K	
A1Q2	Emitter	-34 V	1K	
A1Q2	Base	-35 V	1K	
A1Q2	Collector	0 V	0	(RX1)
A1Q3	Emitter	-34 V	1K	
A1Q3	Base	-35 V	1K	
A1Q3	Collector	0 V	0	(RX1)
A1A1Q2		-36 V	5.5K	
A1A1Q2		-45 V	2.8K	
A1A1Q2		-44.8 V	3.3K	
A1A1Q3	Emitter	-11.5 V	3.1K	
A1A1Q3	Base	-12 V	4.4 K	
A1A1Q3	Collector	-35 V	6.5K	
A1A1Q4	Emitter	-35 V	1.1K	
A1A1Q4	Base	-35.8 V	5.5K	
A1A1Q4	Collector	-45 V	2.8K	
A1A1Q5	Emitter	-34.5 V	1K	
A1A1Q5	Base	-34.2 V	1K	
A1A1Q5	Collector	-11.8 V	18K	
A1A1MD1 #1		-11.2 V	3.1K	
A1A1MD1 #2		-11.2 V	7 K	
A1A1MD1 #3		-11.2 V	4.2K	
A1A1MD1 #4		-17 V	2.4K	
A1A1MD1 #5		-8 V	4K	
A1A1MD1 #6		-11.2 V	3.6K	
A1A1MD1 #7		-12 V	5.9K	
A1A1MD1 #8		0 V	0	(RX1)
A2Q1	Emitter	+124 V	23K	(RX10 k)
A2Q1	Base	+124 V	24K	(RX10 k)
A2Q1	Collector	+208 V	25K	(RX10 k)
A2Q2	Emitter	+120 V	22.5K	(RX100 k)
A2Q2	Base	+120 V	23.5K	(RX10 k)
A2Q2	Collector	+124 V	24K	(RX10 k)
A2Q3(A)	Emitter	+108 V	18K	(RX10 k)
A2Q3(A)	Base	+108 V	18K	(RX10 k)

Point of measurement		Dc voltage (nominal)	Resistance (nominal) RX100 scale unless otherwise specified	
A2Q3(A)	Collector	+112 V	22K	(RX10 k)
A2Q3(B)	Emitter	+108 V	18K	(RXO1 k)
A2Q3(B)	Base	+108 V	10K	(RX10 k)
A2Q31B	Collector	+112 V	32K	(RX10 k)
A2Q4	Emitter	+112 V	33K	(RX10 k)
A2Q4	Base	+112 V	22K	(RX10 k)
A2Q4	Collector	+124 V	25K	(RX10 k)
A3Q1	Emitter	-43 V	3.8K	(RX1 k)
A3Q1	Base	-44.3 V	7.2K	(RX1 k)
A3Q1	Collector	-4 V	3.2K	
A3Q2	Emitter	-0.35 V	6	(RX1)
A3Q2	Base	0 V	0	(RX1)
A3Q2	Collector	-44.5 V	6	(RX1)
A3Q3	Emitter	-43.3 V	3.8K	
A3Q3	Base	-44.8 V	7K	
A3Q3	Collector	-4 V	3.2K	
A3Q4	Emitter	-0.32 V	6	(RX1)
A3Q4	Base	0 V	0	(RX1)
A3Q4	Collector	-44.5 V	6	(RX1)
A4Q1	Emitter	-750 V	10K	(RX10 k)
A4Q1	Base	-750 V	11K	(RX1Ok)
A4Q1	Collector	-740 V	11K	(RX1O k)
A4Q2	Emitter	-760 V	10K	(RX10 k)
A4Q2	Base	-760 V	11	(RX10 k)
A4Q2	Collector	-750 V	1K	(RX10 k)
A4Q3	Emitter	-750 V	9K	(RX10 k)
A4Q3	Base	-750 V	9K	RX10 k)
A4Q3	Collector	-750 V	11K	(RX10 k)
A4Q4	Emitter	-760 V	11K	(RX10 k)
A4Q4	Base	-760 V	10K	(RX10 k)
A4Q4	Collector	-760 V	11K	(RX10 k)
A4Q5	Emitter	-760 V	11K	(RX10 k)
A4Q5	Base	-760 V	10K	(RX10 k)
A4Q5	Collector	-760 V	11K	(RX10 k)
A5Q1	Emitter	-2.6 V	5.3K	
A5Q1	Base	-3.1 V	6.3K	
A5Q1	Collector	-16.5 V	5.8K	
A5Q2	Emitter	-2.5 V	5.5K	
A5Q2	Base	-3.1 V	6.3K	
A5Q2	Collector	-16.5 V	6.7K	
ASQ3	Emitter	-0.88 V	4.6K	
A5Q3	Base	-1.5 V	1K	
A5Q3	Collector	-6.1 V	4.3K	
A5Q4	Emitter	-16 V	13K	
A5Q4	Base	-16.5 V	5.8K	
A5Q4		-8.4 V	8K	
A5Q5	Emitter	-16 V	13K	
A5Q5	Base	-16.5 V	6.8K	
A5Q5	Collector	-8.1 V	8K	
A5Q6	Emitter	-36 V	9.5K	
A5Q6	Base	-36.7 V	8K	
A5Q6	Collector	-46 V	3.2K	
A5Q7	Emitter	-12 V	8K	
A5Q7	Base	-12.5 V	5.8K	
A5Q7	Collector	-36.5 V	8K	
A6Q1	Emitter	-12.4 V	1.7K	
A6Q1	Base	-13 V	8K	
A6Q1	Collector	-21 V	2..8K	
A6Q2	Emitter	-13 V	8K	
A6Q2	Base	-13.2 V	19K'	
A6Q2	Collector	-21 V	2,8K	
A6Q3	Emitter	-11.6 V	11.5K	
A6Q3	Base	-12 V	16K	
A6Q3	Collector	-13.2 V	19K	
A6Q4	Emitter	-11.6 V	11.5K	
A6Q4	Base	-7.8 V	10K	
A6Q4	Collector	--19.5 V	16K	
A6Q5(A)	Emitter	-5.8 V	9K	
A6Q5(A)	Base	-6.2 V	5.5K	
A6Q5(A)	Collector	-12 V	16K	
A6Q5(B)	Emitter	-5.8	9K	
A6Q5(B)	Base	-6.2 V	6.2K	
A6Q5(B)	Collector	-7.8 V	10K	
TB1 #1		-11 V	5.5 (RX1)	
TB1 #2		-11 V	11K	
TB1 #3		0 V	0	(RX1)
TBI #4		0 V	0	(RX1)
TBI #5		-48 V	12K	(RX10O k)
TB1 #6		+10 V	90K	(RX10 k)
TB1 #7		+120 V	22K	(RX10 k)
TB1 #8		-10 V	1OOK	(RX10 k)
TB2 #1		-34 V	8	(RX1)
TB2 #2		-1200 V	12K	(RX10 k)
TB2 #3		-750 V	9K	(RX10 k)
TB2 #6		-757 V	10K	(RX10 0k)
TB2 #8		0 V	0	(RX1)
J6		-750 V	8K	
J7		-1200 V	10K	(RX10 k)
J8+		120 V	800K	(RX100)
J9		0 V	0	(RX1)

6-46. Adjustment Data

a. General. The following procedures should be performed after repairs have been made to the power supply, or if the performance testing requires that alignment be accomplished. The alignment must be in the indicated sequence without skipping.

b. Test Equipment Setup. The test equipment used for the alignment and adjustment procedures is the same as that described in paragraph 6-45 unless otherwise indicated in the procedure.

c. Preliminary Adjustments. When the test setup is completed, perform the preliminary adjustments listed in paragraph 6-45c.

d. Voltage Controlled Multivibrator. This procedure provides a means of adjusting the output waveform from the multivibrator.

(1) On the Klystron power supply, set the MAIN POWER switch to OFF.

(2) On an oscilloscope, set the controls as follows:

HORIZONTAL DISPLAY	to	A
TM/CM	to	50 µ sec
TRIGGER SLOPE	to	INT +
TRIGGERING MODE	to	DC
INPUT SEI.ECTOR	to	DC
VOLTS/CM	to	1

(3) Connect a 10X oscilloscope probe to INPUT A of the oscilloscope, and across E17 and chassis ground of the Klystron power supply. See figure 6-91 for location of E-17.

(4) Connect the positive lead of a digital voltmeter to E1 on the A5 card and the negative lead to chassis ground on the Klystron power supply. See figure 6-88 for location of E1.

(5) On the Klystron power supply, set the MAIN POWER switch to its ON position.

(6) Adjust R19 on the A5 card until the digital voltmeter indicates 36.3 volts.

(7) Adjust R4 on the A5 card until the oscilloscope display indicates 300 ±-20 microseconds for 1 period. See figure 6-96 for a correct display.

(8) Adjust R5 on the A5 card to achieve a symmetrical waveform (50 percent duty cycle). See figure 6-96 for the required display.

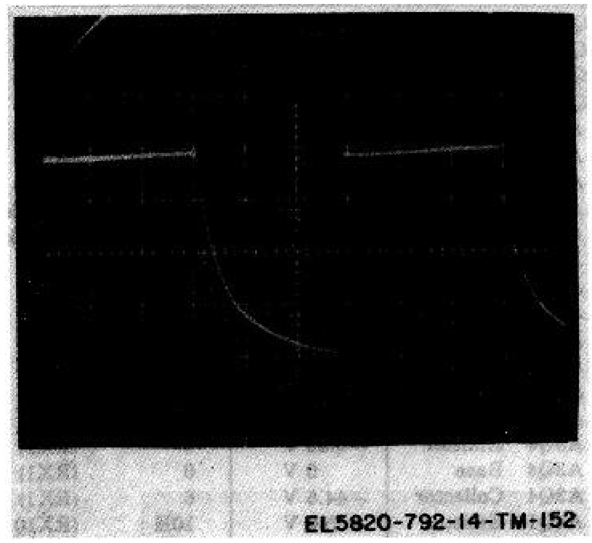


Figure 6-96. Klystron power supply, voltage-controlled multi-vibrator waveform.

(9) On the Klystron power supply, set the MAIN POWER switch to its OFF position, then proceed to e below.

e. 750-Volt and 120-Volt Sections. This procedure provides a means of adjusting the output of the 750-volt and 120-volt sections of the Klystron power supply.

(1) Reconnect the lead removed in the preliminary steps to its normal position behind the front panel.

(2) Connect the negative lead of the digital voltmeter to J9 and the positive lead to J6 of the Klystron power supply.

(3) Turn potentiometer R20 to its fully clockwise position.

(4) On the Klystron power supply, set the MAIN POWER switch to its ON position.

(5) Adjust A6R12 until the digital voltmeter indicates 750 ± 0.5 V dc.

(6) Connect the negative lead of the digital voltmeter to J9 and the positive lead to J8.

(7) Adjust R10 for an indication of 120 ± 0.5 volts.

(8) Set the MAIN POWER switch of the

Klystron power supply to its OFF position, then proceed to f below.

6-Volt and 450-Volt Sections. This procedure provides a means of adjusting the output from the 6-volt and' 450-volt sections of the Klystron power supply.

WARNING

Both the 6-volt sections are referenced to the 750-volt output from the power supply under test. Be extremely careful when measuring this voltage.

(1) Isolate the digital voltmeter from station ground by using a 3-prong-to-2-prong adapter in the ac powerline. In the following steps, the digital voltmeter chassis is 750 volts above ground potential.

(2) Connect the negative lead of the digital voltmeter to J6, and the positive lead to TB2-6.

(3) On the Klystron power supply, set the MAIN POWER switch to its ON position.

(4) Adjust R6 for an indication of 6 ±0.01 V dc.

(5) Reconnect the negative lead of the digital voltmeter to J6 and the positive lead to J7.

(6) Adjust R9 on the Al card assembly until the digital voltmeter indicates 350 volts, then proceed to the next (*g* below).

g. Overvoltage Protection Section. This procedure provides a means of adjusting the overvoltage level for the power supply.

(1) Connect the negative lead of the digital voltmeter to J9 and the positive lead to J6.

(2) On the A6 card, adjust R12 until the digital voltmeter indicates 800 V dc.

(3) Slowly adjust R20 counterclockwise until the digital voltmeter indicates in the region between 770 and 780 V dc.

(4) On the A6 card, adjust R12 for a digital voltmeter indication of 750 ± 0.05 V dc.

(5) On the Klystron power supply, set the MAIN POWER switch to its OFF position.

(6) This step concludes the power supply adjustment. Disconnect input power, all load resistances remove jumper connections, and replace covers.

Section XI. LIMITER-DISCRIMINATOR MODULES (368-43489-1, -6 AMD -8)

6-47. Introduction

a. The limiter-discriminator module, which belongs to the microwave receiver, provides amplitude limiting and demodulation of the 70-MHz frequency-modulated IF signal. The limiter-discriminator module consists of a single printed-wiring card (A2) on which all components, with the exception of controls, test jacks, and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis (A1). The limiter-discriminator has provisions for the inclusion of deemphasis network (A3) in its output circuit. Three different deemphasis networks, having different frequency characteristics are used in this module. The network used in a given application depends upon the channel loading of a particular system.

b. Module Configuration Data.

Limiter-discriminator module part No.	Deemphasis network part No.	Channel capacity	f max (kHz)
368-43489-1	None	Any	Any
368-43489-6	398-11360-5	Any	1024
368-43489-8	398-11360-7	600	2660

6-48. Functional Description

a. A functional block diagram of the module appears in figure 6-97. The frequency-modulated 70-MHz IF signal from the IF amplifier module is applied to the 75-ohm termination pad through coaxial connector J1. This signal is then processed by a phase equalizer to minimize any envelope delay distortion within the module. Following equalization, the signal is amplified before delivery to the limiters.

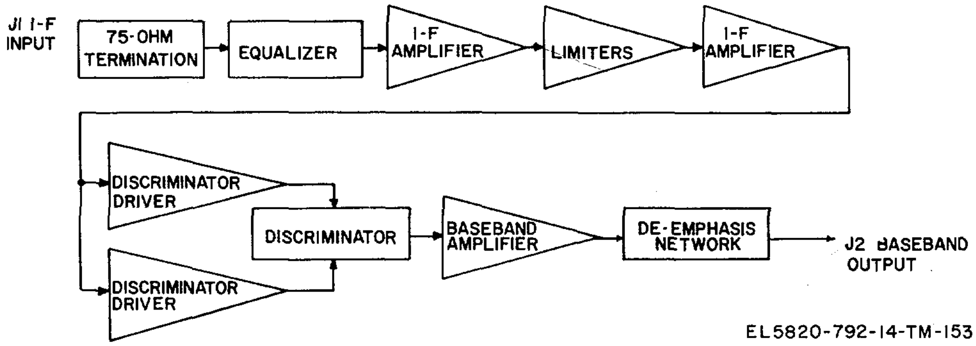


Figure 6-97. Limiter-discriminator module, functional block diagram.

b. The three-stage limiters are peak-clipping amplifiers; clipping occurs at approximately 0.7-volt rms to remove any amplitude variations in the IF signal. The IF signal is amplified once more, then it is applied to two detector driver stages. The detector drivers prevent distortion at low signal levels.

c. The demodulator is a Travis discriminator which provides better linearity over a wider passband than other types of discriminators. The discriminator is then followed by an amplifier and two impedance transformation stages.

d. The -limiter-discriminators do include a deemphasis network; these submodules used are listed in paragraph 6-47.

6-49. Circuit Analysis

a. The schematic diagram of the module appears in figure FO-25. The frequency-modulated 70 MHz IF signal from J1 of the limiter-discriminator module is applied to a 75-ohm termination pad consisting of resistors R1, R2, and R3. This pad also terminates the input of the phase equalizer. The phase equalizer consists of L1, C1, T1, C2, C3, and L2, and is used to minimize any envelope delay distortion within the module. The equalizer is terminated in 75 ohms by the network R4, R5, and T2.

b. The output signal from the equalizer is taken from the tap of transformer T2 and applied to the emitter of common-base amplifier Q1. Inductor L3 is the collector load for amplifier Q1. Its output signal is developed across the network C7, R9, and T3.

c. The output signal from amplifier Q1 is obtained from the tap of transformer T3 and passed into the first stage of three-element common-base limiter amplifier. Limiting takes place in diodes CR1 and CR2, where the positive and negative peaks are clipped above 0.7 volt rms. The flat tops resulting from clipping action are restored to sinusoidal shape as the signal is sent through the output transformer T4 and coupling circuit C12 and R13 into the next limiter stage.

d. The output signal of the third limiter stage, Q4, is coupled through a tapped transformer into a common-emitter amplifier Q5. Resistor R21 in the emitter circuit of amplifier Q5 directly affects the gain of the stage. Capacitor C26 is adjustable to match interstage impedances between the IF amplifier, Q5, and the discriminator drivers Q6 and Q7. The discriminator driver stages, Q6 and Q7, are used to increase the signal voltage levels sufficiently to prevent the diodes from operating at or near the nonlinear region of their characteristics. Inductor L15 and capacitor C32 are tuned to resonate above the. 70-MHz center frequency; inductor L18 and capacitor C40 are tuned to resonate below the 70-MHz center frequency. Diodes CR7 and CR8 rectify the 70-MHz signal. The rectified signal is filtered by pitype filters consisting of C33, L16, and C34 on one side and C41, L19, and C42 on-the other side. The 70-MHz IF signal is shunted to ground by these filters while the baseband signal is passed out of the discriminator into .the baseband amplifier. Potentiometer R31 is a balancing control, which is adjusted to compensate for slight differences in efficiency of -the two sides of the discriminator.

e. The baseband signal developed in the discriminator is applied to common-emitter amplifier Q8. Following this, the signal is sent through two emitter-followers, Q9, and Q10, in cascade to drop the output impedance-to 75 ohms. The baseband signal is used in-the 368-43489-6 and -8 modules; -the 368-43489-1 does not use a deemphasis network.

f. Technical Characteristics.

Parameter	Specifications
Overating frequency	70 MHz
Input impedance	75 ohms
Output impedance	75 ohms
Input level	0.5 V rsm (+5 dBm)
Demodulation sensitivity	20 mV rms/SCTT (-23 dBm/ 75 ohms) at 140 kHz rms deviation.
Baseband linearity	Less than 1.5 percent over 12 MHz.
Differential phase	Less than 2 ns over 12 MHz.
Input return loss	26 dB over 12 MHz
Power requirements	225 mA at +28 V dc

6-50. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following subparagraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Tolerances. Dc voltage readings should be within 10 percent and ac voltage readings within 20 percent.

c. Test Equipment Setup. Figure 6-98 shows the basic test equipment setup.

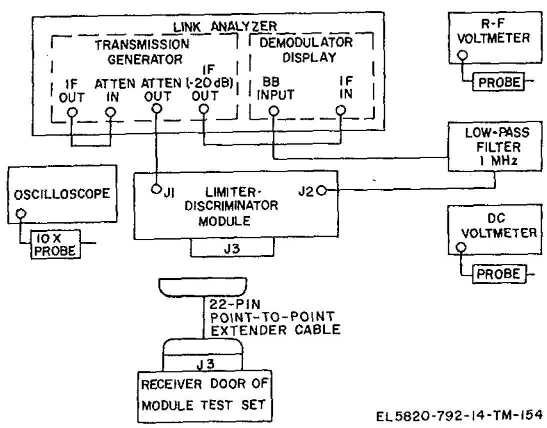


Figure 6-98. Limiter-discriminator module, initial test equipment setup.

d. Preliminary Adjustments. Due to the nature of the limiter-discriminator module, .the top and bottom covers are a significant part of the procedure. If general performance tests are being conducted, the top and bottom covers must remain in place, except where noted. If alignment is being performed, substitute the modified top cover for the regular cover; however, the bottom cover must remain in place. Remove top and bottom covers from the module only for troubleshooting and for test/alignment of the deemphasis network. The modified top cover is shown in figure 6-99.

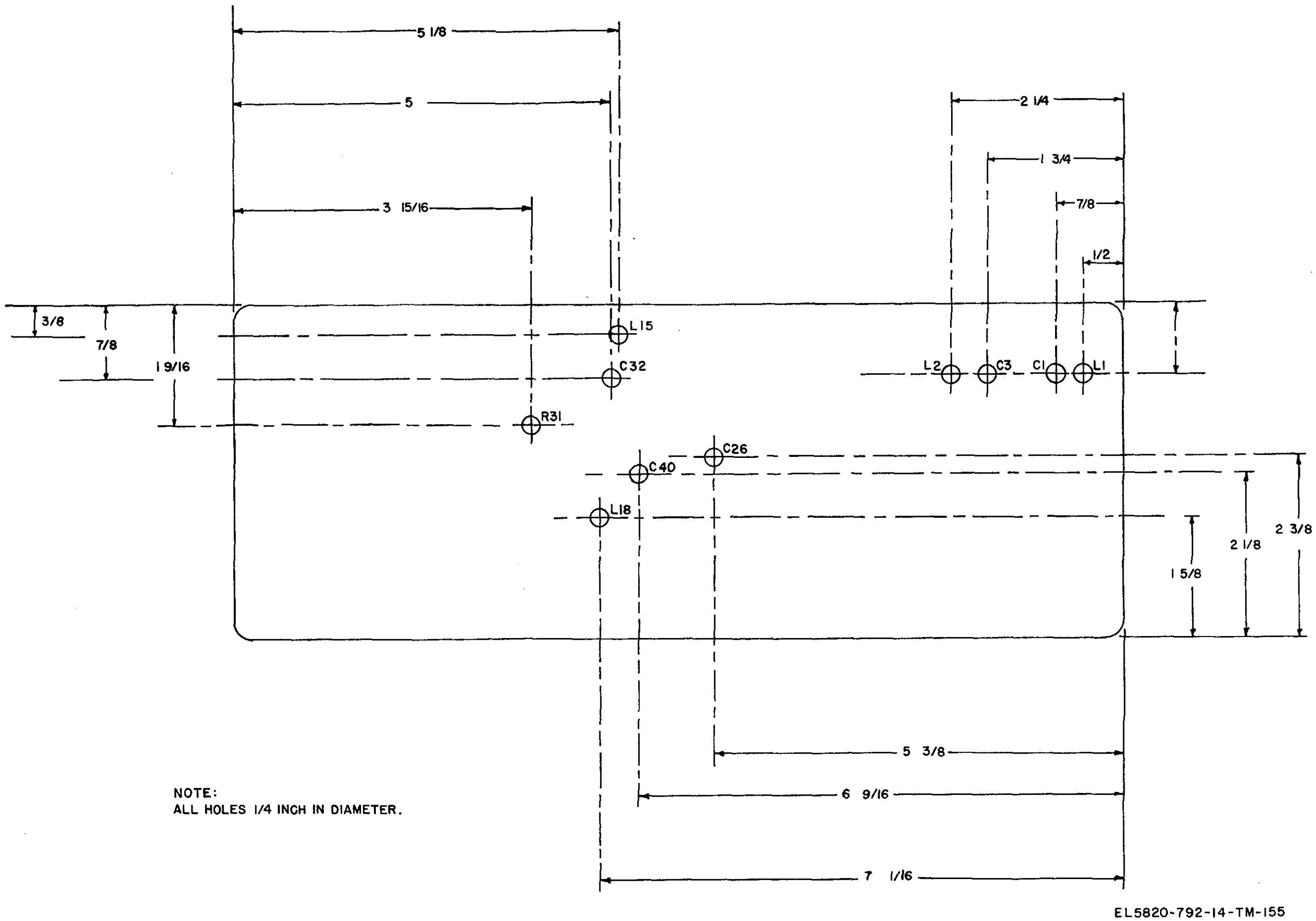


Figure 6-99. Modified module top cover for alignment.

(1) Remove the -top cover of -the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for a minimum of 30 minutes with -top and bottom covers in place.

(3) Insure that +28 ± 0.1 V dc is maintained in the module -test set before conducting any tests.

e. Test Procedures. After completing procedures in c and d above, perform the procedures in below. Figure 6-100 provides parts location data.

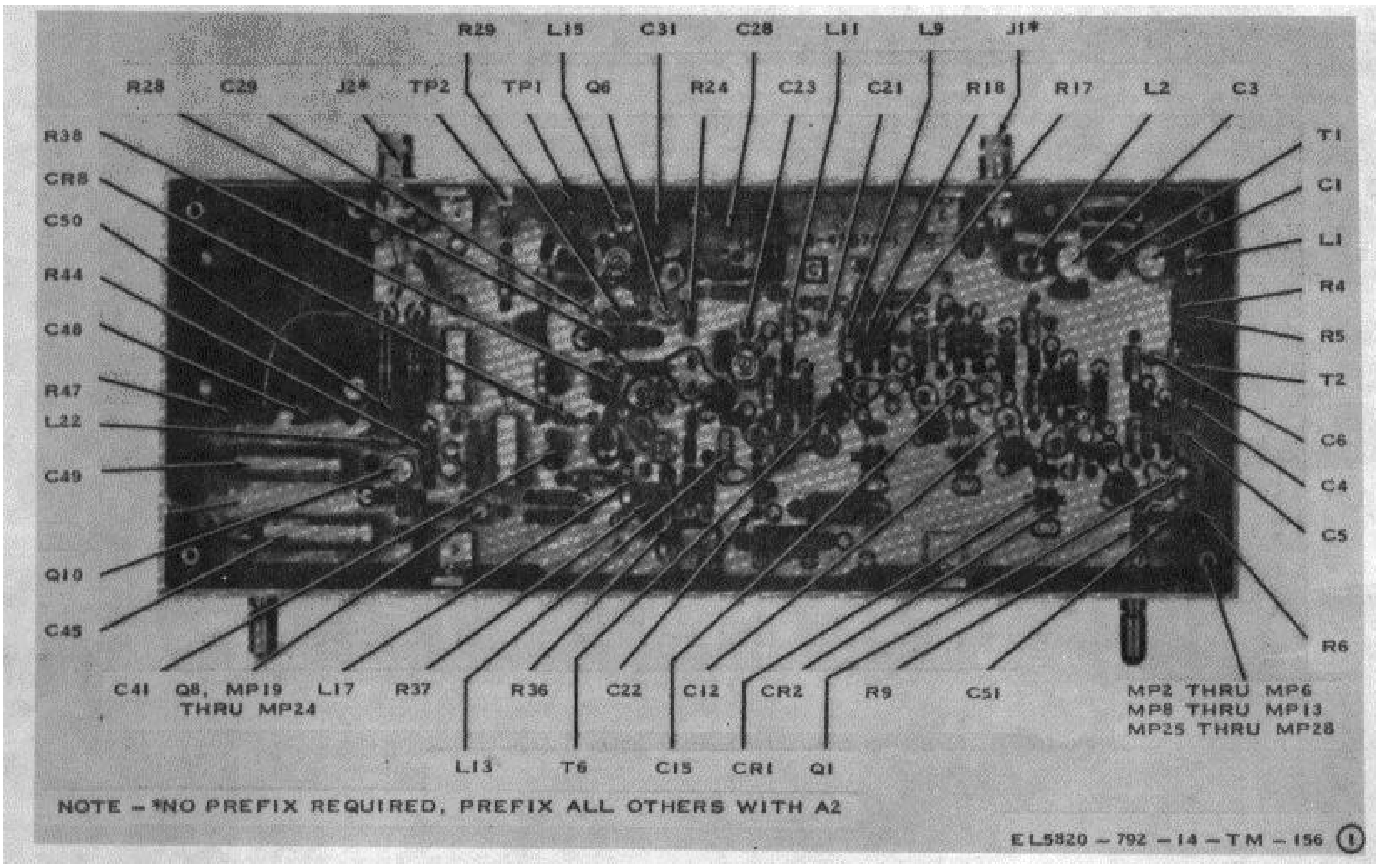


Figure 6-100 (1) Limiter-discriminator module, parts location diagram (sheet 1 of 3).

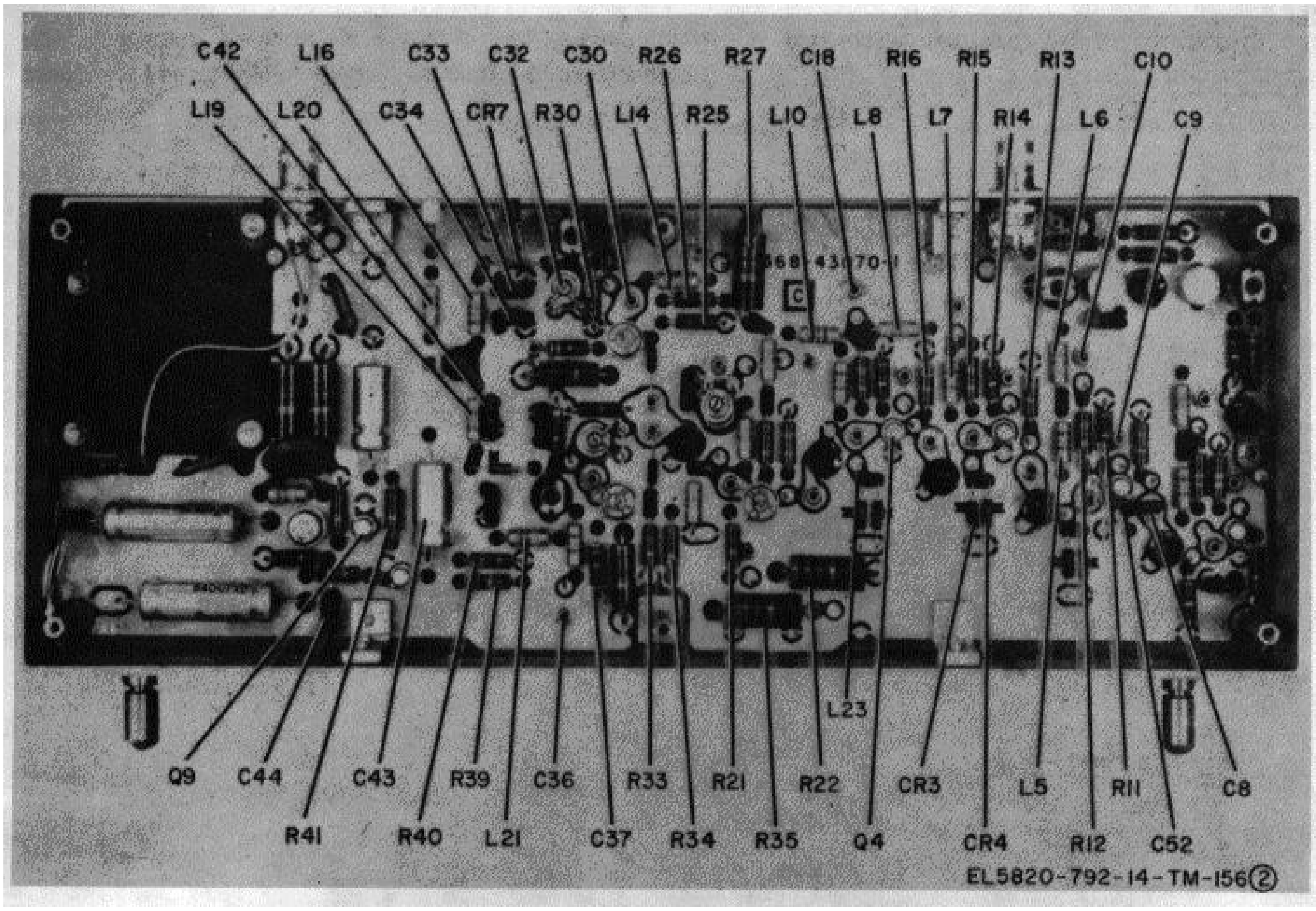


Figure 6-100 (2) . Limiter-discriminator module, parts location diagram (sheet 2 of 3).

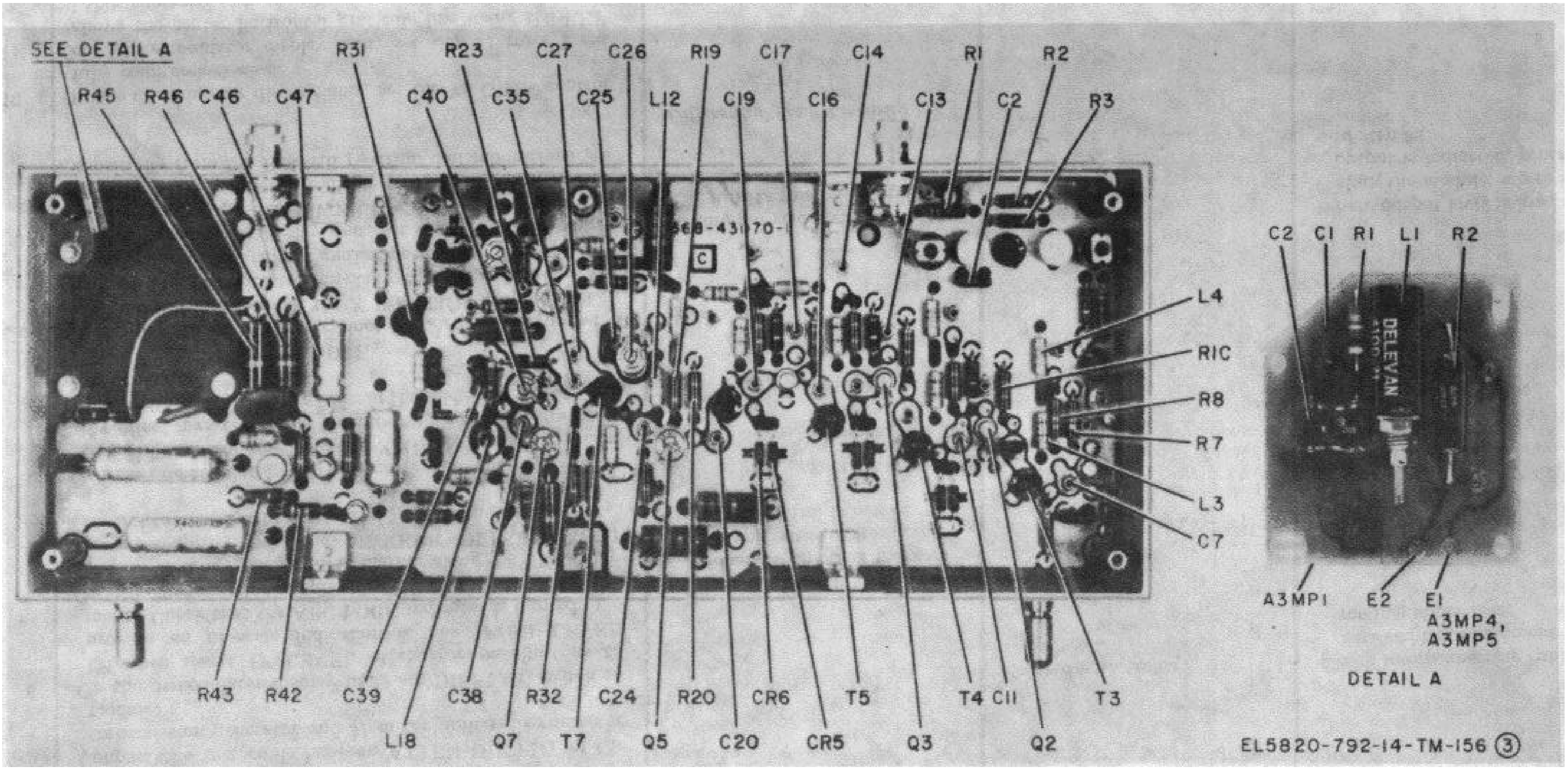


Figure 6-100 (3) Limiter-discriminator module, parts location diagram (sheet 3 of 3)

f. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Demodulator Sensitivity Performance Check		
1	On the transmission, generator, set the controls as follows: FREQUENCY (MHz) COARSE to '70; FREQUENCY (MHz) FINE to 0 SWEEPWIDTH (MHz) COARSE to 10; SWEEPWIDTH (MHz) FINE to 3; BB FREQUENCY (kHz) to 500; MODE to BB + SWEEP.			
2	On the transmission generator, set DEVIATION (kHz RMS) control to 140.			
3	On the transmission generator, set the ATTENUATION (dB) pushbuttons for 6.			
4	On the rear of the transmission generator, position the I. SWEEP switch to NORMAL.			
5	Connect the test cable between ATTEN OUTPUT of the transmission generator and J1 of the limiter-discriminator module.			
6	On the demodulator display unit, set DISPLAY switch to IF, then insert IF LEVEL attenuator pushbuttons to provide an on-scale indication of the IF/BB LEVEL meter. Check that the AFC LOCK indicator is lighted.		Proceed with tests.	Check interconnecting cables between test equipment and module under test.
7	On the demodulator display, adjust X' PHASE SHIFT control to center the 70-MHz marker along the Y2 display trace. Slightly rock the MARKER OFFSET (MHz) control to identify the stationary 70-MHz marker.	Center marker (70 MHz) is stationary with offset markers moving outward from center as the control is moved.	Proceed with tests.	
8	On the demodulator display unit, set the MARKER OFFSET control to 5. Adjust X GAIN control to place the offset markers at the 1-cm and 9-cm vertical graticule lines, with the 70-MHz marker in the middle at the 5th-cm graticule line. NOTE If the pattern of markers cannot be lined up on the 1st, 5th, and 9th lines, adjust the X POSITION control at the rear of the demodulator display, then repeat steps as necessary to obtain correct marker positions.			
9	On the demodulator display unit, set the DISPLAY switch to BB, and adjust BB POWER (-dBm) controls until the IF/B LEVEL meter indicates 0. Read demodulator sensitivity 'from BB POWER (-dBm) dial calibrations.	minimum sensitivity 20 mV/ 140 kHz rms (-23 dBm)	Proceed to step 10.	Where output level is low, re-align the module; where no output is indicated, proceed to step 32.
	Differential Gain(Linearity)			
10	On the demodulator display unit, set the Y2 GAIN control fully counterclockwise.			
11	On the demodulator display unit, set the Y1 trace 2 cm above the center horizontal graticule line using the REF LINE control.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
12	On the demodulator display unit, set the Y1 SENSITIVITY control to X1.			
13	On the demodulator display unit, set the CALIBRATION (dB) % switch to 1, then adjust the Y1 GAIN control to obtain l-cm separation between the split traces, then set CALIBRATION (dB)% switch to its OFF position.			
14	Observe differential gain on the Y1 trace.	Tilt and ripple 1.5% across ± 6 MHz band.	Proceed with tests.	Align the module Ipara 6-51).
		Differential Phase (Group Delay) Performance Check		
15	On the demodulator display unit, set the rear panel controls as follows: Y2 to DELAY; SWEEP to INTERNAL; UNBLANK to DOWN.			
16	On the group delay detector, set the controls as follows: DELAY OUTPUT to NORMAL; BB FREQUENCY (kHz) to 500; DEMOD INPUT to EXT.			
17	On the group delay detector, adjust the SET LEVEL control until the PHASE LOCK/LEVEL meter indicates in the green zone.			
18	On the group delay detector, set the DELAY CALIBRATION Ins) to 10, then, on the demodulator display unit, adjust the Y2 GAIN control for a split trace separation of 10 cm. Then turn off the DELAY CALIBRATION ins) switch.			
19	Observe the differential phase (group delay) on the Y2 trace.	Maximum delay 2.0 ns across ± 6 MHz band.	Proceed with tests.	Align the module (para 6-51).
		Cross-Over Voltage Performance Check		
20	On the transmission generator, set the SWEEP WIDTH (MHz) controls to their 0 positions.			
21	On the limiter-discriminator module, connect a multimeter between test points TP1 and TP2.	± 3'V dc or less.	Proceed with tests.	If all other parameters are within specification, refer to paragraph 1le, step 21. If other parameters are out, of limits general alignment required.
		De-emphasis Network Performance Check *using link analyzer*		
22	Configure the test equipment per figure 6-105.			
23	On the transmission generator, set the controls as follows: FREQUENCY (MHz) COARSE to 70 FREQUENCY (MHz) FINE to O SWEEPWIDTH (MHz) COARSE to 0 SWEEPWIDTH (MHz) FINE to 0 BB FREQUENCY to EXT			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
24	On the transmission generator, set the ATTENUATION (db) pushbuttons for 5.			
25	On the test oscillator, set the output level to approximately, -40 dBm.			
26	On the test oscillator, set the output frequency to the 04 minimum frequency (F min) (para 6-51g).			
27	On the AC voltmeter, set the RANGE control to --3(DB	Mid- to full-scale reading on meter.	Proceed with test.	Check test equipment hookup, test oscillator output level and test oscillator output frequency.
28	Adjust test oscillator output level for precisely -21 dBm (-30 dB indicated) level on AC voltmeter. Record test oscillator output level as indicated on output monitor meter for reference in later steps.			
29	Adjust test oscillator output frequency to pivot frequency (F pivot) (para 6-51g). Then reset test oscillator output level to reference obtained in step 28 above.			
3)	Read output level on AC voltmeter	-25 ± 0.2 dBm (-34 ± 0.2 dB indicated)	Proceed with test.	Align de-emphasis network (para 6-51g).
31	Adjust test oscillator output frequency to maximum frequency(F Max)(para 6-51g). Then reset test oscillator output level to reference obtained in step 28 above.			
32	Read output level on AC voltmeter	-29 ± 0.2 dBm (-38 ± 0.2 dB indicated)	Test complete. Disconnect test equipment.	Align de-emphasis network (para 6-52g).
		Trouble Analysis Checks		
33	Reconfigure the test equipment and module under test per figure 6-98. Remove both covers of the module and strap out the A3 assembly if installed.			
34	Repeat steps 1 through 4 of this procedure.			
35	Connect the RF voltmeter to Q1 collector.	85 mV..	Proceed to step 36.	Check Al and associated components, and circuitry towards J1.
36	Connect the RF voltmeter to Q2 collector.	275 mV..	Proceed to step 37.	Check 'Q2 and associated components, and circuitry towards Q1.
37	Connect the RF voltmeter to Q3 collector.	475 mV	Proceed to step 38.	Check A3 and associated components, and circuitry towards Q2.
38	Connect the RF voltmeter to Q4 collector.	480 mV..	Proceed to step 39.	Check Q4 and associated components towards Q3.
39	Connect the RF voltmeter to Q5 collector.	1.0 V..	Proceed to step 40.	Check Q5 and associated cir-cuits toward Q4.
40	Connect the RF voltmeter to Q6 collector.	1.7 V..	Proceed to step 41.	Check Q6 and associated components and circuits toward Q5.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
41	Connect the RF voltmeter to Q7 collector.	1.9 V	Proceed to step 42.	Check Q7 and associated compo-nents and circuits toward T7.
42	Connect an oscilloscope between test points TP2 and TP1 (ground).	0.7 V peak-to-peak.	Proceed to step 43.	Check circuitry from TP2 towards Q6 and Q7.
43	Connect an ac voltmeter to Q8 collector.	1.65 V	Proceed to step 44.	Check Q8 and associated compo-nents and circuitry toward R31.
44	Repeat step 8 of this procedure	Minimum sensitivity: 20 cm V/140 kHz rms.	Test complete. Remove the strap on A3 assembly,if installed. Disconnect all test equipment.	Check components from Q8 collec-tor toward J2.
		Preemphasis alignment without Link Analyzer		
45	Connect test equipment per figure 6-105a with R2 shorted out using a short clip lead.			
46	Adjust oscillator output for 0 dB indicated on AC voltmeter at F mil			
47	Remove short from R2 and note ac voltmeter indication. Record as a reference level. Replace short across R2.			
48	Adjust test oscillator frequency to F max Adjust output level to 0 dB indicated on ac voltmeter. Remove short from R2.			
49	Adjust L1 for an indicated level 8 dB below reference obtained in step 47. Replace short across R2.			
50	Adjust oscillator to F pivot Adjust output level to 0 dB indicated on ac voltmeter. Remove short from R2.			
51	Read indicated level on AC voltmeter. Level should be 4 dB i0.2 below reference level obtained in step 47. If level is in tolerance, procedure is completed; if not, adjust L1 ONLY THE AMOUNT NECESSARY to be in tolerance. Then repeat steps 48 through this step until both F max and F pivot are in tolerance.			
52	Disconnect test equipment and restore module to normal con-figuration.			

g. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in h below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources. The RX100 scale of the multimeter are used as the standard range unless otherwise stated; the common multimeter lead is connected to J4-3 (ground) during all measurements.

(2) Dc voltage measurements are made with the module connected to the receiver door of the module test set using the appropriate point-to-point extender cable. No signal source is employed.

(3) Ac voltage measurements are made using the following procedure:

(a) On a VHF oscillator set the FREQUENCY RANGE (MHz) to 68-130 and set the TUNE control to 75 MHz using dial-scale calibrations; calibration accuracy is unimportant.

(b) Set an IF attenuator to provide 40 dB.

(c) Connect the test equipment as shown in figure 6-101.

(d) Set the RF voltmeter to the .03-volt scale, then connect it to the limiter-discriminator module between the nearest ground lug and INPUT J1.

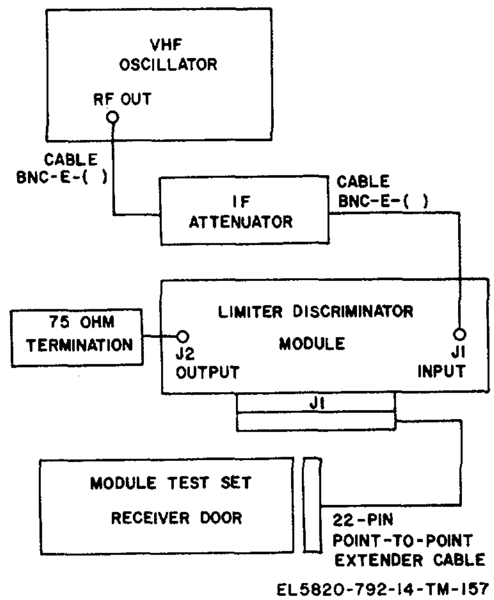


Figure 6-101. Troubleshooting test equipment setup, limiter-discriminator module .

(e) Add or remove attenuation until the RF voltmeter indicates 20 millivolts.

(f) Perform ac voltage measurements as necessary. Since the VHF oscillator is not being used in a sweep configuration, ac voltage measurements beyond Q7 are not indicated.

h. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (rms nominal)	Resistance (ohms nominal)	
Q1	Base	15.1	11.5 mV	6.0K	
	Emitter	14.5	10.5 mV	2.0K	
	Collector	28.0	21.0 mV	0	
Q2	Base	17.0	17.5 mV	3.7K	
	Emitter	16.2	20.5 mV	2.0K	
	Collector	28.0	160.0 mV	670	
Q3	Base	17.1	160.0 mV	3.7K	
	Emitter	16.2	38.0 m V	2.2K	
	Collector	28.0	360.0 mV	680	
Q4	Base	16.8	63.0 mV	3.7K	
	Emitter	16.1	135.0 mV	2.2K	
	Collector	28.0	440.0 mV	660	
Q5	Base	22.5	210.0 mV	1.9K	
	Emitter	21.8	200.0 mV	700	
	Collector	28.0	400.0 mV	670	
Q6	Base	5.2	145.0 mV	470	
	Emitter	4.5	140.0 mV	87	RX10
	Collector	17.0	470.0 mV	730	
Q7	Base	5.2	137.0 mV	470	
	Emitter	4.5	131.0 mV	90	RXIO
	Collector	17.5	720.0 mV	740	
Q8	Base	10.4		3.7K	
	Emitter	9.4		1.6K	
	Collector	20.5		2.0K	
Q9	Base	20.5		1.9K	
	Emitter	19.8		450	
	Collector	28.0		660	
Q10	Base	19.8		1.9K	
	Emitter	19.2		450	
	Collector	28.0		660	

6-51. Alignment Data

a. General. The following procedures should be performed after repairs have been made to-the module.

NOTE

The limiter-discriminator contains many tuned' circuits which must be carefully aligned to obtain optimum module performance. The arrangement of ..the procedures in-this paragraph is based on a requirement for a complete realignment.

b. Test Equipment Setup. The test equipment setup used for the alignment and adjustment procedures is shown in figure 6-98.

c. Preliminary Adjustments. When the test setup is completed, perform the preliminary adjustments listed in paragraph 6.50.

CAUTION

Adjustable coils, capacitors, and potentiometers may be sealed by clear, fingernail polish. To avoid damage to the component, this sealant must be broken loose prior to any attempt to perform an adjustment. Use a sharp pointed knife or scribe to carefully remove the sealant which is inhibiting the movement of the adjustable part of the component. If, during any adjustment, any binding occurs, reinspect the component. The adjustment need not be resealed after alignment.

d. Equalizer Alignment. This alignment sets the optimum return loss and aids the phase delay characteristics of the module.

(1) Remove the top cover of the module and substitute a modified cover; refer to figure 6-99.

This cover prevents detuning due to body or hand capacitance.

(2) All final adjustments must be made only after a 30-minute warmup period has been allowed.

(3) Configure the test equipment setup as shown in figure 6-48.

(4) On the transmission generator, set SWEEP WIDTH (MHz) COARSE and FINE controls to 10 and 2, respectively.

On the demodulator display unit, set attenuators for a loss of 6dB, and operate IF LEVEL pushbuttons to set IF/BB LEVEL meter as close as possible to zero.

(5) Set the DISPLAY switch of the demodulator display to RET LOSS and adjust RETURN LOSS (dB) control to 17.

(6) On the electronic counter, set SENSITIVITY (VOLTS RMS) to 1.

(7) Adjust. the MARKER OFFSET (MHz) control until the electronic counter indicates 6 ± 0.1 MHz.

(8) On the rear apron of the demodulator display unit, set Y2 switch to RET LOSS.

(9) On the demodulator display unit, set SENSITIVITY control to X0.1, Y1 GAIN control to its maximum counterclockwise position, then spread the display to full width (± 5 cm) using the X GAIN control.

(10) Carefully and accurately adjust the RETURN LOSS SET control to obtain a zero indication on the RETURN LOSS meter.

(11) On the demodulator display unit, set the CALIBRATION (dB) % control to 1.0, and adjust the Y2 GAIN control to obtain. a 1-cm separation between chopped traces, then set the CALIBRATION (dB) % control to its OFF position.

(12) Using the Y1 position control, move the reference line to the 2-cm graticule (from the top of the display); then adjust the Y2 trace to coincide with the Y1 trace using the REF LINE control.

NOTE

Y1 GAIN, Y1 POSITION, REF LINE, and Y2 GAIN controls are now calibrated, and MUST NOT be readjusted again until directed in -the procedure. Furthermore, removal of the 17-dB mismatch in a subsequent step causes the RETURN LOSS meter indicator to move off-scale. DO NOT disturb the RETURN LOSS SET control-let the meter continue - to indicate off-scale.

(13) Disconnect the 17-dB mismatch.

(14) Connect an UG-491A/U adapter to the hybrid.

(15) Connect the INPUT of the limiter-discriminator to the open port of the UG-491A/U.

(16) Adjust the RETURN LOSS (dB) control so that the return loss trace is as close as possible to the lower side of the reference line.

(17) The adjustment of the limiter-discriminator return loss involves the adjustment of L1, L2, C1, and C3. Each time an adjustment is made, reset the RETURN LOSS (dB) control to move the display into proper position with respect to the reference line; refer to figure 6-102.

(18) The return loss is read directly from the coarse and fine RETURN LOSS (dB) control. The specification is 26 dB minimum return loss over a 12 MHz bandwidth. Disconnect the hybrid from the limiter-discriminator module and remove the test cables from the hybrid.

e. Discriminator Alignment This alignment sets the optimum linearity and phase delay characteristics of the module.

(1) Remove the top cover of the module and substitute a modified cover; refer to figure 6-99. This cover prevents detuning due to body or hand capacitance.

(2) All final adjustments must be made only after a 30-minute warmup period has been allowed.

(3) On the transmission generator, set the controls as follows:

FREQUENCY (MHz) COARSE to 70
FREQUENCY (MHz) FINE to 0
SWEEP WIDTH (MHz) COARSE to 10
SWEEP WIDTH (MHz) FINE to 3
BB FREQUENCY (kHz) to 500
MODE to BB + SWEEP
DEVIATION (kHz RMS) to 140
ATTENUATION (dB) to 6
SWEEP to NORMAL

NOTE

SWEEP NORMAL control is located on rear of transmission generator.

(4) Connect the test cable between ATTEN OUTPUT of the transmission generator and J1 of the limiter-discriminator module.

(5) On the demodulator display unit, set the DISPLAY switch to IF, then operate IF LEVEL pushbuttons to provide an on-scale indication of the IF/BB LEVEL meter. Check to see that the AFC LOCK indicator is lighted.

(6) On the demodulator display unit, adjust X PHASE SHIFT control to center the 70 MHz marker along the Y2 trace. Slightly vary the MARKER OFFSET (MHz) control, the stationary marker is the 70 MHz marker; following this, set the MARKER OFFSET (MHz) control to 6.

(7) Adjust the X GAIN control to place the offset markers on the 1 cm and 9 cm positions. The 70 MHz marker should be located at the 5 cm position. The X POSITION control on the rear apron of demodulator display can be used to laterally shift the trace if necessary to meet the requirement.

(8) On the demodulator display unit, set the DISPLAY switch to BB, then adjust the BB POWER (dBm) controls until the IF/BB LEVEL meter indicates 0.

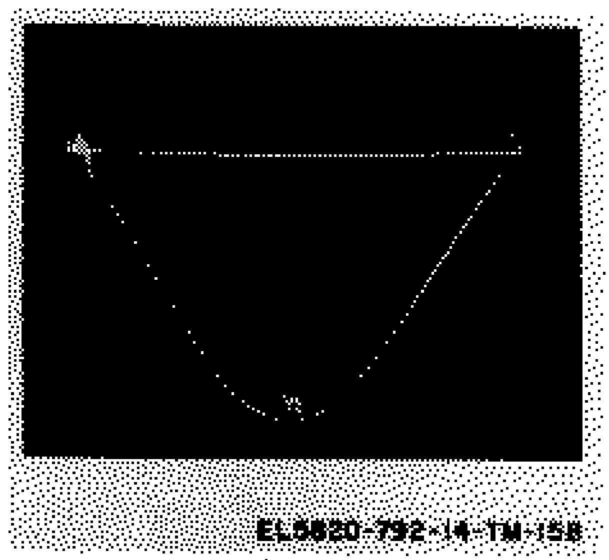


Figure 6-102. Equalizer return loss, limiter-discriminator module.

(9) On the demodulator display unit, set the Y2 GAIN control fully counterclockwise, set the Y1 trace 2 cm above the horizontal center using the Y1 POSITION control, then using the REF LINE control, set the Y2 trace 2 cm below the horizontal center.

(10) On the demodulator display unit set Y1 SENSITIVITY control to X1.

(11) On the rear apron of the demodulator display unit, set the Y2 switch to its DELAY position, SWEEP to INTERNAL, and UNBLANK to DOWN.

(12) On the group delay detector, set
DELAY OUTPUT to NORMAL
BB FREQUENCY (kHz) to 500
DEMOD INPUT to EXT

(13) On the group delay detector, adjust the SET LEVEL control until the PHASE LOCK/LEVEL meter indicates in the green zone.

(14) On the group delay detector, set the DELAY CALIBRATION (ns) switch to 10, then on the demodulator display unit, adjust the Y2

GAIN control for a split trace separation of 10 cm, then set the DELAY CALIBRATION (ns) control to its OFF position.

(15) On the demodulator display unit, set the CALIBRATION (dB) % switch to 1, then using the Y1 GAIN control, adjust for a 1-cm separation between chopped traces. Set the CALIBRATION (dB) % control to OFF.

(16) Read the following information before proceeding further.

(a) Inductor L18 and capacitor C40 tune the low frequency pole (left-hand side of analyzer trace) of the discriminator. Inductor L15 and capacitor C32 comprises the equivalent high frequency pole. The relationship of these networks affect circuit Q, which in turn broadens or narrows the response.

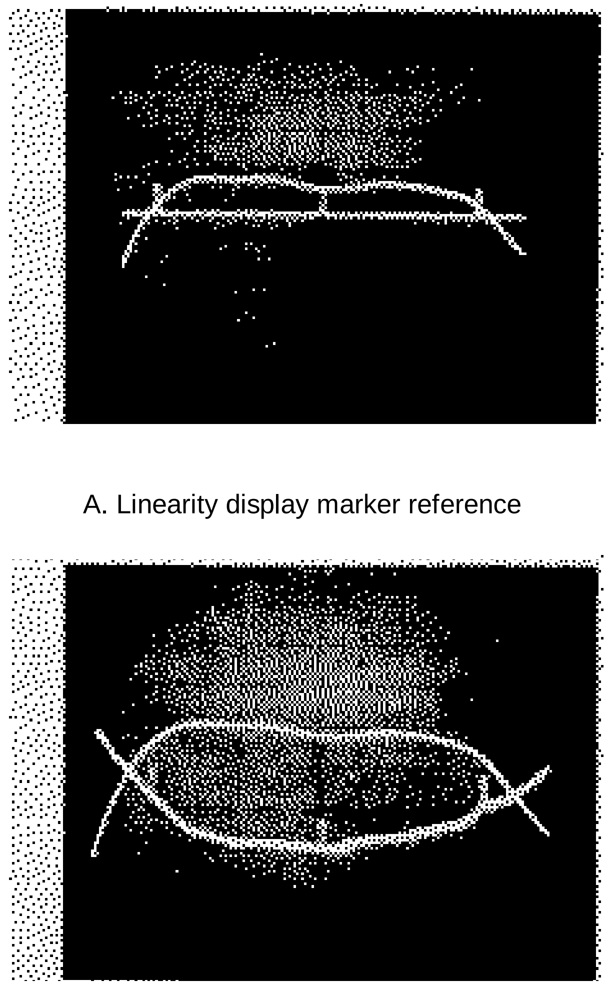
(b) Capacitor C26 is the center frequency tuning (70 MHz) control for the driver pole. Its effect is to provide a tilt control primarily for differential gain Y1.

(c) Resistor R31 is a dc crossover adjustment which affects both differential gain (Y1) and group delay (Y2).

(d) Because of the nature of the circuits involved, interaction between controls exists.

Normally, adjustment of one control will require a touchup adjustment of one or more other controls.

(e) The proper alignment is obtained when the combination of adjustments results in the response curves of figure 6-103.



A. Linearity display marker reference

B. Linearity and group Delay Display

EL5820-792-14-TM-159

Figure 6-103. Discriminator linearity and phase delay specifications without deemphasis.

(f) Perform steps in (16) above and (17) through (21) below when the module is considerably out of alignment. However, when the module is reasonably close to the specification, proceed directly to (21) below.

(17) Set R31 to its mechanical center position.

(18) Observe the differential gain display (Y1). Adjust L15 and C32 (high pole) and L18 and C40 (low pole) obtain the flattest response.

(19) Adjust C26 to minimize trace tilt, then using a combination of pole adjustments (L15, L18, C32, and C40) and C26 to obtain the flattest symmetrical response across + 6.0 MHz, centered at 70 MHz.

(20) Observe the group delay (Y2) and adjust L1, L2, C1, and C2 to minmize this delay.

(21) Adjust R31 to obtain a level and symmetrical group delay (Y2), then adjust C26 to obtain a level and symmetrical differential gain (Y1) pattern.

(22) Using a combination of all adjustments, moving each control very slightly, adjust circuit elements for best similarity to the response curves shown in figure 6-103. During adjustment, insure that an on-scale indication is present on the IF/BB LEVEL meter of the demodulator display unit. The RETURN LOSS (dB) control of the demodulator display unit is the only control used to maintain an on-scale indication. The values shown are typical and acceptable limits of differential delay (Y2) and differential gain (Yl)characteristics. Typical values for well aligned modules are on the order of 1.0 to 1.5 ns differential delay and 1 percent differential gain.

(23) Set the SWEEP WIDTH (MHz) COARSE and FINE of the transmission generator to 0, then check the crossover voltage by connecting a multimeter set to measure not more than + 0.3 volts across test points TP1 and TP2 on the limiter-discriminator module. DO NOT leave the multimeter connected when observing response curves. Typical results for properly aligned modules range between 0 and 0.25 V dc. If crossover voltage is not within specification, adjust R31 to bring the crossover below 0.3 V dc.

(24) On the transmission generator, reset SWEEP WIDTH (MHz) COARSE and FINE controls to 10 and 3 respectively. Readjust circuit components to obtain acceptable group delay and linearity characteristics where the crossover voltage does not exceed+ 0.3 V dc.

(25) Measure the baseband power by reducing the sweep width on the transmission generator to 0 and adjusting the BB POWER (-dBm) control on the demodulator display to obtain an indication of 0 on the IF/BB LEVEL meter. The baseband power shall be -23 dBm (minimum) for 140 kHz RMS deviation. If baseband power is not within specification, a new combination of adjustments must be found resulting in the acquisition of all specified parameters: group delay, linearity, crossover voltage, and baseband power.

(26) Repeat the input return loss adjustments, until satisfactory linearity, delay, output level, and crossover are achieved, in addition to the 26-dB return loss.

f. Intermodulation Distortion Test. This procedure is used to evaluate the linearity characteristics of the limiter-discriminator module. The intermodulation distortion test is the final major performance test of the module. The levels and frequency slots used in this test are based upon 600-channel loading conditions. A discussion of this type of test, and the modifications required for other channel loadings, appears in chapter 5. The test equipment setup is shown in figure 6-104. The deviator module used in this procedure must be properly operating.

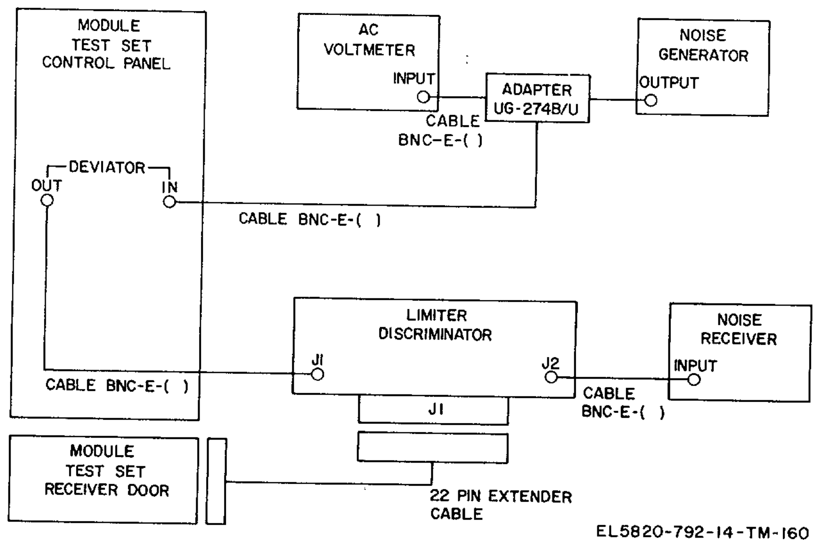


Figure 6-104. Limiter-discriminator module intermodulation distortion, test equipment setup.

(1) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(2) Adjust the 28-volt power supply in the module test set for 28 ± 0.1 V dc.

(3) Adjust the 6-volt power supply in the module test set for -6 ± 0.06 V dc.

(4) On the noise generator, set the meter range switch to RED. Set the dial attenuator to 35 dB. Set the noise generator 60 kHz high- and 2540 kHz low-pass filters to their IN positions and all band-stop filters to their OUT positions.

Set noise generator output level to 4.8 mV/75 ohms (-35 dBm) as read on ac voltmeter.

(5) Set the noise receiver frequency selector to 70 kHz, then adjust the attenuator controls to produce a meter reference indication.

(6) Read and record the attenuator setting of the noise generator.

(7) Switch in the 70-kHz band-top filter on the noise generator.

(8) Set the attenuator controls of the noise receiver to produce the same level as reference 1.

(9) Read and record the attenuator settings of the noise receiver. Label the reading as reference 2.

(10) Subtract reference 1 from reference 2 to obtain the noise power ratio at the 70-kHz slot.

The resulting noise power ratio shall not be less than 50 dB (54 dB typical).

(11) Set the 70-kHz band-stop filter switch to its out position.

(12) Repeat steps (5) through (10) using 1002 kHz instead of 70 kHz.

(13) Set the 1002-kHz band-stop filter switch to its out position.

(14) Repeat (5) through (10) above using 2438 kHz instead of 70 kHz.

g. Deemphasis Network Alignment. The following procedure is used to align the deemphasis network. Either one of two networks may be used, depending upon the voice channel capacity of the terminal. The frequencies used for alignment of each type of network are shown in the chart which follows.

(1) Remove the top cover of the module.

(2) Connect test equipment as shown in figure 6-105.

(3) Perform steps in paragraph 6-50f(23) through (29).

(4) Adjust inductor L1 (deemphasis coil) for a level of --25 ± 0.2 dBm (-34 ± 0.2 dB indicated) at the module output as shown on the AC voltmeter.

(5) Perform steps in paragraph 6-50f(3) and (32).

(6) Readjust inductor L1 slightly if required to obtain required level on AC voltmeter.

(7) Repeat (3) through (6) above until both F-pivot and F max are within specifications.

(8) Disconnect all test equipment and replace module cover.

DEEMPHASIS NETWORK	Voice channels	$f_{resonant}$	f_{piv}	f_{max}	f_{nun}
368-11360-5	240	1315 kHz	640 kHz	1052 kHz	105 kHz
368-11360-7	600	3180 kHz	1540 kHz	2540 kHz	25A kHz

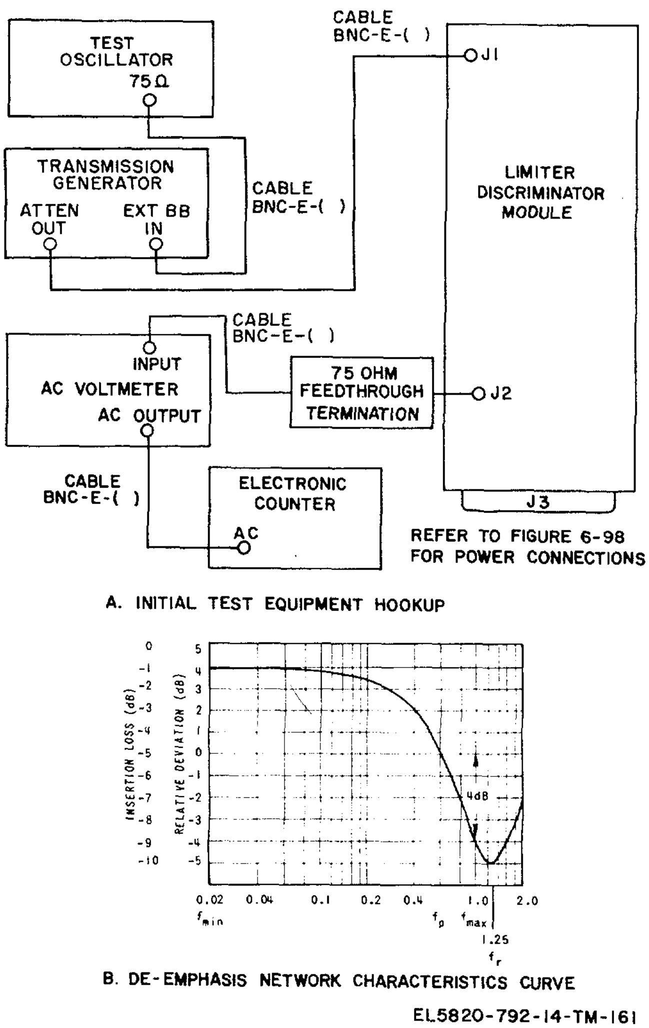


Figure 6-105. Multiplex frequency response test and deemphasis network response.

Section XII. LOCAL OSCILLATOR (368-42299)

6-52. Introduction

The local oscillator is used as a reference oscillator in AFC control of the radio transmitter, and as a local oscillator in the radio receiver. The frequency range is between 4.33 GHz and 5.3125 GHz which corresponds to the G band. This range is covered by two fundamental oscillator bodies.

6-53. Functional Description

a. The functional block diagram is shown in figure

6-106. The crystal oscillator is a grounded base oscillator with a fifth overtone series resonant crystal in the feedback circuit the oscillator generates a stable reference frequency in the 90 to 115-MHz range. The complete crystal part number is constructed using a crystal drawing number followed by seven digits representing the crystal frequency. The first three digits of the seven-digit crystal frequency represents a whole number and the last four digits represents the fractional part of a whole number. An example is as follows:

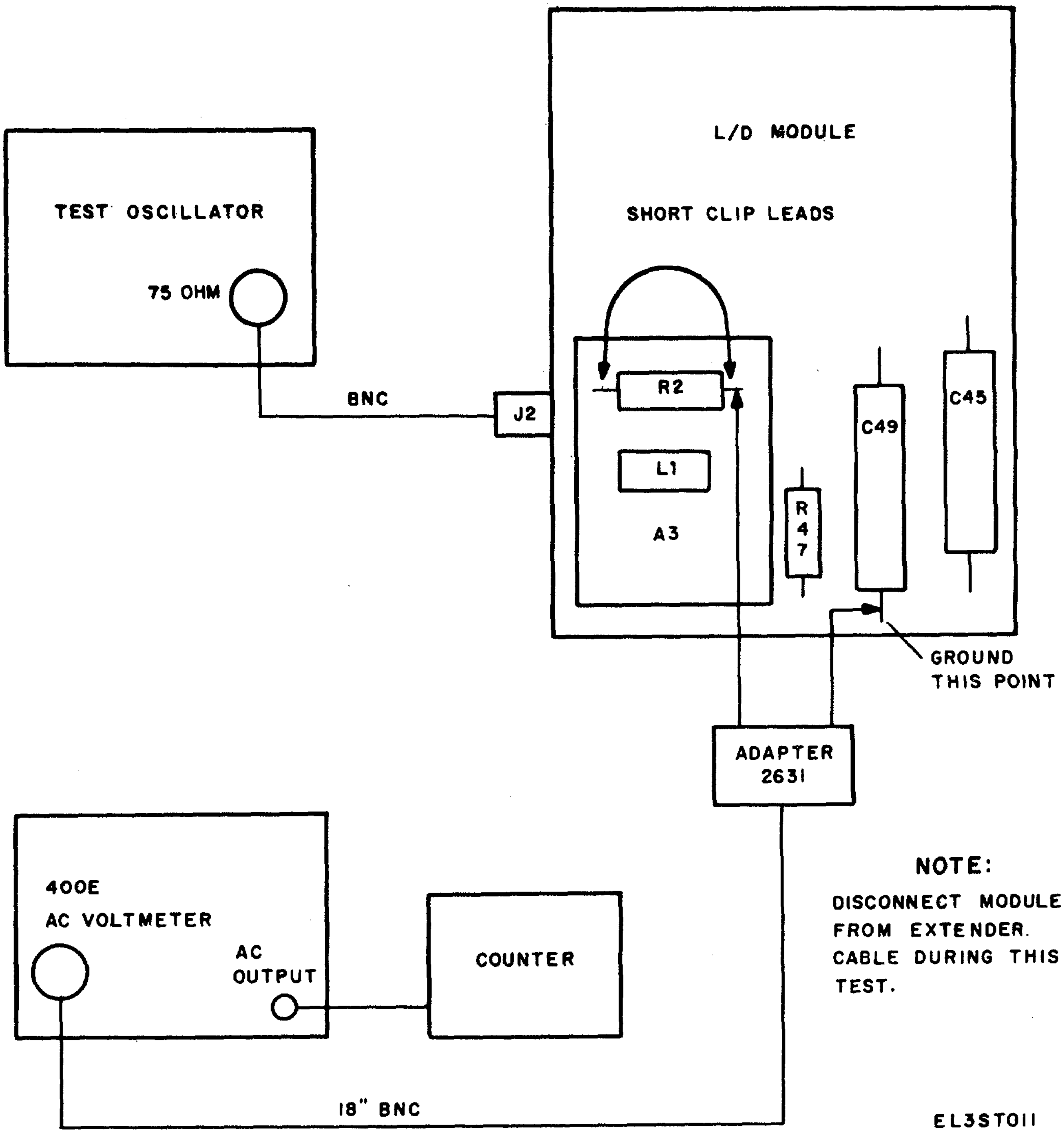


Figure 6-105.1. Multiplex frequency response test and deemphasis network response, alternate test procedure.

COMPLETE CRYSTAL PART NO.		CRYSTAL FREQUENCY
364-8029 0989489	=	98.9489 MHz
364-8029 1057670	=	105.7670 MHz

1057670 — FRACTIONAL FREQUENCY
1057670 — WHOLE FREQUENCY
364-8029 — CRYSTAL DRAWING NO.

The crystal frequency for a given application may be 70 MHz above or below the RF operating frequency. The crystal frequency also depends upon the multiplication factor of the frequency source as indicated in the technical characteristics. The equation with an example are provided as follows:

$$\text{Crystal Frequency} = \frac{\text{RF operating frequency} \pm 70\ \text{MHz}}{\text{Total multiplication factor of source}}$$

$$\text{Crystal Frequency} = \frac{(5063-70)\ \text{MHz}}{48} = \frac{104.020\ \text{MHz}}{48}$$

Crystal Part No. = 364-80291040200

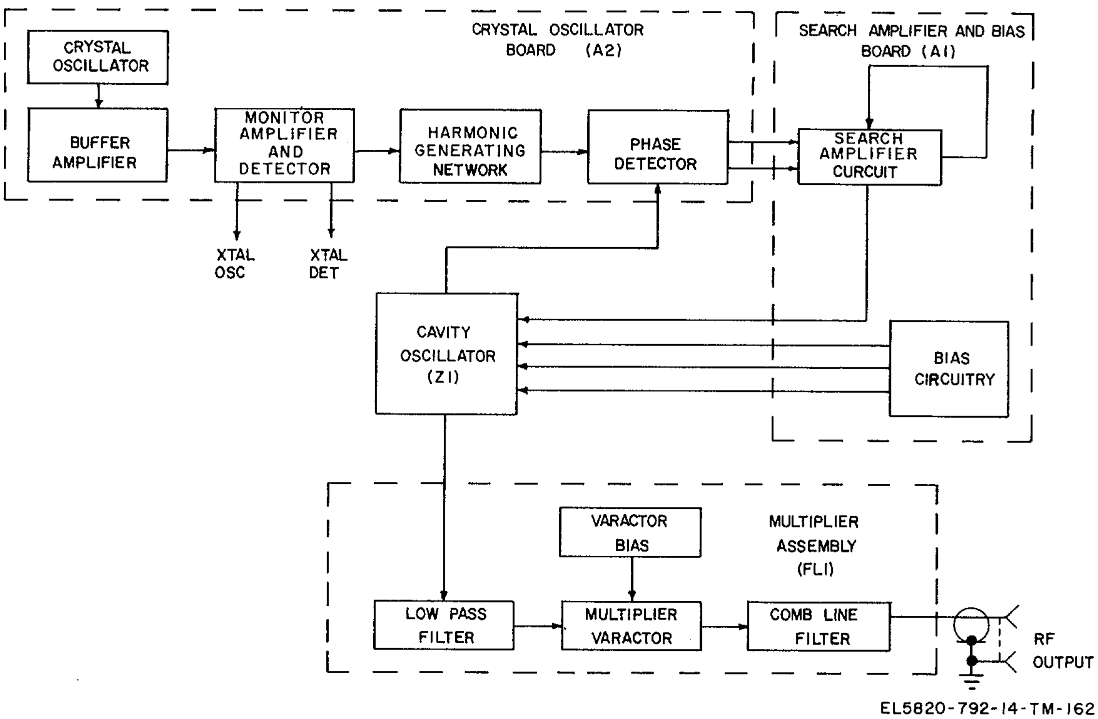


Figure 6-106. Local oscillator, functional block diagram.

b. The crystal oscillator is followed by an untuned buffer amplifier which provides a stable load for the crystal oscillator and isolation between the oscillator and the remaining circuitry. The output of the buffer amplifier passes through a monitor amplifier and detector to a harmonic generating network. The monitor amplifier and detector provide outputs for checking the crystal output frequency and level. The harmonic generating network develops harmonics (10th through 20th) for use by the phase detector.

c. The phase detector compares the harmonics of the crystal oscillator signal with the output sample of the cavity oscillator signal and generates an error signal. The output error signal is coupled to a search amplifier circuit where it is amplified and then applied to a varactor diode located within the cavity oscillator. Variations in voltage causes the interbarrier capacitance of the varactor diode with the cavity to vary, thereby changing the resonant frequency. When lock is lost, the error voltage applied to the search amplifier causes this circuit to apply a sawtooth signal (approximately 15 volts peak-to-peak at a 100-Hz rate) to the varactor diode in the cavity oscillator. This causes the cavity frequency to be swept above and below the desired frequency by approximately 20 MHz. When the frequency of the cavity oscillator is swept to the frequency of the crystal oscillator harmonic, a zero beat occurs and the search amplifier is turned off. The correction voltage (dc) phase locks the cavity oscillator to the harmonic of the crystal oscillator.

d. The output of the cavity oscillator passes through a low-pass filter to a multiplier varactor. The high harmonic output of the multiplier varactor is passed through a comb-line filter which is resonant at the desired RF output frequency.

e. The technical characteristics are as follows:

Part number	True manufacturers P N	Frequency range
368-42299	MSC-49X	4.33GHz-4.93GHz
368-42299-37	MSC-51X	4.8125GHz-5.3125 GHz
frequency stability	....	± 0.005%
(over temperature range	....	
-30° C. to +60° C.).	....	
Multiplication factor:	....	
4.33GHz-4.93GHz units	....	44
4.8125GHz-5.3125GHz	....	48
DC power requirements	....	+20 ± 0.5 V dc 500 mA
	....	dc (max)
Crystal frequency range	....	90 to 115 MHz
Its' output impedance	....	50 ohms
Crystal monitor impedance	....	50 ohms
Main power output level	....	5 mW (+7 dBm)
Monitor power output level	....	0 dBm ± 3 dB

6-54. Maintenance Data

a. Performance Test and Trouble Analysis Procedure. The following subparagraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. Figure 6-107 shows the initial test equipment setup.

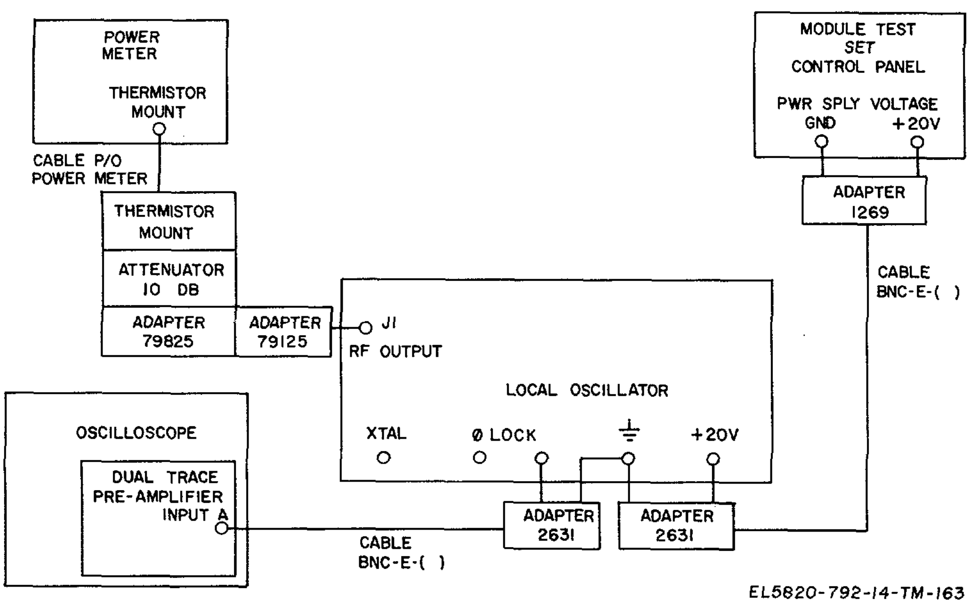


Figure 6-107. Local oscillator, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments.

CAUTION

Do not apply power to the local oscillator until a load is connected to the RF output.

(1) Set all test equipment power switches to their ON positions; allow the test equipment to stabilize for 20 minutes.

(2) Refer to paragraph 6-55c for crystal installation.

(3) Determine the frequency of the installed crystal.

(4) On the power meter, set MOUNT RES to 200 Ω and the RANGE control to 10 mV.

(5) Connect the equipment as shown in figure 6-107, except for the oscilloscope. Use figure 6-108 for the location of local oscillator connection points, test points and controls.

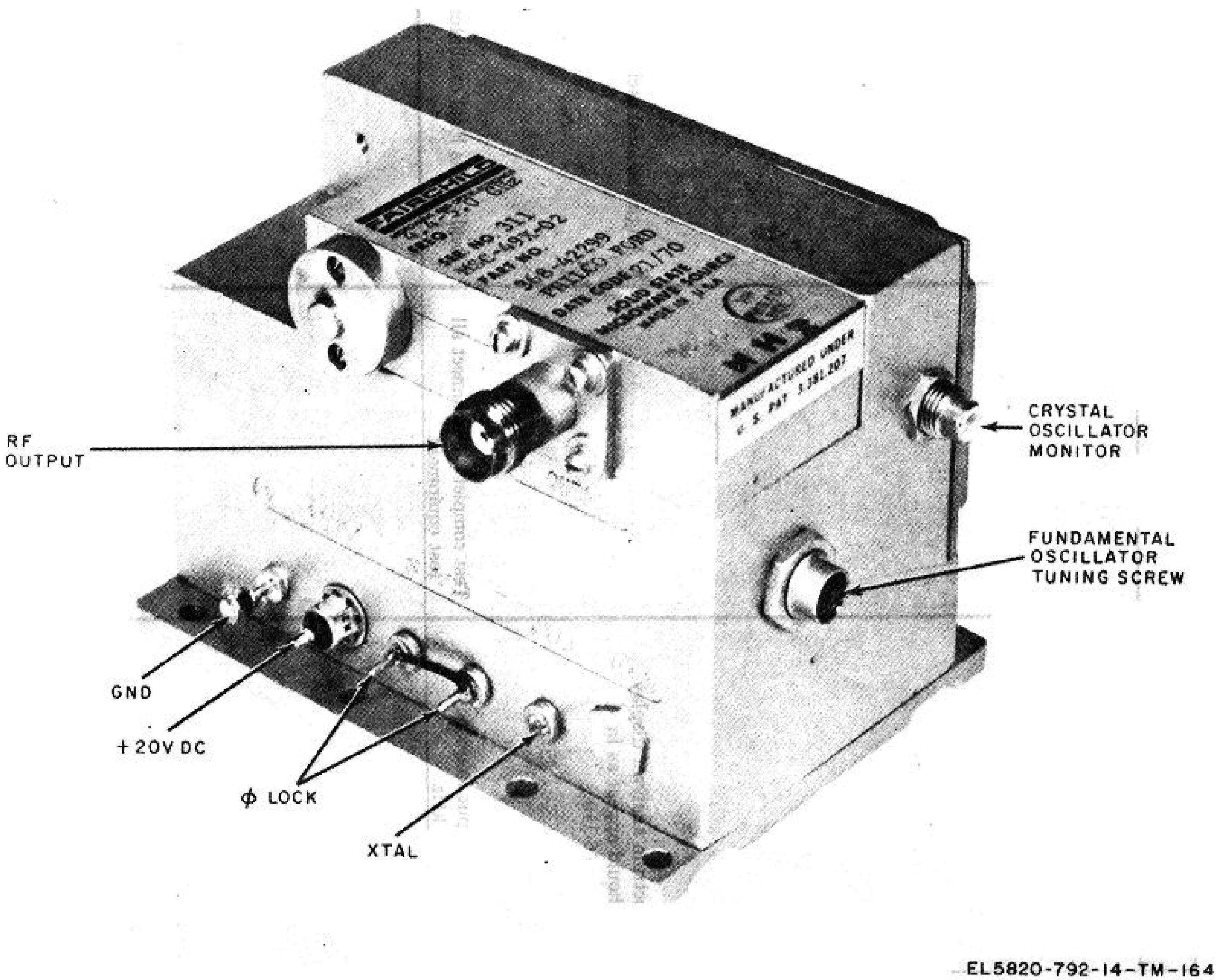


Figure 6-108. Local oscillator, connection points and controls.

d. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
1	Read and record the output power indicated by the power meter, and multiply by the attenuation factor.	5 mW min	....	Check frequency source for damage; proceed to step 2.
2	Set a multimeter FUNCTION switch to +, and its RANGE to 30 V, then connect the meter between LOCK and ground terminals.	10± 1 V dc	....	Align the oscillator.
3	Configure the test equipment as shown in figure 6-109. Take care to observe the polarity of the 1269 and 2631 adapters when preparing to connect dc power to the local oscillator.			
4	Set the oscilloscope controls as follows: TIME/CM to 1 HORIZONTAL DISPLAY to A			
5	Set the spectrum analyzer controls as follows: VERTICAL DISPLAY to LOG VIDEO FILTER to down DISPERSION RANGE o MHz/CM DISPERSION to 10 COUPLED RESOLUTION to 500 IF ATTEN DB to OFF			
6	Tune spectrum analyzer to the local oscillator RF output frequency.	Spectrum analyzer display .... should appear as in figure 6-110.	....	Align the local oscillator.
7	Transfer the spectrum analyzer cable to the 3-12.4GHz input of the frequency converter/electronic counter.			
8	On an electronic counter, set the SENSITIVITY control to PLUG IN.			
9	Adjust the frequency converter controls until the electronic counter indicates the local oscillator frequency.	Desired output frequency,.................... f_o ± 250 kHz.	Test complete. Disconnect all test equipment.	Realign the local oscillator.

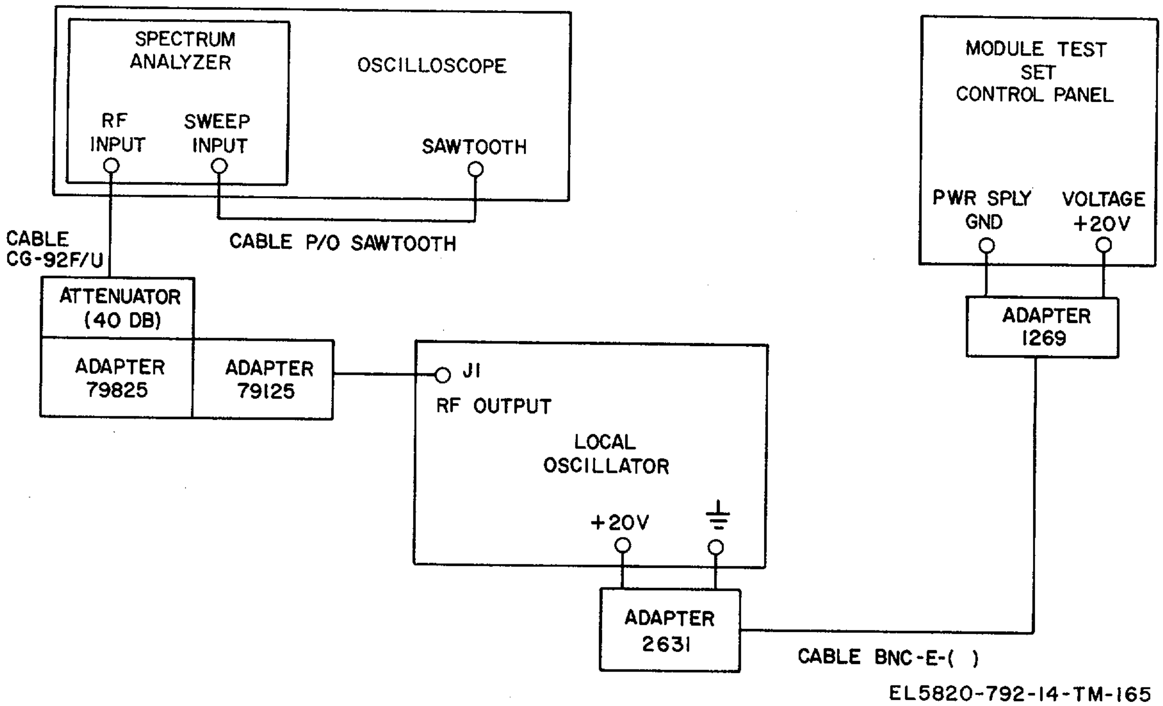


Figure 6-109. Local oscillator, spectrum analyzer setup.

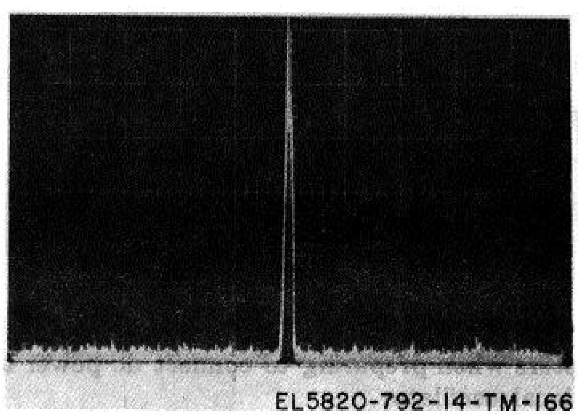


Figure 6-110. Local oscillator, spectrum analyzer waveform.

6-55. Alignment Data

a. General. The following procedures should be performed whenever the performance test indicates that the local oscillator frequency, or output level is not in accordance with its technical specifications.

b. Test Equipment Setup. The test equipment setup used for the alignment procedures is the same as that described in paragraph 6-54, unless otherwise indicated in the procedure.

c. Crystal Installation. Perform the following installation, refer to figure 6-111.

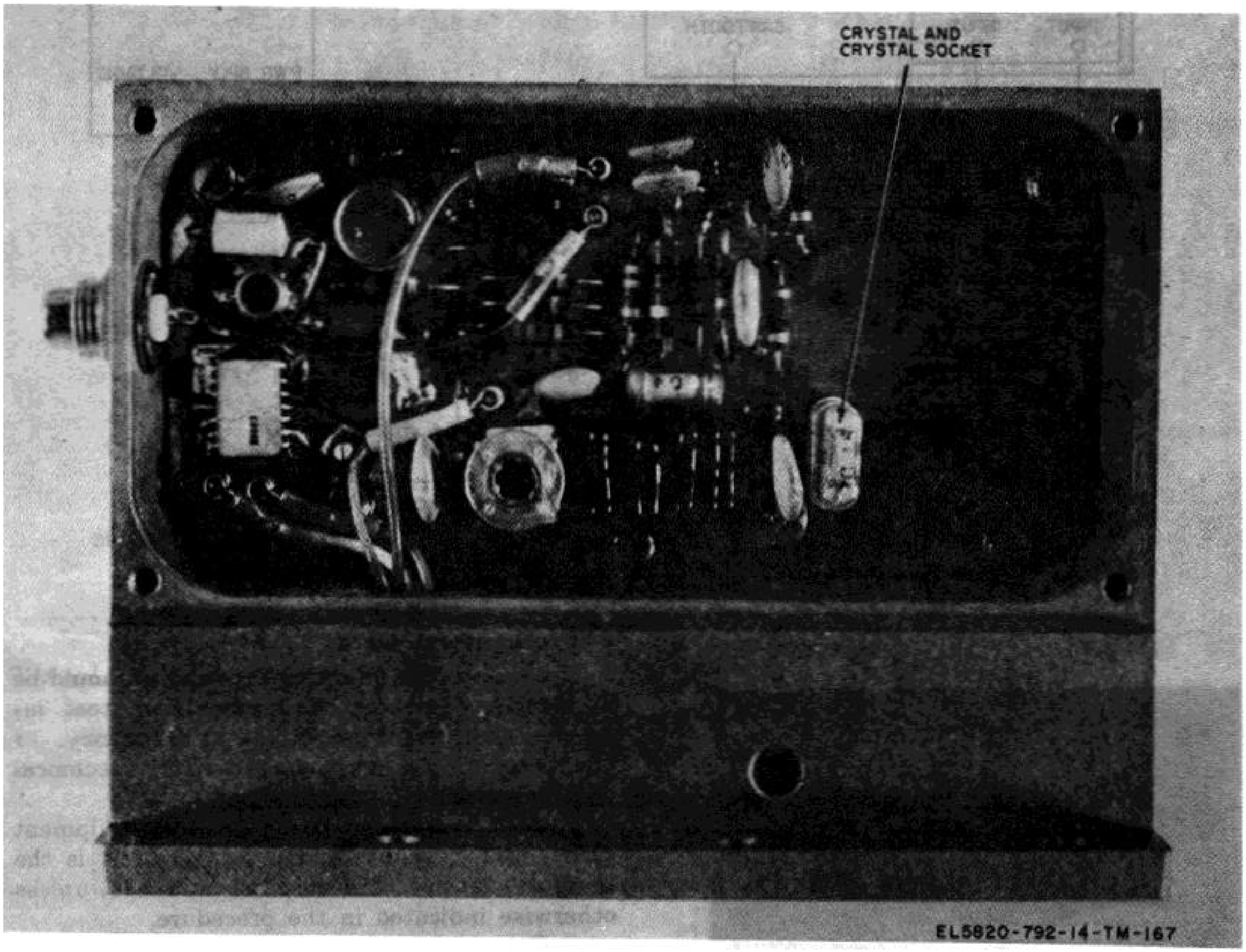


Figure 6-111. Local oscillator, crystal location.

(1) Obtain a crystal for installation or replacement, and verify that the frequency of the crystal is correct. The crystal frequency is printed on the side of the plastic crystal housing.

(2) On the crystal, cut the leads to a length of one-fourth inch.

(3) Remove left-side plate, identified by manufacturer's placard. Four machine screws retain the plate.

(4) Remove the old crystal, if applicable, and install the desired crystal socket. Replace the side plate.

d. Preliminary Adjustments. Perform the following preliminary adjustments.

(1) Check the module test set to be certain that the low-voltage power supply is 20 ± 0.5 V dc.

(2) Observe the polarity of the 1269 and 2631 adapters when preparing to connect dc power to the local oscillator.

(3) Connect the test equipment as shown in figure 6-107.

(4) Install a frequency converter unit in an electronic counter; connect a 3221 adapter to one end of a BNC-E-( ) test cable, then connect the other end to AUX IN 1-200 MHz on frequency converter unit.

(5) Turn on all test equipment and allow the equipment to stabilize for 30 minutes.

e. Alignment. The following steps provide a means to align the local oscillator.

(1) Touch the red lead of the electronic counter test cable to the crystal oscillator monitor of the local oscillator; hold while performing next step.

CAUTION

When tuning a local oscillator, use a proper noninductive plastic tuning tool. Do not use a metallic-bladed screwdriver.

(2) Insert the tuning tool through the XTAL TUNE access hole and adjust the control until the electronic counter indicates the crystal frequency. Extreme tuning accuracy is not required at this point.

(3) On the oscilloscope, set the INPUT SELECTOR to AC the VOLTS/CM control to 5, and the VARIABLE to CALIBRATED.

(4) On the oscilloscope, set TIME/CM control to 2 MILLISEC, VARIABLE to CALIBRATED, TRIGGER SLOPE to INT +, and TRIGGERING MODE to AUTO.

(5) The oscilloscope should indicate at least 10V ac peak-to-peak sawtooth waveform at A 50 to 500 Hz rate. Refer to figure 6-112. If there is no sawtooth waveform, or the sawtooth waveform is not per figure 6-112, insert the alignment tool in D. C. ADJ access and adjust the control until a sawtooth waveform just appears and appears exactly as shown in figure 6-112. Note the approximate position of the tuning tool slot. Continue tuning the control until the waveform degenerates into a straight line again. Note the position of the tuning tool slot. Set potentiometer midway between these extremes.

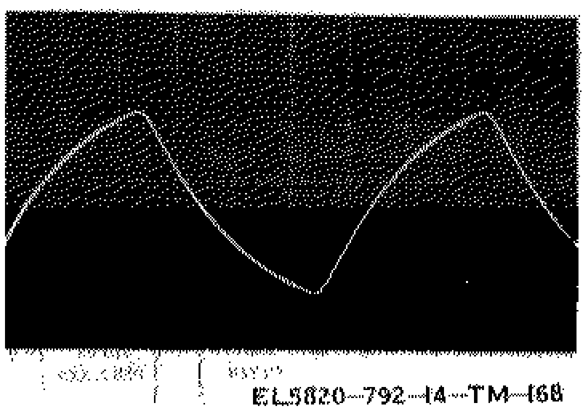


Figure 6-112. Local oscillator, search waveform.

(6) Observe the waveform on the oscilloscope. Slowly tune the frequency tuning adjustment in either direction until the sawtooth waveform degenerates into a straight line: refer to figure 6-113. A straight line indicates that the fundamental oscillator is locked in phase with the resonant frequency of the crystal. If the unit is operating near the top of the frequency band, two lock positions occur. The correct lock position is the second position when tuning in a clockwise direction.

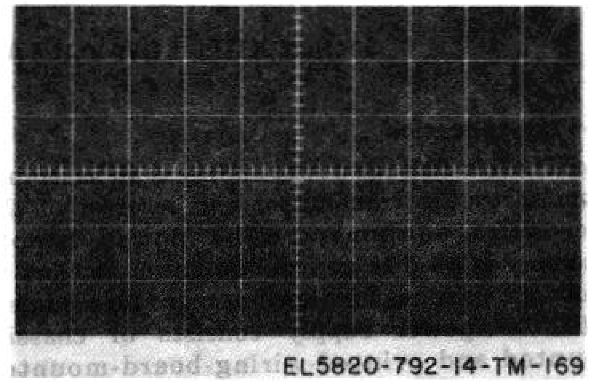


Figure 6-113. Local oscillator, phase-lock waveform.

(7) When the oscillator is in lock, set a multimeter FUNCTION control to 20 K ohm/V, and the RANGE control to 10.

(8) Connect the negative lead of the multimeter to ground and either of the ∅ LOCK terminals.

(9) Check for final phase-lock condition by slightly rocking the frequency tuning adjustment in either direction and observing the dc level of the waveform. As the tuning screw is varied slightly, the, voltage level of the waveform present at ∅ LOCK terminals should change. If the voltage changes rapidly, the fundamental oscillator has not phase-locked on the correct position, and it is necessary to repeat the alignment between steps (6) and (8).

(10) Slowly adjust oscillator tuning adjustment in the direction which increases the indicated voltage on the multimeter; stop the adjustment as soon as the oscilloscope indicates the search sawtooth. Carefully back off adjustment until the oscilloscope indicates phase lock. Record the multimeter indication noted at this point. Requirement is +16 VDC ± 2 volts.

(11) Adjust the oscillator tuning adjustment in the direction which 'decreases indicated voltage while observing the multimeter and oscilloscope. As in step (10), stop adjustment as soon as oscilloscope indicates the search sawtooth: then carefully back off adjustment until the oscilloscope indicates phase lock. Record the multimeter indication at this point. Requirement is +3 VDC ± 2 volts.

(12) Adjust oscillator tuning adjustment between the limits of steps (10) and (11) until the multimeter indicates +10 VDC. Observe oscilloscope for phase lock.

(13) Alignment is now complete. Disconnect all test equipment.

(14) Perform Performance Tests in accordance with paragraph 6-54*a* through *d*.

Section XIII. LOW-VOLTAGE POWER SUPPLY (398-12051-1)

6-56. Introduction

a. The low-voltage power supply is an assembly common to the transmitter and receiver of the microwave equipment. The power supply assembly is used to convert dc power sources to dc output voltages for distribution to all modules.

b. The power supply consists of chassis mounted and printed-wiring-board-mounted components. The physical size of the basic power supply permits the required identical units to be mounted side-by-side on the same panel, hence the term "dual" low-voltage power configuration.

6-57. Functional Description

A functional block diagram of the low-voltage power supply appears in figure 6-114. The power supply, provides several output potentials to a terminal strip at the rear of the unit. The positive 28-volt supply furnishes the general operating .potentials to most components and modules of the terminal. The negative 6-volt supply provides operating voltages for several modules, such as the IF amplifier, baseband combiner, alarm amplifier assembly and deviator. A positive 20 volt supply is used to power the local oscillators mounted on the RF panel. All output voltages, except the 65-volt power supply, are regulated to maintain the supply voltages within the required ratings; the 65-volt power supply is not used in the AN/FRC-154(V) or the module test set.

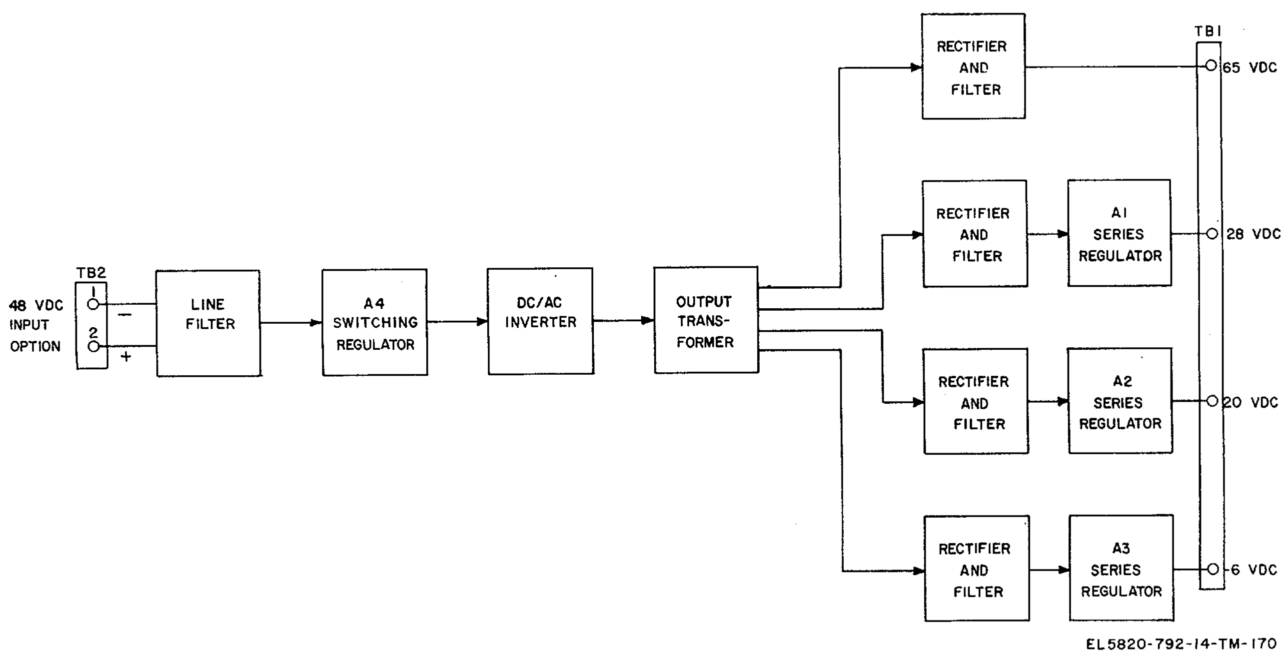


Figure 6-114. Low-voltage power supply, block diagram.

6-58. Circuit Analysis

a. Input Section. The schematic diagram of the power supply is shown in figure FO-26. The power source positive wire is connected to TB2-2 and the negative wire is connected to TB2-1. Power is delivered through switch S1 and fuse F1 to a steering diode to protect the unit from damage due to incorrect connection of power source polarity. The power is then applied to a line filter 6-184 composed of capacitors C22 and C3, and reactor L2. The line filter reduces the switching transients generated in the power supply that reach the power source.

b. Switching Regulator. The basic switching regulator is shown in the simplified schematic diagram (fig. 6-115). The circuit is energized when S1 is closed and current flows through L1 to charge the output capacitor C4 and supply current to load resistor R_L. The voltage across the load resistor rises at a rate determined by the time constant derived from the values of R_L, L2, and C4. At the time the output voltage reaches the desired level, switch S1 is opened. As the switch is opened, the energy stored in L1 generates a reverse voltage across L1 to maintain current flow through L1 in the same direction. Inductor L1 becomes a power source and discharges C4 through the load resistor and through CR6. In the power supply the power transistor Q1 performs the function of the switch. The output voltage is sensed by the voltage divider network R4, R5, and R6 on printed wiring board A4. The desired output voltage is selected by the setting of R5. The integrated circuit A4U1 contains a high gain differential amplifier, a temperature compensated voltage reference, and output driver transistors. A simplified diagram of the integrated circuit appears in figure 6-116. When the power is applied to the power supply no voltage appears at the sensing terminal No. 6 of A4U1. The differential amplifier compares this voltage to the voltage reference (terminal 5). Since terminal 6 is less positive than terminal 5, transistor Q_c is off and current flows into terminal 3 through resistor R_A and into the base-to-emitter junction of Q_A to terminal 8. Terminal 8 of A4U1 is connected to the output voltage and is at zero potential. The base current of Q_A causes collector current to flow from terminal 3 through resistor R_A. As the voltage rises across R_B , the voltage developed across terminals 3 and 2 of A4U1 is applied to the base-to-emitter junction of A4Q2. Collector current I_C Q2 is drawn through resistor A4R1 and develops a voltage across A4R1 to turn on A4Q1. Collector current I_C Q1 flows through the base-to-emitter junction of Q2 which provides sufficient drive to turn Q1 into saturation. The voltage of C4 now rises to the desired operating voltage level. An overvoltage protection circuit is a permanent part of the switching regulator and protects against excessive voltages from being applied to the dc/ac inverter circuit and the various circuits which follow. The circuit senses the voltage regulator output by means of Zener A4VR2 and resistor A4R7, and gates the silicon-controlled rectifier CR5 on. This action provides crowbar action across the input of the switching regulator, and thus opens fuse F2. Resistor R4 limits the current through CR5 while reactor L7 limits the rate of current rise of CR5 to safe limits. Diode CR4 commutates current flowing in L7 after fuse F2 opens, thereby preventing the occurrence of dangerous levels of voltage transients.

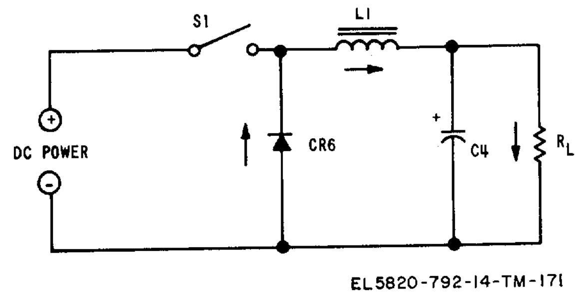


Figure 6-115. Basic switching regulator, simplified schematic diagram.

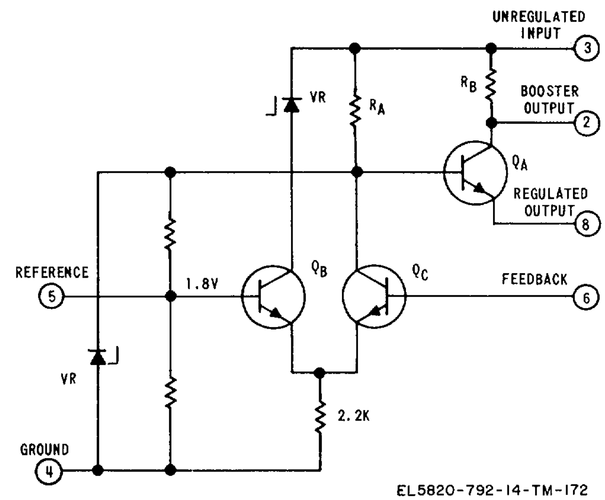


Figure 6-116. Simplified integrated circuit module.

c. Dc/Ac Inverter Circuit. The dc/ac inverter used in this power supply is basically a dual transformer circuit with two switching transistors connected in a common-emitter configuration, as shown in simplified schematic diagram (fig. 6-117). Transformer T1 is a saturating core type (square loop) whereas transformer T2, which is the output transformer, is designed to operate in the linear region. Starting resistor RS provides a slight forward bias for both transistors to insure switching operation under initial heavy loads which can make starting difficult. Operation occurs when feedback is taken from the primary winding to T2, through a feedback resistor R_F to the primary of saturable transformer T1. The secondary of T1 is applied to the transistor bases. When sufficient positive feedback is applied to T1, the polarity of the secondary causes one transistor (assume Q2) to conduct resulting in an induced voltage, equal to the dc input voltage, in winding N_{p22} Transistor Q1 is now driven into the OFF condition. The core of T1 is driven into saturation. Power in the feedback winding N_{P11} decreases due to an increase in the magnetization current causing a larger voltage drop across the feedback resistor R_F. As the magnetization current is increased further, the drive necessary to maintain transistor conduction is removed. The energy stored in all windings reverses the polarity of the voltage and oscillation reverses. Since the output transformer T2 does not saturate, the collector current is determined primarily by the load on the secondary. Large spikes which are normally created in a single transformer converter do not exist here in the dual transformer converter since a minimum of energy is stored in the leakage inductance of T2, reducing the danger of transistor damage. The dual transformer configuration differs from the conventional converter in that switching is determined by the small saturating "square core" transformer, while the larger nonsaturating power transformer handles the feedback and output power transformation. Switching occurs when the ON transistor is pulled out of saturation by the decrease in base current which occurs when the "square core" transformer T1 saturates. As the core reaches saturation, the increasing magnetizing current causes an additional voltage drop across the feedback resistor R_F. Thus, the primary of the saturated transformer has less voltage dropped across it, affecting the decrease in secondary or base-drive voltage. Capacitors C1 and C2 help to speed up the switching process. Diodes CR1 and CR2 help to reduce losses by eliminating the need for higher resistance values of R_{B1} and R_{B2} These diodes also enable the value of starting resistance RS to be increased, for more reliable operation, since the diodes appear as an open circuit until the oscillations begin.

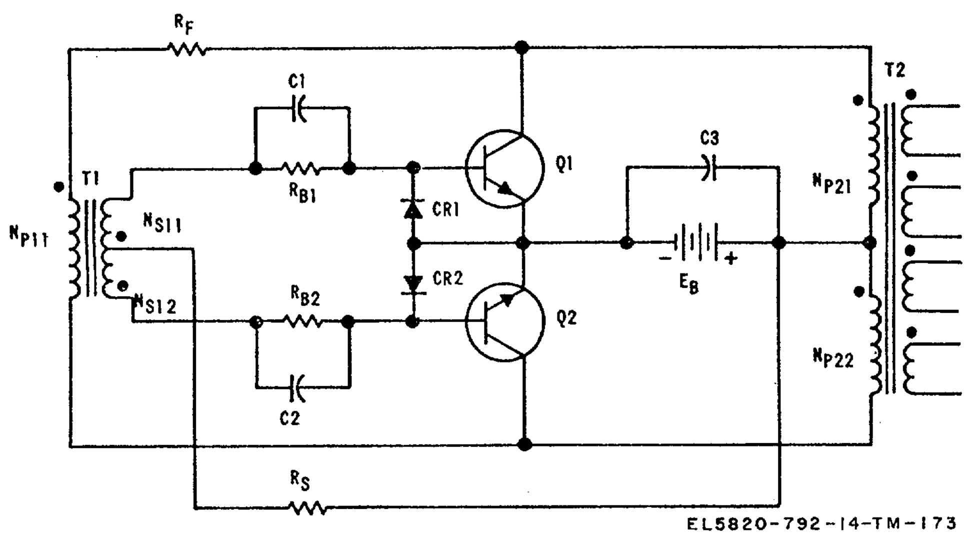


Figure 6-117. Simplified integrated inverter circuit.

d. Output Circuits. As shown in the block diagram of figure 6-114, the output circuits consist of three regulated and one unregulated output, all filtered. Four separate secondary windings on inverter output transformer T2 provide proper voltages and power for the four output circuit load requirements. The 65-volt circuit is fed from a center-tap, full-wave rectifier circuit which is followed by an LC filter network and a fuse for overload protection. The L6, C8 filter network is a ripple reduction filter, whereas the R11, C23, and C24 are de-spiking networks. There is no voltage regulation circuitry associated with the 65-volt output other than its own inherent circuit regulation. The other three output circuits (+28-volt, +28-volt, and -6-volt circuits), are similar in functional design; therefore only the +28-volt dc circuit will be described. A center-tap, full wave, rectifier configuration is used which feeds into a pi-type ripple filter, consisting of choke L3 and capacitors C9 and C10. A de-spiking network R12, C25 is connected across the secondary winding for suppression of unwanted voltage surges and spikes. Another de-spiking circuit, consisting of capacitor C26, is connected from the negative (center-tap) side of the circuit to chassis ground in order to suppress any unwanted noise appearing in the +28-volt circuit. The +28-volt regulator (like the +20-volt and -6-volt regulators) is a series pass transistor type of circuit which regulates the output voltage within specified tolerances for the range of specified changes. The pass transistor is mounted separately from the printed-circuit regulator control card A1 for the +28-volt supply (A2 and A3 for the +20-volt and --6-volt supplies). The A1 card contains a voltage - divider sensing transistor for the pass transistor. The sensing circuit consists of dividing resistors R5, R6, and R7 with R6 adjustable so as to select the nominal output voltage which is to be regulated. The sensed voltage is fed to terminal 6 of A1U1 voltage regulating integrated circuit (fig. 6-116). The sensed voltage at terminal 6 is compared with that at terminal 5 through the operation of the high-gain differential amplifier consisting of transistors Q_B When the voltage at terminal 6 is less positive than that at terminal 5, transistor Q_C is off and current flows into terminal 3 through resistor R_A and into the base-to-emitter junction of QA to terminal 8. Terminal 8 of A1U1 is connected to the output and, at turn-on is at zero potential. The base current of QA causes collector current to pass from terminal 3 through resistor R_B . As the voltage rises across R_B , the voltage developed across terminals 3 and 2 of A1U1 is applied to the base-to-emitter junction of A1Q1. A1Q1 now turns on and injects its collector current I_C Q1 into the base of Q6 of the Darlington pair Q5 and Q6, thus providing a series regulating feature by virtue of the controlled collector-to-emitter voltage drop of Q6, the series pass transistor. The voltage regulating integrated circuit module (type LM305H) used in the other circuits (A2U1 and A2U2) are identical in operation to integrated circuit module (type M205H) used in A1U1, except that the device has a lower maximum operating voltage.

e. Technical Characteristics.

Parameter	Specifications
Input power	43 to 56 V dc; 260 watts max.
Output voltages	28 V dc, adjustable, regulated 20 V dc, adjustable, regulated -6 V dc, adjustable, regulated
28 V dc output:	
Range	27.7 to 28.3 V dc
Maximum load	3.0 amperes (intermittent duty); 2.0 amperes (continuous rating)
Minimum load	0.70 ampere
Maximum ripple	20 mV p-p (maximum)
line and load regulation	±1 %
20 V dc output	
Range	19.6 to 20.4 V dc
Maximum load	0.9 ampere
Minimum ripple	0.04 ampere
Maximum ripple	20 mV p-p (maximum)
Line and load regulation	± 2 %
20V dc output:	
Range	5.9 to 6.1 V dc
Maximum load	0.50 ampere
Minimum load	0.10 ampere
Maximum ripple	20 mV p-p (maximum)
Line and load regulation	±1 %

6-59. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following subparagraphs contain procedures to test the performance of the major circuits, and give probable causes of abnormal indication.

WARNING

Make sure the MAIN POWER circuit breaker on the test set and power supplies are OFF when connecting and disconnecting the equipment.

b. *Preliminary Test.*

(1) Set multimeter FUNCTION switch to OHMS and its RANGE switch to X100.

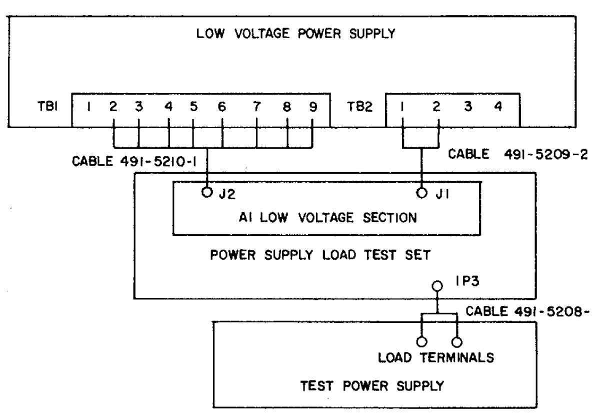


Figure 6-118. Low-voltage power supply, initial test equipment setup.

(2) Turn switch S1 on power supply under test to ON.

(3) Verify the condition of lamp DS1 by removing and checking with a multimeter. If good, reinstall lamp, if not, replace with a good lamp.

NOTE

If lamp DS1 is bad, the following two steps will be impossible to perform.

(4) Connect the multimeter leads to TB2-1 and TB2-2. Note the multimeter indicator.

(5) Reverse the multimeter leads and note the multimeter indication. In one direction, the multimeter should indicate approximately 2K ohms, and in the other, the indication should be infinity. If the readings are unsatisfactory, check CR1.

(6) Turn switch S1 on power supply under test to OFF.

WARNING

Make sure the MAIN POWER circuit breaker on the test set and power supply switch S1 are in the OFF position when connecting and disconnecting the equipment.

c. Test Equipment Setup. Connect the test equipment to the low-voltage power supply as shown in figure 6-118.

(1) Set all power switches to ON and allow the test equipment to stabilize for 20 minutes.

(2) Adjust the test power supply output voltage to 48 vdc as indicated by the power supply load test set meter.

(3) Turn on the power supply under test. Use figures 6-119 for location of adjustment controls, and 6-120 and 6-121 for parts location diagrams.

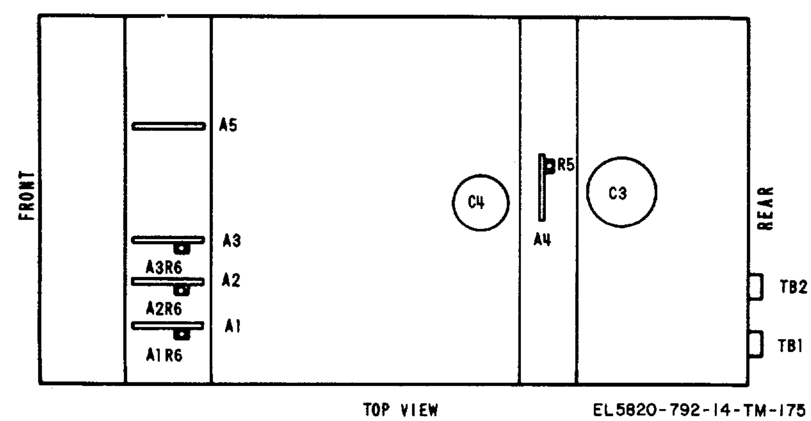


Figure 6-119. Low-voltage power supply, location of adjustment controls.

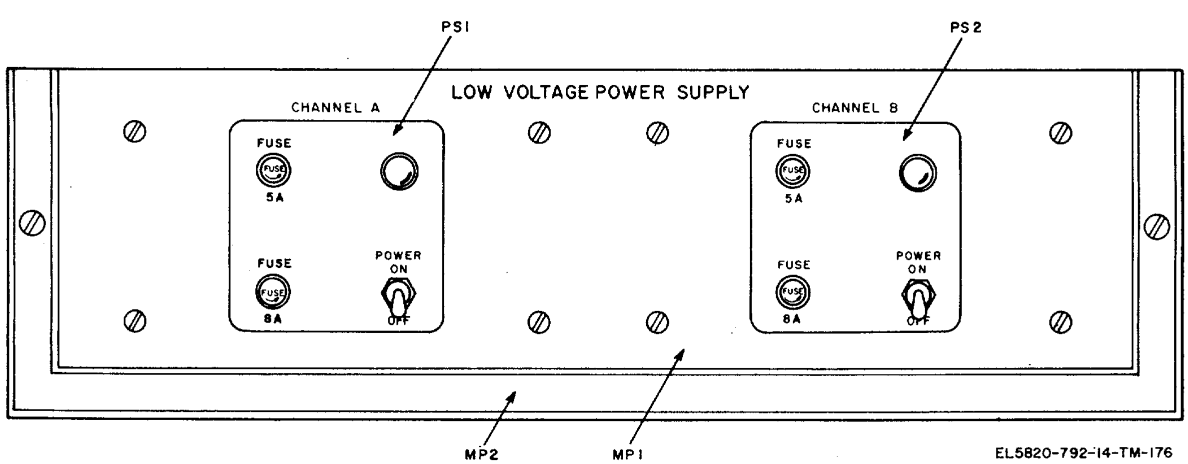


Figure 6-120. Low-voltage power supply, front panel controls.

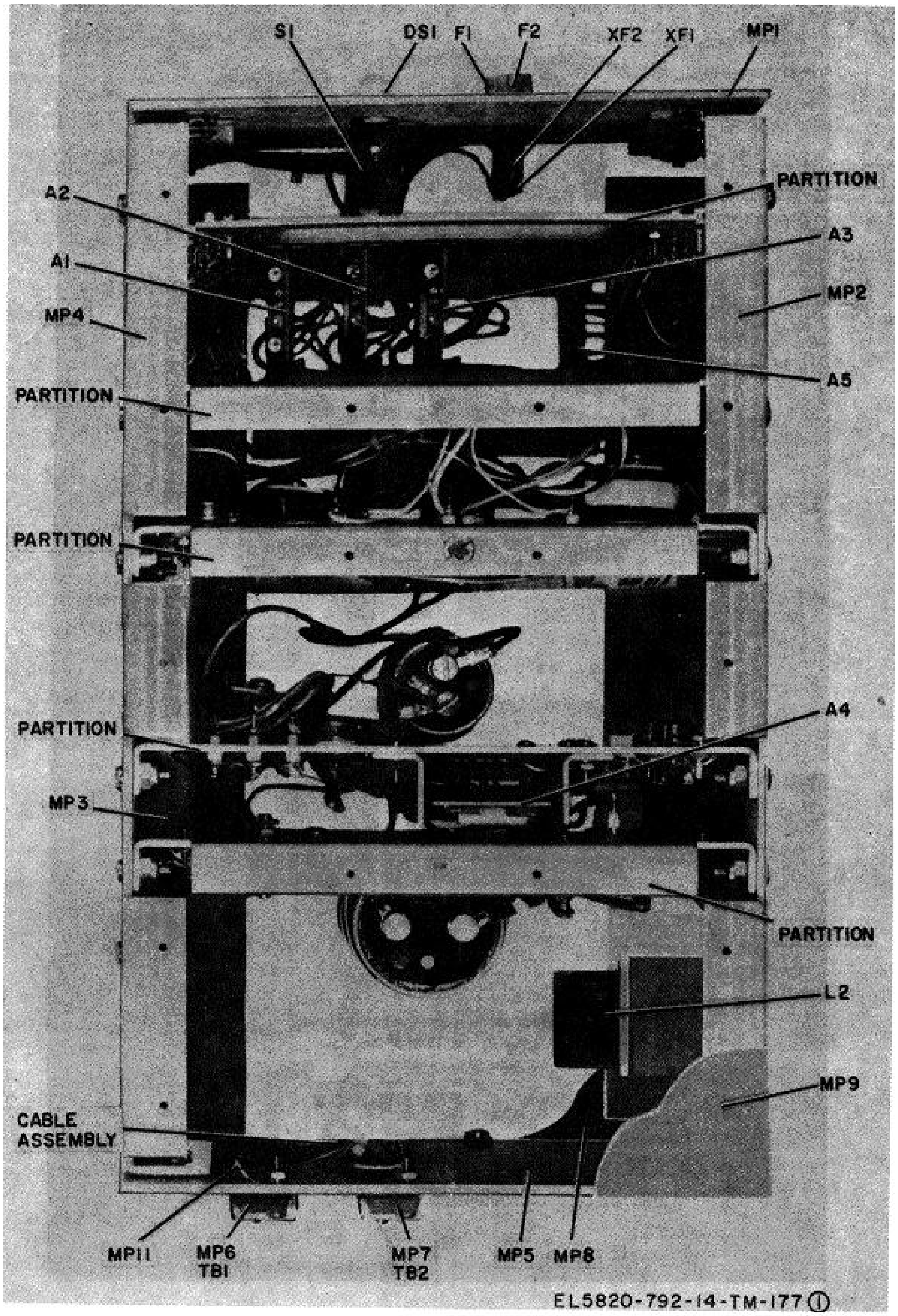


Figure 6-121 (1). Low-voltage power supply, parts location diagram (sheet 1 of 6).

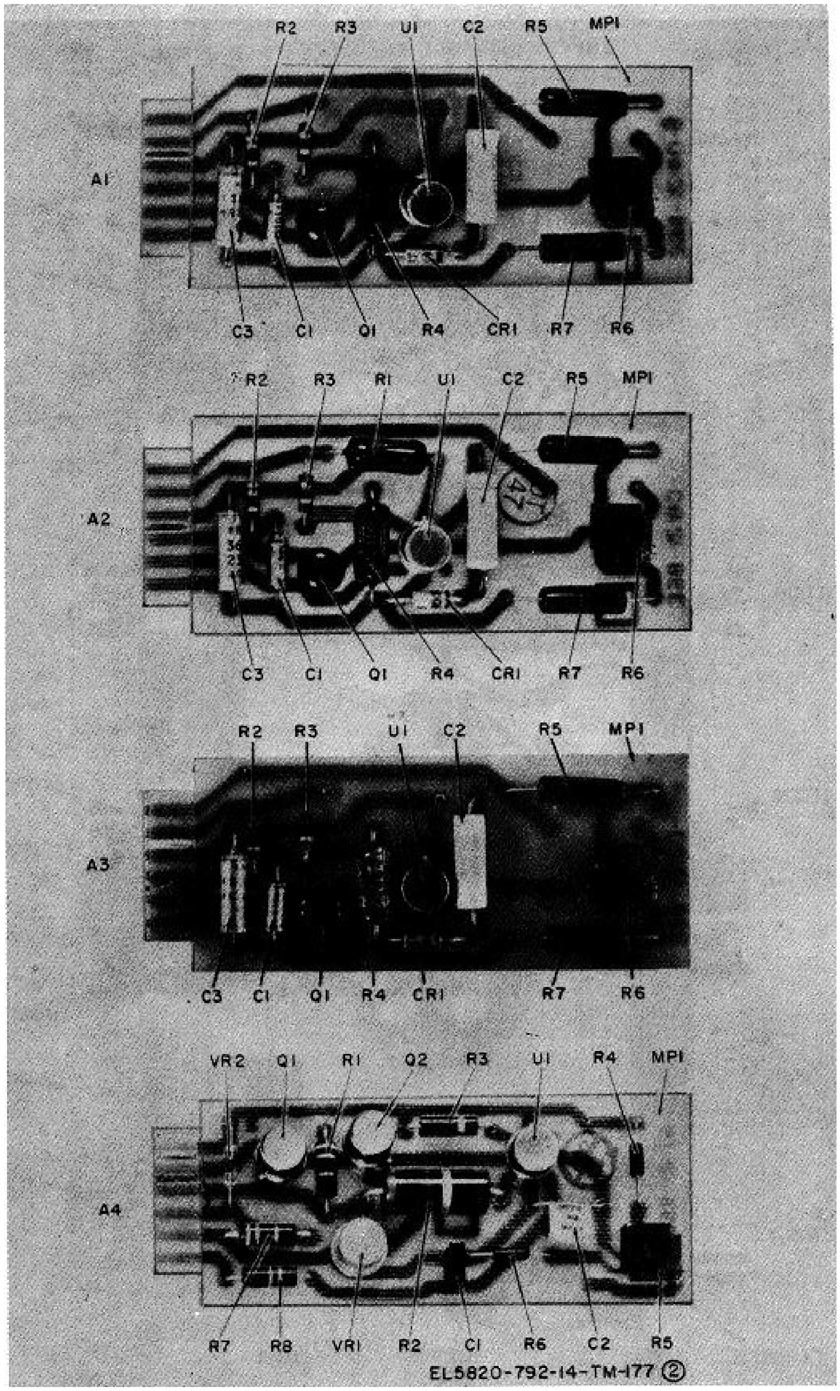


Figure 6-121 (2). Low-voltage power supply, parts location diagram (sheet 2 of 6).

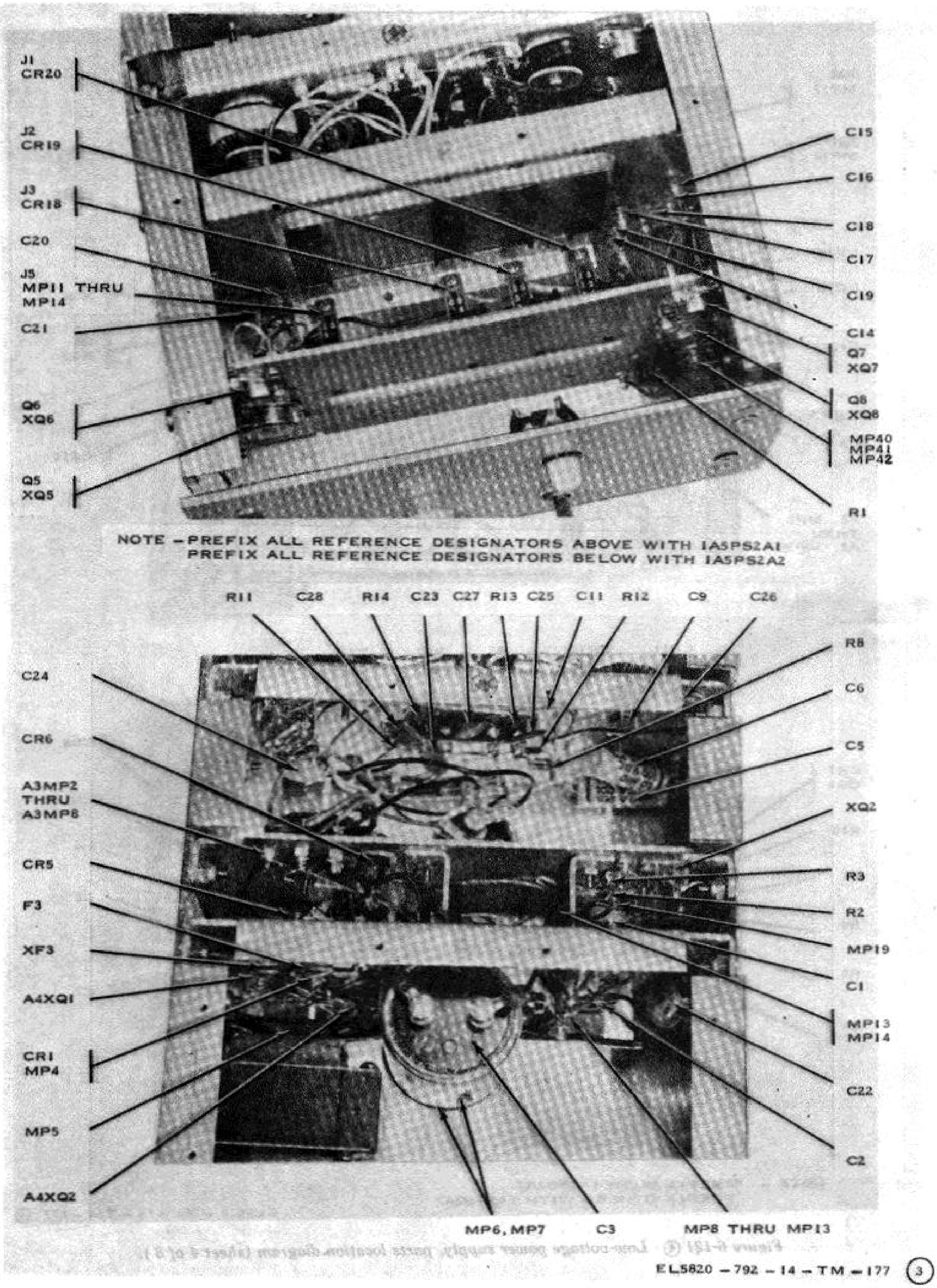


Figure 6-121 (3). Low-voltage power supply, parts location diagram (sheet 3 of 6).

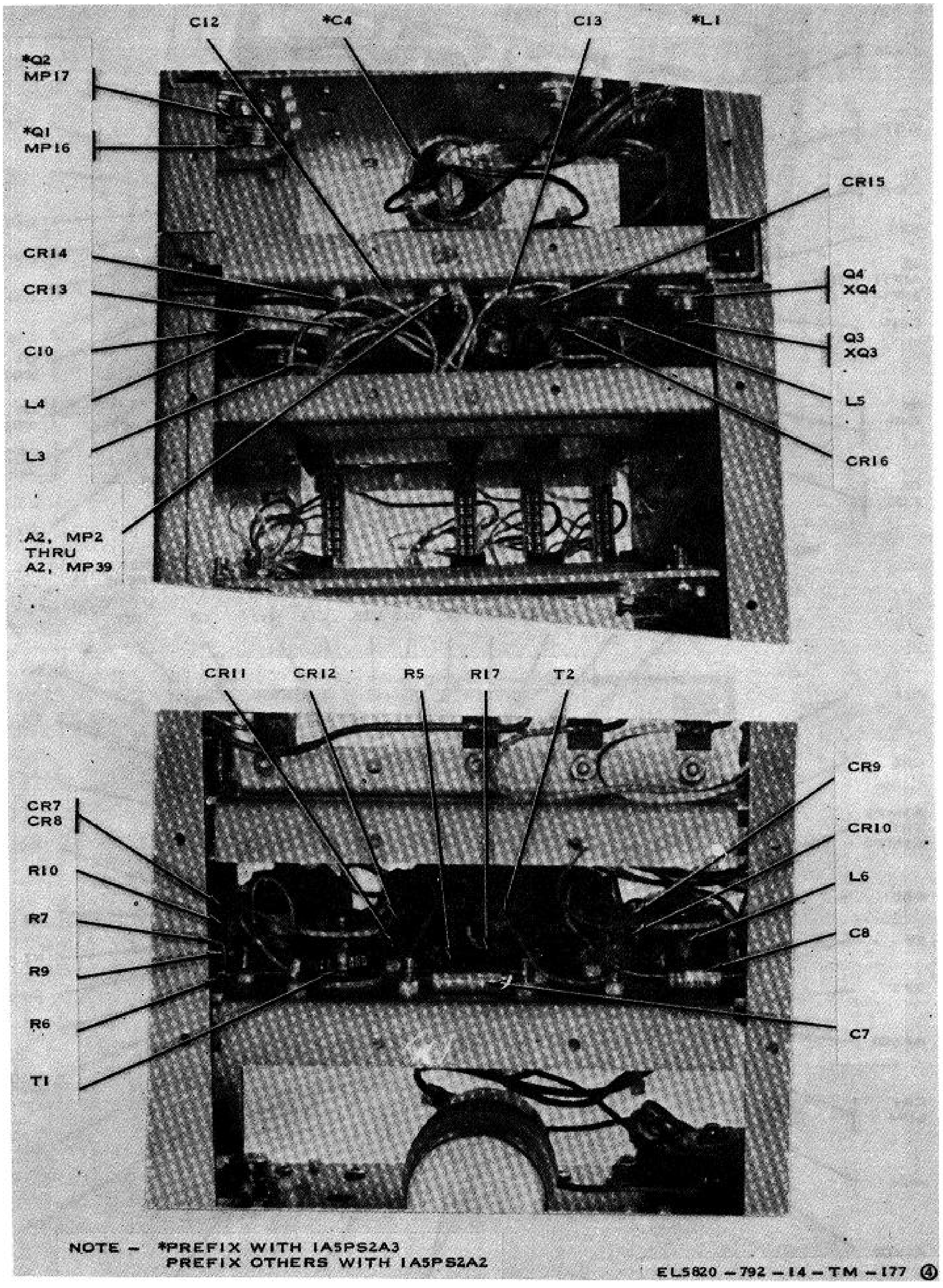


Figure 6-121 (4). Low-voltage power supply, parts location diagram (sheet 4 of 6).

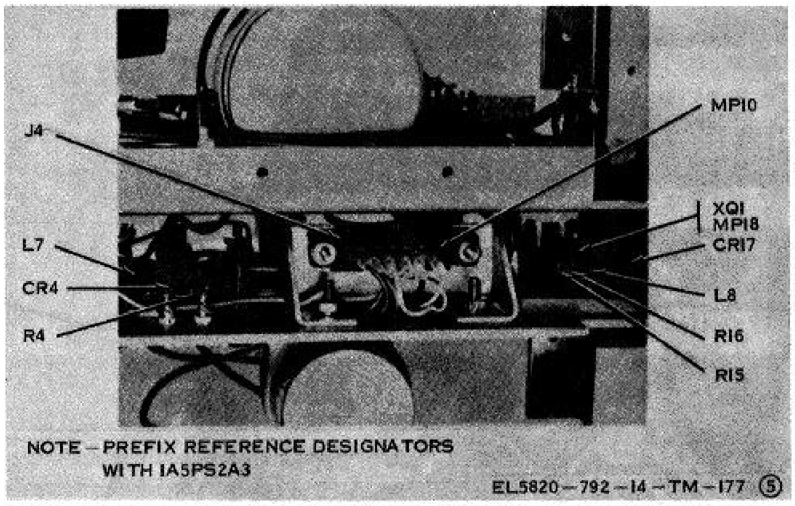


Figure 6-121.(5). Low-voltage power supply, parts location diagram (sheet 5 of 6).

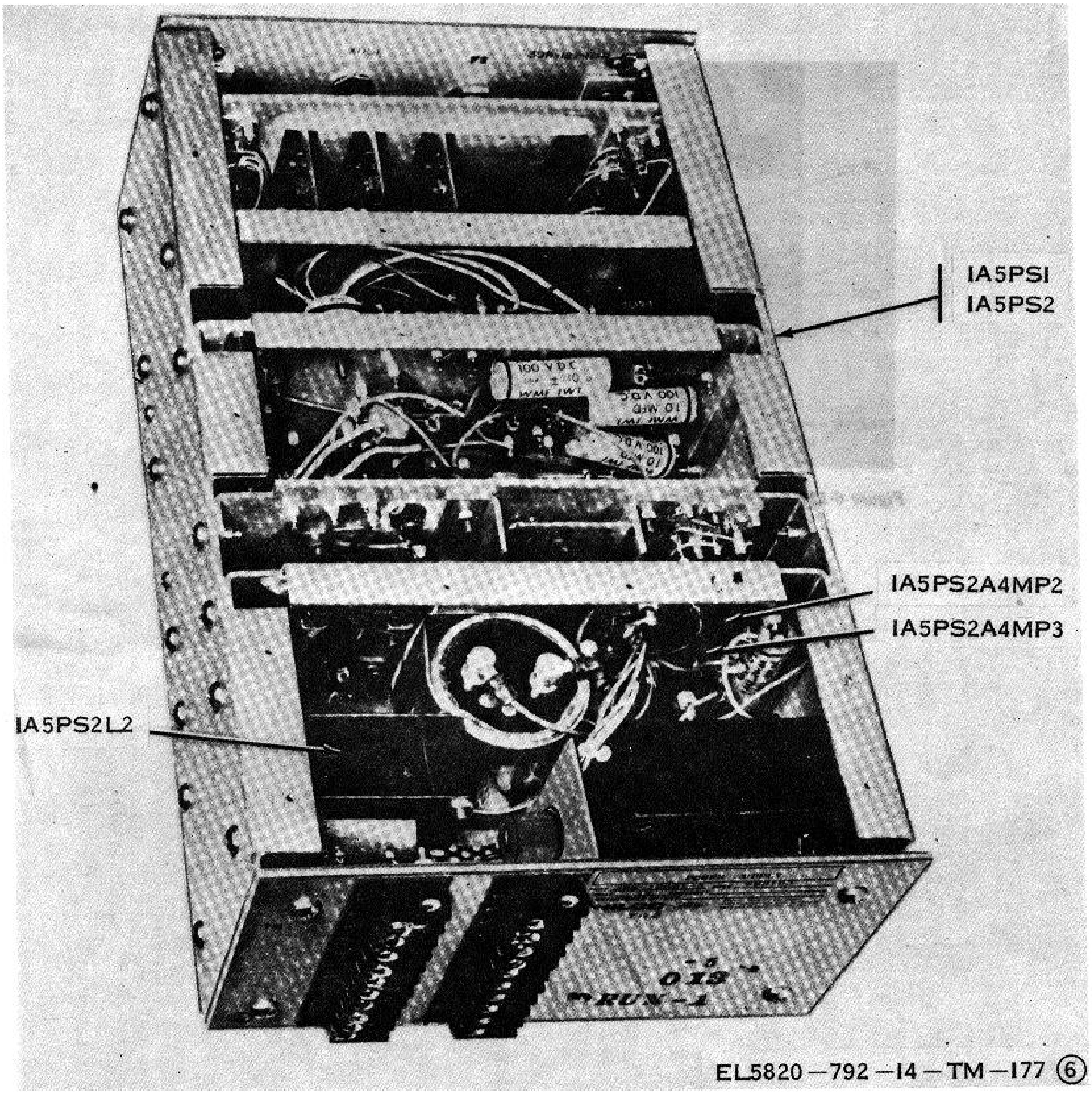


Figure 6-121 (6) . Low-voltage power supply, parts location diagram (sheet 6 of 6).

d. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		28-Volt Section Check		
1	Connect the negative lead of a digital voltmeter to TB1-5 and the positive lead to TB 1-2.			
2	On the load test set, place the 28 V load switch to its MAX LOAD position.			
3	Observe the digital voltmeter indication, use this voltage as reference.	28 V dc (nominal).	Proceed to step 4.	Check CR11, CR12, Q5, Q6 and the components on the A1 assembly.
4	Adjust the test power supply until the load test set meter indicates 43 V dc. Observe digital voltmeter.	Reference voltage ± 0.28 V dc.	Proceed to step 4	Check A1 assembly components.
5	Adjust the test power supply until the load test set meter indicates 56 V dc. Observe digital voltmeter.	Reference voltage ± 0.28 V dc.	Proceed to step 6.	Check A1 assembly components.
6	On the load test set, place the 28 V load switch to MIN LOAD position.			
7	Adjust the test power supply until the load test set indicates 43 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.28 V dc. ponents.		Check A1 assembly com-
8	Adjust the test power supply until the load test set indicates 56 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.28 V dc.		Check A1 assembly components.
9	Adjust the test power supply until the load test set meter indicates 48 V dc.			
10	Momentarily set the 28 V SHORT CIRCUIT TEST switch to its short position and then release. Observe the digital voltmeter indication.	Voltages should drop to zero then return to 28 V dc.	Disconnect the digital voltmeter from the power supply.	Check A1 assembly components.
		20-Volt Section Check		
11	Connect the negative lead of a digital voltmeter to TB1-5 and the positive lead to TB1-3 of the power supply under test.			
12	On the load test set, place the 20 V load switch in its MAX LOAD position.			
13	Observe the digital voltmeter indication, use this value as reference.	20 V dc. (nominal)		Check CR13, CR14, C7, and A2 card assembly.
14	Adjust the test power supply until the load test set meter indicates 43 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.4 V dc.		Check A2 card assembly.
15	Adjust the test power supply until the load test set meter indicates 56 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.4 V dc.		Check A2 card assembly.
16	On the load test set, place the 20 V load switch in its MIN LOAD position.			
17	Adjust the test power supply until the load test set meter indicates 56 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.4 V dc.		Check A2 card assembly.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
18	Adjust the' test power supply until the load test meter indicates 43 V dc.	Reference voltage ± 0.4 V dc. ponents.		Check A2 assembly com-
19	Adjust the test power supply until the load test set meter indicates 48 V dc.			
20	Momentarily, set the 20 V SHORT CIRCUIT TEST switch to its short position and then release it. Observe the digital voltmeter indication.	Voltage should drop to zero then return to +20 V dc.	Disconnect the digital voltme- ter from the power supply	Check A2 assembly ponents.
	6-Volt Section Check			
21	Connect the negative lead of a digital voltmeter to TB1-6 and the positive lead to TB1-8.			
22	On the load test set, place the 6 V load switch in its MAX LOAD position.			
23	Observe the digital voltmeter indication, use this value as the reference.	-6 V dc (nominal)		Check CR15, CR16, Q8, and the A3 card assembly.
24	Adjust the test power supply until the load test set meter indicates 43 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.06 V dc.		Check A3 card assembly.
25	Adjust the test power supply until the load test set meter indicates 56 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.06 V dc.		Check A3 card assembly.
26	On the load test set, place the 6 V load switch in its MIN LOAD position.			
27	Adjust the test power supply until the load test set meter indicates 56 V dc. Observe the digital voltmeter indication.	Reference voltage -± 0.06 V dc.		Check A3 card assembly.
28	Adjust the test power supply until the load test set meter Indicates 43 V dc. Observe the digital voltmeter indication.	Reference voltage ± 0.06 V dc.		Check A3 card assembly.
29	Adjust the test power supply until the load test set meter indicates 48 V dc.			
30	Momentarily, set the 6 V SHORT CIRCUIT TEST switch to its short position and then release it. Observe the digital voltmeter indication.	Voltage should rise to zero then return to -6 V dc.		Check A3 card assembly.
		65-Volt Section Check		
	NOTE **A 65-volt rectifier and filter assembly are provided in the low voltage power supply, but is not used in either the radio set or the module test set.**			
		Ripple Check		
31	Set the controls of an oscilloscope as follows: HORIZONTAL DISPLAY to A TRIGGERING MODE to AC TRIGGER SLOPE to INT TIME/CM to 20 Asec INPUT/SELECTOR to AC VOLTS/cm to .005			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
32	Set 6 V, 20 V, and 28 V load switches to their MAX LOAD positions.			
33	Connect the oscilloscope probe between TB1-2 and TB1-5 (ground). Observe the ripple voltage; disregard the spike content.	20 mV peak-to-peak (maximum).	Check the 28-volt card assembly A1.	
34	Connect the oscilloscope probe between TB1-3 and TBf-5 (ground). Observe the ripple voltage; disregard the spike content.	20 mV peak-to-peak (maximum).	Check the 20-volt card assembly A2.	
35	Connect the oscilloscope probe between TB1 -8 and TB1-6. Observe the ripple voltage; disregard the spike content.	20 mV peak-to-peak (maximum).	Check the -6-volt card assembly A3.	
36	Set the 6 V, 20 V, and 28 V load switches to their MIN LOAD positions.			
37	Connect the oscilloscope probe between TB1-2 and TB1-5 (ground). Observe the ripple voltage; disregard the spike content.	20 mV peak-to-peak (maximum).	Check the 28-volt card assembly A1.	
38	Connect the oscilloscope probe between TB1-3 and TB1-5 (ground). Observe the ripple voltage; disregard the spike content.	20 mV peak-to-peak (maximum).	Check the 20-volt card assembly A2.	
39	Connect the oscilloscope probe between TB1-8 and TB1-6. Observe the ripple voltage; disregard the spike content.	20 mV peak-to-peak (maximum).	End of test. Disconnect all test equipment.	Check the -6 volt card assembly A3.

e. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data given in f below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the power supply connected to the load test set and by using the multifunction meter. The plug-in cards can be pulled out and bench checked. DC voltages are measured with the multimeter.

f. Voltage and Resistance Data.

Point of measurement		Voltage (dc) (nominal)	Resistance (nominal) RX100scale unless specified	Remarks
A1, Q1	B	36.2	40	For card A1, resistance
E		36.7	30	and voltage
C		29.7	0.8	measurements are from
TB1-5.				
A1, U1-1		27.0	0.65	
2		36.1	40	
3		36.7	30	
4		0.0	0	
5		1.67	8	
6		1.69	8	
7		27.5	1.3 x 10 k	
8		28.0	0.15	
A2, Q1	B	27.2	40	For card A2, resistance
	E	27.8	33	and voltage
	C	21.0	0.9	measurements are from
				TB1-5.
A2, U1-1		18.9	0.7	
2		27.2	40	
3		27.7	33	
4		0.0	0	
5		1.72	9.2	
6		1.71	10	
7		19.1	1.35 x 10 k	
8		20.0	0.2	
A3, Q1	B	11.5	45	For card A3, resistance
E		12.2	30	and voltage
C		7.2	0.8	measurements are from
TB1-5.				
A3, U1-1		5.6	0.55	
2		11.5	45	
3		12.2	30	
4		0.0	0	
5		1.7	7	
6		1.71	6.3	
7		6.2	1.3	
8		6.0	0.1	
A4, Q1		B.8	4.6	For card A4, resistance
	E	0.24	0	and voltage
	C	NA	2.4	measurements from
				A4Q1-E.
A4, Q2	B	8.2	5.5	
	C	0.8	4.6	
	E	8.8	12	
A4, U-11		12.4	2.5	
2		8.8	12	
3		8.2	5.5	
4		40.2	2.1	
5		38.0	18	
6		38.1	13.5	
7		11.5	Not Used	
8		12.4	2.1	

Point of measurement		Voltage (dc) (nominal)	Resistance (nominal) RX100scale unless specified	Remarks
Q1	B	NA	2	Q1, Q2, W3, and Q4 measure same as A4.
	C	0.15	0	
	E	NA	2.1	
Q2	B	NA	2.4	
	C	0.15	0	
	E	NA	2	
Q3	B	NA	2.1	
	C	NA	2.1	
	E	NA	6.5	
Q4	B	NA	2.1	
	C	NA	2.1	
	E	NA	6.6	
Q5	B	29.3	2.3	Q5 and Q6 measure same as A1.
	C	36.5	30	
	E	28.6	0.15	
Q6	B	29.7	0.8	
	C	36.5	30	
	E	29.2	2.3	
Q7	B	21.0	0.85	Q7 measure same as A2
	E	20.3	0.2	
Q8	B	7.2	0.8	Q8 measure same as A3.
	C	12.1	30	
	E	6.5	0.1	

6-60. Adjustment Data

a. General. The following procedures should be performed after repairs have been made to the power supply. Observe sequential ordering of adjustments as well as the individual steps within the adjustment.

b. Test Equipment Setup. The test equipment setup used for the adjustment procedures is shown in figure 6-122.

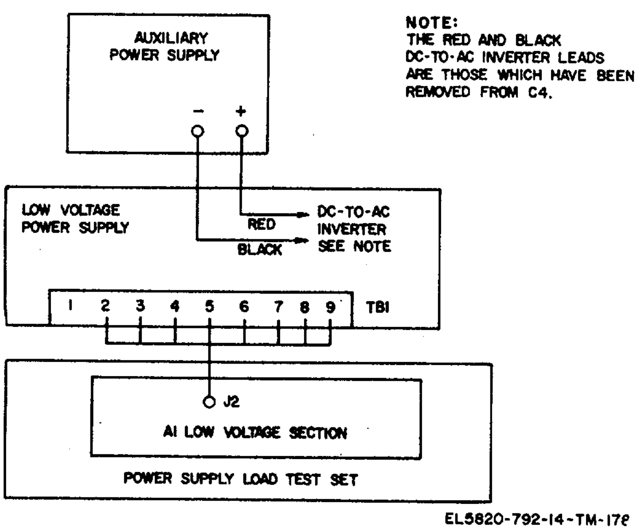


Figure 6-122. Low-voltage power supply, adjustment test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments.

(1) Remove the top cover from the module.

(2) Set all test equipment power switches to their ON positions. Do not turn on the power supply under test and adjustment. Allow the test equipment to stabilize for 20 minutes.

(3) On the auxiliary power supply, adjust the output for 27.5 ± 0.1 V dc. Turn off the auxiliary supply.

(4) On the low-voltage power supply to be adjusted, locate the position of C4 (fig. 6-119 and 6-121 (4).

(5) Remove both sets of black and red leads from C4.

(6) One set of black and red leads are connected to the dc to ac inverter. Connect the red lead to the positive terminal of the auxiliary power supply, and the black lead connects to the negative terminal of the auxiliary power supply. The other set of red and black leads are not applicable to this part of the adjustment.

(7) Turn on the auxiliary power supply.

d. 28-Volt Regulator Adjustment. This procedure provides for the alignment of the regulated 28-volt section of the power supply.

(1) Connect the negative lead of the digital voltmeter to TB1-5 of the low-voltage power supply under adjustment; connect the positive lead of the digital voltmeter to TB1-2.

(2) On the load test set, place the 28 V load switch to its MAX LOAD position.

(3) Adjust R6 on the A1 card assembly until the digital voltmeter indicates 28 ± 0.01 V dc.

e. 20-Volt Regulator Adjustment. This procedure provides for the alignment of the regulated 28-volt section of the power supply.

(1) Transfer the digital voltmeter lead from TB1-2 to TB1-3.

(2) On the load test set, place the 20 V load switch to its MAX LOAD position.

(3) Adjust R6 on the A2 card assembly until the digital voltmeter indicates 20 ± 0.1 V %c.

f. 6-Volt Regulator Adjustment. This procedure provides for the alignment of the regulated negative 6-volt section of the power supply.

(1) Disconnect the digital voltmeter from the low-voltage power supply under adjustment.

(2) Connect the negative lead of the digital voltmeter to TB1-6 and the positive lead to TB18.

(3) On the load test set, place the 6 V load switch to its MAX L,OAD position.

(4) Adjust R6 on the A3 card assembly until the digital voltmeter indicates 6 ± 0.03 V dc.

g. 65-Volt Section. The 65-volt section of the low-voltage power supply is not used.

h. Switching Regulator Section. This procedure provides a means of adjusting the duty cycle and output voltage of the switching regulator. Do not perform this adjustment unless the adjustments of the 28, 20, and -6-volt regulators have been previously performed.

(1) Turn off and disconnect the auxiliary power supply.

(2) Connect the red and black leads to C4 to restore the low-voltage power supply to normal connections. Both red leads connect to the positive terminal of C4; both black leads then connect to C4 negative terminal.

(3) Connect the negative lead of the auxiliary power supply to TB2-1 and the positive lead to TB2-2.

(4) On the load test set, place the 6 V, 20 V and 28 V load switches to their MIN LOAD positions.

(5) Connect the digital voltmeter across capacitor C4; the red leads are the positive leads.

(6) On the auxiliary power supply, set the power switch to its on position and adjust its output for 43 ± 0.1 volts. Turn power supply under test to ON.

(7) Adjust R5 on the A4 card assembly until the digital voltmeter indicates 28 ± 0.5 volts across C4.

(8) On the load test set, place 6 V, 20 V, and 28 V load switches in their MAX LOAD positions.

(9) Readjust R5 on the A4 card assembly until the digital voltmeter indicates 28 ± 0.1 V dc across C4.

(10) This step completes the adjustment procedure. Disconnect all test equipment.

Section XIV. METER PANEL MODULE (398-12041-1)

6-61. Introduction

a. The meter panel provides a convenient method for monitoring the performance of both transmitter and receiver sections of microwave radio equipment, either terminal or repeater configuration. The microwave radio equipment is designed for continuous unattended operation for extended periods without adjustment or malfunctions. A limited amount of monitoring can be done by means of the meter panel. Equipment operation or performance is not affected by controls on the meter panel with the exception of the primary power switch. It is important to note that the channel meter function switch positions are divided into two types: those that select fixed quantities and those that select variable quantities for monitoring. The fixed quantity measurements are those included within the boxed area indicated as READ RED LINE. As long as the meter indication is within the red-line limits for these switch positions, the quantity being measured is considered satisfactory. The variable quantities are not variable in the sense that the meter indication can be anywhere at any time; instead, the readings are a function of the transmission path.

b. Meter panel assembly, part No. 398-12041-1, provides mounting for dual control, metering, and indicating components required for monitoring and scheduled downtime system testing and maintenance. The meter panel provides transmitter and receiver performance monitoring, using both meters and indicator lamps. System measurements are performed using channel A and channel B meter function switches and their associated panel meters. Indicator functions, such as RF Power and AGC, are driven from solid-state circuits mounted on the meter panel itself. Most of -the remaining indicators are driven from circuits contained within the noise amplifier and pilot-tone detector modules on the door assemblies. The schematic diagram of this assembly is shown in figure FO-27. The schematic shows the control, metering, and indicating component parts, as well as the alarm amplifier assembly (368-42300-3), the AGC meter shaping network (368-43696-2), and the meter function switch assembly (368-43581-1).

c. The meter panel, which is designed to mount in the cabinet of the microwave radio equipment, consists of various controls and indicators mounted on the front panel. Figure 3-1 shows the locations of the front-panel operator's controls and indicators; figure 6-123 also shows the top view of the meter panel.

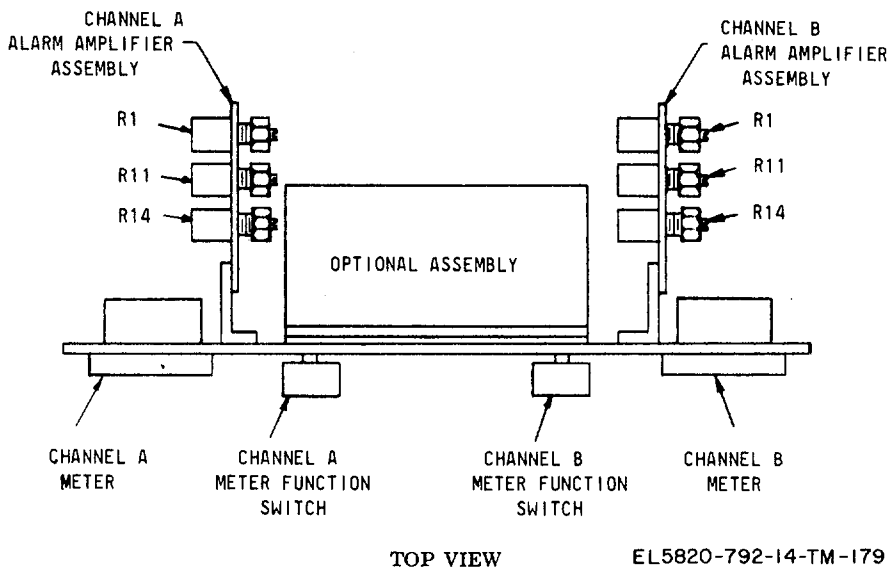


Figure 6-123. Meter panel.

6-62. Functional Description

The functional description of the meter panel is explained in section II of chapter 3, and should be reread before further in this section.

6-63. Circuit Analysis

a. Alarm Amplifier Assembly. The alarm amplifier assembly is a solid-state circuit which includes AGC and RF power alarm control circuits.. Two of these card assemblies are included in each meter panel. Figure 6-123 shows the location of the alarm amplifier assemblies and their associated controls. The schematic diagram of the alarm amplifier assembly is included in the schematic diagram of the meter panel. The varying AGC voltage from the IF amplifier module is delivered to the AGC (-5 V) position of the corresponding meter function switch. This voltage is also applied to the base of emitter-follower transistor Q2 on the associated alarm amplifier assembly. If the AGC voltage stays above a certain preset level, relay K2 in the relay driver stage remains energized; no AGC alarm indication results. When the AGC voltage falls below the preset level or fails entirely, relay K2 deenergizes; the K2-1 and K2-3 relay contacts close, causing the AGC indicator lamp to come one. A remote indicator can also be activated through relay contact closure of K2-6 and K2-8. Transistor Q2 is an emitter follower stage that provides isolation and impedance transformation between the high-impedance agc and/or metering circuits and the low-impedance input circuit of the relay driver Q3. Transistor Q3 is an emitter-biased relay driver stage. The resistance setting of potentiometer R14 determines the bias level of Q3 and, consequently, its operation point. This in turn, governs the operating point of K2 with respect to a desired agc level. The RF power monitor alarm circuit, which is shown in figure 6-124, differs from the agc alarm circuit in that the power alarm circuit rectifies and amplifies the RF power output voltage before delivering it to the OUTPUT POWER position of the meter function switch. The RF output from the AFC module is applied to integrated network MD1. The RF signal is then rectified and amplified before reaching the meter function switch. The output of MD1 is also applied to the relay driver stage, Q1. If the RF output from the exciter stays above a certain preset level, relay K1 in the relay driver stage remains energized and the RF POWER alarm lamp is out. When power output falls to a value below the preset level or fails completely, relay K1 deenergizes; the K1-1 and K1-3 contacts close, causing the RF power indicator to come on. A remote indicator can also be activated through relay contact closure of K1-6 and K1-8. Since the RF output is constant for a given (Klystron) and operating frequency, it is desirable and also possible to choose a fixed point (redline) on the meter scale to indicate normal power output. With normal RF power present for a given terminal, potentiometer R1 can be adjusted so that the meter indication occurs on the red-line portion of the meter scale. Bias resistors R3 and R4 set the operating point of integrated network MD1. Zener diode CR1 maintains the proper supply voltage for MD1. Thermistor RT1 varies its resistance in accordance with the ambient temperature, thereby controlling signal through the feedback loop. Resistor R8 is the multiplier resistor inserted to provide proper meter deflection. Resistances R10 through R12 form the input voltage divider to relay driver Q1. Resistors R10 and R12 are included to limit the upper and lower adjustment ranges of potentiometer R11, and also to reduce shunt impedance effects upon the metering circuits as the potentiometer is adjusted. Resistor R7 is an emitter current limiting resistor, while Zener diode CR3, in conjunction with the base circuit, sets the operating point of transistor Q1.

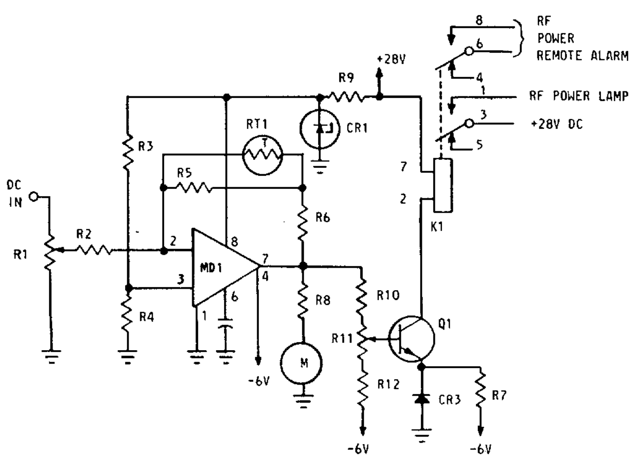


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Figure 6-124. Meter panel, alarm amplifier assembly, RF alarm, simplified schematic diagram.

b. AGC Meter Shaping Network. The schematic of this circuit is included in the schematic of the meter panel. The AGC voltage which is received on the meter panel varies from approximately -5.8 V dc to +1 V dc as the IF level varies, and has a logarithmic variation over part of the AGC level range. Diodes CR1 and CR2 are used as blocking diodes to prevent the reverse biasing of the emitter base junction of Q2 on the alarm amplifier assembly and reverse voltage on the meter. Diodes CR1, CR2, and resistor R2, and diode CR3 give a logarithmic attenuation to the AGC voltage applied to the meter circuit. This attenuation is in the same order of magnitude as the logarithmic AGC curve but in the reverse direction, and allows the meter to be more linear with respect-to IF (i.e. RF) level into the receiver over the entire metering range.

c. Technical Characteristics.

Parameter	Specifications
Meter:	
Scale	21/2 inches
Full scale current	200 microamperes
Sensitivity	5 K per volt
Resistance	225 ohms
Indicator lamps:	
Incandescent	Midget flanged type 327
Neon	Midget flanged type NE2D
Power requirements for indicator lamp:	
I**ncandescent**	40 mA at 28 V dc
Neon	1/15 watt at 115 V ac, 60 Hz
Power requirements for alarm amplifier assembly.	100 mA at 28 V dc; 20 mA at -6 Vdc

6-64. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following subparagraphs contain procedures to test -the performance of -the meter panel and its assemblies, and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect -the meter panel to the test set as shown in figure 6-125.

c. Preliminary Adjustments. Use figures 6-126, 6-127, and 6-128 for parts location data. Perform the following adjustments:

(1) Loosen one of the cross-slotted screws that secure the trim to the meter panel chassis.

(2) Connect a strap wire between terminal 3 of A PRI PWR switch and 3 of B PRI PWR switch.

(3) Connect a strap wire between terminal 3 of A PRI PWR switch and the loosened cross-slotted screw. Tighten the cross-slotted screw, and terminal 3 of both PRI PWR switches.

(4) Connect the PRI PWR cable to the A PRI PWR switch S1 as shown in figure 6-125.

(5) Observe figure 6-125 very closely to note the way the black and white wires of the primary power cable is oriented, then connect the cable to PRI PWR OUT on the module test set.

(6) Do not connect extension cable 491-5184-1 to the meter panel under test until directed by the procedure.

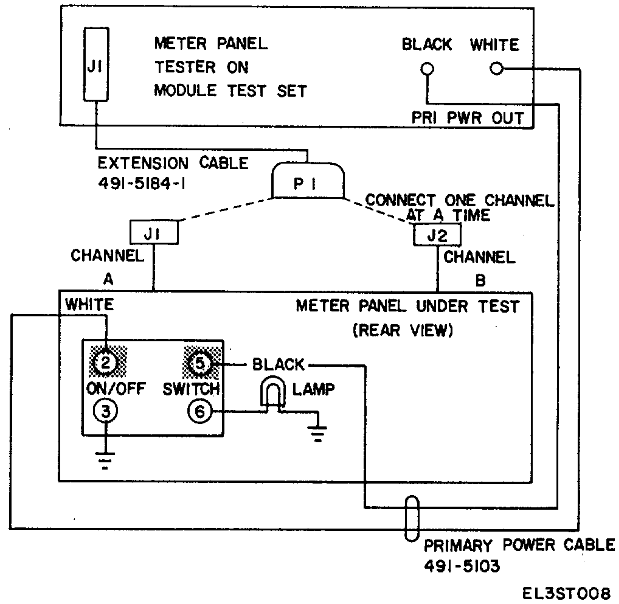


Figure 6-125. Meter panel test equipment setup.

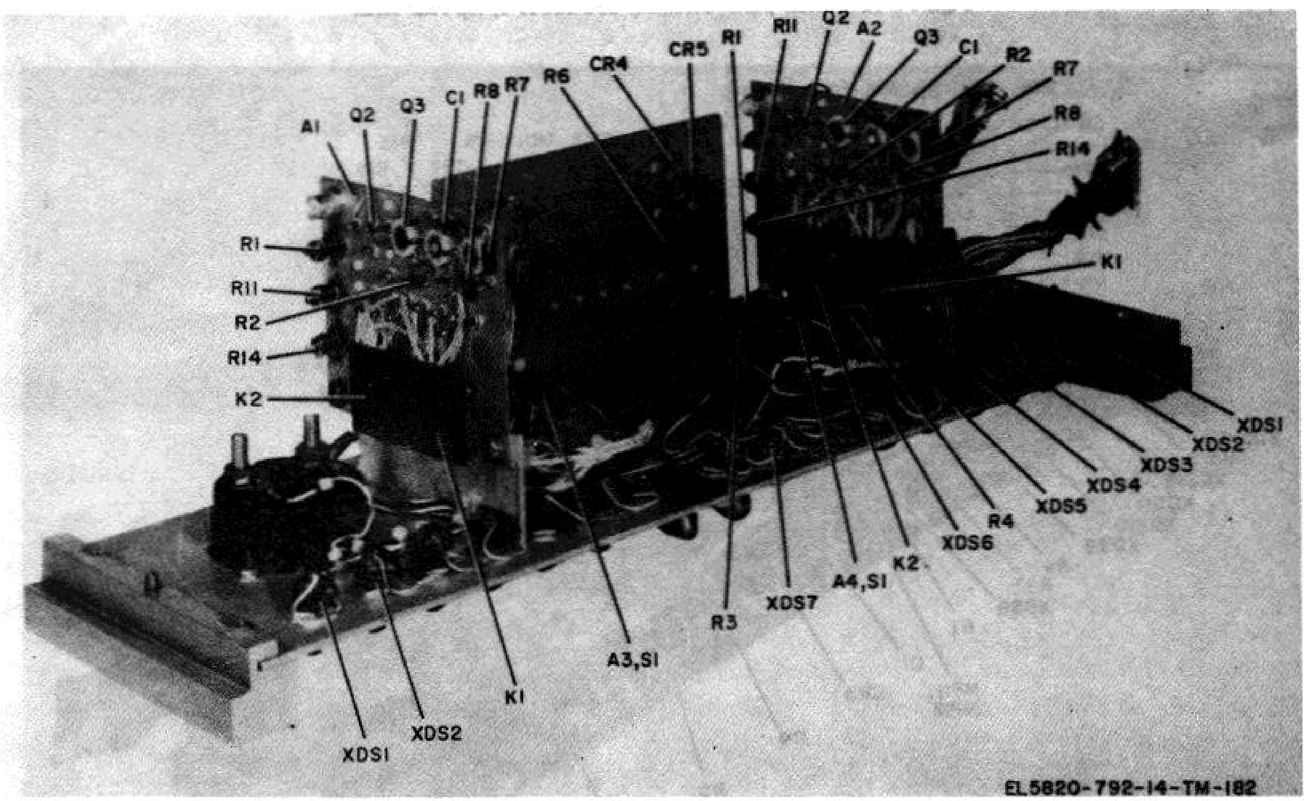


Figure 6-126. Meter panel assembly 398-12041-1, bottom left-side view.

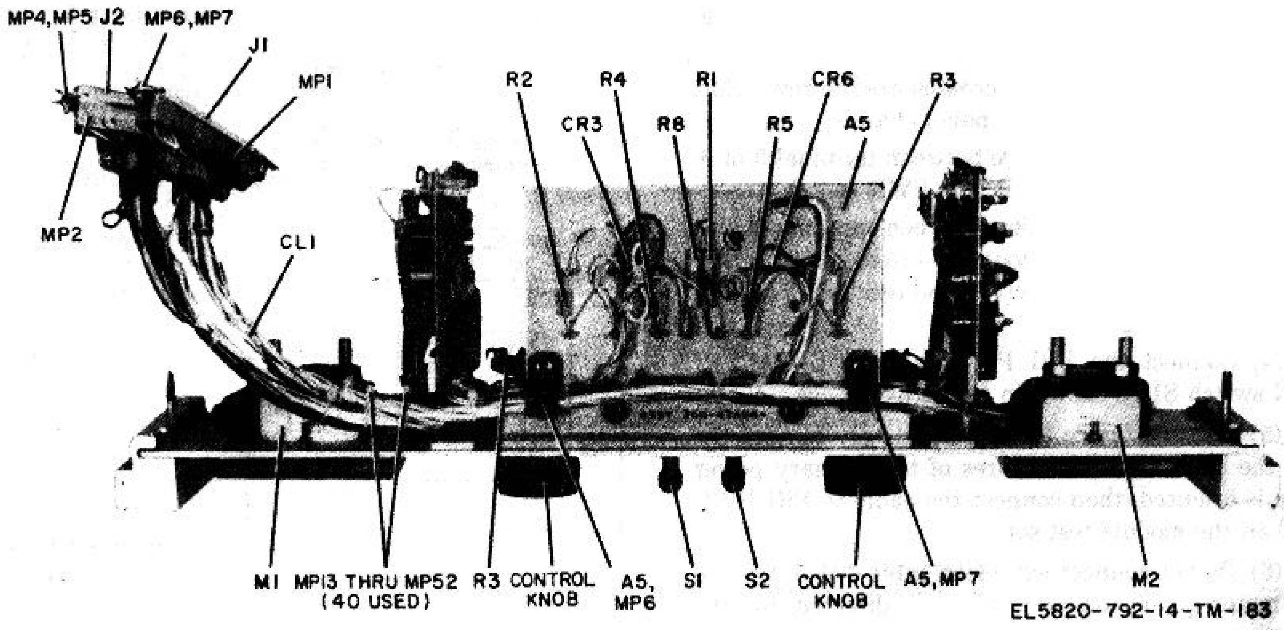


Figure 6-12Z Meter panel assembly 398-12041-1, top rear view.

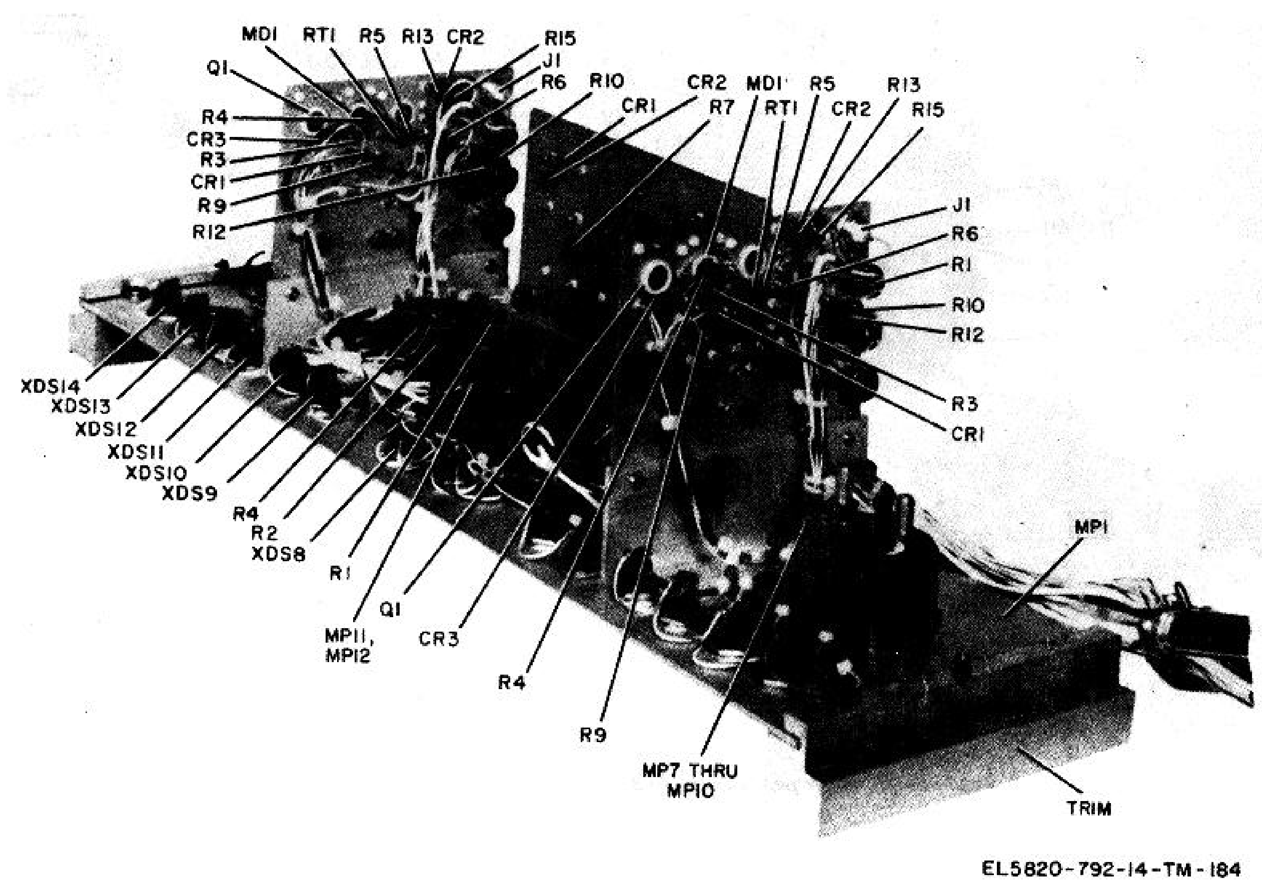


Figure 6-128. Meter panel assembly 398-12041, bottom rear right view.

d. Procedure.

Step	Procedure	Normal indication	If indication is normal
1	On the meter panel under test, set A PRI PWR switch to its ON position.		
2	On the module test set, press the METER PANEL POWER switch.	A PRI PWR indicator is dimly lighted.	
3	Release the METER PANEL POWER switch.	A PRI PWR indicator is no longer lighted.	
4	Remove the connection from the PRI PWR OUT connector on the module test set.		
5	On the meter panel under test, transfer the black and white leads from S1 to the corresponding terminals of S2.		
6	Observe figure 6-125 very closely to note the way the black and white wires of the primary power cable is oriented, then connect the cable to PRI PWR OUT on the module test set.		
7	On the meter panel under test, set B PRI PWR switch to its ON position.		
8	On the module test set, press the METER PANEL POWER switch.	B PRI PWR indicator is dimly lighted.	
9	Release the METER PANEL POWER switch.	B PRI PWR indicator is no longer lighted.	
10	Connect the 491-5184-1 extension cable between J1 of the meter panel tester on the module test set and channel A (J1) of the assembly under test.		
11	On the module test set, place the AGC REMOTE ALARM switch in the AGC position.	A RCVR AGC indicator on the meter panel under test and the AGC indicator on the module test set are lighted.	....
12	On the meter panel tester of the module test set, operate the PILOT ALARM switch, and return it to its OFF position after observing A RCVR PILOT TONE indicator on assembly under test.	A RCVR PILOT TONE indicator is lighted, then goes out.	....
13	On the meter panel tester of the module test set, operate the NOISE ALARM switch, and return it to its OFF position after observing A RCVR NOISE indicator on assembly under test.	A RCVR NOISE indicator is lighted, then goes out.	....
14	On the meter panel tester at the module test set, operate the BB PILOT ALARM switch, and return it to its OFF position after observing A RCVR BB PT indicator on assembly under test.	A RCVR BB PT indicator is lighted; then goes out.	....
15	On the meter panel tester of the module test set, operate the RF PWR REMOTE ALARM switch, and return it to its OFF position after observing a XMIT RF PWR indicator on assembly under test.	A XMIT RF PWR indicator is lighted, then goes out.	....

Step	Procedure	Normal indication	If indication is normal
16	On the meter panel tester of the module test set, operate the MOD LOSS ALARM switch, and return it to its OFF position after observing A XMIT MOD LOSS indicator on the assembly under test.	A XMIT MOD LOSS indicator is lighted, then goes out.	....
17	On the assembly under test, rotate CHANNEL A meter function switch through each of its positions, with results as follows:	....	....
	AGC (-5V)	0.5 V approx.	
	COMBINER (+20 V)	Red zone	
	XTAL CUR........	Red zone	
	OUTPUT POWER	Red zone	
	(+28 V)	Red zone	
	(-6 V)	Red zone	
	(-750 V)	Red zone	
	AFC	Red zone	
	REFL (-500 V)	75 V approx.	
	DRIVER (+200 V)	Red zone	
18	Connect the 491-5184-1 extension cable between J1 of the meter panel tester on the module test set and channel B (J2) of the assembly under test.		
19	On the module test set, place the AGC REMOTE ALARM switch in the AGC position.	B RCVR AGC indicator on the meter panel under test and the AGC indicator on the module test set are lighted.	....
20	On the meter panel tester of the module test set, operate the PILOT ALARM switch, and return it to its OFF position after observing B RCVR PILOT TONE indicator on the assembly under test.	B RCVR PILOT TONE indicator is lighted, then goes out;	....
21	On the meter panel tester of the module test set, operate the NOISE ALARM switch, and return it to its OFF position after observing B RCVR NOISE indicator on assembly under test.	B RCVR NOISE indicator is lighted, then goes out. wiring.	....
22	On the meter panel tester of the module test set, operate the BB PILOT ALARM switch, and return it to its OFF position after observing B RCVR BB PT indicator on the assembly under test.	B RCVR BB PT indicator is lighted, then goes out. wiring.	....
23	On the meter panel tester of the module test set, operate the RF PWR REMOTE ALARM switch, and return it to its OFF position after observing B XMIT RF PWR indicator on assembly under test.	B XMIT RF PWR indicator is lighted, then goes out.	....

Step	Procedure	Normal indication	If indication is normal
24	On the meter panel tester of the module test set, operate the MOD LOSS ALARM switch, and return it to its OFF position after observing B XMIT MOD LOSS indicator on the assembly under test.	B XMIT MOD LOSS indicator is lighted then goes out.	
25	On the assembly under test, rotate CHANNEL B meter function switch through each of its positions with results as follows:		
	AGC (-5 V)	0.5 V approx.	End of test. test equipment.
	COMBINER (+20 V)	Red zone	
	XTAL CUR	Red zone	
	OUTPUT POWER	Red zone	
	(+28 V)	Red zone	
	(-6 V)	Red zone	
	(-750 V)	Red zone	
	AFC	Red zone	
	REFL (-500 V)	75 V approx.	
	DRIVER (+200 V)	Red zone	

e. Voltage and Resistance Measurements. If performance of the test and or alignment procedures does not result in acceptable meter panel operation, use of the voltage and resistance data provided in *f* below, in conjunction with standard troubleshooting techniques should enable location and correction of the fault. Resistance measurements are made with the meter panel disconnected from all external components using a multifunction meter. All voltages are measured using the test setup of figure 6-125. The multifunction meter is also used to measure dc voltages.

f. Voltage and Resistance Data.

Point of measurement		Dc voltage alarm on	Dc voltage alarm off	Resistance (nominal) RX100 scale unless otherwise specified
		Alarm amplifier assembly		
MD1	1	0	0	0
	2	. . . . .	. . . . .	100
	3	. . . . .	. . . . .	1.7K
	4	--6	--6	2K
	6	6	0	4K
	7	5.8	--0.5	4K
	8	10	10	1.5K

Point of measurement		Dc voltage alarm on	Dc voltage alarm off	Resistance (nominal) RX100 scale unless otherwise specified
Q1	E	--0.4	--0.6	4K
	B	0.3	--2.5	5K
	C	4.8	28	5K
Q2	E	--0.5	--1.7	1.2K
	B	--0.7	--2.2	20K
	C	--6	--6	2K
Q3	E	1.2	--1.,3	2.2K
	B	--0.5	--1.7	1.2K
	C	--1.1	28	5.5K

6-65. Alignment Data

The meter panel does not require alignment at the test bench location; however, when the module is installed in an operational terminal, the module must be aligned to meet system specifications. The meter panel includes R1, R11, and R14 in the Al and A2 assemblies. Refer to chapter 5 for the adjustment of these controls.

Section XV. NOISE AMPLIFIER MODULE (368-43018-1)

6-66. Introduction

The noise amplifier module is a module in the microwave receiver. The primary function of the noise amplifier module is to produce a combiner bias-control voltage which is proportional to the square of the signal-to-noise ratio obtained from a noise slot above the information band. Two secondary functions are performed in this module. The first secondary function is pilot-tone detection through the noise amplifier module, resulting in a squelch voltage output accompanied by external alarms. The other secondary function is excess noise detection through the noise amplifier. module, resulting in a muting voltage output accompanied by external alarm. The noise amplifier module consists of a single printed-wiring card on which all components with the exception of controls, test jacks and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis. The module is equipped with a noise slot filter that can be changed to accommodate changes in channel density in the system.

6-67. Functional Description

a. A functional block diagram of the module appears in figure 6-129. The input signal to the noise amplifier module is taken from the combiner module. This composite demodulated signal is processed by a three-stage amplifier and then split up into two signal paths. The first path is routed into the bandpass filter to remove all baseband signals and to obtain the out-of-band noise signal. The second path is routed out of the noise amplifier module into the dual pilot-tone detector module, where the pilot-tone signal is extracted from the baseband signal. The pilot-tone signal is then returned to the noise amplifier module through A2J1-16 to be combined with the noise-slot signal. These signals are then passed into an impedance-matching circuit and then into a varilosser network to control signal gain automatically.

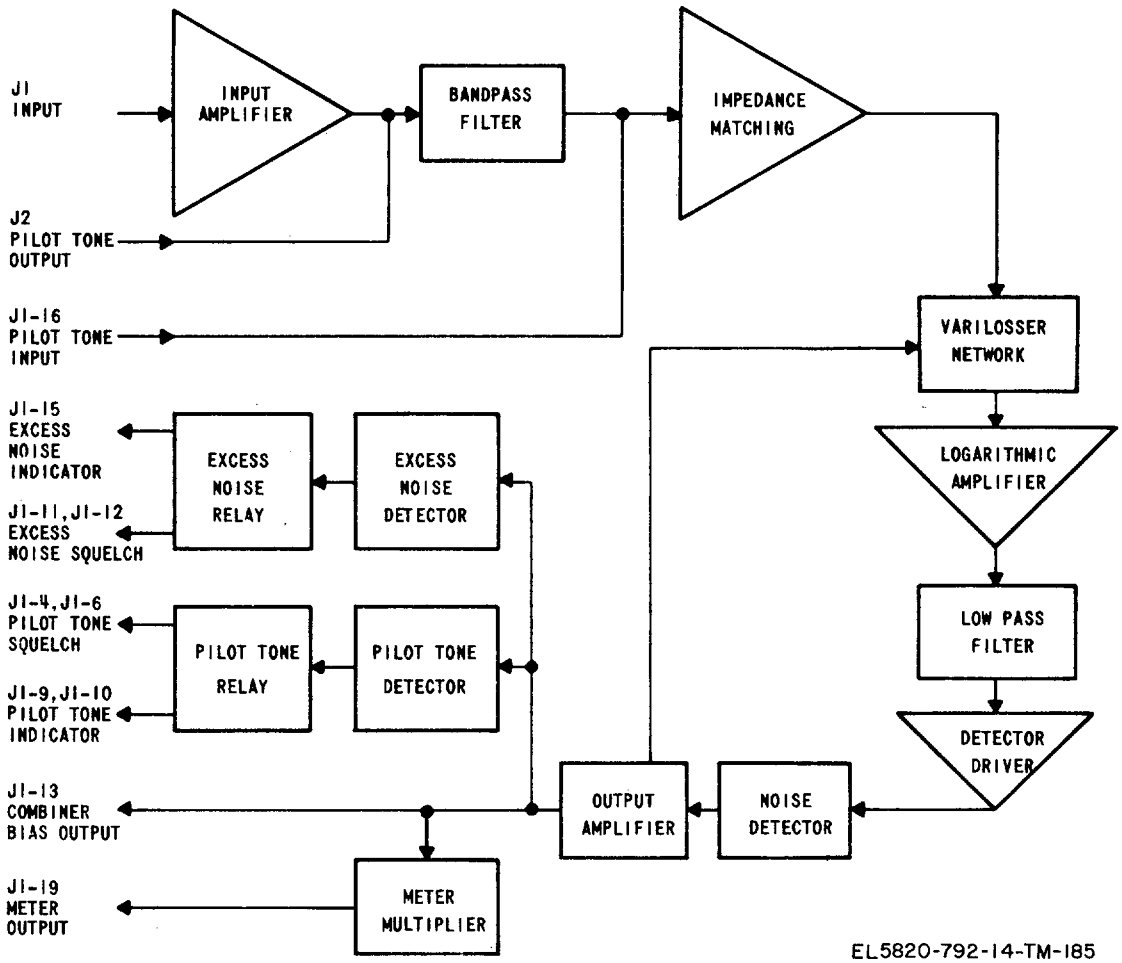


Figure 6-129. Noise amplifier module, functional block diagram.

b. Amplifiers having logarithmic characteristics, instead of linear characteristics, are used following the varilosser stage. This amplifier is a three-stage feedback circuit, providing an output signal which is proportional to the instantaneous signal-to-noise ratio of the radio receiver. This signal is then processed by a low-pass filter to insure that only the noise-slot and pilot-tone signals are sent into the detector driver stages.

c. After amplification by the detector driver stage, the noise-slot and pilot-tone signals are detected by a voltage-doubler circuit. The action of voltage doubling with respect to a logarithmic signal characteristic is equivalent to squaring the signal-to-noise ratio, which is the desired end result.

d. The noise detector is followed by a high-gain output amplifier which prevents loading of the noise detector circuit by the output circuits. The high-impedance output of this final stage is the agc signal used to drive the varilosser network. The low-impedance output circuit is a spilt-path circuit. The primary output signal from the noise amplifier, termed the combiner bias, is one of the low-impedance output signals. The remaining path passes the output signal into the excess noise and pilot-tone detector circuits.

e. The pilot-tone detector is used to detect the loss of the pilot-tone signal through the noise amplifier and to provide a squelch signal in addition to providing a visual alarm signal. The excess noise detector is used to detect the loss of receiver signal and to provide a muting signal to the combiner module; a visual alarm is also activated.

6-68. Circuit Analysis

a. The schematic diagram of the noise amplifier module is shown in figure FO-29. The noise amplifier module receives its input signal from the associated diversity channel drive amplifier of the combiner module.

b. Preceding noise slot filter FL1 is a three stage, broadband, feedback amplifier consisting of transistors Q1, Q2, and Q3. The gain at the emitter of Q3 is 6 dB, but it is adjustable for application in different systems by changing the feedback loop.

c. The output of the feedback amplifier is divided into two paths. The first path is to the dual pilot-tone detector via J2. The second path is through the noise bandpass filter, FL1. Filter FL1 passes an out-of-hand noise above the information band, and at the same time, rejects the entire baseband signal. The continuity pilot-tone signal from the dual pilot-tone detector is then applied to A2J1 (pin 16) of the noise amplifier. The noise and pilot-tone levels are adjusted by means of potentiometers R2 and R3, respectively, which must be adjusted so that the proper proportions of each are applied to the remaining noise amplifier.

d. The noise-slot and pilot-tone signals are then passed through an emitter follower (Q4) used for impedance-matching between the filter and the varilosser circuit. In' the varilosser circuit, the two signals are passed through biased diodes CR2, CR3, CR4, and CR5. The bias control is derived from an AGC loop acting through the circuit consisting of the dc amplifier Q10 and Q11 (Darlington circuit). The AGC provides for more than 40 dB of dynamic range and biases diodes CR2, CR3, CR4, and CR5 to provide a logarithmic response characteristic. The noise-slot and pilot-tone signals are amplified by a three-stage feedback amplifier circuit, consisting of transistors Q5, Q6, and Q7, which has a gain of 45 dB.

e. This same signal is fed to a 7.5-MHz low-pass filter consisting of capacitors C30 and C31 and inductor L2. The purpose of the filter is to reject the transistor-generated noise above 7.5 MHz, and to pass the noise-slot and pilot-tone signals for further amplification within the noise amplifier module. After emerging from the filter, the noise-slot and pilot-tone signals are amplified by a two-stage feedback amplifier, consisting of transistors Q8 and Q9, which has a gain of 36 dB. The feedback amplifier is designed to insure good frequency response and temperature stability.

f. After amplification, the noise is detected by a voltage doubler using CR6 and CR7. The Darlington-connected transistors, Q10 and Q11, are employed so as not to load the detector circuitry; these transistors provide the combiner bias-control output signal, the fault circuitry voltage, and the AGC voltage for the varilosser network composed of diodes CR2, CR3, CR4, and CR5. The AGC rise time response is 1 millisecond, and its decay or fall time response is 2 milliseconds.

g. The various noise amplifiers employed in diversity systems are adjusted so that the input output characteristics (noise inputs versus dc bias control) of the overall amplifier-detection combination align reasonably close with each other. The noise level adjust potentiometers R2, and the slope adjust potentiometer, R4, in combination with the AGC loop, are used for aligning the noise amplifiers.

h. The dc output signal from transistor Q11 is applied to the combiner bias control input for the associated diversity channel. The dc output signal is also fed to the meter panel for monitoring at the COMBINER (+20V) position of the function switch.

i. The excess-noise fault circuit uses the integrated circuit, MD1. This integrated circuit is used to sense the noise-level voltage out of Qll1 and compare it with the threshold level set by R1. If the noise level exceeds this threshold level, the output of MD-1 increases in a negative direction and triggers Q12, a Schmidt trigger oscillator, which in turn energizes relay K1. Relay K1 provides squelching of the combiner, removes B + from the first stage of that channel of the combiner, energizes the "excess noise" fault light, and provides control closure for remote monitoring.

j. The loss of pilot tone can be detected only when the noise level is below the continuity pilot-tone level. When this condition exists, the output level of Q11 will be determined by the continuity pilot-tone level. If the output of Q11 drops below the level produced by a normal continuity pilot tone, the loss-of-pilot-tone integrated circuit, MD-2, senses it. The level to which the output of Q11 drops before it is sensed by MD-2 (the threshold level) is set by potentiometer R79; and when this threshold is reached, the output of MD2 goes negative, triggering Schmidt trigger oscillator Q13. The output of the Schmidt trigger energizes relay K2, which in turn actuates the squelching of the combiner, energizes the loss-of-pilot-tone fault light, and provides contact closure for remote monitoring.

k. Diodes CR10 and CR13 prevent spikes which would normally occur as a result of the opening of the relay coil and thus protect transistors Q12 and Q13 from excess emitter-to-collector voltage. Switch S1 is a double-pole-double-throw switch which disables both pilot-tone loss fault indication and excess noise fault indication when placed in the bypass position. It also disables the squelching which normally accompanies a fault indication, and thus allows evaluation of combiner operation in the presence of excess-noise or loss-of-pilot-tone in the noise amplifier.

l. Technical Characteristics.

Parameter	Specifications
Input impedance	600 ohms, unbalanced
Input level	-20 dBm to -60 dBm
Output level:	
Pilot tone	-42 to -34 dBm; 75 ohms
Combiner bias	+6.5 to +18 V dc
Mute level	0 V dc
Squelch level	+28 V dc
Maximum available gain	90 dB
AGC control range	40 dB
Frequency range	4.8 MHz to.7.3 MHz
Power requirements	200 mA at +28 V dc

6-69. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. This paragraph contains procedures to test the performance of the overall module and its major circuits, and gives probable causes of abnormal indication.

b. Test Equipment Setup. Connect test equipment to the module as shown in figure 6-130 when directed in the test procedure. Figure 6-131 provides parts location data.

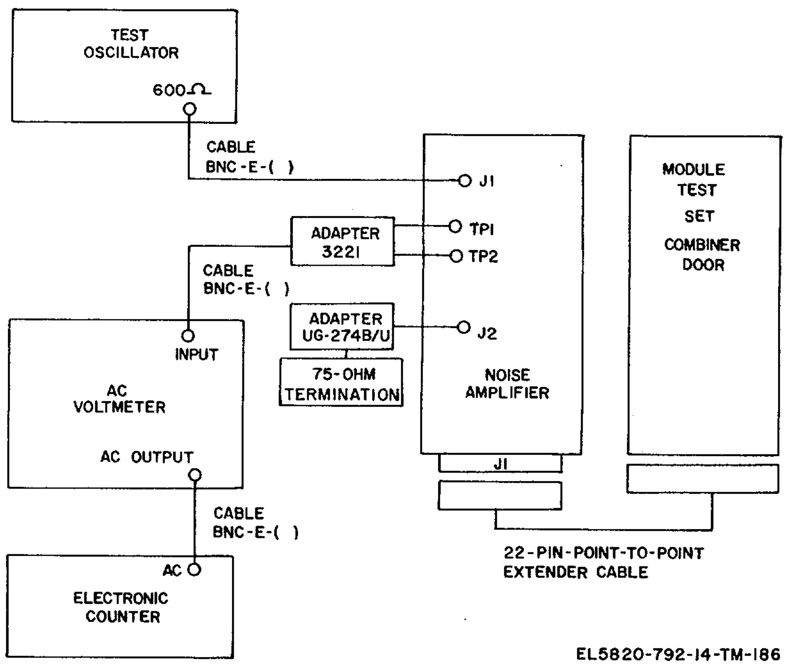


Figure 6-130. Noise amplifier module, initial test equipment setup.

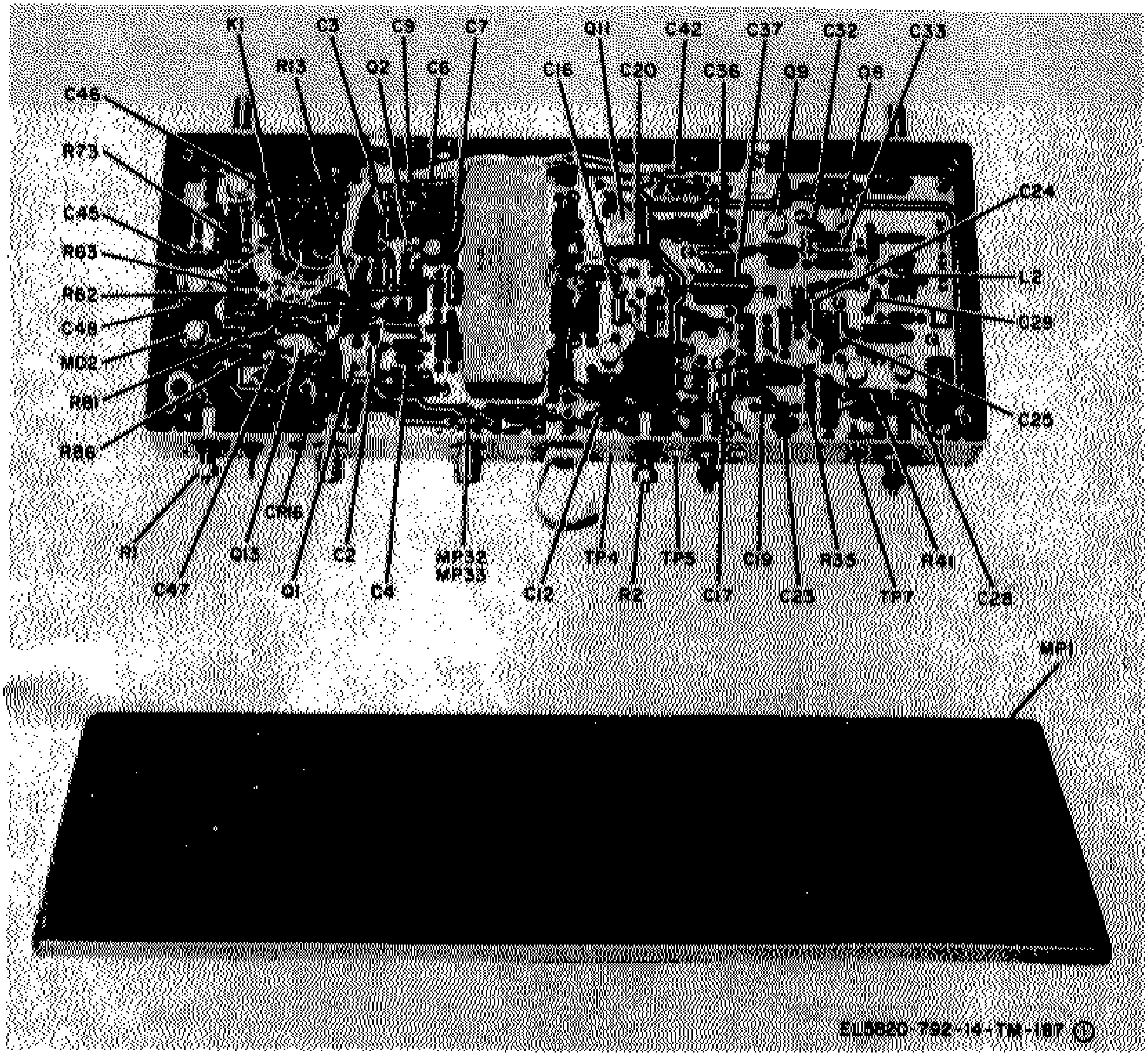


Figure 6-131 (1). Noise amplifier module, parts location diagram (sheet 1 of 4).

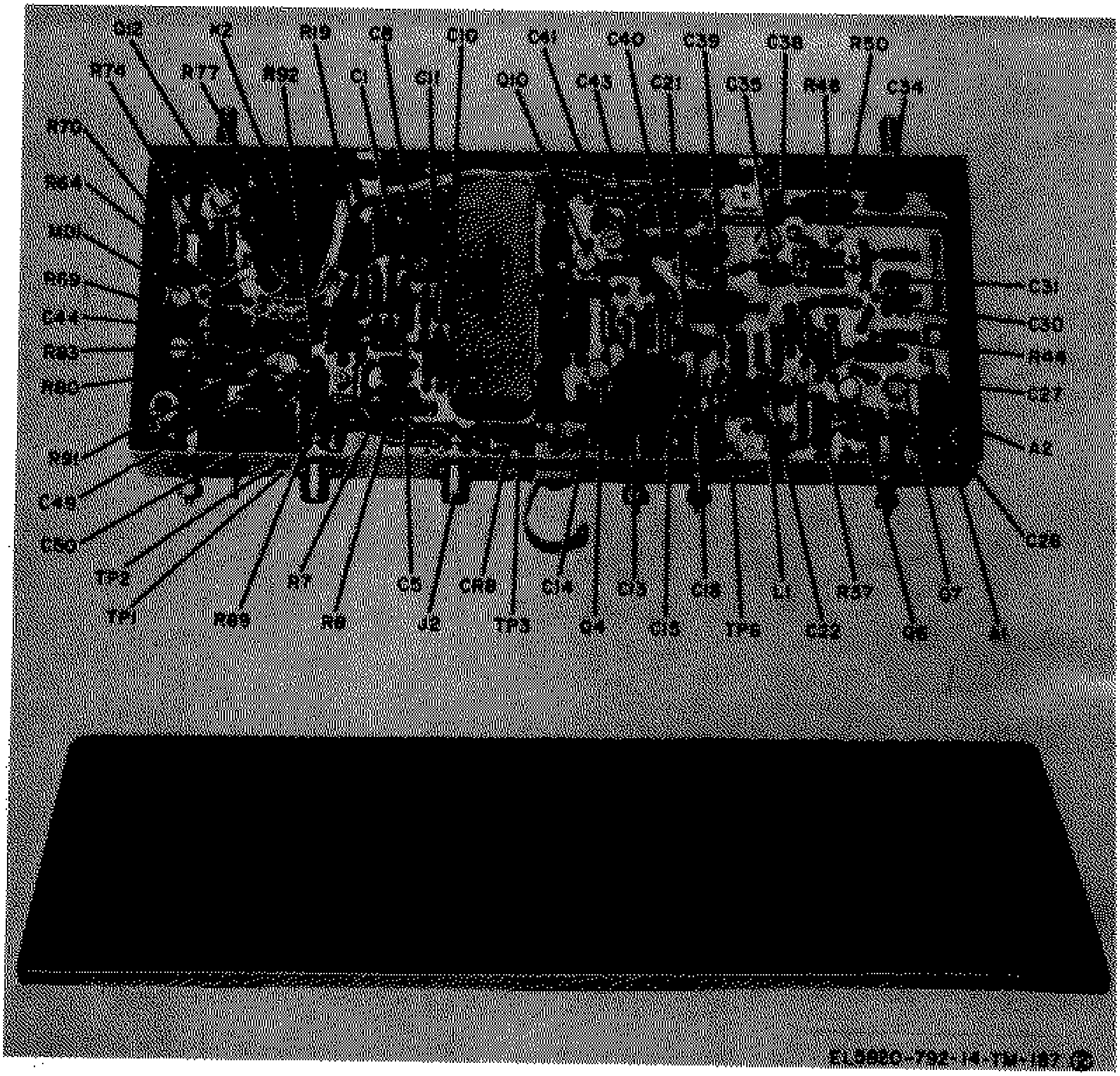


Figure 6-131 (2) Noise amplifier module, parts location diagram (sheet 2 of 4).

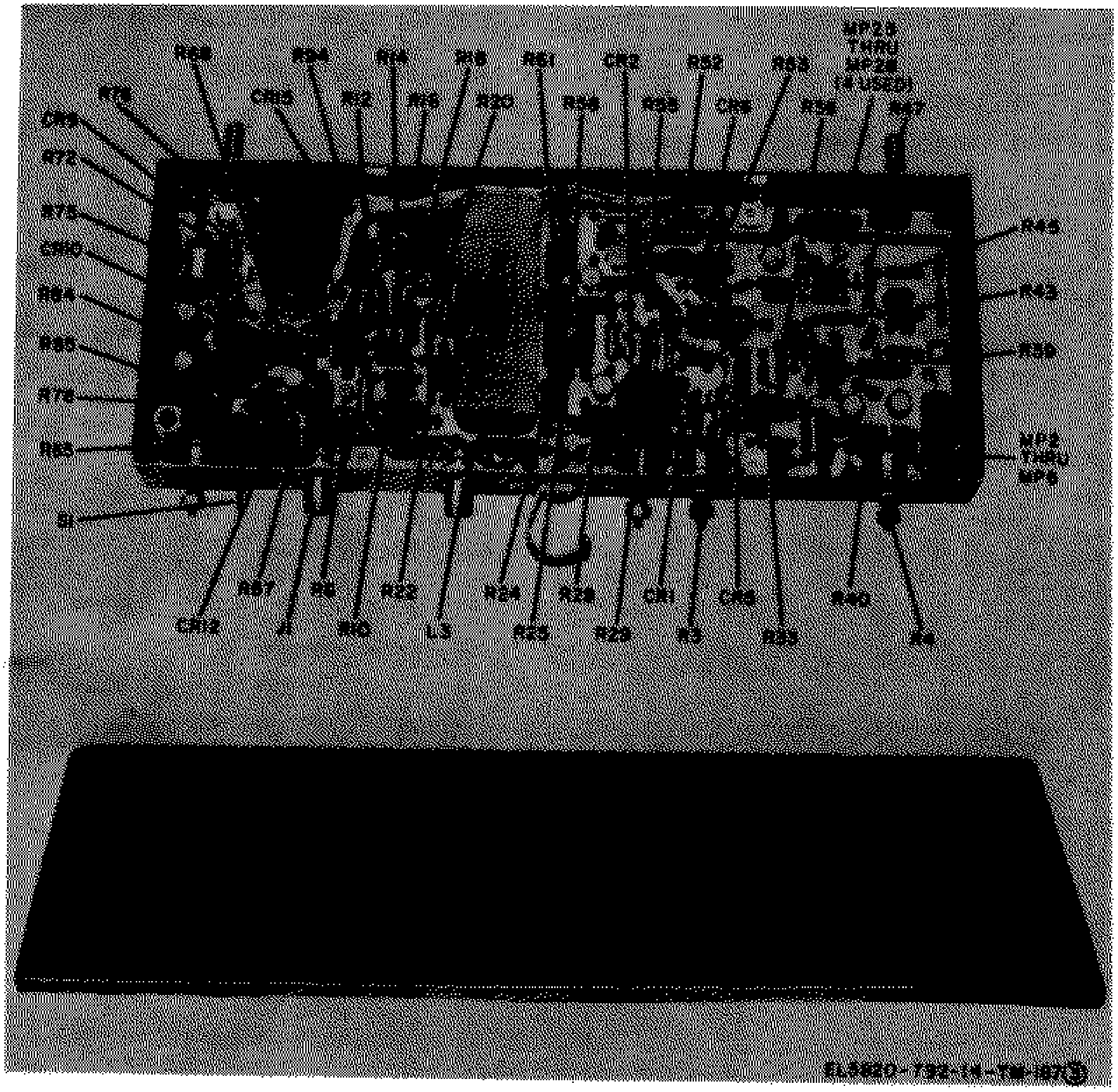


Figure 6-131 (3). Noise amplifier module, parts location diagram (sheet 3 of 4).

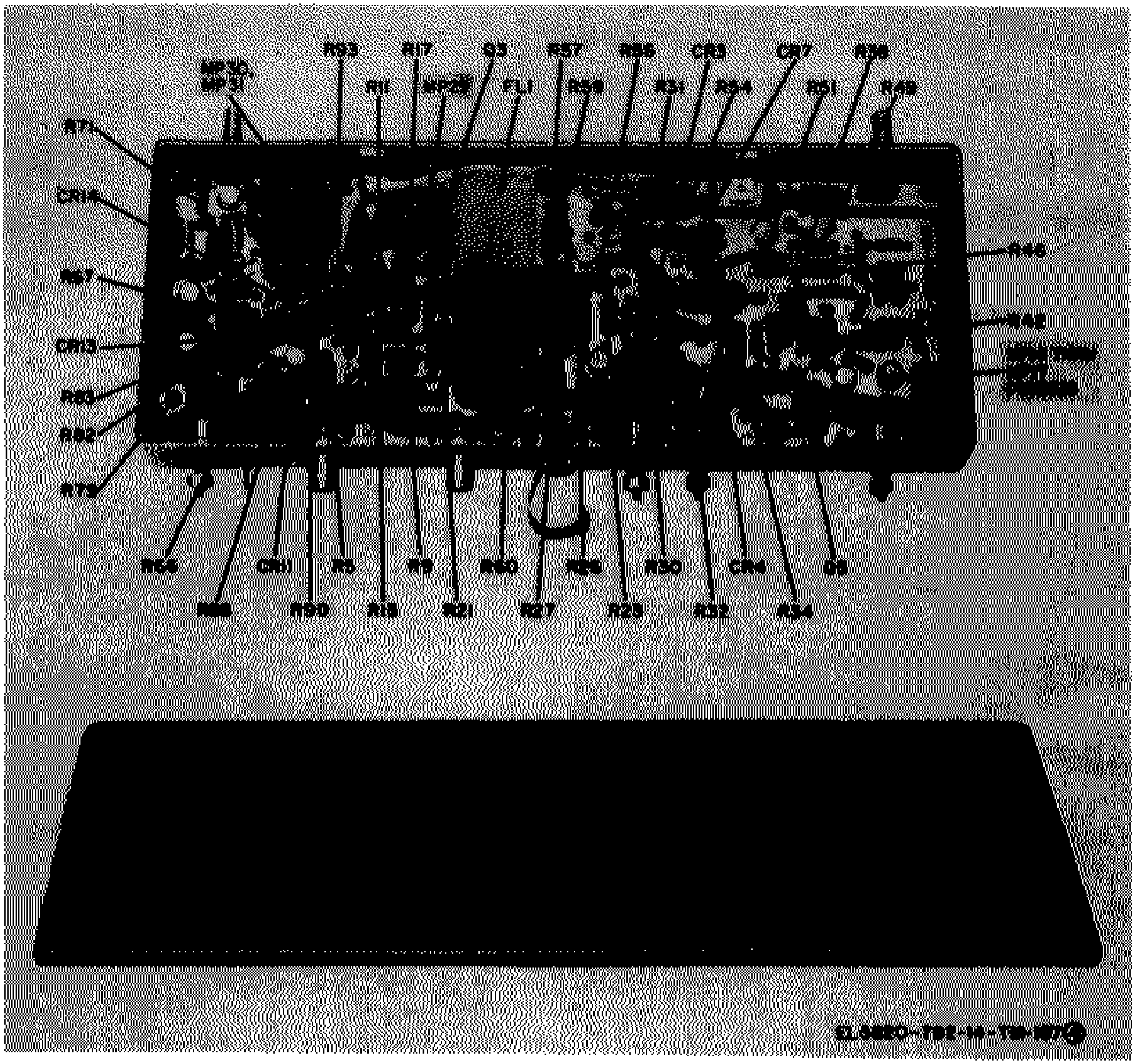


Figure 6-131 (4). Noise amplifier module, parts location diagram (sheet 4 of 4).

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove the top and bottom covers from the module.

(2) Connect the test equipment as shown in figure 6-130.

(3) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(4) Adjust the +28-volt power supply in the module test set for 28 ±0.1 Vdc.

d Test Procedures. After completing the procedures in *b* and *c* above, perform the procedures in e below.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Noise Amplifier Gain Check		
1	On the module, set R2, R3, and R4, fully clockwise and set SI to its NORM position. Set R1 fully COUNTERCLOCKWISE.			
2	Set the RANGE of the ac voltmeter to its .01 VOLTS position.			
3	On the test oscillator, set the FREQUENCY dial to 6, its RANGE to X1M, then set its OUTPUT ATTENUATOR to minimum output.			
4	Connect the test equipment to the module as shown in figure 6-130.			
5	On the test oscillator, adjust the OUTPUT ATTENUATOR, COARSE and FINE output controls until the ac voltmeter indicates 4.5 mV.			
6	Set the VOLTS-FULL SCALE control of an AC voltmeter to .01 VOLTS, then connect it between the center conductor of the UG-274B/U and ground.	4.4 mV (minimum)	....	Check Q1, Q2, Q3, and associated components.
7	Disconnect, the AC voltmeter, adapter, and 75-ohm termination.			
8	Connect an oscilloscope between test points TP4 and TP2 (ground).	35 mV peak-to-peak (nominal).	....	Check R20 and FL1.
9	Connect an oscilloscope between ground and Q4 emitter.	35 mV peak-to-peak (nominal).	....	Check Q4 and associated components.
10	Connect an oscilloscope between ground and Q9 collector.	6 V peak-to-peak (nominal)	....	Check varilosser circuits consisting of CR2, CR3, CR4, CR5 and associated circuits. AGC Loop Gain Check
11	Disconnect the test equipment from the noise amplifier module.			
12	Interconnect the ac voltmeter and test oscillator, as shown in figure 6-132.			
13	On the test oscillator, set the FREQUENCY dial to 4, and the RANGE control to X100K. Set the output level to minimum.			
14	Remove power from the noise amplifier module, unsolder the + end of C22 from the circuit board assembly, pull the unsoldered end free of the circuit card, and let it hang free. Reapply power to the module.			
15	Connect a 2631 adapter between ground and the + side of C22.			
16	On the test oscillator, adjust the output level controls until the ac voltmeter indicates 8 mV. Disconnect the ac voltmeter.			
17	Connect the oscilloscope probe between ground and Q5 collector.	7 mV peak-to-peak (nominal).	....	Check Q5, Q6, Q7 and associated components. Transistors Q5 through Q7 are in a feedback network; failure in one stage will produce changes in remaining transistors.
18	Connect the oscilloscope probe between ground and Q6 collector.	2.1 V peak-to-peak (nominal).	....	Check Q5, Q6, Q7, and associated components.
19	Connect the oscilloscope probe between ground and the junction of R44-C29.	1.2 V peak-to-peak (nominal).	....	Check Q5, Q6, Q7 and associated components.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
20	Reduce the output level of the test oscillator to minimum and transfer the 2631 adapter to the junction of R45 and C31 through a 1 ofd capacitor.			
21	Reconnect the ac voltmeter to the test oscillator as shown in figure 6-132.			
22	On the test oscillator, adjust the output level controls until the ac voltmeter indicates 44 mV. Disconnect the ac voltmeter.			
23	Connect the oscilloscope probe between ground and Q8 collector.	280 mV peak-to-peak (minimum).	....	Check Q8, Q9, and associated components.
24	Connect the oscilloscope probe between ground and Q9 collector, remove cap installed in step 20.	1.5 V peak-to-peak (minimum).	....	Check Q8, Q9, and associated components.
25	Transfer the 2631 adapter between ground and the + side of C22.			
26	Reconnect the ac voltmeter to the test oscillator as in figure 6-132.			
27	On the test oscillator, adjust the output level controls until the ac voltmeter indicates 8 mV.			
28	On a multimeter, set the FUNCTION switch to + and the RANGE control to 30 V. Connect the multimeter between TP3 and TP2 (ground).	16 V dc (minimum).		
29	Disconnect the clip lead from the + side of C22 and note the multimeter indication.	+6.5Vdc(nominal)		
30	Reconnect the 2631 adapter to the junction of R45 and C31 through a 1 μfd capacitor.			
31	On the multimeter, set the RANGE control to 10 V. Connect the multimeter between ground and the junction of C41 and C42.	7.1 V dc (nominal).	....	Check CR6, CR7, Q10, and Q11.
32	Disconnect the clip lead from the junction of R45 and C31.			
33	Connect the multimeter between ground and the junction of C41 and C42.	6.8 V dc (nominal).	....	Recheck the circuitry associated with CR6, CR7, Q10, and Q11.
34	Reconnect and resolder C22 to the circuit card assembly.			
		Combiner Bias Output Voltage Check		
35	Reconfigure the test equipment as shown in figure 6-130.			
36	On the test oscillator, set the FREQUENCY dial to 6, the RANGE control to X1M, and the output level to minimum.			
37	On an AC voltmeter, set the VOLTS-FULL SCALE control to .01 VOLTS, then connect it between test points TP4 and TP2 (ground).			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
38	On the test oscillator, adjust the output level until the AC voltmeter indicates 7.8 mV.			
39	On a multimeter set its FUNCTION switch to + and its RANGE switch to 30 V, then connect the multimeter between TP3 and TP2 (ground).			
40	On the noise amplifier adjust R2 until the multimeter indicates 10.8 V dc.			
41	On the AC voltmeter, set the VOLTS-FULL SCALE control to .1 VOLTS, then connect it to test points TP4 and TP2.			
42	On the test oscillator, adjust the output level controls until the AC voltmeter indicates 78 mV.			
	43 Read and record the multimeter indication.	18 ± 2 V dc..	....	Check Q8 through Q11, CR7, CR8, and associated corm-ponents.
44	On the AC voltmeter, set the VOLTS-FULL SCALE control to 0.03 VOLTS, then connect it to test points TP4 and TP2.			
45	On the test oscillator, adjust the output level controls until			
46	the AC voltmeter indicates 24 mV.			
46	Read and record the multimeter indication.	14 ± 1.5 V dc.......................................	....	Check Q8 through Q11, CR7, CR8, components.
47	On the AC voltmeter, set the VOLTS-FULL SCALE control to .003 VOLTS, then connect it to test points TP4 and TP2.			
48	On the test oscillator, adjust the output level controls until the AC voltmeter indicates 2.4 mV.			
49	Read and record the multimeter indication.	8.5 ± 1 V dc...	....	Check Q8 through QI 1, CI.7, CR8, and associated com-ponents.
50	On the AC voltmeter, set the VOLTS-FULL SCALE control to .001 VOLTS, then connect it to test points TP4 and TP2.			
51	On the noise amplifier module, set S1 to its BYP position.			
52	On the test oscillator, adjust the output level controls until the AC voltmeter indicates .78 mV.			
53	Read and record the multimeter indication.	7 ± 1 V dc..	....	Check Q8 through Q11, CR7. CR8, and associated com-ponents.
54	Disconnect the test cable from J1 of the noise amplifier module.			
55	Read and record the multimeter indication.	6.5 + 0.5 V dc......................................	....	Check Q8 through Q11 , CR7, CR8, and associated com-ponents.
56	On the noise amplifier module, set R4 to its maximum counterclockwise position,			
57	On the AC' voltmeter, set the VOLTS-FULL SCALE control to its .1 VOLTS position, then connect it to test points TP4 and TP2.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
58	Reconnect the test oscillator cable to J1 of the noise amplifier module.			
59	On the test oscillator, adjust the output level controls until the AC voltmeter indicates 78 mV.			
60	Read and record the multimeter indication.	15 ± 2 V dc...	....	Check Q8 through Q11, CR7, CR8, and associated com-ponents.
61	On the AC voltmeter, set the VOLTS-FULL SCALE control to its .03 VOLTS position, then connect it to test points TP4 and TP2.			
62	On the test oscillator, adjust the output level controls until the, AC voltmeter indicates 24 mV.			
63	Read and record the multimeter indication.	12.5 ± 1.5 V dc	....	Check Q8 through Q11, CR7, CRS, and associated com-ponents.
64	On the AC voltmeter, set the VOLTS-FULL SCALE control to its .01 position, then connect it to test points TP4 and TP2.			
65	On the test oscillator, adjust the output level controls until the AC voltmeter indicates 7.8 mV.			
66	Read and record the multimeter indication.	10 ± 1 V dc...	....	Check Q8 through Q11, CR7, CR8, and associated com-ponents.
67	On the AC voltmeter, set the VOLTS-FULL SCALE control to its .003 position, then connect it to test points TP4 and TP2.			
68	On the test oscillator, adjust the output level control until the AC voltmeter indicates 2.4 mV.			
69	Read and record the multimeter indication.	8 ± 1 V dc...	....	Check Q8 through Q11, CR7, CR8, and associated com-ponents.
70	On the AC voltmeter, set the VOLTS-FULL SCALE control to its .001 position, then connect it to best points TP4 and TP2.			
71	On the test oscillator, adjust the output level controls until the AC voltmeter indicates 0.78 Mv.			
72	Read and record the multimeter indication.	7 ± 1 Vdc	....	Check Q8 through Q11, CR7, CR8, and associated corn-ponents.
73	Disconnect the test cable from JI of the noise amplifier module.			
74	Read and record the multimeter indication.	6.5 ± 0.5 V dc	....	Check Q8 through Q11 CR7, CR8, and associated corn-ponents.
		Pilot-Tone Alarm Performance Check		
75	On the noise amplifier module, set R4 back to its fully clockwise position.			
76	Reconfigure the test equipment as shown in figure 6-132.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
77	Connect the 2631 adapter to Jl-16 and J1-17 (ground) of the 22-pin point-to-point extender cable.			
78	On the ac voltmeter, set its RANGE to .01 VOLTS.			
79	On the test oscillator, adjust the output level controls until the ac voltmeter indicates .8.8 mV. Then adjust the FREQUENCY dial until the electronic counter indicates 3.2 ± 0.1 MHz.			
H 80	On the multimeter, set the RANGE control to 30 V, then connect it between J1-4 and J1-3 (ground) on the 22-pin point-to-point extender cable.	7.3 V dc.		
81	Disconnect the ac voltmeter from the test setup, reset the RANGE control to .003 VOLTS, and connect it between TP 6 and TP2.			
82	Adjust R3 on the noise amplifier, until the ac voltmeter indicates 3 mV.			
83	Adjust R79 on the noise amplifier until K2 just operates.			
84	Observe multimeter indication..	28 V dc..	....	Check R79, MD2, Q13, K2, and associated circuits.
85	On the noise amplifier module, operate S1 to BYP, note the multimeter indication, then return S1 to its NORM position.	7.3 V dc	....	Check S1, Q13, Ke. and associated circuits.
		Excess Noise Alarm Check		
86	Set R4 of the noise amplifier to its fully clockwise position.			
87	Set the RANGE control of a multimeter to 30 V, then connect it between TP3 and TP2 (ground).			
88	Disconnect the 2631 adapter from the test equipment setup.			
89	On the test oscillator, set the RANGE to X1M, the FREQUENCY dial to 6, and adjust the FREQUENCY dial until the electronic counter indicates 6 MHz.			
90	Connect the test oscillator setup to J1 of the noise amplifier, then adjust its output level controls until the multimeter indicates 18 -2 V dc.			
91	Transfer the multimeter to Jl-15 and J1-17 (ground), then observe the multimeter indication.	0 V dc.		
92	On the noise amplifier module, set S1 to its BYP position, note the multimeter indication, then return S1 to its NORM position.	28 V dc..		Check S1, Q12, K1, and associated circuits.
93	Transfer the multimeter to test points TP3 and TP2 (ground).			
94	On the test oscillator, adjust its output level controls until the multimeter indicates 15 V dc.			
95	Transfer the multimeter to Jl-15 and J1-17 (ground) then observe the multimeter indication.	28 V dc	Disconnect all test equipment.	

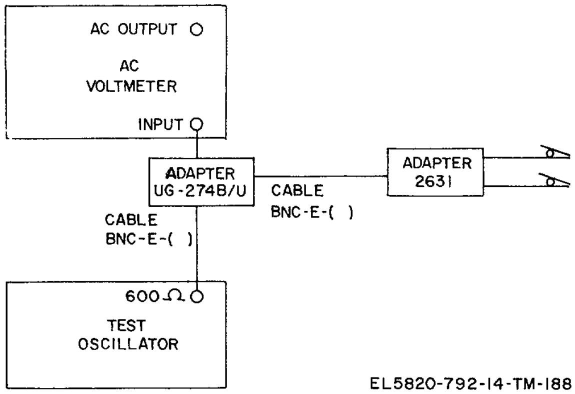


Figure 6-132. AGC loop gain test equipment setup.

f. Voltage and Resistance Measurements. If performance of test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in *g* below, in conjunction with standard trouble-shooting techniques, should enable location and correction of the fault.

(1) Resistance measurements are made with the module disconnected from all voltage and signal sources. The RX100 scale of the multimeter is used as the standard range unless otherwise stated; the common multimeter lead is connected to J1-3 (ground) during all measurements.

(2) Dc voltage measurements are made with the module connected to the combiner door of the module test set using the appropriate point-to-point extender cable. No signal source is employed.

NOTE

Stages Q12 and Q13 are dual transistors. When viewing foil-side connections, count the pins in a clockwise direction, using the casing tab of the stage as an indexing or starting point. In the case of MD1 and MD2, the counting scheme is the same; however, pin 4 (which is grounded) is the only pin that is readily located because of the large foil area adjacent to and connected to it.

(3) Ac voltage measurements are made using the following procedure:

(a) Set the RANGE control of an ac voltmeter to its .01 VOLTS position.

(b) On a test oscillator, set the FREQUENCY dial to 6, its RANGE control to X1M, then set the OUTPUT ATTENUATOR to minimum output.

(c) Connect the test equipment as shown in figure 6-130.

(d) On the test oscillator, adjust the OUTPUT ATTENUATOR, COARSE and FINE controls until the ac voltmeter indicates 4.5 mV.

(e) Perform ac voltage measurements, as necessary, using an RF voltmeter with the high-impedance probe.

g. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (nominal)	Resistance (ohms nominal)
Q1	Base	5.0	4.0 mV	7K
	Emitter	4.3	4.0 mV	22 ohms
	Collector	13.9	1.4 mV	4.5K
Q2	Base	14.1	14 mV	12K
	Emitter	13.4		15K
	Collector	19.0	18.0 mV	2.9K
Q3	Base	19.0	18.0 mV	2.9K
	Emitter	18.4	17.5 mV	680 ohms
	Collector	27.0	0	800 ohms
Q4	Base	18.9	10.0 mV	8K
	Emitter	18.1	8.4	1.6K
	Collector	27.0	0	800 ohms
Q5	Base	1.8	2.3 mV	850 ohms
	Emitter	1.2	2.25 mV	180 ohms
	Collector	6.0	1.7 mv	1.6K
Q6	Base	6.1	1.7 mV	1.6K
	Emitter	5.4	1.0 mV	660 ohms
	Collector	13.5	165 mV	1.8K
Q7	vase	13.5	165 mV	1.8K
	Emitter	12.8	164 mV	1.4K
	Collector	27.2	0	800 ohms
Q8	Base	2.5	10 mV	2K
	Emitter	3.2	1.7 mV	560 ohms
	Collector	9.5	710 mV	2.5K

See footnotes at end of chart.

Point of measurement		Dc voltage (nominal)	Ac voltage (nominal)	Resistance (ohms nominal)
Q9	Base	9.5	710 mV	2.5K
	Emitter	8.8	54 mV	500 ohms
	Collector	18.5	2.05 mV	1.45K
Q10	Base	7.5	. . . . .	30K
	Emitter	7.0	. . . . .	4K
	Collector	23.0	. . . . .	2.9K
Q11	Base	7.0		4K
	Emitter	6.2	. . . . .	3K
	Collector	23.0	. . . . .	2.9K
Q12	Pin 1	19.0a 6.3b	. . . . .	1.6K
	Pin 2	0.6a 7.0 b	. . . . .	1.3K
	Pin 3	3.2a 6.3b	. . . . .	580 ohms
	Pin 4	3.3a 6.3b	. . . . .	620 ohms
	Pin 5	4.la'1.8b	. . . . .	1.3K
	Pin 6	3.4a27.5 b	. . . . .	1.7K
Q13	Pin 1	19.5a6.4b	. . . . .	1.7K
	Pin 2	3.4a 27.5b	. . . . .	1.3K
	Pin 3	3.4a 3.4b	. . . . .	580 ohms
	Pin 4	3.4a 3.4b	. . . . .	580 ohms
	Pin 5	4.1a 1.8b	. . . . .	1.3K
	Pin 6	oa7.ob	. . . . .	1.6K
MD1	Pin 1	5.8	. . .	1.3K
	Pin 2	5.8	. . . . .	1.5K
	Pin 3	5.8	. . . . .	15K itX1K
	Pin 4	0	. . . . .	0
	Pin 5	4.1	. . . . .	5K RX1K
	Pin 6	0.75	. . . . .	5K RX1K
	Pin 7	0.2	. . . . .	1.2K
	Pin 8	18.0	. . . . .	950 ohms
MD2	Pin 1	5.8	. . . . .	1.3K
	Pin 2	5.8	. . . . .	1.5K
	Pin 3	6.0	. . . . .	15K RX1K
	Pin 4	0	. . . . .	0
	Pin 5	4.1	. . . . .	5K RX1K
	Pin 6	0.67	. . . . .	5K RX1K
	Pin 7	0.15	. . . . .	1.2K
	Pin 8	18.0	. . . . .	950 ohms
Filter IN			11 mV	
Filter OUT			10 mV	
Junction of				
R29, C16, CR2		22.2		
R32, C18, CR4		22.2		
R29, C15, CR1		19.0		
TP1			4.4 mV	1.1K
TP2		0	0	0
TP3		6.5	0	2.3K
TP4		0	11.0 mV	0
TP5		0	11.0 mV	0
TP6		0		
TP7		0	0	0
J1-1		28	. . . . .	950 ohms
J1-2		0		
J1-3		0		
J1-4		27.0 [a]7.3[b]		
J1-5		27.5		
J1-6		26.5[a] 0[b]		
J1-7		0		
J1-8		0		
J1-9		0		
J1-10		0		
J1-11		27.0[a]7.3[b]		
J1-12		26.0[a] 0[b]		
J1-13		6.5		
J1-14		0		
J1-15		0[a] 27.0[b]		

See footnotes at end of chart.

Point of measurement	Dc voltage (nominal)	Ac voltage (nominal)	Resistance (ohms nominal)
J1-16	0		
J1-17	0		
J1-18	0		
J1-19	6.2		
J1-20	0		
J1-21	0		
J1-22	0		

[a] Switch S1 in NORM position.
[B] Switch S1 in BYP position.

6-70. Alignment Data

a. General. The noise amplifier module is preset at the -test bench location to provide acceptable operation when inserted into the radio set. Alignment of the noise amplifier to provide module interchangeability may require replacement of one component (R57) with a 120-ohm, one-half watt resistor; R57 should be replaced only if specified voltage cannot be obtained at TP3 in *b* (8) through (13) below.

b. Combiner Bias and Alarms Adjustment. Perform the following adjustments:

(1) On a noise generator, set the 60 kc/s HIGH PASS filter to its IN position, set all other filters to their OUT positions.

(2) On the noise generator, set the ATTENUATOR ADD DB controls to 50.

(3) Set the RANGE control of an ac voltmeter to its -50 dB- position.

(4) Set a multimeter FUNCTION switch to DCV 20 k Ω /v and its RANGE control to 10 VOLTS.

(5) On the noise amplifier module, set R1, R2, and R4 to their maximum clockwise positions; set R3 to its maximum counterclockwise position.

(6) Remove the top cover of the noise amplifier module, and set R79 to its maximum clockwise position.

(7) Connect the test equipment as shown in figure 6-133.

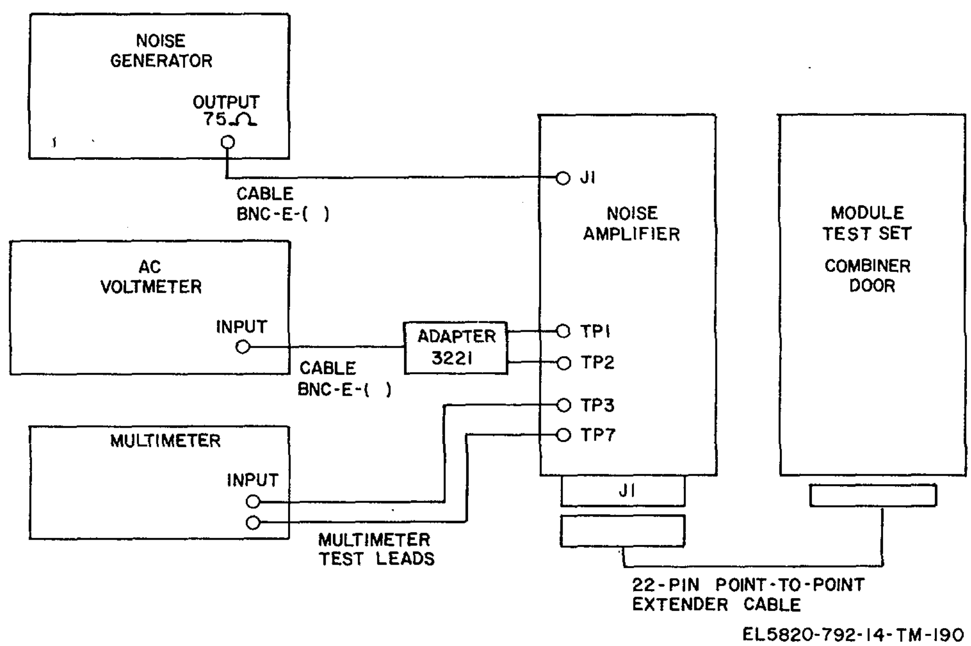


Figure 6-133. Noise amplifier alignment test equipment setup.

(8) On the noise generator, adjust the ATTENUATOR ADD DB controls until the ac voltmeter indicates - 55 dB. Use NOISE LEVEL control of the noise generator for fine adjustment to -55 dB. Use great care in setting this level.

NOTE

IF -55 dB cannot be obtained using the controls specified, or if NOISE LEVEL control is too difficult to set, connect an IF ATTENUATOR between the noise generator and J1 of the noise amplifier. When this is done, set NOISE LEVEL control to its midposition, then add dB until the ac voltmeter nears --55 dB. Following this, the NOISE LEVEL control can be used to obtain the exact setting.

(9) On the noise amplifier, adjust R2 until the multimeter indicates 7.5 V dc. Be especially careful when obtaining this level; all other adjustments depend on the setting of R2.

(10) Observe the ac voltmeter indication to determine whether the adjustment of R2 has produced a shift of noise signal input level. If so, repeat (8) and (9) above as necessary to obtain the proper setting of R2.

(11) On the noise generator, adjust the ATTENUATOR ADD DB controls until the ac voltmeter indicates --20 dB. Use NOISE LEVEL control of the noise generator for fine adjustment to - 20 dB. Be careful when setting this level.

(12) On the noise amplifier, adjust R4 until the multimeter indicates 15.0 Vdc.

(13) Repeat (8) through (12) above to be certain the setting of R4 has not interacted with the setting of R2. Repeat as necessary to obtain both requirements. Replace R57 with 120- to 220-ohm, 1/2-watt resistor if required to obtain specified voltages at TP3. Seal R2 and R4 in position.

(14) On the noise generator, adjust ATTENUATOR ADD DB and NOISE LEVEL controls until the ac voltmeter indicates 15 + 0.1 volt.

(15) On the noise amplifier module, adjust R1 until the NOISE ALARM indicator lights, back the control off until the indicator is off, then very carefully readjust R1 until the NOISE ALARM indicator just does come on.

(16) On the noise amplifier module, set S1 to BYP position; the NOISE ALARM indicator is now no longer lighted.

(17) On the noise amplifier module, set S1 to NORM position and the NOISE ALARM indicator is lighted.

(18) On the noise generator, add 1-dB attenuation using the ATTENUATION ADD DB control.

(19) On the module test set note that the NOISE alarm indicator is not lighted. Seal R1 in position.

c. Final Check. After the noise amplifier has been aligned, the following procedure is to be used to check the tracking of noise amplifier modules. Noise amplifier tracking is very important for proper combiner action. It is possible to properly and satisfactorily align a noise amplifier on the work bench and have it fail in the terminal because it will not track with the other channel. To track properly, BOTH noise amplifiers must produce the same dc output voltage (within 0.25 Vdc) with the same input noise level. Such a test at a single input level is insufficient, the range between 7 Vdc and 16 Vdc should be checked at 5 or 6 points. The important point is that the excess noise alarms turn on and go off within 1 dB (input signal) of each other, and that the DC combiner control voltage measured at TP2 be within the tolerances in (1) below at each noise input level specified.

(1) Module Performance Requirements are as follows:

Noise Input TP4	*Control Voltage TP3*	*Remarks*
-65dB	7.0 V maximum	
-55dB	7.5 ± 0.1 volts	R2 set point
-45dB	8.9 V ± 0.25 volts	
-35dB	11.0 V ± 0.25 volts	
-25dB	13.5 V ± 0.25 volts	
-20dB	15.0 V ± 0.1 volts	R4 set point R1 set point
-17dB	15.8 V minimum	
-21 dB	NONE	NOISE ALARM OFF check point

(2) On the noise generator, adjust the ATTENUATOR AA DB and NOISE LEVEL controls for each of the noise input levels specified in the table.

(3) On the multimeter, note and record the voltage at TP3 for each specified noise input level. Verify that each noted reading is within tolerances.

(4) Alignment and final test are complete. Disconnect all test equipment and replace module cover(s).

Section XVI. RADIOFREQUENCY FILTERS

6-71. Introduction

The radiofrequency filters are used in both the transmitter and receiver sections of a microwave radio receiver.

6-72. Module Configuration

Transmit and receive RF filters are different only in the number of tuned sections, the receive filters are 6-section units, and the transmit filters are four-section filters.

6-73. Functional Description

a. The microwave radio receiver includes two 6-section waveguide, iris-coupled, radiofrequency filters. One filter is used for channel A and the other is used for channel B. The purpose of these receiver filters is to select and pass the assigned operating frequency into the radio receiver and reject all other input frequencies.

b. The microwave radio transmitter includes two four-section waveguide, iris-coupled, radiofrequency filters. One filter is used for channel A and the other is used for channel B. These transmitter filters select and pass the assigned operating frequency out of the radio transmitter and absorb and reject all harmonics and undesirable related modulation products.

c. Technical characteristics are given below.

Parameter	Specifications	
Receive filters:	Part No. 368-43346	Part No. 368-43627
Frequency band	4400 to 4700 MHz	4700 to 5000 MHz
Flat bandwidth	19 MHz minimum	19 MHz minimum
Bandwidth to the 0.1 dB point	21 MHz minimum	21 MHz minimum
Bandwidth to the -3.0 dB points	47 MHz maximum	47 MHz maximum
Rejection:		
f_o + 80 MHz	60 dB minimum	60 dB minimum
f_o +100 MHz	71 dB minimum	71 dB minimum
Insertion loss at f_o	1.0 dB maximum	1.0 dB maximum
Voltage reflection coefficient	0.0476 maximum (VSWR1.1:1)	0.0476 maximum (VSWR 1.1:1)
Transmit filters:		
Frequency band	4400 to 4700 MHz	4700 to 5000 MHz
Flat bandwidth	19 MHz	19 MHz minimum
Bandwidth to the 0.1-dB points	21 MHz minimum	21 MHz minimum
Bandwidth to the -3.0-dB points	52 MHz maximum	52 MHz maximum
Rejection:		
f_o +80 MHz	35 dB minimum	35 dB minimum
f_o + 100 MHz	45 dB minimum	45 dB minimum
Insertion loss at f_o	0.8 dB maximum	0.8 dB maximum
Voltage reflection coefficient	0.04786 maximum (VSWR 1.1:1)	0.0476 maximum (VSWR 1.1:1}

6-74. Alignment Data

a. General. The following procedures should be performed only when the filter must be adjusted to a new operating frequency or when the possibility of disturbed screw settings exist.

b. Test Equipment Setup. The test equipment setup used for the following alignment and adjustment procedures is shown in figure 6-134.

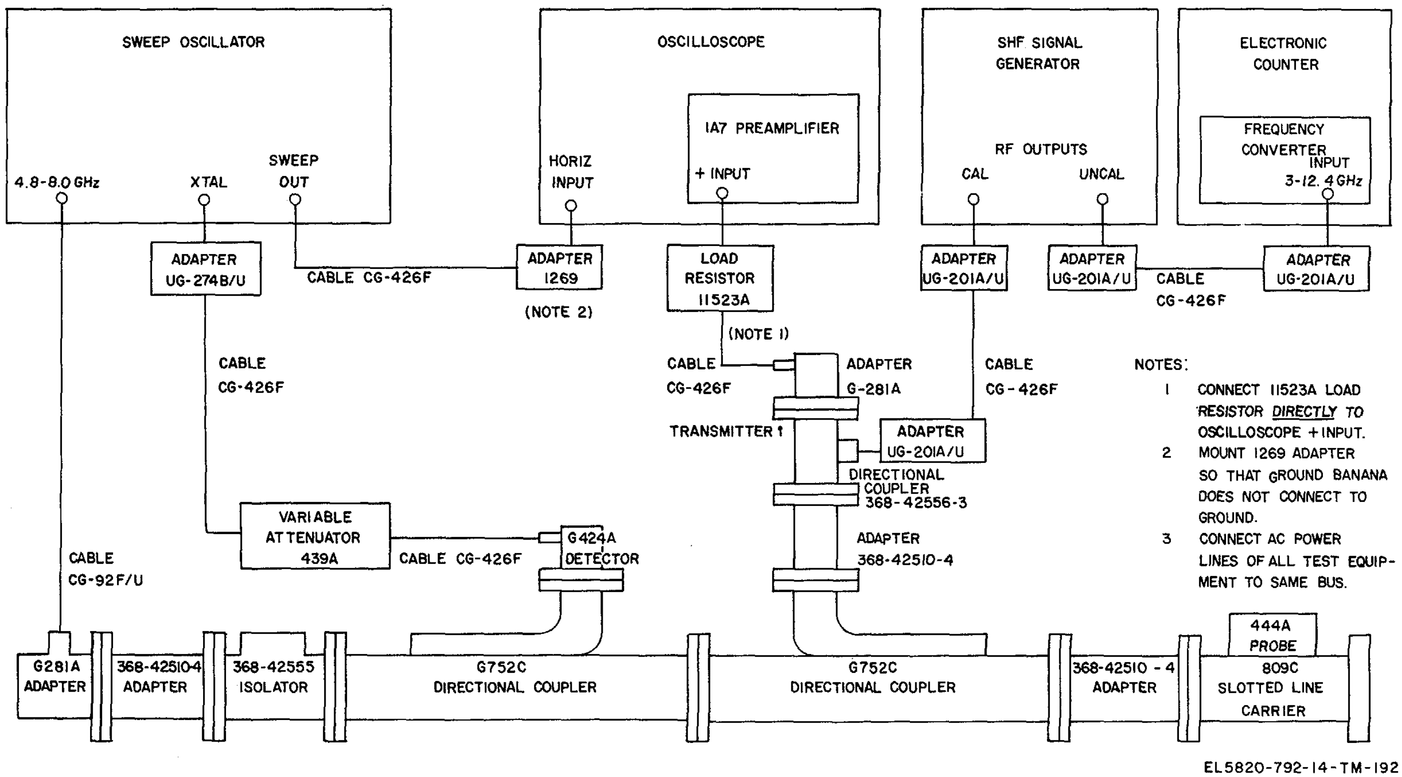


Figure 6-134. Waveguide filter, initial alignment setup.

c. Preliminary Adjustments. When the test setup of figure 6-134 is completed, perform the following procedure.

(1) Set all test equipment POWER switches

FUNCTION
ALC
SWEEP SELECTOR
SWEEP TIME (SEC)
SWEEP TIME VERNIER
POWER LEVEL
START/CW
STOP/F
LINE

(3) On the electronic counterfrequency converter, preset the following controls as directed:

POWER/SAMPLE RATE

SENSITIVITY (VOLTS/CM)
TIME BASE
LEVEL
FUNCTION

(4) On the frequency converter, set the frequency dial to the approximately f o frequency.

MOD SELECTOR
OUTPUT ATTEN

(6) On the SHF signal generator, adjust the POWER SET control until the meter indicates zero.

(7) On the SHF signal generator and the frequency converter, adjust the frequency con-

HORIZONTAL DISPLAY
MAGNIFIER
VARIABLE 10-1

HORIZONTAL POSITION

(9) On the oscilloscope, preset the following vertical controls as directed:

VOLTS/CM
VARIABLE
+ INPUT
- INPUT

DC OFFSET
HIG FREQ-3 DB
LOW FREQ-3 DB

(10) On the oscilloscope, use the vertical POSITION control to move the trace exactly 3 cm above the graticule centerline.

(11) On the sweep oscillator, set the LINE switch to the ON position and note that a marker is visible on the oscilloscope display. If the marker is not visible, insert additional at to their ON positions; allow the test equipment to stabilize for 30 minutes.

(2) On the sweep oscillator, preset the following controls as directed:

depress ∆ F
depress
to .... AUTO
to 18.01
to .... LINE SYNC
to 10
to .... fo
to .... 200 MHz
to .... Standby (center position).

adjust Gate lamp should flash approximately once per second.

to PLUG IN
to .1 MS
to PRESET
to FREQUENCY

(5) On the SHF signal generator, preset the following controls as directed:

to CW
to fully counterclockwise.

trols until the electronic counter/frequency converter indicates f o 0.5 MHz..

(8) On the oscilloscope, preset the following horizontal controls as directed:

to EXT X1
to OFF
to Position the left-edge of the trace at the left-edge of the graticule.
to 10 cm horizontal trace.

to 20 MV
to CALIBRATED
to DC
to GND
to OFF
to 10 kHz
to DC

tenuation in the variable attenuator until marker appears.

(12) On the sweep oscillator, adjust START/CW control to position the marker at the center of the oscilloscope trace. Then adjust the STOP/∆ F control to 10 MHz

(13) On the sweep oscillator, adjust the

START/CW control to position the marker at the center of the trace again. Then adjust the STOP/ Δ F control to 200 MHz.

(14) On the SHF signal generator, adjust the OUTPUT ATTEN control to its full clockwise position. Note that the marker disappears.

(15) Disconnect the load resistor and test cable from the + INPUT of the oscilloscope.

(16) Connect a test cable between the UG-274B/U adapter at XTAL of the sweep oscillator and the + INPUT on the oscilloscope. Release the ALC button of the sweep oscillator.

(17) On the rear apron of the sweep oscillator, set ALC GAIN control fully clockwise.

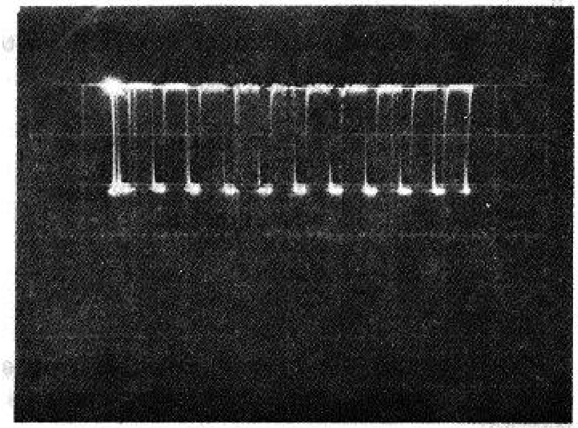
(18) On the sweep oscillator, depress the INT SQ WAVE pushbutton.

(19) On the oscilloscope set the VOLTS/CM control to 10 mV

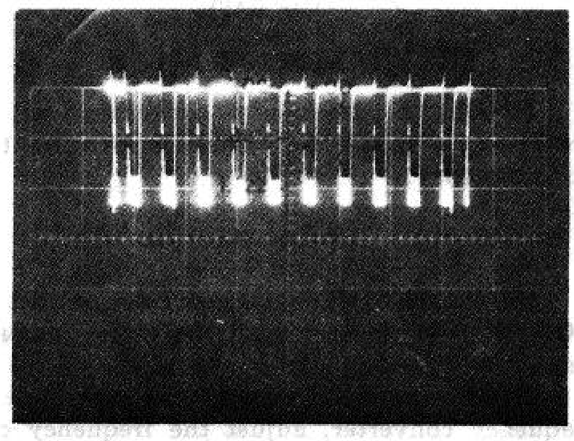
(20) On the variable attenuator, insert attenuation until the trace amplitude is between 3 cm and 5 cm, but the trace MUST NOT exceed 5 cm which corresponds to 50 mV.

(21) On the sweep generator, adjust the INT SQ WAVE FREQ control to stabilize the trace.

(22) Depress the ALC pushbutton of the sweep generator. Inspect the oscilloscope trace to be certain that no oscillation is present in the waveform and that the bottom of the trace is in a straight line. Refer to figure 6-135.



A. Correct ALC waveform



B. Incorrect ALC waveform

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Figure 6-135. Sweep oscillator ALC adjustment waveform.

(23) Vary the amount of attenuation, using the step attenuator, there must be no oscillation in the displayed waveform as long as the signal level does not exceed 50 mV. Leave the attenuator set to limit the displayed waveform between 3 cm

(30 mV) and (50 mV).

(24) On the sweep oscillator, release the INT SQ WAVE pushbutton to remove the signal from the display.

(25) Remove the test cable between + INPUT of the oscilloscope and XTAL of the sweep oscillator.

(26) Connect the 11523A load resistor (with the test cable from G281A adapter, fig 6-136) to the + INPUT of the oscilloscope. Set VOLTS/SM control to 20 mV.

(27) Remove the UG-274B/U from XTAL of the sweep oscillator and connect the CG-426F test cable directly to XTAL.

(28) On the SHF signal generator, check that the OUTPUT ATTEN control is still fully clockwise position.

(29) On the sweep oscillator, set the LINE switch to its center position, verify that the oscilloscope trace is 3 cm above center graticule. If required, adjust the vertical POSITION control to position the trace correctly. Set the LINE switch to its ON position.

(30) Place a short over the open end of the slotted line carrier; fully withdraw the slotted-line probe.

(31) On the sweep oscillator, adjust the POWER LEVEL control to position the oscilloscope trace 3 cm below the center graticule. If the trace cannot be moved to this position using only the POWER LEVEL control, insert additional attenuation using the 439A attenuator, then using the POWER LEVEL control set the trace as required. Check that the UNLEVELED indicator is *not* lighted.

(32) Remove the short from the open end of the slotted line carrier.

(33) On the SHF signal generator, adjust the OUTPUT ATTEN control to full counter-clockwise position.

(34) On the SHF signal generator, adjust the frequency controls until the electronic counter/converter indicates $f_o \pm 0.1$ MHz.

(35) On the sweep oscillator, adjust the START/CW control to position the marker precisely at the center graticule.

(36) On the sweep oscillator, adjust STOP/ Δ F control to 10 MHz. Using START/CW control, position the marker precisely at the center graticule. Then set the STOP/ Δ F control to 60 MHz.

(37) On the SHF signal generator, set the OUTPUT ATTEN control to its full clockwise position.

(38) Repeat steps (29) through (32), above then set the LINE switch on the sweep oscillator to its center position.

(39) Watch the trace closely while shifting the VOLTS/CM control through its range to .1 mV. If the trace shifts away from the 3-cm graticule position, use the STEP ATTEN DC BAL control to move the trace to the 3-cm graticule.

(40) Reset the VOLTS/CM control of the oscilloscope to 20 mV. The trace should not shift away from the 3-cm graticule at any position of the VOLTS/CM control.

(41) On the sweep oscillator, set the LINE control to its ON position, then turn the OUTPUT ATTEN of the SHF signal generator in a counterclockwise direction until the marker is barely visible.

(42) Assemble the filter to be aligned with adapters and load as shown in figure 6-136 as a single assembly, then connect the assembly to the test equipment setup (fig. 6-134).

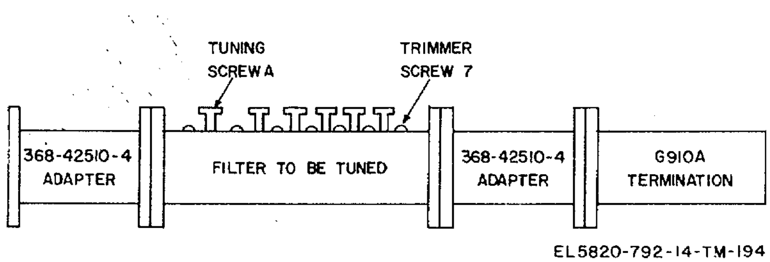

Figure 6-136. Filter and load assembly.

d. Waveguide Filter Alignment. On the filter, loosen all locknuts and back the screws nearly out of the filter, then tune as follows:

(1) Turn tuning screw A into the filter until a peak is noticed in the oscilloscope presentation; move the peak to the center of the trace. Notice that the peak may not be large since the Q of this part of the filter is relatively low.

NOTE

In any and all of the following steps, as the filter approaches the tuned state, change the setting of the VOLTS/CM control to maintain the oscilloscope trace within the viewing area. Also maintain the retrace on the 3-cm line above the center graticule using the STEP ATTEN DC BAL control of the oscilloscope.

(2) Adjust screw B into the filter until the peak is increased. Tune the screw until the peak is centered between the markers. Notice that the top of the oscilloscope trace is beginning to flatten.

(3) Adjust tuning screw C into the filter until the peak is increased again, center the peak between trace limits.

(4) On the oscilloscope, using the VOLTS/CM control only, move the trace downward toward a lower graticule line.

(5) Adjust tuning screws D, E, and F into the filter to increase and center the peak.

(6) Adjust tuning screw A once again to flatten the trace as much as possible and to obtain the same number of poles as there are tuning screws. It is more probable that two poles will merge together to form a single pole that is wider than either pole by itself; this is a function of circuit Q and is a normal occurrence. Figure 6-137 shows a typical return loss trace after initial tuning using the large tuning screws only.

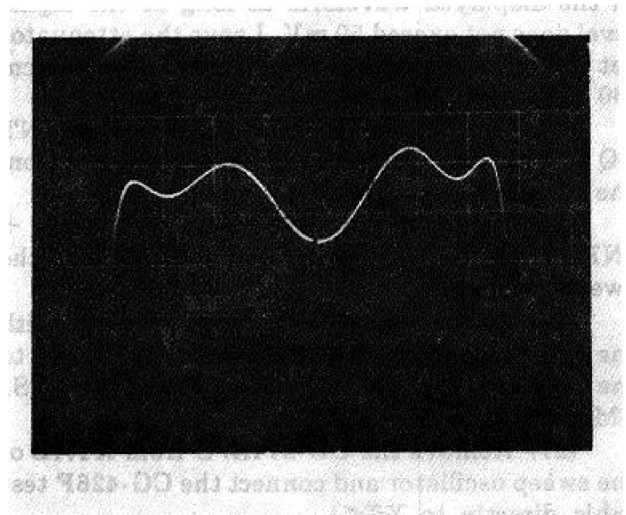

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Figure 6-137. Return loss trace after initial tuning, sensitivity is 1 mV/cm.

(7) When the initial tuning is satisfactory, start with the trimmer screws nearest tuning screw A. Adjust each trimmer, in succession, while watching the trace. For the initial trimmer settings turn each screw into the filter until a barely noticeable effect is produced in the oscilloscope trace.

(8) From this point, the tuning of the filters screws and which one to adjust next, is dictated by the VSWR pattern shown by the oscilloscope. Start by pressing slightly with the fingers on each tuning screw in succession. If one is found to provide a more favorable trace pattern, adjust it slightly to obtain a better, smoother trace. Use the trimmer screws as necessary to equalize the peaks and dips in the presentation, thereby flattening the response curve, refer to figure 6-138.

NOTE

When the initial tuning is considered satisfactory, inspect all the large tuning screws; these should all be approximately the same height from the body of the filter.

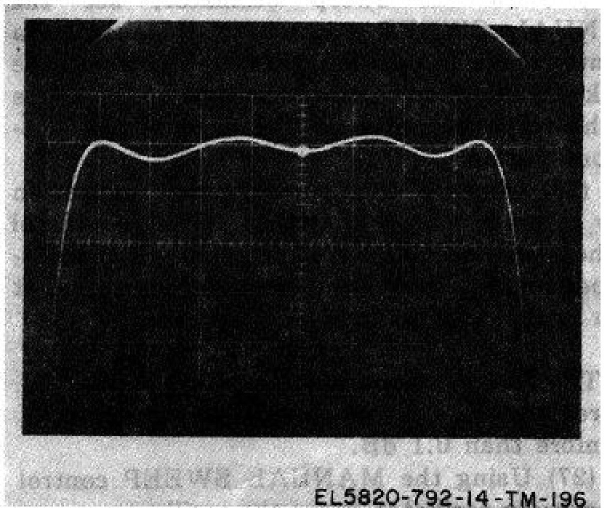


Figure 6-138. Return loss trace, satisfactorily tuned, sensitivity is 0.1 mV/cm.

(9) Move your hand carefully and slowly along the filter surfaces without touching the filter, while watching the oscilloscope trace. If the trace fluctuates during this part of the procedure, investigate more closely. Tap the filter lightly while watching the oscilloscope trace; if the trace fluctuates, the filter has a loose element. The purpose of these maneuvers are to detect any cracks or loose elements in the filter. If a cracked area or loose element is discovered, suspend any further tuning, the unit must be returned to higher category of maintenance for repair.

(10) When a satisfactory tuning has been achieved, remove the filter and load assembly from the test setup.

(11) Remove the termination from the assembly and transfer it to the other end of the filter.

(12) Reassemble the reversed filter and load assembly on the test equipment setup.

(13) Tune the reversed filter by refining any and all adjustments made in the forward direction. When tuning in the reverse direction, adjust primarily the small trimmer screws and avoid adjustment of the large screws as much as possible.

(14) Repeat (11) and (12) one more time; a typical final return loss waveform is shown in figure 6-139.

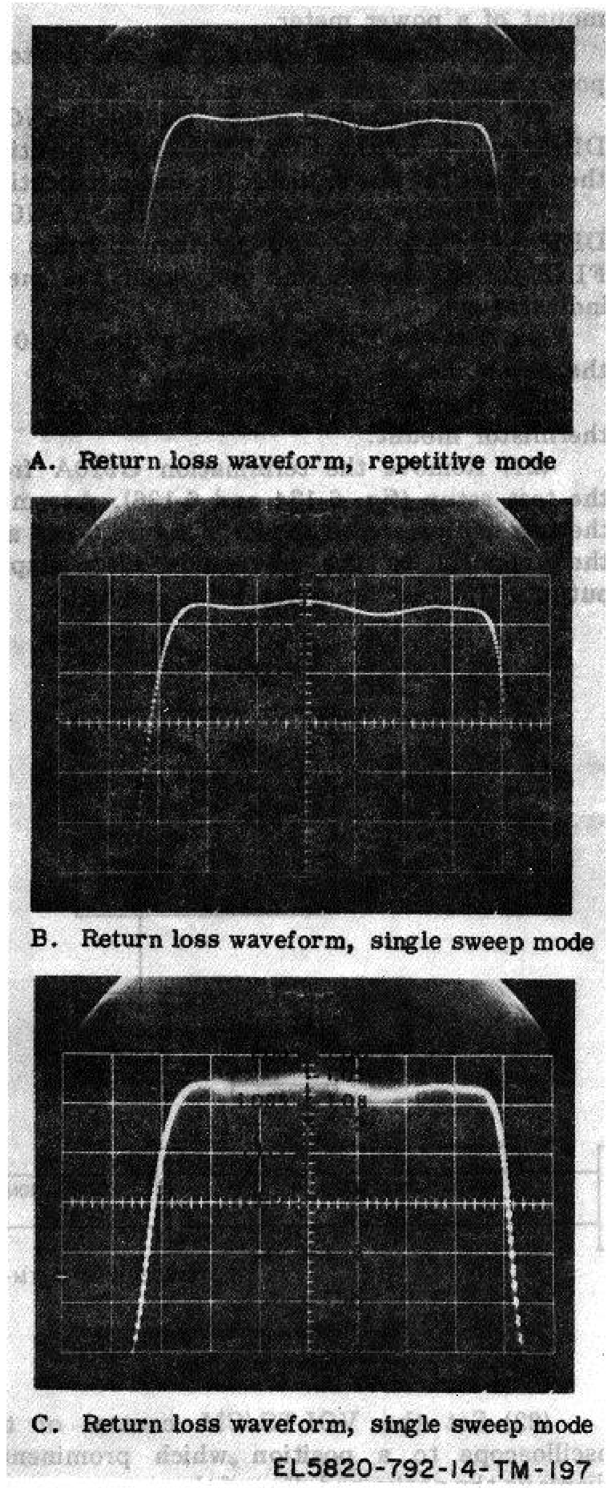


Figure 6-139. RF filter, typical final return loss waveform.

(15) Connect a 50-ohm load to the thermistor mount of a power meter.

(16) Connect the thermistor mount to a power meter.

(17) On the power meter, set the RANGE-DBM switch to the COARSE ZERO position, then adjust the power meter for a zero indication.

(18) On the power meter, set the RANGE-DBM switch to its -20 position; depress the FINE ZERO switch and note that the meter indicates zero.

(19) Set the RANGE-DBM switch to 10 on the power meter.

(20) Remove the termination from the thermistor mount.

(21) Remove the termination G910A from the test setup (fig. 6-134 and 6-136). Assemble the test equipment as shown in figure 6-140 and then connect to the waveguide filter-adapter output of the test setup (fig. 6-134 and 6-136).

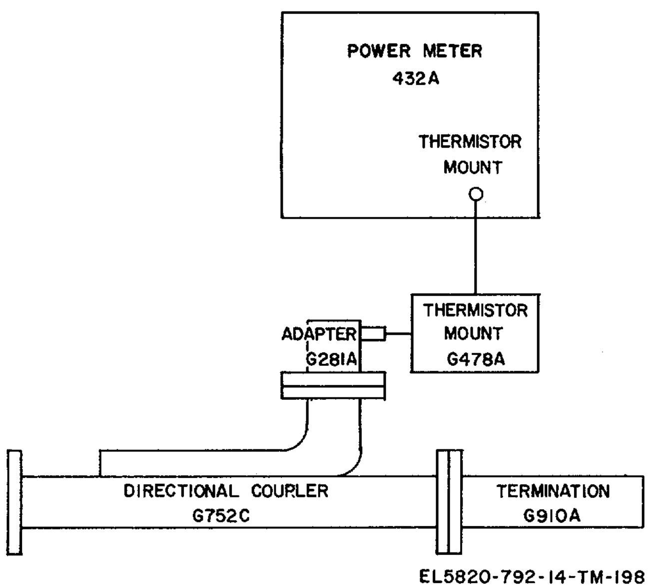


Figure 6-140. Forward power measurement, test equipment setup.

(22) Set the VOLTS/CM control of the oscilloscope to a position which prominently displays the peaks and dips of the response curve flat-topped region.

(23) Observe the oscilloscope trace closely to note approximately where the peaks of the response curve are located with respect to the graticule lines.

(24) On the sweep oscillator, set the SWEEP SELECTOR to its manual position. The sweep trace vanishes at this time; however, the point where the beam strikes the CRT screen should be visible. If it is not proceed to the next step and it will become visible as controls are operated.

(25) On the sweep oscillator, set the MANUAL SWEEP control to its maximum counterclockwise position, then tune slowly in the clockwise direction to move the spot up the skirts of the response curve to the edge of the flat-topped region.

(26) Observe the power meter indication very carefully as the MANUAL SWEEP control of the sweep oscillator is tuned through the flat-topped region. Note the power meter indication at each peak and dip.

NOTE

The FLAT response of the filter is that region where the ripple does not vary by more than 0.1 dB.

(27) Using the MANUAL SWEEP control of the sweep oscillator, move the oscilloscope spot to the left-edge of the flat response region on the response curve until the power meter indicates the power has dropped by 0.1 dB.

(28) Using the frequency control of the SHF signal generator, move the marker to the point selected. When the sweep frequency coincides with the marker frequency, a marker will be displayed on the oscilloscope.

(29) Read and record the marker frequency in the FLAT MARKER 1 entry of figure 6-144 is desired.

(30) While watching the power meter indication, adjust the MANUAL SWEEP control of the sweep oscillator in the counterclockwise direction until the power meter indicates an additional 0.1 dB drop in power.

(31) Using the frequency control of the SHF signal generator, adjust the output frequency until it coincides with the sweep frequency and a marker is displayed on the oscilloscope display.

NOTE

The 0.1-dB response of the filter is the point where the response is 0.1 dB below the flat response of the filter. Since the flat response permits one-tenth-dB ripple, this point is located two-tenths dB below the point of maximum response.

(32) Record the frequency indicated by the electronic counter at the 0.1-dB point of the curve in figure 6-144 if desired.

(33) Repeat steps (25) through (32) above for the corresponding FLAT MARKER 2 and the 0.1-dB points on the right-hand side at the response curve. Record the frequencies in figure 6-144 if desired.

(34) Repeat steps (31) through (33) above for the corresponding 3-dB point.

(35) The bandwidth specification for the filter is

6-section Flat	±9.5 MHz minimum
6-section 0.1-dB points	± 10.5 MHz minimum
6-section 3.0-dB points	± 23.5 MHz maximum
4-section Flat	± 9.5 MHz minimum
4-section 0.1-dB points	±10.5 MHz minimum
4-section 3.0-dB points	± 26.0 MHz maximum

(36) Disconnect the test equipment shown in figure 6-140 from the waveguide filter.

(37) Remove the RF filter from the slotted line carriage.

(38) Connect a G281A adapter to the open end of the slotted line carriage.

(39) Connect a 10-dB pad/thermistor mount to the G281A adapter.

(40) Adjust the frequency control of the SHG signal generator until the electronic counter/converter indicates fo ± 0.1 MHz.

(41) On the sweep oscillator, adjust the MANUAL SWEEP until the oscilloscope displays the marker pattern.

(42) On the SHF signal generator, set the OUTPUT ATTEN to the full clockwise position.

(43) Read and record the power meter indication as reference level.

(44) Remove the power meter and associated adapter/attenuator from the test setup.

(45) Reassemble the filter to the test equipment setup.

(46) Mount the power meter and associated adapter/attenuator on the open end of the filter.

(47) Read and record the power meter indication as insertion level.

(48) Subtract the insertion level from the reference level to obtain the insertion loss at the center frequency f o. The insertion loss of any six section filter shall not exceed 1.0 dB, and the loss for any four section filter shall not exceed 0.8 dB.

(49) Remove the power meter and associated adapter/attenuator from the test equipment setup.

(50) Mount the load assembly on the open end of the filter to conform with figure 6-136.

(51) On the sweep oscillator, set the SWEEP SELECTOR to its AUTO position. Set the VOLTS/CM control of the oscilloscope to the .2 mV position and the oscilloscope should display the return loss pattern.

(52) On the SHF generator, adjust the OUTPUT ATTEN control until the marker is just visible. The electronic counter indicates the marker frequency which should be fo -± 0.1 MHz from step (40).

(53) Inspect the oscilloscope trace with respect to the SWR overlay. Refer to figure 6-141. Select a point in the filter bandpass which has the highest SWR (which is minimum trace amplitude).

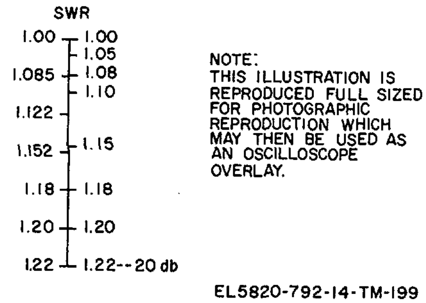


Figure 6-141. Oscilloscope SWR overlay.

(54) Adjust the frequency control of the SH-F generator until the marker is positioned on the selected point of lowest SWR.

(55) On the sweep oscillator, set the SWEEP SELECTOR to its MANUAL position, then set the MANUAL SWEEP control fully counterclockwise.

(56) Tune the MANUAL SWEEP control until the marker appears on the oscilloscope display.

(57) On a SWR meter, preset the control as follows:

INPUT	to	LOW
RANGE-DB	to	40
EXPAND	to	NORM
VERNIER	to	midrange
GAIN	to	midrange

(58) Connect a CG-4Z6F cable between the slotted-line probe and the INPUT of the SWR meter.

(59) Insert the slotted-line probe. Lock the probe in position using the lock collar.

(60) On the SHF signal generator, set the following controls:

MOD SELECTOR	to -	
RATE	to	100
SYNC SELECTOR	to	X10
OUTPUT ATTENUATOR	to	fully counterclockwise

(61) Disconnect the test cable from the CAL output of the SHF signal generator.

(62) Transfer the test cable from 4.0-8.0 GHz of the sweep oscillator to the CAL output of the SHF signal generator.

(63) On the SHF signal generator, adjust the PULSE RATE control so that the SWR meter indicates a peak reading.

(64) Adjust the slotted-line carriage for maximum deflection on the SWR meter.

(65) On the SWR meter, adjust the GAIN and VERNIER controls for a meter indication of 1.0.

(66) On the SWR meter, adjust the FREQ control for maximum deflection on the SWR meter, then reset the GAIN and VERNIER controls for a meter indication of 1.0.

(67) On the SWR meter, set the EXPAND control to 0 (zero); reset the meter indication to 0 using the upper red scale.

(68) Adjust the slotted-line carriage along the track, observing the SWR meter for a minimum meter deflection, note the track calibration at each minimum deflection.

(69) Reset the slotted-line carriage to the point along the track that provide the most favorable minimum indication. Read and record the VSWR indication. The VSWR specification for any RF waveguide filter in this manual is 1.1:1 maximum.

(70) Disconnect the cable from the slotted-line probe.

(71) On the SHF signal generator, set the MOD SELECTOR to its CW position. Then transfer the test cable from CAL on the SHF generator to the 4.0-8.0 GHz output of the sweep oscillator.

(72) Reconnect the CG-426F cable leading from the directional coupler to the CAL output on the SHF signal generator.

(73) If an X-Y recorder is available and a recording of the filter response is desired, proceed to (74) below, otherwise the alignment is complete at this point.

(74) Insert a graph chart in the recorder.

(75) Connect additional test equipment as shown in figure 6-141.

(76) On the SHF signal generator, set the OUTPUT ATTEN control to full counterclockwise position.

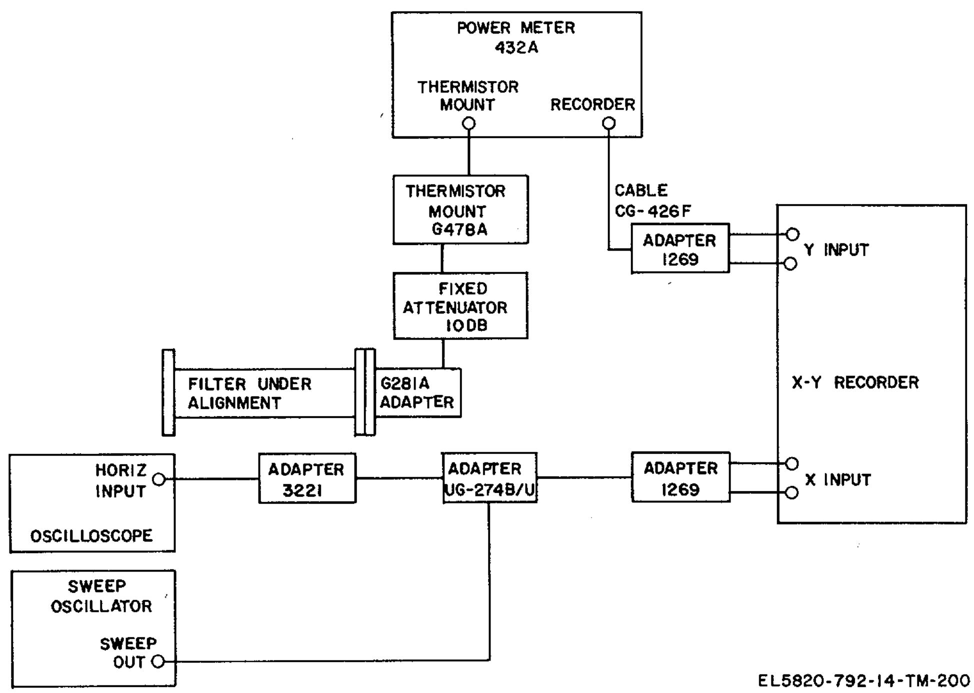


Figure 6-142. X-Y recorder test equipment setup.

(77) Temporarily disconnect the Y INPUT of the recorder.

(78) On the sweep oscillator, set the SWEEP SELECTOR to MANUAL and the MANUAL SWEEP control fully counterclockwise.

(79) On the oscilloscope preset the following controls:

VOLTS	to	.2 mV
TRIGGERING MODE	to	AUTO
TRIGGER SLOPE	to	+
TIME/CM	to	1 μ sec
VARIABLE	to	uncalibrated

(80) On the recorder, set the X RANGE control to the small circle between 1 and 10 V/IN. Also set the Y RANGE control to-the small circle between 100 MV/IN and 1 V/IN.

(81) On the recorder, set the POWER/SERVO switch to its ON/ON position, the PEN in the UP position, and the CHART switch in the HOLD position.

(82) Insert a pen in the penholder.

(83) Unlock the X ZERO control, and using this control move the pen to the left edge of the chart. Using the LOCK ring, lock the X ZERO control, making sure that the locking process does not move the pen from the chart edge.

(84) On the sweep oscillator, turn the MANUAL SWEEP control fully clockwise.

(85) On the recorder, adjust the X VERNIER control to position the pen at the right edge of the chart. Using the LOCK ring, lock the X VERNIER control, making sure that the locking process does not move the pen from the chart edge.

(86) On the sweep oscillator, turn the MANUAL SWEEP control to full counterclockwise position and check that the pen is positioned on the left edge of the chart, then turn the MANUAL SWEEP control to full clockwise position to return the pen to the right edge of the chart. If the servo is audible at either chart edge, slightly readjust the X ZERO or X VERNIER as necessary to quiet the servo.

(87) Reconnect the test cable to the Y INPUT of the recorder.

(88) On the sweep oscillator set the MANUAL SWEEP to its full counterclockwise position.

(89) Unlock the Y ZERO control, and using this control move the pen to the bottom edge of the chart. Using the LOCK ring, lock the Y ZERO control, making sure that the locking process does not move the pen from the chart edge.

(90) On the sweep oscillator, adjust the MANUAL SWEEP control until the pen is positioned approximately midway in the chart.

(91) Unlock the Y VERNIER control, and using this control move the pen to position which is one major chart division from the chart top.

(92) Return the MANUAL SWEEP control of the sweep oscillator to its fully counterclockwise position.

(93) While watching the pen, slowly turn the MANUAL SWEEP control through its range noting that the pen moves vertically when the power meter indicates increasing power levels. Then return the MANUAL SWEEP fully counterclockwise.

(94) On the sweep oscillator, preset the controls as follows:

SWEEP TIME (SECS)	to	100-10
VERNIER	to	full counterclockwise
SWEEP SELECTOR	to	TRIG

(95) On the sweep oscillator, observe the SWEEP indicator in the dial area. If it is lighted, depress the MANUAL pushbutton to turn the light off.

(96) On the X-Y recorder, set the PEN switch in the DOWN position.

(97) On the sweep oscillator, depress the MANUAL pushbutton and note that the SWEEP indicator is lighted. The recording has been initiated and will require about 100 seconds (1/2 minutes) to complete.

(98) When the pen nears the right edge of the chart, set the PEN switch to its UP position to avoid recording the sweep oscillator return trace.

(99) On the sweep oscillator, set the SWEEP SELECTOR to the MANUAL position. At this point the insertion loss of the RF filter has been plotted. All that remains is to mark specific points of interest. Refer to figure 6-143.

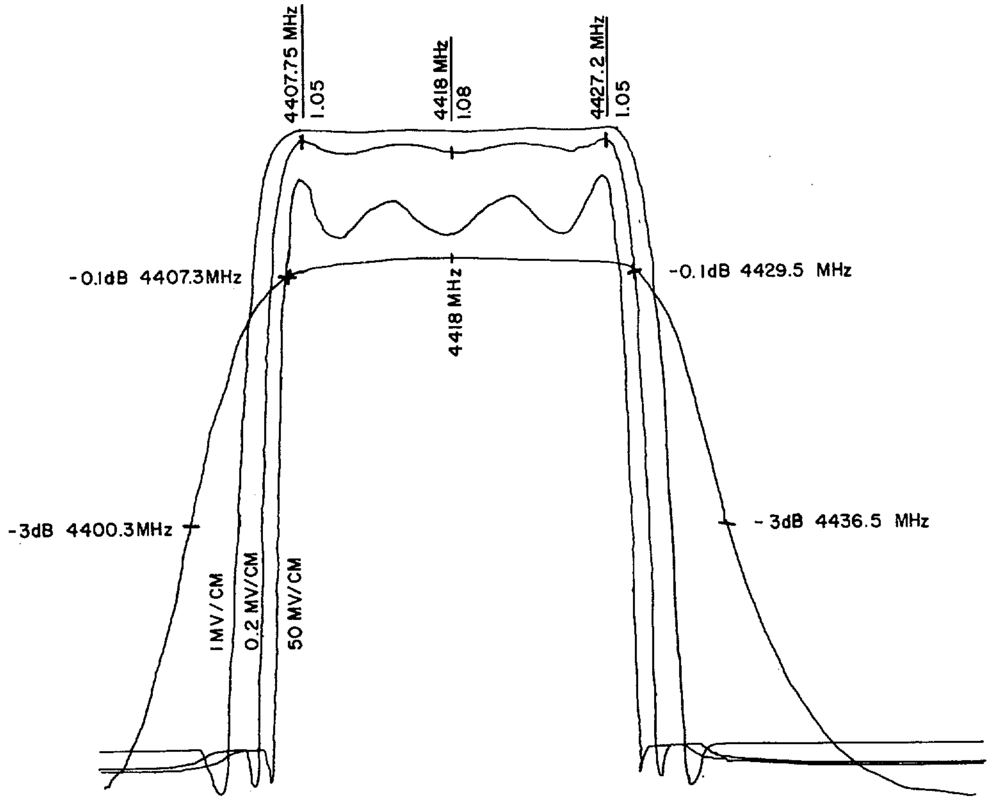


Figure 6-143. Typical X-Y recording of insertion loss and return loss (VSWR) response.

(100) Adjust-the MANUAL SWEEP control to its maximum counterclockwise position, then turn the control carefully until the power meter indicates that the output power is 3 dB down from its maximum output level

(101) On the recorder, set the PEN switch to DOWN, then back to UP.

(102) On the SHF generator, adjust the frequency controls until a marker is visible on the oscilloscope. Reduce the marker amplitude to a suitable value.

(103) Observe the frequency indicated by the electronic counter and record this frequency beside the point on the recorder tracing.

(104) On the sweep oscillator, carefully tune the MANUAL SWEEP control in the clockwise direction until the power meter indicates that the output power is 0.1 dB down from its maximum output level.

(105) On the recorder, set the PEN switch to DOWN, then back to UP.

(106) On the SHF generator, adjust the frequency controls until a marker is visible on the oscilloscope.

(107) Observe the frequency indicated by the electronic counter and record this frequency beside the point on the recorder tracing.

(108) On the SHF signal generator, adjust the frequency controls until-the electronic counter indicates fo ± 0.1 MHz.

(109) Adjust the MANUAL SWEEP control of the sweep oscillator until -the marker is displayed on the oscilloscope.

(110) On the recorder, set-the PEN switch-to DOWN then back to UP.

(111) Record this frequency under the trace line adjacent to the marked point.

(112) Adjust the MANUAL SWEEP control of the sweep oscillator until the power meter indicates that the output power is 0.1 dB down from its maximum output level.

(113) On-the recorder, set the PEN switch-to DOWN, then back to UP.

(114) On the SHF signal generator, adjust the frequency controls until a marker is visible on the oscilloscope.

(115) Observe the frequency indicated by the electronic counter and record this frequency beside the point on the recorder tracing.

(116) Adjust the MANUAL SWEEP control of the sweep generator until the power meter indicates-that-the output power is 3 dB down from its maximum output level.

(117) On the recorder, set the PEN switch to DOWN then back to UP.

(118) On the SHF signal generator, adjust

the frequency controls until a marker is visible on the oscilloscope.

(119) Observe the electronic counter and record the frequency indicated on the recorder tracing.

(120) On the recorder, set the POWER/SERVO switch to its ON/OFF position. At this point the insertion loss of the filter just aligned has been recorded and marked at primary points.

(121) Transfer the test cable from RECORDER on the power. meter to SIGNAL OUTPUT on the oscilloscope plug-in.

(122) On the sweep oscillator, set the MANUAL SWEEP to its full counterclockwise position.

(123) Set the Y RANGE to the small circle between 1 and 10 V/IN.

(124) Unlock the Y VERNIER and set the control fully clockwise.

(125) Unlock the Y ZERO control, momentarily set the POWER/SERVO switch to ON/ON and adjust the Y ZERO control to position the pen approximately one-half major division from the chart bottom. Lock the Y ZERO control; set POWER/SERVO switch to ON/OFF.

(126) On the sweep oscillator, set the MANUAL SWEEP control to its approximate midrange position.

(127) Momentarily set the POWER/SERVO switch to its ON/ON position and adjust the Y VERNIER to position the pen approximately one-half major division from the top of the chart. If the servo motor whines, readjust the Y VERNIER slightly -to stop the servo motor.

(128) On the sweep oscillator, set the MANUAL SWEEP control to fully counterclockwise position. Then set the SWEEP SELECTOR to its TRIG position. If the SWEEP indicator comes on, depress the MANUAL pushbutton to turn the indicator off.

(129) Observe the VOLTS/CM dial on the oscilloscope; in this procedure at this time the control is set for .2 mV. Record this sensitivity level on the chart. If a different sensitivity is desired, change it at this time.

(130) If a different color pen is desired for this new recording, remove the old pen at this -time and insert the desired color.

(131) On the recorder, set the PEN switch to its DOWN position.

(132) On the SHF signal generator, set the OUTPUT ATTEN fully clockwise to remove the possibility of a marker.

(133) Depress the MANUAL pushbutton on the sweep oscillator, and note that the SWEEP indicator is lighted. The recording has been initiated and will require about 100 seconds to complete.

(134) When the pen nears the right edge of the chart, set the PEN switch to its UP position to avoid recording the return trace. Set the POWER/SERVO to its ON/OFF position.

(135) At this point, a return loss response (which is the same as a VSWR response curve) has been recorded. All that remains is to locate the primary points of interest.

(136) On the sweep oscillator, set the SWEEP SELECTOR to its AUTO position. The oscilloscope should now display the return loss trace.

(137) On the SHF generator, turn the OUTPUT ATTEN clockwise to obtain a visible marker, then adjust the frequency controls to position the marker on the peak of the band edge similar to that shown in figure 6-143.

(138) On the sweep oscillator, set the SWEEP SELECTOR to MANUAL, then tune the MANUAL SWEEP until a marker becomes visible on the oscilloscope.

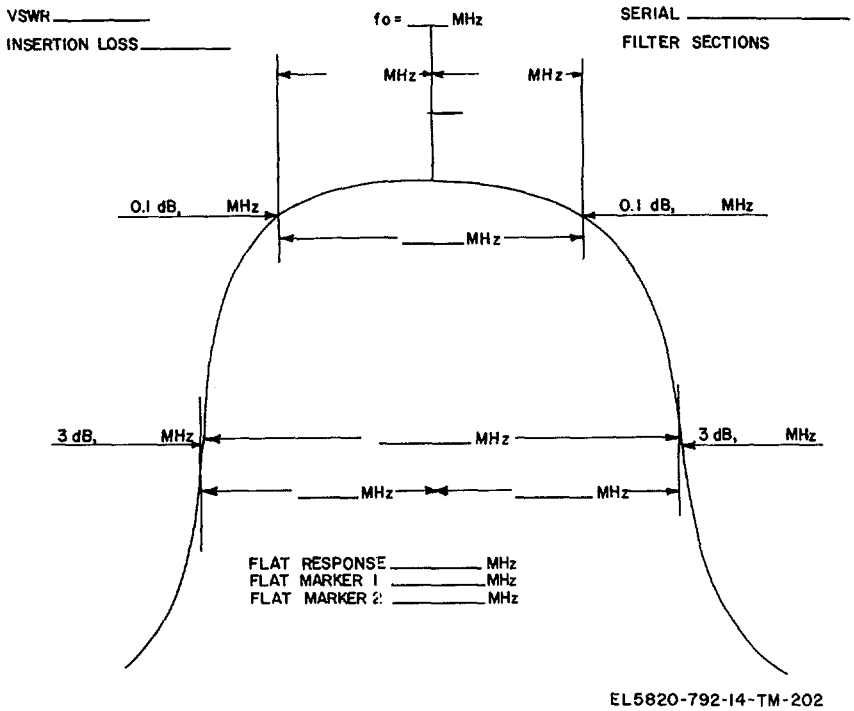
(139) Connect a CG-426F/U cable between the slotted-line probe and the INPUT of a SWR meter.

(140) Repeat steps (54) through (69) above to obtain the VSWR at the selected point, and read the electronic counter to obtain the corresponding frequency.

(141) Repeat steps (136) through (140) above for the two remaining points as indicated in the figure.

(142) This step completes the procedure; disconnect all test equipment.

(143) Seal the adjustment screws with a volatile-base enamel lacquer. Do not use glyptol under any circumstances.



EL5820-792-14-TM-202

Figure 6-144. Waveguide filter data sheet.

Section XVII. TERMINAL FILTER MODULE (368-43020-7 and -8)

6-75. Introduction

a. Terminal filter modules are modules common to microwave receivers or transmitters which permit interfacing adjustments between external communication equipments and the microwave radio terminal. Input and output signal levels of the radio set are functions of the communications system. The levels are usually uniform for all radio sets throughout a microwave radio communications system. Upon receipt of the equipment it may be necessary to adjust the input and/or output circuits to different levels specified for a change in the communications system parameters.

b. The multiplex section of the transmit terminal filter employs T-pad attenuators which are placed in use through strap connections. Additional components required within the module are also strap connected. Any change in level setting involves selecting the appropriate attenuator and making the necessary strap connections.

c. The multiplex and orderwire sections of the receiver terminal filter are similar in detail to the corresponding sections of the transmit terminal filter.

d. For computing the db of new levels, use the following basic data:

$$dB = 20 \log \frac{E_1}{E_2}$$

Where E_1 is always taken as greater than E_2.

e. For computing the dBm of new levels, use the following basic data:

$$dBm = 20 \log \frac{E_1}{E_2}$$

where E_1 is always taken as greater than E_2
E_2 = specific voltage level
and E_1 = 0.274 volts (0 dBm/75 ohms)
or E_1 = 0.775 volts (0 dBm/600 ohms)

6-76. Module Configurations

a. The terminal filter module consists of a single printed-wiring card on which all components, with the exception of test jacks and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis. The module is equipped with bandpass filters secured -to the main printed-wiring card.

b. The bandpass filter used in a given application depends upon .the supervisory channel and multiplex frequency ranges of the particular communication system.

c. The model configurations are as follows:

Terminal fitter module part number	Supervisory channel filter (FL1)		* Multiplexer channel filter (FL2)	
	Part number	Bandpass	Part number	Bandpass
368-43020-7	362-7671-3	300 Hz to 3.4 kHz	Omit*	
368-43020-8	362-7649-5	300 Hz to 3.4 kHz	362-7648-10	4.3 kHz to 2.6 MHz

* Contains a hybrid with bandpass 4 kHz to 2.8MHz.

6-77. Functional Description

The functional block diagram of the-terminal filter appears in figure 6-145. Terminal filter are used in both receiver and -transmitter applications. Terminal filter 368-43020-7 is a transmit filter, while terminal filter 368-43020-8 is a receive terminal filter. In receiver applications, the terminal filter module separates the multiplex and supervisory channel signals from -the received baseband; receiver output levels are adjusted to the requirements of external communications equipments. The baseband enters the receiver terminal filter modules via coaxial connectors J2 and J3, is filtered, then attenuated, and sent out of the module. The multiplex signals are sent through coaxial connector J1, while the supervisory signals are sent through printed-circuit connector A2J1. In transmitter applications, the terminal filter module adjusts the input levels from external communications equipments to the requirements of the microwave transmitter. The supervisory channel signals enter the transmit terminal filter through printed circuit connector A2J1. The multiplex signals make entry through coaxial connector J1.

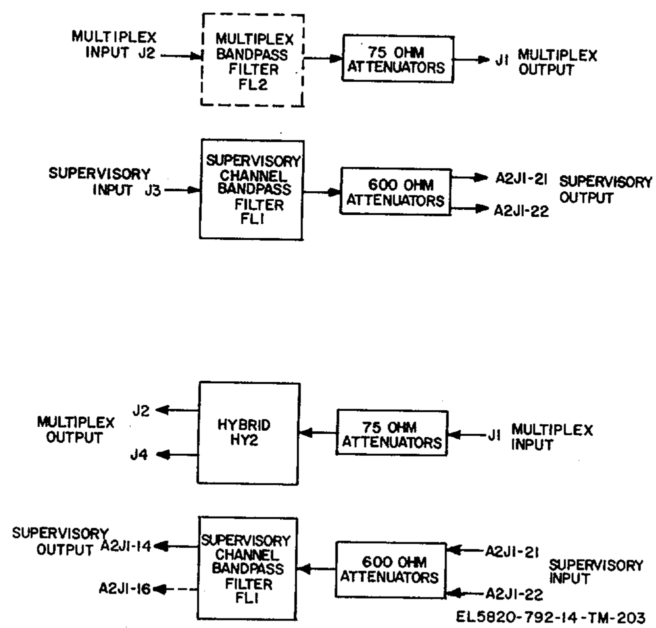


Figure 6-145. Terminal filter module, functional block diagram.

6-78. Circuit Analysis

a. Receive Terminal Filters. The schematic diagram of the receive terminal filter module is shown in figure FO-30. The baseband signal, received from -the common baseband module or the baseband combiner module, enters the receive terminal filter module through coaxial connectors J2 and J3. The baseband signal arriving through coaxial -connector J2 is applied to multiplex bandpass filter FL2, which passes the multiplex frequencies and rejects the pilot-tone and supervisory channel frequencies. At the output of filter FL2 are five fixed, 75-ohm unbalanced T-pad attenuators. The attenuation may be varied from 0 to 31 dB in 1 dB steps. The correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. The multiplex signs are routed out of the receive terminal filter module via coaxial connector J1. The baseband signal arriving through coaxial connector J3 is applied to supervisory channel bandpass filter FL1 which passes the supervisory channel signals and rejects the pilot-tone and multiplex signals. At the output of filter FL1 are five fixed, 600-ohm balanced H-pad attenuators. The attenuation may be varied from 0 to 31 dB in 1 dB steps. The correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. The supervisory signals are routed out of the receive terminal filter module via pins 21 and 22 of printed-circuit connector A2J1.

b. Transmit Terminal Filters. Multiplex signals from external communications equipment are applied to coaxial connector J1 in transmitter applications. Five fixed, 75-ohm unbalanced T-pad attenuators are available to interface external equipment with the microwave radio transmitter. The correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. The multiplex signals are then sent through hybrid HY2 to adder modules via coaxial connectors J2 and J4. Supervisory channel signals from external communications equipment are applied to pins 21 and 22 of printed-circuit connector A2J1 in transmitter applications. Five fixed, 600-ohm balanced H-pad attenuators are available to interface external equipment with the microwave transmitter. The correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. At the output of the attenuators, the supervisory channel signals are passed through bandpass filter FL1 to limit the band of frequencies and to convert the 600-ohm balanced line into an unbalanced line. Bandpass filter FL1 used in terminal filter 368-43020-7 converts the 600-ohm balanced line to a 600-ohm unbalanced line in addition to the required filtering; supervisory channel signals are sent through resistors R43, R44, and R45 to match impedance and to split the signals into two output signals. The two output signals are sent out of the terminal filter module on 600-ohm unbalanced lines to the adder modules via pins 14 and 16 of printed-circuit connector A2J1. Terminal filter 368-43020-7 includes PILOT TONE switch S1. This switch obtains +28 V dc through steering diodes CR1 and CR2 and is used to apply operating voltage to the desired pilot tone oscillator assembly located in each of two adder modules.

c. Technical Characteristics.

Parameter	Specifications
Input impedance (multiplex)	75 ohms, unbalanced
In put impedance (supervisory):	
368-43020-7	600 ohms, balanced
368-43020-8	75 ohms, unbalanced
Output impedance (multiplex)	75 ohms, unbalanced
(Output impedance (supervisory):	
368-43020-7	600 ohms, unbalanced
368-43020-8	600 ohms, balanced
Frequency response	Paragraph 6-75c
Power requirements	None

6-79. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. This paragraph contains procedures to test the performance of the overall module and its major circuits, and gives probable causes of abnormal indication.

b. Test Equipment Setup. Connect -test equipment as shown in the applicable portion of figure 6-146.

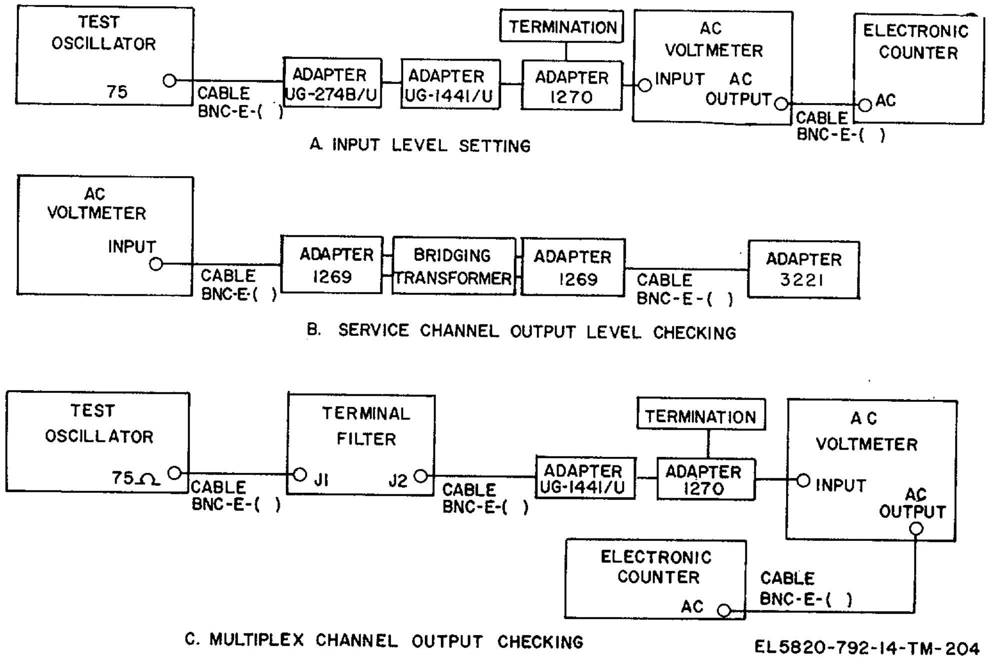


Figure 6-146. Terminal filter module, initial test equipment setup.

c. Service Channel Preliminary Adjustments. Perform the following preliminary adjustments for the 368-43020-7 or 368-43020-8 terminal filter module. After removing bottom module cover, disconnect any service channel attenuator pads and jumper for zero loss. Use figures 6-147 and 6-148 for parts location data.

(1) Set the voltmeter RANGE to 0 dB.

(2) Set the test oscillator RANGE to X1K, FREQUENCY to 3, and the OUTPUT ATTENUATOR to +10 dBm.

(3) Connect the test equipment as shown in part A, figure 6-146. For-testing-the 368-43020-7 module use the 600-ohm output of the test oscillator and for the 368-43020-8 use the 75-ohm output,

(4) Connect a 600-ohm-termination (MDP-12-600) to-the 1270 adapter to match the 600-ohm test oscillator output or a 75-ohm termination (MDP-R-75) to match the 75-ohm output.

(5) On the test oscillator, adjust the COARSE and FINE output level controls until the ac voltmeter indicates 0.dB.

(6) Check the electronic counter to verify the 3 kHz ± 20 Hz of the test oscillator; adjust FREQUENCY dial as necessary.

(7) Transfer the test cable from UG-174B/U to J3 of the terminal filter module.

(8) Remove the test setup from the ac voltmeter.

(9) Configure the test equipment as shown in B, figure 6-146. Set transformer switch to 600 ohms. Connect terminated winding of transformer to AC voltmeter.

(10) On the ac voltmeter, change the range to +10 dB.

(11) Connect the pin tips to TP7 and TP8.

(12) Proceed-to step 2 of the chart in e below.

d. Multiplex Channel Preliminary Adjustments. Perform the following preliminary adjustments for the 368-43020-8 terminal filter module only. The 368-43020-7 terminal filter module does not contain a filter in multiplex channel. Use figures 6-147 and 6-148 for parts location data.

(1) Set the ac voltmeter RANGE to 0 dB.

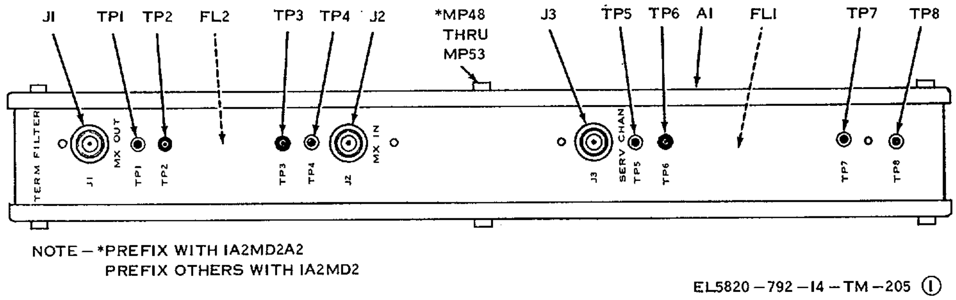


Figure 6-147 (1). Terminal filter module 368-43020-7 or 368-43020-8, parts location data (sheet 1 of 2).

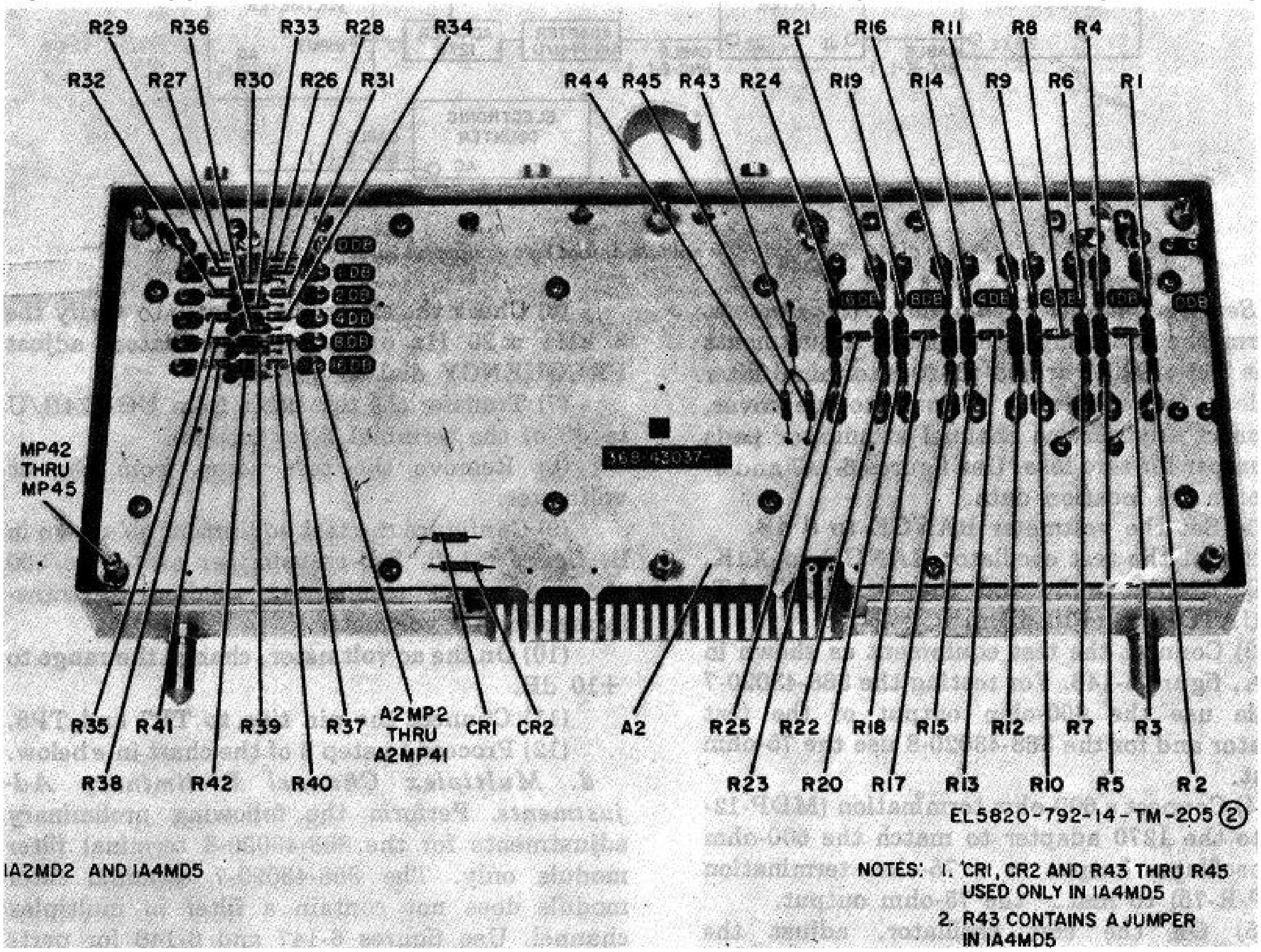


Figure 6-147(2). Terminal filter module 368-43020-7 or 368-43020-8, parts location data (sheet 2 of 2).

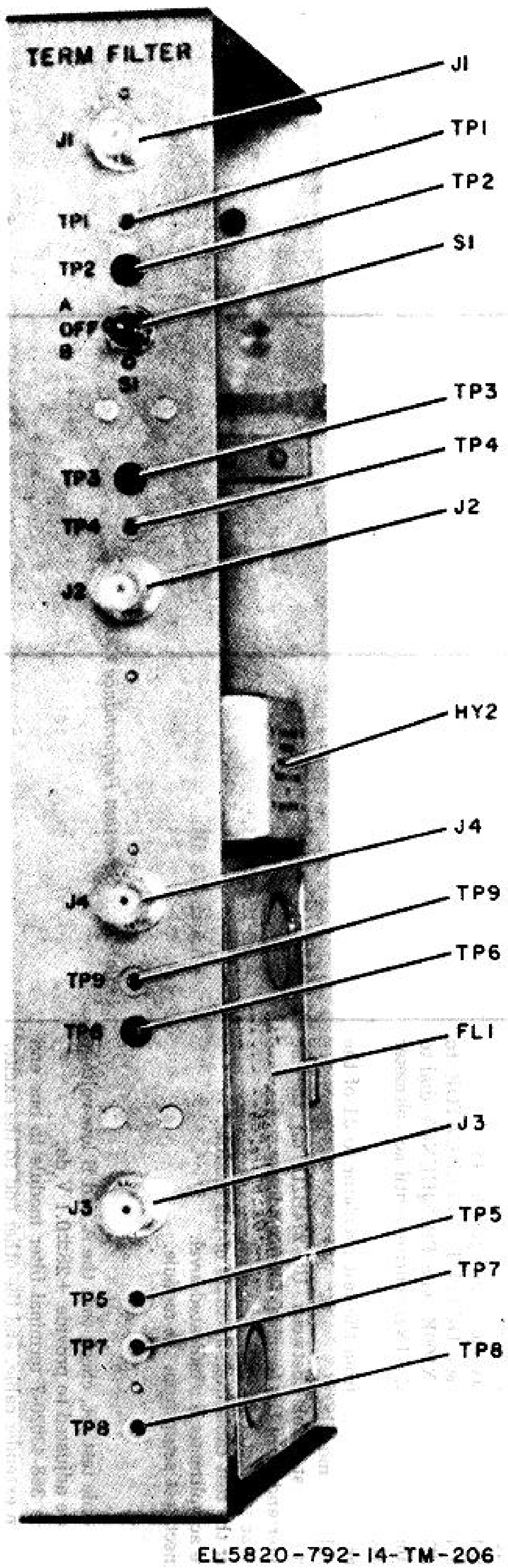


Figure 6-148. Terminal filter module 368-43020-7, parts location data.

(2) Set the test oscillator RANGE to X100K, FREQUENCY to 1, and the OUTPUT ATTENUATOR to +10 dBm.

(3) Connect the test equipment as shown in C, figure 6-146, but with connection to J1 and J2 reversed so that test oscillator is connected to J2. Connect UG-274B/U adapter to J2.

(4) Connect a 75-ohm .termination (MDP-R75) to the 1270 adapter at the ac voltmeter.

(5) Connect an ac voltmeter to the UG274B/U at J2 of the filter. Then adjust the COARSE and FINE controls on the test oscillator until the ac voltmeter indicates 0 dB. Maintain this input level throughout the test.

(6) Check the electronic counter to verify the 100 kHz ±50 Hz of the test oscillator, adjust-the frequency dial as necessary.

(7) Proceed to step 49 of the chart in *e* below.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Service Channel 368-43020-7		
1	Perform preliminary service channel adjustments in *c* above.			
2	Observe the ac voltmeter for the indicated output level. Record this reading as reference level.	-1.0 ± 5 dB.		
3	Observe level indicated by the test oscillator meter. Use this setting as standard input level.			
4	On the test oscillator, set RANGE to X100 and check the meter for standard input level.			
5	Observe the ac voltmeter for the indicated output level.	Reference level ± 0.1 dB to -0.5 db.		
6	On the test oscillator, set RANGE to X1K, adjust FREQUENCY dial to 4. Check the meter for standard input level.			
7	Observe the ac voltmeter for the indicated output level.	Reference level -12 ± 2 dB.		
8	On the test oscillator, adjust FREQUENCY dial to 1.2 set RANGE to X10K; check the meter for standard input level.			
9	Observe the ac voltmeter for the indicated output level.	Reference level -45 ± 5 dB		
10	Disconnect test setup from filter.			
		Multiplex Channel 368-43020-7		
11	Set ac voltmeter RANGE to 0 dB.			
12	Connect test equipment as shown in figure 6-146.			
13	On the test oscillator, set OUTPUT ATTENUATOR to +10 dBm, RANGE to X100K, and FREQUENCY dial to 1. Adjust COARSE and FINE controls until ac voltmeter indicates 0 dB.			
14	Transfer the test cable from the test oscillator to J1 of the terminal filter module.			
15	Connect a test cable between UG-274B/U on the ac voltmeter and J2 of the terminal filter module.			
16	Observe ac voltmeter for indicated level.	-3.5 ± 0.3 dB.		
17	Transfer the test cable from J2 to J4 of the module.			
18	Observe ac voltmeter for indicated level.	-3.5 ± 0.3 dB.		
19	Disconnect test setup from the module.			
		Pilot-Tone Selection Performance Check		
20	On the module test set, check that the A and B low-voltage supplies are adjusted to provide = 28 ± -0.1 V dc.			
21	Connect the 368-43020-7 terminal filter module to one end of a 22-pin extender cable, and the other end to the exciter door of the module test set.			
22	Locate test points 17, 18, and 19 of the 22-pin extender cable.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
23	Connect the COMMON lead of a multimeter to test point 19.			
24	On the t6rminal filter module, set switch S1 to its OFF position.			
25	On a multimeter, set the FUNCTION switch to +, the RANGE switch to 30 V, and then connect the DC probe to test point 17.	0 V dc	Proceed to step 7	Replace S1 and/or check wiring.
26	Transfer the DC probe of the multimeter to test point 18.	0 V dc	Proceed to step 27.	Replace S1 and/or check wiring.
27	On the terminal filter, set S1 to its A position.			
28	With the DC probe of the multimeter on test point 18, observe multimeter indication.	+27.5 V dc	Proceed to step 27	Replace CR1 and CR2.
29	On the low voltage power supply of the module test set, place the CHANNEL B POWER switch to its OFF position.			
30	With the DC probe of the multimeter on test point 18, observe multimeter indication.	+27.5 V dc		Replace CR1.
31	Transfer the DC probe of the multimeter to test point 17, observe the multimeter indication.	0 V dc		
32	On terminal filter module, set S1 to its B position. Observe the multimeter indication.	+27.5 V dc		Replace S1.
33	On the low voltage power supply of the module test set, place the CHANNEL B POWER switch to its ON. position.			
34	On the low voltage power supply of the module test set, place the CHANNEL A POWER switch to its OFF position.			
35	With the DC probe of the multimeter on test point 17, observe multimeter indication.	27.5 V dc		
36	On the terminal filter module, set switch S1 to its A position. Observe the multimeter indication.	0 V dc		Replace CR2.
37	Transfer the DC probe of the multimeter to test point 18. Observe multimeter indication.	27.5 V dc		Replace S1.
38	On the terminal filter module, set switch S1 to its B position. Observe multimeter indication.	0 V dc	End of tests. Disconnect all test equipment. Turn CHANNEL A power supply ON.	
		Service Channel 368-43020-8		
39	Perform preliminary service channel adjustments in *c* above.			
40	Observe the ac voltmeter for the indicated output level. Record this reading as reference level.	+8.5 ±- 0.5 dB	,	
41	Observe level indicated by the test oscillator meter. Use this setting as standard input level.			
42	On the test oscillator, set RANGE to X100 and check the meter for standard input level.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
43	Observe the ac voltmeter for the indicated output level.	Reference level +0.1 to -0.5 dB		
44	On the test oscillator, set RANGE to XIK, adjust FREQUENCY dial to 4. Check the meter for standard input level.			
45	Observe the ac voltmeter for the indicated output level.	Reference level -12 +2 dB		
46	On the test oscillator, set RANGE to X10K, adjust FREQUENCY dial to 1.2. Check the meter for standard input level.			
47	Observe the ac voltmeter for the indicated output level.	Reference level -45 ± 5dB		
48	Disconnect test setup from filter.			
49	Perform preliminary steps in d above.			
50	Observe the ac voltmeter for the indicated output level. Record this level for reference.	-0.2 ± 0.1 dB.		
51	On the test oscillator, observe the meter indication and use this reading as standard input level.			
52	On the test oscillator, set RANGE to XIK, and the FREQUENCY dial to 8. Set standard input level.			
53	Observe the ac voltmeter for the indicated output level. dB.	Reference level +0.1 to -0.5		
54	On the test oscillator, set RANGE to X1OK, and the FREQUENCY dial to 1.2. Set standard input level.			
55	Observe the ac voltmeter for the indicated output level.	Reference level +0.1 to -0.5 dB.		
56	On the test oscillator, set RANGE to X1M and the FREQUENCY dial to 1. Set standard input level.			
57	Observe the ac voltmeter for the indicated output level. dB.	Reference level +0.1 to -0.5		
58	On the test oscillator, set FREQUENCY dial to 2, and set standard input level.			
59	Observe the ac voltmeter for the indicated output level. dB.	Reference level +0.1 to -0.5		
60	On the test oscillator, set the FREQUENCY dial to 3 and set standard input level.			
61	Observe the ac voltmeter for the indicated output level.	Reference level -10 ± 3 dB.		
62	On the test oscillator, set the FREQUENCY dial to 3.2 and set standard input level.			
63	Observe the ac voltmeter for indicated output level.	50 dB or more below reference level.	End of test. Disconnect all test equipment.	

f. Disposition of Modules. The multiplex channel for all terminal filter modules are to be strapped for 0 dB. The service channel is to be strapped per system requirements.

CHAPTER 7

ASSOCIATED DATA

Section I. GENERAL

7-1. Scope of Associated Data

This chapter contains information on modular assemblies which are not a part of the AN/FRC154 (V), but are related to the modules and assemblies discussed in chapter 6.

7-2. Maintenance Allocation Chart

The maintenance allocation chart in appendix C identifies the test equipment necessary for performing the test and alignment procedures. If the model identified is not available, substitute items having equivalent technical characteristics may be used.

Section II. ADDER MODULE (368-42029-6, -8, AND -9)

7-3. Introduction

a. General. The adder module is located in the microwave transmitter and is used to combine the individual multiplex signals, service channel signals, and pilot-tone signals, thereby forming one composite baseband output signal. The multiplex and service channel signals are received from external sources; the pilot-tone signal is generated by a submodule within the adder itself.

b. Module Configuration.

(1) The adder module consists of two printed-wiring cards (A2) and (A3) on which all components, with the exception of controls, test jacks, and connectors, are mounted. The latter components are mounted on the front flange of the metal module chassis (A1).

(2) The method of adding the service channel signal to the composite baseband signal governs the choice between three basic adder modules. Selection of the pilot-tone oscillator submodule (A3), mounted on the main printed wiring card (A2), is dictated by the communications system requirements.

(3) Adder module configuration data follows:

Adder module		Multiplex		Service channel		Pilot-tone oscillator	
Part No.	Schematic	Pads	Input impedance	Pads	Input impedance	Frequency	Schematic
368-42029-1	FO-9	T[a]	75 ohms	H[b]	600 ohms	10 kHz	FO-12
368-42029-2	FO-10	T[a]	75 ohms	N/A	N/A	3.2 MHz	FO-13
368-42029-3	FO-11	T[a]	75 ohms	T[a]	600 ohms	1.499 MHz	FO-13
368-42029-4	FO-11	T[a]	75 ohms	T[a]	600 ohms	8.5 MHz	FO-13
368-42029-5	FO-11	T[a]	75 ohms	T[a]	600 ohms	3.2 MHz	FO-13
368-42029-6	FO-9	T[a]	75 ohms	H[b]	600 ohms	3.2 MHz	FO-13
368-42029-8	FO-11	T[a]	75 ohms	T [a]	600 ohms	8.5 MHz	FO-13
368-42029-9	FO-11	T[a]	75 ohms	T[a]	600 ohms	10.0 MHz	FO-12'

[a] Unbalanced.
[b] Balanced.

7-4. Functional Description

a. As shown in figure 7-1 the multiplex input signals of all adder modules are attenuated by 75ohm T-pads, capable of 1to 31-db attenuation depending upon strapping arrangements. A similar configuration is used for the service channel input circuit, except for the 368-42029-1 (which uses 600-ohm H-pads) and 368-42029-2 modules. The 368-42029-2 adder module adds the service channel output signal to the multiplex input signals to form the complete baseband in the output circuit of the driver stage. The pilottone signal passes through a very simple attenuator network before application to the summing point. The summing point is a low impedance (virtual ground) and provides high isolation between the input signal channels.

b. The pilot-tone oscillator generates a tone for indicating radio system continuity between the transmitting and receiving stations. Controls are provided to stop the pilot-tone oscillator as desired in order to check system operation.

c. The output driver feeds the baseband into two identical parallel output circuits. This circuit forms the source which branches out into diversity channels A and B. From this point throughout the remainder of the radio system, the baseband signals, being generated from the same source, will always be coherent with respect to each other.

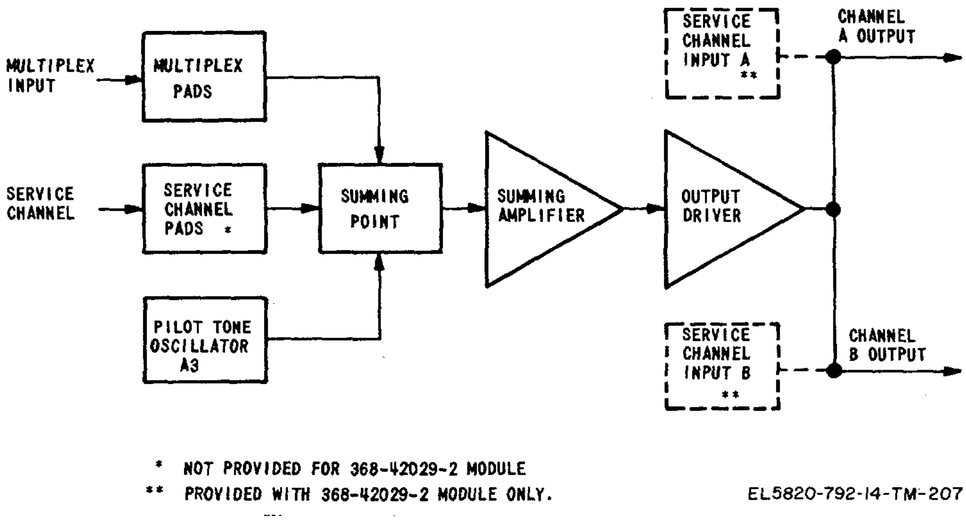


Figure 7-1. Adder module, functional block diagram.

7-5. Circuit Analysis

a. Figures FO-9, FO-10, and FO-11 show that the multiplex input signal is applied to the 75ohm unbalanced T-pad networks via MX INPUT connector J3. The T-pad networks provide a maximum of 31-db attenuation in 1-db steps. The attenuators are strapped as necessary to obtain a multiplex input level of -45 dbm (SCTT) measured between test points TP5 and TP3.

b. While the multiplex input is standard circuitry in any of the adder modules, the service channel is not standard. The service channel input circuit of the 368-42029-1 and -6 adder modules is from pins 16 and 17 of printed-circuit connector J4, as shown in figure FO-9. The service channel is then passed through 600-ohm balanced T-pads to provide a maximum of 31-db attenuation. The attenuators are strapped as necessary to obtain a multiplex input level of 35 dbm (SCTT) measured between test points TP4 and TP3. After attenuation, the service channel signal is transformer-coupled into the summing point.

c. Certain microwave systems required an orderwire line in addition to the service channel line. These two signals were combined on a separate panel, then brought directly into the adder module 368-42029-2 as shown in figure FO-10. The combined service channel and orderwire signal is brought into the adder via pins 16 and 17 of the printed-circuit connector J1. Addition of the orderwire and supervisory channel signals with the multiplex and pilot-tone signals is then accomplished in the output lines of the added module. Notice that signal addition is not made between the diversity output lines and ground but takes place across the high sides of the diversity channel output lines.

d. As shown in figure FO-, the service channel input signal is brought into the 36842029-3 through -5 and -8 through -9 modules via pin 16 of printed-circuit connector J1. It is applied to a set of 600-ohm unbalanced T-pad attenuators, which provides signal attenuation capability of 1 to 31 db. These pads are used to attenuate the service channel input signal so that it is equal to the SCTT multiplex level, measured between output test points TPI/TP3 for diversity channel B and test points TP2/TP3 for diversity channel A.

e. The output of the pilot-tone oscillator, on submodule A3, is sent through resistor R63, combined with the service channel, and applied to the junction of R1, R2, and C1. The output signal from the pilot-tone oscillator is adjustable to a level between --6 and -10 db below the SCTT level measured between test points TP1 or TP2 to ground TP3. The adjustment is performed using the PLT ADJ potentiometer behind an access port in the adder module casing.

f. The three input signals are combined at the junction of resistors R1 and R2 and capacitor C1, which is known as the summing point. After amplification by transistor Q1 the baseband signal is direct coupled into transistor Q2 to eliminate the possibility of undesirable phase shifts. A portion of the output signal, developed across Q2 emitter resistance, is fed back to the base of transistor Q1 through RC network R64 and C14. This feedback path holds the input impedance of transistor Q1 and the summing point at a very low impedance, which provides isolation between the input signals. Isolation of the multiplex signal from the service channel or pilot tone is -26 db. Isolation of the service channel or pilot tone from the multiplex signal is -35 db.

g. The baseband output signal from transistor Q2 is RC-coupled into the base of emitter follower Q3. Emitter follower Q3 is an output driver providing impedance transformation and isolation between the summing amplifiers and the output circuits of the module. The output circuit of emitter follower Q3 is capacitively coupled to dual 75-ohm output circuits at coaxial connectors J1 and J2. The composite output level, measured between test points TP1 TP2 and ground (TP3), is -31 dbm.

h. The dc operating supply is taken from two independent positive 28-volt power supplies. Diodes CR1 and CR2 are the steering and isolation diodes. Under normal operating conditions, diodes CR1 and CR2 are forward-biased so that the voltage drop across each diode is very small. If one of the power supplies fails, the diode associated with the failing power supply is reverse-biased into cutoff, thereby isolating this supply from the adder module. The adder module continues to function, using power from the remaining power supply.

i. Switch S1 is the PLT NORM/PLT BYP switch. When this switch is in the PLT NORM position, operating voltage is supplied to the pilot-tone oscillator submodule; pilot tone is generated and sent into the summing point. When this switch is in the PLT BYP position, operating voltage is not supplied to the pilot-tone submodule and the pilot-tone signal is absent from both diversity channels.

j. Figure FO-12 shows the schematic diagram of the pilot-tone oscillator used only in the 36842029-1 and -9 modules. The pilot-tone oscillator stage Q1 is a variation of a Hartley oscillator, in which inductive collector-to-emitter feedback is employed. The tank circuit develops an oscillator voltage across it in excess of 60 volts rms, which results in excellent frequency stability and isolation from transistor variations. Note that capacitor C5 is a vernier frequency adjustment and is used to set the pilot-tone frequency. The output signal is applied to a series-resonant bandpass filter consisting of capacitors C6 and C7 and inductor L1; this filter is tuned to 10 kHz. Following this, a parallel-resonant network consisting of inductor L2 and capacitor C8, is tied across the output line and is also tuned to 10 kHz. The purpose of this bandpass filter is to attenuate oscillator harmonics.

k. Figure FO-13 shows the schematic diagram of the pilot-tone oscillator submodule used with all adder modules except the 368-42029-1 and -9. The oscillator stage Q1 is a modified Colpitts oscillator using collector-to-base feedback. Control of the oscillator is maintained by a crystal, Y1, in series with the feedback path. The output frequency of the oscillator is only slightly variable, using adjustable inductor L1 which resonates with the crystal holder and stray wiring capacitances. Emitter-follower stage Q2 isolates the oscillator from its load to improve frequency stability. The output from emitter-follower Q2 is applied to a dual low-pass filter with the pilottone signal as its cutoff frequency, and all undesired frequencies are attenuated. The output level control, R15, is adjusted to obtain an output tone that is -6 db to --10 db below the single channel test tone level.

l. Technical characteristics are as follows:

Parameter	*Specifications*
Multiplex input impedance	75 ohms, unbalanced
Service channel impedance	
368-42029-1 and -6	600 ohms, balanced
368-42029-2	N/A
368-42029-3 thru -5, and -8 through -9	600 ohms, unbalanced
Multiplex input level	-45 to -15 dbm
Service channel input level	
368-42029-1, -3 through .6, and -8 through -9	-35 to -15 dbm
368-42029-2	-25 to 5 dbm
Output level	-31 dbm
Maximum available gain	+15 dbm (multiplex)
Input attenuators:	
Multiplex	0-31 db in 1-db steps
Service channel (except -2)	0-31 db in 1-db steps

Parameter	*Specifications*
Frequency response:	
Multiplex	12 kHz to 2.8 MHz, +0.2 db reference
Service channel	300 Hz to 13 kHz
Signal isolation:	
Multiplex to service channel or pilot-tone signals	-26 db
Service channel or pilot-tone signals to multiplex signal	-35 db
Power requirements	100 ma at +28 V dc
Pilot-tone oscillator:	
Output frequency:	
368-42326	10 kHz, ± 15 Hz
368-43022-1	3.2 MHz ± 150 Hz
368-43022-2	1.499 MHz ± 75 Hz
368-43022-3	8.5 MHz ± 425 Hz
Output impedance:	
368-42326	600 ohms, unbalanced
368-43022-1 through -3	70 ohms, unbalanced
Output level	>17 mv (adjustable)

7-6. Maintenance Data

a. Performance Test and Trouble Analysis Procedures (General). The following paragraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect the test equipment to the module as shown in figure 7-2. Refer to figures 6-3 (2), (3) and 7-4 for parts location.

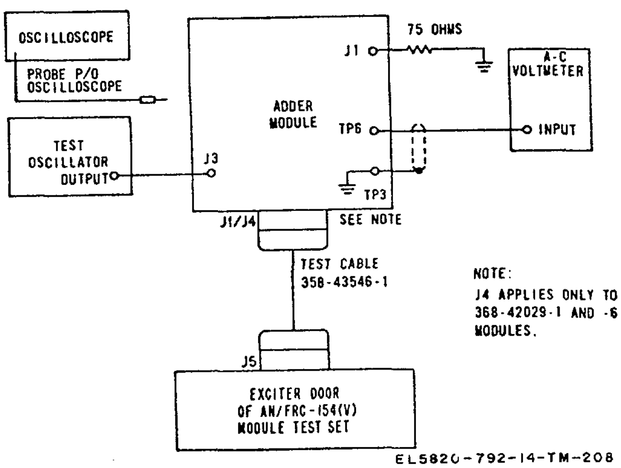


Figure 7-2. Adder module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments: (1) Remove the top and bottom covers from the adder module; in addition, remove the cover from the pilot-tone oscillator submodule.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the ±28-volt power supply in the test set for 28 ± 0.5V.

d. Test Procedures. Dc voltage readings should be within 10 percent and ac readings should be within 20 percent.

e. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Multiplex amplifier circuit check		
1	Connect negative lead of multifunction meter to test point TP3 (ground) and positive lead to the junction of diodes CR1 and CR2.	+27.5 V dc [a]	Proceed to step 2	Replace CR1 and/or CR2.
2	Connect a jumper wire between test points TP6 and TP5. If module is equipped with switch S1, set the switch in the PL,T BYPASS position.			
3	Set frequency of test oscillator to 100 kHz.			
4	Adjust output level control test oscillator for an indication of -40 db (8 mv, rms ac voltmeter.			
5	Connect oscilloscope probe to test points TP1 and TP2, in turn.	100-kHz sine wave, 180 mv, peak-to-peak.	Proceed to step 9	Proceed to step 6.
6	Connect oscilloscope probe to collector of Q1 (fig. 7-3 (2)).	100-kHz sine wave, 350 mv, peak-to-peak. dc coupled. Failure of either transistor will affect the bias on the other.)	Proceed to step 7	Check Q1, Q2, and associated components. (Q1 and Q2 are
7	Connect oscilloscope probe to collector of Q2 (fig. 7-3 (2)).	100-kHz sine wave, 240 mv, peak-to-peak.	Proceed to step 8	Check Q1, Q2, and associated components.
8	Connect oscilloscope probe to emitter of Q3 (fig. 7-3 (2)).	100-kHz sine wave, 240 mv, peak-to-peak.	Check capacitor C10 and resistors R17, R18, and R19; then proceed to step 9.	Check Q3 and associated components.
9	Disconnect jumper wire between TP6 and TP5.			
		Service channel check [b]		
10	Connect test oscillator to adder as follows: *Module part No.* — *Connector Pins* 368-42029-1, -6 — 16 and 17 of J4 -2 — 16 and 17 of J1 -3 through -5 — 16 and 14 of J1			
11	Bypass any attenuator pads connected to pins listed in step 10.			
12	Connect ac voltmeter to pins listed in step 10.			
13	Set frequency of test oscillator to 1 kHz. Adjust output level control for an indication of -25 db (44 mv, rms) on ac voltmeter.			
14	Connect oscilloscope probe to test point TP1.	1-kHz sine wave, 100 mv, peak-to-peak.	Proceed to step 17	Proceed to steps 15 and 16.
15	Connect oscilloscope probe to test point TP4 (applicable to adder module 368-42029-1 and -6 only).	1-kHz sine wave, 100 mv, peak-to-peak.	Proceed to step 16	Check transformer T1 and associated components.
16	Connect oscilloscope probe to base of Q3 (fig. 7-3(2)).	1-kHz sine wave, 170 mv, peak-to-peak.	Proceed to step 17	Check R3 and connections to base of Q1.
17	Disconnect oscilloscope, test oscillator, and ac voltm eter from module.			

See footnotes at end of chart.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Pilot-tone oscillator check		
18	If switch S1 exists on the module set switch to PLT NORM and if the switch does not exist on the module, set the switch on the terminal filter module in the test set to the "A" position.			
19	Set gain potentiometer of pilot-tone oscillator fully clockwise. *Module part No.* — *Potentiometer* 368-42039, -9 -2 — R5 through -6 and -8 — R1			
20	Connect oscilloscope probe to test point TP1 Module part No. Module part No. 368-42029-1,-9 -2 -3 through -6 and -8	Sinewave, greater than the following peak-to-peak voltages: 50 mv. 11 mv. 30 mv.	Proceed to step 27	Proceed to step 21.
21	Check resistance between all ground lugs and mounting plate in pilot-tone oscillator submodule, using the multifunction meter as an ohmmeter.	0 ohm	Proceed to step 22	Resolder and repair faulty connections.
22	Check ground wiring between pilot-tone oscillator submodule and adder circuit.	0 ohm	Proceed to step 23 or 24	Resolder and repair faulty connections.
23	Connect oscilloscope probe to terminal 5 on transformer T1 of pilot-tone oscillator (applicable to adder modules 368-42029-1 and -9).	Sine wave, 1.6V, peak-to-peak	Proceed to step 25	Check T1, Q1, and associated components of pilot-tone oscillator.
24	Connect oscilloscope probe to test point TP 7 and ground. *Module part No.* 368-42029-1, -9 -2 -3 through -6 and -8	Sine wave, peak-to-peak 1 56 mv. 17 my. 55 mv.	Proceed to step 25	Check C6, C7, C8, 1,1, and 1,2 of pilot-tone oscillator.
25	Set potentiometer R5 fully counterclockwise (applicable to adder module 368-42029-1 and -9 only). Set potentiometer R15 fully counterclockwise (applicable to adder modules 368-42029-3 through -6 and -8 only). Set potentiometer R15 fully counterclockwise (applicable to adder module 368-42029-2 only).	Sine wave, less than 8.5 mv, Sine wave, less than 3 mv, peak-to-peak. Sine wave, less than 1 mv, peak-to-peak.	Check resistor R63, and peak-to-peak.	Check potentiometer R5 of proceed to step 26. pilot-tone oscillator.
26	Set potentiometer R5 fully clockwise for adder modules 368-42029-1 and -9 and R15 clockwise for the -2 through -6 ands-8.			
27	Disconnect 75-ohm load resistor from J1. Connect input connector of a frequency counter to AC OUTPUT connector on ac voltmeter. Connect AC INPUT connector of ac voltmeter to connector J1 on the module. Set meter range switch to -60 db. Observe frequency reading on frequency counter.		Proceed to step 28	Perform pilot-tone oscillator frequency adjustment and proceed to step 28.

See footnotes at end of chart.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
	Module part No.			
	368-42029-1, -9	10 kHz ± 5 Hz.		
	-2, -5	3.2 MHz ± 20 Hz.		
	through -6			
	-3	1.499 MHz ± 20 Hz.		
	-4, -8	8.5 MHz ± 100 Hz.		
		Adder bandwidth check		
28	Reconnect the 75-ohm load resistor to J1. Connect a jumper wire between test points TP6 and TP5.			
29	Connect test oscillator output to adder module connector J3.			
30	Set frequency of test oscillator to 100kHz.			
31	Connect input probe of ac voltmeter to test point TP6.			
32	Adjust output level control of test oscillator for an indication of -40 db (8 mv, rms) on ac voltmeter.			
33	Connect input probe of ac voltmeter to test point TP1.	35 mv to 50 mv. Record reading as reference level.	Proceed to step 34	Check transistors Q1, Q2, and Q3 and associated components.
34	Repeat steps 30, 31, 32, and 33 using the following test frequency chart: *Module Part Nos. 368-42029-* *-1, -9* / *-2* / *-3* 12 kHz / 12 kHz / 12 kHz 50 kHz / 50 kHz / 50 kHz 500 kHz / 500 kHz / 500 kHz 1.3 MHz / 1.3 mHz / 1.5 MHz 3.2 MHz *-4, -3* / *-5* / *-6* 12 kHz / 12 kHz / 12 kHz 50 kHz / 50 kHz / 50 kHz 500 kHz / 500 kHz / 500 kHz 1.5 mHz / 1.5 MHz / 1.3 MHz 3 MHz / 3.2 MHz 5 MHz 8.5 MHz	±2 mv of reference level	Proceed to step 35	Check capacitors C13 and C14.
35	Disconnect jumper wire between TP6 and TP5.			
36	Connect test oscillator to adder [b] as follows: *Module part No.* — *Connector Pins* 368-42029-1, -6 — 16 and 17 of J4 -3 through -5 — 16 and 14 of J1 -8 through -9 — 16 and 14 of J11			

See footnotes at end of chart.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
37	Bypass any attenuator pads connected to pins listed in step 36.			
38	Connect input probe of ac voltmeter to test point TP4.			
39	Set frequency of test oscillator to 1 kHz.			
40	Adjust output level control of test oscillator for an indication of -35 db on ac voltmeter.		Proceed to step 41	Check transformer T1.
41	Connect input probe of ac voltmeter to test point TP1.	-38 db ± 2 db; record reading as reference level.	Proceed to step 42	Check transistors Q1, Q2, and Q3 and associated components.
42	Repeat steps 38, 39, 40, and 41, using the following test frequencies:		Test is complete. Disconnect all test equipment and jumper wires.	
	300 Hz	± 3 db maximum above reference level.		
	3 kHz	± 0.5 db of reference level	Replace module covers.	
	5 kHz	± 0.5 db of reference level		Check capacitors C1, C11, and C10.
	8 kHz	± 1 db of reference level.		

[a] To obtain a valid reading, alternately disconnect the B + inputs to steering diodes CR1 and CR2
[b] Not applicable to 368-42029-2.
[c] The normal output signal level of the pilot-tone oscillator circuit is not high enough to drive the frequency counter. These connections permit the use of the ac voltmeter internal amplifier circuit for obtaining the signal level required.

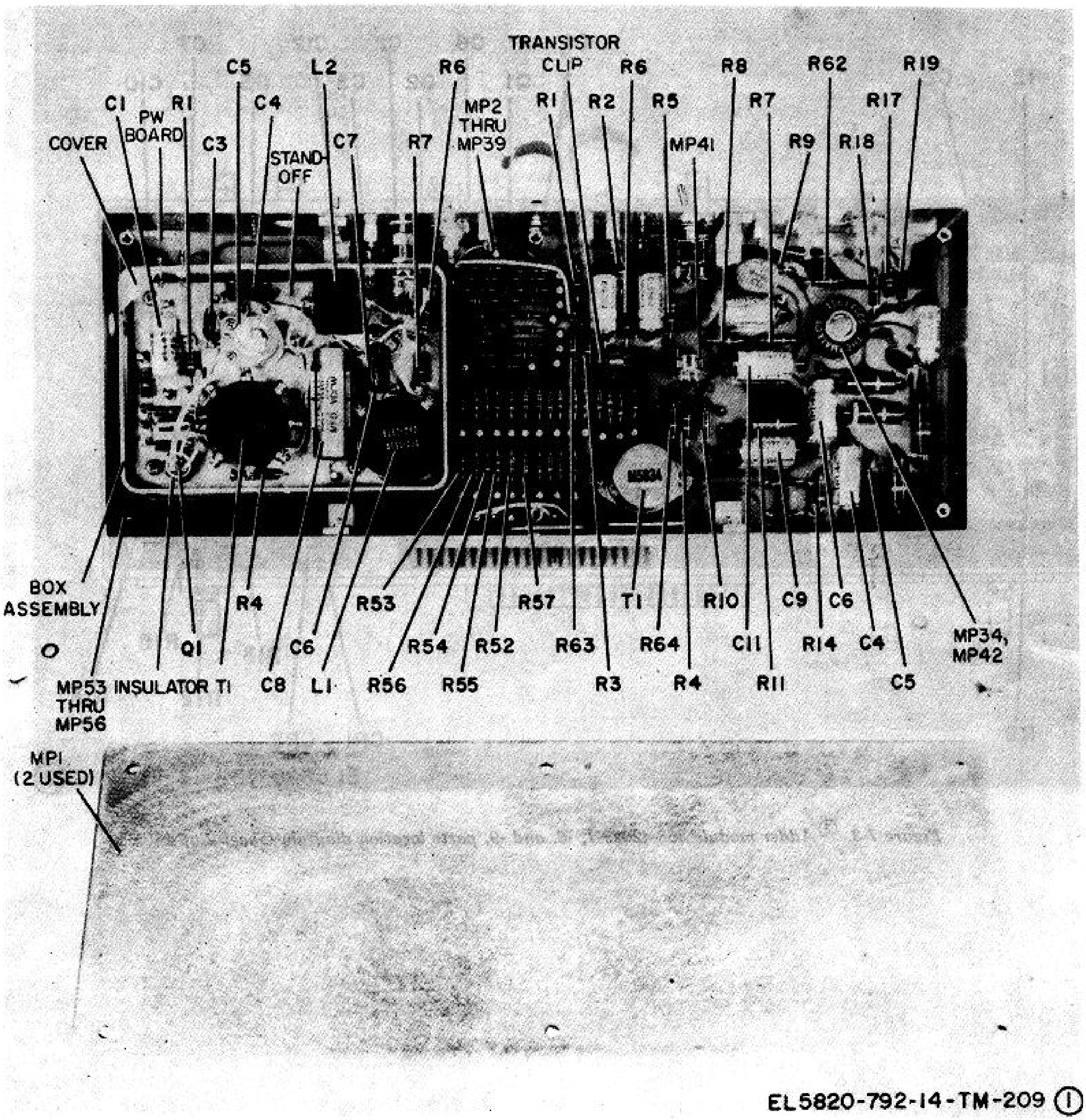


Figure 7-3. (1) Adder module 368-42029-1, -6, and -9, parts location diagram (sheet 1 of 4).

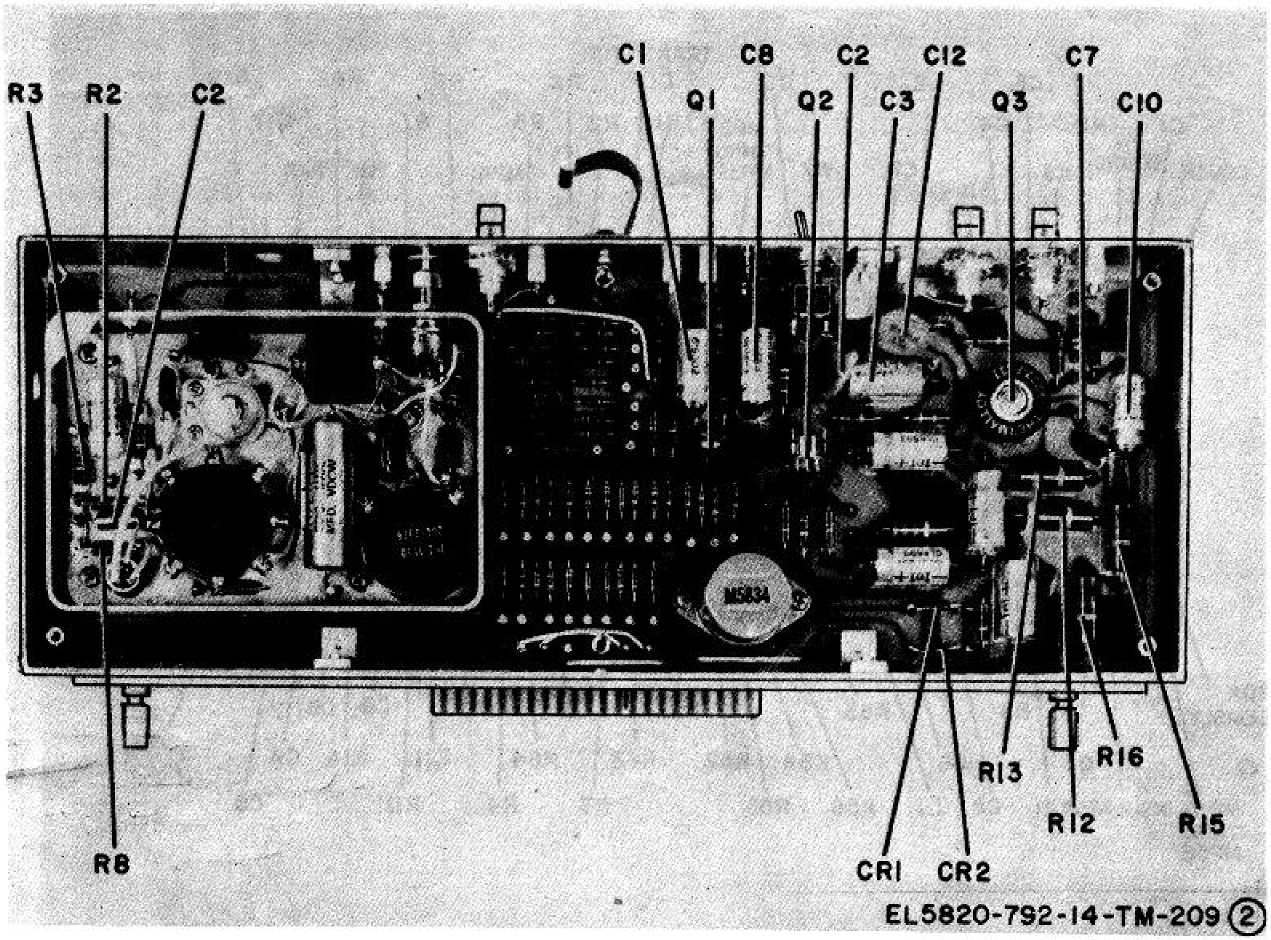


Figure 7-3. (2) Adder module 368-42029-1, -6, and -9, parts location diagram (sheet 2 of 4).

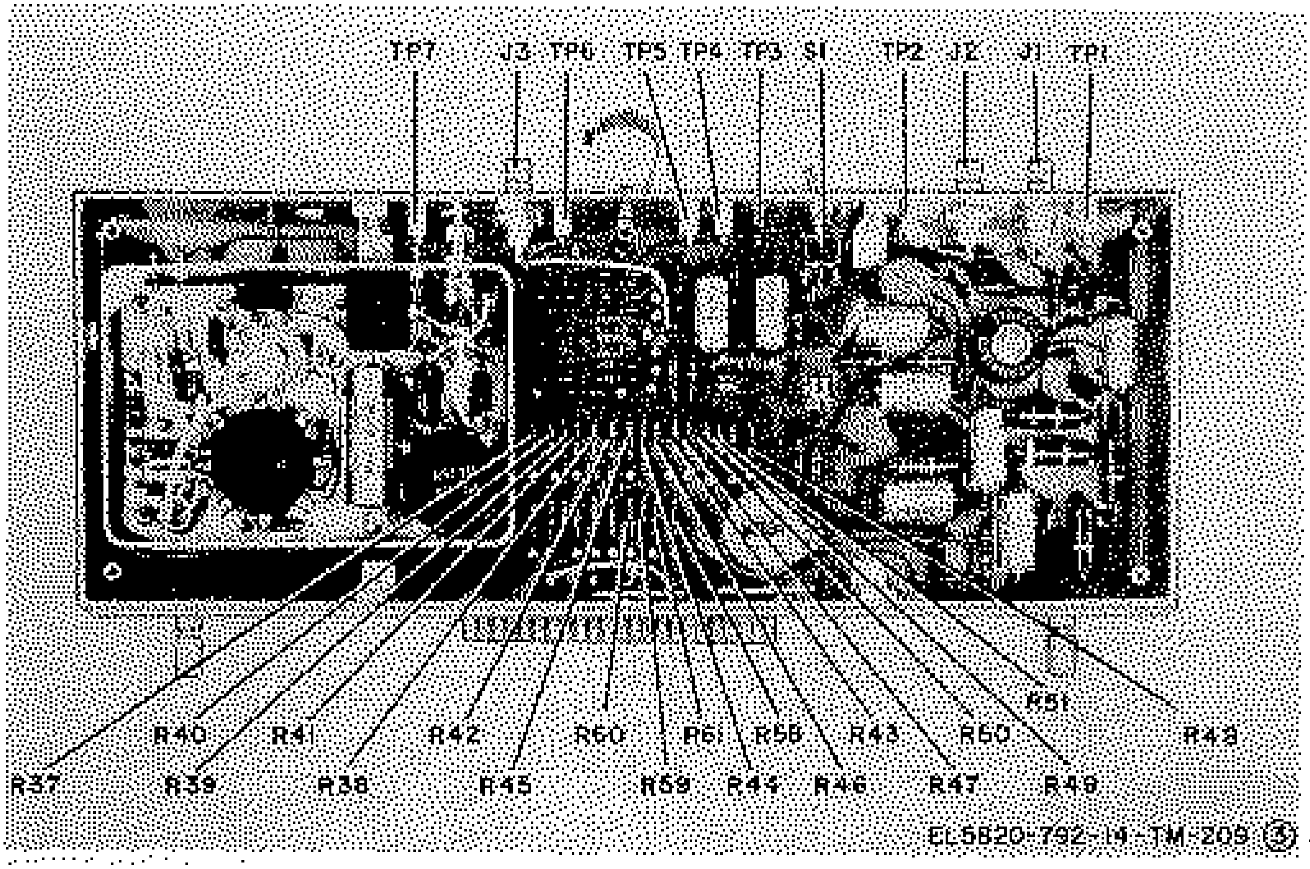


Figure 7-3. (I)Adder module 368-42029-1, -6, and -9, parts location diagram(sheet 3 of 4).

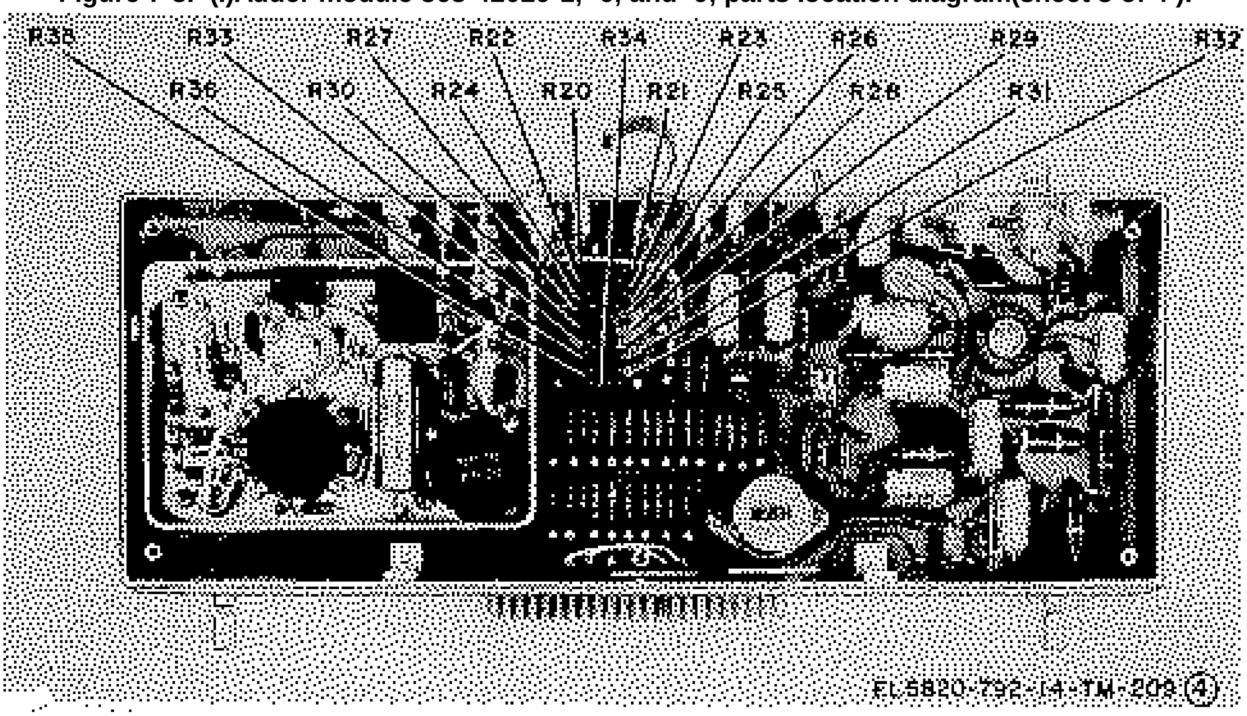


Figure 7-3. ()Adder module 368-42029-1, -6, and -9, parts location diagram (sheet 4 of 4).

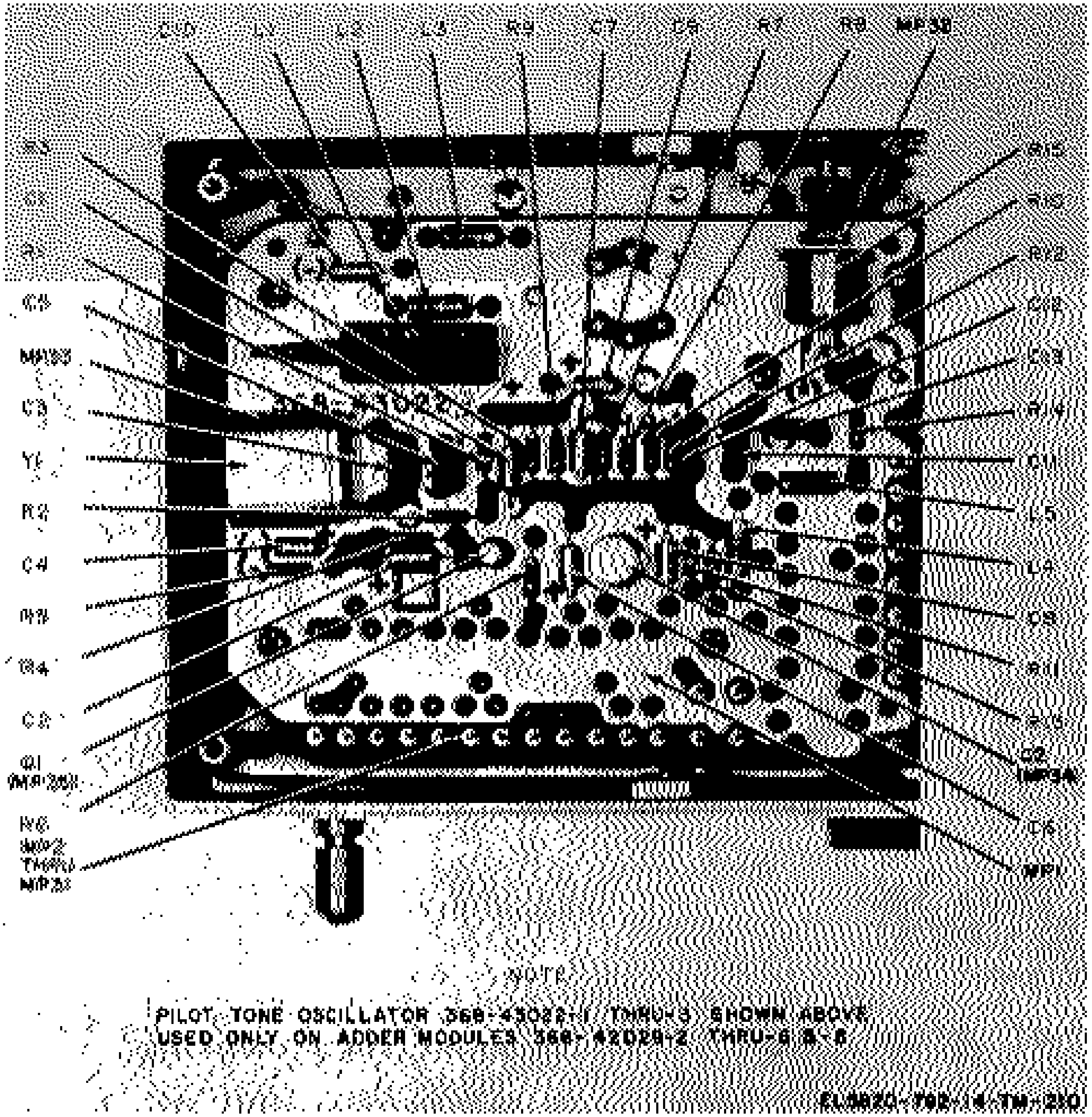


Figure 7-4. Adder module 368-42029-2, parts location diagram.

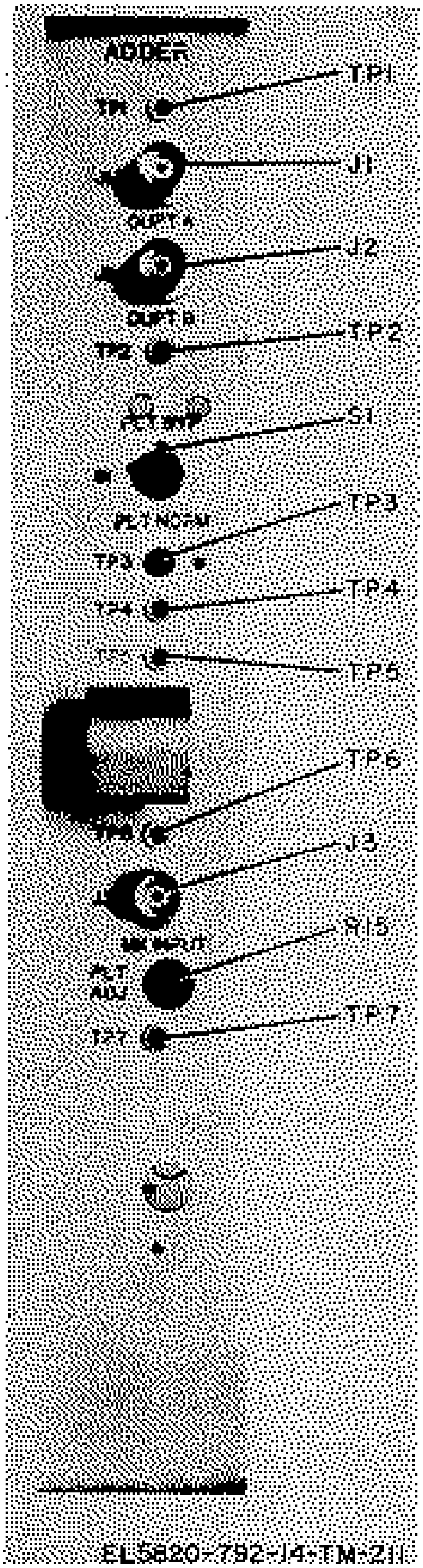


Figure 7-5. Adder module 368-42029-3, -4, -5, and -8, parts location diagram.

f. Intermodulation Distortion Test. This procedure is used to evaluate the linearity characteristics of the adder module. The intermodulation distortion test is the final major performance test of the module. The levels and frequency slots used in this test are based upon 600 channel loading conditions. A discussion of this type of test, and the modification required for other channel loadings, appears in chapter 5. The test equipment setup is shown in figure 7-6.

(1) Replace test set standard adder module with adder module under test.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the 28-volt power supply in the module test set for 28 + 0.5 V dc.

(4) Adjust the 6-volt power supply in the module test set for -6+0.5 V dc.

(5) Connect test set cables as shown in figure 7-6.

(6) Set the noise generator 60-kHz high-and the 2660-kHz low-pass filters to their IN positions. Set noise generator output level to 12mv (-27 dbm/75 ohms) as read on ac voltmeter.

(7) Set the noise receiver frequency selector to 70 kHz, then adjust the attenuator controls to produce a meter reference indication.

(8) Read and record the attenuator setting of the noise receiver. Label the reading as reference 1.

(9) Switch in the 70-kHz bandstop filter on the noise generator.

(10) Set the attenuator controls of the noise receiver to produce the same level as reference 1.

(11) Read and record the attenuator settings of the noise receiver. Label the reading as reference 2.

(12) Subtract reference 1 from reference 2 to obtain the noise power ratio at the 70-kHz slot. The resulting noise power ratio shall not be less than 60 db.

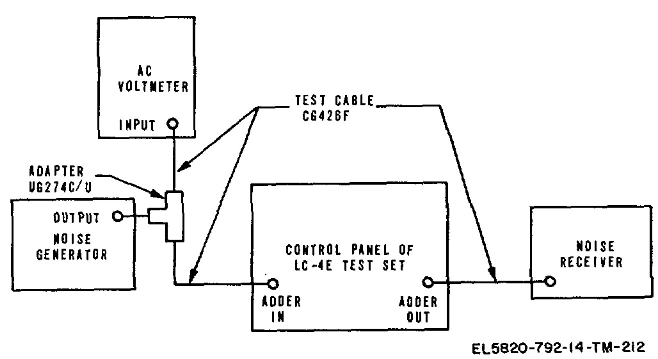


Figure 7-6. Adder module intermodulation distortion test equipment setup.

(13) Set the 70-kHz bandstop filter switch to its out position.

(14) Repeat steps (7) through (12) above using 1002 kHz instead of 70 kHz.

(15) Set the 1002-kHz bandstop filter switch to its out position.

(16) Repeat steps (7) through (12) above using 2438 kHz instead of 70 kHz.

(17) Disconnect all test equipment from the module test set.

(18) Remove the module under test from the module test set.

(19) Replace the standard adder module in the module test set. This step completes the procedure.

g. Voltage and Resistance Measurements. If performance of the foregoing test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in *h* below in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the module disconnected from all external components using the multifunction meter. All voltages are measured using the test setup of b above. The multifunction meter is also used to measure dc voltages.

CAUTION

Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if this voltage exceeds 1.5 volt. Also, since the R x 1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more) may damage the transistor under test. As a general rule, it is not recommended that the R x 1 range of any ohmmeter be used when testing low power transistors.

Point of measurement		Dc voltage (nominal)	Ac voltage (peak-to-peak) (nominal	Resistance (nominal) RX100 scale unless otherwise specified
			Adder circuit	
Q1	Base	6.8 V		1 k Ω
	Emitter	5.6 V		1.2 k Ω
	Collector	11 V	350 mv[a]	2.3 k Ω
Q2	Base	11V	350 mv[a].	2.3 k Ω
	Emitter	10.4 V	350 mv[a]	650 ohms
	Collector	20.5 V	240 mv[a]	2.7 k Ω
			170 mv[b]	
Q3	Base	15 V	250 mv[a]	1.8 k Ω
			170 mv[b]	
	Emitter	14.4 V	240 mv[a]	200 ohms
			170 mv[b]	
	Collector	19 V		2.3 k Ω
TP1			140 mv[a]	10 k Ω
			100 mv[b]	
TP2			140 mv[a]	10 k Ω
			100 mv[b]	
TP7			> 50 mv, max[a]	8 ohms
TP1			40 mv[a]	
TP2			>40 mv[a]	
Pin 5 of T1			1.6 V[a]	
			Pilot-tone os- cillator cir- cuit d (for 368-42029- 1 and -9)	
Q1	Base	11.5 V		5.0 k Ω
	Emitter	11.0 V		2.0 k Ω
	Collector	23.7 V		2.2 k Ω
Pin 5 of T1			1.6 V[a]	
			Pilot-tone os- -cillator circuit' [e] (for 368-42029- through -6, -8)	

Point of measurement		Dc voltage (nominal)	Ac voltage (peak-to-peak) (nominal	Resistance (nominal) RX100 scale unless otherwise specified
Q1	Base	23.2 V	1.6 V	6.0 k Ω
	Emitter	22.6 V	1.6 V	8.0 k Ω
	Collector	24.8 V	2.6 V	6.5 k Ω
Q2	Base	9.3 V	2.4 V	1.9 k Ω
	Emitter	8.7 V	2.4 V	1.0 k Ω
	Collector	17.4 V	0 V	7.0 k Ω

[a] With 100-kHz test signal connected at J3: input level of 40 db (8 mv, rms).
[b] With 1.0-kHz test signal connected at pins 16 and 17 of J4; input level of -25 db (44 mv, rms).
[c] All dc voltage readings made with switch SI in PLT BY-PASS position.
[d] All dc voltage readings made with switch S1 in PLT NORM position and potentiometer R5 set fully clockwise.
[e] All dc voltage readings made with' switch S1 in PLT NORM position and potentiometer R15 set fully clockwise.

7-7. Alignment Data.

a. General. The following procedures should be performed as part of scheduled maintenance and after repairs have been made in the module.

b. Test Equipment Setup. The test equipment setup used for the following alignment and adjustment procedures is the same as that described in paragraph 6-6 b, unless otherwise indicated in the procedure.

c. Preliminary Adjustments. When the test set-up above is completed, perform the preliminary adjustments listed in paragraph 6-6c.

d. Pilot-Tone Oscillator Adjustments (368-42326). The following procedure is provided for use in adjusting the output level and frequency of the pilot-tone oscillator 368-42326 of the adder module whose schematic diagram is shown in figure FO-12.

(1) Connect the adder module to the module test set as shown in figure 7-2.

(2) Connect a 75-ohm load resistor across multiplex output connector J1.

(3) Set switch S1 of the module to the PLT NORM position.

(4) Set potentiometer R5 fully clockwise.

(5) Connect the input connector of a frequency counter to the AC OUTPUT connector on the ac voltmeter. Connect the AC INPUT connector of the ac voltmeter to test point TP7 on the adder module. Set the meter range switch to - 60 db.

NOTE

The normal output signal level of the pilot-tone oscillator circuit is not high enough to drive the frequency counter. The connections made above permit the use of the ac voltmeter internal amplifier circuit for obtaining the signal level required.

(6) Adjust capacitor C5 until the frequency counter indicates 10 kHz + 5 Hz. If the 10-kHz frequency count cannot be obtained and the count is greater than 10 kHz, increase the value of capacitor C3 from 160 pf to 180 pf. If the 10-kHz frequency count cannot be obtained and the count is less than 10 kHz, reduce the capacitor C3 from 160 pf to 130 pf. In either case, where the value of capacitor C3 must be changed, adjust capacitor C5 until the standard output frequency is within limits.

(7) Disconnect the frequency counter.

(8) Connect the ac voltmeter between test points TP3 (ground) and TP1; record the output level indicated.

(9) Set potentiometer R5 to the fully counterclockwise position; record the output level indicated by the ac voltmeter.

(10) The levels recorded in steps (8) and- (9) above should cover a range between 20 mv (-32 db) or greater (with R5 fully clockwise) to 3 mv (-48 db) or less (with R5 fully counterclockwise).

(11) Set potentiometer R5 to the midrange position.

(12) Disconnect all test equipment and replace the module covers.

e. Pilot-Tone Oscillator Adjustments (368-42022). The following procedure is provided for use in adjusting the output level and frequency of the pilot-tone oscillator 368-42022-1 through -3 of the adder module (fig. FO-13).

(1) Connect the adder module to the module test set as shown in figure 7-2.

(2) Connect a 75-ohm load resistor across multiplex output connector J1.

(3) Set switch S1 of the test set terminal filter module to its A position.

(4) Set pilot adjust potentiometer R15 fully clockwise.

(5) Connect the input connector of a frequency counter to the AC OUTPUT connector on the ac voltmeter. Connect the AC INPUT connector of the ac voltmeter to test point TP7 on the adder module. Set the meter range switch to - 30 db.

NOTE

The normal output signal level of the pilot-tone oscillator circuit is not high enough to drive the frequency counter. The connections made above permit the use of the ac voltmeter internal amplifier circuit for obtaining the signal level required.

(6) Adjust inductor L1 until the frequency counter indicates the value provided below.

Pilot-tone oscillator	*Output frequency*
368-42022-1	*3.2 MHz t20 Hz*
-2	*1.499 MHz + 20 Hz*
-3	*8.5 MHz +100 Hz*

(7) Disconnect the frequency counter.

(8) Connect the ac voltmeter between test points TP3 (ground) and TP1; record the output level indicated.

(9) Set potentiometer R15 to the fully counterclockwise position; record the output level indicated by the ac voltmeter.

(10) The levels recorded in steps (8) and (9) above should cover a range between 10 mv (-38 db) or greater (with R15 fully clockwise) to 1.4 mv (-55 db) or less (with R15 fully counterclockwise).

(11) Set potentiometer R15 to the midrange position.

(12) Disconnect all test equipment and replace the module covers.

Section III. AFC MODULE (368-42098-3)

7-8. Introduction

The AFC module is located in the microwave transmitter. The AFC module compares samples of an internal 70-MHz oscillator signal with a sample of the transmitter output signal (reduced to 70 MHz) and produces an output error voltage that is proportional to the difference in the two frequencies. This error voltage is then used to maintain constant frequency output from the transmitter.

7-9. Module Configurations

a. The AFC module consists of a metal chassis and components that are connected by means of point-to-point wiring between standoff terminals. Controls, test jacks, and connectors are mounted on the front flange of the module chassis.

b. The basic difference between the AFC modules is the method of applying the correction voltage. The AGC module provides an output signal referenced to ground for general use, with up converters used to drive traveling-wave tube power amplifiers.

7-10. Functional Description

a. The functional block diagram of the AFC module appears in figure 7-7. A frequency-modulated 70-MHz sample of the transmitter output signal is applied to the input of the AFC module. The input signal to the AFC module is obtained direct from a deviator module. This signal is amplified and sent into the transmitter signal switch circuit. The 70-MHz reference oscillator is a crystal-controlled stage that produces the reference signal. After amplification, the reference signal is sent into the reference signal switching circuit.

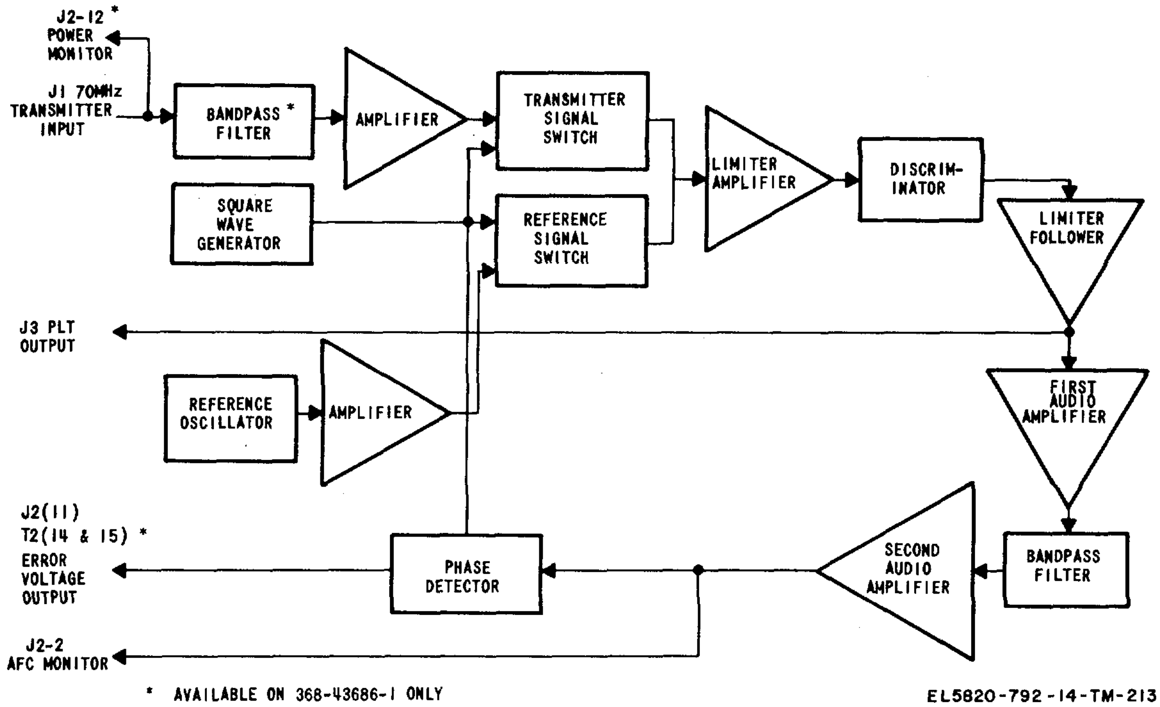


Figure 7-7. AFC module, functional block diagram.

b. The alternate switching between the incoming transmitter signal and the reference signal is accomplished by a 9-kHz square wave generator. Since the output circuits of the two signal switches are connected together, the output signal consists of reference signal samples interlaced with transmitted signal samples of equal time intervals. The output of the signal switches is amplified and limited before application to the discriminator for demodulation.

c. The demodulated signal at the output of the discriminator has a frequency of 9 kHz. Amplitude differences between the interlaced pulses are proportional to the differences between the reference and transmitter frequencies. Each alternate pulse of the demodulated signal contains baseband components. This baseband, in certain system applications, is sent via connector J3 into a pilot-tone detector module to extract the pilot tone from the transmitted baseband. Absence of the transmitted pilot-tone implies loss of modulation.

d. Following amplification, the interlaced transmitter and reference signals are sent through a bandpass filter. The purpose of the bandpass filter is to pass only the 9-kHz error signal which it converts from square waveform to sinusoidal waveform, and to reject all modulation.

e. The 9-kHz error signal is amplified once more and then sent into a phase detector. The phase detector compares the 9-kfHz error signal with the 9-kHz switching signal. The output signal from the phase detector is a dc voltage whose amplitude is proportional to transmitter frequency error and whose polarity indicates whether the frequency error is above or below the assigned frequency.

f. At the output of the final audio amplifier, the 9-kHz error signal is detected and a dc signal is passed out of the AFC module at pin 2 of multiple pin connector J2 for purposes of monitoring the frequency drift.

g. Frequency drift versus AFC voltage amplitude.

Frequency drift	Afc voltage	Frequency drift	Afc voltage
0	± 0.02 V	± 3 MHz	± 1.65 V
± 140 kHz	± 0.32 V	± 4 MHz	± 1.69 V
± 1 MHz	± 1.29 V	± 5 MHz	± 1.71V
± 2 MHz	± 1.58 V		

7-11. Circuit Analysis

a. As shown in figure FO-15), a continuous sampling of the transmitter output signal is applied through coaxial connector J1 to the 75-ohm unbalanced input of the AFC module. The network consists of R19, C17, and C18. The input is capacitively coupled to the base of common-emitter amplifier Q7. The biasing arrangement used for amplifier Q7 is one method of stabilizing gain with temperature variations, but more important, the output impedance of amplifier Q7 is stabilized at a fixed value to properly terminate the transmitter signal switching circuit.

b. The reference oscillator is a Hartley oscillator using transistor Q4 as the active element and a quartz crystal Y1 as the control element. Resistors R8 and R9 in conjunction with resistor R10 apply base bias to oscillator Q4. Inductors L11 and L12 are used to increase the input impedance of the base circuit; capacitor C5 bypasses resistor R9 at 70 MHz. Inductor L1 and capacitors C6 and C7 are filters to isolate the 70-MHz signal from the dc powerline. The resonant circuit consists of transformer T1 and capacitor C9; adjustment of variable capacitor C9 permits a slight amount of tuning to set the oscillator on 70 MHz.

c. Capacitor C11 isolates the dc supply from crystal Y1 while coupling the 70-MHz signal into the control circuit. Inductor L3 and resistor R11 in this feedback control circuit are used to counteract crystal holder effects at 70 MHz.

d. The oscillator output is RC-coupled by C10 and R12 into common base amplifier Q5; resistor R12 is also Q5 emitter resistor. Resistors R13 and R14 set up the dc base voltage for the reference amplifier Q5. Capacitor C12 bypasses R13 to ground, holding Q5 base at ground potential for the 70-MHz reference signal. The filter, made up of L5, C15, and C16, prevents the 70-MHz signal from entering the dc powerline. Inductor L4 is the collector load which is effectively in parallel with capacitors C13 and C58. Capacitor C13 is adjusted for impedance matching between stages. Emitter follower Q6 provides isolation and impedance transformation between the 70-MHz amplifier and the reference signal switching circuit.

e. The 9-kHz square wave generator, which is a free-running a stable multivibrator, is made up of transistors Q1 and Q2. Diodes CR1 and CR2 perform the dual functions of ensuring transistor cutoff, and providing base-to-emitter protection. Potentiometer R5 is used for frequency adjustment. The 9-kHz switching signal is applied to emitter follower Q3 which provides impedance matching and isolation. Diode CR3 is used for temperature compensation of Q3. The output of emitter follower Q3 is applied to both sections of the switching circuitry through resistors R4, R25, and R22. Potentiometer R4 is used as a balance control to insure that the amplitude of the switching pulse in each signal switch is the same. Test point TP5 is used to monitor or measure the square wave output signal into the signal switches.

f. The switching circuits are shown in the simplified schematic diagram of figure 6-8. The transmitter 70-MHz signal present at the output of amplifier Q7 is applied across diodes CR4 and CR6 to ground. The output of emitter follower Q3, which is associated with this portion of the circuit, is applied to the series circuit consisting of capacitor C4, resistor R22, and diode CR6. Diode CR6 is the common element for both the 9-kHz sampling pulse and the 70-MHz transmitter signal.

g. When the sampling pulse switches are positive, diode CR6 is cut off. The voltage at the junction of resistor R22 and diodes CR4, CR5, and CR6 is raised from ground potential to ap- proximately 10 volts positive. Diodes CR4 and CR5 become highly conductive. The 70-MHz transmitter signal is superimposed on the sampling pulse and passed by diode CR5 to load resistor R24. The dc level arising from the use of the sampling pulse, is blocked by capacitor C21. Only the 70-MHz transmitter signal is present in the output of the switching circuit across resistor R32.

h. During this same time period, the positive sampling pulse present across diode CR9 drives the diode into a highly conductive state. In this case, the voltage at the junction of resistor R25 and diodes CR7, CR8, and CR9 is lowered to essentially- ground potential. The 70-MHz reference signal is now shunted to ground. Diode CR8 is, of course, in the nonconductive state and also blocks the passage of the 70-MHz reference signal to the output-channel load resistor, R32.

i. When the sampling pulse switches to its negative value, the conditions at the two junction points previously discussed are reversed. The net result is that the 70-MHz transmitter signal is shunted to ground, while the 70-MHz reference signal is passed to the output across the resistor R32.

j. The signal across resistor R32 consists of samples of the 70-MHz transmitter signal alternately interlaced with samples of the 70-MHz reference signal at a 9-kHz rate. The output of the switching circuit can be measured or monitored at test point TP4. This interlaced signal is sent into common-emitter stage Q8 for amplification. Diodes CR10 and CR11 limit the positive and negative peaks of the interlaced signal. Transformer T2 tends to restore the interlaced signal to its sinusoidal waveform in addition to coupling the signal into common-base amplifier Q9. The signal from amplifier Q9 is limited a second time, then sent into amplifier Q10. The collector Q10 is a tuned circuit consisting of L8, R42, and C36; adjustable capacitor C36 is used to obtain maximum signal into the discriminator.

k. The discriminator is a stagger-tuned Travis circuit. The upper leg of the circuit consisting of L9, C59, and C39 is tuned to 60 MHz, while the lower leg of the circuit consisting of L10, C61, and C40 is tuned to 80 MHz. The resonant or center frequency is 70 MHz. Diodes CR14 and CR15 are the detector diodes; these are poled in opposite directions so that the positive signal detected at 70 MHz by diode CR14 is canceled out by the negative signal detected at 70 MHz by diode CR15 across resistors R3 and R46. Capacitors C41 and C42 bypass the 70-MHz signal in their respective branches to ground. If no modulation is present in the transmitted signal, the discriminator output signal will be 0 volt at the 9-kHz switching frequency. If modulation is present in the transmitted signal, this baseband will be present in the discriminator output. Potentiometer R3 is adjusted to produce 0 volt at the output of the discriminator when the un- modulated transmitter output signal is 70 MHz. Test point TP3 is used to monitor and measure the discriminator output voltage.

1. The output signal of the discriminator is RC-coupled into emitter follower Q11 which provides impedance matching between discriminator and succeeding audio amplifier stages. Notice that an output signal is developed at the collector of transistor Qll1 and passed via coupling capacitor C65 to coaxial connector J3; this is sent into a pilot-tone detector module and is used as a modulator-loss alarm.

m. The output of transistor Q11 is RC-coupled to the base of common-emitter amplifier Q12, which is the first of three audio amplifiers. After the first stage, the audio signal is sent through a dual-purpose bandpass filter FL1. This filter rejects all modulation from the error signal, and converts the error signal from a square wave to a sinusoidal wave. The 3-db passband of the filter ranges between 8.98 kHz and 9.03 kHz. Potentiometer R1 in the emitter circuit of amplifier Q13 is used as a gain adjustment by varying the applied base bias. The overall gain of the audio amplifier is approximately 600.

n. The output of emitter follower Q15 is applied to the primary winding of transformer T4, which is one input signal into the phase detector. This same signal is rectified by diode CR18 and filtered by C72-R82 and passed through pin 2 of printed circuit' connector J2; this error voltage can be monitored by a voltmeter externally. The phase detector is a standard synchronous detector shown in the simplified schematic of figure 6-9. The 9-kHz switching signal is injected by means of T5 secondary into the centertap of T4 secondary; this signal is the standard or synchronizing signal. The 9-kHz error signal developed across the secondary of transformer T4 is mixed with the switching signal also present in T4 secondary. If the transmitter is exactly on frequency, the error and switching signals cancel each other in T4 secondary and the AFC output signal to the transmitter is zero. If the transmitter is not on frequency, the error and switching signals do not completely cancel, so that the difference in signal amplitudes is rectified by diodes CR16 and CR17 and the resulting AFC output voltage is sent into the transmitter to correct transmitter output frequency. During normal operation, the AFC voltage varies between the limits of + 0.5V, which can be measured between test points TP1 and TP6. Potentiometer R2 is provided to balance the phase detector so that the detector output voltage is zero when the transmitter frequency error is zero. Figure FO-15 ()shows that the AFC module provides an unbalanced (ground referenced) output line at pin 11 of printed-circuit connector J2. The output line is provided with an ON-OFF switch S1 to enable or disable AFC action as desired.

o. Technical characteristics are as follows:

Parameter	*Specifications*
Input impedance	75 ohms, unbalanced
Output impedance:	
Pilot-tone output	75 ohms, unbalanced.
Error voltage output	Matched to 75 ohms.
Input level	100 mv at 70 MHz
Output level:	
Pilot-tone	5 mv (min) peak-to-peak (variable).
AFC	Refer to para 7-10g.
Power requirements	265 ma at +28 V dc.

7-12. Maintenance Data

a. Performance Test and Trouble Analysis Procedures (Genera4. The following paragraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect the test equipment and test cable to the module as shown in figure 7-8.

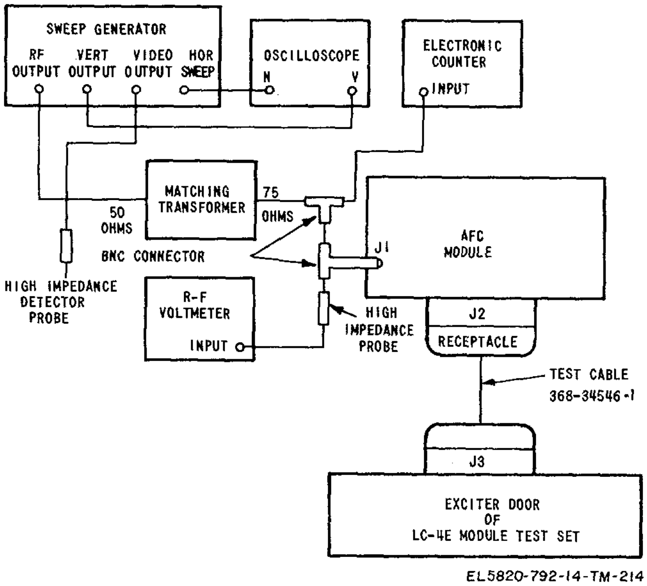


Figure 7-8. AFC module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove the top and bottom covers from the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the +28-volt power supply in the test set for 28 ± 0.5 V dc.

d. Test Procedures. After completing procedures in b and c above, perform the procedures provided in e below. Figures 6-11 and FO-6 contain parts location data.

e. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Sensitivity		
1	Connect RF voltmeter across sweep generator output.			
2	Set AFC ON-OFF switch to ON.			
3	Set frequency of sweep generator to 70+0.003 MHz (CW) using frequency counter, and adjust attenuator for an indicator of 20 mv on RF voltmeter.			
4	Connect a dc voltmeter to terminals 14 and 15 of J2 of the AFC module.	0 ± 0.2 V	Proceed to step 5	Proceed to step 7.
5	Set frequency of sweep generator to 70.064+0.002 MHz using frequency counter, and adjust for an indication of 20 mv on RF voltmeter. Observe reading on dc voltmeter.	>1.0 V	Proceed to step 6	Adjust R1 counterclockwise until 1 volt is obtained. If 1 volt is not obtainable, proceed to step 7.
6	Set frequency of sweep generator to 69.946+0.002 MHz using frequency counter, and adjust attenuator for an indication of 20 mv on RF voltmeter. Observe reading on dc voltmeter.	< 1.0 V	Test is complete. Disconnect all test equipment and replace module cover.	Proceed to step 7.
7	Connect frequency counter to test point TP2 and test point TPG (ground).	9 ± 0.025 kHz	Proceed to step 8	Perform square wave generator frequency adjustment procedure under para 7-13f. If normal indication is not obtained with adjustment, check Q1, Q2, and Q3 and associated components.
8	Connect frequency counter to junction of C14 and C26 through a 10 pf coupling capacitor.	70 ± 0.0005 MHz	Proceed to step 11	Perform reference oscillator alignment procedure under para 7-13e. If normal indication is not obtained with adjustment, proceed to step 9.
9	Connect RF voltmeter (high-impedance probe) to emitter of Q4.	2 ± 0.5 V rms	Proceed to step 10	Check Q4 and associated corm-ponents.
10	Connect RF voltmeter to base of Q6	0.4 ± 0.1 V rms	Proceed to step 11	Check Q5, C14, and associated components.
11	Connect RF voltmeter across output of sweep generator.			
12	Using frequency counter, set frequency of sweep generator to 70+0.002 MHz (CW) and adjust attenuator for an indication of 20 mv on RF voltmeter.			
13	Observe waveform at test point TP4 on oscilloscope.	fig. FO-15)	Proceed to step 16	Adjust variable resistor R4 for normal indication. If normal indication is not obtained with adjustment, proceed to step 14.
14	Connect RF voltmeter to collector of Q7	0.56 ± 0.1 V rms	Proceed to step 15	Check Q7 and associated components.
15	Connect RF voltmeter to emitter of Q6	0.56 ± 0.1 V rms	Proceed to step 16	Check Q6 and associated components.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal	
16	Connect RF voltmeter to junction of CR5 and C21.	0.3 ± 0.1 V rms	Proceed to step 17	Check CR4, CR5, CR6, C20, R23, and R24.	tn
17	Connect RF voltmeter to junction of CR8 and C22.	0.4 ± 0.1 V rms	Proceed to step 18	Check CR7, CR8, CR9, C23, R27, and R25.	
18	Connect RF voltmeter to emitter of 10	0.3 ± 0.1 V rms	Proceed to step 19	Check associated components.	Q8 v
19	Remove sweep generator from input connector J1, and connect oscilloscope to test point TP3.	(fig. FO-15)	Proceed to step 26	Perform discriminator balance adjustment procedure under para 7-13d. If normal indication is not obtained with adjustment, proceed to step 20.	
20	Connect RF voltmeter to junction of C38, R43, and R44.	2.5 + 0.5 V rms	Proceed to step 21	Check Q10 and associated components.	4o
21	Connect RF voltmeter to junction of L9 and C39, adjust potentiometer R1 for straight line balance on oscilloscope, then read RF voltmeter.	(fig. FO-15) 1 ± 0.1 Vrms	Proceed to step 22	Check 1,9, R43, R3, C59, CR14, and C39.	
22	Connect RF voltmeter to junction L10 and C40, adjust potentiometer R1 for straight line balance on oscilloscope, then read RF voltmeter.	(fig. FO-15) 0.6 ± 0.1 Vrms	Proceed to step 26	Check 1,10, R44, C61, C40, and CR15.	
23	Disconnect test equipment from J1.				
24	Connect the oscilloscope between test points TP3 and TP6 (gnd).				
25	Adjust potentiometer R1 for straight line balance on oscilloscope.	Peak-to-peak voltage less than 0.005 V			
26	Connect RF voltmeter across output of sweep generator.	(fig. FO-15)			
27	On sweep generator, set sweep width for 30 MHz centered at 70 MHz, and adjust attenuator for an indication of 20 mv on RF voltmeter.				
28	Observe waveform on oscilloscope at TP2	(fig. FO-15)	Waveform may be inverted. Proceed to step 30.	Adjust L9, C39, L10, and C40 for normal indication.	
29	Set frequency of sweep generator to 72+0.5 MHz and adjust the output level for 20 mv.				
30	Connect oscilloscope to test point TP2	20 + 2 V peak-to peak	Proceed to step 31	Proceed to step 38.	
31	Connect oscilloscope to pin 1 of transformer T5.	24 + 2 V peak-to-peak	Proceed to step 32	Check cable from square wave generator to pin 3 of transformer T5.	
32	Disconnect AFC module from extender and connect ohmmeter to terminals 14 and 15 of J2.				
33	Adjust variable resistor R2 over entire range.	Resistance changes from 1 to 5k Ω	Proceed to step 35	Check CR16, CR17, and R2.	
34	Reconnect AFC module to extender.				
35	Disconnect sweep generator from input connector J1, and connect oscilloscope to base of Q12. Adjust potentiometer R3 for a 0.005 volt peak-to-peak waveform as observed on the oscilloscope.	0.005 ± 0.001 V peak-to-peak	Proceed to step 36	Check C45, Q11, and associated components.	
36	Connect oscilloscope to base of Q13	0.03 ± 0.05 V peak-to-peak	Proceed to step 37	Check Q12, Fl,1, and associated components.	

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
37	Connect oscilloscope to base of Q14	0.26 ± 0.05 V peak-to-peak	Proceed to step 38	Check Q13 and associated components.
38	Connect oscilloscope to base of Q15	3 ± 0.5 V peak-to-peak	Proceed to step 39	Check Q14, Q15 and associated components.
39	Connect oscilloscope to TP3 and adjust R3 for normal waveform.	(fig. FO-15)	Test completed. Disconnect all test leads from the module.	

f. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in *g* below, in conjunction with standard troubleshooting techniques, should enable location and correlation of the fault. Resistance measurements are made with the module disconnected from the external components using the multifunction meter. All voltages are measured using the test setup of b above. The multifunction meter is also used to measure dc voltages. For ac voltage measurements, use the oscilloscope, unless otherwise directed to use the RF voltmeter.

CAUTION

Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if this voltage exceeds 1.5 volt. Also, since the R x 1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more) may damage the transistor under test. As a general rule, it is not recommended that the R x 1 range of any ohmmeter be used when testing low-power transistors.

g. Voltage and Resistance Data.

Point of measurement		Ac voltage Dc voltage (nominal)	(nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unless otherwise specified
Q1	Base	0.45 V	0.4 V	950 ohms
	Emitter	0 V	0 V	O ohms
	Collector	13.0 V	28.0 V	2.0 k Ω
Q2	Base	0.45 V	0.4 V	950 ohms
	Emitter	0 V	0 V	0 ohms
	Collector	13.0 V	28.0 V	1.5 k Ω
Q3	Base	12.5 V	27 V	1.55 k Ω.
	Emitter	12.0 V	26 V	1.15 k Ω
	Collector	27.0 V	1.0 V	1.0 k Ω
Q4	Base	7.5 V	0.800 V rms	1.2 k Ω
	Emitter	7.0 V	1.0 V rms	700 ohms
	Collector	27.5 V	3.0 V rms	1.0 k Ω
Q5	Base	6.8 V	0.090 V rms	1.2 k Ω
	Emitter	6.2 V	1.0 V rms	700 ohms
	Collector	27.5 V	0.73 V rms	1.0 k Ω
Q6	Base	4.6 V	0.750 V rms	900 ohms
	Emitter	4.0 V	0.800 V rms	550 ohms
	Collector	18.0 V	0.300 V rms	2.2 k Ω
Q7	Base	4.5 V	0.100 V rms	1.0 k Ω
	Emitter	4.0 V	0.20 Vrms	600 ohms
	Collector	16.5 V	1.20 V rms	2.8 k Ω
Q8	Base	14.0 V	0.400 V rms	2.1 k Ω
	Emitter	13.5 V	0.400 V rms	2.7 k Ω
	Collector	28.0 V	0.400 V rms	1.0 k Ω
Q9	Base	14.0 V	0.010 V rms	2.0 k Ω
	Emitter	13.5 V	0.140 V rms	3.0 k Ω
	Collector	28.0 V	0.040 V rms	1.0 k Ω
Q10	Base	16.0 V	0.050 V rms	2.0 K Ω
	Emitter	15.5 V	0.220 V rms	1.9 k Ω
	Collector	28.0 V	3.0 V rms	1.0 k Ω
Q11	Base	12.5 V	0.005 V	1.5 k Ω
	Emitter	12.0 V	0.005 V	1.0 k Ω
	Collector	28.0 V	0.005 V	1.0 k Ω
Q12	Base	10.5 V	0.005 V	1.5 k Ω
	Emitter	10.0 V	0.005 V	800 ohms
	Collector	13.5 V	0.100 V	2.2 k Ω
Q13	Base	11.5 V	0.030 V	2.5 k Ω
	Emitter	11.0 V	0.30 V	2.8 k Ω
	Collector	22.0 V	0.28 V	2.6 k Ω
Q14	Base	4.5 V	0.2 V	1.3 k Ω
	Emitter	4.0 V	,0.26 V	480 ohms
	Collector	15.0 V	3.0 V	2.6 k Ω

Point of measurement		Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unless otherwise specified
Q15	Base	14.5 V	3.0 V	1.4 k Ω
	Emitter	14.0 V	3.0 V	600 ohms
	Collector	27.5 V	0.005 V	1.0 k Ω
TP1		0V	0 V	Infinity
TP2		0V	20.0 V	45 ohms
TP3		0V	0 V	1.4 k Ω
TP4		0V	0 V	Infinity
TP5		0V	24.0 V	45 ohms
TP6		0V	0 V	0 ohms
Power Connector (DA 15P):				
Pin 1		28.0 V	O V	950 ohms
Pin 5		0 V	0 V	O ohms
Pin 6		0 V	0 V	O ohms
Pin 11		0 V	0 V	Infinity
Pin 14		0 V	0 V	Infinity
Pin 15		0 V	V	Infinity

7-13. Alignment Data

a. General. The following procedures should be performed as a part of scheduled maintenance and after repairs have been made to the module.

NOTE

The AFC module contains many tuned circuits which must be carefully aligned to obtain optimum module performance. The arrangement of the procedures in this section is based on a requirement for a complete realignment.

b. Test Equipment Setup. The test equipment setup used for the alignment and adjustment procedures is the same as that described in paragraph 7-12 b.

c. Preliminary Adjustments. When the test setup is completed, perform the preliminary adjustments listed in paragraph 7-12c.

d. Discriminator Alignment. The alignment of the discriminator consists of tuning the resonant circuits to produce zero output voltage when the input frequency is 70 MHz. This routine involves a soldering operation which must be followed by an inspection for loose bits of solder and cold-solder connections.

NOTE

Perform steps (1) through (4) below before connecting the module to the power source.

(1) Disconnect resistor R7 from the junction of capacitor C3, and wire lead from J1.

(2) Disconnect resistor R15 from the junction of capacitor C8, and capacitor C71 from junction with resistor R19.

(3) Temporarily connect a 4.7K resistor between the junction of diodes CR4, CR5, and CR6 and the free end of resistor R17. This places +28 volts on the diode junctions. Then connect an 820 pf capacitor from J1 to the junction of R19 and Q7 base.

NOTE

Resistor R17 is connected between transistor Q7 and a standoff terminal on the chassis. For this test, the free end of R17 is considered to be that end which is connected to the standoff terminal.

(4) Replace the top cover of the AFC module.

(5) Connect the module and test equipment as shown in figure 7-8; disconnect the frequency counter and dc voltmeter.

(6) Set the CW frequency of the sweep generator to 70 M Hz at a level of 100 mv.

(7) Connect the vertical input lead of the oscilloscope to the vertical output of the sweep generator.

(8) Adjust the oscilloscope controls, as necessary, to observe the waveform.

(9) Set the marker switches on the sweep generator to the ON position. Adjust the sweep controls of the sweep generator for a sweep of 30 MHz centered at 70 MHz.

(10) Adjust the marker controls to intensify the markers on the oscilloscope display.

(11) Adjust the vertical and horizontal positioning controls of the oscilloscope to place the 70-MHz marker at the approximate center of the screen.

(12) Adjust capacitors C36, C39, and C40 and inductors L9 and L10 and potentiometer R3, to produce a linear discriminator waveform on the oscilloscope display.

(13) Compare the discriminator response curve with that shown in figure 7-9. The curve should be symmetrical and centered at 70 MHz. The positive and negative peaks should be located at 60 and 80 MHz, respectively.

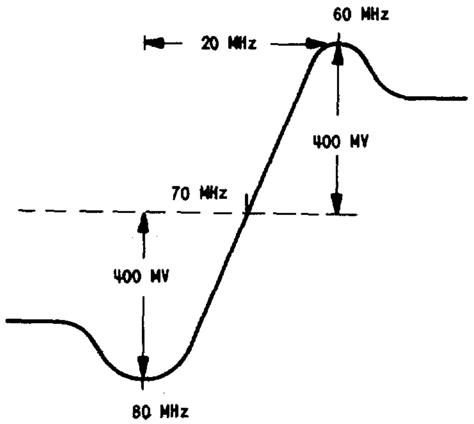


Figure 7-9. AFC module, discriminator characteristic curve.

(14) Measure the amplitude of the waveform peaks. These peaks should have an amplitude of 400 millivolts on either side of the zero-crossing point (70-MHz marker pip).

(15) If the discriminator output signal fails to satisfy the specifications, repeat steps (12) through (14) above until the specifications are met.

(16) Disconnect all test equipment.

(17) Remove the top cover of the AFC module.

(18) Remove the 4.7K resistor and the 820 pf capacitor installed in step (3) above.

(19) Reconnect resistor R15 to its respective standoff terminal and capacitor C71 to resistor R19; refer to step (2) above. If the reference oscillator is to be aligned, do not reconnect resistor R7, but proceed to step (2) of e below; otherwise reconnect R7 and replace the module covers.

(20) Reconnect wire lead to J1; refer to step (1).

e. Reference Oscillator Alignment. The alignment of the reference oscillator consists of tuning the oscillator to the proper frequency and obtaining the correct output amplitude. This routine involves a soldering operation which must be followed by an inspection for loose bits of solder and cold-solder connections.

(1) Disconnect resistor R7 from junction of capacitor C3.

(2) Connect a 10 pf capacitor to the junction of resistor R31 and capacitor C23.

(3) Connect the remaining end of the 10 pf capacitor to the input of a frequency counter.

(4) Connect the common terminal of the frequency counter to chassis ground.

(5) Connect the high-impedance probe of an RF-Voltmeter to the junction of resistor R31 and capacitor C23. Set the meter controls to measure 650 millivolts.

(6) Connect the module to the test set as shown in figure 7-8.

(7) Adjust capacitor C13 for a maximum voltage indication, as read on the RF voltmeter.

(8) Adjust inductor T1 and capacitor C9 for a maximum voltage indication, as read on the RF voltmeter. The required output voltage of the reference oscillator circuit, as measured at the junction of R31 and C23, is 650 millivolts.

NOTE

Occasionally a tuning slug is provided with inductor T1.

(9) Observe the frequency counter indication. The required frequency measured at the junction of R31 and C23 is 70 MHz + 500 Hz.

(10) If the output frequency does not meet the specification, readjust induction T1 capacitor C9 slightly to meet the frequency requirement. (The output amplitude is of secondary importance.)

(11) Disconnect all test equipment, including the 10 pf capacitor connected to the junction of R31 and C23.

f. Square Wave Generator Output Frequency. This alignment procedure is used primarily to establish the output frequency of the square wave generator.

(1) Set the sensitivity controls of an electronic counter to 10 volts.

(2) Connect a cable between test points TP5 and TP6, and the AC connector of the electronic counter.

(3) Adjust potentiometer R5 until the electronic counter indicates 9 kHz ± 20 Hz.

(4) Connect an oscilloscope between test points TP5 and TP6 (ground) of the AFC module.

(5) Check the peak-to-peak amplitude of the 9-kHz switching signal. Minimum amplitude should be 24 volts.

(6) Disconnect all test equipment and replace module covers.

g. Switch Circuit Balance. This alignment procedure is used to equalize the amplitude of the switching pulses at the output of the switching circuits.

(1) Connect a coaxial T-connector to input connector J1 of the AFC module.

(2) Connect the output terminals of a VHF oscillator to one of the terminals of the coaxial T-connector. Set the oscillator output control for minimum output.

(3) Connect a frequency counter to the remaining terminal of the T-connector.

(4) Adjust the frequency control of the VHF oscillator until the frequency counter indicates 70 MHz.

(5) Disconnect the frequency counter from the coaxial T-connector.

(6) Connect an RF voltmeter to the remaining terminal of the coaxial T-connector. Set the meter controls to measure 20 millivolts.

(7) Set the output signal level of the VHF oscillator to 20 millivolts.

(8) Connect a lead between the external sync terminals of an oscilloscope and test point TP5 of the AFC module.

(9) Connect the vertical input terminal of the oscilloscope to TP4 and ground to TP6 (ground) of the AFC module.

(10) Adjust switch balance potentiometer R4 until the oscilloscope display forms a single continuous line.

(11) Disconnect all test equipment.

h. Discriminator Balance. This alignment procedure is used to equalize the amplitudes of the switching pulses at the output of the discriminator. No input signals from an external source are required in this procedure.

(1) Set the vertical gain controls of the oscilloscope to provide 50 millivolts dc, per division with the probe grounded. Adjust the trace to coincide with the centerline of the graticule.

(2) Connect the common lead of the oscilloscope to test point TP6 on the AFC module.

(3) Connect the remaining oscilloscope probe to test point TP3.

(4) Connect a lead between test point TP5 of the AFC module and the external sync terminals of the oscilloscope.

(5) Adjust discriminator balance potentiometer R3 until the oscilloscope trace forms a single line that is both straight and unbroken.

(6) Disconnect all test equipment.

i. Phase Detector Zero Adjustment. This alignment procedure is used to adjust the output of the phase detector circuit to 0 volt when the detector input is 70 MHz.

(1) Connect a VHF oscillator to the input of the frequency counter.

(2) Adjust the frequency controls of the VHF oscillator until the frequency counter indicates 70 MHz + kHz. Disconnect the equipment.

(3) Connect the VHF oscillator to input connector J1 of the AFC module. Set the output amplitude to 20 millivolts, using an RF voltmeter to indicate the level.

(4) Connect the dc voltmeter to pin 14 and 15 or to pin 6 and 11 as applicable.

(5) Connect the module to the test set as shown in figure 7-8.

(6) Adjust zero adjust potentiometer R1 of the phase detector circuit to produce a zero indication on the voltmeter.

(7) Set the voltmeter range switch to progressively more sensitive voltage scales, and readjust potentiometer R2, as necessary, to obtain a zero indication.

(8) Disconnect all test equipment.

Section IV. BASEBAND COMBINER MODULE (398-12040-2 AND -3 AND 398-12069-1, -2, AND -3)

7-14. Introduction

a. The baseband combiner module is a module belonging to the microwave receiver. In frequency-modulated dual (or quad) diversity systems, the baseband information from the receivers is the same (coherent) while the noise output is noncoherent and its magnitude varies as a function of the received RF level. The output signals resulting from -the demodulation of the two (or four) receiver channels are essentially constant and equal in magnitude. The noise output of these channels may be used as a measure of the signal-to-noise ratio of each diversity receiver. The noise products of each receiver channel can be used to control the relative baseband contribution of each receiver channel to the combined output signal.

b. The combiner circuitry uses redundant elements in all circuits common to the received signal paths. When equal signal levels are present in each radio receiver, their paralleled outputs are combined for an improvement in the signal-to-noise ratio greater than 2.5 db. The signal-to- noise ratio of the combiner output is no worse than the signal-to-noise ratio of the better of the input signals. The output of either receiver is muted when the continuity pilot tone is lost or when the per channel noise exceeds a selectable level resulting in a signal-to-noise ratio in the range from 25 to 40 db. However, a failure of the incoming continuity pilot in all the associated receivers while the noise level is not excessive does not cause the combiner to mute or otherwise affect its combining operation. There is no baseband signal interruption due to fading in one signal path or to manual selection of one receiver output for maintenance purposes.

7-15. Module Configurations

a. The dual-configuration baseband combiner module (398-12040) consists of a single printed-wiring card (A2) mounted in a metal module chassis (Al). All components, with the exception of controls, test jacks, and connectors, are mounted on the printed-wiring card. The latter components are mounted on the front flange of the metal chassis.

b. The quad-configuration baseband combiner module (398-12069) printed-wiring card is similar to the card used in the dual configuration. Four printed-wiring cards are placed in a single shielded enclosure. Each individual printed-wiring card includes a front angle on which the controls, test jacks, and connectors are mounted; all other components are mounted directly on the printed-wiring card.

c. Differences between various baseband combiner modules are determined by the channel capacity, and the pilot frequency which determine the roofing filter components used and the combiner circuit configuration.

d. Module configuration data.

Module part number	Configuration	Channel capacity	Maximum pilot frequency (MHz)
398-12040-2	Dual	24-180	3.2
398-12040-3	Dual	24-180	1.499
398-12069-1	Quad	240-600	8.5
398-12069-2	Quad	24-180	3.2
398-12069-3	Quad	24-180	1.499

7-16. Functional Description

a. As shown in figure 7-10, the baseband combiner module accepts baseband input signals direct from the demodulator of its associated receiver. The baseband signals pass through a roofing filter to attenuate noise above the information band. The filtered signal is then applied to two independent paths; one path is sent out of the combiner to the noise amplifier module, and the remaining path is sent into the baseband combiner stage.

b. The baseband combiner stage controls the combining action of its associated receiver. Since the bias voltage is a variable control voltage, the stage gain varies directly with the applied control voltage. Under conditions of excessive noise, combiner stage gain is reduced to near zero levels.

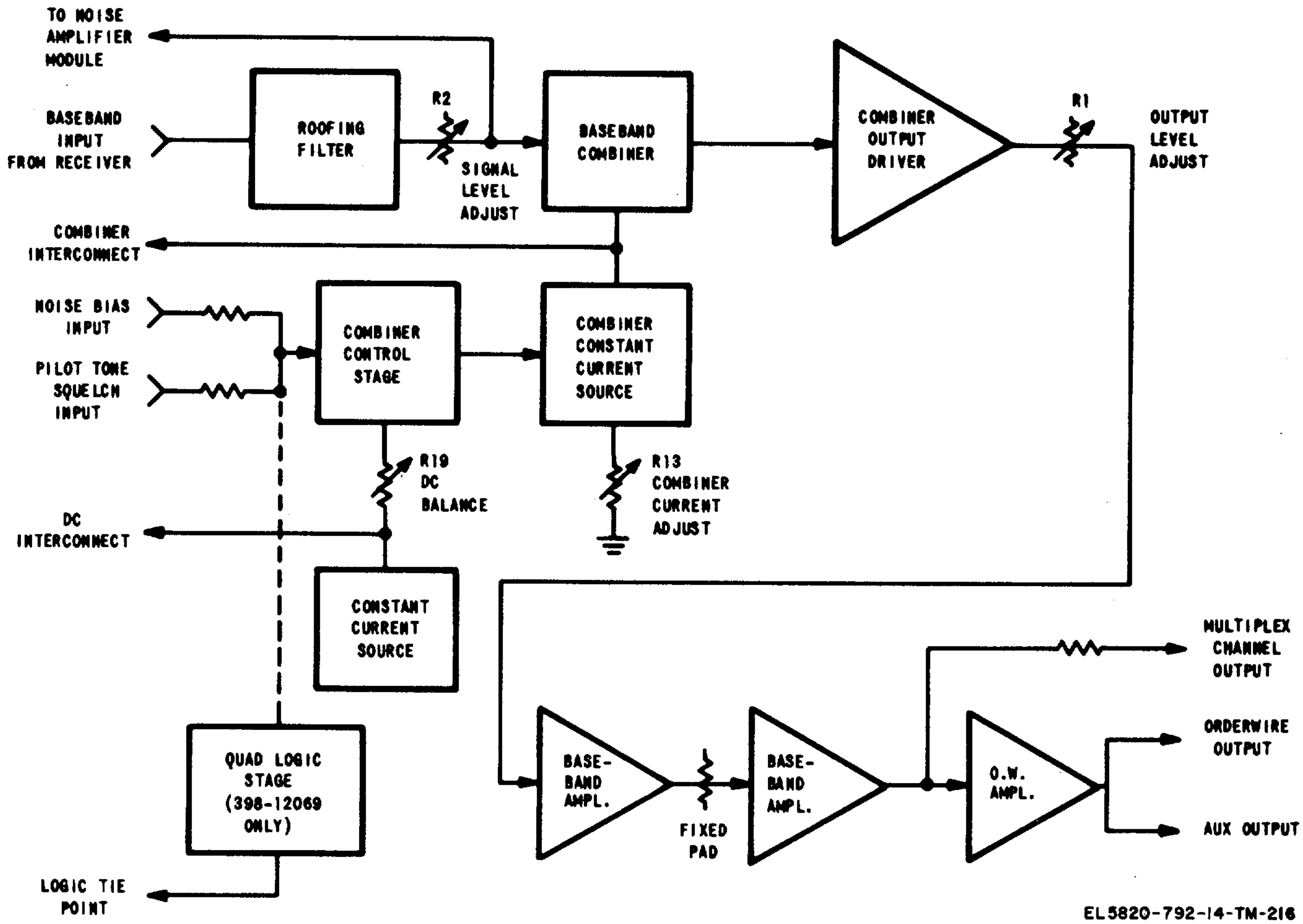


Figure 7-10. Baseband combiner module, functional block diagram.

c. The output signal of the baseband combiner stage is connected to the combiner output driver stage. The baseband output level is adjusted and applied to two 3-stage amplifiers in cascade. The baseband signal is applied to two paths. One path is sent out of the combiner module via J3 and eventually becomes the multiplex output line. The second path is applied to an additional stage to derive two additional output lines that eventually become the orderwire line and the auxiliary output or baseband pilot-tone output lines.

d. A low or absent signal at the input to the receiver produces excessive noise in that particular receiver channel. Since excessive noise degrades system quality if propagated through the system, a muting feature is incorporated to remove the baseband signal from the input to the baseband combiner stage. The detection of excessive noise levels is accomplished in the noise amplifier module associated with the individual receiver channel; if the noise level in a particular receiver channel increases beyond an arbitrary threshold, diode CR10 is switched on and CR11 is switched off to remove the baseband signal from the in- put to the baseband combiner stage. When the excess noise condition is corrected diode CR10 switches off i and the combiner is restored to normal operation as diode CR11 is switched back on.

e. The noise bias input from the noise amplifier is applied to the combiner control stage; pilot-tone squelch voltage from the pilot-tone detector module is also applied to the combiner control stage. The noise bias controls the operating point of the combiner in accordance with the instantaneous noise level. The pilot-tone squelch overrides the noise amplifier bias and squelches the combiner upon the loss of pilot tone.

f. To ensure uninterrupted system operation, the operating power for the baseband combiner module is provided by two positive and two negative power supplies which are connected to the module through steering diodes mounted directly on each baseband combiner printed-wiring card. If one of the positive or the negative power supplies should fail, the defective power supply is automatically isolated from its companion power supply through the action of the steering diodes; the remaining power supply will continue to provide operating power for the module circuits.

7-17. Circuit Analysis

a. The schematic diagram for both dual and quad combiners is shown in figure FO-16. The baseband signal output of the demodulator for each diversity channel is sent into its roofing filter via connector J6. The roofing filter is a lowpass network consisting of L7, L8, and C45 through C47, used to attenuate the noise above the in- formation band. Component values for the roofing filter change with channel capacity of the communication system; these filter component values are shown in the chart on the schematic diagram.

b. Potentiometer R2 compensates for variations in demodulator sensitivity into the combiner stage and into the associated noise amplifier module via connector J5.

c. Transistor Q3 is a constant current source which supplies emitter current to the differential amplifier. Recall the fact that the schematic circuit shown in figure FO-16 must work in conjunction with a companion combiner circuit which has the same schematic as that shown in figure FO-16; otherwise, combiner action does not occur. 'On this basis, observe that constant current generator Q3 has a combiner interconnect leaving the combiner card at coaxial connector J4 that is routed into connector J4 of the companion combiner card. This interconnect serves two purposes. First, it places the constant current source (Q3) on each combiner board in parallel for greater reliability through redundancy. Second, it interconnects the emitter circuits of transistor Q1 on each combiner board to form a differential amplifier.

d. The basic combining operation is performed by the differential amplifier comprised of Q1 on each card. These stages have their emitters connected to a common output line via diode CR1 in each emitter current. If the base of Q1 in the left channel becomes more negative than the base of Q1 in the right channel, then emitter current of right channel's Q1 decreases while the emitter current of Q1 in the left channel increases by a corresponding amount. Under these circumstances, less of the available right channel baseband signal present at Q1 base is gated through to the output of the corresponding side of the differential amplifier. On the other hand, a corresponding increase of the available left baseband signal present at companion Q1 base, is gated through to the output of that side of the differential amplifier. The decrease in, right channel baseband is exactly compensated by the corresponding increase in the left channel baseband at the output of the differential amplifier. The result is that the output level of the differential amplifier remains constant, but the ratio of one channel to the other channel contribution in the output level changes continuously. This same explanation holds when the bias levels of the differential amplifier are reversed. Another point to be made is that the same argument is valid for the combiner differential amplifier circuit regardless of the number of paralleled stages used.

e. The method of changing and controlling the ratios of the baseband in the combined output will now be discussed. Transistor Q5 is a constant current source, used in dual baseband combiner applications only, supplying emitter current to the combiner stages; refer to figure 6-27. Observe that transistor Q5 has a dc interconnect line leaving the combiner card at printed circuit connector A2J1-16 that is routed into connector A2J1-16 of its companion combiner card. The interconnect line, therefore, places two Q5 stages in parallel to form a complete constant current source. The purpose of the constant current source is to supply the total emitter current to the combiner control stage Q4, which is part of a differential amplifier.

f. The noise amplifier output voltage which provides the combiner control voltage, is positive. An increase in noise level causes the control voltage to become more positive. Suppose that right channel noise level increases, with no in- crease in the other channel noise level. Emitter current through Q4 of the right channel increases while emitter current through Q4 to the left channel decreases by a corresponding amount. The collector voltage for transistor Q4 in the right channel is now more negative while its companion Q4 in the left channel is now more positive. The reverse situation merely interchanges the balancing conditions of the combiner control stage.

g. It is interesting to note two operational facets of the combiner. First, the amplitude of the combiner output signal in each emitter of the combiner differential amplifier Q1, has no relationship to the amplitude of -the baseband signal present at each of -the Q1 bases once a minimum threshold level is reached. The output level of the combiner differential amplifier Q1, is dependent upon the instantaneous balance of the combiner control differential amplifier Q4, which is in turn, dependent upon instantaneous noise levels in each diversity channel. Hence, the combiner output level is inversely proportional to the instantaneous noise level. The second point is that while one channel's noise level has been permitted to vary for purposes of explanation, it is nevertheless true that by differential amplifier action, the noise level may be varying simultaneously in all channels. As the noise bias is increased in one channel, it is reduced by the corresponding amount in the remaining channels. Thus, the combiner changes the ratio of the baseband signals, such that the baseband signal containing the least noise is increased while the noisy baseband signal is suppressed, even though the overall output signal amplitude remains constant.

h. On those occasions when the continuity pilot tone is lost, a squelch bias is applied from an associated pilot-tone detector module, across resistor R20, to the base of transistor Q4. The squelch bias of +28 volts drives transistor Q4 into saturation to drive the combiner state Q1 into cutoff. Thus the defective diversity channel is squelched. The combiner output then consists of baseband signals obtained from the remaining unaffected diversity channel(s). If the pilot-tone signal is simultaneously lost in both diversity receivers, then a squelch bias of +28 volts is applied to each combined board through printed circuit connector A2J1-20. The combiner control differential amplifier, having 28 volts applied to its base inputs, is balanced with respect to the pilot tone; in this case, neither baseband channel is squelched out. The combiner control differential amplifier, now in a balanced condition as far as pilot-tone squelch bias is concerned, continues to respond to the noise amplifier control signal as previously explained.

i. Certain occasions may arise where one of the baseband combiner modules must be removed from service. When this is done, the differential amplifier interconnects are broken. Looking at the combiner control stage Q4, its emitter current is determined by transistor Q5. At the same time, Q1 emitter current is determined by transistor Q3. The bias applied to the combiner stage, Q1, therefore, is unchanged. Since Q1's dc operating point is unchanged, then the baseband output level from Q1 remains the same as before the module was removed. The incoming noise amplifier bias, applied to the base of Q4, has little effect on the combiner stage, Q1, so that the baseband output signal depends only on the baseband input signal. This should be intuitive, since it would be undesirable to reduce baseband output to near zero without being able to compensate with the other baseband combiner module.

j. In quad combiner applications, figure 7-11 is applicable. Zener diode CR7 and the resistive circuit R22, R23, and R24 forms a constant voltage source associated with transistor Q4. Transistor Q4 on each of the four baseband combiner boards form an inverting dc amplifier used to control the combiner stage. Notice that the dc interconnect at printed circuit connector A2J1-16 is not connected externally between baseband combiner cards. Therefore, removal of combiner cards does not affect the emitter current of transistor Q4.

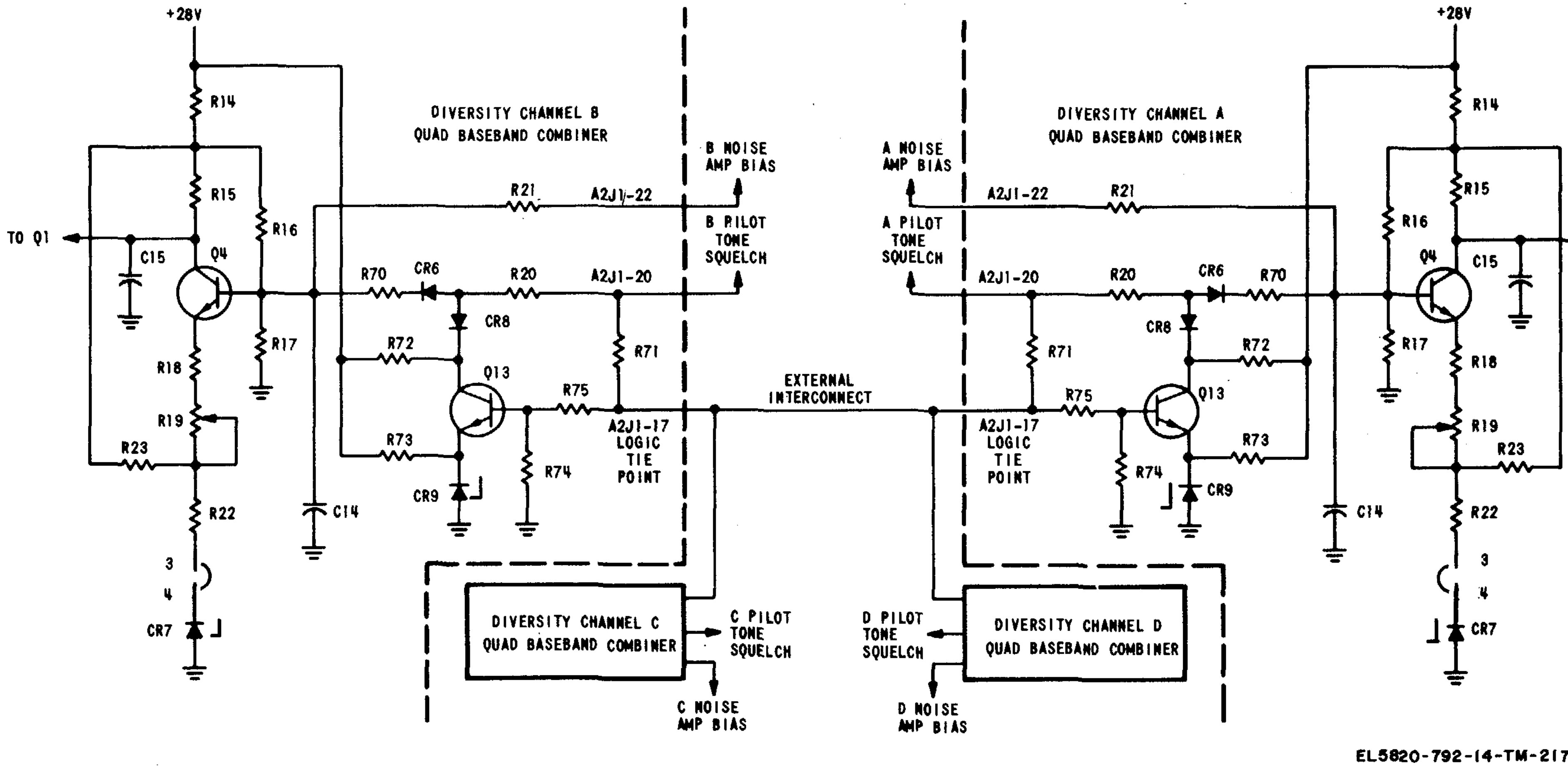


Figure 7-11. Quad baseband combiner, interconnection of control stages.

k. The logic tie point at printed circuit connector A2J1-17 interconnects the bases of all the Q13 logic stages on each baseband combiner card. Printed-circuit connector A2J1-20 connects the pilot-tone squelch voltage from each receiver dual pilot-tone detector module. The emitter circuit of the logic stage contains Zener diode CR9 and resistor R73 returned to the +28volt line; holding the emitter of Q13 at 6.2 Vc. The normal variation in noise amplifier bias output ranges between +7 and +18V dc. The base bias of logic stage Q13 is derived from the squelch bias line through resistors R71, R74, and R75. When pilot-tone is present in the receiver, the applied Q13 bias is zero, therefore, Q13 is at cutoff. Lack of collector current through resistor R72 causes Q13 collector voltage to become approximately 28 volts, which then reverse biases diode CR8. As far as the incoming noise amplifier bias signal is concerned, diode CR6 is also reverse biased so that noise amplifier bias is routed directly into the combiner control stage only. When pilot-tone is lost in one receiver, squelch voltage is present at A2J1-20. Squelch voltage applied across the bias network R71, R75, and R74 is insufficient to pull the logic stage Q13, out of cutoff. Hence, diode CR8 remains reverse biased while diode CR6 is forward biased. The squelch voltage is applied to the combiner control stage Q4. The final result, for loss of pilot-tone in a single receiver channel, is that squelch voltage is applied to the combiner control stage Q4 which cuts off the associated combiner stage Q1 to squelch receiver output for that channel only. As more channels are squelched, transistor Q13 becomes biased into the conduction region but normal operation is retained. If pilot-tone is lost simultaneously in all receiver channels, sufficient bias is developed across network R71, R75, and R74 to place logic circuit Q13 into saturation. The collector of the logic stage becomes more negative and diode CR8 on each combiner board is forward biased into conduction. The junction of CR6 and CR8 drops below 7.0 volts on each baseband combiner card. Recall that the noise amplifier bias applied to A2J1-22 never drops below 7.0 volts, so that diode CR6 is reverse biased. The pilot tone squelch is now effectively canceled out so that Q4 reacts to the noise input signal to printed-circuit connector A2J1-22 just as though the squelch voltage were not present. Thus, loss of baseband output signal is not permitted with complete loss of pilot-tone signals in all receiver channels.

l. The output of the combiner stage is passed through an output driver which is an emitter follower stage (Q2) with feedback through capacitors C17 and C18. The output level of the combiner stage is adjusted by means of potentiometer R1 to drive the baseband combiner to the desired output level.

m. The emitter follower is followed by a three-stage feedback amplifier consisting of transistors Q6, Q7, and Q8. The amplifier employs feedback from the emitter of Q8 to the emitter of Q6, via the parallel combination of C25 and C26, and the resistor feedback network made up of R40 and R41. This method of feedback stabilizes the grain of the amplifier, increases the bandwidth, and improves the linearity, as well as reducing the amplifier output impedance at the emitter of Q8.

n. The baseband signal then passes through a second ultralinear, broadband, three-stage feedback amplifier, made up of transistors Q9, Q10, and Q11. The output line, which eventually is used for multiplex output, is taken direct from the amplifier triplet through coaxial connector J3. The baseband pilot output can be taken from this same line through coaxial connector J2. The triplet amplifier output signal is then passed through coaxial connector J2. The triplet amplifier output signal is then passed through a driver stage to derive two output signals. One line is the orderwire line. The other output line is generally used to drive a baseband pilot-tone detector, depending upon system requirements.

o. Inspection of the schematic diagram (fig. FO-16), shows that A2J1-15 and A2J1-4 are both labeled with auto-level adjust. Note that A2J1-4 is the dc supply line for the baseband combiner module. An external line is connected from A2J1-4 of one baseband combiner to A2J1-15 of a companion baseband combiner. When one of the combiner cards is removed from the combiner door, relay K2 deenergizes to connect resistors R57 and R58 in parallel. The output impedance of the multiplex line, for the operating combiner card is then automatically adjusted to maintain the proper output level.

p. Diodes CR10 and CR11 are part of a muting feature supplied in the overall terminal. The line entering the baseband combiner at A2J1-18 is interconnected with the excess noise alarm in the associated noise amplifier module. When excess noise is detected on a given diversity channel, the noise detector interrupts 28 volts de to muting diodes CR10 and CR11. The positive 28 volts dc which switches CR11 on and CR10 off is removed and a negative 6 volts dc is applied through resistor R76. Diode CR10 is switched on and resistor R4 is placed across the input of the combiner balance stage. This action disconnects the baseband signal from combiner stage Q1 and prevents the excess noise from being sent through the remainder of the combiner.

q. The two +28-volt supplies are connected together by diode rectifiers CR2 and CR3; the two -6-volt supplies are connected together by diode rectifiers CR4 and CR5. These rectifiers act as steering diodes to isolate a defective power supply from the module. This way, the module automatically receives its power from the remaining supply in the event of a power supply failure.

r. Technical characteristics are as follows:

Parameter	*Specifications*
Input impedance	75 ohms, unbalanced.
Out impedance:	
Multiplex	75 ohms, unbalanced.
Orderwire	75 ohms, unbalanced.
Auxiliary channel	75 ohms, unbalanced.
Input signal levels:	
Demodulated input	-20 dbm SCTT (200-kHz rms deviation).
Noise amplifier bias input.	+7 to +18 V dc, nominal.
Pilot-tone squelch input.	+28 V dc (loss of pilot) 0 V dc (pilot present).
Output levels: *	
Multiplex	-11 dbm SCTT.
Orderwire	-5.5 dbm SCTT.
Auxiliary channel	-17 dbm SCTT.
Frequency response:	
Multiplex	12 kHz to 2.6 MHz ±0.25 db.
Orderwire	200 Hz to 60 kHz ± 0.7 db.
Auxiliary channel	200 Hz to 60 kHz±0.7 db.
Power requirements	500 ma at +28 V dc; 15 ma at -6 V dc.

* based on 200 kHz rms deviation but are adjustable as per system requirements.

7-18. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The baseband combiner module presents two choices in test methods. One method is to test two or more interoperating baseband combiners to obtain functional operation on the test bench similar to that obtained in a fully operating terminal. The other method is to test a single card, on its own merits and without reference to companion cards, to isolate a malfunctioning stage on a particular card. The following paragraphs contain both types of procedures. Test for the single card are present in chart form, while tests for interoperating cards are given in procedural step forms.

b. Single Card Test Equipment Setup. Connect the test equipment to the module as shown in figure 6-28.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) If the dual combiner is to be tested, remove the top and bottom covers from the module. If the quad combiner is to be tested, there are no covers to remove.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the +28-volt power supply for 28 +0.5 V dc.

(4) Adjust the -6-volt power supply for -6 +-0.2 V dc.

d. Single Card Test Procedures. After completing the test equipment hookup and preliminary adjustments of *b* and *c* above, perform the test procedures of the following chart, using figures 7-12 and 6-29 (1) and (2) for parts location purposes. Voltages shown in the following performance test chart are permitted variations on the order of +10 percent.

e. Dual Combiner Test Equipment Setup. Connect the test equipment to the dual baseband combiner as shown in figure 7-13.

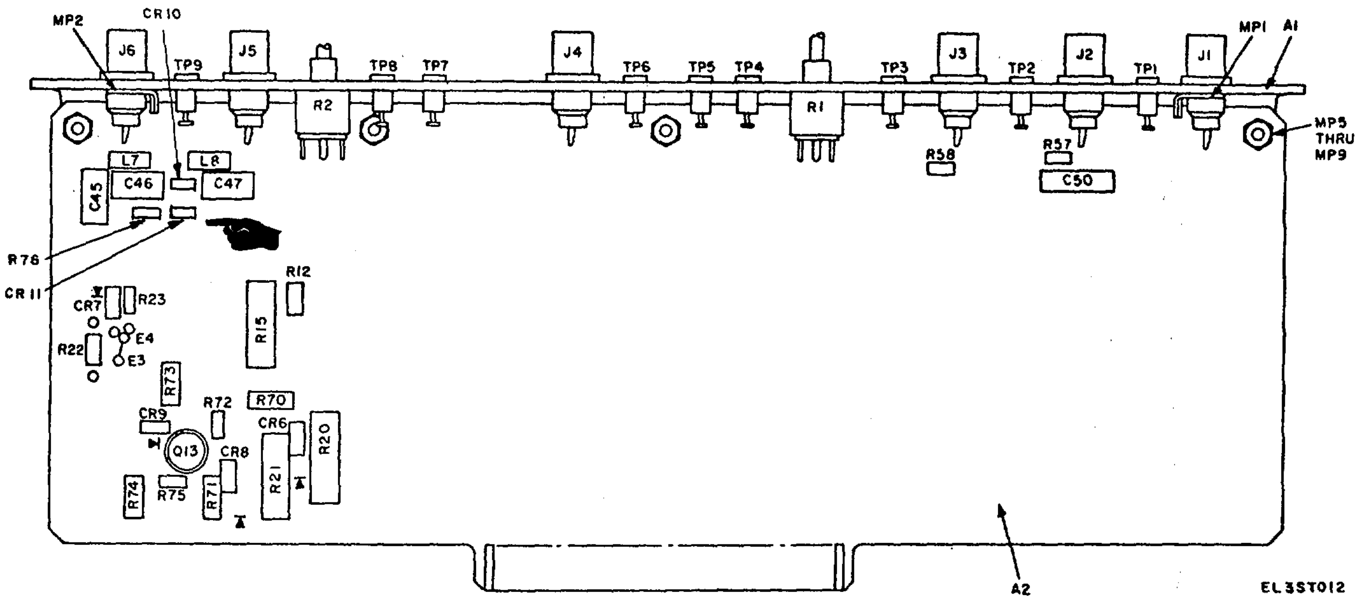


Figure 7-12. Dual baseband combiner assembly 368-12040-3 and -3 and quad combiner assembly 368-12069-1, -2, and -3, parts location

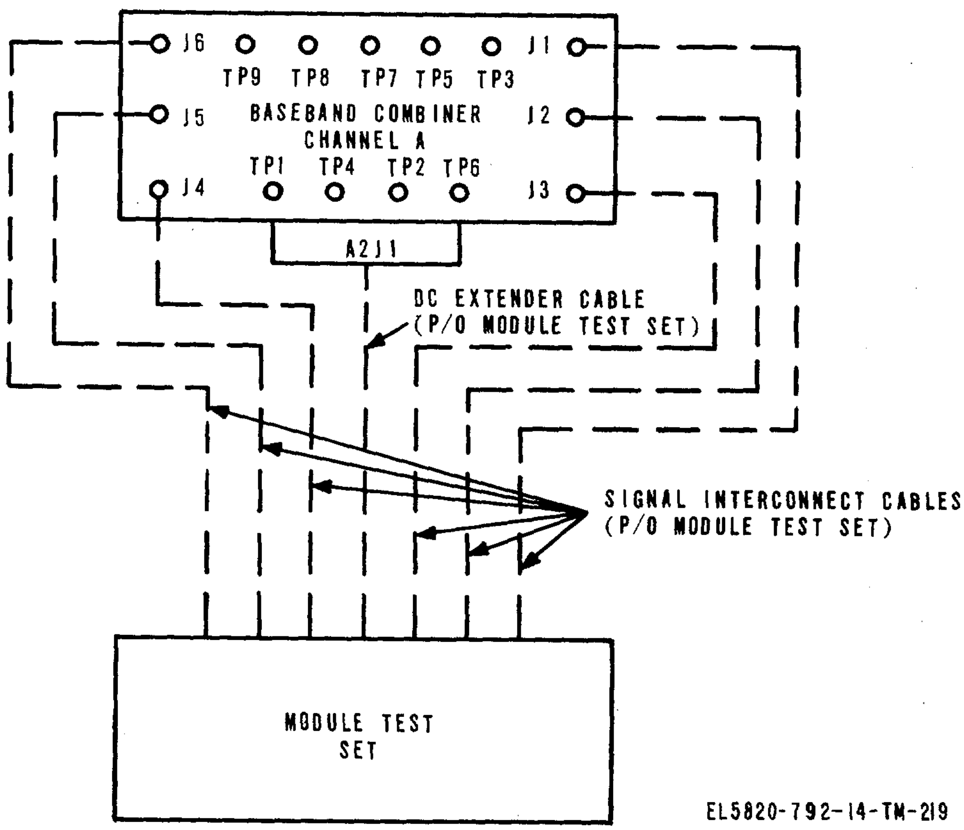


Figure 7-13. Baseband combiner balance adjustment, initial test equipment setup.

f. Procedure

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
1	Set the multifunction meter to measure 28 V dc. Connect the meter between TP1 and TP6 (ground).	+26.7 V dc		Check CR2, CR3, L1.
2	Set the multifunction meter to measure 6 V dc. Connect the meter between TP4 and TP6 (ground).	-5.4 V dc		Check CR4, CR5.
3	Set the multifunction meter to measure 28 V dc. Connect the meter between TP7 and TP6 (ground).	+23 V dc		Check filter components between TP1 and TP7.
4	Set the multifunction meter to measure 15 V dc. Connect the meter between TP8 and TP6 (ground).	+ 13.5 V dc		Check dc voltages at Q4 and Q5.
5	Set the multifunction meter to measure 28 V dc. Connect the meter between Q2 collector and ground.	+26.2 V dc		Check Q2.
6	Connect the multifunction meter between Q8 collector and ground.	+25.2 V dc		Check Q6, Q7, and Q8. Note dc coupling, a defective transistor will unbalance the remaining transistor voltages.
7	Connect the multifunction meter between Q11 collector and ground.	+26.2 V dc		Check Q9, Q10, and Q11. Note dc coupling, a defective transistor will unbalance the remaining transistor voltages.
8	Set the test oscillator frequency to produce 1 MHz.			
9	Set potentiometers RI and R2 fully clockwise (maximum gain).			
10	Set the test oscillator output level to 15 mv, as indicated by the ac voltmeter.			
11	Connect an oscilloscope to test point TP9.	41 mv (p-p		Check whether R2 is set for maximum gain. Check roofing filter consisting of C45, C46, C47, L7, and L8.
12	Connect the oscilloscope to test point TP8.	40 mv (p-p)		Check diodes CR10 and CR11 Check Q1 and C11.
13	Connect the oscilloscope to test point TP5.	37 mv (p-p)		Check whether R1 is set for maximum gain. Check CR1. Check Q2, C16, and C19.
14	Connect the oscilloscope to test point TP3	310 mv (p-p	Proceed to step 19	Proceed to step 15.
15	Connect the oscilloscope to Q6 collector.	20 mv (p-p)		Check Q6, C21, C25, and C26.
16	Connect the oscilloscope to Q7 collector.	310 mv (p-p		Check Q7 and associated components.
17	Connect the oscilloscope to Q8 emitter	310 mv (p-p)		Check Q8 and associated components.
18	Reconnect the oscilloscope to test point TP3.	310 mv (p-p)		Check C27, C28, and R42.
19	Connect the oscilloscope to Q11 emitter	2.2 V (p-p)	Proceed to step 23	Proceed to step 20.
20	Connect the oscilloscope to Q9 collector	230 mv (p-p)		Check Q9 and associated components. Check C31, C37, and C38.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
21	Connect the oscilloscope to Q10 collector.	1.7 V (p-p)		Check Q10 and associated components. Check C32.
22	Connect the oscilloscope to Q11 emitter	2.2 V (p-p)		Check Q11 and associated components.
23	Connect the oscilloscope to TP2 or J3	570 mv (p-p)		Check C39. Check K2 to determine whether R58 and R57 are in parallel.
24	(connect the oscilloscope to J2	420 mv (p-p)		Check Q12 associated components. Check C40 and C42.
25	Set the test oscillator frequency to produce 1 kHz. Maintain the 15 mv output level.			
26	Connect oscilloscope to J1	600 mv (p-p)		Check C41.

g. Dual Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(2) Adjust the +28-volt power supply for 28 ± 0.5 V dc.

(3) Adjust the -6-volt power supply for -6 ± 0.2 V dc.

(4) In the module test set, remove the A baseband combiner module.

(5) Substitute the baseband combiner under test for the A baseband combiner module, while the B channel baseband combiner remaining in the test set becomes the standard baseband combiner module.

(6) Interconnect all cables between the two combiner modules.

h. Squelch Rejection Test. This procedure is used to check the response of the baseband combiner when the pilot-tone squelch signal is applied in various combinations. Use figure 7-13 for the test setup.

(1) Perform the preliminary adjustments given in g above.

(2) On the receiver pilot-tone detector module of the module test set, place switches S1 and S2 in their TEST positions.

(3) Connect a multifunction meter between test points TP7 and TP6 (ground) of the combiner module under test. Read and record the voltage indication of the multifunction meter, then compare with data provided in *i* below. Disconnect the multifunction meter from the baseband combiner under test and repeat this step for the standard combiner in the module test set.

(4) Connect the multifunction meter between TP8 and TP6 (ground) of the combiner module under test. Read and record the voltage indication of the multifunction meter, then compare with data given in the squelch rejection chart. Disconnect the multifunction meter from the baseband combiner under test and repeat this step for the standard combiner in the module test set.

(5) On the receiver pilot-tone detector module of the module test set, place switch S1 in its NORMAL position, leaving switch S2 in its TEST position.

(6) Repeat steps (3) and (4) above.

(7) On the receiver pilot-tone detector module of the module test se set, place switch S2 in its NORMAL position, and switch S1 in its TEST position.

(8) Repeat steps (3) and (4) of this procedure.

(9) On the receiver pilot-tone detector module of the module test set, place switches S1 and S2 in their NORMAL positions.

(10) Repeat steps,(3) and (4) above.

j. Squelch Rejection Test Completion. This completes the squelch rejection test. Disconnect the extender cable from the module test set, and replace the standard combiner in the module test set.

i.Squelch Rejection Chart.

Pilot-tone detector		Combiner under test		Standard combiner	
S1	S2	TP7 / TP6	TP8 /TP8	TP7 / TP6	TP8
TEST	TEST	23.5 V dc	13.5 V dc	23.5 V dc	13.5 V dc
NORMAL	TEST	26.0 V dc	11.0 V dc	21.0 V dc	19.0 V dc
TEST	NORMAL	21.0 V dc	19.0 V dc	26.0 V dc	11.0 V dc
NORMAL	NORMAL	23.5 V dc	13.5 V dc	23.5 V dc	13.5 V dc

k. Intermodulation Distortion Test. This procedure is used to evaluate the linearity characteristics of the baseband combiner module. The intermodulation distortion test is used as the concluding major performance test of the baseband combiner module. The levels and frequency slots used in this test are based upon 600-channel loading; for a discussion of this type of test and its modification to other channel 7-38 loading factors, refer to chapter 5. The test equipment setup is shown in figure 7-14.

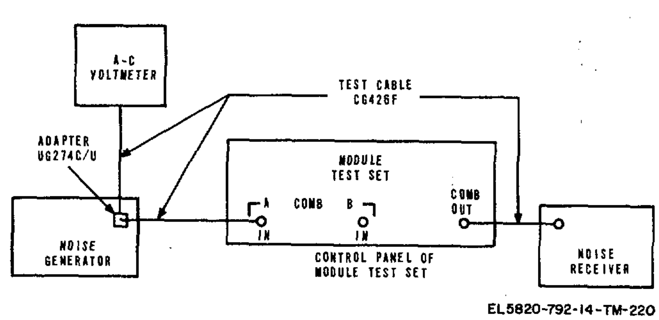


Figure 7-14. Baseband combiner inter-modulation distortion, test equipment setup.

(1) Perform the preliminary adjustments given in c above.

(2) Set the noise generator high- and low-pass filters to their IN positions, and all bandstop filters to their OUT positions. Adjust the output level of the noise generator to 140 mv (-6dbm/75 ohms) are indicated by the ac voltmeter.

(3) Set the noise receiver frequency selector to 70 kHz, then adjust the attenuator controls to produce a meter reference indication.

(4) Read and record the attenuator setting of the noise receiver. Label the reading as reference 1.

(5) On the noise generator, switch in the 70 kHz bandstop filter.

(6) Set the attenuator controls of noise receiver to produce the same reference level as reference 1.

(7) Read and record the attenuator settings of the noise receiver. Label the reading as reference 2.

(8) Subtract reference 1 from reference 2 to obtain the noise-power ratio at the 70 kHz slot. The resulting noise-power ratio for this slot shall not be less than 60 db.

(9) Set the 70 kHz bandstop filter switch to its out position.

(10) Repeat steps (3) through (8) above using 1002 kHz instead of 70 kHz.

(11) Set the 1002 kHz bandstop filter switch to its out position.

(12) Repeat steps (3) through (8) above using 2438 kHz instead of 70 kHz.

(13) Disconnect all test equipment from the module test set.

(14) Remove the module under test from the module test set.

(15) Replace the standard baseband combiner module in the module test set. This step completes this procedure.

l. Frequency Response Test. This procedure measures the baseband combiner output signal level at connector J1, J2, or J3, as applicable, versus constant input level at J6 for various frequencies. Various suggested test frequencies and standard output levels are provided in m below. Where a dash appears in each column, the test for that frequency may be omitted. If the multiplex or orderwire channels are to be tested, the reference frequency should be chosen first, followed by testing at the remaining frequencies.

m. Test frequencies Versus Standard Output Levels.

Test frequency	Multiplex output J3	Service channel output J1	Pilot-tone output J2
400 Hz	Reference ± 0.5 db	Reference ±0.5 db	-
1 kHz	-	Reference ±0.2 db	-
2 kHz[b]	Reference ±0.2 db	-16.5 ± 1.0 db	-
8 kHz	-	Reference ± 0.2 db	-
10 kHz	-	Reference ±0.2 db	-22 ± 1 db[c]
20 kHz	Reference - 0.2 db	Reference ± 0.2 db	-
50 kHz	-	Reference ±0.2 db	-
100 kHz	Reference ± 0.2 db	-	-
600 kHz	Reference ± 0.2 db	-	-
1.0 MHz [a]	-20.5 ±1.0 db[a]	-	-
1.5 MHz	-	-	-22 ± 1 db[c]
2.0 MHz	Reference +0 db, -0.5 db	-	-
3.0 MHz	Reference +0 db, -1.0 db	-	-
3.2 MHz	-	-	-23 ± 1.5 dbc

[a] Multiplex reference frequency and output level.

[b] Orderwire reference frequency and output level.

[c] Output level for pilot-tone frequency.

(1) Perform the preliminary adjustments given in g above.

(2) On the receiver pilot-tone detector module of the module test set, place switches S1 and S2 in their NORMAL positions if they are not already there.

(3) Connect the test equipment to the module test set as shown in figure 7-15.

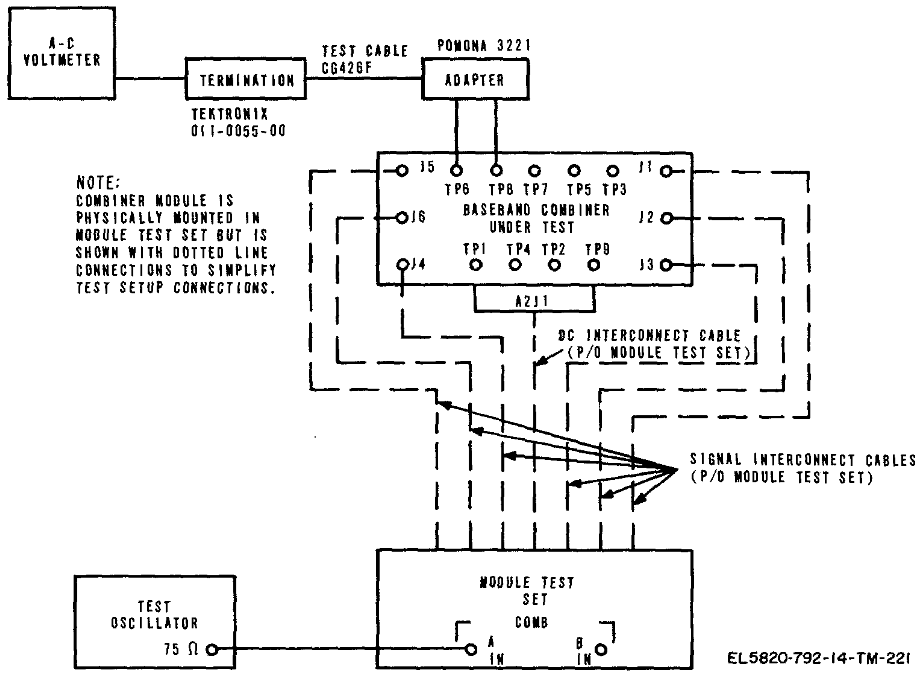


Figure 7-15. Baseband combiner, frequency response and level adjustment, initial test equipment setup.

(4) Set frequency controls of the test oscillator to provide 1 MHz, and the output level control to produce -45 db.

(5) The ac voltmeter should indicate 8 mv.

(6) Disconnect the adapter from baseband combiner test points TP8 and TP6. Then remove the adapter from the test cable.

(7) Connect the test cable to output connector J3 of the baseband combiner module.

(8) The ac voltmeter must indicate 71 millivolts. Vary the output level of the test oscillator and observe that the ac voltmeter indication changes directly with changes in test oscillator output level settings.

(9) Set the output level of the test oscillator to provide an output of -34 db.

(10) The ac voltmeter should indicate the reference level of -20.5 db/75 ohms (approximately 27.5 mv).

(11) Select each of the suggested test frequencies listed for the multiplex channel; maintain the test oscillator output at -34 db. The response of the baseband combiner for each test frequency is shown in the chart.

(12) Disconnect the ac voltmeter from J3 of the baseband combiner module under test and transfer it to J1.

(13) Set the frequency controls of the test oscillator to provide 2 kHz; set the output level to produce -34 db.

(14) The ac voltmeter should indicate the service channel reference level of -16.5 db/75 ohms (approximately 43.5 mv).

(15) Select each of the suggested test frequencies listed for the service channel; maintain the test oscillator output at -34 db. The response of the baseband combiner for each test frequency is shown in the chart.

(16) Disconnect the ac voltmeter from J1 of the baseband combiner module under test and transfer it to J2.

(17) Set the frequency controls of the test oscillator to provide pilot-tone frequency; set the output level to produce -34 db.

(18) The ac voltmeter should indicate the pilot-tone level provided in *n* below.

(19) Disconnect all test equipment from the module test set.

(20) Remove the module under test from the test set.

(21) Replace the standard baseband combiner module in the module test set. This step completes this procedure.

n. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, the use of voltage and resistance data given, in conjunction with standard troubleshooting techniques, should enable the location and correction of the fault. Resistance measurements are made with the modules disconnected from all external components using a multifunction meter. All voltages are measured using the test setup of figure 6-28. The voltages given in the table are based on a single baseband combiner card under test, which does not require interconnection with other similar combiner cards. No noise amplifier bias voltage is applied and potentiometers R1 and R2 are fully clockwise. The multifunction meter is also used to measure dc voltages. In ac voltage measurements, a test oscillator set for 1 MHz at an output level of 15 millivolts is used and is connected to connector J6.

CAUTION

Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if this voltage exceeds 1.5 volt. Also, since the RX1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more) may damage the transistor under test. As a general rule, it is not recommended that the RX1 range of any ohmmeter be used when testing low-power transistors.

NOTE

Voltage and resistance measurements given in the chart for a single card dual configuration baseband combiner module (part number 398-12040) includes Q5 and excludes Q13; measurements for a single card quad-configuration baseband combiner module (part number 39812069) includes Q13 and excludes Q5.

o. Voltage and Resistance Data.

Point of measurement	Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unless otherwise specified
Q1 Base	13.5	41 mv	6.3 kΩ
Emitter	13.0	41 mv	5.1 kΩ
Collector	22.5	-	3.7 kΩ
Q2 Base	18.7	32 mv	4.3 kΩ
Emitter	18.2	38 mv	340
Collector	26.2	-	1.3 kΩ
Q3 Base	7.0	-	1.1 kΩ
Emitter	6.4	-	3.7 kΩ
Collector	11.8	-	4.0 kΩ
Q4 Base	6.0	-	1.7 kΩ
Emitter	5.4	-	3.5 kΩ
Collector	15.2	-	3.4 kΩ
Q5 Base	3.8	-	1.9 kΩ
Emitter	3.2	-	2.0 kΩ
Collector	4.4	-	3.9 kΩ
Q6 Base	3.4	34 mv	1.4 kΩ
Emitter	2.8	-	410
Collector	8.2	20 mv	2.0 kΩ
Q7 Base	8.2	20 mv	2.0kΩ
Emitter	7.6	-	390
Collector	16.7	310 mv	1.8 kΩ
Q8 Base	16.7	310 mv	1.8 kΩ
Emitter	16.2	310 mv	380
Collector	26.4	-	1.3 kΩ
Q9 Base	6.6	210 mv	3.6 kΩ
Emitter	6.0	-	1.4 kΩ
Collector	14.0	230 mv	2.6 kΩ
Q10 Base	-0.3	230 mv	5.5 kΩ
Emitter	-0.9	-	2.8 kΩ
Collector	18.0	1.7 mv	1.9 kΩ
Q11 Base	18.0	1.7 V	1.9 kΩ
Emitter	17.4	1.7 V	220
Collector	26.4	-	1.3 kΩ
Q12 Base	4.3	780 mv	4.6 kΩ
Emitter	3.7	800 mv	200
Collector	23.7	1.1 V	1.4 kΩ

Point of measurement	Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unless otherwise specified
Q13[b] Base			
Emitter			
Collector			
TP1	26.7		
TP2		570 mv	
TP3		310 mv	
TP4	-5.4 V		
TP5		37 mv	
TP6	0	0	0
TP7	23.0	-	
TP8	13.5	40 mv	
TP9	d	41 mv	
J1[c]	-	600 mv	
J2	-	420 mv	
J3	-	570 mv	
J4 (no load)	-	40 mv	
J5	-		
J6	-	15 mv	

[a] Used only on dual-configured baseband combiners.
[b] Used only on quad-configured baseband combiners.
[c] Terminated in 75-ohm load.
[d] Dc measured here depends on setting of R2.

7-19. Alignment Data

a. General. The following procedures should be performed as a part of scheduled maintenance and after repairs have been made to a combiner card. When the module is installed in an operational terminal, the module must be aligned to meet system receiver specifications. Potentiometers.R1 and R2 in either the dual or quad-configurations are used to control signal combining action; any alignments given in this manual involving these components are given only to demonstrate the capability of the module to meet the required electrical specifications. Refer to paragraph 5-24 for alignment procedures involving these controls.

b. Dc Voltage and Current Source Balance. This adjustment procedure is used to set up the constant current sources and to equalize emitter currents through the interoperating combiner control stages. The test equipment setup is shown in figure 7-16.

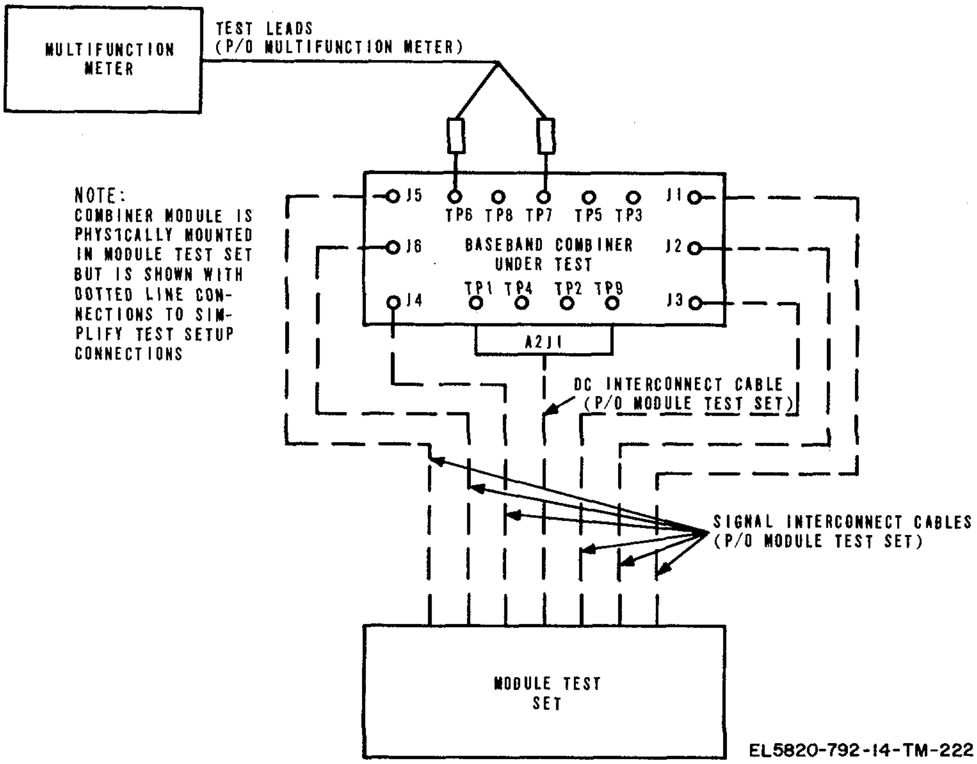


Figure 7-16. Baseband combiner dc voltage and current source balance adjustment, initial test equipment setup.

(1) Perform preliminary adjustments given in paragraph 7-18c and disconnect the coaxial cable between J4 of both combiner modules.

(2) Connect the multifunction meter between test points TP8 and TP6 (ground) of the standard baseband combiner module.

(3) Adjust potentiometer R19 of the standard baseband combiner to obtain +13.5 V dc indicated by the multifunction meter. Disconnect the multifunction meter from test setup.

(4) Connect the multifunction meter between test points TP8 and TP6 (ground) of the baseband combiner module under test.

(5) Adjust potentiometer R19 of the baseband combiner module under test to obtain +13.5 V dc as indicated by the multifunction meter. Disconnect multifunction meter leads from the test setup.

(6) Connect the multifunction meter to test point TP8 of the standard combiner and TP8 of the combiner under test.

(7) Adjust potentiometer R19 of the combiner under test for 0 V dc as indicated by the multifunction meter. Shift meter ranges to lower scales, if necessary, to obtain an accurate reading. Disconnect the multifunction meter from test setup.

(8) Connect the multifunction meter between test points TP7 and TP6 (ground) of the baseband combiner under test.

(9) Adjust potentiometer R13 of the baseband combiner under test to obtain +23.5 V dc indicated by the multifunction meter. Disconnect multifunction meter from the combiner unit.

(10) Connect the multifunction meter between test points TP7 and TP6 (ground) of the standard baseband combiner.

(11) Adjust potentiometer R13 of the standard baseband combiner to obtain +23.5 V dc indicated by the multifunction meter.

(12) Disconnect the multifunction meter lead from test point TP6 of the standard baseband combiner; transfer and connect this lead into test point TP7 of the baseband combiner under test.

(13) Adjust potentiometer R13 of the baseband combiner under test for 0 V dc indicated by the multifunction meter. Shift meter ranges to lower scales, if necessary, to obtain an accurate reading.

(14) Connect a short length of coaxial cable from J4 of baseband combiner under test to J4 of the standard baseband combiner.

(15) Observe the multifunction meter indication. If the meter indicates 0 vdc then the adjustment is satisfactory, if the meter does not

indicate 0 V dc, disconnect the cable between J4 of both modules and repeat steps (8) through (15) until the required reading is obtained.

(16) Disconnect all test equipment from the module test set.

(17) Remove the module under alignment from the test set.

(18) Replace the standard baseband combiner module in the module test set. This step completes this procedure. Rebalance both standard combiners if the standard module required adjustment in step (3) or (11) above.

c. Dual Baseband Level Adjustments. This procedure is used to equalize the baseband output levels from each of the combiner units. This adjustment must be performed in order to obtain acceptable operation from the radio terminal at the time of module installation; however, it does not necessarily mean that optimum performance can be expected from the radio terminal without further trim-type adjustments. The reason for this is that signal input levels from each diversity receiver into the baseband combiner cannot reasonably be expected to be the same even under test conditions.

(1) Perform the preliminary adjustments given in paragraph 7-18c.

(2) Connect the test equipment as shown in figure 7-15.

(3) On the receiver pilot-tone detector module of the module test set, place switches S1 and S2 in their NORMAL positions if they are not already there.

(4) Set the controls of the test oscillator to provide an output signal of 1 MHz at a level of 45 db.

(5) Adjust R2 of the baseband combiner under test until the ac voltmeter indicates 8 millivolts. Disconnect the ac voltmeter from the combiner module.

(6) Disconnect the adapter from the test cable attached to the ac voltmeter.

(7) Disconnect the coaxial cable from connector J3 of the baseband combiner under test.

(8) Connect the ac voltmeter to J3 of the baseband combiner under test.

(9) Adjust potentiometer R1 of baseband combiner under test to obtain 71 millivolts indicated by the a¢ voltmeter.

(10) Disconnect all test equipment from the module test set.

(11) Remove the module under alignment from the test set.

(12) Replace the standard baseband combiner module in the test set. This step completes this procedure.

Section V. DUAL PILOT-TONE DETECTOR (368-43035-2 THROUGH -8)

7-20. Introduction

The pilot-tone detector module is a module that can be used equally well in radio transmitter or receiver applications. The pilot-tone detector module amplifies, detects, and provides pilot-tone squelch and pilot-tone alarms in the event that pilot-tones are missing in the baseband signals.

7-21. Module Configurations

a. The pilot-tone detector module consists of a single printed-wiring card on which all components, with the exception of controls, test jacks, and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis (A1).

b. Several different pilot-tone detector modules are available, depending upon the particular radio system requirements. Subparagraph c below lists the major differences between the module configurations.

c. Module configuration data.

Pilot-tone detector module part No.	Filter part No.	Pilot-tone frequency	Single channel detector	Dual channel detector
368-43035-2	362-7651-1	1.499 MHz	No	Yes
368-43035-3	362-7651-2	8.5 MHz	No	Yes
368-43035-4	362-7651-1	1.499 MHz	Yes	No
368-43035-5	362-7651-2	8.5 MHz	Yes	No
368-43035-6	398-12061-1	12 kHz	No	Yes
398-12061-2	398-12061-2	16 kHz No	No	Yes
368-43035-7	398-12061-3	20 kHz	No	Yes
	362-7651-2	8.5 MHz No	No	Yes
368-43035-8	362-7651-3	10 kHz	No	Yes

7-22. Functional Description

a. The functional block diagram of the pilot-tone detector appears in figure,6-35. Pilot-tone detector modules have three major applications. The first application is their use with dual receivers to detect pilot-tone continuity over the radio path from distant to local stations. The second application is their use with dual transmitters to detect pilot-tone continuity through the transmitter modules; loss of pilot tone in this application is interpreted as loss of modulation. The third application is the use of single-channel pilot-tone detectors as dictated by special microwave system parameters.

b . The circuit of the pilot-tone detector is the same for single or dual-channel modules. In the dual pilot-tone detector modules, two independent pilot-tone detectors are placed on the same printed-wiring assembly; one is used for diversity channel A detection and one is used for diversity channel B detection. In the single channel units, the printed-wiring assembly is etched as a dual-channel circuit, but the components are located in diversity channel A positions. The pilot-tone detector module receives its input signal from the noise amplifier module associated with that transmission path; this signal contains all components of the baseband. The test-normal switch is used, at the desire of the maintenance personnel, to provide a simulated loss of pilot-tone for test purposes. The multiplex and service channel signals are rejected by the crystal filter, while the pilot-tone signal is passed through into the first stage of amplification.

d. After amplification, the pilot-tone is passed through another filter which eliminates transistor noise. The pilot-tone signal is split into two paths; one path attenuates the signal and routes it out of the pilot-tone detector module to the noise amplifier module, and the second path passes the pilot-tone into another amplifier prior to the detector. The pilot-tone is detected by means of a voltage-doubling detector circuit, and the output is used to bias off the Schmidt trigger (the relay driver). With the Schmidt trigger biased off, the relay driver keeps the relay energized. A loss of pilot-tone or the loss of +28 V dc causes the relay driver to deenergize the relay. When the relay is deenergized in receiver pilot-tone applications, squelch bias is applied to the combiner module to suppress the failing channel, and to both the local and remote alarms of its associated receiver channel. In transmitter pilot-tone applications, both local and remote alarms of the associated transmitter channel are activated and in some cases, transmitter switching action is initiated (depending upon microwave system requirements). In some applications, only local and remote alarms are activated; the squelch output is unused. Dc power for the pilot-tone detector module is supplied from dual low voltage power supplies external to the module. Steering diodes in the module are connected so that either supply can operate the squelch circuit. In normal operation, however, supply A is used only for channel A, and supply B is used only for channel B.

7-23. Circuit Analysis

a. The schematic diagram of the dual pilot-tone detector module is shown in figure FO-17, and the single pilot-tone detector module is shown in figure FO-18. The circuits for the A and B pilot-tone channels are the same, except for circuit reference designators, so that the discussion which follows for channel A pilot-tone channel is also applicable to channel B circuits using the corresponding reference designators. The baseband signal received at the input connector is applied to PLT NORM/TEST switch S1. If connection is made in the NORM position of switch S1, the pilot-tone signal is passed into crystal filter FL2 without attenuation. If connection is made in the TEST position of switch S1, the pilot-tone signal is attenuated by 6 db and the T-pad consisting of R62, R63, and R64. Following this, provisions are made for additional attenuation, as desired, by strapping in a T-pad consisting of R34, R35, and R36.

b. The input signal applied to crystal filter FL2 is processed to reject the multiplex and supervisory-channel signals while the pilot-tone signal is passed into integrated circuit MD2. The bias supply for module MD2 is taken from the 28-volt supply at the junction of resistors R37 and R38. Bias current is passed from this junction through R40 to the inverting input pin 2 of MD2; similarly, the bias current is passed through R41 into the noninverting pin 3 input of MD2. Any baseband signals reaching pin 3 of MD2 are passed to ground via C47 and C26. Capacitor C28 is connected across the frequency-compensation terminals of the integrated circuit module. Resistor R42 is a feedback resistor. Pin 8 of the integrated circuit supplies the dc operating voltage to the module.

c. The output signal from MD2 is RC-coupled into a second filter stage consisting of inductor

L10 and capacitors C32 and C33. This filter is resonant at the pilot-tone frequency and presents an infinite impedance to the pilot-tone frequency only; other frequencies are shunted to ground. When E10 is strapped to E9, the pilot-tone frequency is attenuated by voltage divider R45 and R46, then sent out of the pilot-tone detector module through shielded wire into the noise amplifier module. The setting of potentiometer R1 determines the specific level at which the loss of-pilot alarm and squelch circuits are activated.

d. The amplified continuity pilot tone is detected by diodes CR11 and CR12 in a voltage doubler circuit configuration arranged to provide a negative output voltage. This negative dc voltage is used to oppose the quiescent positive bias at the base of Schmidt trigger Q6 to maintain the input stage at cutoff, causing the relay driver to keep the squelch relay energized. A loss of pilot-tone drives the Schmidt trigger into conduction, and causes the relay driver to deenergize relay K2. The reaction time of the pilot-tone detector is 200 milliseconds after the loss of the pilot-tone signal. The recovery time, that is, the time from the initial receipt of the continuity pilot tone until the alarms are deactivated, is 20 milliseconds. Diode CR14 is used to protect driver stage Q6 from base to emitter voltage breakdown, which could result from the negative detected pilot-tone signal.

e. Switch S2 is open in the PLT NORM position; closing the switch (PLT BYPASS position) grounds the base of Schmidt trigger Q6. The input stage of the relay driver (the Schmidt trigger) is forced into cutoff, and the relay driver energizes relay K2, thus simulating the presence of the pilot tone. Switch S1 is a manual switch which introduces 6 db attenuation into the input of the dual pilot-tone detector. This simulates a 6 db drop in pilot-tone which causes operation of the pilot-tone squelch and fault signal circuits for test purposes.

f. The +28-volt dc power for this module is obtained from the dual low voltage power supplies; channel A supply powers channel A and channel B supply powers channel B. Diode steering of these supplies is employed within the module in such a way that both supplies are applied to the squelch circuits of both channels. Consequently, if one of the supplies fails, the squelch circuit of that channel still operates.

g. Technical characteristics are as follows:

Parameter	*Specifications*
Input impedance	75 ohms, unbalanced.
Input level	5 mv minimum.
Outputs	0 or +28 V dc for combiner squelch.
	0 or +28 V dc for alarm indication.
	Form C dry contacts for external alarm.
Gain	+55 db at pilot-tone frequency.
Frequency response:	
10-kHz pilot-tone	± 30 Hz
1.499-MHz pilot-tone	± 600 Hz
3.2-MHz pilot-tone	± 600 Hz
8.5-MHz pilot-tone	± 2 kHz
Reaction time:	
Alarm ON	200 milliseconds (activation).
Alarm OFF	20 milliseconds.
Power requirements:	
Dual units	90 ma at +28 V dc.
Single units	45 ma at +28 V dc.

7-24. Maintenance Data

a. *Performance Test and Trouble Analysis Procedures*. The following paragraphs contain procedures for testing the performance of the overall module and its major circuits, and gives probable causes of abnormal indications.

b. *Test Equipment Setup*. Connect the test equipment and module test set to the module as shown in figure 7-17.

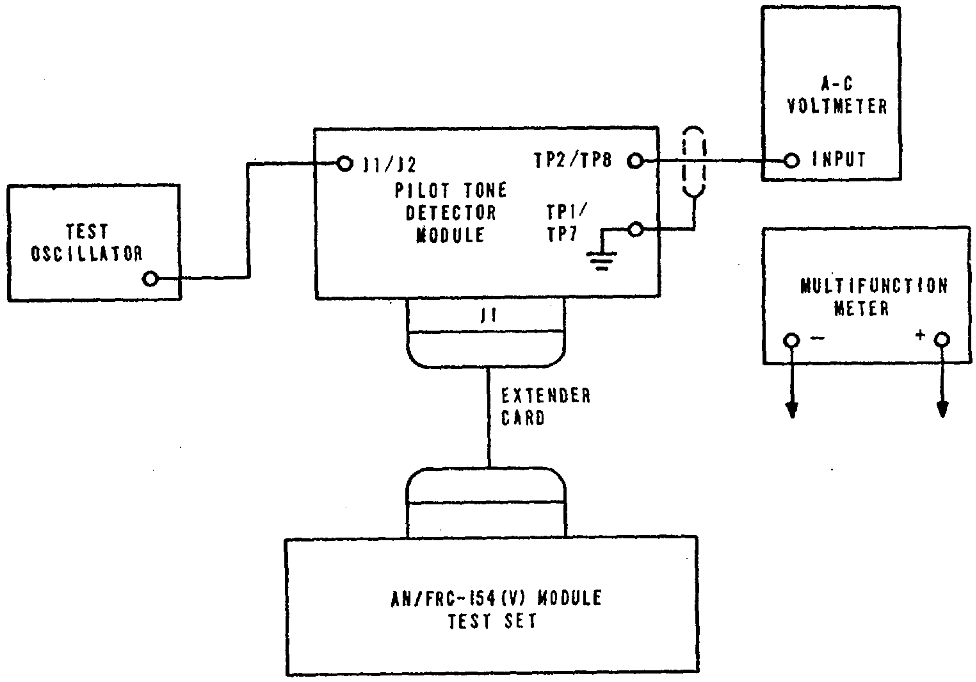


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Figure 7-17. Pilot-tone detector module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

NOTE

Strapping of attenuator pads of the module is based on the particular system configuration in which the module is connected. If for any reason the strapping of these pads must be changed, first make a record of the original strapping so that the strapping can be restored to the original condition when desired.

(1) Remove the top and bottom covers from the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the +28-volt power supply in the module test set for 28 0.5 V dc.

d. Test Procedures. After completing the procedures of *b* and *c* above, perform the procedures provided in *e* below. Figure 6-37 contains parts location data.

e. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
	Channel A (steps 1-6)			
1	Set frequency of test oscillator to the proper pilot-tone frequency, and connect to J1. Set S1 and S2 to NORMAL position.			
2	Set potentiometer R1 fully clockwise. Adjust output level control of test oscillator for an indication of -42 db (6 mv on ac voltmeter).			
3	Set multifunction meter controls to permit an indication of +28 V dc; connect positive lead to pin 13 of J1 and negative lead to ground (TP1).	0 volt	Proceed to step 4	Proceed to step 5.
4	Set switch S1 to TEST position and observe reading on Multifunction meter. Return switch S1 to NORMAL position.	+28 V dc	Proceed to step 5	Proceed to step 10.
5	Connect ac voltmeter from TP3 to ground (TP1).	60 mv rms	Proceed to step 6	Check crystal filter FL2 and MD-2 and associated components.
6	Connect ac voltmeter from collector Q5 to ground (TP1).	3 v rms	Proceed to step 7	Check transistors Q4, Q5 and associated components.
	Channel A (steps 6-9)			
7	Set multifunction meter to permit an indication of +10 V dc; connect positive lead to TP4 and negative lead to ground (TP1).	Less than +2 V dc	Proceed to step 8	Check CR11, CR12, and associated components.
8	Connect positive lead of multifunction meter to anode of CR15 and negative lead to ground (TP1).	Less than +6 V dc	Proceed to step 9	Check transistor Q6 and associated components.
9	Set multifunction meter to permit an indication of +28 V (dc; connect positive lead to pin 13 of J1 and negative lead to ground ('"1).	0 V dc	Repeat step 4	Check relay K3 and associated components.
	Channel B (steps 10-11)			
10	Set frequency of test oscillator to the proper pilot-tone frequency, and connect to J2. Set S3 and S4 to NORMAL position. Connect ac voltmeter from TP8 to ground (TP7).			
11	Set potentiometer 1R2 fully clockwise. Adjust output level control to test oscillator for an indication of -42 db (6 m v on the ac voltmeter.			
	Channel B (steps 12-17)			
12	Set multifunction meter controls to permit an indication of +28 V dc: connect positive lead to pin 16 of J1 and negative lead to ground (TP7).	0 V dc	Proceed to step 13	Proceed to step 14.
13	Set switch S4 to TEST position and observe reading on multifunction meter. Return S4 to NORMAL position.	+28 V dc	Proceed to step 14	Test complete. Disconnect all test equipment.
14	Connect ac voltmeter from TP6 to ground (TP7).	60 mv rms	Proceed to step 15	Check crystal filter FL1 and MD-1 and associated components.
15	Connect ac voltmeter from collector of Q2 to ground (TP7).	3 V rms	Proceed to step 16	Check transistors Q1, Q2 and associated components.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
16	Set multifunction meter to permit an indication of +10 V dc; connect positive lead to TP5 and negative lead to ground (TP7).	Less than +2 V dc	Proceed to step 17	Check CR2 and CR3 and associated components.
17	Connect positive lead to multifunction meter to anode of CR6 and negative lead to ground (TP7).	Less than +6 V dc	Proceed to step 18	Check transistor Q3 and associated components.
	Channel B (step 18)			
18	Set multifunction meter to permit an indication of +28 V dc: connect positive lead to pin 16 of J1 and negative lead to ground (TP7).	0 V dc	Proceed to step 13	Check relay K2 and associated components.

f. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in *g* below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the module disconnected from all external components using the multifunction meter. All voltages are measured using the test setup of *b* above. The multifunction meter is also used to measure dc voltages. For ac voltage measurements, use the oscilloscope.

CAUTION

Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if this voltage exceeds 1.5 volt. Also, since the R x 1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more) may damage the transistor under test. As a general rule, it is not recommended that the R x 1 range of any ohmmeter be used when testing low-power transistors.

g. Voltage and Resistance Data.

Point of measurement	Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100scale unless otherwise specified
MD-1 1	6.6	0	2.2 kΩ
2	6.6	.07 mv	3 kΩ
3	6.6	1.5 mv	3.3 kΩ
4	0	0	0
5	10.9	0.51 mv	4 kΩ
6	7.2	.035 mv	3.5 kΩ
7	6.6	0.45 mv	2.2 kΩ
8	17.6	0.36 mv	2.2 kΩ
Q1 Base	3.2	4 mv	1.2 kΩ
Emitter	2.9	0	560 ohms
Collector	8.9	0.35 V	1.8 kΩ
Q2 Base	8.9	0.4 V	1.8 kΩ
Emitter	8.9	0.4 V	500 ohms
Collector	19.2	2.5 V	1.9 kΩ
Q3 Base	5.9[a]0[b]	.....	1.7 kΩ
Emitter	5.2[a]3.4[b]	.....	500 ohms
Collector	7.0[a] 20.0[b]	.....	2.6 kΩ
Q3 Base	1.8[a]4.2[b]	....	1 kΩ
Emitter	5.2[a]3.4[b]	.....	560 ohms
Collector	27.7[a] 3.5[b]	.....	4 kΩ
MD-2 1	6.6	0	2.2 kΩ
2	6.6	0.7 mv	3kΩ
3	6.6	1.5 mv	3.3 kΩ
4	0	0	0
5	10.9	0.5 mv	4 kΩ
6	7.2	0.35 mv	3.5 kΩ
7	6.6	0.35 mv	2.2 kΩ
8	17.6	0	2.2 kΩ
Q4 Base	3.2	4 mv	1.2 kΩ
Emitter	2.5	0	560 ohms
Collector	9.0	0.35 mv	1.8 kΩ
Q5 Base	9.0	0.4	1.8 kΩ
Emitter	8.3	0.4	500 ohms
Collector	18.3	2.5	1.9 kΩ
Q6 Base1	6.0[a]0[b]	.....	1.7 kΩ
Emitter 1	5.2[a]3.5[b]	.....	560 ohms
Collector 1	6.9[a]20.0[b]	15	2.6 kΩ
Q6 Base2	1.8[a] 4.0[b]	.....	1 kΩ
Emitter 2	5.2[a] 3.5[b]	.....	560 ohms
Collector 2	27.7[a] 3.4 [b]	1.5	4 kΩ

[a] With switches S1 and S2 in the PLT NORM position.

[b] with switches S1 and S2 in the BYPASS position.

[c] With proper pilot-tone frequency, 5 mv (-43.8 db) input and 4 db as the AR T-pad at input; all switches in NORM position; all potentiometers in maximum position.

7-25. Alignment Data

The pilot-tone detector does not require alignment at the test bench location; however, when the module is installed in an operational terminal it must be aligned to meet system specifications. The pilot-tone detector uses potentiometers R1 and R2 in addition to an attenuator pad to set the threshold for the pilot-tone alarms. Refer to paragraphs 5-16, 5-25, and 5-26 for alignment procedures involving these components.

Section VI. IF AMPLIFIER MODULE (368-43488-2, -3, AND-4)

7-26. Introduction

The IF amplifier module is used in both the microwave receiver and in the transmitter portions of microwave repeaters. The function of the IF amplifier module is to receive the 70-MHz receiver IF signal from the IF filter module, amplify this frequency-modulated signal, and deliver it to a demodulator, which may be either a limiter-discriminator module or a phase lock detector module. The amplifier has a 50-MHz bandwidth with a gain of approximately +80 db, subject to AGC control over a dynamic range of 60 db.

7-27. Module Configurations

a. The IF amplifier module consists of a single printed-wiring card on which all components, with the exception of test jacks and connectors, are mounted. The latter components are mounted on the front face of the metal module chassis. The module used in a given application depends upon the input signal level and whether fast or slow AGC response time is required.

b. Module configuration data follows:

IF amplifier module part No.	AGC response time	IF signal input level
368-43488-2	200 microseconds	Less than -10 dbm
368-43488-3	5 milliseconds	Greater than -10 dbm
368-43488-4	5 milliseconds	Less than -10 dbm

7-28. Functional Description

a. The functional block diagram of the IF amplifier appears in figure 6-39. The 70-MHz FM input signal, ranging between 70 dbm and 10 dbm, enters the IF amplifier module through coaxial connector J1. This signal is first passed through a varilosser circuit which operates to maintain a constant output signal despite input signal amplitude fluctuations. The IF signal is then amplified by a two-stage transistor amplifier prior to its application to the second varilosser stage. The second varilosser stage is followed by another two-stage amplifier which has a bandwidth of 100 MHz and a signal gain of approximately +22 db.

b. The 70-MHz IF signal is then sent into a bandpass filter which reduces receiver noise products and limits the module output bandwidth to 50 MHz. Following the filter, another varilosser stage is used to control signal gain. Two more two-stage amplifiers are used, with a final varilosser between them, to produce the final IF output signal at coaxial connector J3. The final output level of the 70-MHz IF signal at J3 is approximately -6 dbm across 75 ohms.

c. The 70-MHz output signal is amplified prior to the AGC detector. The IF signal level available at auxiliary output J2 ranges between +3 and +6 dbm across 75 ohms. The IF signal is passed into a voltage-doubling rectifier which is referenced to --6 V dc. The AGC voltage is amplified by an operational amplifier and applied to an AGC driver stage which supplies AGC control voltage to all varilosser stages. The output of the operational amplifier is also available for external meter monitoring.

7-29. Circuit Analysis

a. The schematic diagram of the module is shown in figure FO-19. The 70-MHz IF signal is brought into the module at coaxial connector J1. Depending upon path performance, this level ranges between --10 dbm and --70 dbm. From J1, the IF signal is sent to the first of four bridged-T varilosser networks driven by the AGC circuits.

b. Resistor R6 is used in conjunction with Zener diode CR1 to reduce the 28-volt supply to 18 volts and to regulate one end of the varilosser control line. Capacitors C107 and C1 are used to bypass the IF signal at the Zener diode. Inductor L1 is used to prevent the IF signal from reaching the Zener diode. The path for the varilosser control circuit is through diodes CR2, CR4, CR6 and CR8, then through inductor L33 and diodes CR9, CR7, CR5 and CR3 to the collector of varilosser driver Q10. Inspection of the circuit shows that a resistor is connected across each diode in this series circuit to restrict the impedance range within proper limits as the varilosser operates. Bypass capacitors and RF chokes are used at the terminals of each varilosser diode to provide RF isolation at each point. As shown in figure FO-19, the value of resistor R7 changes with the part number of the module. If the dynamic operating range of the input IF signal is anticipated to be greater than the standard 10 dbm level, resistor R7 is increased. Greater attenuation of the input IF signal is obtained under these conditions so that the signal input at Q1 is the same as for standard conditions.

c. Each varilosser is a bridged-T network. The T portion of the first varilosser network consists of resistors R4 and R8, with the network CR3, R5, and C4 acting as the common leg of the T. Capacitor C4 provides signal ground for the common leg to the dc operated T circuit. Capacitors C2 and C7, in addition to passing the IF signal input, also block the dc voltage of the T network; capacitors performing this same function are used at each varilosser. Inductor L2, capacitors C3 and C5, and the CR2-R7 network forms the bridging portion of the bridged-T network. While inductors are not used in all varilossers, the two capacitors are used to isolate the T network from its associated bridging network because of dc circuit requirements.

d. To explain its operation, assume that the input varilosser control voltage has increased in the positive direction. The forward bias across diode CR3 decreases, with a resulting increase in diode impedance. The impedance of the R5-CR3 combination increases. At the same time, the forward bias across diode CR2 increases, with a resulting decrease in diode impedance. The impedance of the bridging network R7-CR2 decreases. Although the impedance of the separate bridged-T components acts in opposite directions, the amplitude of the change is the same in each component because it is the series collector current of transistor Q10 which drives them both. From an overall circuit standpoint, the decreased bridging impedance is canceled out by the increased T impedance, resulting in a constant impedance looking through the input and output terminals of the bridged-T. Internally, however, decreased bridging impedance means that a greater portion of the IF input signal is shunted across the T into the amplifier input.

e. Resistor R9 is part of the termination for the input varilosser network, and from here the IF input signal if RC-coupled into amplifier Q1. Resistor R13 and capacitor C9 are the elements of a decoupling filter network. The emitter circuit of transistor Q1 uses a variable peaking capacitor which varies the amplifier gain and bandwidth by varying the amount of degenerative feedback in the stage.

f. The IF signal is coupled into amplifier Q2 by means of capacitor C16. The RC circuit, R18 and C18, is a decoupling filter. Resistors R15, R16, and R17 set the base bias for the amplifier. Signal feedback occurs through network C17, R16, and L8. Notice that inductors L8 used in amplifier Q2 and L29 in amplifier Q6 are specially selected with reference to the part number of the module. The 368-43488-3 module is used to drive long lengths of coaxial cables; in which case, the IF bandpass curve must be intentionally fitted in the IF amplifier module to compensate for the effects of cable loading.

g. In regard to amplifier stage Q3, observe inductor L49 and R24. There is also a corresponding RL network, L50 and R58, in the base circuit of amplifier Q7. In either case, only the resistor or only the inductor is used for high frequency peaking, never both in the same position. Selection of this circuit element is determined during test.

h. The output signal from amplifier Q4 is sent through a 50-MHz bandpass filter consisting of inductors L18 and L21, capacitors C38, C42, and C44. This filter reduces the noise content of the 70-MHz IF signal. The filter is terminated at either end by a T-pad.

i. Amplifier Q8, the final IF amplifier stage, has two output signal paths. The primary signal path is terminated in coaxial connector J3; the output level at this point is approximately +6 dbm. The secondary signal path is used to develop an AGC signal.

j. Inductor L48 is the collector load for amplifier Q9. This inductive load is used to obtain a very high impedance at the collector of Q9 to operate the AGC detector rectifiers. Two RF filter sections, L40-C86 and L41-C89, are used to prevent passage of IF signals onto the power supply line. The IF signal output from amplifier Q9 is sent to output transformer T1 and capacitively coupled to coaxial connector J2 (AUX OUTPUT). The auxiliary output line is used in applications where IF heterodyne repeater service is required.

k. Negative 6 volts dc, taken from the power supply at pin 3 of printed-circuit connector J4, is filtered by the twin-section filters consisting of inductors L42 and L43 and capacitors C95 through C99. The dc output from the filter is connected to resistors R80 and R81. Potentiometer R80 is used as a balance control for setting the dc output level of amplifier MD1. This balance voltage is connected through resistor R82 to the noninverting input of MD1. After an additional filter stage L44 and C101, the negative (6 volt) power supply output is used as one of the operating voltages for the integrated operational amplifier module MD1 .at pin 4. Finally, this negative 6-volt supply is decoupled by R77-C91, and applied to the network R75, CR11, and CR12. Diodes CR11 and CR12 are temperature compensating circuit elements for the AGC detector.

l. The AGC detector is a voltage-doubler network consisting of coupling capacitor C88: and rectifier CR10 during the positive half-cycles and capacitor C94 and diode CR13 during the negative half-cycles. The output from the detector is a dc voltage which is proportional to the average IF signal amplitude. The detector voltage rides on the negative 6 volts present at the junction of CR10, R75, C91, and R77. If the IF signal is removed from the input to the module at J1, the IF signal input to the detector drops to zero. Under these conditions, the negative 6 volts sends current through diodes CR10 and CR-13 to resistor R79 and then to ground. The voltage, developed across R79, is present at the inverting input to operational amplifier MDI and causes a positive dc voltage at the output. When the IF signal is present at the input, J1, a positive dc voltage is developed by rectifiers CR10 and CR13, which reduces the negative bias sent into the inverting input of MD1. Thus, the positive dc output voltage from pin 7 of MD1 has its maximum value, during, no-signal conditions and minimum value during maximum signal amplitude.

m. Capacitor C100 is connected to the pin 6, terminal of MD1 to complete the frequency compensation circuit of the operational amplifier. The 28-volt dc line is reduced to 12 volts by resistor R84 and Zener diode CR14; this voltage is used as the positive operating potential for MD1 at pin 8. Capacitors C92 and resistor R83 and C102 change with module part number due to system requirements. These components affect the AGC response line.

n. The output signal from integrated operational module MD1 is split into two paths. The secondary path exists through inductor L45 and resistor R72 or inductor L47 (whichever used) to pin 10 of the printed-circuit connector J4 and to test, point TP1; bypassing is accomplished by capacitors C104 and C106. The primary path exists through L46 into the base of AGC control Q10. Suppose that the IF signal amplitude decreased through the module; then the positive base drive into AGC control Q10 decreases. Collector current through Q10 decreases, permitting the AGC voltage to rise in the positive direction. The remaining circuit action of the AGC loop has already been described.

o. Technical characteristics are as follows:

Parameter	*Specifications*
Input impedance	75 ohms, unbalanced.
Output impedance	75 ohms, unbalanced.
Input level:	
368-43488-2	--10 to --70 dbm.
368-43488-3	+5 to -10 dbm.
368-43488-4	-10 to -70 dbm.
Output level:	
Main output	+6 to +14 dbm.
Auxiliary output	+3 to +14 dbm.
Maximum available gain	80 db.
AGC response time:	
368-43488-2	200 milliseconds
368-43488-3	5 milliseconds.
368-43488-4	5 milliseconds.
AGC'c6ntrol range	60 db.
IF bandwidth	50 MHz.
Power requirements:	
+28 volt source	150 ma.
-6 v6lt source	25 ma.

7-30. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following paragraphs contain procedures to test the performance of the overall module and its major circuits and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect test equipment and test cable to the module as shown in figure 7-18.

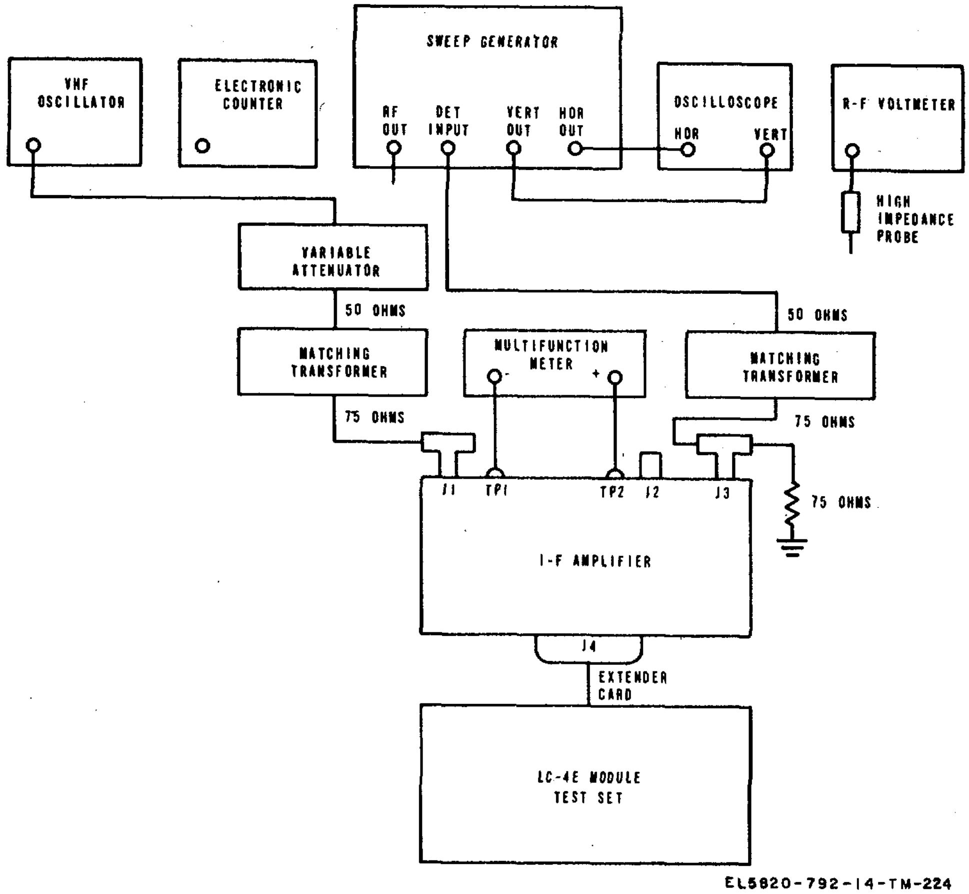

Figure 7-18. IF amplifier module, initial test equipment setup .

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove top and bottom covers from the module.

(2) On the module test set, set AGC/MAN control to MAN and adjust for minimum meter indication.

(3) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(4) Adjust the 28-volt power supply in the module test set for 28 ± 0.5 V dc (current drain approximately 155 ma).

(5) Adjust the 6-volt power supply in the module test set for -6 ± 0.5 V dc (current drain approximately 30 ma).

d. Test Procedures. After completing procedures indicated in b and c above, perform the procedures provided in e below. Figures 6-41 and 7-19 contain parts location data.

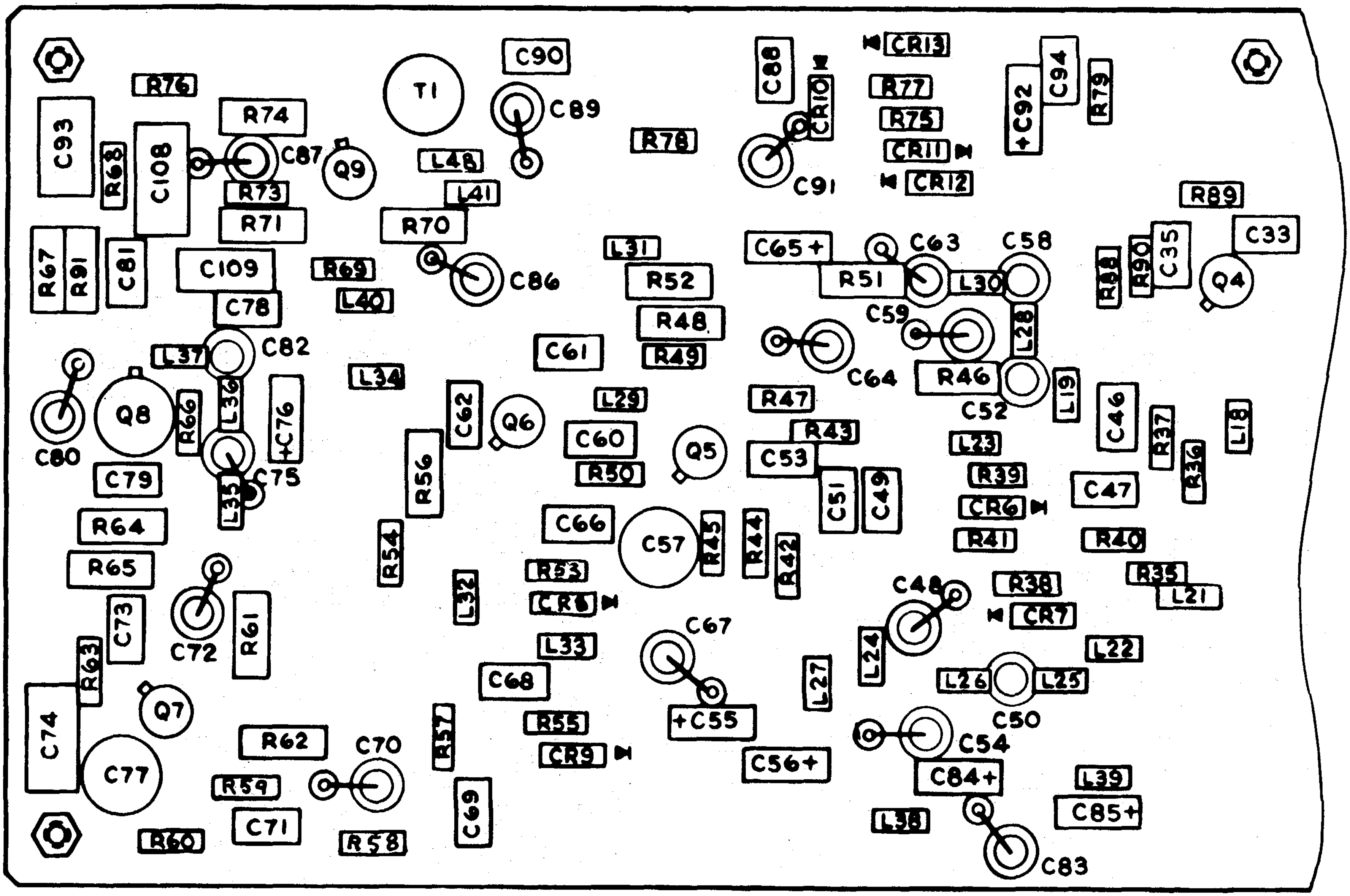

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Figure 7-19. (1) IF amplifier module, parts location diagram (sheet 1 of 2).

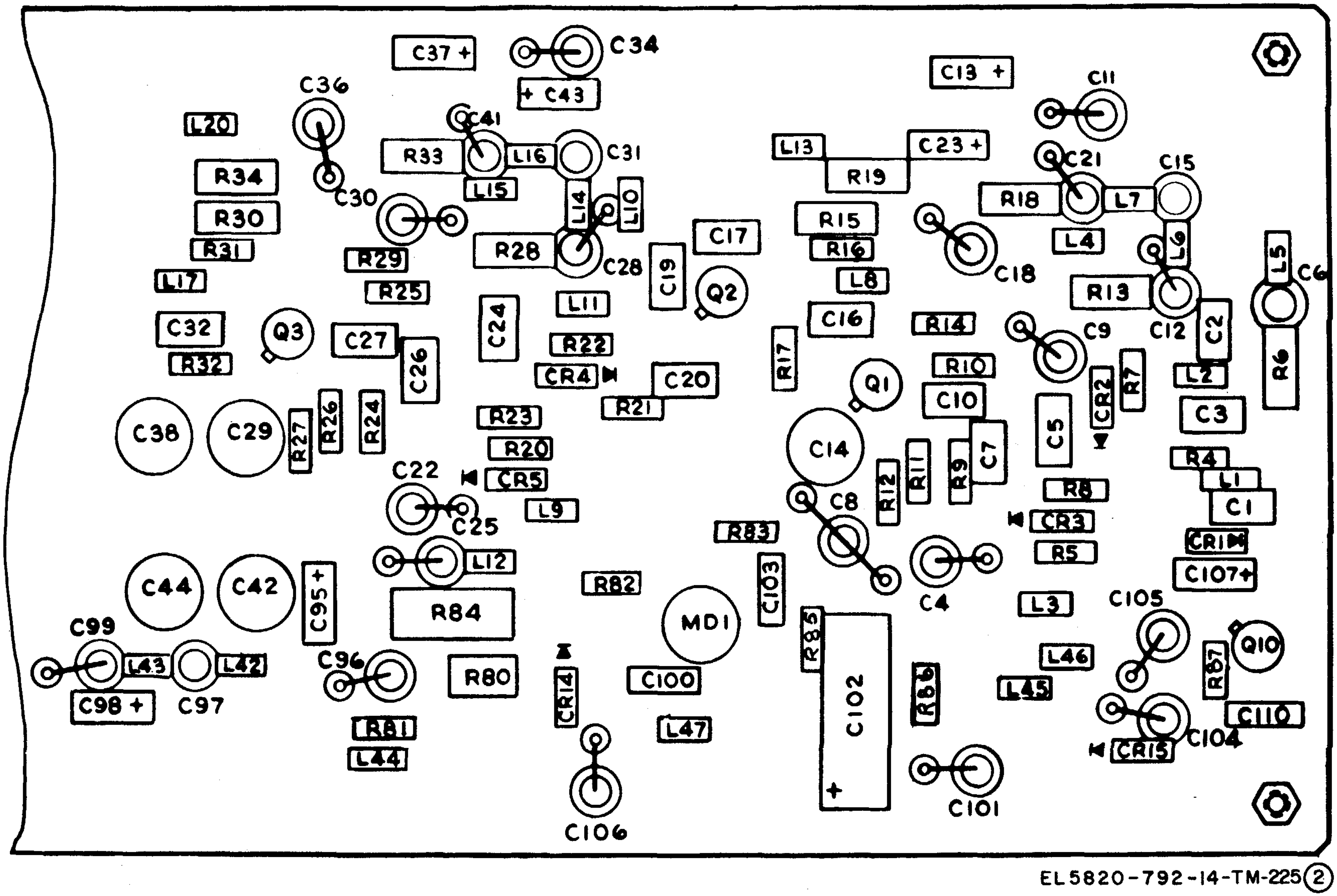

Figure 7-19. (2) IF amplifier module, parts location diagram (sheet 2 of 2).

e. Procedure.

Step No.	Procedure	Normal indication	If indication is normal--	If indication is not normal--
		IF amplifier check		
1	Set the frequency of the VHF oscillator to 70 MHz.			
2	Connect the RF voltmeter to the remaining part of the T-connector at J1 of the IF module.			
:3	Adjust the output level of the VHF oscillator until the RF voltmeter indicated 30 mv. Disconnect RF voltmeter from J1.			
4	Connect the RF voltmeter to Q1 base	8.5 mv	Proceed to step 5	If 30 mv appears at Q1 base, proceed to step 1 of AGC circuit check.
5	Connect the RF voltmeter to Q2 base	14.5 mv	Proceed to step 6	Check Q1 and associated circuits.
6	Connect the RF voltmeter to Q3 base	17.5 mv	Proceed to step 7	If reading is low, check Q2 circuit; if high, check associated varilosser circuit.
7	Connect the RF voltmeter to Q4 base	22 mv	Proceed to step 8	Check Q3 and associated circuits.
8	Connect the RF voltmeter to Q4 collector	250 mv	Proceed to step 9	Check Q4 and associated circuits.
9	Connect the HF voltmeter to Q5 base	13 mv	Proceed to step 10	Check filter network. If reading is high, check associated varilosser circuit.
10	Connect the RF voltmeter to Q6 base	23 mv	Proceed to step 11	Check Q5 and associated circuits.
11	Connect the RF voltmeter to Q7 base	38 mv	Proceed to step 12	If reading is low, check Q6 and associated circuits. If reading is too high, check the associated varilosser network.
12	Connect the RF voltmeter to Q8 base	47 mv	Proceed to step 13	Check Q7 and associated circuit.
13	Connect the RF voltmeter to output connector J3.	500 mv	IF amplifier is operational; check AGC circuit.	Check Q8 and associated circuits.
14	Connect the RF voltmeter to Q9 collector	600 mv	Auxiliary output and AGC	Check Q9 and associated circuits. drive is operational.
		AGC circuit check		
15	Connect a multifunction meter to pin 7 of MD1.	-1.6 V dc	Proceed to step 16	Check Q9 and associated circuitry of MD1.
16	Connect a multifunction meter to pin 7 of MD1.	+2.8 V dc	Proceed to step 17	Check MD1 and associated circuits; check AGC power supply.
17	Connect a multifunction meter to Q10 collector.	+ 14 V dc	Proceed to step 18	Check Q10 and associated circuitry.

Step No.	Procedure	Normal indication	If indication is normal--	If indication is not normal--
18	Check the voltage drop across each varilosser diode as a follows:			
	CR3	0.4 V dc		Check associated varilosser circuit.
	CR5	0.4 V dc	t	
	CR7	18	ACG circuits operational	Replace CR1.
	CR7	0.4 Vdc		
	CR9	0.4 Vdc		
	CR6	0.44 V dc ,		
	CR4	0.53 V dc		
	CR2	0.18 V dc		
	CR1	18 V dc	AGC circuit is operational	Replace CR1.
19	On the test set, set the AGC/MAN potentiometer to its AGC position.			
20	Connect the RF voltmeter to connector J1.	-		
21	Set the VHF oscillator for 30+10 mv as indicated by the RF voltmeter.			
22	The AGC voltage is indicated by the multifunction meter.	0 to -3 V dc (max).		
23	Set the variable attenuator to provide 20 db attenuation.			
24	The AGC voltage is indicated by the multifunction meter.	-5.2 to -6.0 V dc (min).		
		Overall gain		
25	Connect a multifunction meter to test points TP1 and TP2 (ground).			
26	Adjust the AGC/MAN control until the test set meter indicates -6 volts.			
27	Adjust the sweep generator output controls to produce 0.5V rms as indicated by the RF voltmeter at J1. Disconnect RF voltmeter from J1.			
28	Connect the RF voltmeter to module connector J3.			
29	Using the variable attenuator, insert attenuation until the RF voltmeter indicated 0.5 V rms.			
30	Read and record the attenuation added	72 db (min).	End of test, Disconnect all test equipment.	

f. Intermodulation Distortion Test. This procedure is used to evaluate .the linearity characteristics of the IF amplifier module. The intermodulation distortion test is the final major performance test of the module. The levels and TM 11-5820-792-14 / TO 31 R5-4-50-71 frequency slots used in this test are based upon 600 channel loading conditions. A discussion of this type of test, and the modifications required for other channel loadings, appears in chapter 5. This test equipment setup is shown in figure 7-20.

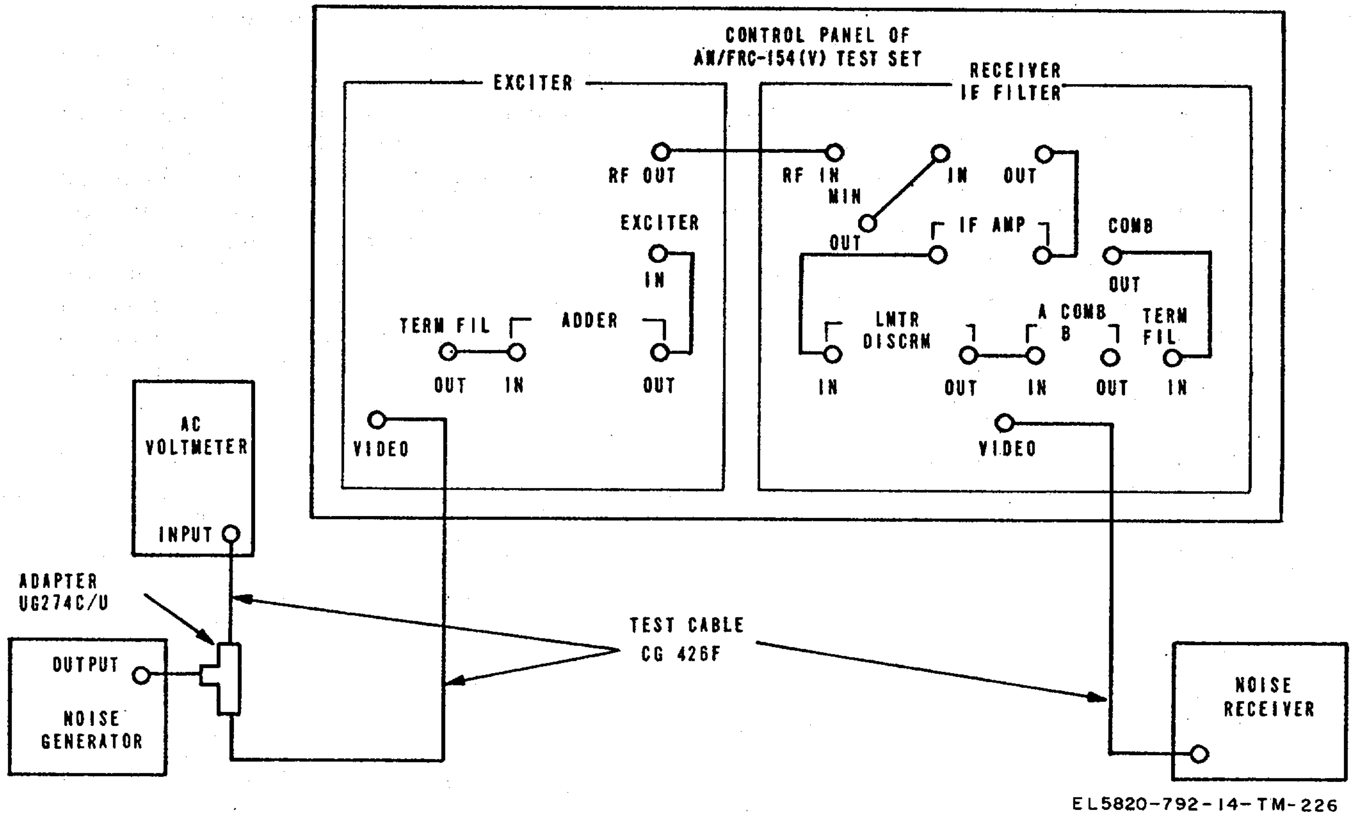

Figure 7-20. IF amplifier intermodulation distortion test equipment setup.

(1) Replace test set standard IF amplifier with IF amplifier under test.

(2) Configure test set for 600 channel noise power ratio test.

(3) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(4) Adjust the 28-volt power supply in the module test set for 28 + 0.5 V dc.

(5) Adjust the 6-volt power supply in the module test set for -6 + 0.5 V dc.

(6) Connect test set jumper cables as shown in figure 7-20. Set RF output attenuator for 0 db attenuation.

(7) Set noise generator output level to 12 mv (-27 dbm/75 ohms) as read on ac voltmeter. Set the noise generator high and low-pass filters to their IN positions and all bandstop filters to their OUT positions.

(8) Set the noise receiver frequency selector to 70 kHz, then adjust the attenuator controls to produce a meter reference indication.

(9) Read and record the attenuator setting of the noise receiver. Label the reading as reference 1.

(10) Switch in the 70-kHz bandstop filter on the noise generator.

(11) Set the attenuator controls of the noise receiver to produce the same level as reference 1.

(12) Read and record the attenuator settings of the noise receiver. Label the reading as reference 2.

(13) Subtract reference 1 from reference 2 to obtain the noise power ratio at the 70-kHz slot.

The resulting noise power ratio shall be 55 ± 1 db.

(14) Set the 70-kHz bandstop filter switch to its out position.

(15) Repeat steps (8) through (13) above using 1002 kHz instead of 70 kHz.

(16) Set the 1002-kHz bandstop filter switch to its out position.

(17) Repeat steps (8) through (13) above using 2438 kHz instead of 70 kHz.

(18) Disconnect all test equipment from the module test set.

(19) Remove the module under test from the module test set.

(20) Replace the standard IF amplifier module test set. This step completes the procedure.

g. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, the voltage and resistance data provided in *h* below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Ac voltage measurements are made with an RF voltmeter and high-impedance probe with -6 V dc applied to the AGC bus and 30 m v at 70 MHz applied to J1. Dc voltage measurements are made with no signal input. Resistance measurements are made using the multifunction meter. All voltages are measured using the test setup given in *h* below. The multifunction meter is also used to measure dc voltages. For ac voltage measurements, use the RF voltmeter.

CAUTION

Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if this voltage exceeds 1.5 volt. Also since the R x 1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more) may damage the transistor under test. As a general rule, it is not recommended that the R x 1 range of any ohmmeter be used when testing low-power transistors.

h. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unless other wise specified
Q1	Base	0.8 V	8.5 mv	850 ohms
	Emitter	0.8 V	6.0 mv	16 ohms R X
	Collector	6.0 V	14.5 mv	5 kΩ
Q2	Base	0.75 V	14.5 mv	350 ohms
	Emitter	0	0	0
	Collector	4.6 V	155 mv	2.2 kΩ
Q3	Base	0.8 V	17.5 mv	850 ohms
	Emitter	0.8 V	11.5 mv	16 ohms (RX 1)
	Collector	6.0 V	22 mv	5 kΩ
Q4	Base	0.75 V	22 mv	350 ohms
	Emitter	0	0	0
	Collector	4.6 V	250 mv	2.2 kΩ
Q5	Base	0.8 V	13.0 mv	850 ohms
	Emitter	0.8 V	8.5 mv	16 ohms (R X 1)
	Collector	6.0 V	23.0 mv	5 kΩ
Q6	Base	0.75 V	23.0 mv	350 ohms
	Emitter	0	0	0
	Collector	4;6 V	200.0 mv	2.2 kΩ
Q7	Base	0.85	38.0 mv	850 ohms
	Emitter	0.1	22.5 mv	16 ohms RX1
	Collector	4.0 V	53.0 mv	4 kΩ
Q8	Base	12.3 V	47.0 mv	1.3 kΩ
	Emitter	13 V	6.0 mv	420 ohms
	Collector	28 V	1.0 V	1 kΩ
Q9	Base	21.3 V	165 mv	2.2 kΩ
	Emitter	22 V	175 mv	1.7 kΩ
	Collector	28 V	600 mv	1 kΩ
Q10	Base	-6.1 V	:	1.3 kg
	Emitter	-6 V		2.2 kΩ
	Collector	+18 V		3.3 kΩ
(MD1)	1	0		0
2		-1.65 V		1.2 kΩ
3		-1.65 V		1.2 kΩ
4		-6 V		600 ohms
5		-0.5 V		3.9 kΩ
6		-5.0 V		3.3 kΩ
7		-5.6 V		1.7 kΩ
8		+11.0 V		1.9 kΩ

7-31. Alignment Data

a. General. The following procedures should be performed as a part of scheduled maintenance after repairs have been made to the module.

NOTE

The IF amplifier module contains many tuned circuits which must be carefully aligned to obtain optimum module performance. The arrangement of the procedures in this section is based on a requirement for a complete realignment.

b. Test Equipment Setup. The test equipment setup used for the alignment and adjustment procedures is the same as that described in paragraph 7-30 b, unless otherwise indicated in the procedure.

c. Preliminary Adjustments. When the test setup is completed, perform the preliminary adjustments listed in paragraph 7-30c.

d. Amplifier Adjustment. This alignment sets the overall bandpass of the IF amplifier. The AGC voltage is held at a fixed value during alignment.

(1) Connect the sweep generator RF output to the electronic counter.

(2) Set the sweep generator to the CW mode, and adjust its center frequency to 70 MHz using the electronic counter.

(3) Disconnect the sweep generator from the electronic counter, and connect the generator to the variable attenuator.< (4) Connect the multifunction meter to test points TP1 and TP2 (ground).

(5) Adjust the AGC/MAN potentiometer, in MAN, until the multimeter indicates -0.5 V dc.

(6) Set the vertical controls of the oscilloscope to .1 Vs/CM and calibrate.

(7) Set the RF sweep output level to midpoint.

(8) On the sweep generator, switch in the 70MHz fixed marker.

(9) Adjust the sweep generator frequency to center the marker on the oscilloscope display.

(10) On the sweep generator, switch in the 5.0-MHz harmonic marker.

(11) Adjust the oscilloscope horizontal gain and sweep generator sweep width controls to obtain a 30-MHz trace centered on 70 MHz.

(12) Adjust the vertical gain of the oscilloscope to obtain a trace that is 4 cm high.

(13) On the IF amplifier module, adjust capacitors C38, C42, and C44 for a response curve as shown in figure 7-21. Use variable capacitors C14, C29, and C57 for peaking the response. Use capacitor C77 to flatten the response.

(14) The IF amplifier must conform to the specifications set forth in figure 7-21.

(15) Disconnect all test equipment unless performing complete alignment.

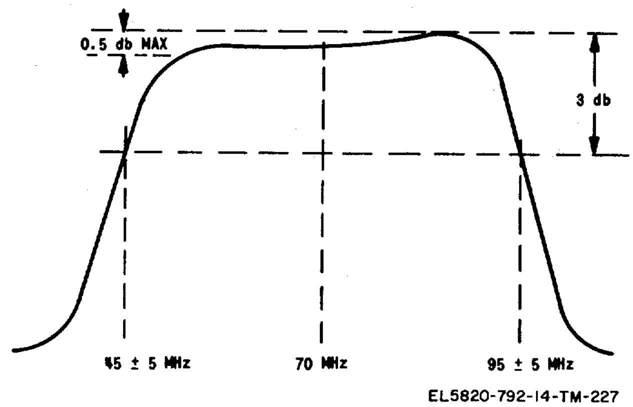

Figure 7-21. IF amplifier module band-width waveform.

e. AGC Adjustment. This adjustment sets the operating point of the AGC circuit when the 70-MHz IF input signal is unmodulated.

(1) Set the mode control of the sweep generator to its CW position.

(2) Set the variable attenuator for zero db attenuation.

(3) Adjust the AGC/MAN potentiometer, in the MAN position, for zero volts.

(4) Set the sweep generator frequency to 70 MHz. Verify the output frequency using the electronic counter.

(5) Connect the RF voltmeter to module connector J1.

(6) Set the sweep generator output level controls to provide 20 mV as indicated by the RF voltmeter. Disconnect RF voltmeter.

(7) Connect RF voltmeter to module connector J3.

(8) On the IF amplifier module, adjust potentiometer R80 for an RF voltmeter indication of 0.5 volt if the module is used with limiter discriminator modules, or 0.3 volt if the module is used with phase lock modules.

(9) Using the variable attenuator, insert 20 db attenuation.

(10) Note that the output voltage indicated by the RF voltmeter does not change. Disconnect the RF voltmeter from J3.

(11) Connect the RF voltmeter to module connector J1.

(12) Set the sweep generator output level controls to 45 mv as indicated by the RF voltmeter. Disconnect RF voltmeter.

(13) Connect RF voltmeter to module connector J3.

(14) Using the variable attenuator, insert 50 db attenuation.

(15) Note that the output voltage indicated by the RF voltmeter does not change by more than 1 db.

(16) Disconnect all test equipment unless performing complete alignment.

f. Maximum Gain Response. This test is performed after alignment to determine whether or not the bandpass and AGC circuits are functioning properly with respect to each other.

(1) Mount both covers on the IF amplifier module.

(2) Connect the RF voltmeter to module connector J1.

(3) Set the sweep generator mode controls to the CW position.

(4) Set the sweep generator frequency to 70 MHz. Verify the output frequency using the electronic counter.

(5) Set the AGC/MAN potentiometer on the test set to MAN and adjust for -6 v on the test set meter.

(6) Set the sweep generator output level controls to provide 20 mv as indicated by the RF meter. Then set the mode controls to the sweep position.

(7) Adjust the AGC/MAN potentiometer until the oscilloscope indicates a signal attenuation of 10 db.

(8) Adjust the oscilloscope vertical controls for a 4 CM display height.

(9) The IF amplifier must conform to the specifications in figure 7-22.

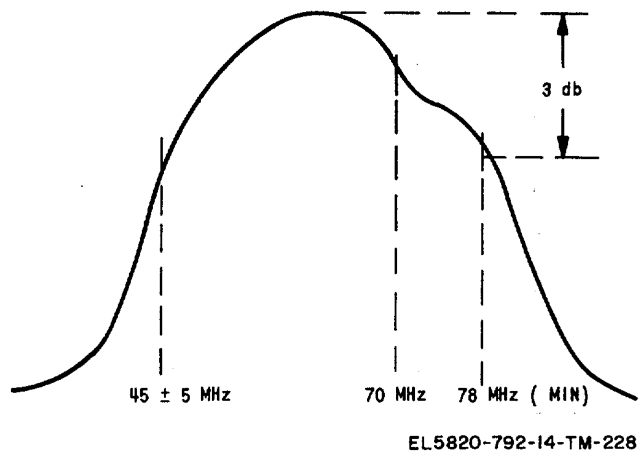

Figure 7-22. IF amplifier module, maximum gain waveform.

Section VII. KLYSTRON DRIVER MODULE (368-43490-3, -4, AND -5, -7, -8, AND -9)

7-32. Introduction

The Klystron driver module is a module belonging to the microwave transmitter which performs the functions of signal amplification, preemphasis processing, and signal injection into the modulator unit.

7-33. Module Configurations

a. The Klystron driver module consists of a single printed-wiring card on which all components are mounted, with the exception of controls, test jacks, and connectors. The latter components are mounted on the front flange of the metal module chassis.

b. The module can be equipped with a telephony preemphasis network; this is mounted on a separate printed-wiring card and is secured to the main printed-wiring card. Several different preemphasis networks having different frequency characteristics are available for use with the klystron driver module. The network used in a given application depends upon the channel loading of the particular system.

c.Module configuration data follows:

Klystron driver module part No.	Preemphasis network part No.	Channel capacity	f_{max} kHz
368-43490-3	368-41959-7	300	1300
368-43490-4	368-41959-5	120	552
368-43490-5	368-41959-2	60	300
368-43490-7	368-41959-1	24	108
368-43490-8	368-41959-4	60	300
368-43490-9	368-41959-3	180	804

7-34. Functional Description

a. A functional block diagram of the Klystron driver is shown in figure 6-65. The multiplex path uses a three-stage feedback amplifier at the input to provide gain of approximately 13 db. Following amplification, the multiplex baseband is sent into a preemphasis network, which introduces a 5 db loss at pivot frequency. The preemphasis network is used to shape the transmit baseband signal so that the high end of the baseband frequencies is amplified more than the low end. The selection of the type of preemphasis network used in a system depends upon the channel capacity required.

b. Two modes of operation can be selected by means of a switch on the klystron driver. The first mode is the multiplex baseband mode. The baseband signal is amplified and processed by the preemphasis network prior to insertion into the high-level output amplifier stages. The second mode is the television/data mode. In this last mode, the television/data signal is sent directly into the high-level output amplifier stages; the multiplex amplifier and the preemphasis network are automatically terminated in this mode. The termination of the multiplex path permits the television/data signal to enter the high-level amplifier chain without interference from the multiplex path, even though the baseband signal may still be present at the input of the module. The overall gain of the high-level amplifiers is 44 db.

7-35. Circuit Analysis

a. The schematic diagram of the module appears in figure FO-24. Resistor R3 is the 75-ohm input termination for the multiplex amplifiers. Resistors R6 and R7 in conjunction with R8 are base-biasing resistors for Q1. Resistor R6 also provides degenerative feedback to stabilize the gain of amplifier Q1. Direct coupling is' used to couple the baseband signal from amplifier Q1 into amplifier Q2. Resistors R11 and R12 are emitter resistors for the second amplifier stage; the voltage gain of this amplifier is heavily dependent upon the value of resistor R11. Capacitors C4 and C6 bypass resistor R12 to ground. Direct coupling is also used to couple the baseband signal into emitter-follower Q3. Direct coupling in these cases provides excellent low-frequency response and eliminates undesired phase shifts. A portion of the baseband signal developed in the output of emitter-follower Q3 is taken across resistor R15 and injected via capacitor C5 into the emitter circuit of input amplifier. Q1. The signals at the emitters of Q1 and Q3 are in phase and provide degenerative feedback to increase bandwidth and stabilize amplifier gain.

b. The A3 assembly is the preemphasis network. The preemphasis network is made up of two fixed resistors, R1 and R2, three AR (as required) capacitors, C1 through C3, and one AR adjustable inductor. The values of the as-required circuit elements are listed in figure FO-24. During transmitter alignment, inductor L1 is adjusted for a peak response at its resonant frequency. In some cases, preemphasis networks are not required; when this situation prevails, resistor R18 is used in place of the preemphasis network to introduce the 5-db signal loss without baseband shaping.

c. Single-pole double-throw switch S1 is the mode-selecting switch of the Klystron driver module. When the switch is placed in the MUX position, the multiplex amplifiers and the preemphasis network are connected to the highlevel modulator driver amplifiers. Potentiometer R1 and resistor R4, connected in parallel, terminate the preemphasis network in 75 ohms. The multiplex level into the high-level amplifiers is adjusted by use of potentiometer R1,. and can be measured at test point TP3. Notice that TV/DATA coaxial connector J2 is always connected to 75-ohm input terminating resistors R1 and R4. When the switch is placed in the TV/DATA position, the multiplex amplifier chain is disconnected from the high-level driver amplifiers and is transferred into 75-ohm termination resistor R20.

d. The high-level amplifier chain receives its dc operating potentials from a 120-volt dc source in the klystron power supply via connector J4-K.

e. The baseband signal is sent through its coupling circuit into the base of amplifier Q4. Resistor R21 serves the dual purpose of biasing and baseband voltage feedback from collector to base. The output signal is coupled from the output of transistor Q4 to the input of transistor Q5 by capacitor C10. Transistor Q6 is direct-coupled to amplifier Q5 collector. Transistor Q6 is an emitter-follower which shares a portion of its emitter resistance with transistor Q4 for degenerative feedback purposes to stabilize amplifier gain and to obtain a wide bandpass characteristic. Capacitor C11 bypasses resistor R30 to eliminate high frequency peaking. The output level and gain of this first high-level triplet amplifier can be measured between test points TP5 and TP6 (ground); the gain of this unit should be 18 db, but the output level depends upon the amount of deviation required.

f. Capacitor C13 and resistor R32 couple the baseband signal into the second high-level amplifier triplet. This amplifier is similar to the previously explained triplet. Diode CR1 is a protective element. If a short circuit, for instance, were to develop in the klystron reflector circuit, diode CR1 would become reverse-biased into cutoff to isolate amplifier Q7 from the high voltage discharge of capacitor C20 through resistors R50, R45, R44, R40, and R37. Diode CR2 is a Zener diode, which sets the proper quiescent current flow through transistor Q8.

This eliminates the need for the use of a resistor and bypass capacitor combination, which would degrade the low frequency response. Inductor L1 is a peaking coil used to flatten the bandwidth response of the amplifier. Recall that for low frequencies, inductor L1 has a negligible effect, while resistors R41 and R42 constitute the basic load impedance; for high frequencies, inductor L1 interoperates with collector capacitance to boost the high frequency response. The two transistors, Q9 and Q10, are used to provide better current handling capabilities than is obtained by a single unit operating at the same temperature. Diode CR3 protects the final amplifiers, Q9 and Q10, from troubles likely to develop in the Klystron circuit. Most troubles would cause capacitor C20 to reflect a positive voltage back toward Q9 and Q10. In such cases. CR3 becomes reverse-biased to cut-off to isolate the final amplifier from the discharge path. In addition, diode CR4 becomes forward-biased for such emergencies and provides a safe discharge path for capacitor C20 through capacitor C18.

g. Figure 6-66 shows how the klystron tube and klystron power supplies are interconnected as far as their effect on the klystron driver module is concerned. Klystron reflector current is passed through resistor R55, as shown in figure FO-24, which is connected in series with the klystron reflector and the negative line of the 450-volt klystron supply. Capacitor C21 establishes an ac ground between the klystron driver signal circuits and the high voltage dc supply. Capacitor C20 feeds the modulating baseband to the reflector of the klystron. Diode CR5 insures that the klystron reflector never goes positive at any time. Resistor R54, in series with diode CR5, limits the maximum direct current through CR5 whenever conduction occurs.

h. Depending upon system requirements, the final modulating signal is monitored for pilot-tone continuity. When required, the baseband is coupled from collector load resistor R47 through resistor R48 and capacitor C19 to an external connector, J3. Resistor R53 terminates this output line. The frequency response on this line is only intended to be sufficient to pass the pilottone signal.

i. Technical characteristics are as follows:

Parameter	*Specifications*
MUX input impedance	75 ohms unbalanced.
TV/DATA input impedance.	75 ohms unbalanced.
Output impedance	Low impedance to drive klystron.
MUX input level	-40 dbm.
TV/DATA input level	-32 dbm.
Output level	800 mv SCTT.
MUX gain	40 db.
TV/DATA gain	32 db.
MUX frequency response	200 Hz to 2.8 MHz +0.2 db.
TV/DATA frequency response.	20 Hz to 9 MHz + 0.2 db.
Power requirements	140 ma at 120 V dc. 50 ma at 28 V dc.

7-36. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following paragraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. The initial test equipment setup for the klystron drive module appears in figure 7-23.

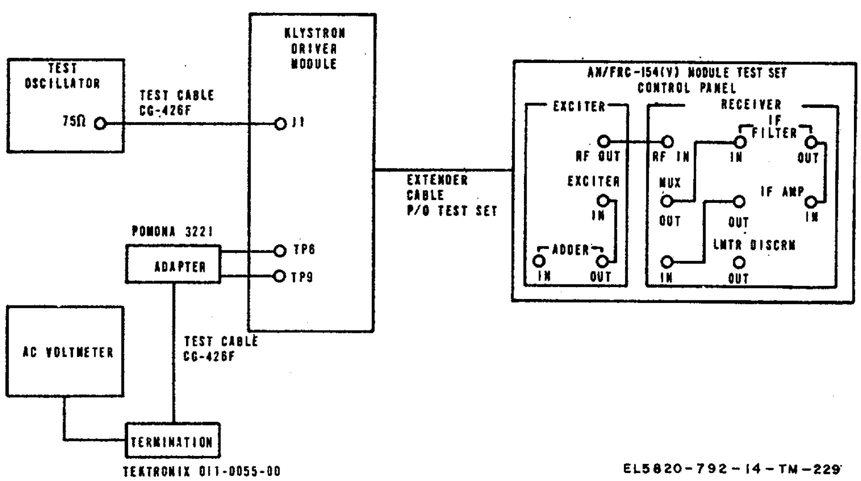

Figure 7-23. Klystron driver module initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

WARNING

Dangerous voltages exist in this equipment. Be careful when working on the +120-volt power supply circuit. Observe the necessary safety precaution.

(1) Remove the top and bottom covers from the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the +120-volt test set power supply for 120 ± 0.3 V dc.

(4) Adjust the +28-volt test set power supply for 28 ±0.3 V dc.

d. Test Procedures. Figure 6-68 contains parts location data.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Amplifier signal gain		
1	Check resistance between each ground lug and mounting plate, using multi-function meter as an ohmmeter.	0 ohms	Proceed to step 2	Resolder and repair faulty connections.
2	Connect test oscillator to J1.			
3	Place switch S1 in MUX position.			
4	Set frequency of test oscillator to 100 kHz.			
5	Connect ac voltmeter to TP1 and TP2 (ground).			
6	Adjust output level control of test oscillator for indication of -40 db (2.7 mv) on ac voltmeter.			
7	Connect oscilloscope probe to emitter of Q3	100-kHz sine wave, 215 mv peak-to-peak.	Proceed to step 8	Check transistors Q1, Q2, and Q3 and associated corn-ponents.
8	Connect oscilloscope probe to test points TP9 and TP6 (ground).	100-kHz sine wave, 2.35 V peak-to-peak.	Proceed to step 12	Proceed to step 9.
9	Connect oscilloscope probe to emitter of Q6	100-kHz sine wave, 280 mv peak-to-peak.	Proceed to step 10	Check transistors Q4, Q5, and Q6 and associated compo-nents; check gain align-ment.
10	Connect oscilloscope probe to emitter of Q9	100-kHz sine wave, 2.35 V peak-to-peak.	Proceed to step 11	Proceed to step 11.
11	Connect oscilloscope probe to emitter of Q10	100-kHz sine wave, 2.35 V peak-to-peak.	Check resistors R50, R54, and R55 and capacitor C20: pro-	Check transistors Q7. Q8, Q9, and Q10 and associated components.
		Bandwidth check		
12	Replace preemphasis network (if provided) with 110-ohm resistor.			
13	Connect ac voltmeter to TP1 and TP2 (ground).			
14	Set frequency of test oscillator to 1 kHz.			
15	Adjust output level control of test oscillator for indication of -40 db on ac voltmeter.			
16	Connect ac voltmeter to test points TP9 and TP6 (ground).	0 dB ±0.2 db	Proceed to step 17	Check gain alignment.
17	Repeat steps 13, 14, 15, and 16 using the following test frequencies: 200 Hz 10 kHz 100 kHz 2.8 MHz	Level recorded in step 17 ± 0.2 db.	Proceed to step 18	Repeat steps 1 through 11.
18	Connect test oscillator to J2.			
19	Place switch S1 in TV/DATA position.			
20	Connect ac voltmeter to TP4 and TP2 (ground).			
21	Set frequency of test oscillator to 1 kHz.			
22	Adjust output level control of test oscillator for indication of -32 db on ac voltmeter.			
23	Connect ac voltmeter to test points TP9 and TP6 (ground).	-3 db ±0.2 db	Proceed to step 24	Check gain alignment.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
24	Repeat steps 20, 21, 22, and 23 using the following test frequencies: 20 Hz 100 Hz 10 kHz 10 kHz 500 kHz	Level recorded in step 23 ± 0.2 db.	Proceed to step 25	Repeat steps 1 through 11.
25	Connect ac voltmeter to TP4 and TP2 (ground).			
26	Set frequency of test oscillator for 500 kHz.			
27	Adjust output level control of test oscillator for indication of -32 db on ac voltmeter.			
28	Connect high impedance probe of RF voltmeter to test point TP9 and TP6 (ground).	-15.2 db ± 0.2 db	Proceed to step 29	Check gain alignment.
29	Repeat steps 26, 27, and 28 using the following test frequency: 7.5 MHz	Level recorded in step 28 ± 0.2 db.	Proceed to step 30	Check high frequency alignment, paragraph 7-37.
30	Reconnect the preemphasis network (if provided).			
		Diode check		
31	Check forward resistance of diode CR5 by connecting an Ohmmeter to test point TP8 and to TP9; then check reverse resistance by reversing the ohmmeter connections.	Low resistance for forward conduction; resistance more than 10 times greater for reverse conduction.	Test is complete. Disconnect all test equipment. Replace module covers.	Replace diode CR5.

f. Intermodulation Distortion Test. This procedure is used to check the linearity characteristics of the klystron drive module. The intermodulation distortion test is used as the concluding major performance test of the module. The levels and frequency slots used in this test are based upon 600-channel loading; for a discussion of this type of test and its modification to other channel loading factors, refer to chapter 5. The test equipment setup is shown in figure 7-20; and the test is performed as outlined in paragraph 730 f, with the standard klystron driver replaced, rather than the IF amplifier. The klystron driver must be equipped with a 600-channel preemphasis network.

g. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data in h below in conjunction with standard troubleshooting techniques, should enable location and correction of the fault.

CAUTION

Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter of this voltage exceeds 1.5 volt. Also, since the R x 1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 mA or more) may damage the transistor under test. As a general rule, it is not recommended that the R x 1 range of any ohmmeter be used when testing low-power transistors.

NOTE

All voltages are measured using the test setup of b above. The multifunction meter is also used to measure dc voltages. For ac voltage measurements, use the oscilloscope.

WARNING

Dangerous voltages exist in this equipment. Be careful when working on the +120-volt power supply circuit. Observe the necessary safety precautions.

h. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unless otherwise specified
Q1	Base	3.5 V	20 mv	910
	Emitter	2.8 V	20 mv	340
	Collector	13.0 V	12 mv	1.9 kΩ
Q2	Base	13.0 V	12 mv	1.9 kΩ
	Emitter	12.3 V	11 mv	1.22 kΩ
	Collector	21.0 V	220 mv	1.17 kΩ
Q3	Base	21.0 V	220 mv	1.17 kΩ
	Emitter	20.3 V	215 mv	290
	Collector	27.0 V	0 mv	1.14 kΩ
Q4	Base	4.0 V	32 mv	1.06 kΩ
	Emitter	3.4 V	32 mv	80
	Collector	18.2 V	60 mv	3.3 kΩ
Q5	Base	5.4 V	60 mv	1.2 kΩ
	Emitter	4.8 V	60 mv	320
	Collector	21.0 V	280 mv	1.9 kΩ
Q6	Base	21.0 V	280 mv	1.9 kΩ
	Emitter	20.0 V	280 mv	1.26 kΩ
	Collector	42.0 V	0 mv	1.7 kΩ
Q7	Base	9.2 V	250 mv	2.7 kΩ
	Emitter	8.7 V	250 mv	900
	Collector	40.5 V	310 mv	6.5 kΩ
Q8	Base	11.7 V	310 mv	3.7 kΩ
	Emitter	11.1 V	310 mv	0
	Collector	69.5 V	2.4 mv	4.5 kΩ
Q9	Base	69.5 V	2.4 mv	4.5 kΩ
	Emitter	69.0 V	2.35 mv	3.0 kΩ
	Collector	108.0 V	100 mv	2.70 kΩ
Q10	Base	69.5 V	2.4 mv	4.5 kΩ
	Emitter	69.0 V	2.35 mv	3.0 kΩ
	Collector	108.0 V	100 mv	2.79 kΩ

[a] Input signal at J1, switch S1 in MUX position
Q1 through Q3: 100-kHz test signal, input level of 7.8 mv rms at TP
Q4 through Q10: 100-kHz test signal, input level of 13 mv rms at TP3.
[b] Using a multimeter on the R x 100 scale with the COMMON (-) lead grounded.

7-37. Alignment Data

a. General. The following procedures should be performed as a part of scheduled maintenance and after repairs have been made to the module. Certain system parameters are imposed on the microwave radio terminal which dictate the settings of the various module controls. The klystron driver module uses potentiometer R1 to control transmitter deviation sensitivity. Refer to chapter 5 for alignment procedures involving these components.

NOTE

The klystron driver module contains peaking circuits which must be carefully aligned to obtain optimum module performance. The arrangement of the procedures in this section is based on a requirement for a complete realignment.

b. Test Equipment Setup. The test equipment setup for the alignment is the same as that described in paragraph 7-36. Unless otherwise indicated in the procedure.

c. Preliminary Adjustments. When the test setup is completed, perform the preliminary adjustments listed in paragraph 7-36.

d. Gain Adjustment. This adjustment sets a standard level into the high-level amplifiers of the klystron driver.

(1) Place switch S1 in the TV/DATA position.

(2) Connect the test oscillator to J2.

(3) Connect the ac voltmeter to TP4 and TP2 (ground).

(4) Set frequency of test oscillator for 500 kHz.

(5) Adjust output level control of test oscillator for indication of -32 db on ac voltmeter.

(6) Connect high-impedance probe of RF voltmeter between test points TP9 and TP6.

(7) Adjust potentiometer R1 for a reading of -15.2 db on the RF voltmeter.

e. High Frequency Alignment. This alignment peaks the high frequency response of the highlevel amplifiers.

(1) Set frequency of test oscillator for 7.5 MHz.

(2) Adjust output level control of test oscillator for indication of -32 db on ac voltmeter.

(3) Adjust capacitor C16 for a reading of --15.2 db on the RF voltmeter.

f. Preemphasis Network Alignment. Several different preemphasis networks may be used with the klystron driver module (as shown in figure FO-24). The following procedure is applicable for aligning any of the standard networks. Subparagraph g below provides a list of the data required for aligning the standard preemphasis networks. Reference to this chart is made throughout the alignment procedure. The initial test equipment setup for aligning the preemphasis networks appears in figure 7-24.

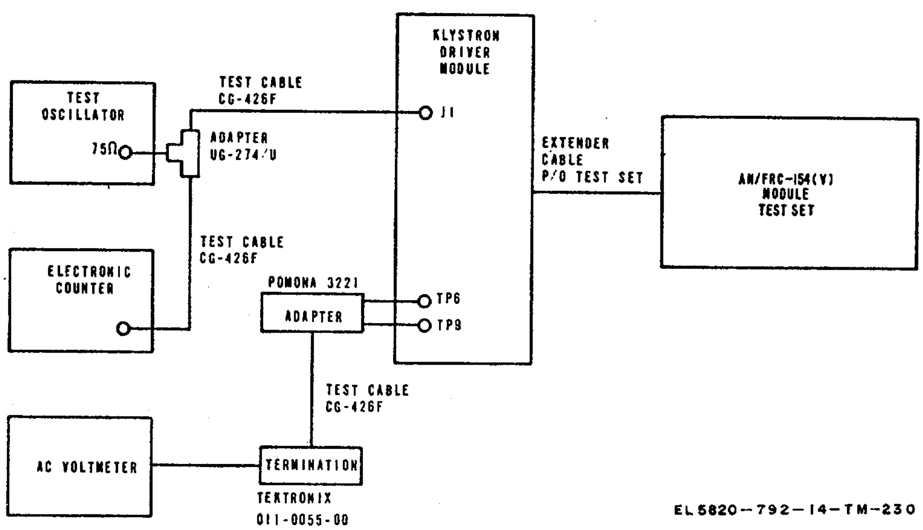

Figure 7-24. Klystron driver module preemphasis network alignment, initial test equipment setup.

(1) Place switch S1 in the MUX position.

(2) Connect the ac voltmeter to TP1 and TP2 (ground).

(3) Set the frequency of the test oscillator to f_{res} as shown in the chart above. An electronic

frequency counter should be used for this purpose.

(4) Connect the test oscillator to J1.

(5) Adjust the level control of the test oscillator for a reading of --43 db on the ac voltmeter.

(6) Connect the ac voltmeter to test points TP9 and TP6 (ground).

(7) Adjust inductor L1 on the preemphasis board for a peak reading on the ac voltmeter. Note the reading.

(8) Connect the ac voltmeter to TP1 and TP2 (ground) .

(9) Set the frequency of the test oscillator to pivas specified in table above.

(10) Adjust the level control of the test oscillator for a reading of --43 db on the ac voltmeter.

(11) Connect the ac voltmeter to test points TP9 and TP6 (ground).

(12) Make note of the reading on the ac voltmeter.

(13) Repeat steps (8) through (12) above for f_{max} and f_{min}

(14) Compare the four readings to the standard, as shown in h below. Disconnect all test equipment.

g. Alignment Data.

Preemphasis network	Channel capacity	Frequency $^{(f)}$			
		^{f} res	^{f} piv	^{f} min	^{f} max
368-41959-3	180	1005 kHz	489 kHz	80 kHz	804 kHz
368-41959-4	60	315 kHz	153 kHz	25 kHz	252 kHz
368-41959-5	120	690 kHz	337 kHz	55 kHz	552 kHz
368-41959-7	300	1625 kHz	790 kHz	130 kHz	1300 kHz
368-41959-8	600	3175 kHz	1544 kHz	254 kHz	2540 kHz

h. Alignment Voltage Level.

Frequency	*Level*
f_{res}	Level at f_{piv} +5 db ± 0.2 db.
f_{piv}	Reference
f_{max}	Level at f_{piv} +4 db ± 0.2 db.
f_{min}	Level at f_{piv} -3.8 db ± 0.3 db.

Section VIII. LIMITER-DISCRIMINATOR MODULE (398-43489-2 THROUGH -5, -7, AND -9, AND 398-11470-1 THROUGH -9)

7-38. Introduction

The limiter-discriminator module, which belongs to the microwave receiver, provides amplitude limiting and demodulation of the 70-MHz frequency-modulated IF signal.

7-39. Module Configurations

a. The limiter-discriminator module consists of a single printed-wiring card (A2) on which all components, with the exception of controls, test jacks, and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis (A1). The 368-43489 series limiter-discriminator modules feature a dc input connector which is an extension of the printed-wiring card through the rear flange of the

metal module chassis. The 398-11470 series modules lack this extension; instead, a 15-pin connector is fastened to the rear flange of the metal module chassis, which is then hard-wired to the main printed-wiring card. The limiter discriminator has provisions for the inclusion of deemphasis network (A3) in its output circuit. Several different deemphasis networks, having different frequency characteristics are used in this module. The network used in a given application depends upon the channel loading of a particular system.

b. Module configuration data follows.

Limiter-discriminator module part No.	Limiter-discriminator module part No.	Demphasis network part No.	Channel capacity	f_{max} (kHz)
368-43489-2	398-11470-2	398-11360-1	24	108
368-43489-3	398-11470-3	398-11360-2	60	252
368-43489-4	398-11470-4	398-11360-3	60	300
398-43489-5	398-11470-5	398-11360-4	120	552
368-43489-7	398-11470-7	398-11360-6	300	1300
398-43489-9	398-11470-9	None	Any	Any

7-40. Functional Description

a. A functional block diagram of the module appears in figure 7-25. The frequency-modulated 70-MHz IF signal from the IF amplifier module is applied to the 75-ohm termination pad through coaxial connector J1. This signal is then processed by a phase equalizer to minimize any envelope delay distortion within the module. Following equalization, the signal is amplified before delivery to the limiters.

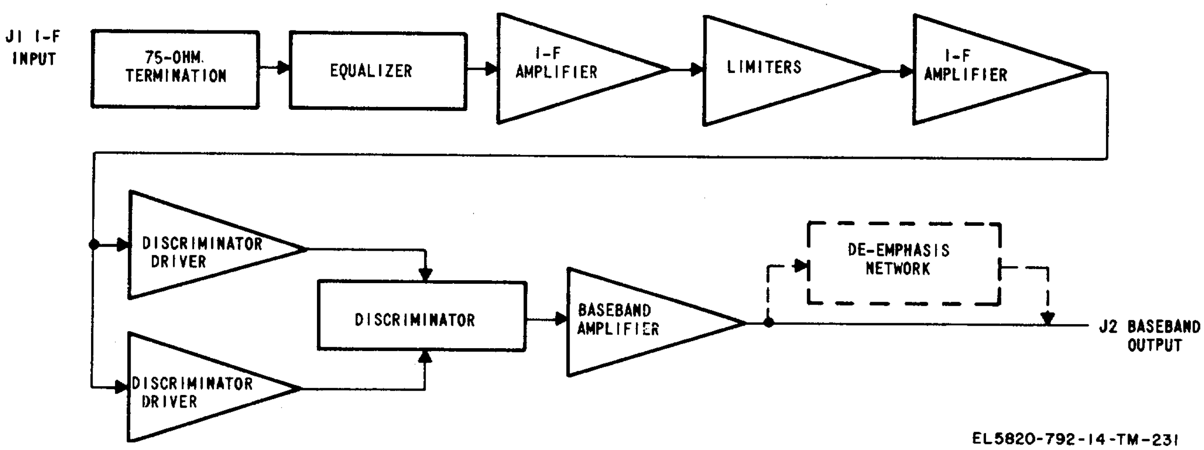

Figure 7-25. Limiter-discriminator module, functional block diagram.

b. The three-stage limiters are peak-clipping amplifier; clipping occurs at approximately 0.7 volt rms to remove any amplitude variations in the IF signal. The IF signal is amplified once more, then it is applied to two detector driver stages. The detector drivers are used to prevent distortion at low signal levels.

c. The demodulator is a Travis discriminator which provides better linearity over a wider passband than other types of discriminators. The discriminator is then followed by an amplifier and two impedance transformation stages.

d. Certain limiter discriminators do not include a deemphasis network although space and terminations for the deemphasis network have been allocated within the module. The deemphasis submodules used are listed in paragraph 7-39.

7-41. Circuit Analysis

a. The schematic diagram of the module appears in figure FO-25. The frequency-modulated 70-MHz IF signal from J1 of the limiter-discriminator module is applied to a 75-ohm termination pad consisting of resistors R1, R2, and R3. This pad also terminates the input of the phase equalizer. The phase equalizer consists of L1, C1, T1, C2, C3, and L2, and is used to minimize any envelope delay distortion within the module. The equalizer is terminated in 75 ohms by the network R4, R5, and T2.

b. The output signal from the equalizer is taken from the tap of transformer T2 and applied to the emitter of common-base amplifier Q1. Inductor L3 is the collector load for amplifier Q1. Its output signal is developed across the network C7, R9, and T3.

c. The output signal from amplifier Q1 is obtained from the tap of transformer T3 and passed into the first stage of three-element common base limiter amplifier. Limiting takes place in diodes CR1 and CR2, where the positive and negative peaks are clipped above 0.7 volt rms. The flat tops resulting from clipping action are restored to sinusoidal shape as the signal is sent through the output transformer T4 and coupling circuit C12 and R13 into the next limiter stage.

d. The output signal of the third limiter stage Q4, is coupled through a tapped transformer into a common-emitter amplifier Q5. Resistor R21 in the emitter circuit of amplifier Q5 directly affects the gain of the stage. Capacitor C26 is adjustable to match interstage impedances between the IF amplifier Q5, and the discriminator drivers Q6 and Q7. The discriminator driver stages Q6 and Q7, are used to increase the signal voltage levels sufficiently to prevent the diodes from operating at or near the nonlinear region of their characteristics. Inductor L15 and capacitor C32 are tuned to resonate above the 70-MHz center frequency; inductor L18 and capacitor C40 are tuned to resonate below the 70-MHz center frequency. Diodes CR7 and CR8 rectify the 70MHz signal. The rectified signal is filtered by Pitype filters consisting of C33, L16, and C34 on one side and C41, L19, and C42 on the other side. The 70-MHz IF signal is shunted to ground by these filters while the baseband signal is passed out of the discriminator into the baseband amplifier. Potentiometer R31 is a balancing control, which is adjusted to compensate for slight differences in efficiency of the two sides of the discriminator.

e. The baseband signal developed in the discriminator is applied to common-emitter amplifier Q8. Following this, the signal is sent through two emitter-followers Q9 and Q10, in cascade to drop the output impedance to 75 ohms. The baseband signal is delivered to coaxial connector J2. The A3 deemphasis stage is optional.

f. Technical characteristics are as follows:

Parameter	*Specifications*
Input impedance	75 ohms
Output impedance	75 ohms
Input level	5 dbm
Output level	-22 dbm/SCTT (200 kHz rms deviation).
Baseband response 1-db points	20 Hz to 10 MHz.

7-42. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following paragraphs contain procedures to test the performance of the overall module and its major circuits, and give probable causes of abnormal indication.

b. Test Equipment Setup. Connect module to module test set using extender card as shown in figure 7-26.

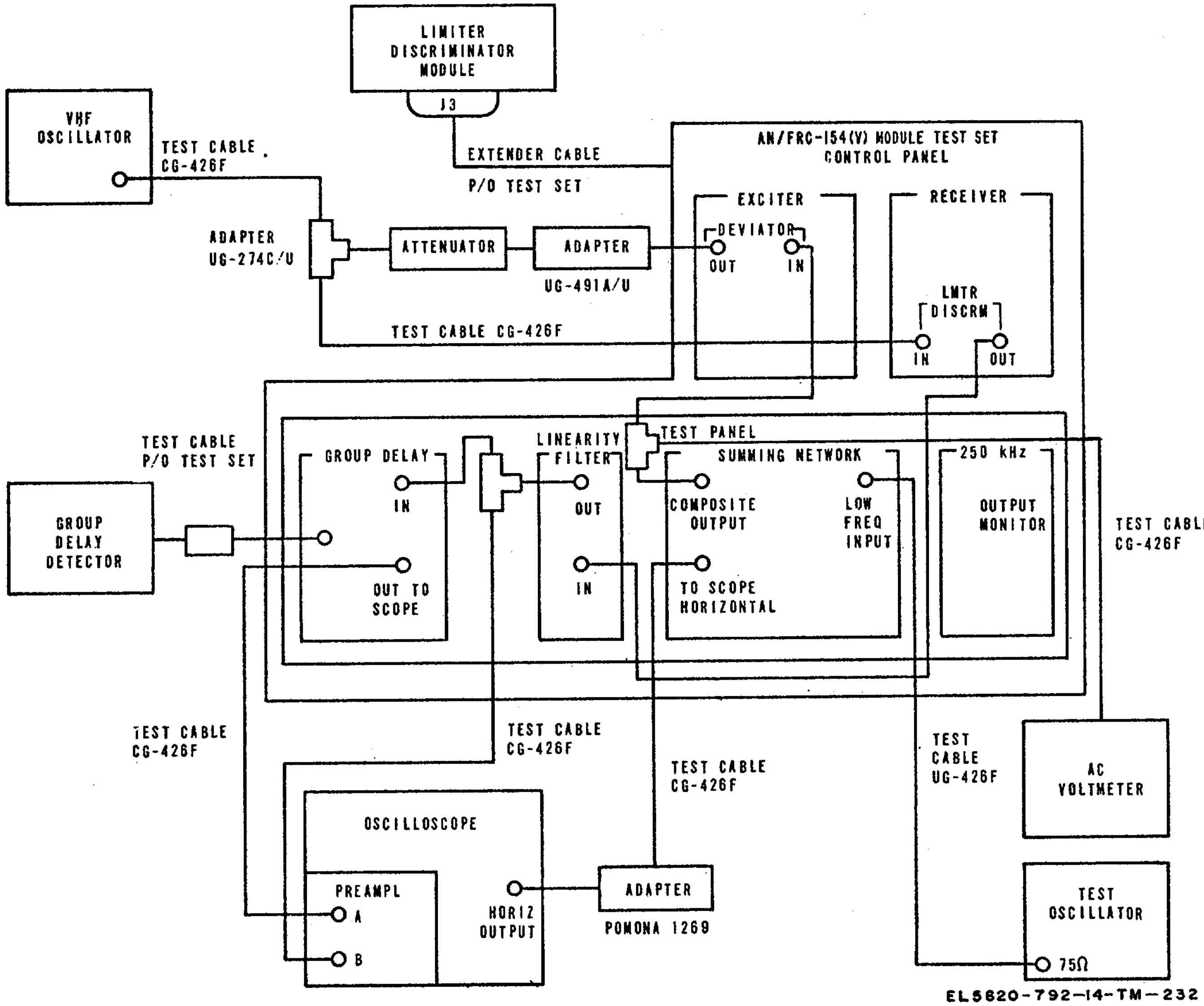

Figure 7-26. Limiter-discriminator module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove the top and bottom covers from the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the +28-volt power supply in the module test set for +28 + 0.1 V dc.

(4) Strap out the deemphasis network for all frequency response tests.

d. Test procedures. After completing procedures in b and c above, perform the procedures provided in e below. Figures 6-101, 727 and 7-28 contain parts location data.

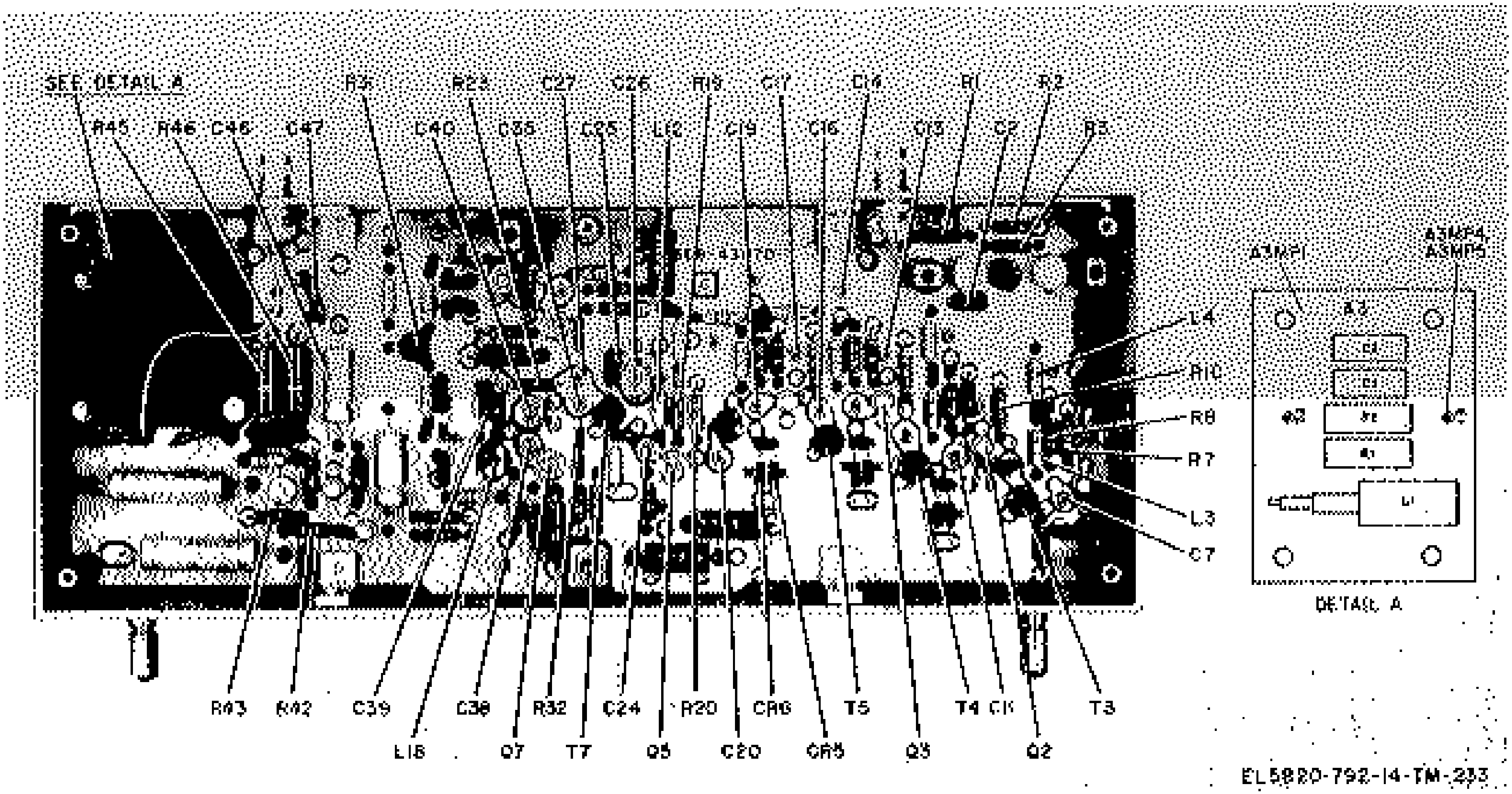

Figure 7-27. Limiter-discriminator module parts location diagram.

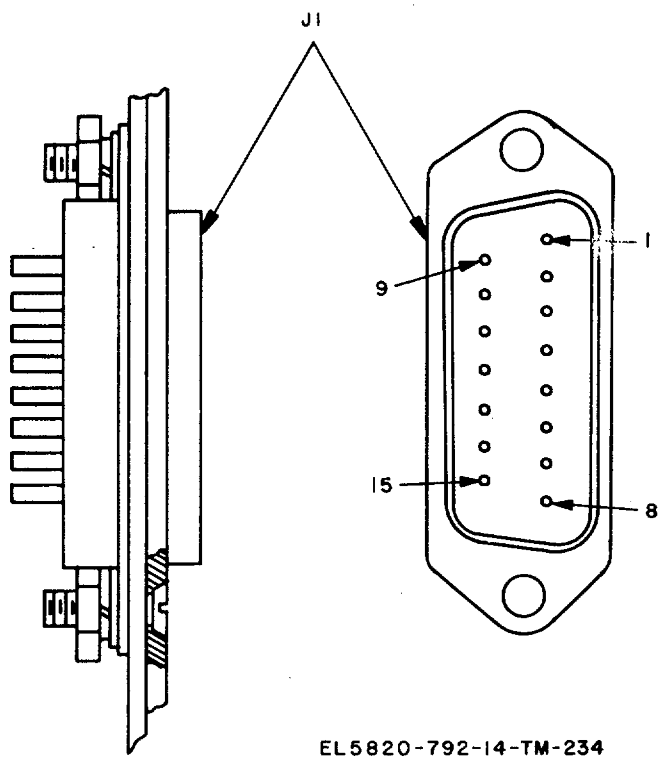

Figure 7-28. Details of 15-pin connector for limiter-discriminator.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Differential gain and group delay		
1	Connect the test set control panel DEVIATOR OUT to the LMTR DSCM IN using the test cable, adapters, and step attenuator. Set the step attenuator for 5 db loss.			
2	Adjust the test oscillator frequency to 100 Hz and the output level to 750 mv on the oscillator voltmeter.			
3	Turn off test oscillator and turn the test set 250-kHz switch to ON and adjust the level control to obtain an indication of 7.0 mv on the ac voltmeter connected to the COMPOSITE OUTPUT.			
4	Turn test oscillator on and set the DELAY CALIBRATION switch on the group delay detector to 1 ns. Turn on the group delay detector.			
5	Set the B. B. FREQUENCY (kHz) switch on the group delay detector to 250.			
6	Set the oscilloscope mode switch to the "A" channel and adjust the oscilloscope vertical gain until the display contains a pair of lines 1 cm apart. Set the lines at the lowest position on the display.			
7	Place the delay calibrate switch on the group delay detector to the OFF position.			
8	Connect a test set jumper from FILTER OUT to GROUP DELAY IN on the linearity test panel.			
9	Turn the 250-kHz generator to off and connect the VHF oscillator to the T-connector at the step attenuator. Set the VHF oscillator to a frequency of 63 MHz (using the dial). Position the marker on the oscilloscope to the extreme end of the trace using the scope horizontal gain control. Set the VHF oscillator to 7 MHz and, using the test oscillator amplitude control, locate the marker on the scope trace. Repeat at both VHF oscillator frequencies and, using the scope horizontal gain, horizontal position and test oscillator amplitude, obtain a response bounded on each end by a marker. Upon completion, remove the T adapter and connect the step attenuator directly to the test set LMTR DSCM IN.			
10	Turn the 250-kHz generator on and adjust the test set linearity panel 250-kHz level control for a reading in the center of the group delay detector level meter. The meter reading should remain steady, indicating phase lock.			
11	The phase response seen on the display should resemble figure 7-29 with no portion of the curve higher than 5 cm.			
12	Set the oscilloscope mode switch to the "B" channel and disconnect the test set linearity panel filter output jumper. Connect the vertical input of the scope directly to the filter output via the test cable. Set scope vertical			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
12 (cont)	attenuator to 20 mv/cm (variable control in calibrate). Adjust test set 250-kHz level control for a 5 cm vertical display of the resultant 250-kHz signal.			
13	Set the scope vertical attenuator to 10 mv/cm (variable in calibrate). Adjust the display so that the top of the signal is at the upper graticle line by using the vertical positioning control.			
14	No portion of the resulting display trace shall "droop" more than 2 mm (a satisfactory curve appears in figure 7-30).	Gain response shall indicate not more than 2% differential within a bandwidth of from 63 to 77 MHz.		
15	Unsolder the negative side of capacitor C43 from printed-wiring card.			
16	Connect limiter-discriminator to the test set as shown in figure 7-30.			
17	Connect the test equipment as shown in figure 7-30.			
18	Set the test oscillator to 60 kHz as indicated by the electronic counter. Adjust test oscillator until the oscilloscope .indicates 3.5 volt peak-to-peak sine wave without clipping.			
19	Disconnect the electronic counter from the module.			
20	Connect the RF voltmeter to the free end of capacitor C43.			
21	Adjust the output level controls of the test oscillator for an indication of -30 db.			
22	Disconnect the RF voltmeter from capacitor C43.			
23	Connect the RF voltmeter to the output J2, of the module.	-23 db (min)		
24	Maintaining the -30-db input level, set the test oscillator to the following frequencies: 100 kHz 1.6 MHz 2.6 MHz	-23 db ± 0.5 db		
25	Disconnect test equipment.			
26	Reconnect capacitor C43.			

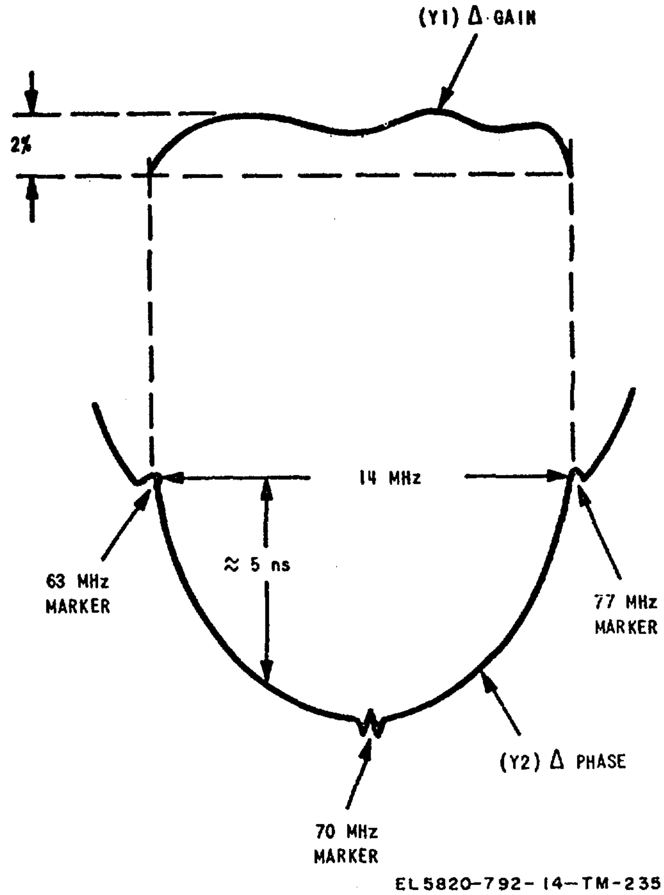

Figure 7-29. Discriminator linearity and phase display specifications without deemphasis network.

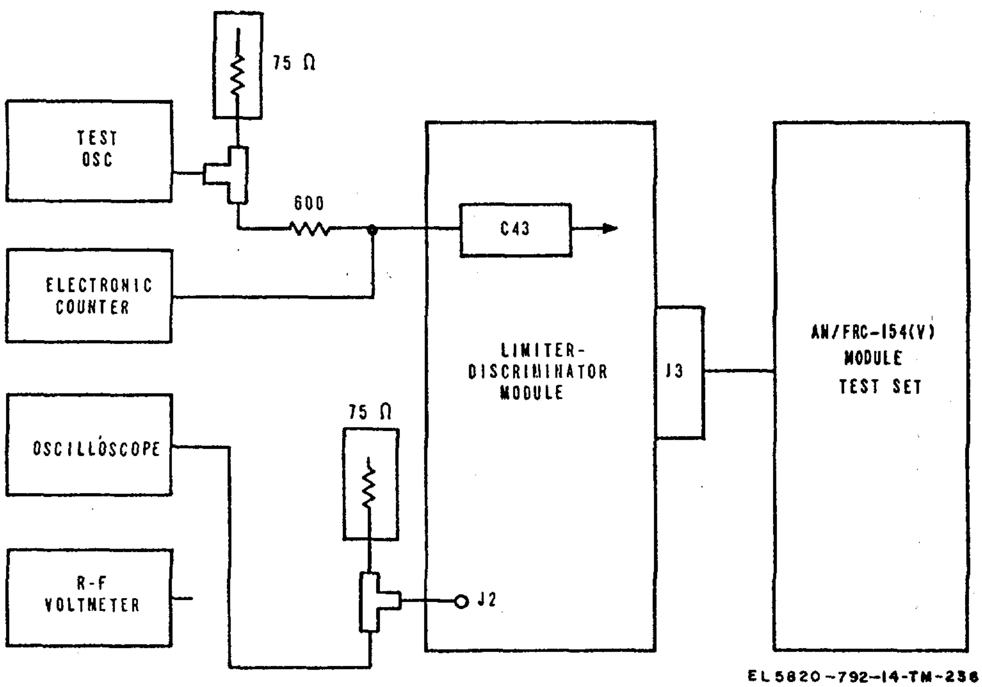

Figure 7-30. Multiplex frequency response, initial test equipment setup.

f. Intermodulation Distortion Test. This procedure is used to check the linearity characteristics of the limiter-discriminator module. The intermodulation distortion test is used as the concluding major performance test of the limiter-discriminator module. The channels and frequency slots used in this test are based upon 600-channel loading; for a discussion of this type of test and its modification to other channel loading factors, refer to chapter 5. The test equipment setup is shown in figure 7-20; and the test is performed as outlined in paragraph 7-30*f*, with the standard limiter-discriminator replaced, rather than the IF amplifier, and the limiter-discriminator under test must be equipped with a 600-channel deemphasis network.

g. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in h below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the module disconnected from all external components using the multifunction meter. All voltages are measured using the extender card to supply power to the module from the test set. The multifunction meter is also used to measure dc voltages. Ac voltages are measured with the RF voltmeter using an input signal of 70 MHz with 100 kHz rms deviation of a 15-kHz modulating frequency at a level of 300 mv rms.

CAUTION

Before using an ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads. Do not use the ohmmeter if this voltage exceeds 1.5 volt. Also, since the R x 1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50 ma or more) may damage the transistor under test. As a general rule, it is not recommended that the R x 1 range of any ohmmeter be used when testing lowpower transistors.

h. Voltage and Resistance Data.

Point of measurement		Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100scale unless otherwise specified
Q1	Base	15.7 V	5 mv (max)	1.8 kΩ
	Emitter	15 V	22 mv	2.7 kΩ
	Collector	28 V	65 mv	670
Q2	Base	16.7 V	6 mv (max)	1.8 kΩ
	Emitter	16 V	280 mv	2.7 kΩ
	Collector	28 V	200 mv	670
Q3	Base	16.7 V	6 mv (max)	1.8 kΩ
	Emitter	16 V	76 mv	3.3 kΩ
	Collector	28 V	540 mv	670
Q4	Base	17.2 V	15 mv (max)	1.8 kΩ
	Emitter	16.5 V	230 mv	3.3 kΩ
	Collector	28 V	600 mv	670
Q5	Base	22 V	350 mv	1.2 kΩ
	Emitter	21.3 V	260 mv	700
	Collector	28 V	820 mv	670
Q6	Base	5 V	320 mv	460
	Emitter	4.4 V	320 mv	80
	Collector	17.5 V	1.7 V	700
Q7	Base	5 V	420 mv	460
	Emitter	4.4 V	420 mv	80
	Collector	17.5 V	1.6 V	700
Q8	Base	10.1 V	5.5 to 8 mv	1.9 kΩ
	Emitter	9.4 V	5.5 to 8 mv	1.7 kΩ
	Collector	20 V	30 to 45 mv	1.7 kΩ
Q9	Base	20 V	30 to 45 mv	1.7 kΩ
	Emitter	19.5 V	30 to 45 mv	850
	Collector	28 V	6 mv (max)	670
Q10	Base	19.5 V	30 to 45 mv	850
	Emitter	19 V	30 to 45 mv	460
	Collector	28 V	5 mv (max)	670
J1		0	300 mv	60
J2		0	15-23 mv	3.6 kΩ

7-43. Alignment Data

a. General. The following procedures should be performed as a part of scheduled off-site maintenance and after repairs have been made in the module.

NOTE

The limiter-discriminator module contains many tuned circuits which must be carefully aligned to obtain optimum module performance. The arrangement of the procedures in this section is on a requirement for a complete realignment.

b. Test Equipment Setup. The test equipment setup used for the alignment and adjustment procedures is shown in figure 7-26.

c. Preliminary Adjustments. When the test setup is completed, perform the preliminary adjustments listed in d below.

d. Discriminator Alignment. Connect the module to be aligned to the test set, using the extender card as shown in figure 7-31.

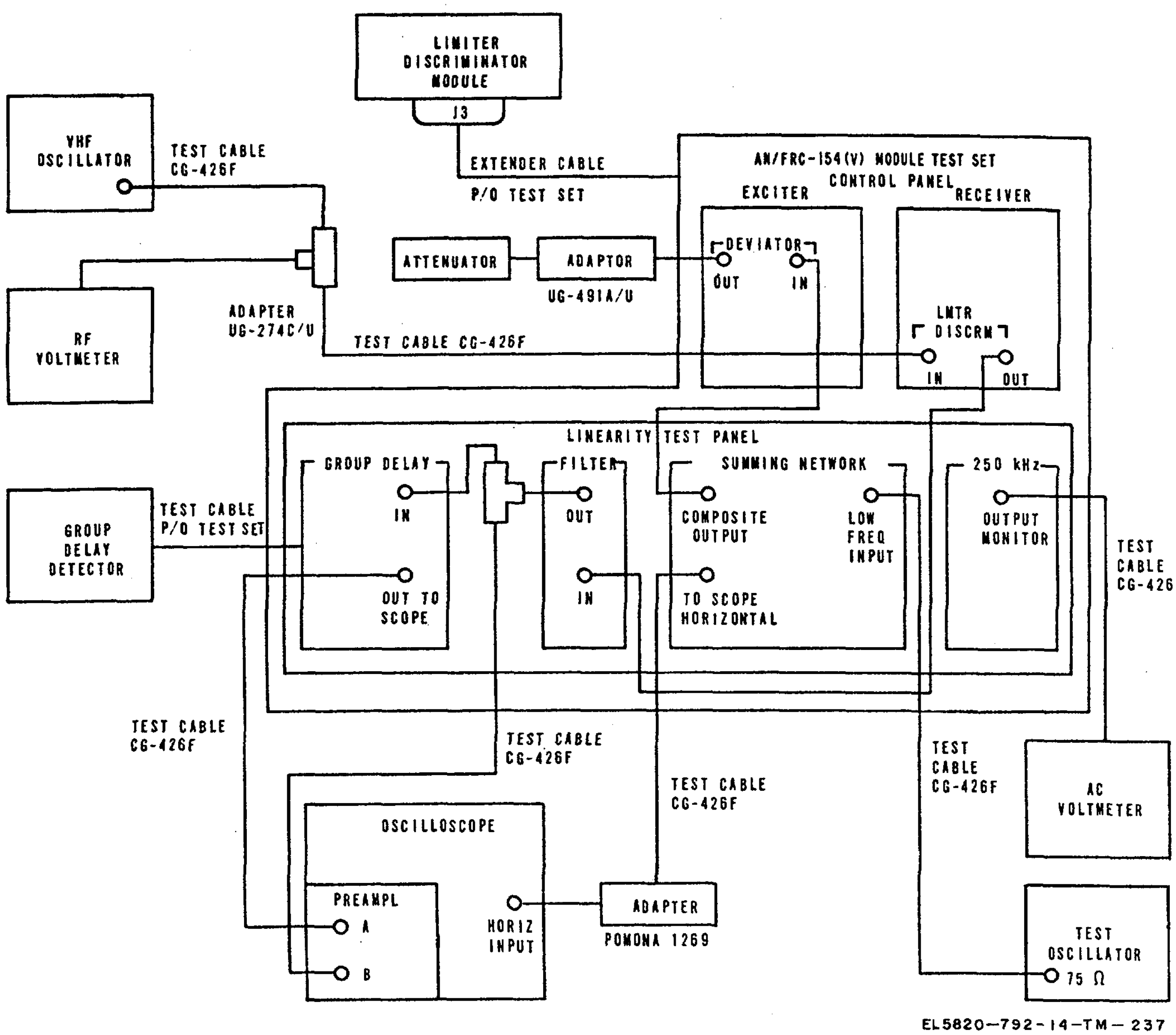

Figure 7-31. Discriminator alignment, initial test equipment setup.

(1) Perform the differential gain and group delay check of paragraph 7-42*d*.

(2) Adjust L1, C1, L2 and C3 for proper result (fig. 7-29).

(3) Continue the procedure in paragraph 7-42 *e* to step 14. Adjust L15, L18, C32, C40, and R31 for proper result (fig. 7-29).

e. Deemphasis Network Alignment. The following procedure is used to align the deemphasis network. Any one of several deemphasis networks may be used, depending upon the voice channel capacity of the terminal. The test setup used is the same as that used for the discriminator alignment.

f. Alignment data.

Deemphasis network	Voice channels	Resonant frequency	Pivot frequency	Maximum frequency	Minimum frequency	Test frequency
368-11360-1	24	135 kHz	65.7 kHz	108 kHz	10 kHz	65.7 kHz
368-11360-2	60	315 kHz	153 kHz	252 kHz	25 kHz	153 kHz
368-11360-3	60	375 kHz	183 kHz	300 kHz	30 kHz	183 kHz
368-11360-4	120	690 kHz	337 kHz	552 kHz	55 kHz	337 kHz
368-11360-5	240	1315 kHz	640 kHz	1052 kHz	105 kHz	640 kHz
368-11360-6	300	1625 kHz	790 kHz	1300 kHz	130 kHz	790 kHz
368-11360-7	600	3250 kHz	1580 kHz	2540 kHz	254 kHz	1580 kHz

(1) Use the frequency counter as an indicator and set the frequency of the test oscillator to "fresonance" specified in the chart above. Remove the counter from the test oscillator.

(2) Set the ac voltmeter to permit an indication of 20 db; connect the meter to J2 of the module.

(3) Remove the strap connected across the deemphasis network. Disconnect the wire lead connected between R47 and terminal 1 of the deemphasis network at terminal 1.

(4) Connect the test oscillator to terminal 1 of the deemphasis network.

(5) Adjust the output level control of the test oscillator for an indication of -20 db on the ac voltmeter.

(6) Adjust inductor L1 (deemphasis coil) for a maximum "peak" indication on the ac voltmeter. Disconnect the ac voltmeter.

(7) Use the frequency counter as an indicator and set the frequency of the test oscillator to "f pivot" specified in the chart above. Remove the counter from the oscillator.

(8) Set the ac voltmeter to permit an indication of --20 db; connect the meter to J2 of the module.

(9) Adjust the output level of the test oscillator for an indication of -20 db on the ac voltmeter. Disconnect meter from J2.

(10) Set the ac voltmeter to permit an indication of --30 db and connect the meter to the output of the test oscillator. Record the reading on the ac voltmeter. Disconnect meter from test oscillator.

(11) Use the frequency counter as an indicator and set the frequency of the test oscillator to "fmax" specified in the chart above. Remove the counter from the test oscillator.

(12) Connect ac voltmeter to the output of the test oscillator; adjust the output level control of the test oscillator to obtain the reading recorded in step (10) above. Disconnect the meter from the test oscillator.

(13) Set the ac voltmeter to permit an indication of -20 db and connect the meter to J2 of the module. The reading on the meter should be within --4.0 db + 0.2 db of reading recorded in step (10) above. Disconnect ac voltmeter from J2.

(14) Repeat steps (11) through (13) above for "$f_{resonance}$" and "f_{min}." Compare readings with the standards of g. below.

g. Standard References.

Frequency	*Standard*
^{f} pivot	(Reference)
^{f} max	within -4.0 db ± 0.2 db of reference.
^{f} res	within -5.0 db ± 0.2 db of reference.
^{f} min	within +4.0 db ± 0.2 db of reference.

Disconnect all test equipment from module, and reconnect unsoldered wire to terminal 1 of the deemphasis network.

Section IX. LOW VOLTAGE POWER SUPPLY, BASIC PART NO. 398-12051-2 THROUGH -6, DUAL CONFIGURATION PART NO. 398-12042-1 THROUGH-3, AND SINGLE CONFIGURATION PART NO. 368-43109-1-0A

7-44. Introduction

a. General. The low voltage power supply is an assembly common to the transmitter and receiver of the microwave equipment. The power supply assembly is used to convert dc or ac power sources to dc output voltages for distribution to all modules. The basic power supply is assigned part number 398-12051 and associated dash numbers assigned in *b* below.

b. Power Supply Module Options.

Power supply	Primary	Remarks
398-12051-2	120 V ac	Autotransformer input.
398-12051-3	-48 V dc	Input overvoltage and transient protection.
398-12051-4	120 V ac	Autotransformer input and input overvoltage protection.
398-12051-5	120 V ac	Isolation transformer input.
398-12051-6	120 V ac	Isolation transformer input and input overvoltage protection.

7-45. Power Supply Configurations

a. The power supply consists of chassis mounted and printed-wiring board mounted components. The power supply is available to operate from either a + 48-volt dc power source or a 120-volt, 60-Hertz, ac power source. The physical size of the power supply permits the required identical units to be mounted side by side on the same panel, hence the term "dual" low voltage power supply configuration. Radio Set AN/FRC-154(V) uses power supply assembly part number 398-12042-1; AN/FRC-154(V) module test set uses power supply assembly part number 398-12042-2.

b. Power supply configurations follows:

Assembly part No.	Configuration	Power supply part No.
398-12042-1	Dual	398-12051-1
398-12042-2	Dual	398-12051-2
398-12042-3	Dual	398-12051-2
398-43109-1-0A	Single	398-12051-2

7-46. Functional Description

A functional block diagram of the low voltage power supply appears in figure 7-32. The power supply, whether it operates from a +-48-volt dc power source or from a 120-volt, 60-Hertz, ac power source, provides several output potentials to a terminal strip at the rear of the unit. The positive 28-volt supply furnishes the general operating potentials to most components and modules of the terminal. The negative 6-volt supply provides operating voltages for several modules, such as the IF amplifier, IF switch, alarm amplifier assembly, deviator, and phaselock modules. A positive 20-volt supply is used to power the frequency sources mounted on the RF panel. The waveguide switches and a portion of the meter panel assembly are powered from the 65-volt supply. All output voltages with the exception of the 65-volt power supply are regulated to maintain the supply voltages within the required ratings.

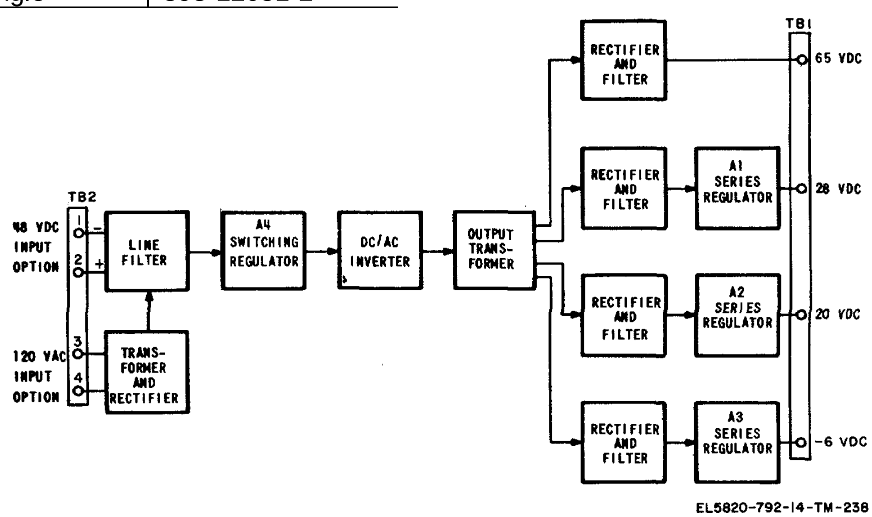

Figure 7-32. Low-voltage power supply, block diagram.

7-47. Circuit Analysis

a. Schematic Diagram. The schematic diagram of the power supply is shown in figure FO-26.

b. Input Section. When operation from a -48-volt dc power source is required, the power supply is not furnished with ac power transformer T3 or rectifier diodes CR2 and CR3. The power source positive wire is connected to TB2-2 and the negative wire is connected to TB2-1. Power is delivered through switch S1 and fuse F1 to a steering diode to protect the unit from damage due to incorrect connection of power source polarity. The power is then applied to a line filter composed of capacitors C22 and C3, and reactor L2. The line filter reduces the switching transients generated in the power supply that reach the power source.

c. Overvoltage and Overcurrent Protection Circuit. This circuit is available as an option in any system where known high amplitude voltage transients are present. Most of the circuit parts are located on A5 printed-wiring board. The function of the overvoltage protection circuit is to remove the power from the power supply when the input voltage exceeds the breakdown voltage of the Zener diode A5VR1. When the A5 circuit is used, transistors Q9 and Q10 are wired in series with the power source. Under normal input voltage conditions of 43 to 56V dc, Q9 and Q10, are driven into saturation by emitter current from A5Q1. The transistor A5Q1 is driven into saturation by base current derived from the input voltage on pin F of A5 via the constant current diode A5CR3 and the steering diode A5CR2. When the input voltage exceeds the nominal breakdown voltage of A5VR1 (56 to 68 volts), A5VR1 Zener current has a path through A5R2 and the base of A5Q3. Collector current of A5Q3 is derived from the input voltage via A5CR3. The characteristics of A5CR3 are selected to deliver a constant current over a wide voltage range such that the conduction of A5Q3 collector current permits A5Q3 to "steer" I_{B1} to I_{B1}.As a result of a decreasing I_{C3}, the voltage across Q9 and Q10 rises to absorb the overvoltage on the input voltage line. An additional function of the circuit is that A5Q2 turns off Q9 and Q10 when an overcurrent condition exists in Q9 and Q10. When the input current passing through A5R1 develops sufficient voltage across the base-to-emitter junction of A5Q2, A5Q2 collector current is conducted through A5R2 and through the base-to-emitter junction to turn off Q9 and Q10 as in the overvoltage condition. When-the A5 circuit is used, the following must be done:

(1) Remove jumper from E6 to C2, and connect jumpers from A5-F to E6, A5-B to C2, and A5-A to C1.

(2) Plug transistors Q9 and Q10 into their sockets.

(3) Plug in the A5 circuit board.

d. Switching Regulator. The basic switching regulator is shown in the simplified schematic of figure 6-115. The circuit is energized when S1 is closed and current flows through L1 to charge the output capacitor C4 and supply current to load resistor R_L.. The voltage across -the load resistor rises at a rate determined by the time constant derived from the values of RL, L1, and C4. At the time the output voltage reaches the desired level, switch S1 is opened. As the switch is opened, the energy stored in L1 generates a reverse voltage across L1 to maintain current flow through L1 in the same direction. L1 becomes a power source and discharges C4 through the load resistor and through CR6. In the power supply the power transistor Q1 performs the function of the switch. The output voltage is sensed by the voltage divider network R4, R5, and R6 on printed-wiring board A4. The desired output voltage is selected by the setting of R5. The integrated circuit A4U1 contains a high gain differential amplifier, a temperature compensated voltage reference, and output driver transistors. A simplified diagram of the integrated circuit appears in figure 6-116. When the power is applied to the power supply no voltage appears at the sensing terminal No. 6 of A4U1. The differential amplifier compares this voltage to the voltage reference (terminal 5). Since terminal 6 is less positive than terminal 5, transistor Q_O is off and current flows into terminal 3 through resistor R_A and into the base-to-emitter junction of Q_A to terminal 8. Terminal 8 of A4U1 is connected to the output voltage and is at zero potential. The base current of Q_A causes collector current to flow from terminal 3 through resistor R_A. As the voltage rises across R_B, the voltage developed across terminals 3 and 2 of A4U1 is applied to the base-to-emitter junction of A4Q2. Collector current I_CQ2 is drawn through resistor A4R1 and develops a voltage across A4Ri to turn on A4Q1. Collector current I_CQ1 flows through the base-to-emitter junction of Q2 which provides sufficient drive to turn Q1 into saturation. The voltage of C4 now rises to the desired operating voltage level. An overvoltage protection circuit is a permanent part of the switching regulator and protects against excessive voltages being applied to the DC/AC inverter circuit and the various circuits which follow. The circuit senses the voltage regulator output by means of Zener A4VR2 and resistor A4R7, and gates the silicon-controlled rectifier CR5 on. This action provides crowbar action across the input of the switching regulator, and thus opens fuse F2. Resistor R4 limits the peak current through CR5 while reactor L7 limits the rate of current rise of CR5 to safe limits. Diode CR4 commutates current flowing in L7 after fuse F2 opens, thereby preventing the occurrence of dangerous levels of voltage transients.

e. Dc/Ac Inverter Circuit. The dc/ac inverter used in this power supply is basically a dual transformer circuit with two switching transistors connected in a common-emitter configuration, as shown in simplified schematic diagram figure 6117. Transformer T1 is a saturating core type (square loop); whereas transformer T2, which is the output transformer, is designed to operate in the linear region. Starting resistor R $_S$provides a slight forward bias for both transistors to insure switching operation under initial heavy-loads which can make starting difficult. Operation occurs when feedback is taken from the primary winding of T2, through a feedback resistor R_F to the primary of saturable transformer T1. The secondary of T1 is applied to the transistor bases. When sufficient positive feedback is applied to T1, the polarity of the secondary causes one transistor (assume Q2) to conduct resulting in an induced voltage, equal to the dc input voltage, in winding N_{P22}. Q1 is now driven into the OFF condition. The core of T1 is driven into saturation. Power in the feedback winding N_{P11} decreases due to an increase in the magnetization current causing a larger voltage drop across the feedback resistor R_F. As the magnetization current is increased further, the drive necessary to maintain transistor conduction is removed. The energy stored in all windings reverses the polarity of the voltage and oscillation reverses. Since the output transformer T2 does not saturate, the collector current is determined primarily by the load on the secondary. Large spikes which are normally created in a single transformer converter do not exist here in the dual transformer converter since a minimum of energy is stored in the leakage inductance of T2, reducing the danger of transistor damage. The dual transformer configuration differs from the conventional converter in that switching is determined by the small saturating "square core" transformer, while the larger nonsaturating power transformer handles the feedback and output power transformation. It should be noted that switching occurs when the ON transistor is pulled out of saturation by the decrease in base current which occurs when the "square core" transformer T1 saturates. As the core reaches saturation, the increasing magnetizing current causes an additional voltage drop across the feedback resistor R_F. Thus, the primary of the saturated transformer has less voltage dropped across it, affecting the decrease in secondary or basedrive voltage. Capacitors C1 and C2 help to speed up the switching process. Diodes CR1 and CR2 help to reduce losses by eliminating the need for higher resistance values of R_{B1} and R_{B2} These diodes also enable the value of starting resistance R_S to be increased, for more reliable operation, since the diodes appear as an open circuit until the oscillations begin.

f. Output Circuits. As shown in the block diagram of figure 7-32, the output circuits consist of three regulated and one unregulated output, all filtered. Four separate secondary windings on inverter output transformer T2 provide proper voltages and power for the four output circuit load requirements. The 65-volt circuit is fed from a center-tap, full-wave rectifier circuit which is followed by an LC filter network and a fuse for overload protection. The L6, C8 filter network is a ripple reduction filter; whereas, the R11, C23, and C24 are despiking networks. There is no voltage regulation circuitry associated with the 65-volt output other than its own inherent circuit regulation. Since the other three output circuits, namely the +28-volt, +20-volt, and -6-volt circuits, are all similar in theory of operation and functional design, only the +28-volt dc circuit will be described. A center-tap, full-wave, rectifier configuration is used which feeds into a Pitype ripple filter, consisting of choke L3 and capacitors C9 and C10. A despiking network R12, C25 is connected across the secondary winding for suppression of unwanted voltage surges and spikes. Another despiking circuit, consisting of capacitor C26, is connected from the negative (center-tap) side of the circuit to chassis ground in order to suppress any unwanted noise appearing in the +28-volt circuit. The +28-volt regulator (like the +20-volt and -6-volt regulators) is a series pass transistor type of circuit which regulates the output voltage within specified tolerances for the range of specified changes. The pass transistor(s) is mounted separately from the printed-circuit regulator control card AI for the +28-volt supply (A2 and A3 for the +20-volt and 6-volt supplies). The A1 card contains a voltage divider sensing circuit, a voltage regulating integrated circuit module, and a driving transistor for the pass transistor(s). The sensing circuit consists of dividing resistors R5, R6, and R7 with R6 adjustable so as to select the nominal output voltage which is to be regulated. The sensed voltage is fed to terminal 6 of A1U1 voltage regulating integrated circuit (fig. 6-116). The sensed voltage at terminal 6 is compared with that at terminal 5 through the operation of the high-gain differential amplifier consisting of transistor Q_B. When the voltage at terminal 6 is less positive than that at terminal 5, transistor Q_C is off and current flows into terminal 3 through resistor R_A and into the base-to-emitter junction of Q_A to terminal 8. Terminal 8 of A1U1 is connected to the output and, at turn-on, is at zero potential. The base current of Q_A causes collector current to pass from terminal 3 through resistor R_B.. As the voltage rises across R_B, the voltage developed across terminals 3 and 2 of A1U1 is applied to the base-to-emitter junction of A1Q1. A1Q1 now turns on and injects its collector current I_C Q1 into the base of Q6 of the Darlington pair Q5 and Q6, thus providing a series regulating feature by virtue of the controlled collector-to-emitter voltage drop of Q6, the series pass transistor. The voltage regulating integrated circuit module (type LM305H) used in the other circuits (A2U1 and A2U2) is identical in operation to integrated circuit module (type M205H) used in A1U1, except that the device has a lower maximum operating voltage. Additional filtering is provided at the outputs of the +28-volt, +20volt and --6-volt supplies in order to suppress high frequency noise and insure the absence of harmonic components at the input of the communication equipment loads connected to these supplies. Additional filtering is employed in each module of the equipment. All three circuits have a diode connected across the filters in order to provide a current discharge path for release of stored energy in the filters.

g. Technical Characteristics.

Parameter	*Specifications*
Input power	43 to 5b V' dc for cc option; 260 watts max. 108 to 132 V ac for ac option at 47 to 63Hz; 280 watts max.
Output voltages	28 V dc, adjustable, regulated, 20 V dc, adjustable, regulated, -6 V dc, adjustable, regulated, 65 ± 15 V dc, unregulated.

Parameter	*Specifications*
28 V dc output:	
Range	27.7 to 28.3 V dc.
Maximum load	3.0 amperes (intermittent duty) 2.0 amperes (continuous rating).
Minimum load	0.70 ampere.
Maximum ripple	20 mv p-p.
Line and load regulation	±1 %.
20 V dc output:	
Range	19.6 to 20.2 V dc.
Maximum load	1.1 ampere.
Minimum load	0.15 ampere.
Maximum ripple	20 mv p-p.
Line and load regulation	±2%.
--6 V dc output:	
Range	5.9 to 6.1 V dc.
Maximum load	0.50 ampere.
Minimum load	0.05 ampere.
Maximum ripple	20 mv p-p.
Line and load regulation	±1%.
65 V dc output:	
Range	55 to 85 V dc.
Maximum load	2 ma.
Maximum ripple	3 volts p-p.

7-48. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. The following paragraphs contain procedures to test the performance of the major circuits, and give probable causes of abnormal indication.

WARNING

Make sure the MAIN POWER circuit breakers on the test set and power supplies are OFF when connecting and disconnecting the equipment.

b. Test Equipment Setup. Connect the test equipment to the low voltage power supply as shown in figure 7-33.

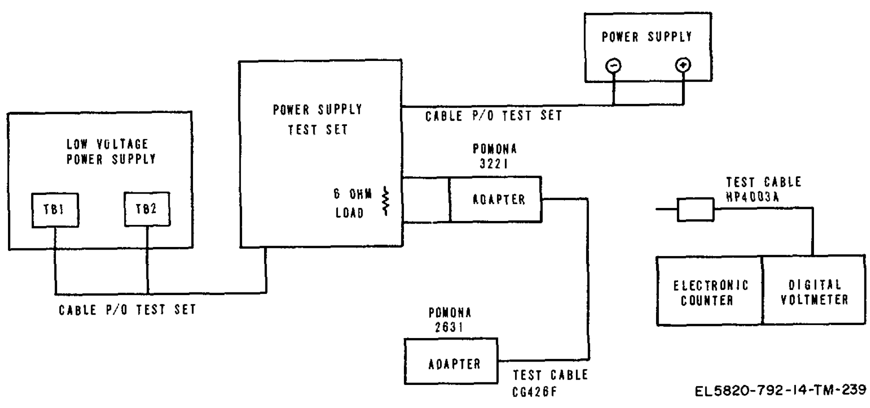

Figure 7-33. Low-voltage power supply, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove top and bottom covers from the power supply.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes. Do not turn on the power supply under test.

(3) For the dc input version of the power supply only, turn on the utility dc power supply and adjust the output voltage for -43 ±0.1 V dc. For the ac input version, adjust VARIAC for 105 V ac.

(4) Perform the test procedures indicated in d below. Figure 5-2 shows the location of the adjustment controls. Figures 6-119 and 6-120 give parts location data.

d. Test Procedures.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
1	Remove board A4 from power supply chassis; set potentiometer A4R5 completely clockwise.			
2	Disconnect positive (red) lead of transformer T2 at capacitor C4.			
3	Connect digital voltmeter across capacitor C3.			
4	Set AC/OFF/DC POWER switch to either AC or DC position and set power supply POWER ON-OFF switch to ON.			
5	Observe digital voltmeter indication	Approximately 70 V dc for autotransformer ac input power supply; approximately 43 V dc for dc input power supply.	Proceed to step 6	Ac input power supplies; check T3, CR2, and CR3. Dc input power supplies; check CR1.
6	Set power supply POWER ON-OFF switch to OFF.			
7	Connect LOAD A TP1 and LOAD A TP2 jacks (6-ohm load) across C4 using adapters an d cable, then connect digital voltmeter across C4.			
8	Plug board A4 into power supply chassis.			
9	Set power supply POWER ON-OFF switch to ON. (Input is either 43 V dc or 105 V ac).			
10	Observe digital voltmeter indication and adjust A4R5 counterclockwise for 27.5 V dc.	27.5 V dc	Proceed to step 11	Check A4 board.
11	Set AC/OFF/DC POWER switch to OFF. Disconnect digital voltmeter and 6 ohm load from C4 and reconnect positive (red) lead to C4. Place all load switches on test set to OPEN position.			
12	Depending upon input requirements of power supply under test, either adjust utility de power supply for -48 ± 0.1 V dc or adjust VARIAC for 115 V ac.			
13	Connect voltmeter to TB1-2 (+) and TB1-5 (-). Set AC/OFF/DC POWER switch to either AC or DC position as required.			
14	Set 28V load switch to MAX. LOAD position. Adjust A1R6 on board Al to give 28 V dc output.	28 V dc	Proceed to step 15	Check CR11 and CR12, then check Q5, Q6, and A1 board.
15	Set 28V load switch to MIN. LOAD position and observe voltmeter indication.	Between 28 and 28.3 V dc	Proceed to step 16	Same as step 14.
16	Connect voltmeter to TB1-3 (+) and TB1-5 (-).			
17	Set 20 V load switch to MAX. LOAD position. Adjust A2R6 on A2 to give 20 V dc output.	20 V dc	Proceed to step 18	Check CR13 and CR14, then check Q7 and Q2 board.
18	Set 20 V load switch to MIN. LOAD position and observe voltmeter indication.	Between 20.0 and 20.2 V dc	Proceed to step 19	Same as step 17.
19	Connect voltmeter to TB1-6 (+) and TB1-8 (-).			
20	Set 6V load switch to MAX. LOAD position. Adjust A3R6 on board A3 to give 6 V dc output.	6 V dc	Proceed to step 21	Check CR15 and CR16, then check Q8 and A3 board.
21	Set 6V load switch to MIN. LOAD position and observe voltmeter indication.	Between 6 and 6.1 V dc	Proceed to step 22	Same as step 20.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
	NOTE 65-volt output is not used in low voltage power supplies for LC-4E Module Test Set (398-12051-2).			
22	Connect voltmeter to TB1-7 (+) and TB1-9 (-)			
23	Observe voltmeter indication	55 to 85 V dc	Proceed to step 24	Check F3. Check CR9 and CR10, then check voltage across C4 for 27.5 V dc.
24	Set all test set (6V, 20V, and 28V) load switches to MAX. LOAD position.			
25	Connect 0.1 of capacitor across oscilloscope probe, then connect oscilloscope probe to TB1-2 (+) and TB1-5 (-)). Measure ripple only.	Ripple less than 20 mv peak-to-peak.	Proceed to step 26	Check Al board.
26	Connect oscilloscope probe to TB1-3 (+) and TB1-5 (- . to-peak.	Ripple less than 20 mv peak-	Proceed to step 27	Check A2 board.
27	Connect oscilloscope probe to TB1-6 (+) and TB1-8 (-). Measure ripple only.	Ripple less than 20 mv peak-to-peak.	Proceed to step 28	Check A3 board.
28	Connect oscilloscope probe to TB1-7 (+) and TB1-9 (-). Measure ripple only.	Maximum ripple: 3 V peak-to-peak.	Proceed to step 29	Check F3. Check CR9 and CR10, Then check the voltage across C4 for 27.5 V dc. If not, localize the problem to the inverter oscillator stage (Q3 or Q4), then to the A4 board or Q1 and Q2.
29	Connect dc voltmeter and oscilloscope probe to TB1-7 (+) and TB1-9 (-).			
30	Vary the input voltage from -43 to -56 V dc by adjusting the utility power supply or from 105 to 125 V ac by adjusting the variac, as required by the power supply under test. Check voltage and ripple.	55 to 85 V dc over range of input voltage; maximum rip-pie 3 V p-p.	Proceed to step 31	Same as step 28.
31	Connect dc voltmeter and oscilloscope probe to TB1-2 (+) and TBI-5 (-).			
32	Adjust the input voltage as follows: For ac input: 115 V ac For dc input: 48 V dc Check the output voltage level and the ripple contents.	28±0.3 V dc; maximum ripple 20 mv p-p.	Proceed to step 33	Check CR11 and CR12, then check Q5, Q6, and A1 board.
33	Vary the input voltage as specified in step 30 above. Check the output voltage regulation and the ripple.	28.+ 0.3 V dc; maximum ripple 20 mv p-p.	Proceed to step 34	Check A1 regulator.
34	Connect dc voltmeter and oscilloscope probe to TB1-3 (+) and TB1-5 (-).			
35	Adjust the input voltage as follows: For ac input: 115 V ac For dc input: 48 V dc Check the output voltage level and the ripple.	20 +0.2 V dc; maximum ripple 20 mv p-p.	Proceed to step 36	Check CR13 and CR14, then check Q7 and A2 board.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
36	Vary the input voltage as specified in step 30 above. Check the output voltage regulation and the ripple.	20 ±0.2 V dc; maximum ripple 20 mv p-p.	Proceed to step 37	Check A2 regulator.
37	Connect dc voltmeter and oscilloscope probe to TB1-6 (+) and T131-8 (-).			
38	Adjust the input voltage as follows: For ac input: 115 V ac For dc input: 48 V dc Check the output voltage level and the ripple.	6.± 0.1 V de; maximum ripple 5 mv p-p.	Proceed to step 39	Check CR15 and CR16, then check Q8 and A3 board.
39	Vary the input voltage as specified in step 30 above. Check the output voltage regulation and the ripple.	6 ± 0.1 V de; maximum ripple 20 mv p-p.	Proceed to step 40	Check A3 regulator.
40	For units equipped with input overvoltage protection circuit (A5), proceed to step 41. For all other units, turn off the supply under test and disconnect all equipment.			
41	Adjust the input voltage as follows: For ac input: 115V ac For dc input: 48 V dc			
42	Connect dc voltmeter across capacitor C3 and observe indication.	Approximately 48 V dc	Proceed to step 43	AC input supplies; check T3, CR2,and CR3. Dc input supplies; check CR1.
43	For ac input supplies, increase the input voltage to 160 ±15 V ac. For dc input supplies, increase the input voltage to 70 ± 3.5 V de.	Dc voltmeter indication will be zero. (The power supply will cease to operate and the high pitched tone will no longer be heard.)	Turn off the supply under test and disconnect all equip- ment.	Check Q9 and Q10, then check A5 board.

e. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data given in *f* below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the power supply connected to the load test set and by using the multifunction meter. The plug-in cards can be pulled out and bench checked. Dc voltages are measured with the multifunction meter.

CAUTION

When testing transistors with an ohm meter, do not use the ohmmeter on the R x 1 range. To do so may destroy the transistor.

f. Voltage and Resistance Data.

Point of measurement		Voltage (dc) (nominal)	Resistance (nominal) RX100 scale unless specified	Remarks
A1, Q1	B	36.2	40	For card A1, resistance and
	E	36.7	30	vo1tage measurements are
	C	29.7	0.8	from TB1-5.
A1, U1-1		27.0	0.65	
2		36.1	40	
3		36.7	30	
4		0.0	0	
5		1.67	8	
6		1.69	8	
7		27.5	1.3 x 10k 1	
8		28.0	0.15	
A2, Q1	B	27.2	40	For card A2, resistance and
	E	27.8	33	voltage measurements are
	C	21.0	0.9	from TB1-5.
A2, U1-1		18.9	0.7	
2		27.2	40	
3		27.7	33	
4		1	0.0	
5		1.72	9.2	
6		1.71	10	
7		19.1	1.35 x 10 kQ1	
8		20.0	0.2	
A3, Q1	B	11.5	45	For card A3, resistance and
	E	12.2	30	voltage measurements are
	C	7.2	0.8	from TB1-8.
A3, U1-1		5.6	0.55	
2		11.5	45	
3		12.2	30	
4		0.0	0	
5		1.7	7	
6		1.71	6.3	
7		6.2	1.3	
8		6.0	0.1	
A4, Q1	B	0.8	4.6	For card A4, resistance and
	E	0.24	0	voltage measurements are
	C	NA	2.4	from A4Q1-E.
A4, Q2	B	8.2	5.5	
	C	0.8	4.6	
	E	8.8	12	
A4, U1-1		12.4	2.5	
2		8.8	12	
3		8.2	5.5	
4		40.2	2.1	
5		38.0	18	
6		38.1	13.5	
7		11.5	Not Used	
8		12.4	2.1	
Q1	B	NA	2	Q1, Q2, Q3, and Q4 measure
	C	0.15	0	same as A4.
	E	NA	2.1	

Point of measurement	Voltage (dc) (nominal)	Resistance (nominal) RX100 scale unless specified	Remarks
Q2 B	NA	2.4	
C	0.15	0	
E	NA	2	
Q3 B	NA	2.1	
C	NA	2.1	
E	NA	6.5	
Q4 B	NA	2.1	
C	NA	2.1	
E	NA	6.5	
Q5 B	29.3	2.3	Q5 and Q6 measure same as A1.
C	36.5	30	
E	28.6	0.15	
Q6 B	29.7	0.8	
C	36.5	30	
E	29.2	2.3	
Q7 B	21.0	0.85	Q7 measure same as A2.
C	27.6	33	
E	20.3	0.2	
Q8 B	7.2	0.8	Q8 measure same as A3.
C	12.1	30	
E	6.5	0.1	

7-49. Adjustment Data

a. General. The following procedures should be performed as part of scheduled off-site maintenance and after repairs have been made to the power supply.

b. Test Equipment. The test equipment setup used for the adjustment procedures is the same as that described in paragraph 7-48.

c. Preliminary Adjustments. When the setup is completed, perform the following preliminary adjustments:

(1) Remove top and bottom covers from the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes. Do not turn on the power supply under test.

(3) For the dc input version of the power supply such as a 398-12051-3, turn on the auxiliary dc source and adjust the output voltage for -48 ± 0.1 V dc.

d. Adjustment of Inverter Regulator. This procedure provides a means of adjusting the duty-cycle of the inverter, and consequently the voltage applied to the inverter's output transformer of the power supply.

(1) Locate the A4 circuit board (fig. 5-2). Locate variable resistor A4R5 mounted along the top edge of the board.

(2) Locate capacitor C4 (fig. 5-2).

(3) Connect a dc voltmeter across the capacitor.

(4) For ac input supplies: Turn on the unit under test. For dc input supplies: Turn on the ac/dc power source and adjust it for 48 V dc ± 100 mv, then turn on the unit under test.

(5) Adjust A4R5 to obtain a reading of 27.5 ± 0.3 V dc. Disconnect the voltmeter from the capacitor.

(5) Adjust A4R5 to obtain a reading of 27.5 ± 0.3 V dc. Disconnect the voltmeter from the capacitor.

e. Regulated +28-Volt Dc Section. This procedure provides for the alignment of the regulated 28-volt dc section of the power supply.

(1) Connect a differential voltmeter between terminals TB1-2(+) and TB1-5(-). Set the controls of the voltmeter to permit an indication of +28 V dc.

(2) Locate A1R6 (fig. 5-2). Adjust the potentiometer for 28 V dc ± 10 mv.

(3) Upon completion of all tests and measurements, turn off all power, disconnect all test equipment, and restore the low voltage power supply to its normal operating configuration.

f. Regulated -6-Volt Dc Section. This procedure provides for the alignment of the regulated -6-volt dc section in the low voltage power supply.

(1) Connect a differential voltmeter between terminals TB1-6(+) and TB-8(-). Set the controls of the voltmeter to permit an indication of -6 volts dc.

(2) Locate A3R6 (fig. 5-2). Adjust the potentiometer for -6 V dc ± 10 mv.

(3) Upon completion of all tests and measurements, turn off all power, disconnect all

test equipment, and restore the low voltage power supply to its normal operating configuration.

g. Regulated +20 V Dc Section. This procedure provides for the alignment of the regulated +20-volt dc section in the low voltage power supply.

(1) Connect a differential voltmeter between terminals TB1-3(+) and TB1-5(-). Set the controls of the voltmeter to permit an indication of +20 volts dc.

(2) Locate A2R6 (fig. 5-2). Adjust the potentiometer for +20 V dc ± 10 mv.

(3) Upon completion of all tests and measurements, turn off all power, disconnect all test equipment, and restore the power supply to its normal operating configuration.

Section X. NOISE AMPLIFIER MODULE (368-43018-2 THROUGH -5)

7-50. Introduction

The noise amplifier module is a module in the microwave receiver. The primary function of the noise amplifier module is to produce a combiner bias-control voltage which is proportional to the square of the signal-to-noise ratio obtained from a noise slot above the information band. Two secondary functions are performed in this module. The first secondary function is pilot-tone detection through the noise amplifier module, resulting in a squelch voltage output accompanied by external alarms. The other secondary function is excess noise detection through the noise amplifier module, resulting in a muting voltage output accompanied by external alarms .

7-51. Module Configurations

a. The noise amplifier module consists of a single printed-wiring card on which all components with the exception of controls, test jacks, and connectors are mounted. The latter components are mounted on the front flange of the metal module chassis. The module is equipped with a noise-slot filter that can be changed to accommodate changes in channel density in the system.

b. Module configurations follow:

Noise amplifier part No.	Channel density	Noise filter	
		Part no.	Passband (noise slot)
368-43018-2	24 CH	362-7650-2	182 kHz-218 kHz
368-43018-3	60 CH	362-7650-3	430 kHz-470 kHz
368-43018-4	120 CH	362-7650-4	775 kHz-825 kHz
368-43018-5	240 CH	362-7650-5	1.57 MHz-1.63 MHz

7-52. Functional Description

a. A functional block diagram of the module appears in figure 6-129. The input signal to the noise amplifier module is taken from the combiner module. This composite demodulated signal is processed by a three-stage amplifier and then split up into two signal paths. The first path is routed into the bandpass filter to remove all baseband signals and to obtain the out-of-band noise signal. The second path is routed out of the noise amplifier module into the dual pilot-tone detector module, where the pilot-tone signal is extracted from the baseband signal. The pilottone signal is then returned to the noise amplifier module via A2J1-16 to be combined with the noise-slot signal. These signals are then passed into an impedance-matching circuit and then into a varilosser network to control signal gain automatically.

b. Amplifiers having logarithmic characteristics, instead of linear characteristics, are used following the varilosser stage. This amplifier is a three-stage feedback circuit, providing an output signal which is proportional to the instantaneous signal-to-noise ratio of the radio receiver. This signal is then processed by a lowpass filter to insure that only the noise-slot and pilot-tone signals are sent into the detector driver stages.

c. After amplification by the detector driver stage, the noise-slot and pilot-tone signals are detected by a voltage-doubler circuit. The action of voltage doubling with respect to a logarithmic signal characteristic is equivalent to squaring the signal-to-noise ratio, which is the desired end result.

d. The noise detector is followed by a high-gain output amplifier which prevents loading of the noise detector circuit by the output circuits. The high-impedance output of this final stage is the agc signal used to drive the varilosser network. The low-impedance output circuit is a split path circuit. The primary output signal from the noise amplifier, termed the combiner bias, is one of the low-impedance output signals. The remaining path passes the output signal into the excess noise and pilot-tone detector circuits.

e. The pilot-tone detector is used to detect the loss of the pilot-tone signal through the noise amplifier and to provide a squelch signal in addition to providing a visual alarm signal. The excess noise detector is used to detect the loss of receiver signal and to provide a muting signal to the combiner module; a visual alarm is also activated.

7-53. Circuit Analysis

a. The schematic diagram of the noise amplifier module is shown in figure FO-29. The noise amplifier module receives its input signal from the associated diversity channel drive amplifier of the combiner module.

b. Preceding noise slot filter FL1 is a three stage, broadband, feedback amplifier consisting of transistors Q1, Q2, and Q3. The gain at the emitter of Q3 is 6 db, but it is adjustable for application in different systems by changing the feedback loop.

c. The output of the feedback amplifier is divided into two paths. The first path is to the dual pilot-tone detector via J2. The second path is through the noise bandpass filter, FL1. The purpose of FL1 is to pass an out-of-band noise above the information band while, at the same time, rejecting the entire baseband signal. The continuity pilot-tone signal from the dual pilottone detector is then applied to A2J1 (pin 16) of the noise amplifier. The noise and pilot-tone levels are adjusted by means of potentiometers R2 and R3; respectively, which must be adjusted so that the proper proportions of each are applied to the remaining noise amplifier.

d. The noise-slot and pilot-tone signals are then passed through an emitter follower (Q4) used for impedance-matching between the filter and the varilosser circuit. In the varilosser circuit, the two signals are passed through biased diodes CR2, CR3, CR4, and CR5. The bias control is derived from an AGC loop acting through the circuit consisting of the dc amplifier Q10 and Q11 (Darlington circuit). The AGC provides for more than 40 db of dynamic range and biases diodes CR2, CR3, CR4, and CR5 to provide a logarithmic response characteristic. The noise-slot and pilot-tone signals are amplified by a three-stage feedback amplifier circuit, consisting of transistors Q5, Q6, and Q7, which has a gain of +45 db.

e. This same signal is fed to a 7.5-MHz lowpass filter consisting of capacitors C30 and C31 and inductor L2. The purpose of the filter is to reject the transistor generated noise above 7.5 MHz, and to pass the noise-slot and pilot-tone signals for further amplification within the noise amplifier module. After emerging from the filter, the noise-slot and pilot-tone signals are amplified by a two stage feedback amplifier, consisting of transistors Q8 and Q9, which has a gain of +36 db. The feedback amplifier is designed to insure good frequency response and temperature stability.

f. After amplification, the noise is detected by a voltage doubler using CR6 and CR7. The Darlington-connected transistors Q10 and Q11, are employed so as not to load the detector circuitry; these transistors provide the combiner bias-control output signal, the fault circuitry voltage, and the AGC voltage for the varilosser network composed of diodes CR2, CR3, CR4, and CR5. The AGC rise time response is 1 millisecond, and its decay or fall time response is 2 milli-seconds.

g. The various noise amplifiers employed in diversity systems are adjusted so that the input/output characteristics (noise inputs versus dc bias control) of the overall amplifier-detection combination align with each other. The noise level adjust potentiometers R2, and the slope adjust potentiometer R4, in combination with the AGC loop, are used for aligning the noise amplifiers.

h. The dc output signal from transistor Q11 is applied to the combiner bias control input for the associated diversity channel. This is the same signal which operates the differential noise amplifiers in the dual and quad combiner modules. The dc output signal is also fed to the meter panel for monitoring at the COMBINER (+20V) position of the function switch.

i. The excess-noise fault circuit uses the integrated circuit MD-1. This integrated circuit is used to sense the noise-level voltage out of Q11 and compare it with the threshold level set by R1. If the noise level exceeds this threshold level, the output of MD-1 increases in a negative direction and triggers Q12, a Schmidt trigger oscillator which, in turn, energizes relay K1. Relay K1 provides squelching of the combiner, removes B + from the first stage of that channel of the combiner, energizes the excess-noise fault light, and provides control closure for remote monitoring.

j. The loss of pilot-tone can be detected only when the noise level is below the continuity pilottone level. When this condition exists, the output level of Q11 will be determined by the continuity pilot-tone level. If the output of Q11 drops below the level produced by a normal continuity pilottone, the loss-of-pilot-tone integrated circuit MD-2, senses it. The level to which the output of Q11 drops before it is sensed by MD-2 (the threshold level) is set by potentiometer R79; and when this threshold is reached, the output of MD2 goes negative, triggering Schmidt trigger oscillator Q13. The output of the Schmidt trigger energizes relay K2 which, in turn, actuates the squelching of the combiner, energizes the loss-of-pilot-tone fault light, and provides contact closure for remote monitoring.

k. Diodes CR10 and CR13 prevent spikes which would normally occur as a result of the opening of the relay coil and thus protect transistors Q12 and Q13 from excess emitter-to-collector voltage. Switch S1 is a double-pole double-throw switch which disables both pilot-tone loss fault indication and excess noise fault indication when placed in the bypass position. It also disables the squelching which normally accompanies a fault indication, and thus allows evaluation of combiner operation in the presence of excess noise or loss-of-pilot-tone in the noise amplifier.

l. Technical characteristics are as follows:

Parameter	*Specifications*
Input inpedance	600 ohms, unbalanced.
Input level	-20 dbm to -60 dbm.
Output level:	
Pilot-tone	-42 to -34 dbm; 75 ohms
Combiner bias	+6.5 to +18 V dc.
Mute level	0 V dc.
Squelch level	+28 V dc.
Maximum available gain	+90 db.
AGC Control:	
Range	40 db.
Risetime	1 millisecond.
Falltime	2 milliseconds.
Power requirements	200 ma at +28 V dc.

7-54. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. This paragraph contains procedures to test the performance of the overall module and its major circuits, and gives probable causes of abnormal indication.

b. Test Equipment Setup. Connect test equipment and test cable to the module as shown in figure 7-34. Figure 6-131 gives parts location data.

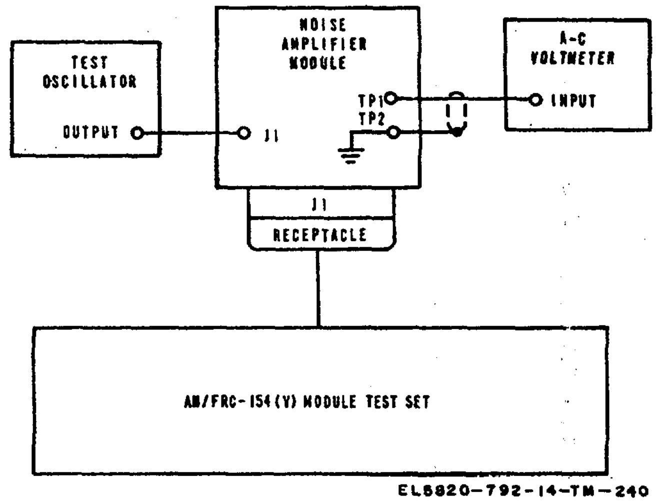

Figure 7-34. Noise amplifier module, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

(1) Remove the top and bottom covers from the module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Adjust the +28-volt power supply in the module test set for 28 ± 0.5 Vdc.

d. Test Procedures. After completing the procedures in b and c above, perform the procedures provided in e below.

e. Voltage and Resistance Measurements. If performance of the test and/or alignment procedures does not result in acceptable module operation, use of the voltage and resistance data provided in g below, in conjunction with standard troubleshooting techniques, should enable location and correction of the fault. Resistance measurements are made with the -module disconnected from all external components using the multifunction meter. All voltages are measured using the test setup of b above. The multifunction meter is also used to measure dc voltages. For ac voltage measurements, use the ac voltmeter. The input signal to J1 of subassembly is set at a signal level of -45 dB.

CAUTION

Before using an ohmmeter to test transistor circuits, check-the open circuit voltage across the ohmmeter - test leads. Do not use the ohmmeter if this voltage exceeds 1.5 volt. Also, since the R x 1 range normally connects the ohmmeter internal battery directly across the test leads, the comparatively high current (50

ma or more) may damage the transistor under test. As a general rule, it is not recommended that the R x 1 range of any ohmmeter be used when testing low-power transistors.

f. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
1	Rotate R1, R2, R3, and R4 fully clockwise.			
2	Set output level control of test oscillator to minimum.			
3	Set test oscillator to the test frequency indicated in the following chart. *Module part No. Test frequency* 368-43018 -2 200 kHz -3 450 kHz -4 800 kHz -5 1.60 MHz			
4	Connect ac voltmeter across TP1 and TP2 (ground) and set its control to read-30 db. Adjust output level control of test oscillator so that meter reads-45 db.			
5	Connect ac meter from test point TP4 to TP2 (ground).	-30 db ± 2.0 db	Proceed to step 6	Check amplifier Q1, Q2, and Q3 a com
6	Disconnect ac voltmeter, and connect oscilloscope probe to emitter of Q4. Disconnect oscilloscope probe from emitter of Q4.	45 mv, peak-to-peak at the frequency.	Proceed to step 7	Check Q4 and associated com- pon
7	Connect the oscilloscope probe to the collector of Q9.	1 7.5 ± 0.3 V peak-to-peak	Proceed to step 8	Check the varilosser cir- cuitr CR5 nent
8	Open AGC loop by unsoldering + side of C22.			
9	Set frequency of test oscillator to 400 kHz. Set output level of test oscillator to minimum.			
10	Connect output of test oscillator to + side of C22, and connect ac voltmeter from + side of C22 to ground.			
11	Adjust output level control of test oscillator for an indication of -40 db (8 mv rms) on ac voltmeter.			
12	Connect oscilloscope probe to collector of Q5	7 mv peak-to-peak	Proceed to step 14	Check Q5, Q6, Q7, and asso- ciate and amp of o erat
13	Connect ac voltmeter probe to collector of Q6	2.1 V peak-to-peak	Proceed to step 14	Check Q5, Q6, Q7, and as- soci step
14	Connect ac voltmeter probe to junction of C29 and R44.	1.2 V peak-to-peak	Proceed to step 15	Check Q5, Q6, Q7, and as- soci che C31
15	Set test oscillator output level control to minimum, and connect output to junction of C13 and R45.			

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
16	Connect ac voltmeter to junction of C31 and R45. Adjust test oscillator output level control for an indication of -25 db (44 mv, rms) on ac voltmeter.			
17	Connect oscilloscope probe to collector of Q8	500 mv peak-to-peak	Proceed to step 18	Check Q8, Q9, and associ- atec com fier; stag of th
18	Connect oscilloscope probe to collector of Q9	Proceed to step 19		Check Q8, Q9, and associated com
19	Disconnect test oscillator from junction of C31 and R45.			
20	Connect output of test oscillator to + side of C22, and connect ac voltmeter from + side of C22 to ground.			
21	Adjust output level control of test oscillator for an indication of -40 db (8 mv rms) on ac voltmeter.			
22	Set range switch of multifunction meter to permit indication of 25 V dc. Connect negative meter lead to test point TP2 (ground) and positive lead to test point TP3.	+ 18.5 ± 0.3 V dc	Proceed to step 23	Proceed to step 23.
23	Disconnect. test oscillator from + side of C22, and note meter reading at TP3. (Do not disturb the test oscillator settings.)	+6.5 V dc	Proceed to step 26	Proceed to step 24.
24	Reconnect test oscillator to junction of C31 and R45, and check dc voltage at junction of CR6, CR7, and C38 to ground.	+7.5 V dc	Proceed to step 25	Check CR6 and CR7 and re- plac ings to st are i and
25	Disconnect test oscillator from junction of C31 and R45 and measure the dc voltage at junction CR6, CR7, and C38 to ground.	+7.4 V dc	Proceed to step 26	Check the circuitry asso- ciate and
26	Reconnect capacitor C22, and proceed to step 29. Noise amplifier dc output			
27	Set test oscillator to test frequency shown in step 3.			
28	Connect output of test oscillator to input connector J1, and connect ac voltmeter to test points TP4 and TP2 (ground).			
29	Adjust output level of test oscillator for an indication of -20 db on ac voltmeter.			
30	Set range switch of multifunction meter to permit indication of 25 V dc, and connect negative lead to test point TP 2 (ground) and positive lead to test point TP3.	18± 2 V dc	Proceed to step 31	Check Q8 through Q11, CR7, CR8 nent
31	Set range of test oscillator to -25 db. Connect multifunction meter across TP3 and TP2 (ground).	16.5 ± 1.5 V dc	Proceed to step 32	Check Q8 through Q11, CR7, CR8 nent
32	Adjust output level of test oscillator for an indication of -30 db on ac voltmeter. Multi-function meter indication should then be as shown.	10.8 ± 1 V dc	Proceed to step 33.	

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
33	Adjust output level of test oscillator for an indication of -50 db on ac voltmeter. Multifunction meter indication c should be as shown.	8.4 ± 1 V dc	Proceed to step 34.	
34	Adjust output level of test oscillator for an indication of -60 db on ac voltmeter. Multi-function meter indication should be as shown.	7.0 ± 1 V dc	Proceed to step 35.	
35	Remove input from test oscillator at J1. Multi-function meter indication should be as shown.	All modules: 6.6 0.5 V dc	Proceed to step 36.	
36	Rotate R4	fully counterclockwise	and repeat steps 27	
	through 33. The results should be as follows:			
	-20 db	15.0 V dc		
	-25 db	14.0.± 1.5 V dc		
	-30db	12.7 ± 1.5 V dc		
	-40 db	9.8 ± 1 V d		
	-50 db	8.0 ± 1 V dc		
	-60 db	7.0 ± 1 V dc		
	No signal	6.6 ± 0.5 V dc		

g. Voltage and Resistance Data.

Point of measurement	Dc voltage (nominal)	Ac voltage (nominal) (peak-to-peak)	Resistance (nominal) RX100 scale unss otherwise specified
Q1 Base	5V		7 kΩ
Emitter	4.3 V		22 ohms
Collector	13.9 V	8 mv	4.5 kΩ
Q2 Base	14.1 V		12 kΩ
Emitter	13.4 V		1.5 kΩ
Collector	19.0 V	80 mv	2.9 kΩ
Q3 Base	19.0 V		2.0 kΩ
Emitter	18.4 V	80 mv	680 ohms
Collector	27.0 V		800 ohms
Q4 Base	18.9 V		8 kΩ
Emitter	18.1 V	50 mv	1.6 kΩ
Collector	7 V		800 ohms
Q5 Base	1.8 V		850 ohms
Emitter	1.2 V		180 ohms
Collector	6 V		1.6 kΩ
Q6 Base	6 V		1.6 kΩ
Emitter	13.5 V	800 mv	1.8 kΩ
Q7 Base	13.4 V		1.8 kΩ
Emitter	12.8 V	800 mv	1.4 kΩ
Collector	27.2 V		800 ohms
Q8 Base	2.5 V		2 kΩ
Emitter	3.2 V		560 ohms
Collector	9.5 V	2.7 mv	2.5 kΩ
Q9 Base	9.5		2.5 kΩ
Emitter	8.8 V		500 ohms
Collector	18.5 V	10 v	1.45 kΩ
Q10 Base	7.5		30 kΩ
Emitter	7.0 V		4 kΩ
Collector	23 V		2.9 kΩ
Q11 Base	7.0 V		4 kΩ
Emitter	6.2 V		3 kΩ
Collector	23 V		2.9 kΩ
TP 5		11 mv	
TP 4		11 mv	
TP 3	6.5 V		
CR8	6.2 V		1.3 kΩ
CR20	20.5 V		800 ohms

7-55. Alignment Data

The noise amplifier module does not require alignment at the test bench location; however, when the module is installed in an operational terminal, the module must be aligned to meet receiver system receiver specifications. The noise amplifier uses potentiometers R2, R3, and R4 to control signal combining action relative to total noise (receiver and propagation) content. Potentiometers R1 and R79 set the threshold for excess-noise and pilot-tone alarms respectively. Refer to the microwave terminal manual for alignment procedures involving these components.

Section XI. TERMINAL FILTER MODULE (368-43020-1 THROUGH -6, -9, AND -10)

7-56. Introduction

Terminal filter modules are modules common to microwave receivers or transmitters which permit interfacing adjustments between external communication equipments and the microwave radio terminal.

7-57. Module Configurations

a. The terminal filter module consists of a single printed-wiring card on which all components, with the exception of test jacks and connectors, are mounted. The latter components are mounted on the front flange of metal module chassis. The module is equipped with bandpass filters secured to the main printed-wiring card.

b. The bandpass filter used in a given application depends upon the supervisory channel and multiplex frequency ranges of the particular communication system.

c. Module configurations follows:

	Supervisory channel filter (FL1)		Multiplexer channel filter (FL-2)		Hybred (HY1 or HY2)	
Terminal filter module part No.	**Part No.**	**Bandpass**	**Part No.**	**Bandpass**	**Part No.**	**Bandpass**
368-43020-1	362-7649-1	300 Hz to 8 kHz	362-7648-1	12 kHz to 2.8 MHz	Omit	
368-43020-2	362-7649-2	300 Hz to 4 kHz	362-7648-2	6 kHz to 2.8 MHz	Omit	
368-43020-3	362-7649-3	200 Hz to 8 kHz	Omit	....	Omit	
368-43020-4	362-7671-1	200 Hz to 8 kHz	Omit	....	Omit	
368-43020-5	362-7649-3	200 Hz to 8 kHz	362-7648-11	12 kHz to 1.3 MHz	Omit	
368-43020-6	362-7649-3	200 Hz to 8 kHz	362-7648-1	12 kHz to 28 MHz	Omit	
368-43020-9	362-7649-6	200 Hz to 8 kHz	362-7648-11	12 kHz to 1.3 MHz	Omit	
368-43020-10	362-7671-1	200 Hz to 8 kHz	Omit	....	Omit	

7-58. Functional Description

a. The functional block diagram of the terminal filter appears in figure 7-35. Terminal filters are used in both receiver and transmitter applications. All terminal filters, except part numbers 368-43020-4 and -10, are used as receive terminal filters. In receiver applications, the terminal filter module separates the multiplex and supervisory channel signals from the received baseband; receiver output levels are adjusted to the requirements of external communications equipments. The baseband enters the receiver terminal filter modules via coaxial connectors J2 and J3, is filtered, then attenuated, and sent out of the module. The multiplex signals are sent through coaxial connector J1, while the supervisory signals are sent through printed-circuit connector A2J1.

b. Terminal filters having part numbers 36843020-4 and -10 are used as transmit terminal filters. In transmitter applications, the terminal filter module adjusts the input levels from external communication equipments to the requirements of the microwave transmitter. The supervisory channel signals enter the transmit terminal filter via printed-circuit connector A2-J1. The multiplex signals make entry through coaxial connector J1.

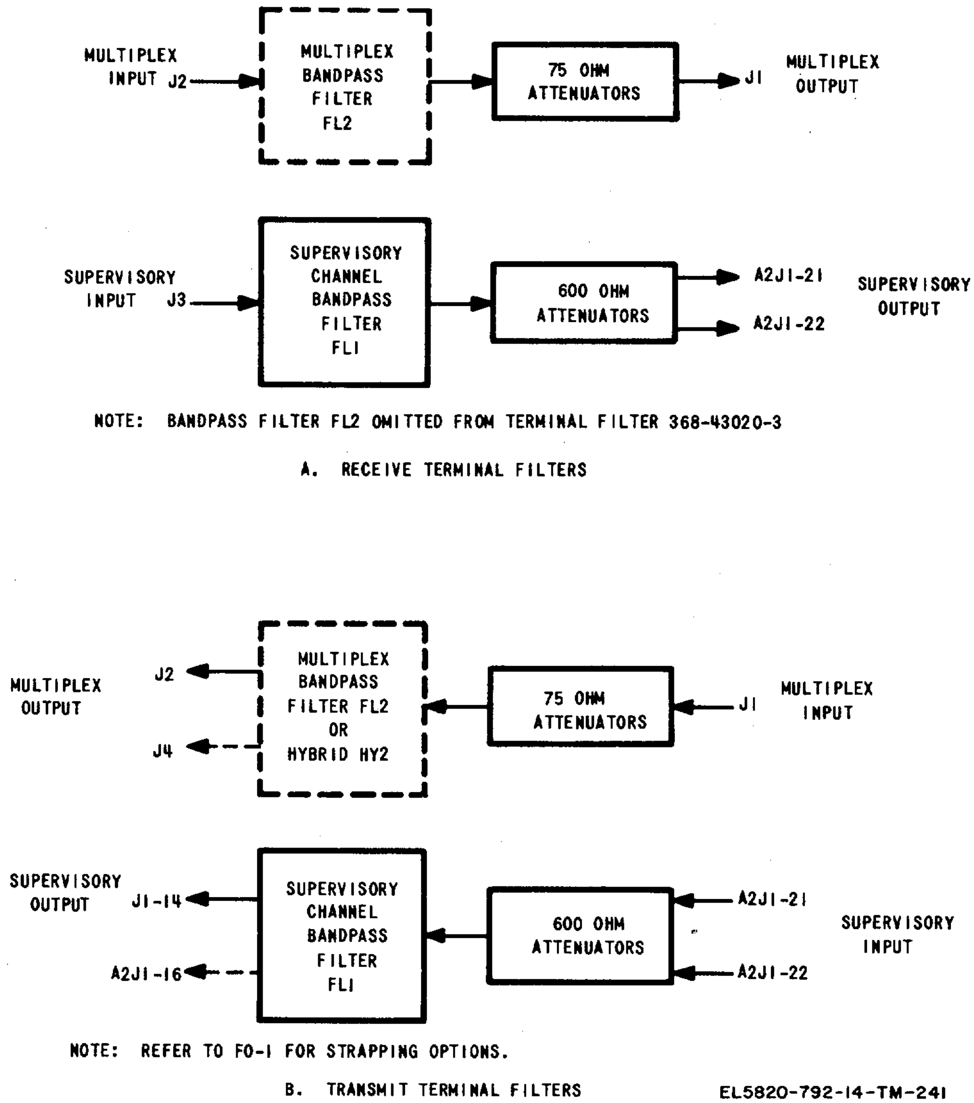

Figure 7-35. Terminal filter module, functional block diagram.

7-59. Circuit Analysis

a. Receive Terminal Filters. The schematic diagram of the terminal filter modules is shown in figure FO-30. The baseband signal, received from the common baseband module or the baseband combiner module, enters the receive terminal filter module through coaxial connectors J2 and J3. The baseband signal arriving through coaxial connector J2 is applied to multiplex bandpass filter FL2, which passes the multiplex frequencies and rejects the pilot-tone and supervisory channel frequencies. At the output of filter FL2 are five fixed, 75-ohm unbalanced T-pad attenuators. The attenuation may be varied from 0 to 31 db in 1-db steps. The correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. The multiplex signals are routed out of the receive terminal filter module via coaxial connector J1. The baseband signal arriving through coaxial connector J3 is applied to supervisory channel bandpass filter; FL1 which passes the supervisory channel signals and rejects the pilot-tone-and multiplex signals. At the output of filter FL1 are five fixed, 600-ohm balanced' H-pad attenuators. The attenuation may be varied from 0 to 31 db in 1-db steps. The, correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. The supervisory signals are routed out of the receive terminal filter module via: pins 21 and 22 of printed-circuit connector A2J1.

b. Transmit Terminal Filters. Multiplex signals from external communications equipment are applied to coaxial connector J1 in transmitter applications. Five fixed, 75-ohm unbalanced T-pad attenuators are available to interface external equipment with the microwave radio transmitter. The correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. Multiplex bandpass filter FL2 is used in the transmit terminal filter; the multiplex signals are sent out of the terminal filter module to the adder module via coaxial connector J2. Hybrid HY2 is used in terminal filter and is required in systems where redundant adder modules are used; the multiplex signals are sent through hybrid HY2 to adder modules via coaxial connectors J2 and J4. The output of the 75-ohm unbalanced T-pad attenuators is strapped direct to coaxial connector J2 in terminal filter 36843020-10 without using either a bandpass filter or a hybrid. Supervisory channel signals from external communications equipment are applied to pins 21 and 22 of printed-circuit connector A2J1 in transmitter applications. Five fixed, 600-ohm balanced H-pad attenuators are available to interface external equipment with the microwave transmitter. The correct amount of attenuation is selected by system tests and inserted by strapping suitable terminals. At the output of the attenuators, the supervisory channel signals are passed through bandpass filter FL1 to limit the band of frequencies and to convert the 600-ohm balanced line into an unbalanced line. Bandpass filter FL1 used in terminal filter 368-43020-4 converts the 600-ohm balanced line to a 75-ohm unbalanced line; supervisory channel signals are sent out of the terminal filter module to the adder module via pin 14 of printed-circuit connector A2J1.

c. Technical Characteristics.

Parameter	*Specifications*
Input impedance (multiplex)	75 ohms, unbalanced.
Input impedance (supervisory)	
368-43020-1	75 ohms, unbalanced.
368-43020-2	75 ohms, unbalanced
368-43020-3	75 ohms, unbalanced.
368-43020-4	600 ohms, balanced.
368-43020-5	75 ohms, unbalanced.
368-43020-6	75 ohms, unbalanced.
368-43020-9	75 ohms, unbalanced.
368-43020-10	600 ohms, balanced.
Output impedance (multiplex)	75 ohms, unbalanced.
Output impedance (supervisory)	
368-43020-1	600 ohms, balanced.
368-43020-2	600 ohms, balanced.
368-43020-3	600 ohms, balanced.
368-43020-4	600 ohms, unbalanced.
368-43020-5	600 ohms, balanced.
368-43020-6	600 ohms, balanced.
368-43020-9	600 ohms, balanced.
368-43020-10	600 ohms, unbalanced.
Frequency response	Paragraph 6-75.
Power requirements	None.

7-60. Maintenance Data

a. Performance Test and Trouble Analysis Procedures. This paragraph contains procedures to test the performance of the overall module and its major circuits, and gives probable causes of abnormal indication.

b. Test Equipment Setup. Connect test equipment as shown in figure 7-36.

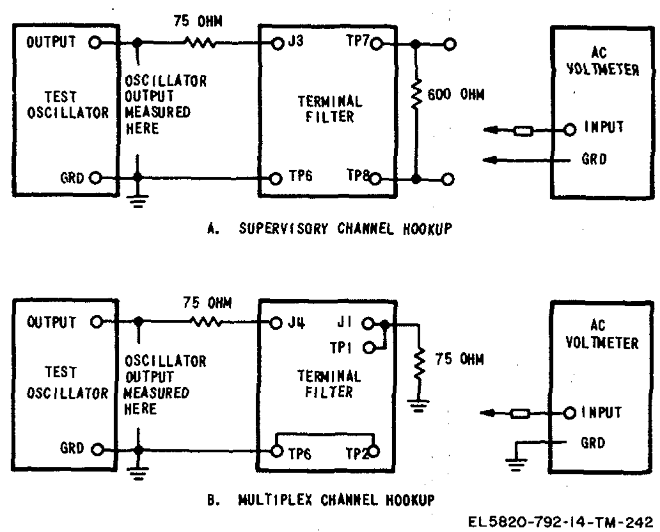

Figure 7-36. Terminal and terminal filter, auxiliary modules, initial test equipment setup.

c. Preliminary Adjustments. Perform the following preliminary adjustments:

NOTE

Strapping of attenuator pads of the module is based on the particular system configuration in which the module is connected. If for any reason the strapping of these pads must be changed, first make a record of the original strapping so that the strapping can be restored to the original condition when desired. Figure 6147 provides parts location data.

(1) Remove the top and bottom covers from the terminal filter module.

(2) Set all test equipment power switches to the ON position; allow the test equipment to stabilize for 20 minutes.

(3) Perform the procedures contained in d and e below.

d. Test Procedures.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Supervisory channel		
1	Connect test equipment as shown in A, figure 7-36.			
2	Connect built-in attenuator for filter FL1 to provide 0 db attenuation.			
3	Set frequency of test oscillator to 3 kHz, and output level to 1 volt rms (+2 db).			
4	Set ac voltmeter to permit indication of +5 db, and connect meter from TP7 to TP8 of module. Record this reading.	Between -1 and +4 db (reference).	Proceed to step 5	Check filter FLA1.
5	Set frequency of test oscillator to 300 Hz.			
6	Set output level to 1 volt rms (+2 db).			
7	Set ac voltmeter to permit indication of +5 db, and connect meter from TP7 to TP8 of module. Record this reading. **NOTE** **Not all of the following steps apply to the test procedure. Choose the appropriate test step based on the module parts numbers listed.**	Within +0.1 db to -0.5 db of reference.	Proceed to step 8	Check filter FL1.
8	Repeat steps 5 through 7, using 12 kHz for all terminal filter modules, except 368-43020-2 and -8.	Within +0.1 db to -0.5 db of reference level.		Check filter FL2.
9	Repeat steps 5 through 7, using 2.6 MHz for all terminal filter modules, except 368-43020-5 and -9.	Within 0.0 db to -0.6 db of reference level.		Check filter FL2.
10	Repeat steps 5 through 7, using 6 kHz for terminal filter module 368-43020-2.	Within +0.1 db to -0.5 db of reference level.		Check filter FI.2.
11	Repeat steps 5 through 7, using 1.3 MHz for terminal filter modules 368-43020-5 and -9.	Within 0.0 db to -0.6 db of reference level.		Check filter FI,2.
12	Repeat steps 5 through 7, using 3.2 MHz for terminal filter modules 368-43020-1, -2, and -6.	At least 35 db below reference level.		Check filter FL2.

e. Procedure.

Step	Procedure	Normal indication	If indication is normal	If indication is not normal
		Multiplex channel		
1	Connect test equipment as shown in B, figure 7-36.			
2	Connect built-in attenuator to provide 0 db attenuation.			
3	Set frequency of test oscillator to 100 kHz, and output level to 1 volt (+2 db).			
4	Set ac voltmeter to permit indication of -0 db, and connect meter from TP1 and TP2 of module. Record this reading.	Between -5 and +2 db (reference).	Proceed to step 5	Check filter FL2.
	NOTE **Omit this test on units that do not - contain filter FL2.**			
5	Set frequency corresponding to module part number. *Module part No.* — *Frequency* 368-43020-1 — 8 kHz -2 — 4 kHz -4 — 10 kHz -5 — 10 kHz -6 — 8 kHz -9 — 8 kHz	of a test oscillator to the frequency		
6	Set output level to I volt rms (+2 db).			
7	Set ac voltmeter to permit indication of -30 db and connect meter from TPI to TP2 of module.	At least 35 db below reference	Proceed to step 8	Check filter FL2.
	NOTE **Not all of the following steps apply to the test procedure. Choose the appropriate test step based on the module part numbers listed.**			
8	Repeat steps 5 through 7, using 8 kHz for all terminal filter modules except 368-43020-2.	Within +0.1 db to -0.5 db of reference level.	Check filter FL1.	
9	Repeat steps 5 through 7, using 12 kHz for all terminal filter modules except 368-43020-2 and -9.	At least 35 db below reference level.	Proceed to step 1 of multiplex channel performance test.	Check filter FL1.
10	Repeat steps 5 through 7, using 4 kHz for terminal filter module 368-43020-2.	Within +0.1 db to -0.5 db of reference level.	Check filter FL1.	
11	Repeat steps 5 through 7, using 6 kHz for terminal filter module 368-43020-2.	At least 35 db below reference level.	Proceed to step 1 of multiplex channel performance test.	Check filter FL1.
12	Repeat steps 5 through 7, using 10 kHz for terminal filter module 368-43020-9.	At least 35 db below reference level.	Proceed to step 1 of multiplex channel performance test.	Check filter FL1.

7-61. Alignment Data

The terminal filter module does not require alignment. Certain system parameters are imposed on the microwave radio terminal which dictate the selection of the various attenuator pads in the module. Refer to chapter 5 for system alignment procedures involving the selection of these attenuators.

APPENDIX A

REFERENCES

The following publications contain information applicable to the operation and maintenance of the radio set:

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	U.S. Army Equipment Index of Modification Work Orders.
SB 38-100	Preservation, Packaging, Packing, and Marking Materials, Supplies, and Equipment Used by the Army.
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TB MED 270	Control of Hazards to Health From Microwave Radiation.
TB SIG 221	Theory and Operation of Transmitter Diversity Communication.
TB SIG 222	Solder and Soldering.
TB SIG 291	Safety Measures To Be Observed When Installing and Using Whip Antennas, Field Type Masts, Towers, Antennas, and Metal Poles That are Used With Communication, Radar, and Direction Finder Equipment (TO 31P5-1).
TB SIG 355-1	Depot Inspection Standard for Repaired Signal Equipment.
TB SIG 355-2	Depot Inspection Standard for Refinishing Repaired Signal Equipment.
TG SIG 355-3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TM 11-673	Generation and Transmission of Microwave Energy.
TM 11-2646A	Capacitance- Inductance- Resistance Test Set AN/URM-90.
TM 11-6625-200-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, ME-26C/U, and ME-26D/U.
TM 11-6625-214-10	Operator's Manual: Signal Generators AN/URM-52 and AN/URM-52A.
TM 11-6625-214-24	Organizational, DS, and GS Maintenance Manual: Signal Generators AN/URM-52 and AN/URM-52A.
TM 11-6625-320-12	Operator and Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30 C/U, and ME-30E/U.
TM 11-6625-359-10	Operator's Manual: Spectrum Analyzer Set AN/UPM-84.
TM 11-6625-359-12-1	Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tools List: Spectrum Analyzer Set AN/UPM-84A.
TM 11-6625-366-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeter TS-352B/U.
TM 11-6625-433-15	Operational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tools Lists: Wattmeters AN/URM-98 and AN/URM-98A.
TM 11-6625-488-15	Operator, Organization, Field and Depot Maintenance Manual: Preamplifier AM-3148/USM.
TM 11-6625-493-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Frequency Comparator CM-77A/USM.
TM 11-6625-494-15	Operator, Organizational, Field and Depot Maintenance Manual: Preamplifier AM-1841B/USM.
TM 11-6625-508-10	Operator's Manual: Signal Generators AN/USM-44 and AN/USM-44A.

TM 11-6625-508-25	Organizational, Field and Depot Maintenance Manual: Signal Generators AN/USM-44 and-AN/USM-44A.
TM 11-6625-524-14	Operator, Organizational and Field Maintenance Manual: Voltmeter, Electronic AN/URM-145.
TM 11-6625-524-15-1	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Electronic Voltmeter AN/URM-145.
TM 11-6625-555-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Oscilloscope AN/USM-182A.
TM 11-6625-555-45	
TM 11-6625-665-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Generator, Signal AN/USM-205.
TM 11-6625-700-10	Operator's Manual: Digital Readout, Electronic Counter AN/USM-207.
TM 11-6625-700-25	Organizational, DS, GS, and Depot Maintenance Manual: Digital Readout, Electronic Counter AN/USM-207.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use.

APPENDIX C

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General

This appendix provides a summary of the maintenance operations for Radio Set AN/FRC154(V). It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine and serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition; i.e., to clean, preserve, drain, paint, or to replenish fuel/lubricants/hydraulic fluids or compressed air supplies.

d. Adjust. Maintain within prescribed limits by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment/system.

h. Replace. The act of substituting a serviceable like-type part, subassembly, module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module/component/assembly, end item or system.

j. Overhaul. That periodic maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (e.g., DMWR) in appropriate technical publications. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree or material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipment/components.

C-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies and modules with the next higher assembly.

b. Column 2, Component Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in Column 2.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of man-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart.

Subcolumns of column 4 are as follows:
C-Operator/Crew
O- Organizational
F-Direct Support
H-General Support
D-Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

C-4. Tool and Test Equipment Requirements (Table 1)

a. Tool or Test Equipment Reference Code. The numbers in this column coincides with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for Manufacturers (5 digit) in parentheses.

SECTION II MAINTENANCE ALLOCATION CHART FOR RADIO SET AN/FRC-154(V) MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
00	RADIO SET AN/FRC-154(V) 1 THRU 28 PHILCO-FORD LC-4E 397-1457-1 THRU 28 (See note A at end of chart)	Inspect		0.5				
		Test[1]		1.5				1,2,5,6,9, THRU 16,18,20,22 THRU 25,27,28,50,54, 64,65,95,96
					2.0			1 THRU 54,56 THRU 65,95,96
		Service[2]		0.8				
					1.5			90,91
		Adjust[3]		1.5				1,2,5,6,9 THRU 16,18,20,22, THRU 28,50,54, 55,57,64,65,89, 96
					2.0			1 THRU 54,56 THRU 66,95,96
		Align			2.0			3,4,6,8 THRU 13,15,17,22,24 THRU 28,46,54, 58,61 THRU 64, 66
		Repair[4]		1.5				55
					1.0			66
01	RECEIVER DOOR ASSEMBLY 1A1							
0101	FILTER, INTERMEDIATE FREQUENCY lA1MD1, 1A1MD4 PHILCO-FORD 398-10267-3	Test[5]		0.5				9,16,25,28,50, 95,96
						3.0		3,6,14,16,19,22, 23,25,28 THRU 44,54,64,73,74, 76 THRU 79,82, 84
		Replace		0.2				55
		Overhaul				6.0		3,6,7,10,14,19, 22 THRU 25,28 THRU 44,49,54, 56,64,66,73 THRU 79,82,84, 86,88,89,92,93
010101	ELECTRONIC COMPONENT ASSEMBLY 1ALMDiAl, 1AtMD4A1 PHILCO-FORD 398-12211-3	Test				1.0		3,6,19,22,23,28, 54,64,73,74,76 THRU 79,84
		Overhaul				2.0		3,6,7,10,19,22, 23,24,28,49,54, 56,64,66,73 THRU 79,84,86, 88,89,92,93
010102	ELECTRONIC COMPONENT ASSEMBLY 1A1MD1A2, AL1MD4A2 PHILCO-FORD 398-12222-3	Test				1.0		3,6,19,22,23, 28,54,64,73,74, 76. THRU 79.84
		Overhaul				2.0		3,6,7,10,19,22, 23,24,28,49,54, 56,64,66,73 THRU 79,84,86 88,89,92,93

1. Performance test and trouble shooting to the module level
2. General cleaning
3. Restore operational status
4. Module replacement
5. Verify performance in end item

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
010103	ELECTRONIC COMPONENT ASSEMBLY 1AllD1A3, 1AUlD4A3 PHILCO-FORD 398-12222-4	Test				1.0		3,6,19,22,23, 28,54,64,73,74, 76 THRU 79,84
		Overhaul				2.0		3,6,7,10,19,22, 23,24,28,49,54, 56,64,66,73, THRU 79,84,86, 88,89,92,93
0102	LIIMTER-DISCRIMINATOR 1A1MD2, lAlMD5 PHILCO-FORD 368-43489-6; 368-43489-8 (See note C at end of chart)	Test[5]		0.5				9,10,11,14,15, 27,28
		[6]			1.0			9,10,11,14,15, 16,19,25,27,28, 58,61,62
						1.0		6,10,14,15,17, 19,21,23,25,28, THRU 44,51,54, 58,64,82
		Replace		0.5				55
		Overhaul				3.0		6,7,10,14,15,17, 19,21, THRU 25, 28,51,54,56,58, 64,66,75,82,86, 88,89,92,93,94
010201	CIRCUIT CARD ASSEMBLY 1A1MD2A3, 1A1MD5A3 PHILCO-FORD 398-11360-5; 398-11360-7 (See note C at end of chart)	Test				2.0		6,10,14,15,17, 19,21,23,25,28 THRU 44,51,54, 58,64,82
		Overhaul				3.0		6,7,10,14,15,17, 19,21 THRU 25, 28,49,51,54,56, 58,64,66,75,82, 86,88,89,93
0103	AMPLIFIER, INTERMEDIATE FREQUENCY 1A1MD3, 1A1MD6 PHILCO-FORD 368-43488-1	Test[5]		0.9				2,9,10,11,13,16, 23,25,27,28,50, 95,96
						2.5		2,3,6,10,11,14, 16,21,22,23,25, 28 THRU 44,54, 64,73,74,76 THRU 79,82,84
		Replace		0.5				55
		Overhaul,				4.0		2,3,6,10,11,16, 21 THRU 25,28, 49,54,56,64,73 THRU 79,82,84, 86,88,89,92
02	COMBINER DOOR ASSEMBLY 1A2							

5. Verify performance in end item
6. Linearity

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
0201	DETECTOR, DUAL 1A2MD1, 1A2MD6 PHILCO-FORD 368-43035-1	Test [5]		0.8				10,14,15,20,28
						1.5		10,14,15,20,28 82
		Replace		0.5				55
		Overhaul				2.5		7,10,14,15,20 22,24,28,49,54, 56,64,66,75,82, 86,88,89,94
0202	TERMINAL FILTER, RECEIVER 1A2MD2 PHILCO-FORD 368-43020-8	Test [5]		1.0				1,6,14,20,28
					2.5			1,6,14,15,19, 20,24,28,50,51
		Replace		0.5				66
		Repair			1.0			66
0203	BASEBAND COMBINER 1A2MD3, 1A2MD4 PHILCO-FORD 398-12040-1	Test [5]		0.5				10,11,14,15,27, 28
		7			1.0			4,8, THRU 11,14, 15,17,19,24,26, 27,28
						1.5		14,15,19,20,24, 25,28, THRU 44, 82
		Replace		0.5				55
		Overhaul				3.5		7,10,14,15,19, 20,22,24,28,49, 54,56,64,66,75, 82,86,88,89,94
0204	AMPLIFIER, NOISE 1A2MD5, 1A2MD7 PHILCO-FORD 368-43018-1	Test [5]		1.0				9,15,24,26,27, 28,57,
						2.0		14,15,19,20,24, 28,82
		Replace		0.5				55
		Overhaul				3.0		7,10,14,15,20, 22,24,28,49,54, 56,64,66,75,82, 86,88,89,94
03	METER ASSEMBLY, ELECTRICAL 1A3 PHILCO-FORD 398-12041-1	Test [5]		1.0				9 THRU 12,27
						3.5		82
		Replace			0.5			66
		Overhaul				4.5		7,10,22,24,49, 54,56,64,66,75, 82,86,88,89,94

5. Verify performance in end item
7. Combiner balance

SECTION II MAINTENANCE ALLOCATION CHART- Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
0301	ELECTRONIC COMPONENT ASSEMBLY 1A3A1, 1A3A2 PHILCO-FORD 368-42300-3	Test				1.0		82
		Replace				0.5		66
		Overhaul				1.5		7,10,22,24,49,54, 56,64,66,75,82,86 88,90,94
0302	SWITCH, ROTARY 1A3A3 PHILCO-FORD 368-43581-1	Test				1		24
		Replace				0.5		66
		Overhaul				1.5		24,66
0303	ELECTRONIC COMPONENT ASSEMBLY 1A3A5 PHILCO-FORD 368-A3696-2	Test				1		82
		Replace				0.5		66
		Overhaul				1.5		24,66
04	EXCITER DOOR ASSEMBLY 1A4							
0401	MODULE AUTOMATIC FREQUENCY CONTROL 1A4MD1,1A4MD3 PHILCO-FORD 368-43686-1	Test 5				1.0		9,10,11,18,22, 27,54,64,65
						3.0		3,6,10,11,16,17, 20,22,23,25,28, 51,54,64,65,72, 73,74,76 THRU 80,82
		Replace		0.5				55
		Overhaul				4.5		3,6,7,10,11,16 17,20,22 THRU 25,28,49,51,54, 56,64,65,66,72 THRU 80,82,86, 88,89,92,93,94
0402	ADDER MODULE 1A44, 1A6 PHILCO-FORD 368-42029-7	Test 5		1.0				10,14,15,20,28
						2.0		14,15,19,25,28 THRU 44,82
		Replace		1.0				55
		Overhaul				4.0		7,10,22,24,49, 54,56,64,66,75, 86,88,89
040201	ELECTRONIC COMPONENT ASSEMBLY 1A4M4A3,1A 6A4 PHILCO-FORD 368-43022-1	Test				1.5		10,14,19,28,82
		Replace				1.0		66
		Overhaul				3.0		7,10,14,19,22, 24,28,49,54,56, 64,66,75,82,86, 88,89,93,94

5. Verify performance in end item

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
0403	TERMINAL FILTER, TRANSMITTER 1A4MD5 PHILCO-FORD 368-43020-7	Test[5]		0.5				1,6,14,20,28
					1.0			1,6,14,15,20,24, 28,50
		Replace			1.0			66
		Repair			1.0			66
05	POWER SUPPLY ASSEMBLY 1PSI, 1PS2 PHILCO-FORD 368-43580-1	Test[8]		1.0			24	
		9			2.0			10,49,56
						3.0		72,81,83,85
		Replace		0.5				55
		Overhaul				6.0		7,10,22,24,49,54, 56,64,66,75,81, 83,85,86,88,89, 94
0501	CIRCUIT CARD ASSEMBLY 1PS1PSA2, 1PS2PSA2 PHILCO-FORD 368-43777-1	Test				1.0		10,49,54,56,72, 81,83,85
		Replace				0.5		66
		Overhaul				2.0		7,10,22,24,49,54, 56,64,66,75,81, 83,85,86,88,89, 94
0502	CIRCUIT CARD ASSEMBLY 1PS1PSA3, 1PS2PSA3 PHILCO-FORD 368-43782-1	Test				1.0		10,49,54,56,72, 81,83,85
		Replace				0.5		66
		Overhaul				1.5		7,10,22,24,49,54. 56,64,66,75,86, 88,89
0503	CIRCUIT CARD ASSEMBLY 1PS1PSA4, 1PS2PSA4 PHILCO-FORD 368-43776-1	Test				1.0		10,49,54,56,72, 81,83,85
		Replace				0.5		66
		Overhaul				2.0		7,10,22,24,49,54 56,64,66,75,81, 83,85,86,88,89, 94
0504	CIRCUIT CARD ASSEMBLY 1PS1PSA5, 1PS2PSA5 PHILCO-FORD 368-43779-1	Test				1.0		10,49,54,56,72, 81,83,85
		Replace				0.5		66
		Overhaul				1.5		7,10,22,24,49, 54,56,64,66,75, 86,88,89,94

5. Verify performance in end item
8. Repeller voltage
9. All voltages

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
0505	CIRCUIT CARD ASSEMBLY 1PS1PSA6, 1PS2PSA6 PHILCO-FORD 368-43778-1	Test				1.0		10,49,54,56,72, 81,83,85
		Replace				0.5		66
		Overhaul				1.5		7,10,22,24,49, 54,56,64,66,75, 86,88,89,94
0506	CIRCUIT CARD ASSEMBLY lPSIPSA8Al, 1PS2PSA8Al PHILCO-FORD 368-43848-1	Test				1.0		10,49,54,56,72, 81,83,85
		Replace				0.5		66
		Overhaul				1.5		7,10,22,24,49, 54,56,64,66,75, 81,83,85,86,88, 89,94
06	POWER SUPPLY 1A5 PHILCO-FORD 398-12042-1	Test [9]		1.0				24
					1.5			10,49,54,56,64
		Repair [10]		1.0				55
0601	POWER SUPPLY MODULE A5PS, IA5PS2 PHILCO-FORD 398-12051-1	Test				2.0		10,20,22,28,49, 51,54,56,64,81, 83
		Replace		0.5	55			
		Overhaul				4.5		7,10,20,22,24, 28,49,51,54,56, 64,66,75,81,83, 86,88,89,94
060101	CIRCUIT CARD ASSEMBLY IA5PSLA1A1, IA5PS2AlAl PHILCO-FORD 398-12180-3	Test				2.0		10,20,22,28,49, 51,54,56,64,81, 83
		Replace				0.5		66
		Overhaul				3.0		7,10,20,22,24, 28,49,51,54,56, 64,66,75,81,83, 86,88,89,94
060102	CIRCUIT CARD ASSEMBLY IA5PSA1A2, IA5PS2AlA2 PHILCO-FORD 398-12180-2	Test				2.0		10,20,22,28,49, 51,54,56,64,81, 83
		Replace				0.5		66
		Overhaul				3.0		7,10,20,22,24, 28,49,51,54,56, 64,66,75,81,83, 86,88,89,94

9. All voltages
10. Repair by replacing module

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
060103	CIRCUIT CARD ASSEMBLY 1A5PSIAIA3, IA5PS2AIA3 PHILCO-FORD 398-12180-1	Test				2.0		10,20,22,28,49, 51,54,56,64,81, 83
		Replace				0.5		66
		Overhaul				3.0		7,10,20,22,24,28 49,51,54,56,64, 66,75,81,83,86, 88,89,94
060104	CIRCUIT CARD ASSEMBLY IA5PSIA3A4, 1ASPS2A3A4 PHILCO-FORD 398-12179-1	Test				2.0		10,20,22,28,49, 51,54,56,64,81, 83
		Replace				0.5		66
		Overhaul				2.5		7,10,20,22,24, 28,49,51,54,56, 64,66,75,81,83, 86,88,89,94
07	RADIO FREQUENCY COMPONENT ASSEMBLY IA6							
0701	AMPLIFIER, RADIO FREQUENCY 1A6MO1, LA6MD2 PHILCO-FORD 398-12215-1	Test5		1.0				2,16,23,27
						2.0		2,3,4,6,9,10,11, 14,16,18,21,23, 25,27, THRU 48, 54,70,72,82,84, 87
		Replace		0.5				55
		Overhaul				3.0		7,10,14,22,24, 25,28, THRU 44, 49,54,56,65,66, 75,82,86,88,89, 93
0702	ELECTRONIC COMPONENT ASSEMBLY 1A6MD3, 1A6MD4 PHILCO-FORD 368-43490-2; 368-43490-6 (See note B at end of chart)	Test5 28		1.0				10,11,14,15,27,
						1.5		6,10,14,15,19, 20,25,28 THRU 44,82
		Replace		1.0				55
		Overhaul				4.0		6,7,10,14,15,19, 20,22,24,25,28, 49,54,56,64,75, 82,86,88,89,93, 94
070201	ELECTRONIC COMPONENT ASSEMBLY 1A6MD3A3, 1A6MD4A3 PHILCO-FORD 368-41959-6; 368-41959-8 (See note B at end of chart)	Test				2.0		6,10,14,15,19, 20,25,28 THRU 44,50
		Overhaul				3.0		6,7,10,14,15,19, 20,22,24,25,28, 49,54,56,64,66, 75,82,86,88,89, 93

5. Verify performance in end item

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	 O	 F	 H	 D	(5) Tools and Equipment
0703	MIXER)MICROWAVE 1A6A5, 1A6A6 PHILCO-FORD 368-42365	Test[5]		0.5				2,9,16,23,27
						1.0		2,3,4,6,9,10,11, 14,16,18,21,23, 25,27, THRU 48, 54,70,72,82,84, 87
		Replace		1.0				55
		Overhaul				1.5		24,66
0704	WAVEGUIDE ASSEMBLY 1A6A7, 1A6A8 PHILCO-FORD 398-12017-1	Test			1.0			3,4,6,8 THRU 13, 15,17,22,24 THRU 28,46,54,58,61 THRU 64
0705	WAVEGUIDE ASSEMBLY 1A6A9, IA6A10 PHILCO-FORD 398-12473-1	Test			1.0			3,4,6,8 THRU 13, 15,17,22,24THRU 28,46,54,58,61 THRU 64
0706	WAVEGUIDE ASSEMBLY 1A6FL1, 1A6FL2 PHILCO-FORD 368-43869XOXXXX (See note D at end of chart)	Test[5]			1.0			3,8 THRU 11,14, 15,17,23,25 THRU 45,47,48,53,57, 58,59,61,62
						1.5		6,27,28,45,54, 67 THRU 72
		Align				2.0		6,27,28,45,54, 66 THRU 72
		Replace			0.8			66
0707	WAVEGUIDE ASSEMBLY lA6FLl, 1A6FL2 PHILCO-FORD 368-43871 XX7 (See note D at end of chart)	Test[5]			1.0			3,8, THRU 11,14, 15,17,23,25 THRU 45,47,48, 53,57,58,59,61, 62
						2.0		6,27,28,45,54,67 THRU 72
		Align				2.0		6,27,28,45,54,66 THRU 72
		Replace			0.9			66
0708	WAVEGUIDE ASSEMBLY 1A6FL3, 1A6FL4 PHILCO-FORD 368-43627 XXXXXX (See note D at end of chart)	Test[5]			1.0			8,10,11,14,17, 25 THRU 44,58, 61,62
						2.0		6,27,28,45,54, 67 THRU 72
		Align				2.0		6,27,28,45,54,66 THRU 72
		Replace			1.0	66		

5. Verify performance in end item

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
0709	WAVEGUIDE ASSEMBLY 1A6FL3, 1A6FL4 PHILCO-FORD 368-43346 XXXXXX (See note D at end of chart)	Test5			1.0			8,10,11,14,17, 25 THRU 44, 58, 61,62
						1.5		6,27,28,45,54, 67 THRU 72
		Align				2.0		6,27,28,45,54, 66 THRU 72
		Replace			1.0			66
0710	ELECTRON TUBE, KLYSTRON 1A6V1, IA6V2 VARIAN VA259T	Test		1.0				12,13
					1.5			3,4,6,8 THRU 13, 15,17,22,24, THRU 28,46,54, 58,61 THRU 64
		Replace		1.0				55
0711	OSCILLATOR, RADIO FREQUENCY IA6Y1, IA6Y2, IA6Y3 PHILCO-FORD 368-42299-37 (FAIRCHILD MSC 49X02, MSC 51XO)	Test12		1.5				5,10 THRU 13, 18,27
		13						
		13			1.5			5,10 THRU 13,18, 22,27,54,55,64, 65
						2.5		5,7,10 THRU 13, 18,22,28,54,64, 65,66,82
		Align				2.0		7,22,54,64,65, 66,82,93,94
		Replace		1.0				55
		Repair14			1.5	66		
		15					1.0	

NOTE A

The Philco-Ford LC-4E is a dual diversity radio set used in the 1JCS with 240 or 600 channel loading at various transmit and receive frequencies. Twenty eight combinations of channel loading and operating frequencies exist, with radio set part numbers 397-1457-1 thru 28. From a maintenance standpoint, all sets are identical.

NOTE B

Klystron driver 368-43490-6 contains preemphasis network 368-41959-6 for 240 channels and klystron driver 368-43490-2 contains preemphasis 368-41959-8 for 600 channels. From a maintenance standpoint, both combinations are identical.

5. Verify performance in end item
11. Power output
12. Frequency and power output
13. Phase lock
14. Replace crystal
15. Proprietary item-return to Fairchild for repair

SECTION II MAINTENANCE ALLOCATION CHART - Continued
FOR
RADIO SET AN/FRC-154(V)
MODELS 1 THROUGH 28

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment
	NOTE C Limiter-discriminator 368-43489-6 contains de-emphasis network 398-11360-5 for 240 channels and limiter-discriminator 368-43489-8 contains de-emphasis network 398-11360-7 for 600 channels. From a maintenance standpoint, both combinations are identical. NOTE D Waveguide assemblies, Philco-Ford 368-43627XXXXXX and 368-43346XXXXXX, are tuned filters for the transmitter. The last six digits of the part number indicate the frequency for which the filter is tuned. The same is true for the assemblies, 368-43869XXXXXX and 368-43871XXXXXX, except these have two extra tuning cavities and are used in the receiver. Assembly families 368-43346 and 368-43869 are used for the lower half of the radio set band and the 368-43627 and 368-43871 families are used for the upper half. A given radio set may have any combination of two transmitter and two receiver assemblies depending on the assigned frequencies. From a maintenance standpoint, all assemblies are identical.							

TABLE 1. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR RADIO SET AN/FRC-154 (V) MODELS 1 THROUGH 28

Tool or Test Equipment Ref Code	Maintenance Category	Nomenclature Available On Site	Nomenclature Military Equivalent	National/NATO Stock Number	Tool Number
1	O, F	LINE TRANSFORMER, HP 11005A			
2	O, F, H	PROBE ADAPTER, BOONTON, 91-8B-1			
3	F, H	MATCHING TRANSFORMER, ANZAC TP-75			
4	F, H	ADAPTER, AMPHENOL UG-107A/U	ADAPTER, CONNECTOR UG-107B/U	5935-00-149-3304	
5	O, F, H	ADAPTER, AMPHENOL 79825			
6	O, F, H	ADAPTER, POMONA 1269			
7	F, H	TEST LEAD, POMONA 1959-48			
8	F	COAXIAL MIXER, SAGE 247M			
9	O, F, H	RF SIGNAL GENERATOR, HP 618C	GENERATOR SIGNAL AN/URM-52B	6625-00-965-1501	
10	O, F, H	ELECTRONIC COUNTER, HP 5245L	COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-207A	6625-00-044-3228	
11	O, F, H	FREQUENCY CONVERTER, HP 5255A	COMPARATOR, FREQUENCY CM-77/USI	6625-00-080-7204	
12	O, F, H	POWER METER, HP 431C	WATTMETER AN/URM-98A	6625-00-566-4990	
13	O, F, H	THERMISTOR MOUNT, HP 478A			
14	O, F, H	LEVEL METER, HP 400E	VOITMETER, ELECTRONIC ME-30E/U	6625-00-643-1670	
15	O, F, H	OSCILLATOR, HP 651B-02	GENERATOR, SIGNAL AN/USM-205	6625-00-788-9672	
16	O, F, H	RF VOLTMETER, BOONTON 91DA	VOLTMETER, ELECTRONIC AN/URM-145	6625-00-973-3986	
17	F, H	VHF OSCILLATOR, HP 3200B	GENERATOR, SIGNAL AN/USM-44A	6625-00-539-9685	
18	O, F, H	ATTENUATOR, NARDA 757C-10	ATTENUATOR, FIXED CN-797/U	5985-00-644-7996	
19	F, H	THRU TERIMINATION, TEKTRONIX 011-0055-00			
20	O, F, H	ADAPTER, POMONA 3221			
21	F, H	STEP ATTENUATOR, KAY 442D			
22	O, F, H	ADAPTER, AMPHENOL UG273/U	ADAPTER UG-273/U	5935-00-149-3534	
23	O, F, H	ADAPTER, AMPHENOL UG491A/U			
24	O, F, H	MULTIMETER, AN/PSM-6B	MULTIMETER TS-352B/U	6625-00-553-0142	
25	O, F, H	ADAPTER, UG-274C/U	ADAPTER, CONNECTOR UG-274C/U	5935-00-926-7523	
26	F	ADAPTER, UG-201A/U	ADAPTER, CONNECTOR UG-201A/U	5935-00-259-0205	
27	O, F, H	TEST CABLE, CG92F	CABLE ASSEMBLY, RADIO FRE-QUENCY CG-92F/U	5995-00-753-2898	
28	O, F, H	TEST CABLE, CG426F	CABLE ASSEMBLY, RADIO FRE-QUENCY CG-426F/U	5995-00-823-2343	
29	F, H	WHITE NOISE TEST SET, MARCONI OA-2090A			
30	F, H	HIGH PASS FILTER 60 KHz, MARCONI TM-7728/1			
31	F, H	LOW PASS FILTER 1052 KHz, MARCONI TM-7720/11			
32	F, H	LOW PASS FILTER 2540 KHz, MARCONI TM-7720/4			
33	F, H	BAND STOP FILTER 70 KHz, MARCONI TM-7729/2			
34	F, H	BAND STOP FILTER 534 KHz, MARCONI TM-7729/6			

TABLE 1. TOOL AND TEST EQUIPMENT REQUIREMENTS - Continued FOR RADIO SET AN/FRC-154 (V) MODELS 1 THROUGH 28

Tool or Test Equipment Ref Code	Maintenance Category	Nomenclature Available On Site	Military Equivalent	National/NATO Stock Number	Tool Number
35	F, H	BAND STOP FILTER 1002 KHz, MARCONI TM-7729/15			
36	F, H	BAND STOP FILTER 2438 KHz, MARCONI TM-7729/8			
37	F, H	BAND PASS FILTER 70 KHz, MARCONI TM-7730/2			
38	F, H	BAND PASS FILTER 534 KHz, MARCONI TM-7730/6			
39	F, H	BAND PASS FILTER 1002 KHz, MARCONI TM-7730/15			
40	F, H	BAND PASS FILTER 2438 KHz, IMARCONI TM-7730/8			
41	F, H	OSCILLATOR MODULE 70 KHz, MARCONI TM-7794			
42	F, H	OSCILLATOR MODULE 534 KHz, MARCONI TM-7794/4			
43	F, H	OSCILLATOR MODULE 1002 KHz, MARCONI TM-7795/5			
44	F, H	OSCILLATOR MODULE 2438 KHz, MARCONI TM-7795/1			
45	F, H	ADAPTER, HP G281A			
46	F, H	COAXIAL RF DETECTOR, HP 420A			
47	F, H	NOISE FIGURE METER, HP 342A			
48	F, H	NOISE SOURCE, HP G347A			
49	F, H	TEST CABLE, HP 11003A			
50	O, F	ADAPTER, POMONA 1270			
51	F, H	ADAPTER, POMONA 2631			
52	F	SPECTRUM ANALYZER, TEKTRONIX IL40	SPECTRUM ANALYZER SET AN/UPM-84A	6625-00-411-3072	
53	F	COAXIAL TERMINATION, PRD 139AM			
54	O, F, H	OSCILLOSCOPE, TEKTRONIX 535A	OSCILLOSCOPE AN/USM-182A	6625-00-133-1196	
55	0	TOOL KIT, PHILCO-FORD 2490-54B013-001	TOOL KIT, RADIO MAINTENANCE TK-87/U	5180-00-690-4452	
56	F, H	DIGITAL VOLTMETER, HP 5265A			
57	F	FREQUENCY SELECTIVE VOLTMETER, SIERRA 128A	6625-00-832-9047		
58	F, H	GROUP DELAY DETECTOR, HP 3703A			
59	F	TRANSITION, PHILCO-FORD 368-42510-22			
60	F	ATTENUATOR, NARDA 757B-30			
61	F	TRANSMISSION GENERATOR, HP 3701A			
62	F	DEMODULATOR /DISPLAY, HP 3702A			
63	F	POWER DIVIDER, FXR D2-4TN			
64	O, F, H	PREAMPLIFIER, AM-1841/USM	PREAMPLIFIER, AM-1841/USM	6625-00-679-6509	
65	O, F, H	VTVM, ME-26D	}ULTIMETER, ME-26D/U	6625-00-913-9781	
66	F, H	TOOL KIT, TK-100/G	TOOL KIT, ELECTRONIC EQUIP-MENT TK-100/G	5180-00-605-0079	

TABLE 1. TOOL AND TEST EQUIPMENT REQUIREMENTS - Continued FOR RADIO SET AN/FRC-154 (V) MODELS 1 THROUGH 28

Tool or Test Equipment Ref Code	Maintenance Category	Nomenclature Available On Site	Nomenclature Military Equivalent	National/NATO Stock Number	Tool Number
67	H	M/W SWEEP GENERATOR/RF UNIT, HP 8690B/8693A			
68	H	DIRECTIONAL COUPLER, HP G752C			
69	H	WAVEGUIDE DETECTOR, HP G424A-02			
70	H	WAVEGUIDE PRECISION LOAD, HP G910A			
71	H	WAVEGUIDE TRANSITION, PHILCO-FORD 368-42510-4			
72	H	DIFFERENTIAL PREAMPLIFIER, TEKTRONIX 1A7A	PREAMPLIFIER, AM-3148/U	6625-00-875-1058	
73	H	SWEEP GENERATOR, TELONICS SM 2000	GENERATOR, SWEEP AN/USW-203	6625-00-935-0145	
74	H	RF HEAD, TELONICS L6M			
75	H	UNIVERSAL BRIDGE, HP 4260A	BRIDGE, CLR AN/URM-90	6625-00-534-7458	
76	H	MARKER, TELONICS C-70 MHz			
77	H	MARKER, TELONICS CDH-5.0 MHz			
78	H	MARKER, TELONICS CDH-1.0 MHz			
79	H	MARKER, TELONICS CDH-250 KHz			
80	H	PROBE, PHILCO-FORD GTE-6315			
81	H	POWER SUPPLY, HP 6439B			
82	H	LC-4E TEST SET, PHILCO-FORD 397-1485-1			
83	H	POWER SUPPLY TEST SET, PHILCO-FORD 398-12395-1			
84	H	VHF DETECTOR, TELONICS XD-9A			
85	H	PROBE, HP K03-427A			
86	H	TRANSISTOR TESTER, TS-1836/U	TEST SET, TRANSISTOR TS-1836-B/U	6625-00-168-0954	
87	H	ADAPTER, UG 29B/U	RADIO FREQUENCY ADAPTER UG-29B/U	5935-00-643-9875	
88	H	BENCH CLAMP W/CARD HOLDER, FLOTRON 1061-L-107			
89	H	MAGNIFIER LAMP, LUXO LFM-1			
90	F	BLOWER, SUCTION UNIT, CLEMENTS G12			
91	F	ACCESSORY KIT, CLEMENTS SA-82			
92	H	TUNING TOOL (CAPACITORS), JFD 5284			
93	H	TUNING TOOL (INDUCTORS), CAMBION 2033			
94	H	TUNING TOOL (SQUARE TRIM), DAYSTROM 491-16			
95	O, F	TERMINATION, POMONA MDP-R75			
96	O, F	ADAPTER, UG 1441/U	ADAPTER, CONNECTOR UG 1441/U	5935-00-149-2848	

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USA Ascom Dep (2)
USA Camp Carroll Depot (2)
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(1 copy each unit)
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29-134
29-136

NG: None

USAR: None
For explanation of abbreviations used, see AR 310-50.

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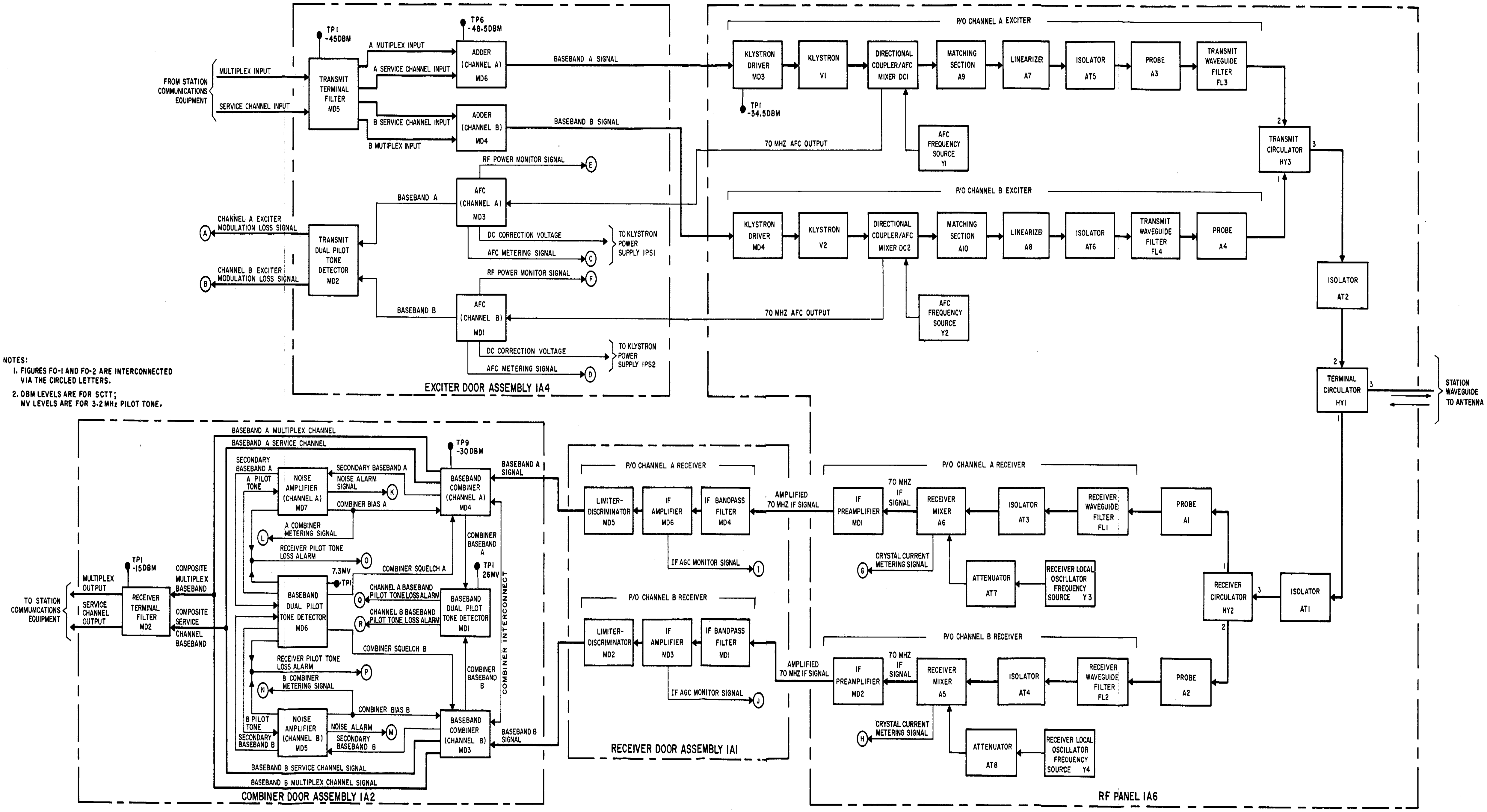

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Figure FO-1. Radio set signal circuits, functional block diagram

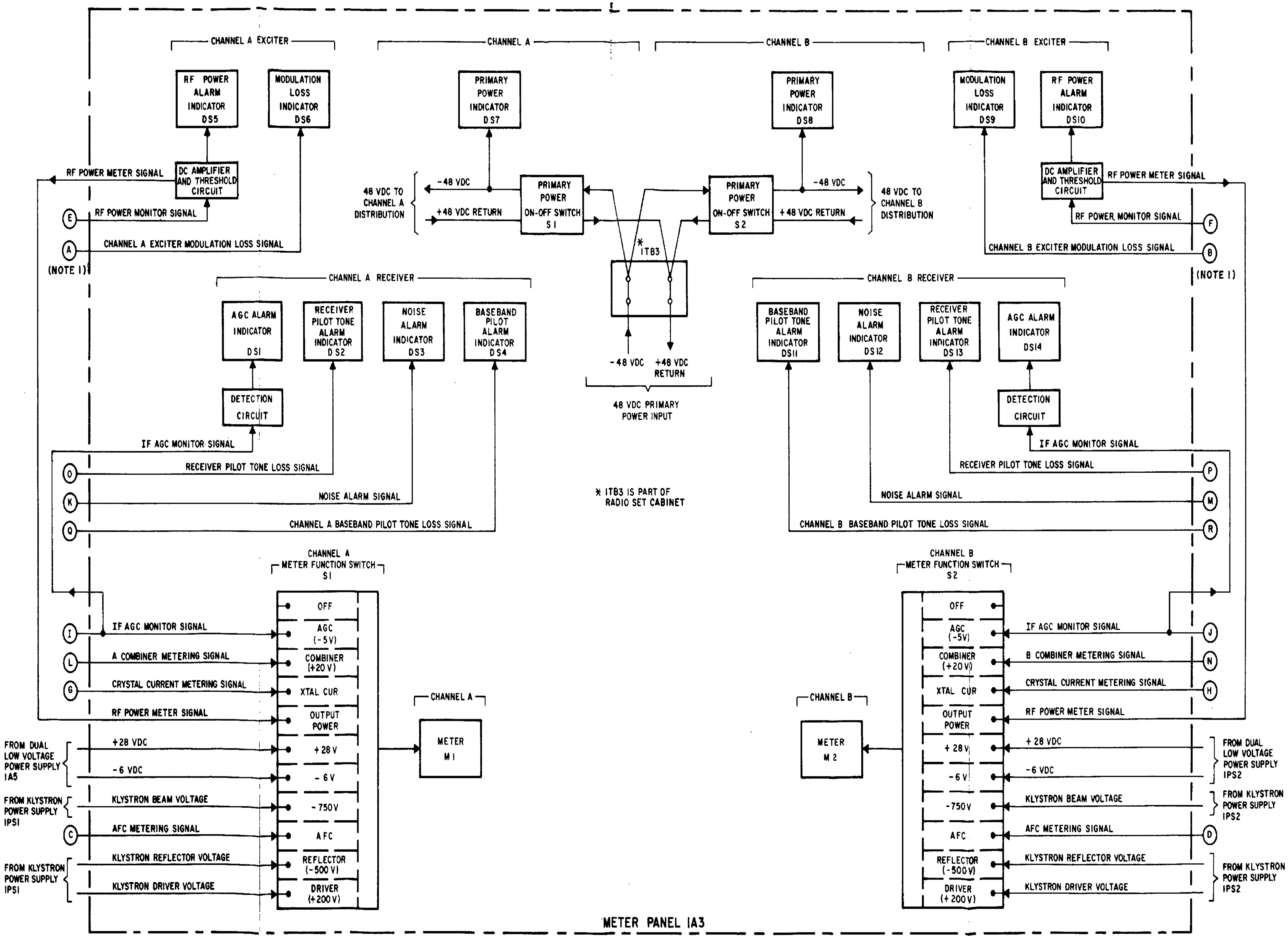

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Figure FO-2. Radio set meter panel, functional block diagram

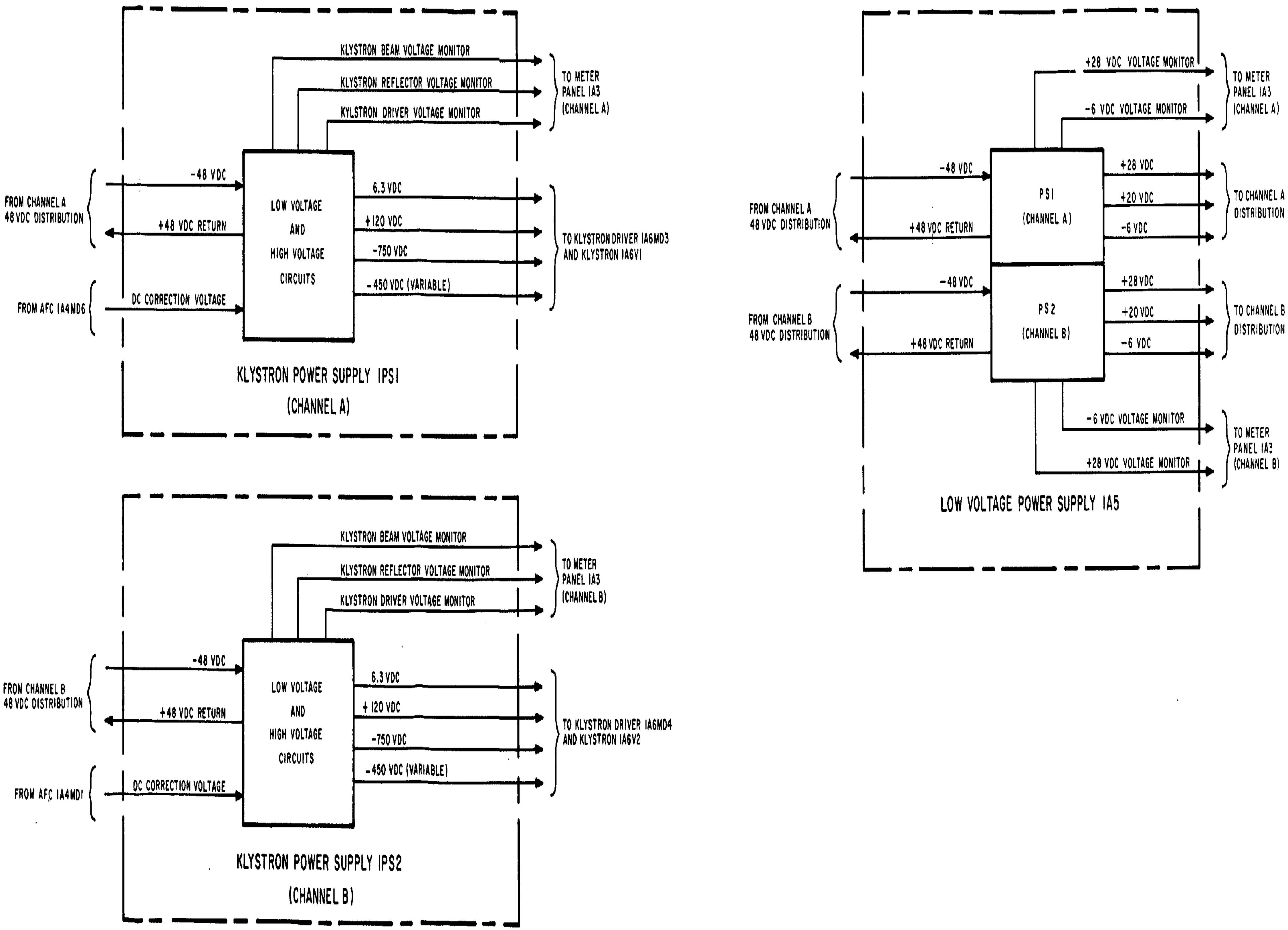

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Figure FO-3. Radio set power supplies, functional block diagram.

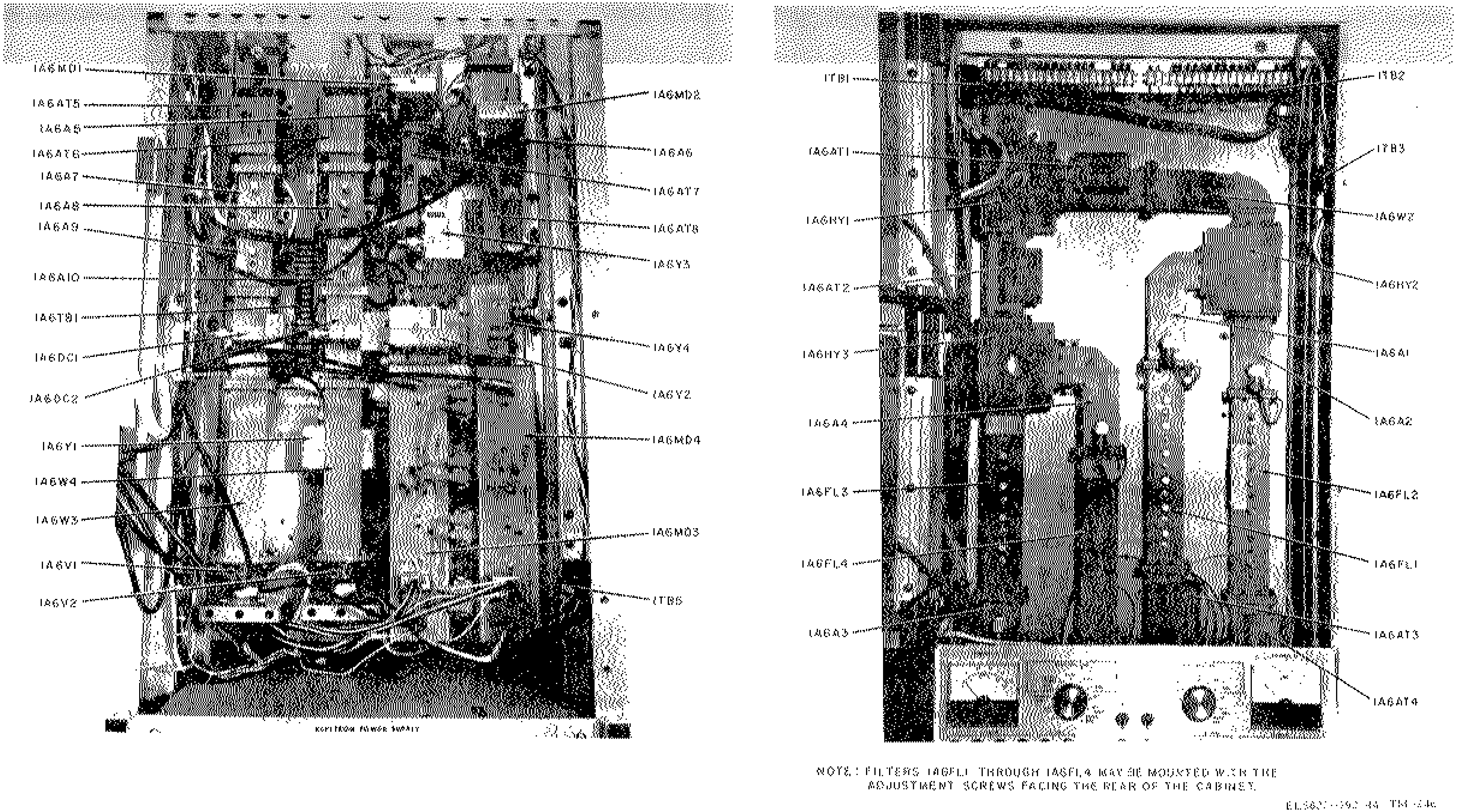

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Figure FO-4. Location of RF panel components.

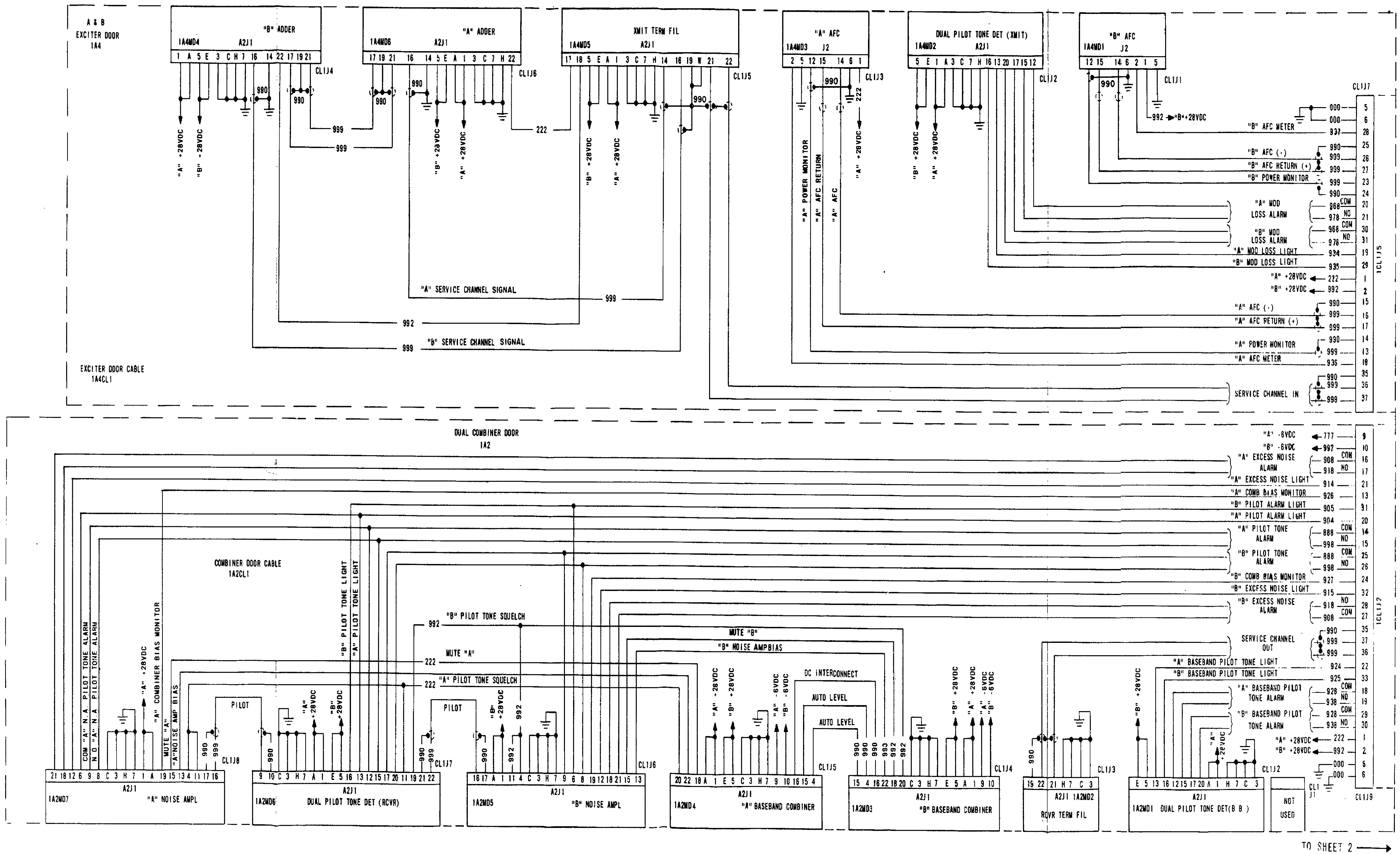

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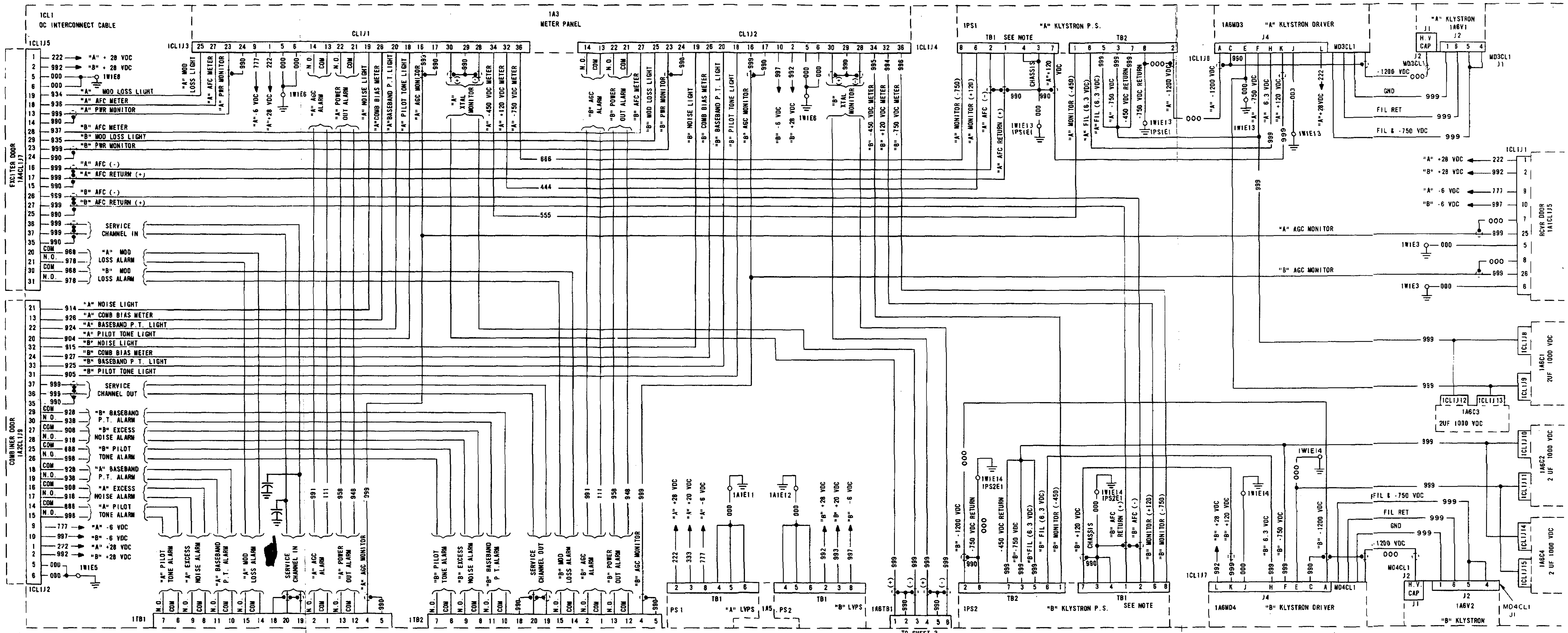
Figure FO-5 (1). Overall wiring diagram (sheet 1 of 3).



NOTE: IF THE AFC LOCAL OSCILLATOR FREQUENCY IS ABOVE THE TRANSMIT FREQUENCY. THE POLARITY OF TB1-1 IS POSITIVE AND TB1-2 IS NEGATIVE.
IF THE AFC LOCAL OSCILLATOR FREQUENCY IS BELOW THE TRANSMIT FREQUENCY. THE POLARITY OF TB1-1 IS NEGATIVE AND TB1-2 IS POSITIVE.

Figure FO-5 (2). Overall wiring diagram (sheet 2 of 3).

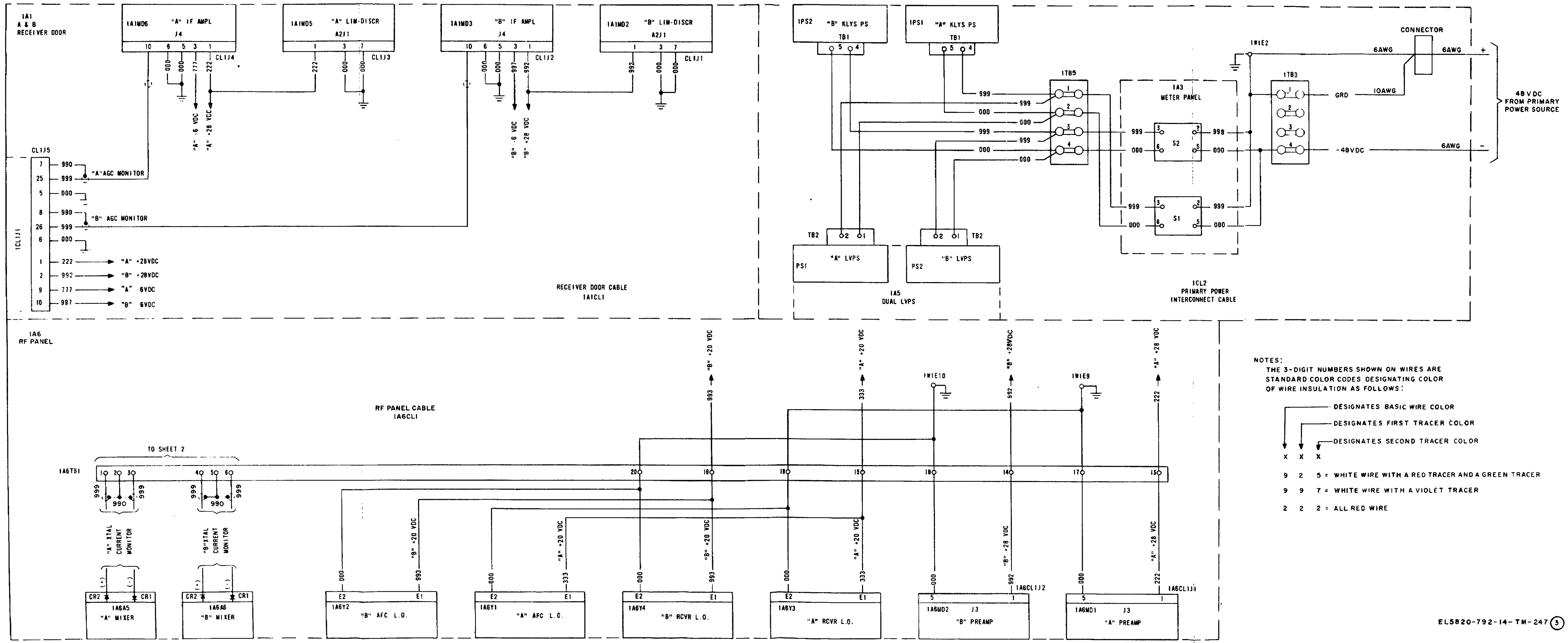
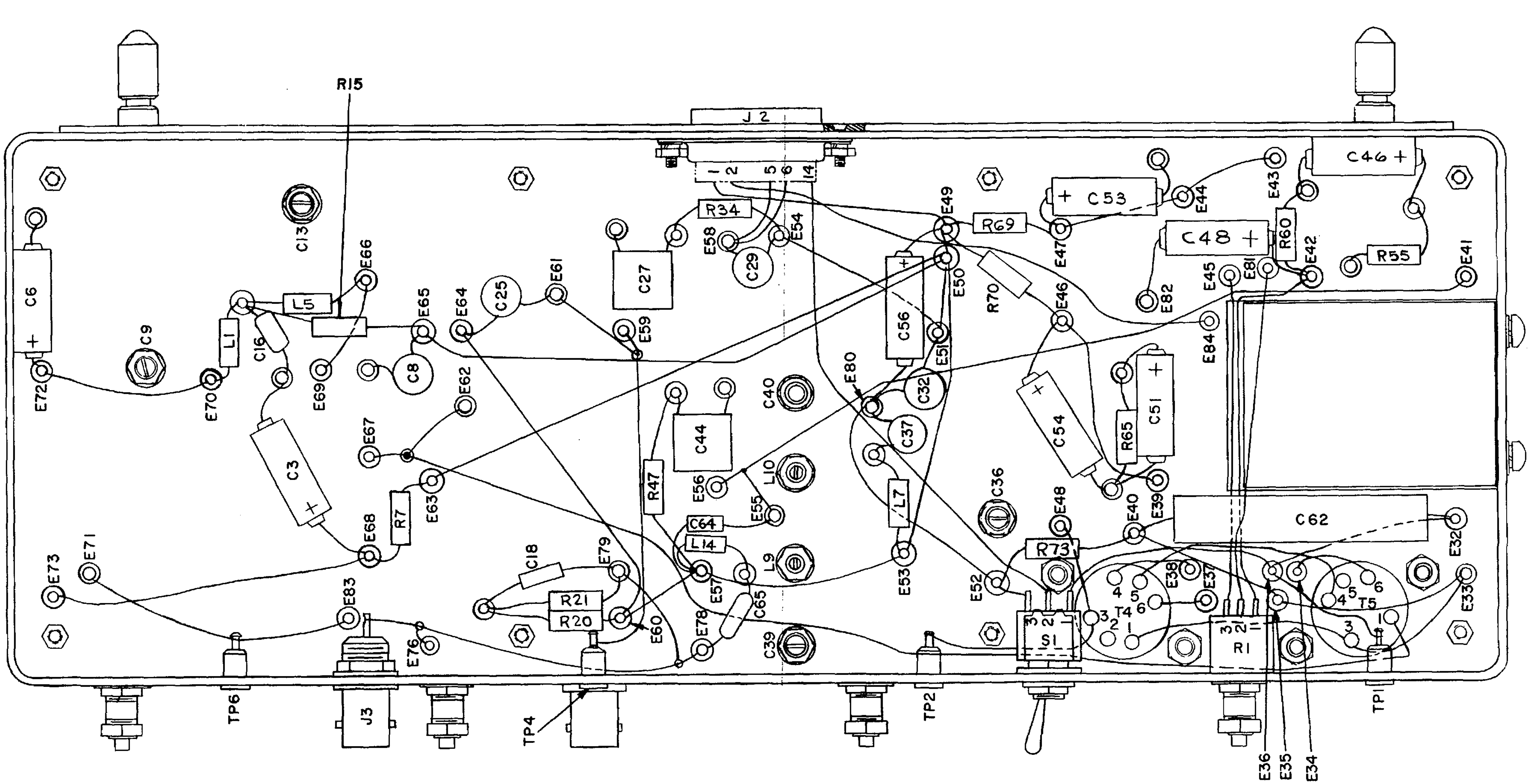
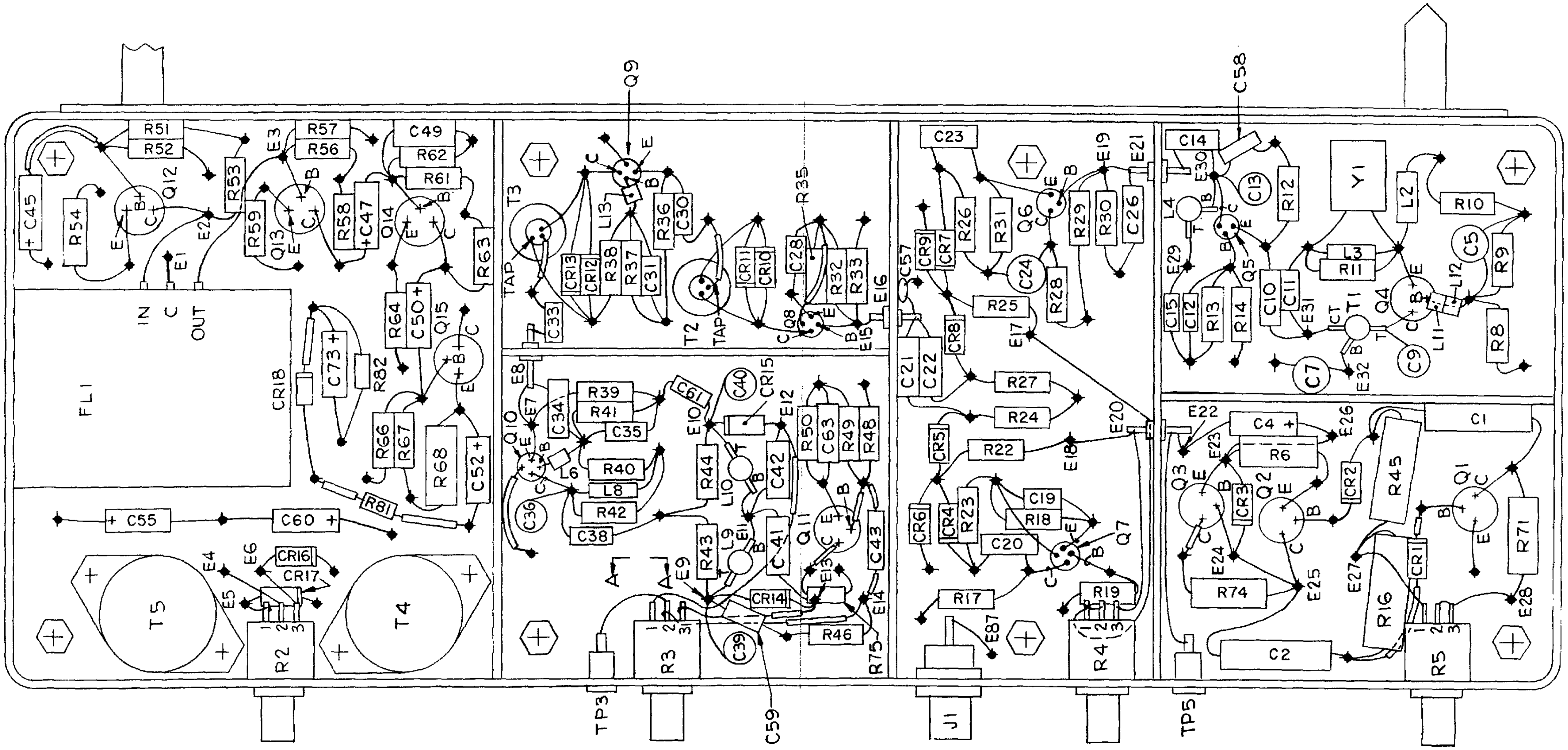


Figure FO-5 (3) Overall wiring diagram (sheet 3 of 3).



EL5820-792-14-TM-249 (1)

Figure FO-6 (1) AFC module, parts location diagram (sheet 1 of 3).



EL5820-792-14-TM-249 (2)

Figure FO-6 (2) AFC module, parts location diagram (sheet 2 of 3).

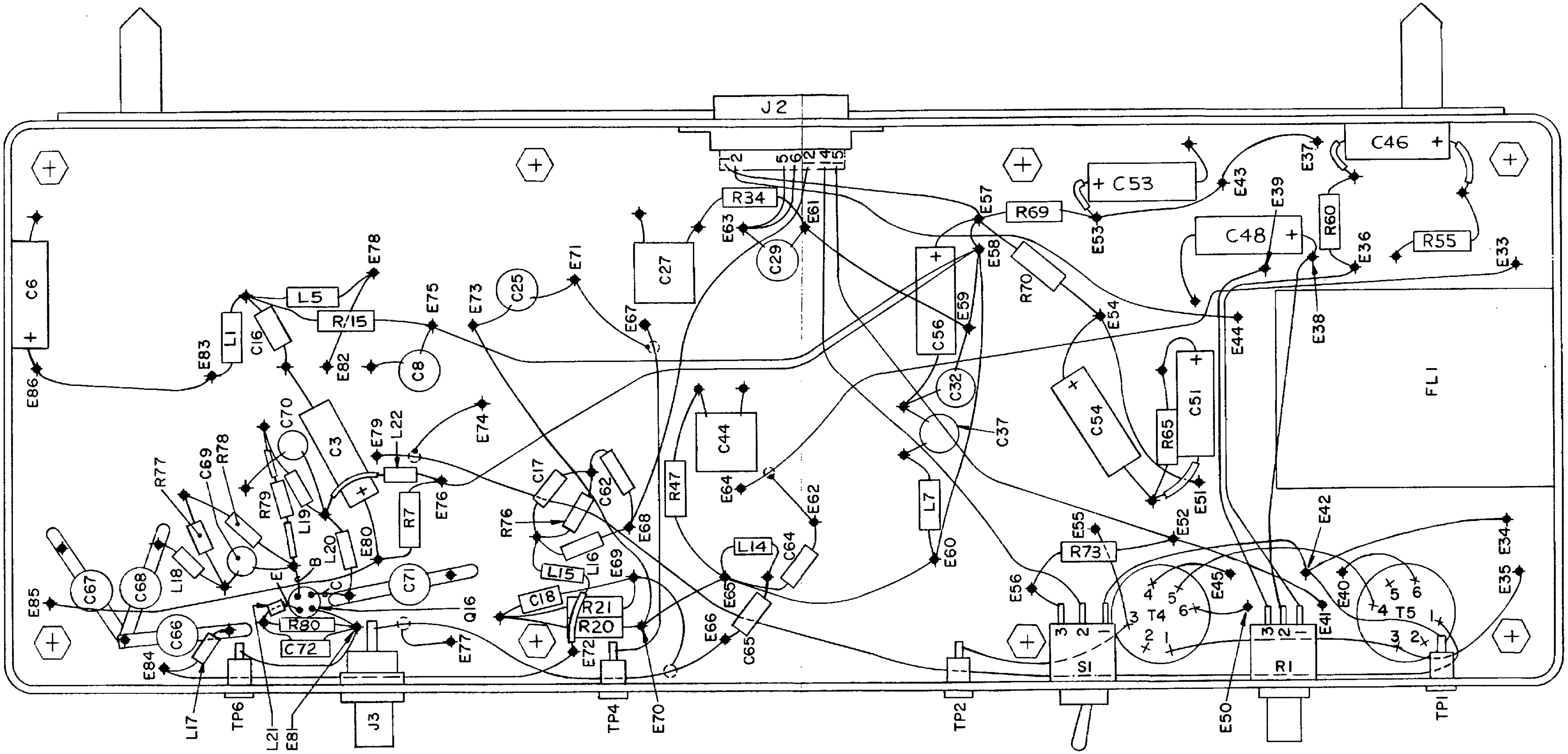


Figure FO-6 (3) AFC module, parts location diagram (sheet 3 of 3).

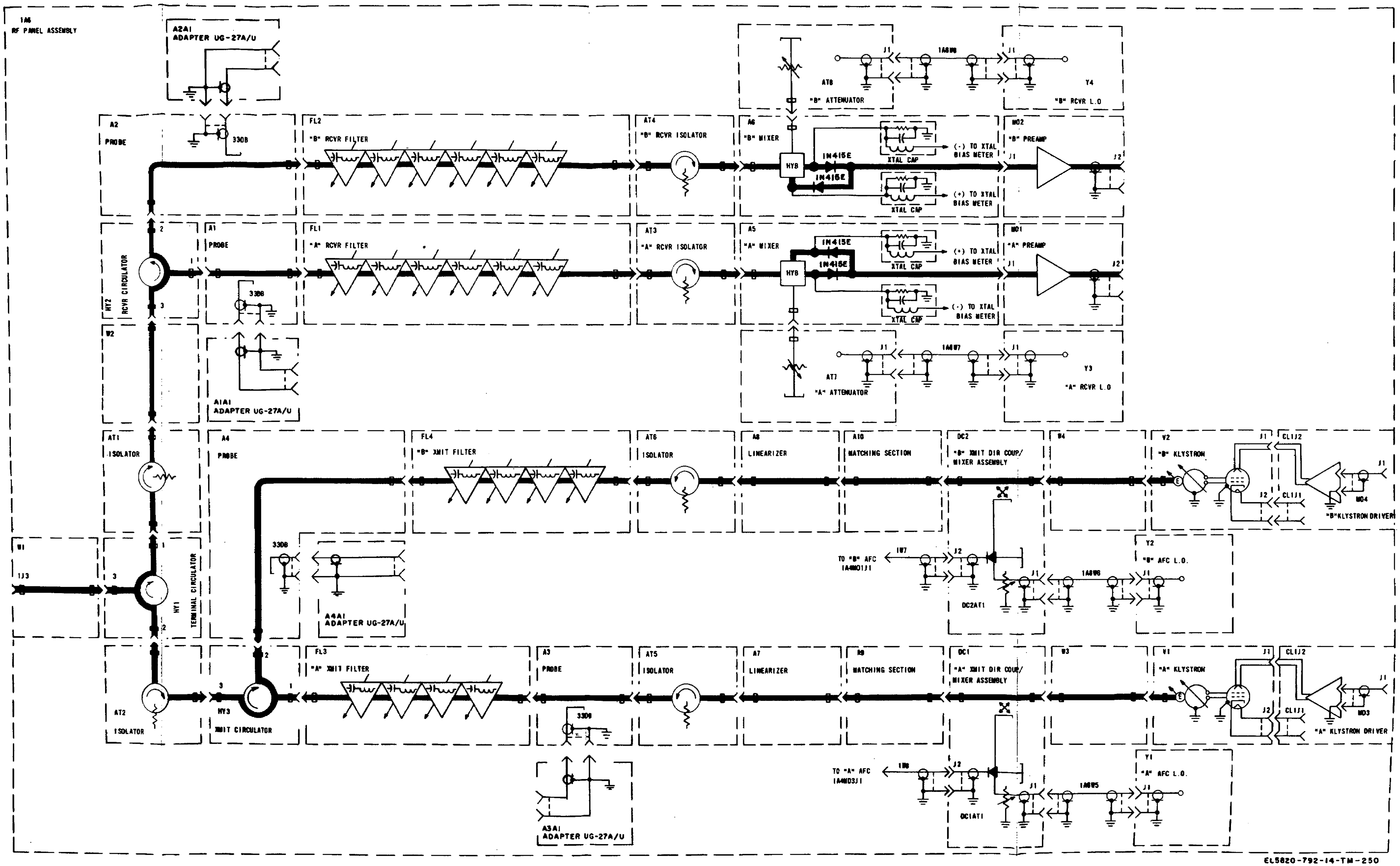


Figure FO-7. RF panel, schematic diagram.

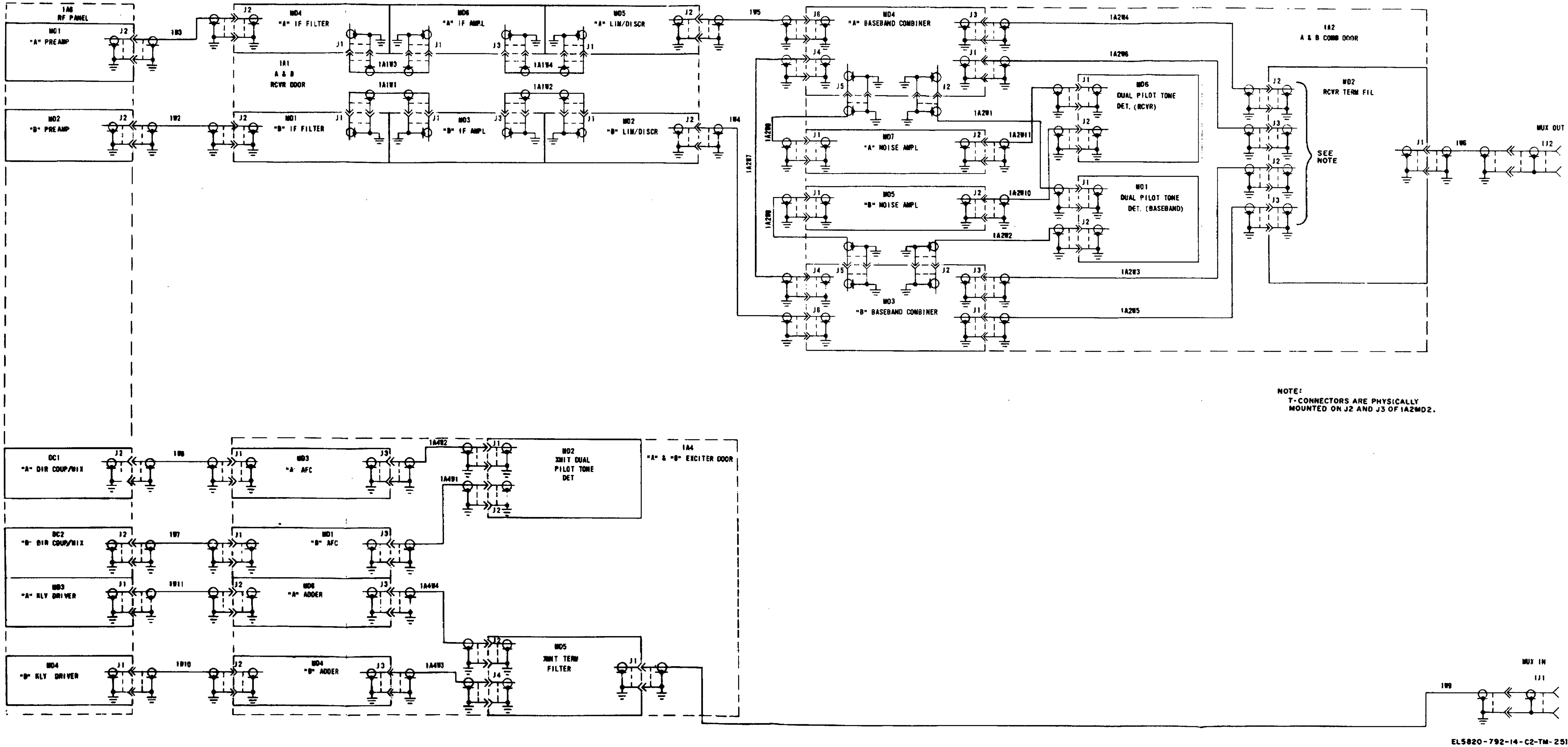


Figure FO-8. RF cabling, interconnection diagram.

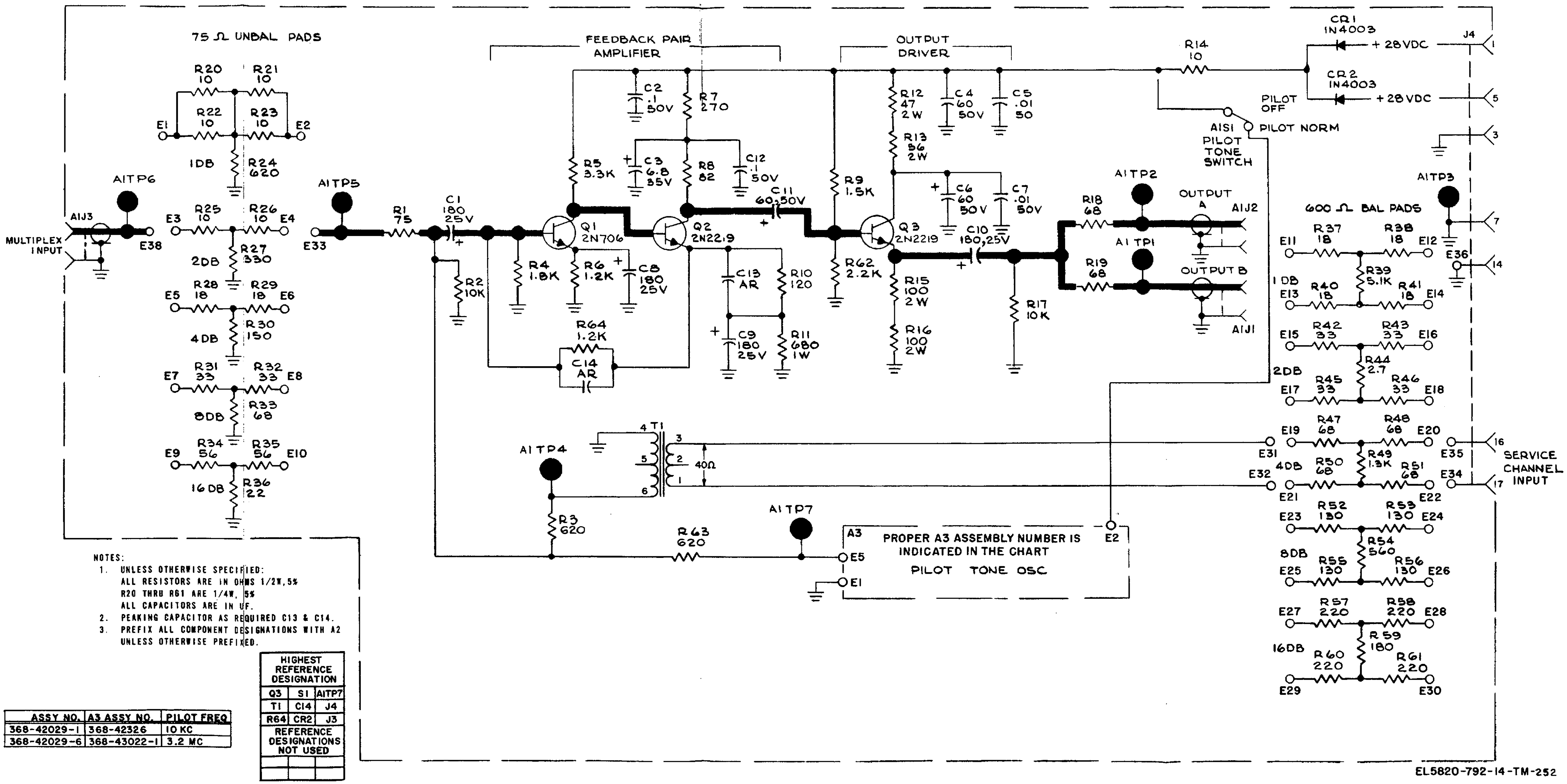


Figure FO-9. Adder module 368-42029-1 and -6, schematic diagram.

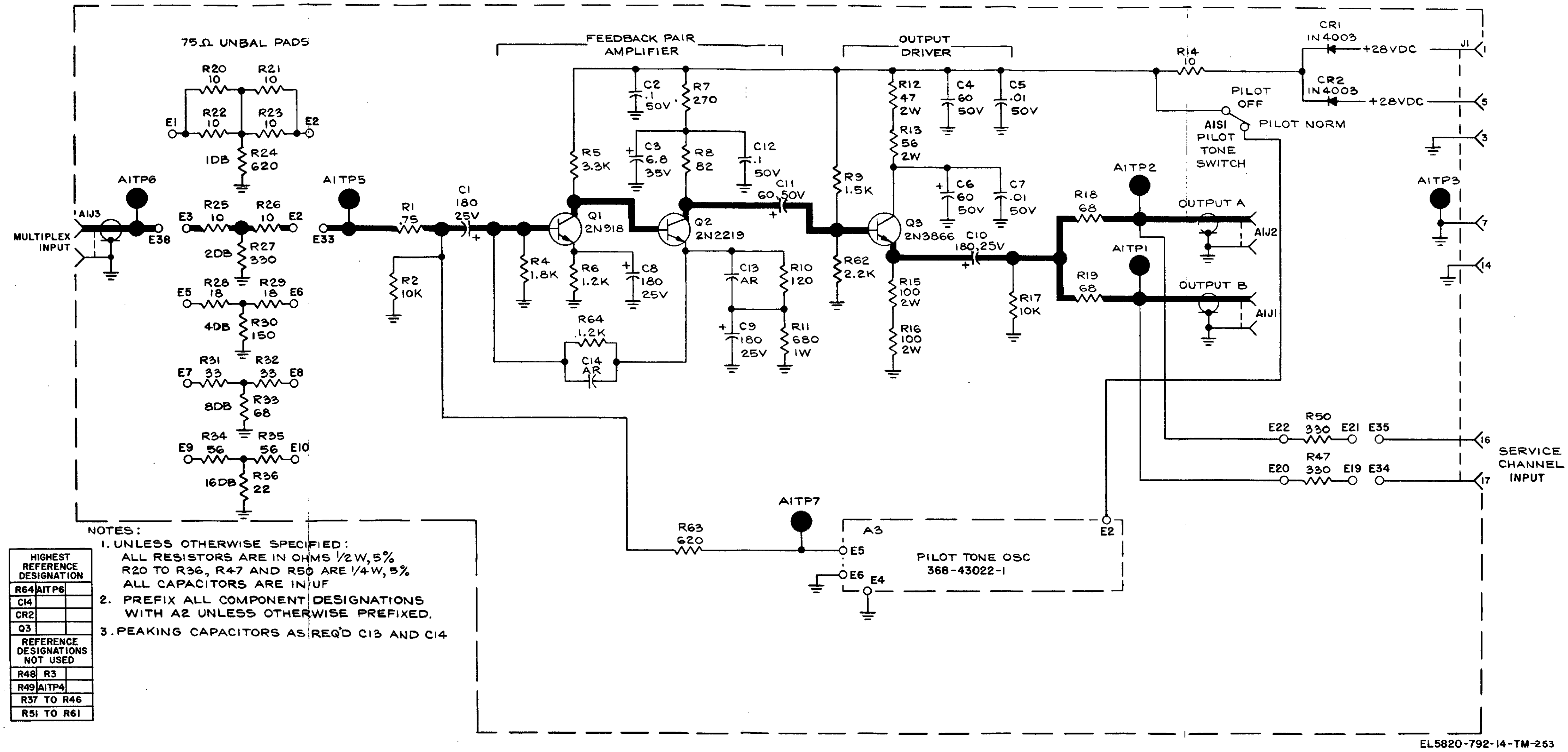
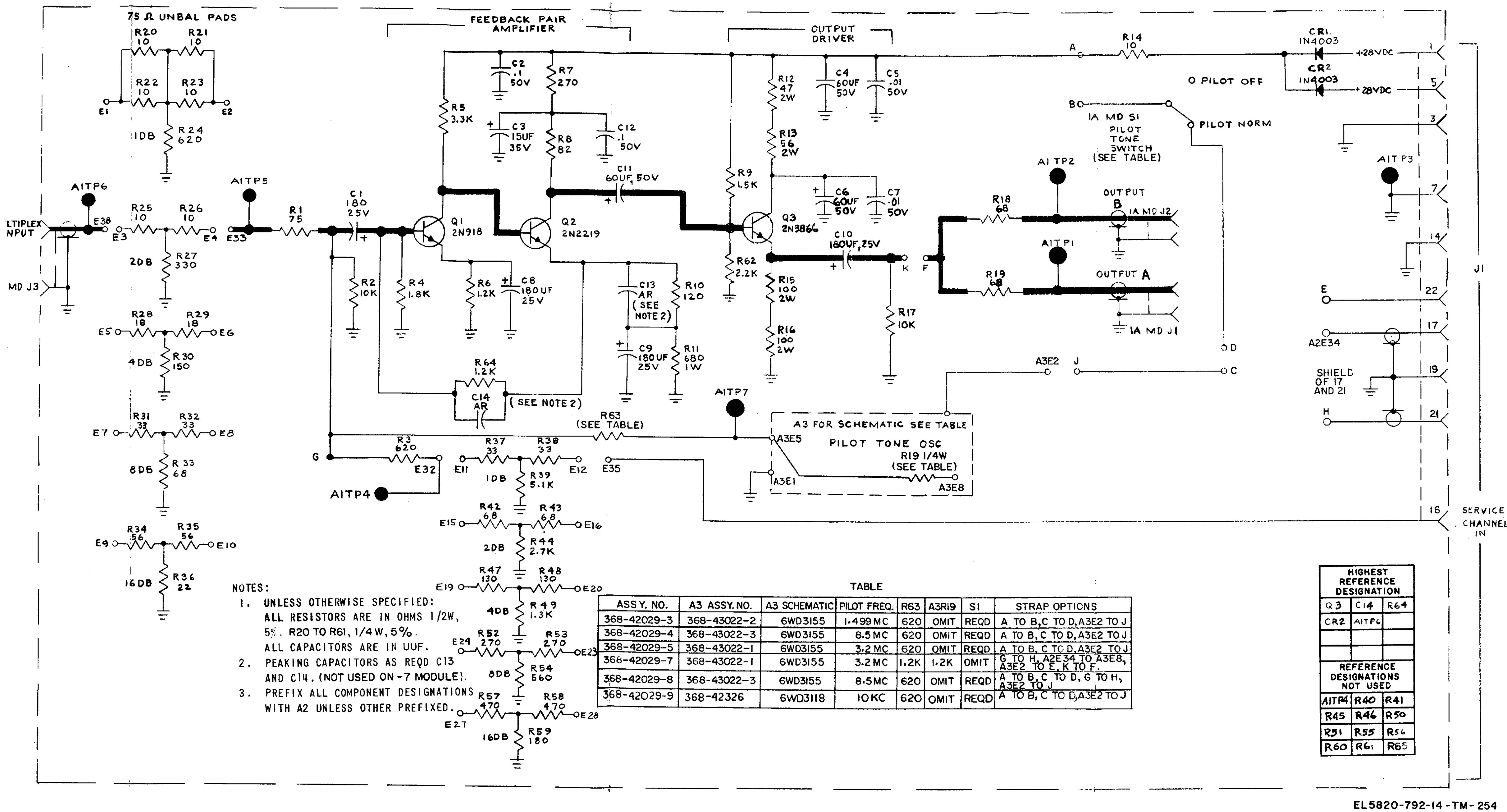


Figure FO-10. Adder module 368-42029-2, through 7 and 368-42029-8 and -9, schematic diagram.

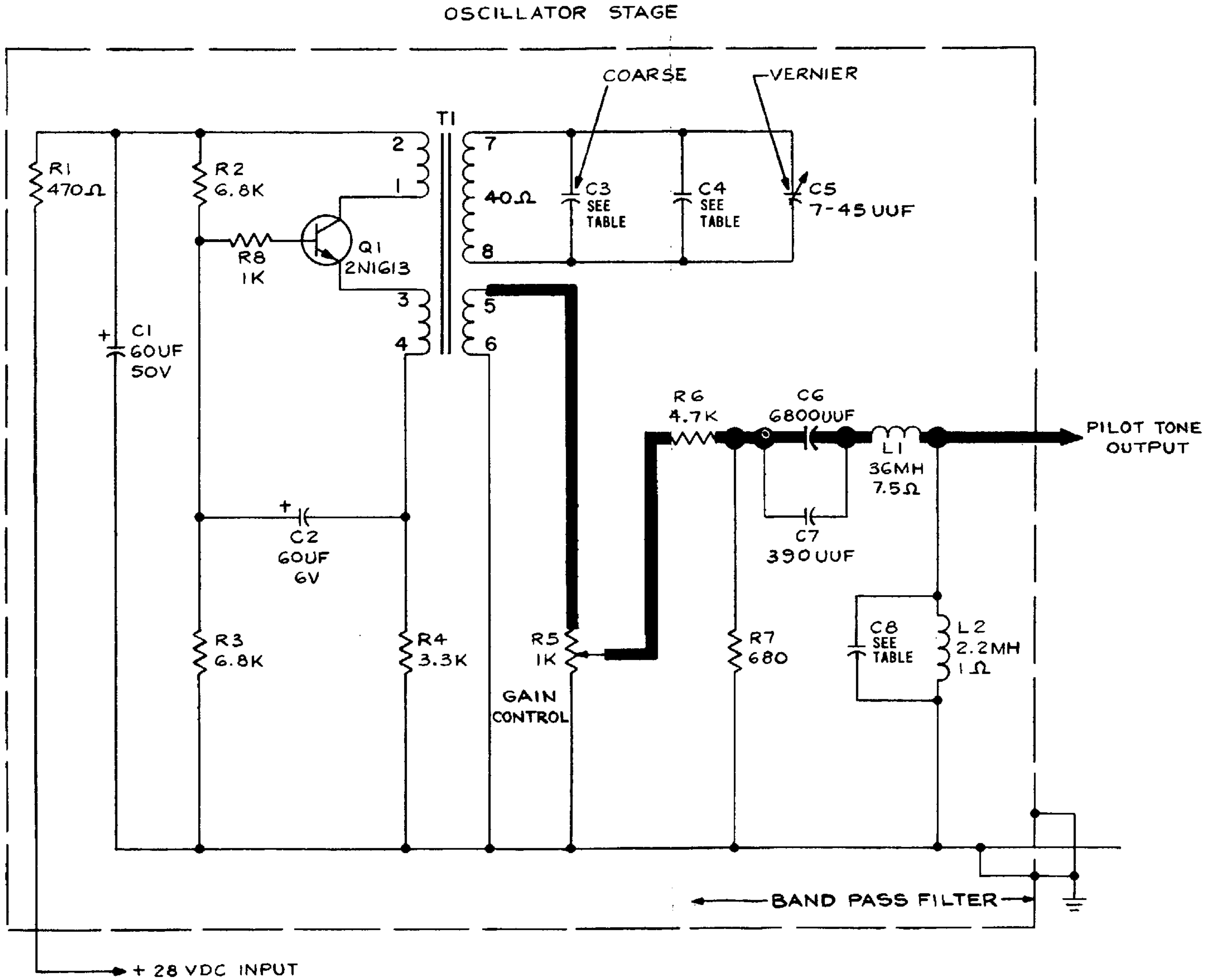


NOTES:
1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS 1/2W, 5%. R20 TO R61, 1/4W, 5%. ALL CAPACITORS ARE IN UUF.
2. PEAKING CAPACITORS AS REQD C13 AND C14. (NOT USED ON -7 MODULE).
3. PREFIX ALL COMPONENT DESIGNATIONS WITH A2 UNLESS OTHER PREFIXED.

TABLE

ASSY. NO.	A3 ASSY. NO.	A3 SCHEMATIC	PILOT FREQ.	R63	A3R19	S1	STRAP OPTIONS
368-42029-3	368-43022-2	6WD3155	1.499 MC	620	OMIT	REQD	A TO B, C TO D, A3E2 TO J
368-42029-4	368-43022-3	6WD3155	8.5 MC	620	OMIT	REQD	A TO B, C TO D, A3E2 TO J
368-42029-5	368-43022-1	6WD3155	3.2 MC	620	OMIT	REQD	A TO B, C TO D, A3E2 TO J
368-42029-7	368-43022-1	6WD3155	3.2 MC	1.2K	1.2K	OMIT	G TO H, A2E34 TO A3E8, A3E2 TO E, K TO F.
368-42029-8	368-43022-3	6WD3155	8.5 MC	620	OMIT	REQD	A TO B, C TO D, G TO H, A3E2 TO J
368-42029-9	368-42326	6WD3118	10 KC	620	OMIT	REQD	A TO B, C TO D, A3E2 TO J

Figure FO-11. Adder module 368-42029-3, -4, and -5, and 368-42029-7, -8, and -9, schematic diagram.



TABLE

PART NUMBER	FREQ.	C3	C4	C8
368-42326	10KHz	AR	2000PF	.15UF 50V
368-42326-1	12KHz	130PF	1300PF	.15UF 50V
368-42326-2	16KHz	30PF	680PF	.047UF 200V
368-42326-3	20KHz		430PF	.022UF 200V

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS 1/2W, 5%.
2. PEAKING CAPACITOR AS REQUIRED DM15.
3. C3 A.R. 130, 160, 180, 220.
4. PREFIX ALL COMPONENT DESIGNATIONS WITH A3.

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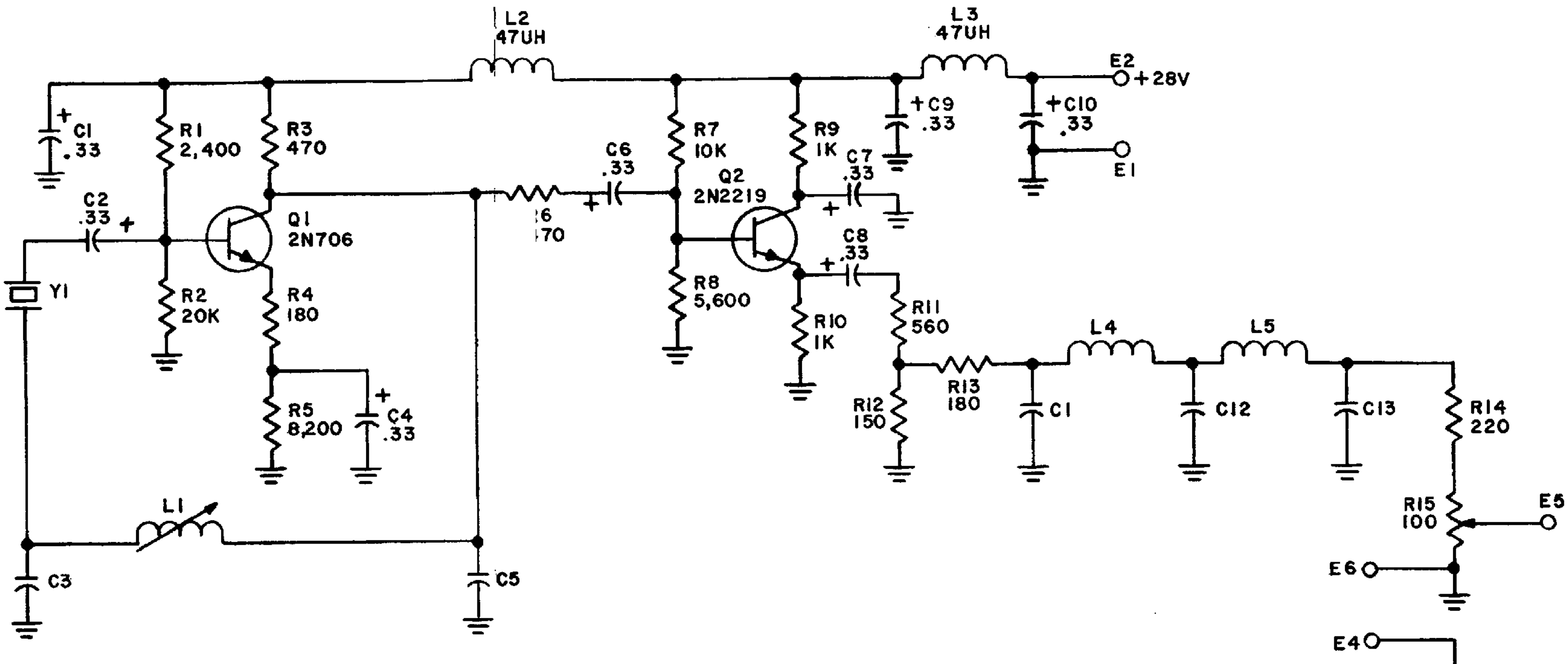
Figure FO-12. Adder pilot-tone oscillator 368-42326, schematic diagram.



ASSY NO.	PILOT FREQ	Y1	L1	L4	L5	C3	C5	C11	C12	C13
368-43022-1	3.2 MC	3.2 MC	15-44UH	27 UH	27 UH	120UUF	120UUF	150UUF	330UUF	150 UUF
368-43022-2	1,499 MC	1,499MC	55-130UH	68 UH	68 UH	300UUF	300UUF	360UUF	680UUF	360UUF
368-43022-3	8.5 MC	8.5 MC	4-11UH	10UH	10 UH	47UUF	47UUF	56UUF	120UUF	56UUF

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/4W, ±5%,
   ALL CAPACITORS ARE IN UF.
2. PREFIX ALL COMPONENT DESIGNATIONS WITH A3.
3. COMPONENT VALUES NOT APPEARING ON THE DIAGRAM ARE SHOWN IN THE ASSOCIATED CHART.

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Figure FO-13. Adder pilot-tone oscillator 368-42322-1, -2, and -3, schematic diagram.

NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTORS ARE IN OHMS, 1/2W, 5%, CAPACITORS ARE IN UUF.
2. RESISTANCE OF COILS, TRANSFORMERS ETC. OF LESS THAN 1 OHM ARE NOT SHOWN.
3. L21 MAY BE REMOVED AND REPLACED BY A SHORT LENGTH OF CABLE IN UNIT TEST TO ACHIEVE PROPER SIGNAL LEVELS.

HIGHEST REFERENCE DESIGNATION		
R82	Q16	Y1
C73	T5	J3
CR18	TP6	S1
L22	FL1	
REFERENCE DESIGNATIONS NOT USED		
R72		

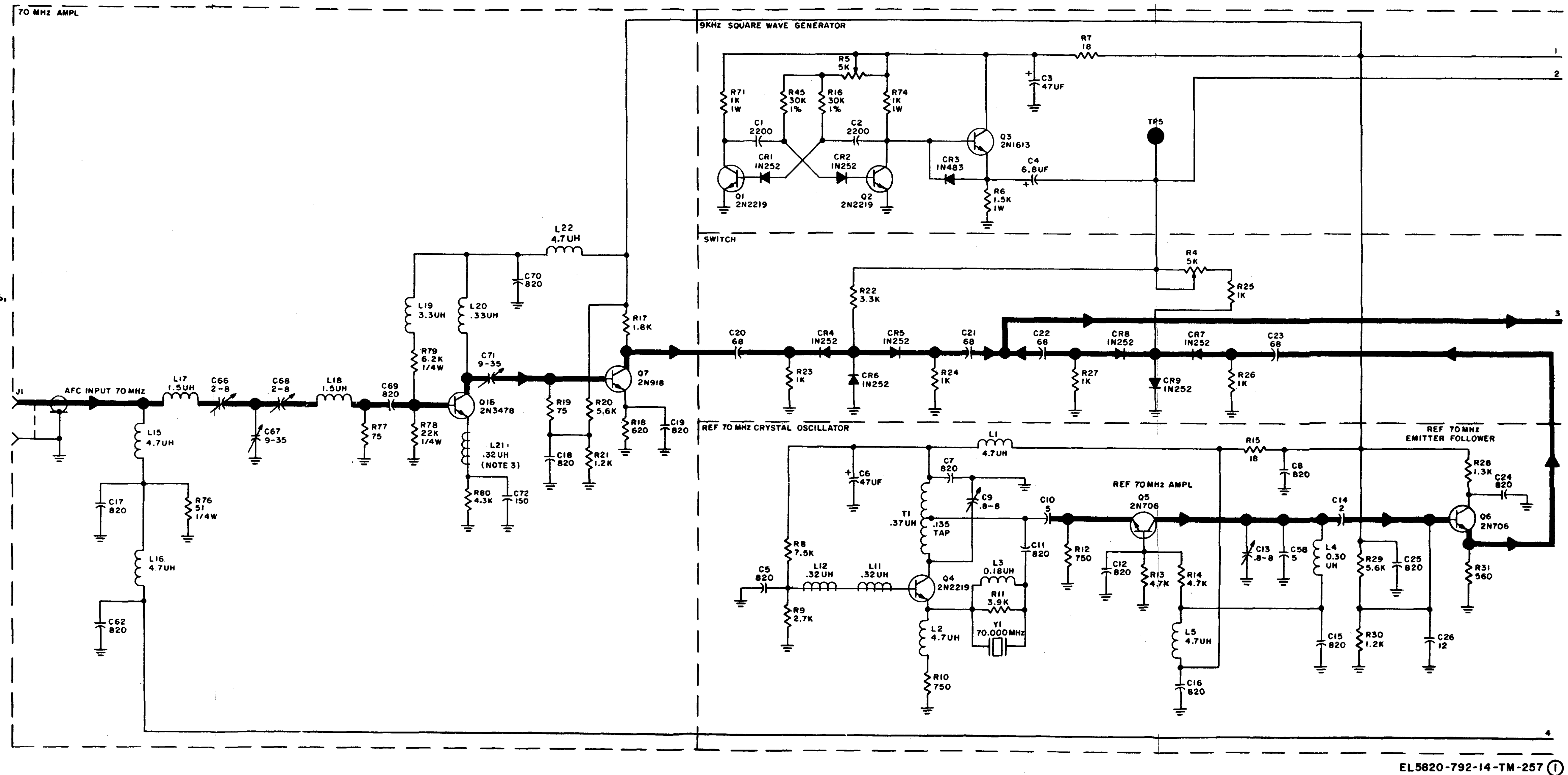


Figure FO-14 (1). AFC module 368-43686-1, schematic diagram (sheet 1 of 3).

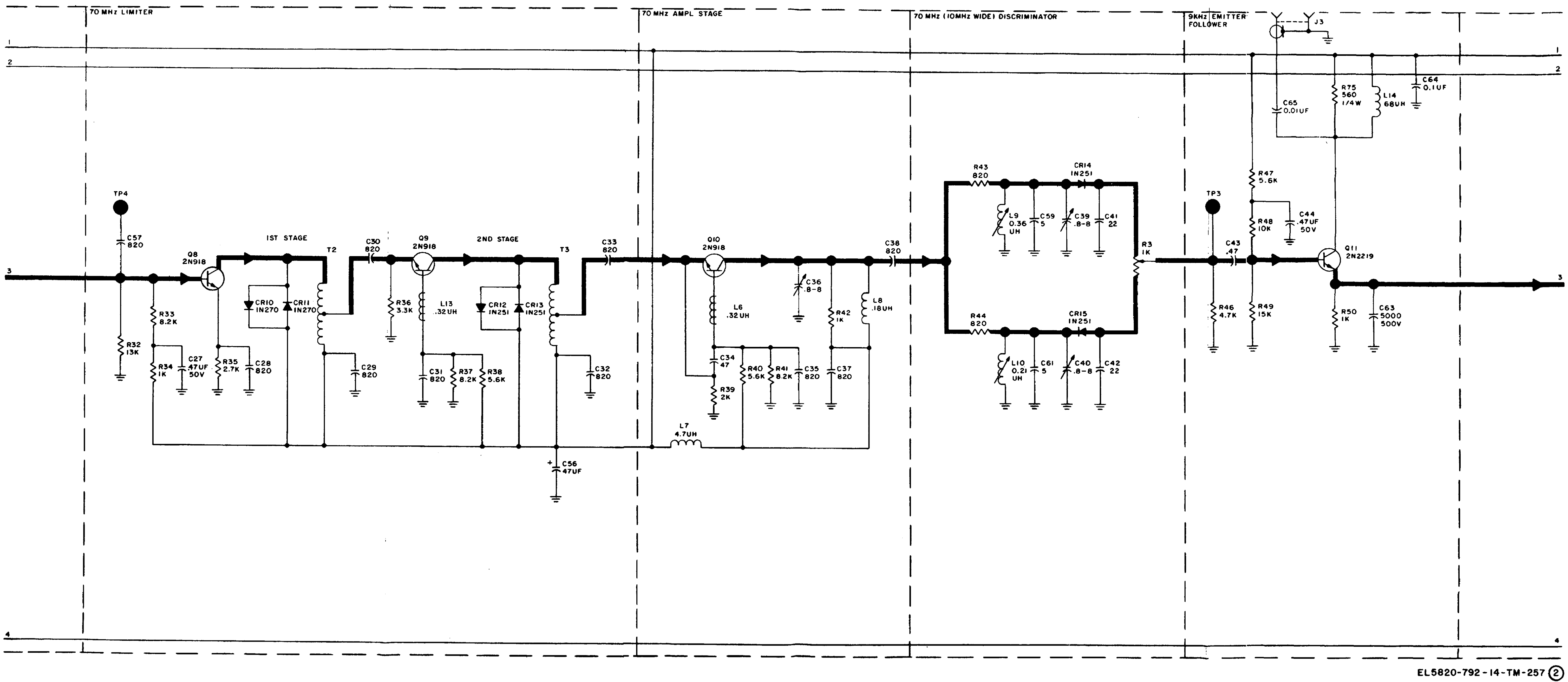


Figure FO-14 (2). AFC module 368-43686-1, schematic diagram (sheet 2 of 3).

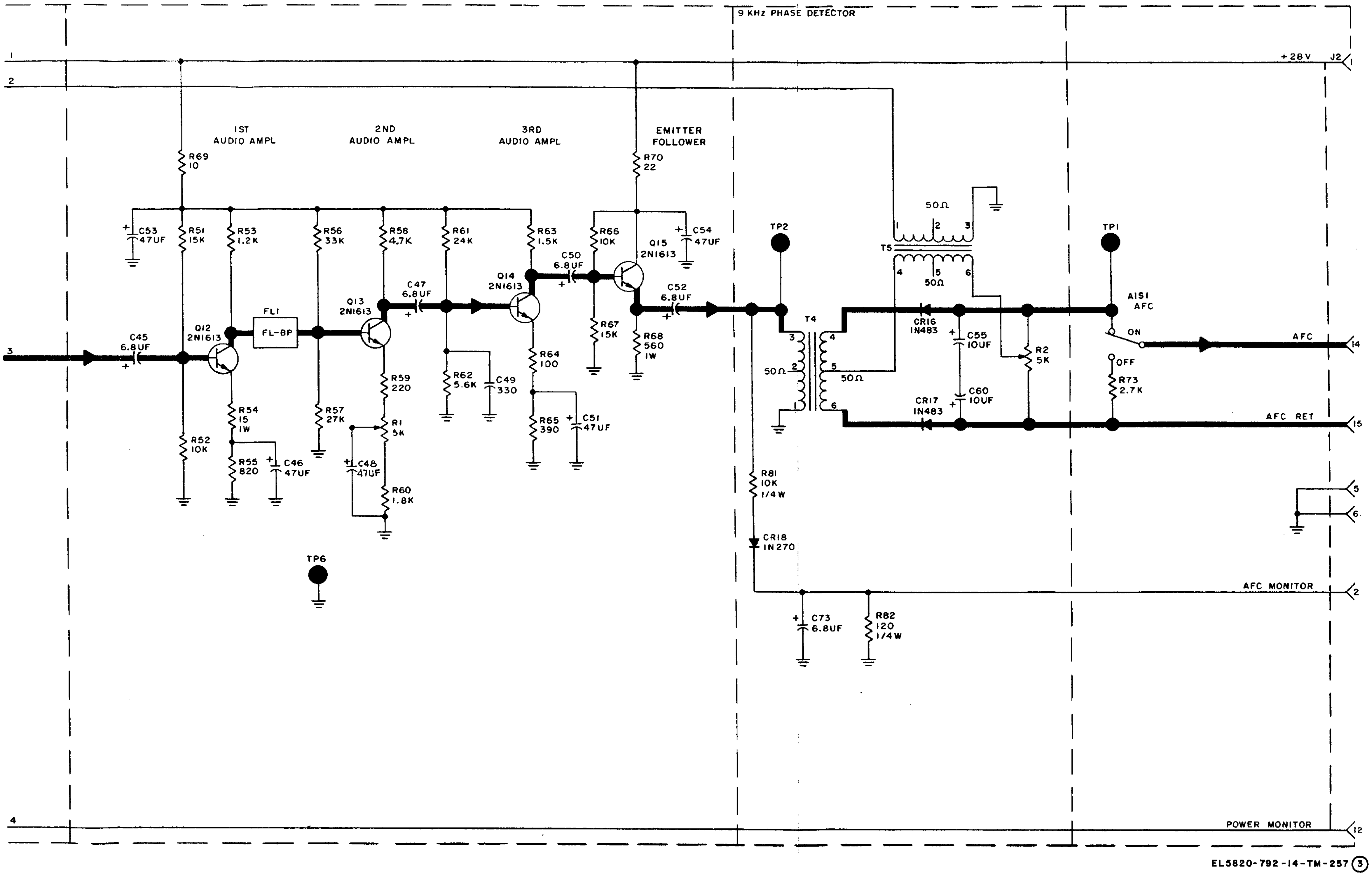
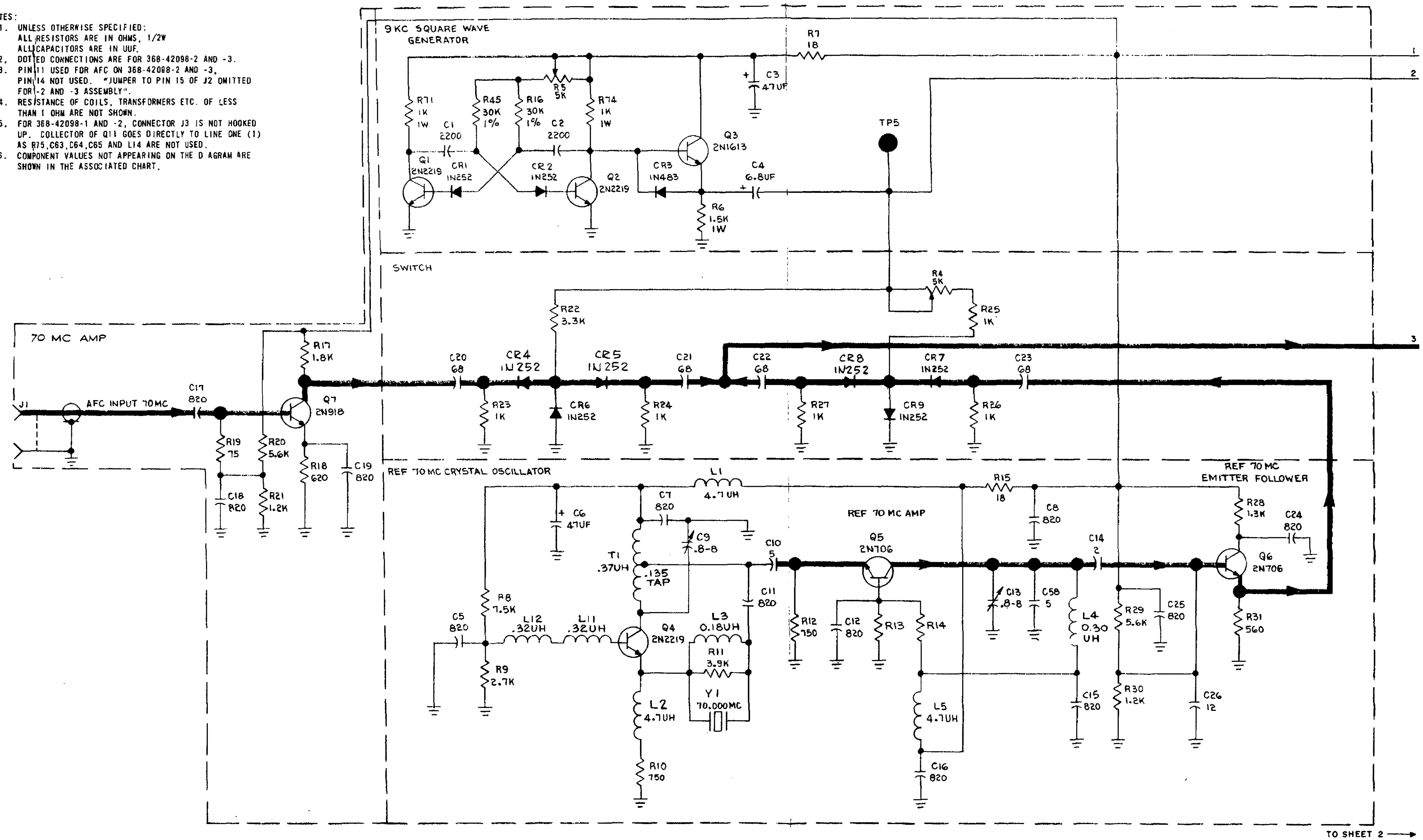


Figure FO-14 (3). AFC module 368-43686-1, schematic diagram (sheet 3 of 3).

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/2W
   ALL CAPACITORS ARE IN UUF.
2. DOTTED CONNECTIONS ARE FOR 368-42098-2 AND -3.
3. PIN 11 USED FOR AFC ON 368-42098-2 AND -3, PIN 14 NOT USED. "JUMPER TO PIN 15 OF J2 OMITTED FOR -2 AND -3 ASSEMBLY".
4. RESISTANCE OF COILS, TRANSFORMERS ETC. OF LESS THAN 1 OHM ARE NOT SHOWN.
5. FOR 368-42098-1 AND -2, CONNECTOR J3 IS NOT HOOKED UP. COLLECTOR OF Q11 GOES DIRECTLY TO LINE ONE (1) AS R75, C63, C64, C65 AND L14 ARE NOT USED.
6. COMPONENT VALUES NOT APPEARING ON THE DIAGRAM ARE SHOWN IN THE ASSOCIATED CHART.



PART NO.	ASSY NO.	C55	C60	C62	C63	C64	C65	R75	L14	R81	R82	C73	CR18	R13	R14	R32	R33	C27	C44	R58	STRAP OPTIONS
6WD3134-1	368-42098-1	REQ'D	REQ'D	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	2.7K	7.5K	12K	10K	.47UF 25V	.47UF 25V	1.5K	E1 TO E2, E2 TO E3, E3 TO E4
6WD3134-2	368-42098-2	OMIT	OMIT	REQ'D	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	2.7K	7.5K	12K	10K	.47UF 25V	.47UF 25V	1.5K	E1 TO E2, E2 TO E3, E3 TO E4
6WD3134-3	368-42098-3	OMIT	OMIT	REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	REQ'D	4.7K	4.7K	13K	8.2K	.47UF 50V	.47UF 50V	4.7K	E1 TO E3, E2 TO E4

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Figure FO-15 (1). AFC module 368-42098-3, schematic diagram (sheet 1 of 3).

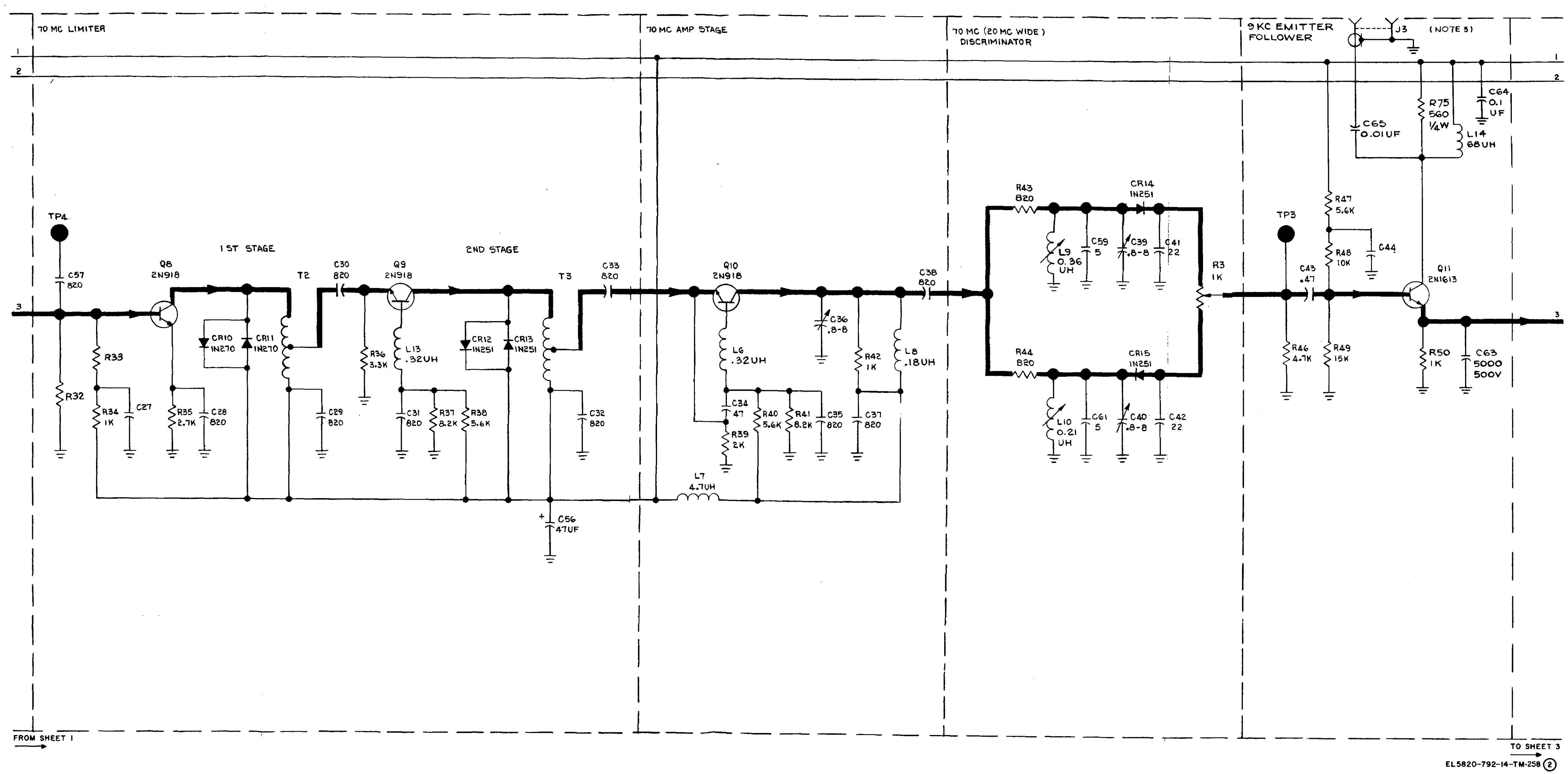


Figure FO-15 (2) AFC module 368-42098-3, schematic diagram (sheet 2 of 3).

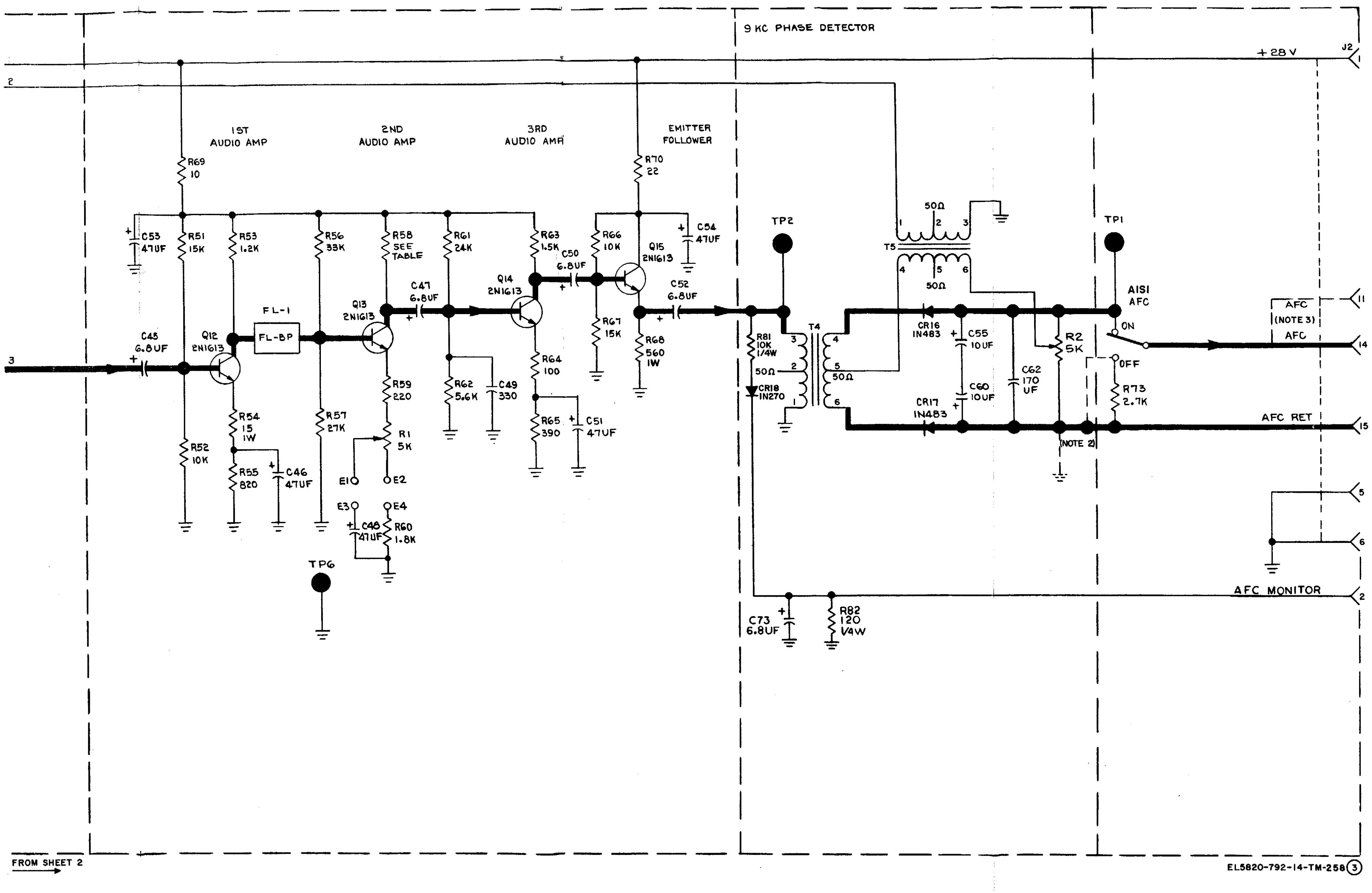
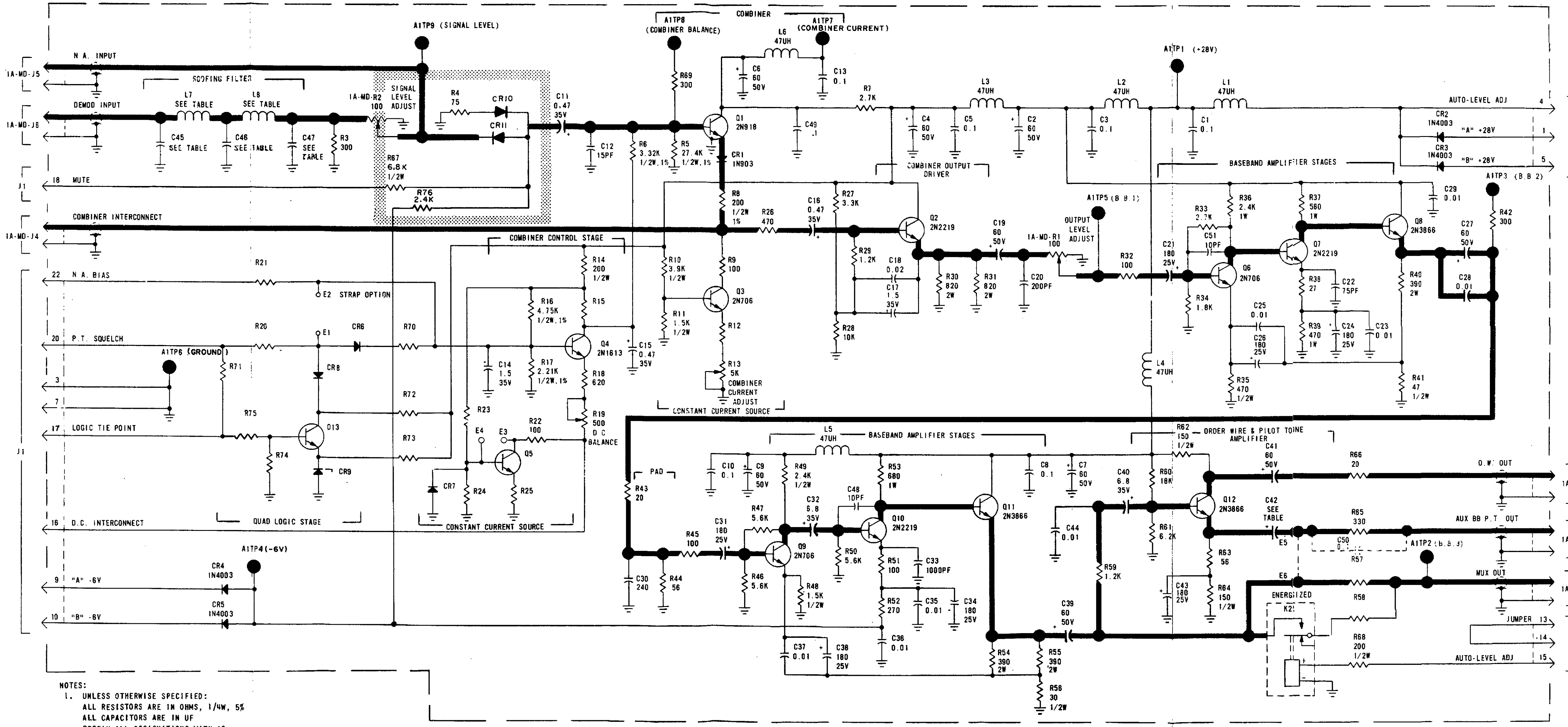


Figure FO-15 (3) AFC module 368-42098-3, schematic diagram (sheet 3 of 3).



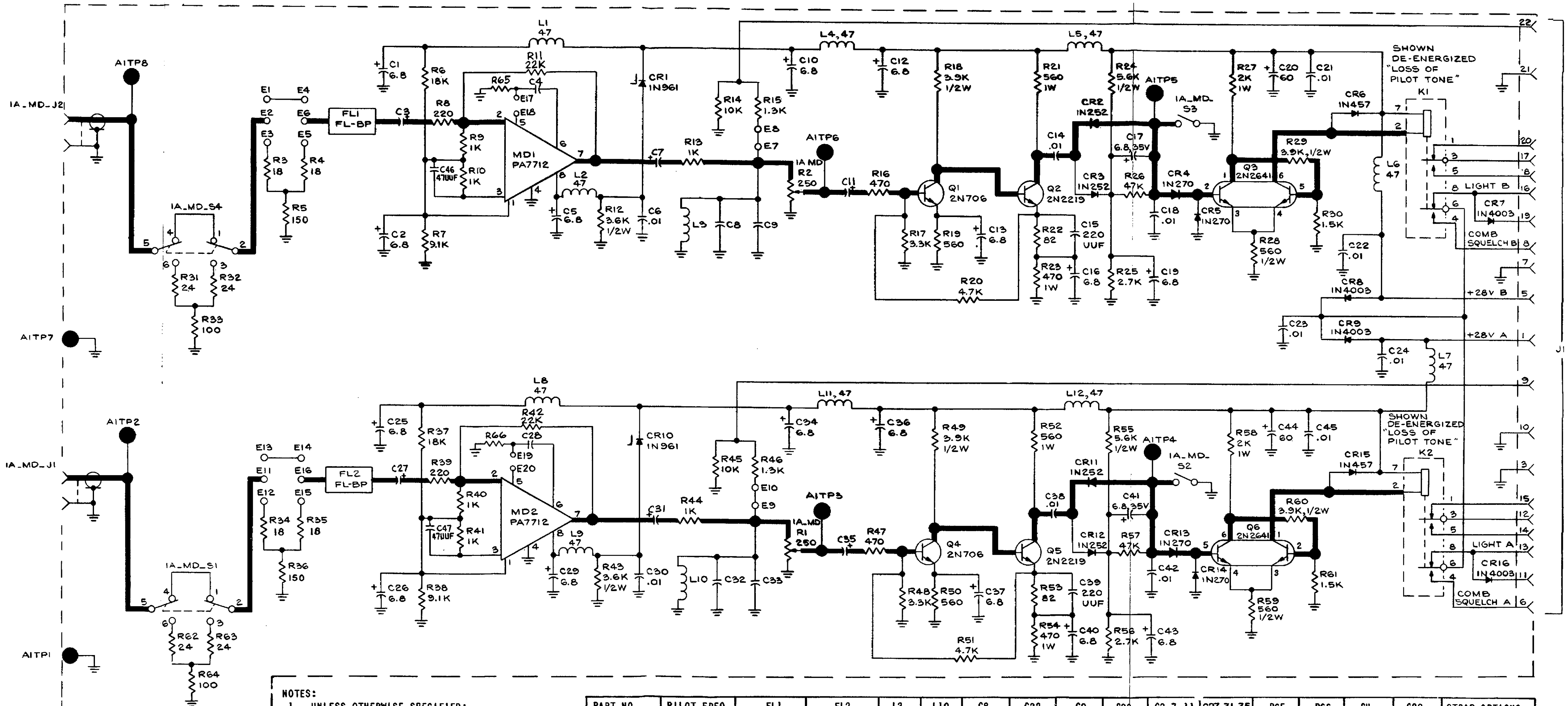
NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/4W, 5%
   ALL CAPACITORS ARE IN UF
   PREFIX ALL DESIGNATIONS WITH A2
2. ADD JUMPER FROM E5 TO E6 WHEN C42 IS NOT USED.
3. C50 IS ADDED WHEN SYSTEM REQUIRES CONTINUITY OF 8.5 MHz PILOT TONE.
4. FOR SIMPLEX OPERATION REMOVE R68.
5. SEE TABLE FOR ALL UNIDENTIFIED COMPONENTS.

PART NUMBER	CONFIGURATION	CHANNEL CAPACITY	MAXIMUM PILOT FREQUENCY	L7.L8	C45, C47	C46	R15	R20	R21	R23	R24	R25	R57	R58	R70	R71	R72	R73	R74	R75	CR6, CR8	CR7, CR8	Q5	Q13	STRAPPING OPTIONS	C42	R12
398-12040-1	DUAL	240-600	8.5 MHz	2.7UH	240PF	470PF	4.75K 1/2W,1%	3.92K 1/2W,1%	5.49K 1/2W,1%	12K	2.2K	2.0K	150	150	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	2N706	OMIT	E1 TO E2 FOR SCHEMATIC PURPOSES ONLY	OMIT	47K 1/2W

EL3ST

Figure FO-16. Baseband combiner module, schematic diagram.



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W, ±5%
ALL CAPACITORS ARE IN UF
ALL INDUCTORS ARE IN UH.
2. PREFIX ALL COMPONENT DESIGNATIONS WITH A2 UNLESS OTHERWISE PREFIXED.

PART NO.	PILOT FREQ	FL1	FL2	L3	L10	C8	C32	C9	C33	C3,7,11	C27,31,35	R65	R66	C4	C28	STRAP OPTIONS
368-43035-1	3.2 MC	362-7651	362-7651	10	10	180UUF	180UUF	68UUF	68UUF	.01	.01	OMIT	OMIT	47UUF	47UUF	E17-E18,E19-E20
368-43035-2	1.499MC	362-7651-1	362-7651-1	10	10	360UUF	360UUF	820UUF	820UUF	.01	.01	OMIT	OMIT	47UUF	47UUF	E17-E18,E19-E20
368-43035-3	8.5 MC	362-7651-2	362-7651-2	1.5	1.5	180UUF	180UUF	39UUF	39UUF	.01	.01	OMIT	OMIT	47UUF	47UUF	E17-E18,E19-E20
368-43035-6	16KC/12 KC	398-12061-2	398-12061-1	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	2.2@20V	2.2@20V	200	200	1000UUF	1000UUF	-
368-34035-7	20KC/8.5 MC	398-12061-3	362-7651-2	OMIT	1.5	OMIT	180UUF	OMIT	39UUF	2.2@20V	.01	200	OMIT	1000UUF	47UUF	E19-E20
368-43035-8	10 KC	362-7651-3	362-7651-3	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	2.2@20V	2.2@20V	200	200	1000UUF	1000UUF	-

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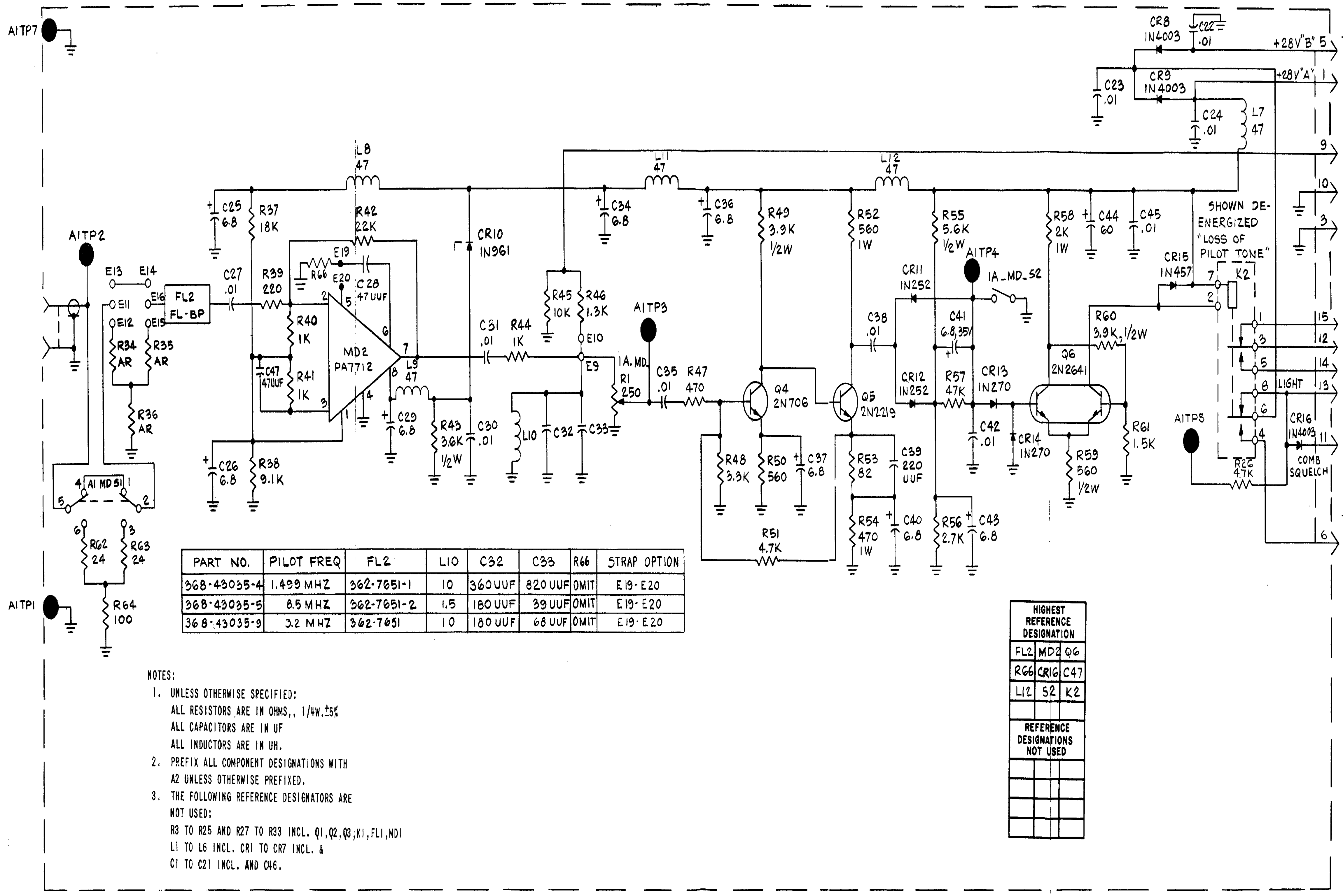
Figure FO-17. Dual pilot-tone detector module, schematic diagram.



PART NO.	PILOT FREQ	FL2	L10	C32	C33	R66	STRAP OPTION
368-43035-4	1.499 MHZ	362-7651-1	10	360 UUF	820 UUF	OMIT	E19-E20
368-43035-5	8.5 MHZ	362-7651-2	1.5	180 UUF	39 UUF	OMIT	E19-E20
368-43035-9	3.2 MHZ	362-7651	10	180 UUF	68 UUF	OMIT	E19-E20

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS,, 1/4W, ±5%
   ALL CAPACITORS ARE IN UF
   ALL INDUCTORS ARE IN UH.
2. PREFIX ALL COMPONENT DESIGNATIONS WITH A2 UNLESS OTHERWISE PREFIXED.
3. THE FOLLOWING REFERENCE DESIGNATORS ARE NOT USED:
   R3 TO R25 AND R27 TO R33 INCL. Q1, Q2, Q3; K1, FL1, MD1
   L1 TO L6 INCL. CR1 TO CR7 INCL. &
   C1 TO C21 INCL. AND C46.

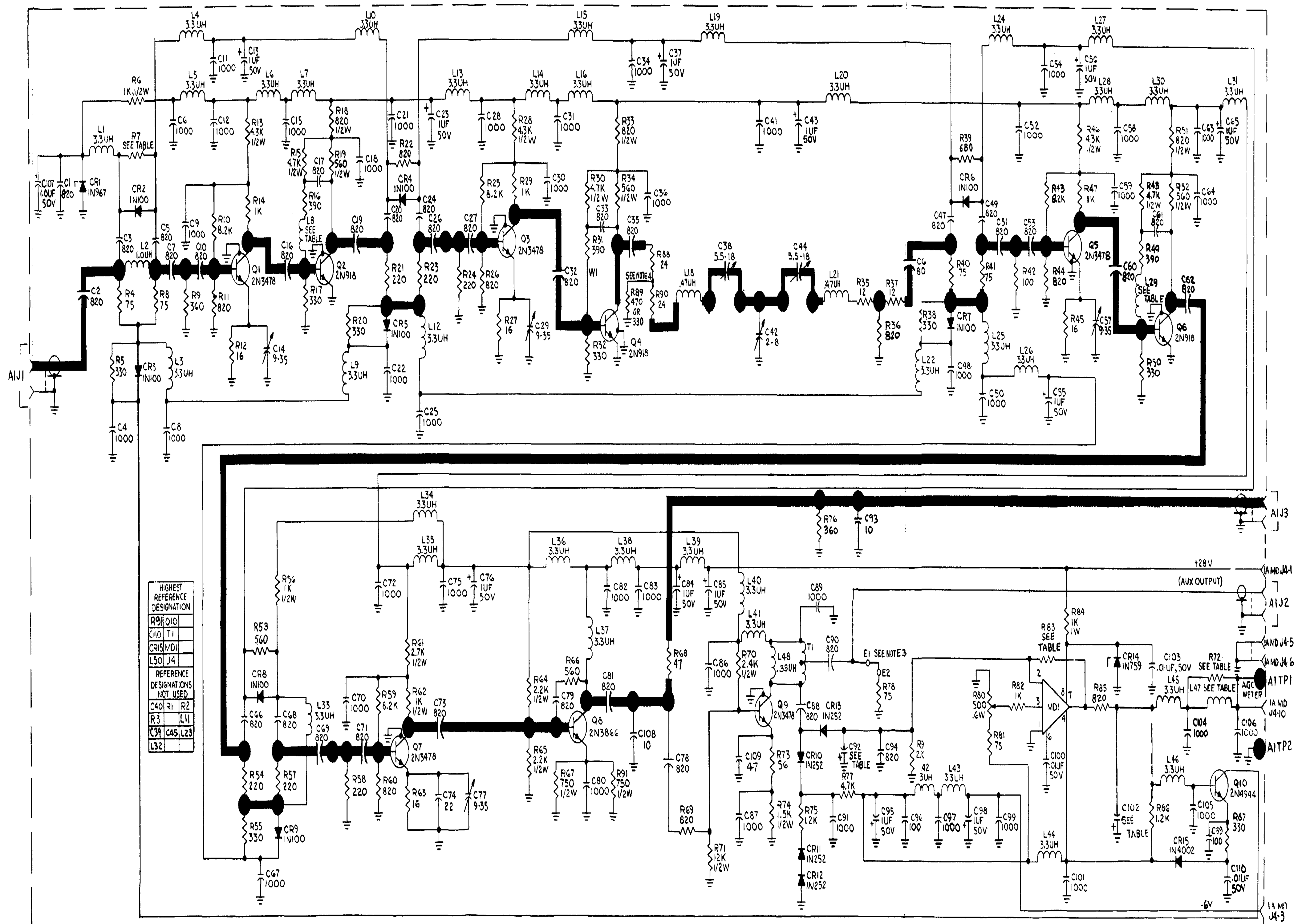
HIGHEST REFERENCE DESIGNATION		
FL2	MD2	Q6
R66	CR16	C47
L12	S2	K2

REFERENCE DESIGNATIONS NOT USED		

Figure FO-18. Pilot-tone detector, module, schematic diagram

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/4W, ±5%.
   ALL CAPACITORS ARE IN UUF.
2. PREFIX ALL COMPONENT DESIGNATIONS WITH A2 UNLESS OTHERWISE PREFIXED.
3. E1 AND E1 NORMALLY STRAPPED TOGETHER. REMOVE STRAP WHEN 'AUX OUTPUT' IS REQUIRED. (E.G. FOR I.F. HETRODYNE REPEATER).
4. VALUE OF R89 TO BE 470Ω UNLESS OTHERWISE DETERMINED AT TEST.



HIGHEST REFERENCE DESIGNATION		
R91	Q10	
C110	T1	
CR15	MD1	
L50	J4	
REFERENCE DESIGNATIONS NOT USED		
C40	R1	R2
R3		L11
C39	C45	L23
L32		

PART NO.	R7	R83	C92	C102	L8	L29	L47	R72
368-43488-1	270	100K	1.0UF 50V	180UF 10V	.22UH	.22UH	3.3UH	OMIT
368-43488-2	270	33K	OMIT	1.0UF 50V	.22UH	.22UH	3.3UH	OMIT
368-43488-3	560	100K	1.0UF 50V	180UF 10V	.27UH	.27UH	3.3UH	OMIT
368-43488-4	270	100K	1.0UF 50V	180UF 10V	.22UH	.22UH	OMIT	15K

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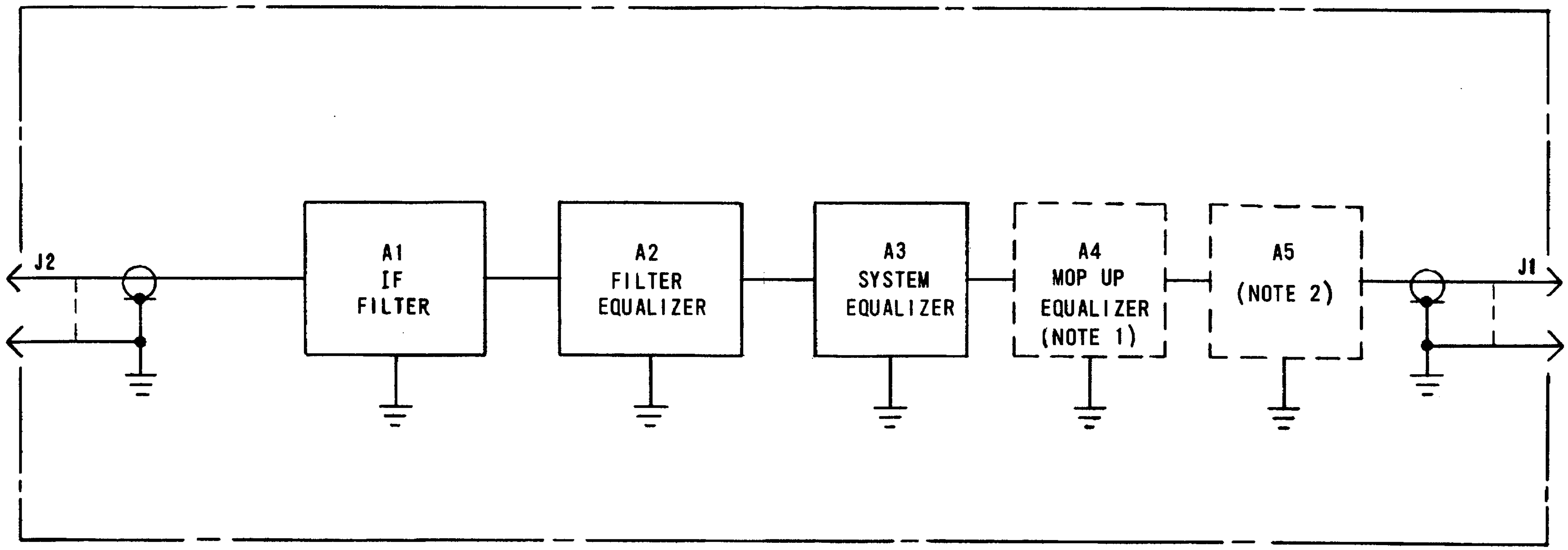
Figure FO-19. IF amplifier, module, schematic diagram



TABLE

PART NUMBER	A1	A2	A3
398-12067-1	398-12211-1	398-12222-1	398-12222-4
398-12067-2	398-12211-2	398-12222-2	398-12222-4
398-12067-3	398-12211-3	398-12222-3	398-12222-4

NOTES:

1. EQUALIZER (A4) IS DETERMINED AT LINK TEST AND IS NOT PART OF THE 398-12067 ASSEMBLY. WHEN NOT INSTALLED, WIRE DIRECTLY FROM A3 TO J1 USING 75 OHM COAXIAL CABLE.

2. POSITION IS PROVIDED FOR ADDITIONAL EQUALIZATION (A5) NOT PRESENTLY REQUIRED.

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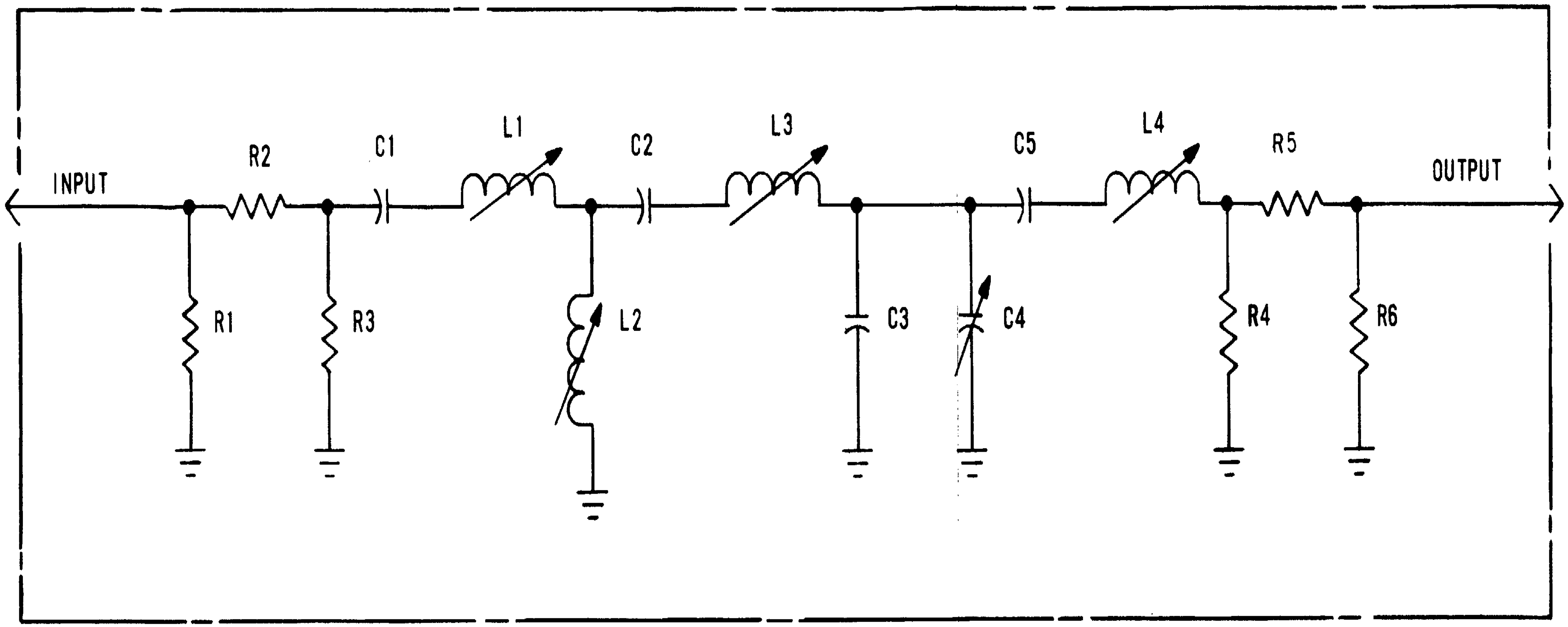
Figure FO-20. IF bandpass filter, module, schematic diagram



TABLE

PART NUMBER	BANDWIDTH	R1	R2	R3	R4	R5	R6	C1	C2	C3	C4	C5	L1	L2	L3	L4
398-12211-1	10 MHz															
398-12211-2	15 MHz															
398-12211-3	25 MHz	OMIT	24	220	180	51	300	15	15	15	9→35	15	.2→.27	.12→.15	.27→.4	.4→.60

NOTE:
UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W,5%,
ALL CAPACITORS ARE PF,
ALL INDUCTORS ARE IN UH.

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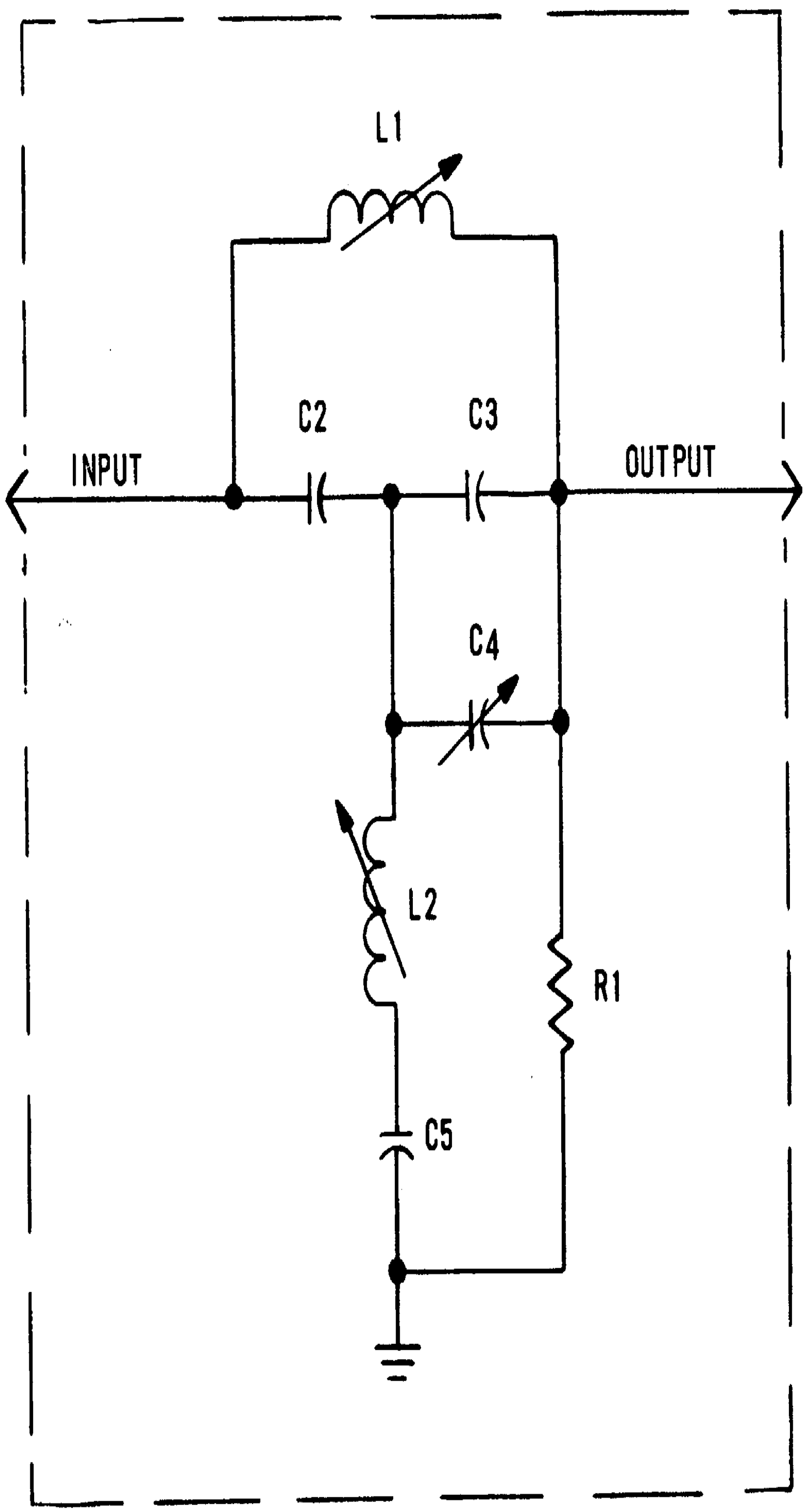
Figure FO-21. IF bandpass filter, card, schematic diagram



TABLE

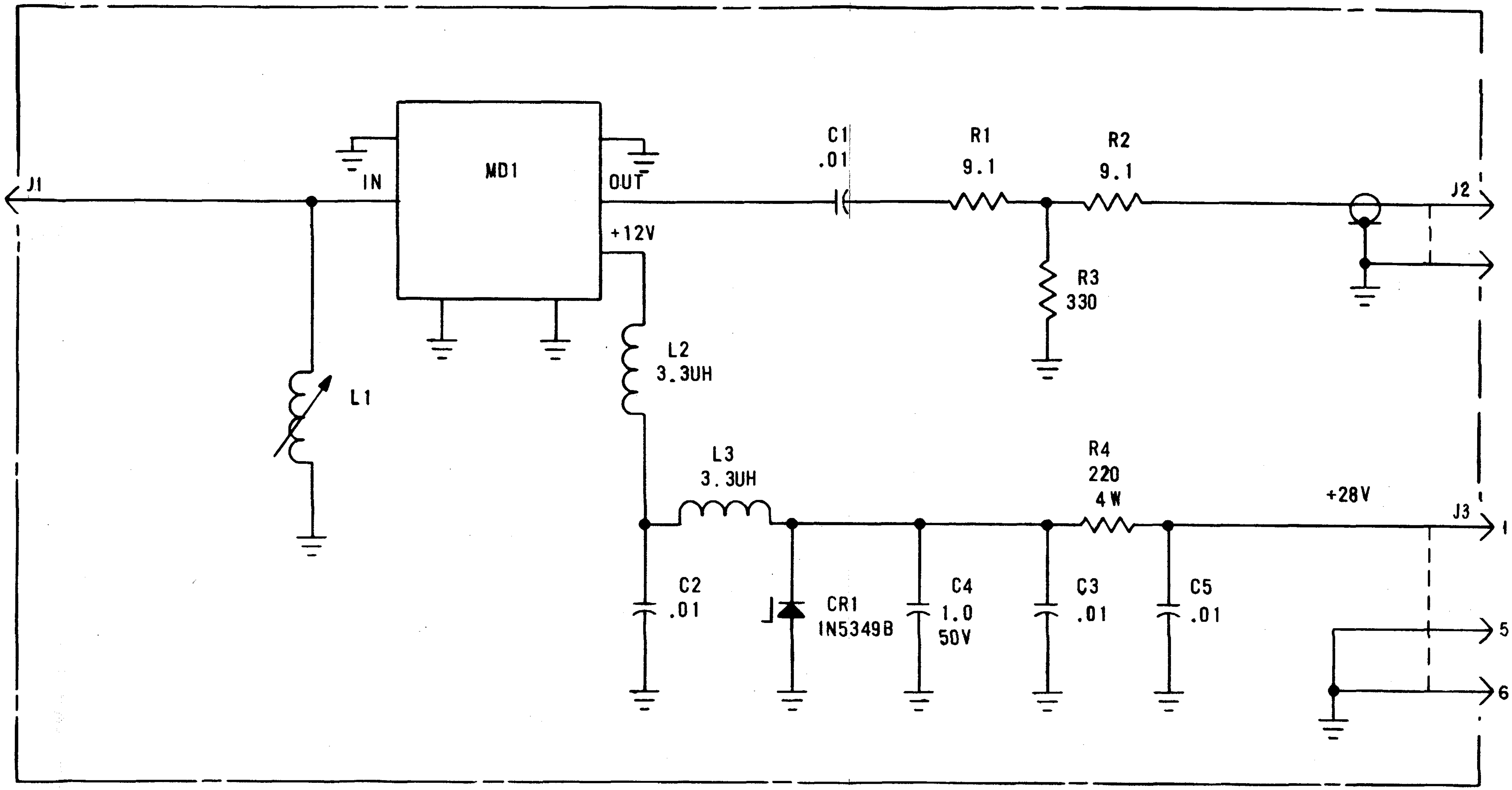
PART NUMBER	CHARACTERISTIC NS/MHz	R1	C2	C3	C4	C5	L1	L2
398-12222-1	DNA							
398-12222-2	DNA							
398-12222-3	DNA	OMIT	51	36	7→25	30	.15→.2	.2→.27
398-12222-4	DNA	OMIT	56	39	7→25	27	.12→.15	.2→.27
398-12222-5	+1/8	OMIT	22	10	5.5→18	82	.2→.27	.1→.12
398-12222-6	-1/8	OMIT	51	36	9→35	SHORT	.6→.87	.15→.2

NOTE:

UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W, 5%,
ALL CAPACITORS ARE IN PF,
ALL INDUCTORS ARE UH.

EL5820-792-14-TM-265

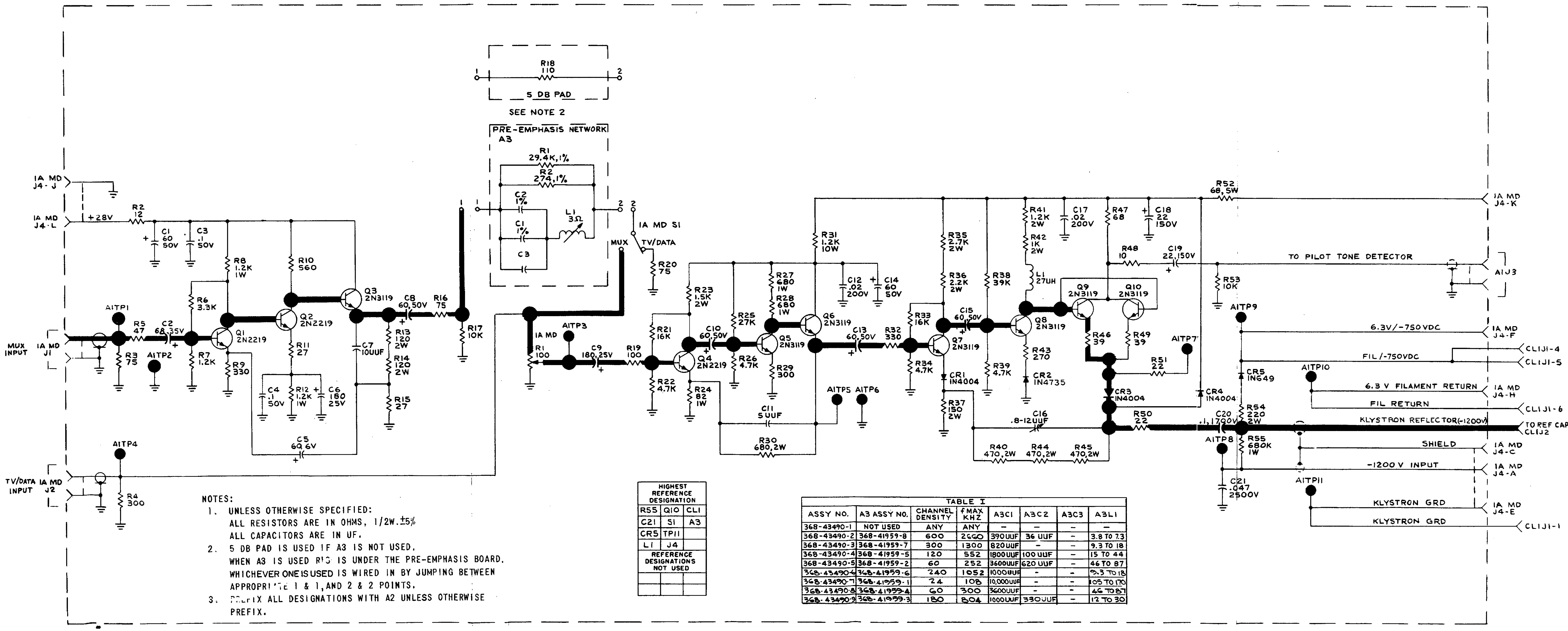
Figure FO-22. IF filter equalizer card, module, schematic diagram



NOTES:
UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/4W, 5%,
ALL CAPACITORS ARE IN UF.

EL5820-792-14-TM-266

Figure FO-23. IF preamplifier module, schematic diagram.



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/2W.±5%
ALL CAPACITORS ARE IN UF.
2. 5 DB PAD IS USED IF A3 IS NOT USED.
WHEN A3 IS USED R18 IS UNDER THE PRE-EMPHASIS BOARD.
WHICHEVER ONE IS USED IS WIRED IN BY JUMPING BETWEEN
APPROPRIATE 1 & 1, AND 2 & 2 POINTS.
3. PREFIX ALL DESIGNATIONS WITH A2 UNLESS OTHERWISE
PREFIX.

HIGHEST REFERENCE DESIGNATION		
R55	Q10	CL1
C21	S1	A3
CR5	TP11	
L1	J4	
REFERENCE DESIGNATIONS NOT USED		

TABLE I

ASSY NO.	A3 ASSY NO.	CHANNEL DENSITY	f MAX KHZ	A3C1	A3C2	A3C3	A3L1
368-43490-1	NOT USED	ANY	ANY	—	—	—	—
368-43490-2	368-41959-8	600	2660	390UUF	36 UUF	-	3.8 TO 7.3
368-43490-3	368-41959-7	300	1300	820UUF	-	-	9.3 TO 18
368-43490-4	368-41959-5	120	552	1800UUF	100 UUF	-	15 TO 44
368-43490-5	368-41959-2	60	252	3600UUF	620 UUF	-	46 TO 87
368-43490-6	368-41959-6	240	1052	1000UUF	-	-	9.3 TO 18
368-43490-7	368-41959-1	24	108	10,000UUF	-	-	105 TO 170
368-43490-8	368-41959-4	60	300	3600UUF	-	-	46 TO 87
368-43490-9	368-41959-3	180	804	1000UUF	330UUF	-	12 TO 30

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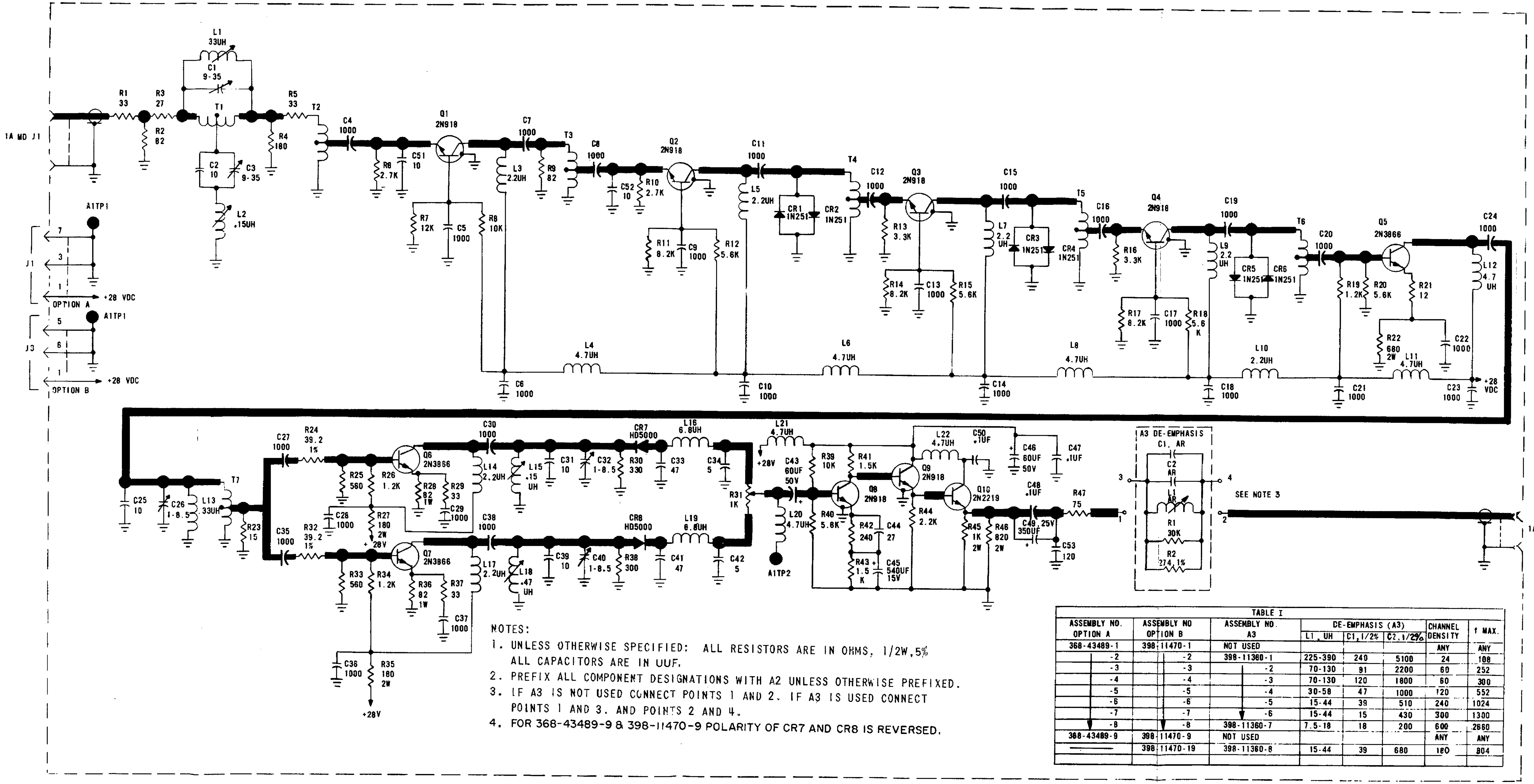
Figure FO-24. Klystron driver module, schematic diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, 1/2W, 5% ALL CAPACITORS ARE IN UUF.
2. PREFIX ALL COMPONENT DESIGNATIONS WITH A2 UNLESS OTHERWISE PREFIXED.
3. IF A3 IS NOT USED CONNECT POINTS 1 AND 2. IF A3 IS USED CONNECT POINTS 1 AND 3. AND POINTS 2 AND 4.
4. FOR 368-43489-9 & 398-11470-9 POLARITY OF CR7 AND CR8 IS REVERSED.

TABLE I

ASSEMBLY NO. OPTION A	ASSEMBLY NO OPTION B	ASSEMBLY NO. A3	DE-EMPHASIS (A3)			CHANNEL DENSITY	f MAX.
			L1, UH	C1, 1/2%	C2, 1/2%		
368-43489-1	398-11470-1	NOT USED				ANY	ANY
-2	-2	398-11360-1	225-390	240	5100	24	108
-3	-3	-2	70-130	91	2200	60	252
-4	-4	-3	70-130	120	1800	60	300
-5	-5	-4	30-58	47	1000	120	552
-6	-6	-5	15-44	39	510	240	1024
-7	-7	-6	15-44	15	430	300	1300
-8	-8	398-11360-7	7.5-18	18	200	600	2660
368-43489-9	398-11470-9	NOT USED				ANY	ANY
———	398-11470-19	398-11360-8	15-44	39	680	180	804

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Figure FO-25. Limiter-discriminator module, schematic diagram.

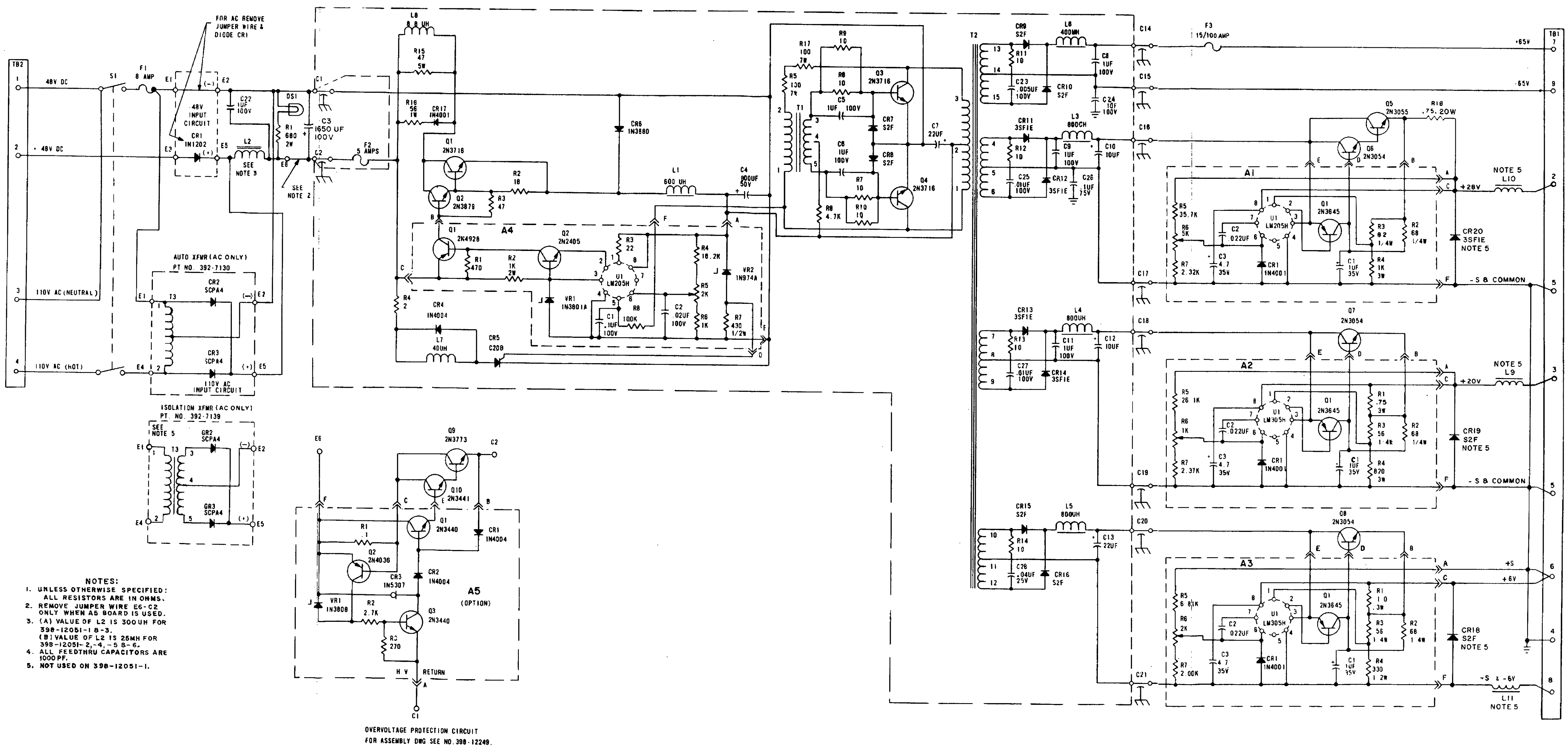

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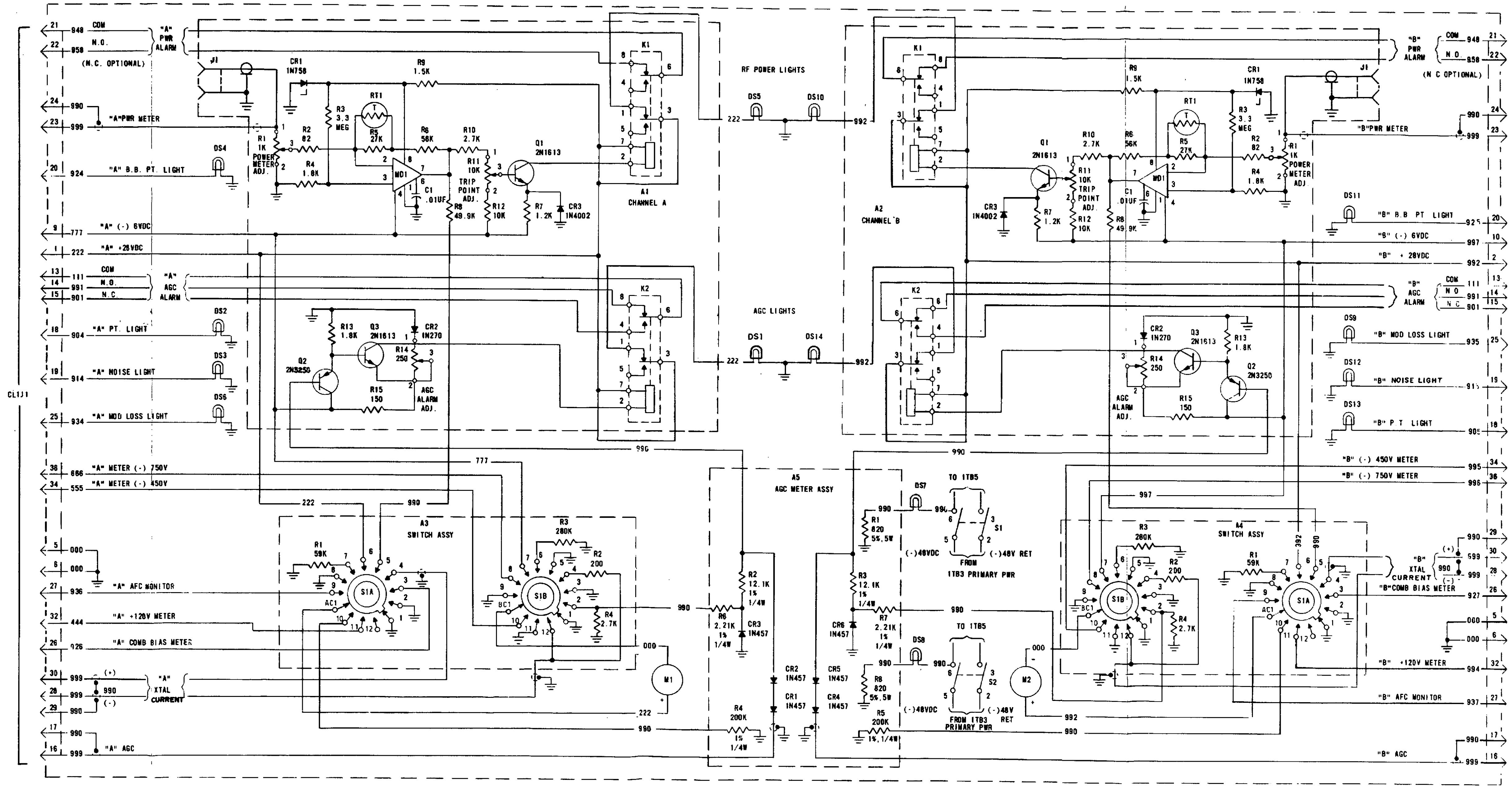
Figure FO-26. Low voltage power supply, schematic diagram.

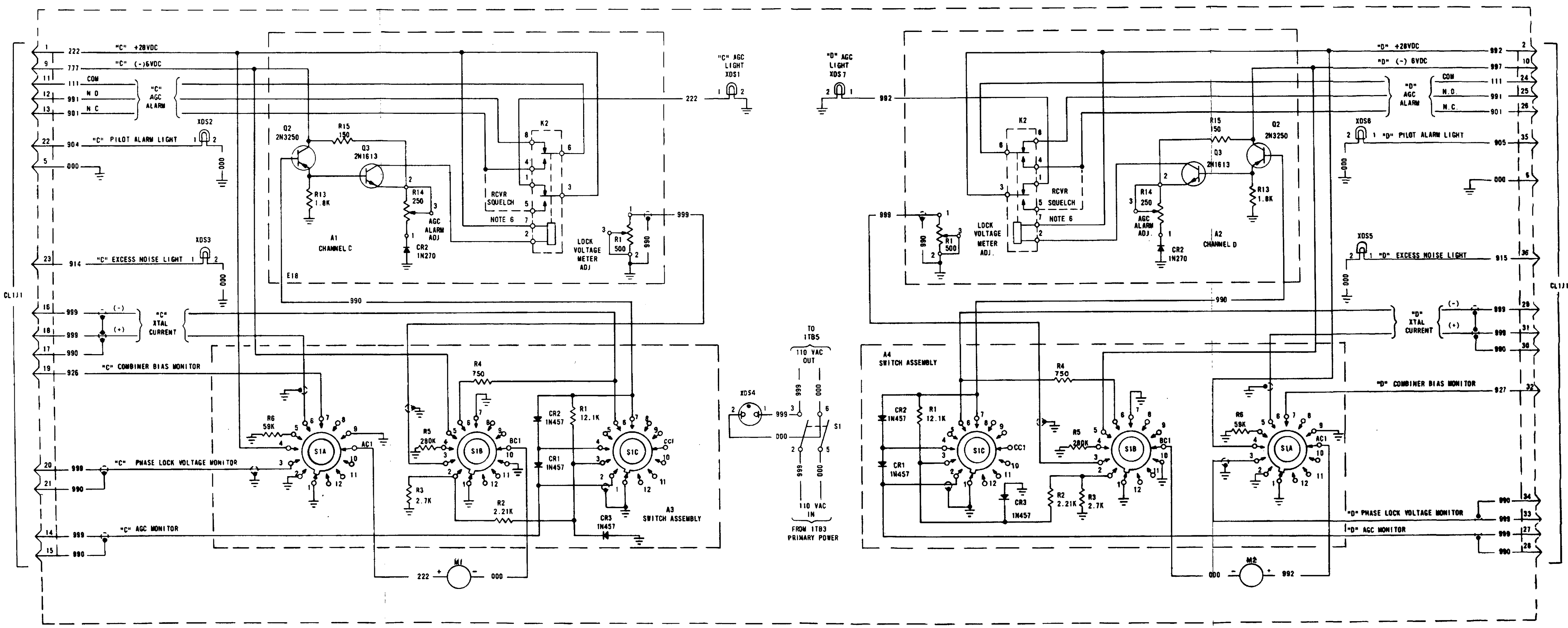
NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/2W,5%
2. ALL RESISTORS ON ROTARY SWITCHES ASSY A3 & A4 ARE 1/4W, 1% EXCEPT R4 IS 1/4W, 5%.
3. 3 DIGIT NUMBERS ARE WIRE COLOR CODE
4. SWITCH POSITIONS ARE NUMBERED FACING THE KNOB. THE COMMON POSITION IS BETWEEN PIN 9 & 10 ON THE FRONT SIDE.



EL5820-792-14-TM-270

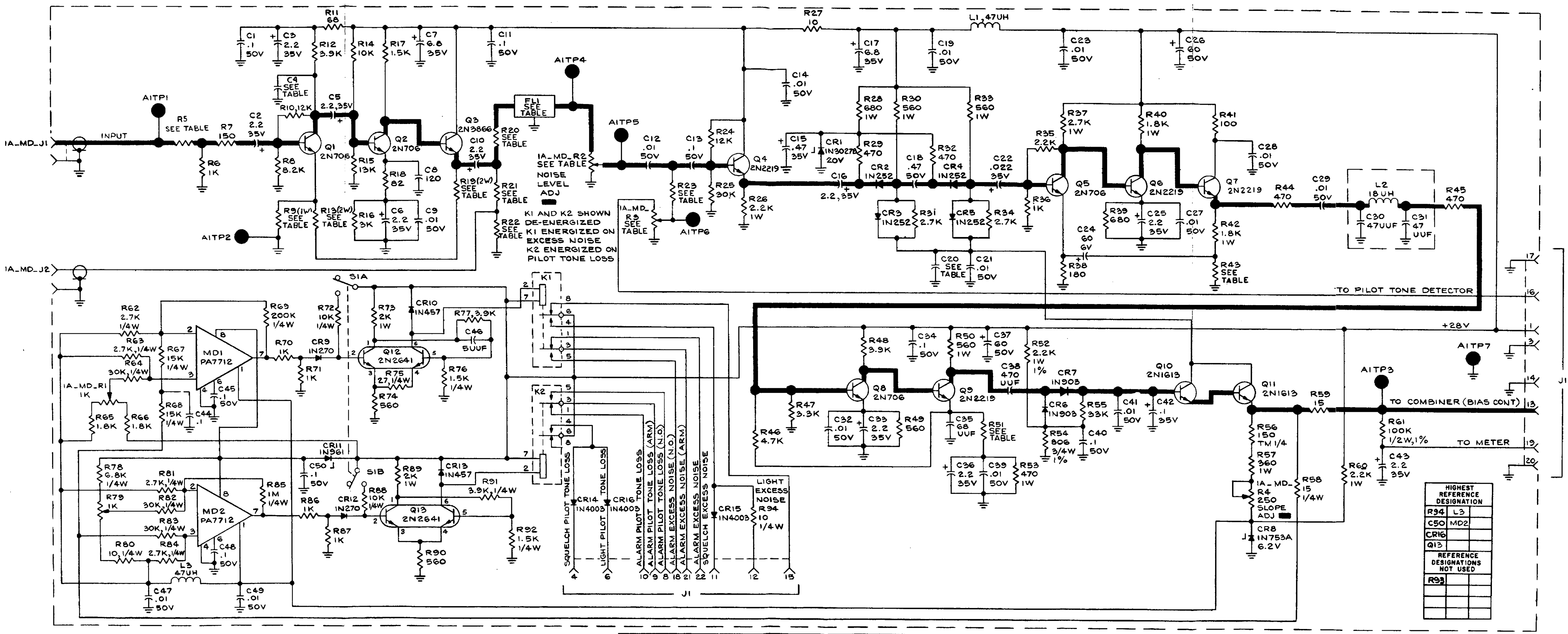
Figure FO-27. Meter panel assembly 398-12041-01, schematic diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, 1/2W, 5%
2. SWITCH POSITIONS ARE NUMBERED FACING THE KNOB.
   THE COMMON POSITION IS BETWEEN PIN 9 & 10 ON THE FRONT SIDE.
3. ALL RESISTORS ON ROTARY SWITCH ASSY A3 & A4 ARE 1/4W,1%, EXCEPT R3 IS 1/4W, 5%.
4. 3 DIGIT NUMBERS ARE WIRE COLOR CODE.
5. WHEN SYSTEM REQUIREMENTS DICTATE RCVR SQUELCH, MOVE LEAD FROM K2-4 TO K2-5.

Figure FO-28. Meter panel assembly 398-12380-1 and -2, schematic diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/2W, 5%
   ALL CAPACITORS ARE IN UF.
2. PREFIX COMPONENT DESIGNATIONS WITH A2 UNLESS OTHERWISE PREFIXED.
3. COMPONENT VALUES NOT APPEARING ON THE DIAGRAM ARE SHOWN IN THE ASSOCIATED CHART.

PART NUMBER	FL1	C4	C20	R5	R9	R13	R19	R20	R21	R22	R23	R43	R51	A1R2	A1R3
368-43018-1	362-7650	100 PF	47,50V	10	68	120	120	100	150	150	1K	20	150	250	250
368-43018-2	362-7650-2	OMIT	1,50V	AR	18	150	150	620	330	1K	3.3K	10	62	1K	5K
368-43018-3	362-7650-3	OMIT	1,50V	AR	18	150	150	620	330	1K	3.3K	10	62	1K	5K
368-43018-4	362-7650-4	OMIT	47,50V	AR	18	150	150	620	330	1K	3.3K	10	62	1K	5K
368-43018-5	362-7650-5	OMIT	47,50V	AR	18	150	150	620	330	1K	3.3K	10	62	1K	5K

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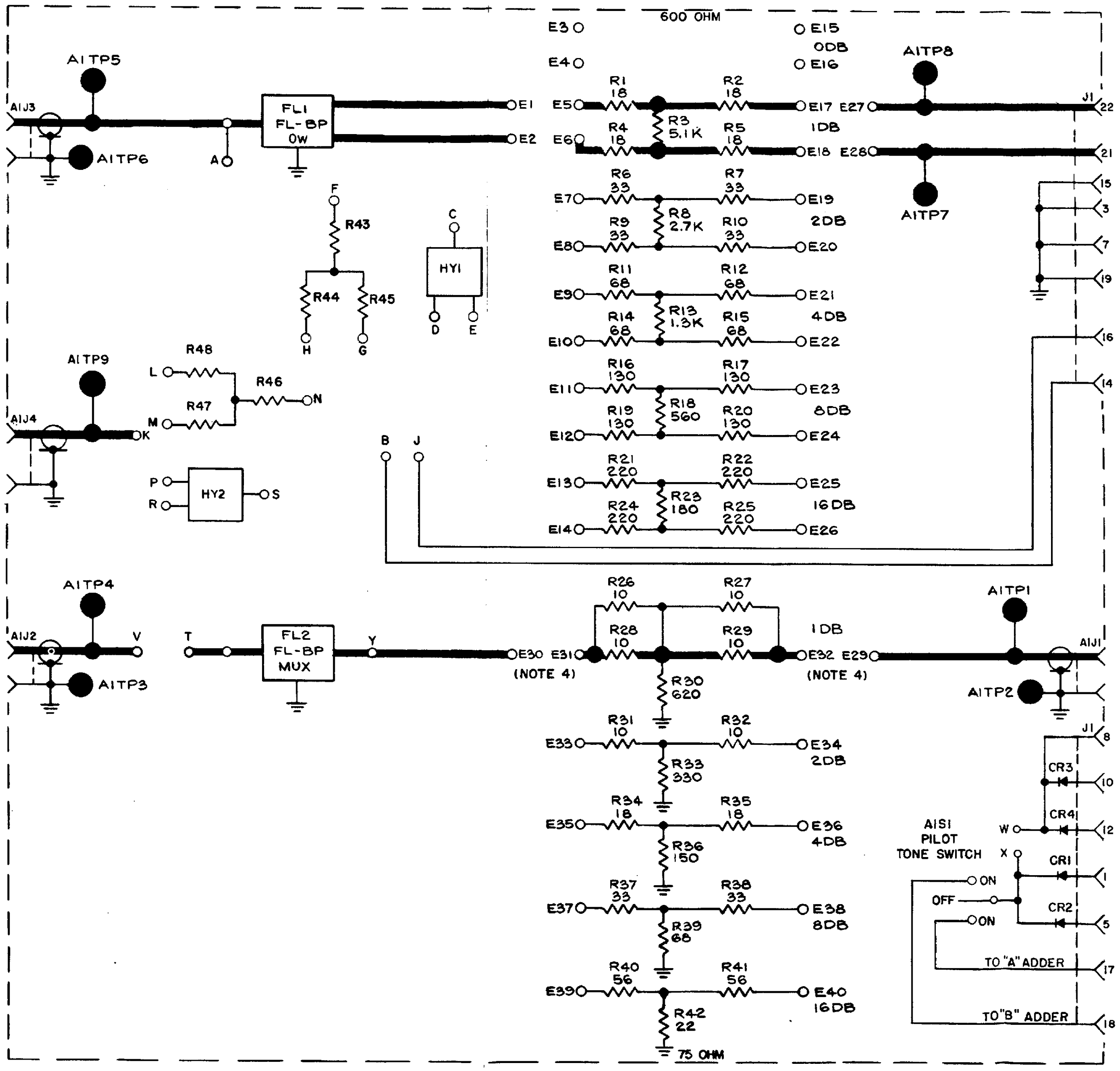
Figure FO-29. Noise amplifier module, schematic diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/4W
2. FOR 368-43050-1
   THE FOLLOWING ARE NOT USED:
   FL2; R26 TO R42 INCLUSIVE; J1 AND J2; AND TP1 TO TP4 INCLUSIVE. CHANGE TP5 TO TP1, TP6 TO TP2, TP7 TO TP3, TP8 TO TP4 AND J3 TO J1.
3. DESIGNATIONS WITH A2 UNLESS OTHERWISE PREFIXED.
4. FOR 0dB ATTENUATION IN MUX, STRAP E29 TO E30.

HIGHEST REFERENCE DESIGNATIONS		
R48	A1S1	
FL2		
CR4		
HY2		
REFERENCE DESIGNATIONS NOT USED		
SEE NOTE 3		

ASSEMBLY	FL1	FL2	HY1	HY2	R43	R44 & R45	R46, 47 & 48	CR1 & 2	CR3 & 4	A1S1	A1TP9	STRAP OPTIONS
368-43020-1	362-7649-1	362-7648-1	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO T
368-43050-1	362-7649-2	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO Y
368-43020-2	362-7649-2	362-7648-2	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO T
368-43020-3	362-7649-3	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO Y
368-43020-4	362-7671-1	362-7648-9	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	A TO B, V TO T
368-43020-5	362-7649-3	368-7648-11	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO T
368-43020-6	362-7649-3	362-7648-1	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO T
368-43020-7	362-7671-3	OMIT	OMIT	398-11287-1	STRAP	200	OMIT	IN4001	OMIT	REQD	REQD	K TO P, V TO R, H TO J, S TO Y A TO F, G TO B
368-43020-8	362-7649-5	362-7648-10	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO T
368-43020-9	362-7649-6	362-7648-11	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO T
368-43020-10	362-7671-1	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO Y, A TO B
368-43020-11	392-7148-5	362-7648-12	OMIT	398-11287-1	STRAP	200	OMIT	IN4001	OMIT	REQD	REQD	V TO P, V TO R, H TO J, S TO T, A TO F, G TO B
368-43020-12	392-1071-5	362-7648-12	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO T
368-43020-13	392-1071-5	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	V TO Y

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Figure FO-30. Terminal filter module, schematic diagram.

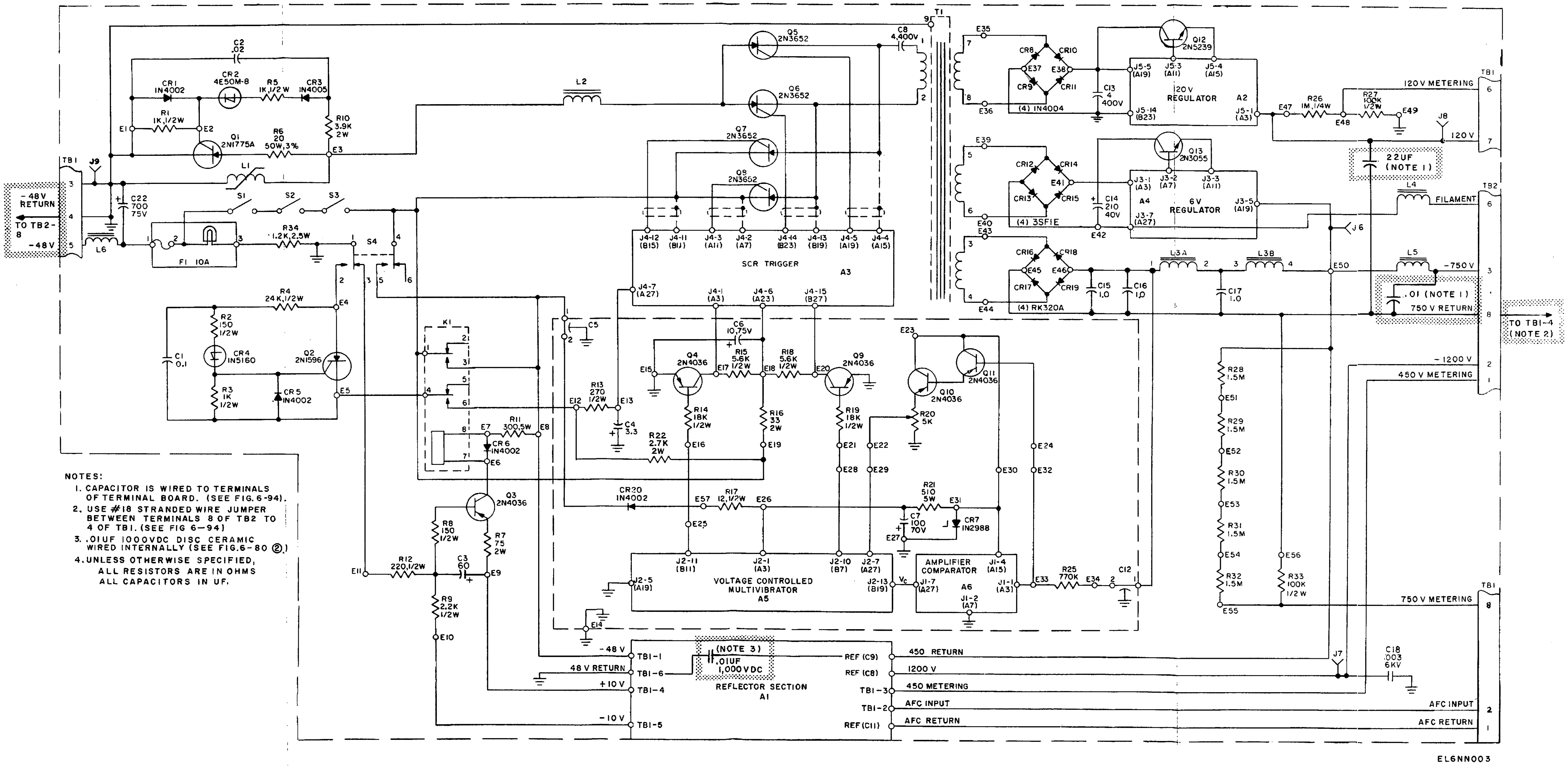


Figure FO-31. Klystron power supply, schematic diagram.

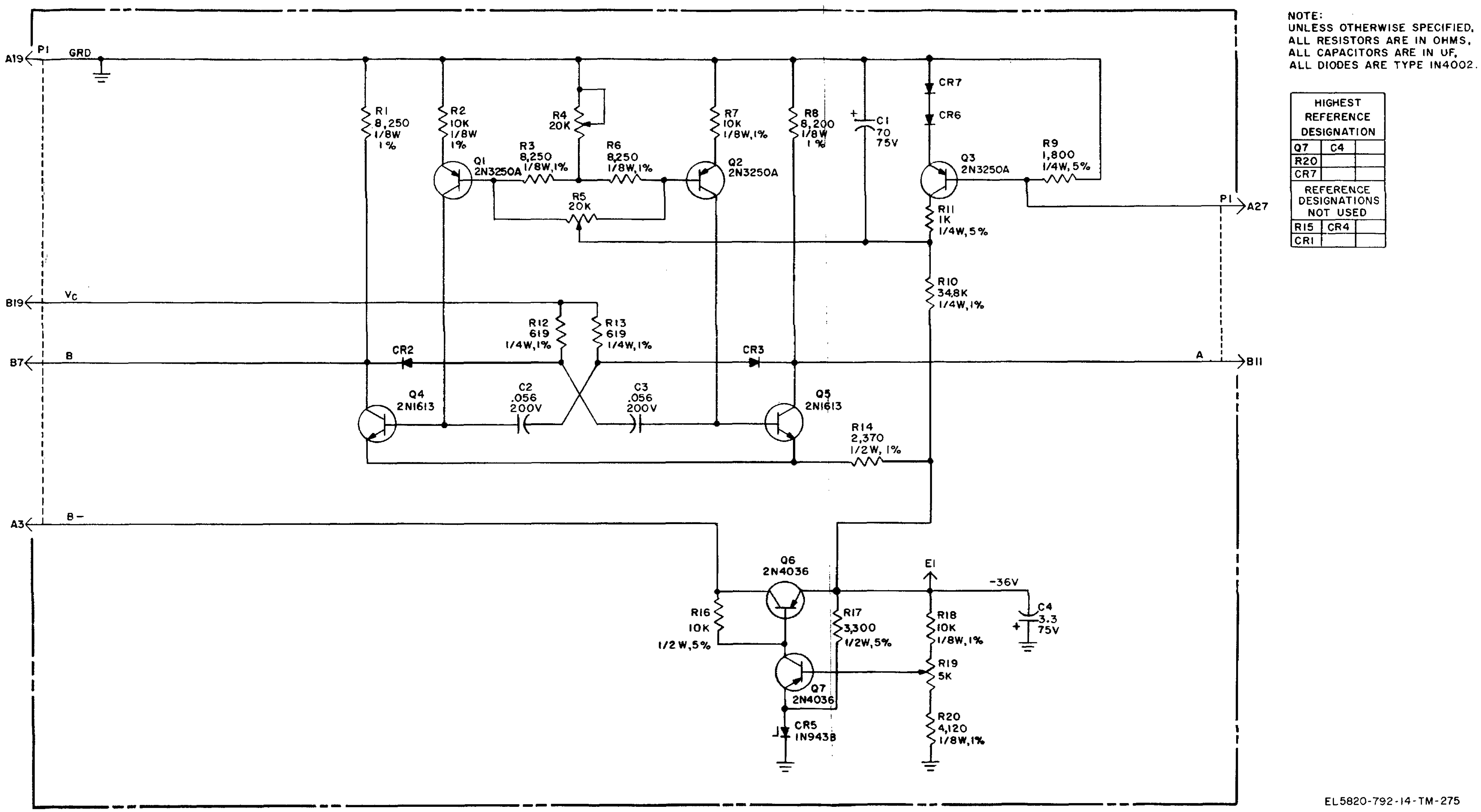


Figure FO-32. Voltage controlled multi-vibrator, schematic diagram.

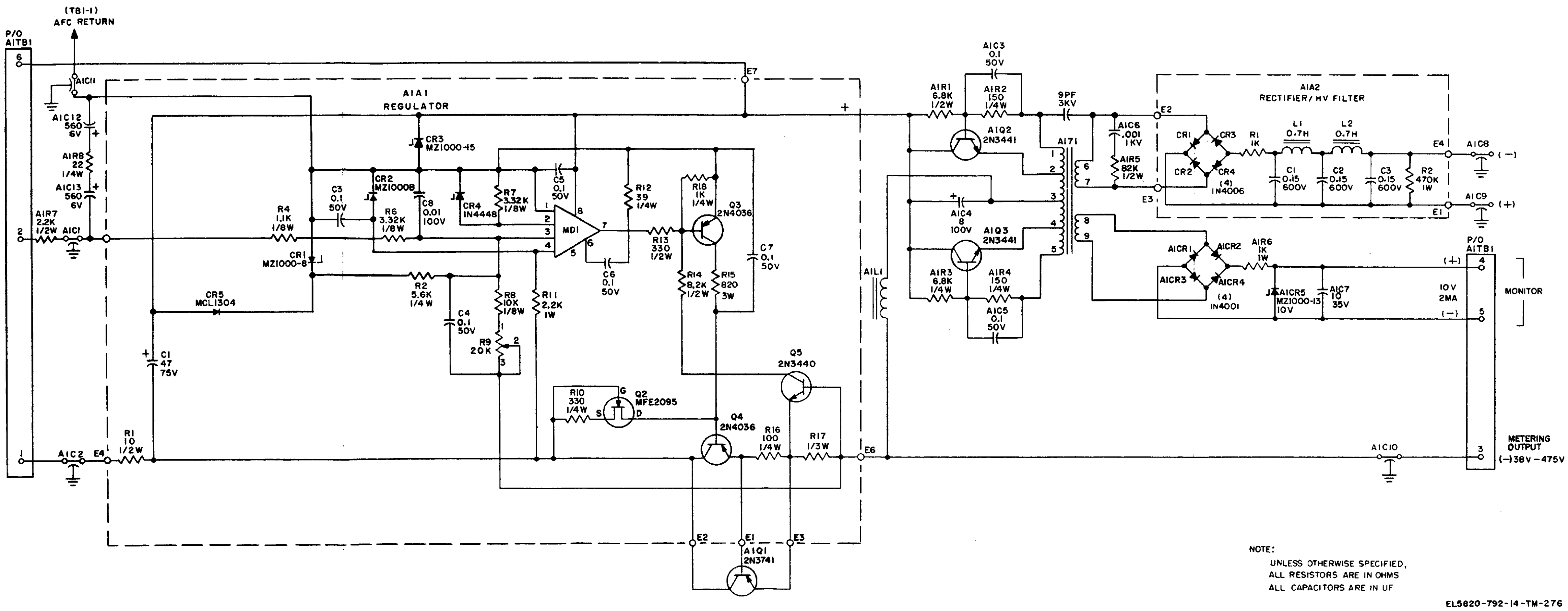


Figure FO-33. 450 Volt Section, schematic diagram

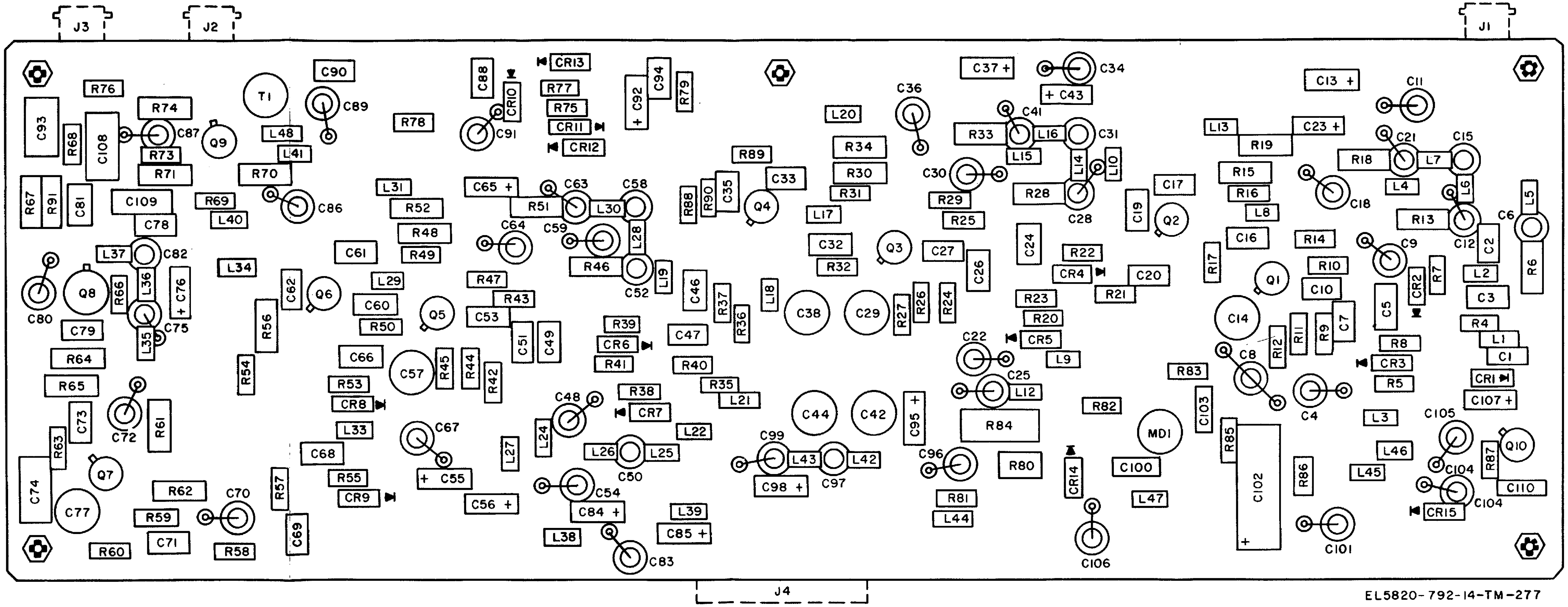


Figure FO-34. IF amplifier module, schematic diagram

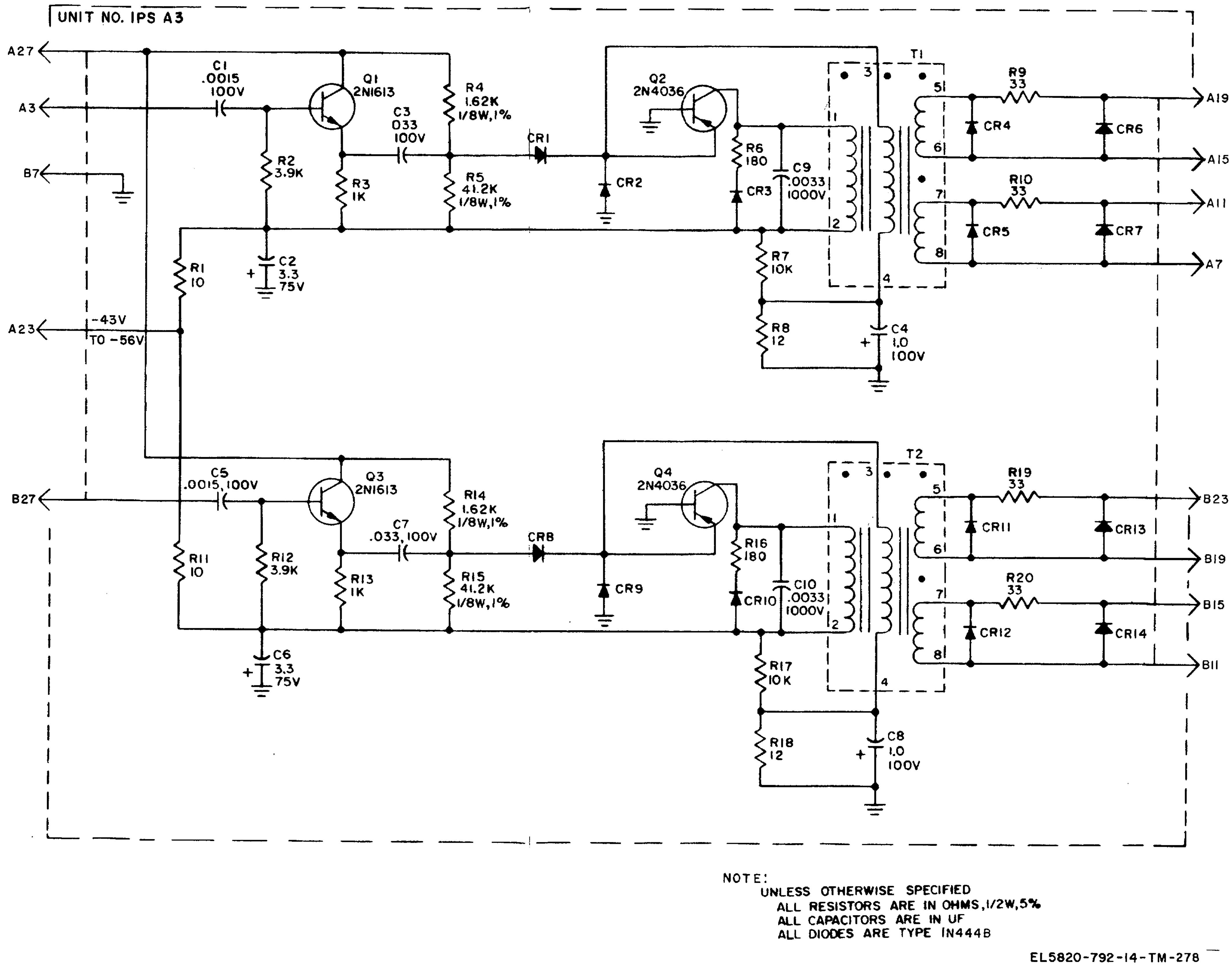
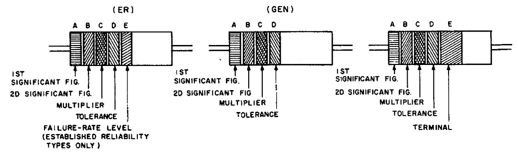


Figure FO-35. SCR trigger assembly, schematic diagram



COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

TABLE I
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS.

BAND A		BAND B		BAND C		BAND D		BAND E		
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL	TERM.
BLACK....	0	BLACK....	0	BLACK....	1			BROWN...	M=1.0	
BROWN....	1	BROWN....	1	BROWN....	10			RED......	P=0.1	
RED.......	2	RED.......	2	RED.......	100			ORANGE..	R=0.01	
ORANGE....	3	ORANGE....	3	ORANGE...	1,000			YELLOW..	S=0.001	
YELLOW....	4	YELLOW...	4	YELLOW...	10,000	SILVER	±10 (COMP. TYPE ONLY)	WHITE...	....	SOLD-ERABLE
GREEN.....	5	GREEN.....	5	GREEN....	100,000	GOLD...	±5			
BLUE......	6	BLUE......	6	BLUE.....	1,000,000	RED....	±2 (NOT APPLICABLE TO ESTABLISHED RELIABILITY).			
PURPLE.... (VIOLET)	7	PURPLE.... (VIOLET)	7							
GRAY......	8	GRAY......	8	SILVER...	0.01					
WHITE....	9	WHITE.....	9	GOLD	0.1					

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH.)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE.

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE.)

BAND D — THE RESISTANCE TOLERANCE.

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE – RATE LEVEL (PERCENT FAILURE PER 1,000 HOURS). ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL.

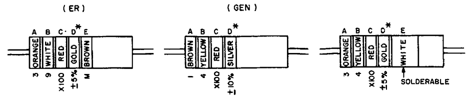
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS
(THESE ARE NOT COLOR CODED)

SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE:

2R7 = 2.7 OHMS   10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED, IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3,900 OHMS
RESISTANCE TOLERANCE ±5%
FAILURE RATE LEVEL M

NOMINAL RESISTANCE 1,400 OHMS
RESISTANCE TOLERANCE ±10%

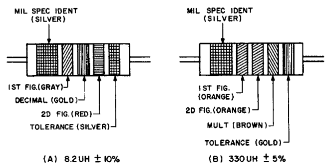
NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±5%
TERMINAL SOLDERABLE

COMPOSITION-TYPE RESISTORS

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



(A) 8.2 UH ± 10%   (B) 330 UH ± 5%

COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES. AT A, AN EXAMPLE OF OF THE CODING FOR AN 8.2 UH CHOKE IS GIVEN. AT B, THE COLOR BANDS FOR A 330 UH INDUCTOR ARE ILLUSTRATED.

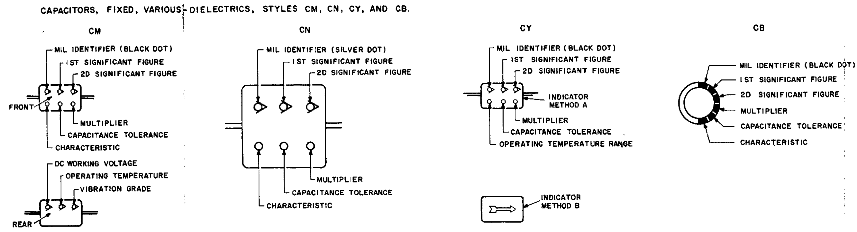
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

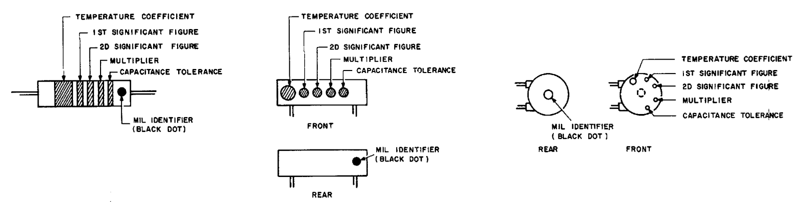
MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL.

B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB.



MICA-DIELECTRIC   PAPER-DIELECTRIC   GLASS-DIELECTRIC, GLASS CASE   MICA, BUTTON TYPE



AXIAL LEAD   RADIAL LEAD   DISK-TYPE

TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB.

COLOR	MIL ID	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]			DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY CB	0	0	1			±20%	±20%		A			−55° TO +70°C	10-55 Hz
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%	±2%	C				−55° TO +85°C	
ORANGE		3	3	1,000		±30%			D		D	300		
YELLOW		4	4	10,000					E				−55° TO +125°C	10-2,000Hz
GREEN		5	5		±5%				F			500		
BLUE		6	6										−55° TO +150°C	
PURPLE (VIOLET)		7	7											
GRAY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN			0.01	±10%	±10%	±10%	±10%						

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC.

COLOR	TEMPERATURE COEFFICIENT[4]	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	
BLACK	0	0	0	1		± 2.0 UUF	CC
BROWN	−30	1	1	10	±1%		
RED	−80	2	2	100	±2%	±0.25 UUF	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		±5%	± 0.5 UUF	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GRAY		8	8	0.01*			
WHITE		9	9	0.1*	±10%		
GOLD	+100			0.1		± 1.0 UUF	
SILVER				0.01			

1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.
2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS: MIL-C-5, MIL-C-25D, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.
3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.
4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

* OPTIONAL CODING WHERE METALLIC PIGMENTS ARE UNDESIRABLE.

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS.

ESC-FM 913-73

Figure FO-36. Color code marking for MIL STD resistors, and capacitors.

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

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