TM 11-5895-1141-34

DIRECT SUPPORT AND GENERAL SUPPORT

MAINTENANCE MANUAL

CONTROL, RADIO CHANNEL

C-1 0931 (P)/FRC

(NSN 5820-01-114-1456)

HEADQUARTERS DEPARTMENT OF THE ARMY
1 JULY 1982

WARNING

HIGH VOLTAGE
is used in the operation of this equipment

DEATH ON CONTACT
may result if personnel fail to observe safety precautions

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technician is aided by operators, he must warn them about dangerous areas.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

Be careful not to contact high-voltage connections or 115 volt ac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through the body.

WARNING: Do not be misled by the term "low voltage". Potentials as low as 50 volts may cause death under adverse conditions.

For Artificial Respiration, refer to FM 21-11.

CHANGE
NO. 1 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 13 May 1985

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL
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TM 11-5895-1141-34, 1 July 1982, is changed as follows:

1. New or changed material is indicated by a vertical bar in the margin. Added or revised illustrations are indicated by a vertical bar in front of the figure caption. Remove and insert pages as indicated below:

Remove	Insert
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1-1 and 1-2	1-1 and 1-2
None	Figure FO-1 through FO-17

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DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL
CONTROL, RADIO CHANNEL C-10931(P)/FRC
(NSN 5820-01-114-1456)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

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, DA Form 2028 (Recommended Changes to Publications and Blank Forms) or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703-5007. A reply will be furnished to you.

HOW TO USE THIS MANUAL

This manual describes test and maintenance of the C-10931(P)/FRC at the direct support and general support maintenance levels. In addition to the introductory chapter, it contains equipment description, test, fault isolation information, maintenance and troubleshooting procedures for its major assemblies.

FRONT COVER INDEX - tells you at a glance on what pages you can find the procedures and information that you will use most often. These items are also enclosed in a box when they appear on the full table of contents.

IMPORTANT INFORMATION IN THE TEXT IS IN BOLD LETTERS. If you are an experienced technician thoroughly familiar with the detailed procedures, this will help you scan the text and find the information you need without reading the entire procedure.

CHAPTER 1

INTRODUCTION

Section I. GENERAL INFORMATION

SECTION CONTENTS PAGE

1-1. SCOPE

This manual provides the theory of operation, instructions for installation, and direct support and general support maintenance procedures for Control, Radio Channel C-10931(P)/FRC equipment.

1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750 as contained in Maintenance Management Update.

1-3. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your C-10931(P)/FRC 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. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, New Jersey 07703-5007. We'll send you a reply.

Section II. EQUIPMENT DESCRIPTION AND DATA

SECTION CONTENTS PAGE

1-4. PURPOSE AND USE

The purpose of the C-10931(P)/FRC equipment is to provide a capability of controlling 1 to 8 radio channels used in air traffic control by means of a complete radio control operator's position. Each radio channel contains a transmitter and receiver remotely operated through the Radio Channel Control System.

1-5. PHYSICAL DESCRIPTION AND MODULE LOCATION

The C-10931(P)/FRC equipment is a self-contained unit designed to be mounted on a flat, horizontal surface wherever operation is convenient and necessary wiring is accessible. The console is 16-1/4 wide by 14-1/2 deep by 7-1/2 inches high at the front, and 5 inches high at the rear. Four rubber feet, 5/8 inches high are attached to the bottom of the console and a microphone hanger bracket is attached on the right side. All necessary wiring passes through a cutout in the rear of the chassis. A front view of the console is shown in figure 1-1. The numbered callouts locate the various modules mounted on the front panel. The list below identifies the modules numbered in figure 1-1.

a. Microphone amplifier/lamp brightener module assembly
b. Recorder-monitor module PL-1455/FRC
c. Volume control module assembly
d. Audio unit assembly
e. Selector Module, Radio Channel SA-2328/FRC
f. Blank panel assembly
g. Selector unit assembly
h. Headset/microphone jack panel assembly
I. Table top console assembly

1-6. DESCRIPTION OF MAJOR COMPONENTS

What follows is a brief functional description of the major assemblies within the system.

a. Microphone Amplifier/Lamp Brightness Assembly. This assembly is mounted on the audio unit assembly. The audio signal inputs from the

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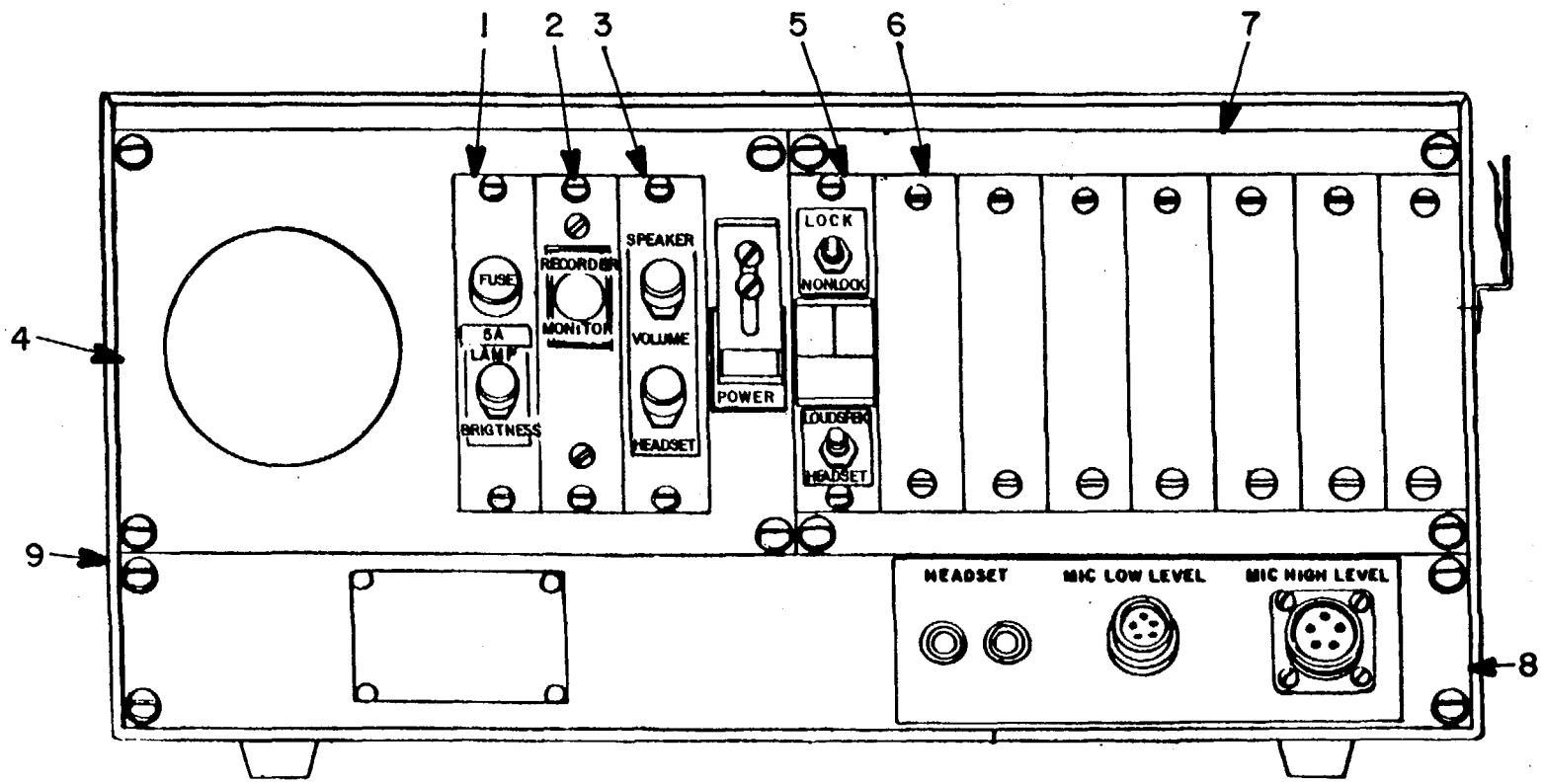

Figure 1-1. Control, Radio Channel Console, Front View

operator's microphone is amplified and processed by this assembly. The assembly output is sent to the selected radio channel selector module and to the recorder-monitor module. A brightness control for all the indicator lamps, as well as the ac power fuse, are located on the front panel of this assembly.

b. Recorder-Monitor Module. This module is used to couple the transmitted audio originating at the operator's microphone and the received audio from the radio receiver to a recorder (not furnished). An indicator lamp mounted on the front panel of the module flashes when audio is being recorded.

c. Volume Control Module. Received audio is amplified by this module whose output is then delivered to either the loudspeaker or the operator's headset. Two volume controls are mounted on the front panel of this module, one for the loudspeaker audio and the other for the headset.

d. Radio Channel Selector Module. The keying and interlocking functions are performed by this module. When the operator depresses his push-to-talk switch, and the lock/nonlock switch (located on the front panel of the module) is closed, the transmitter is then keyed, provided the channel is not already engaged by another operator. In the event the channel is already engaged, the interlock circuits prevent keying the channel transmitter from this position and an audible tone is generated to notify the operator. Note there is provision for up to 8 selector modules to control up to 8 radio channels located on the selector unit. A three section lamp display on this module indicates (1) when the operator has keyed the transmitter from this location (red lamp), (2) when the locking-lock switch is on (green lamp), (3) when the audio is being received from the channel's receiver output (amber lamp).

e. Headset/Microphone Jack Panel Assembly. Receptacles are mounted on this panel for mating with the microphone or headset being used by the operator.

1-7. ELECTRICAL AND SIGNAL CHARACTERISTICS

The C-10931(P)/FRC electrical and signal characteristics are listed in TM 11-5895-1141-12.

1-8. OPERATION

A general description and operating instructions for the C-10931(P)/FRC is given in TM 11-5895-1141-12.

1-9. DIFFERENCES BETWEEN MODELS

There is only one model of the C-10931(P)/FRC.

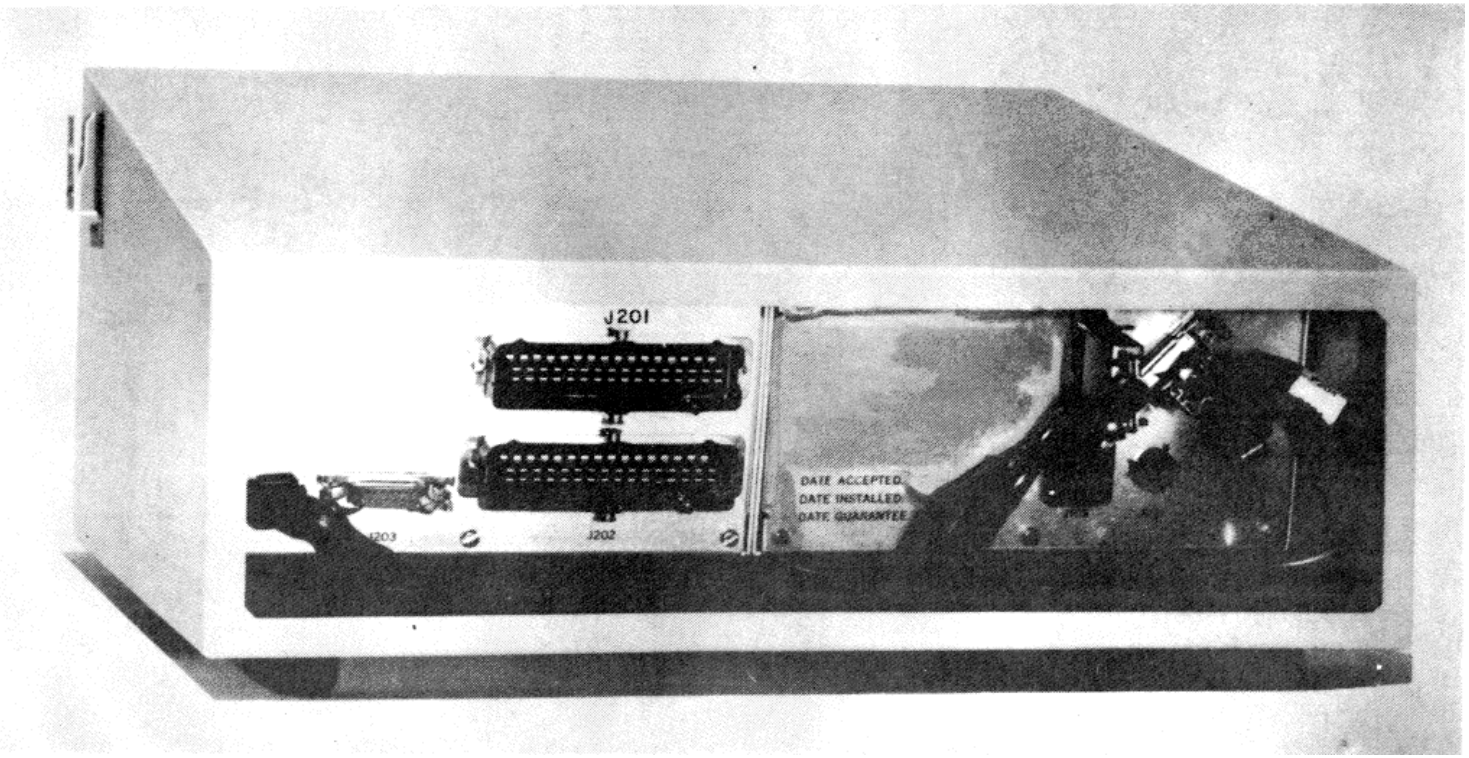

Figure 1-2. Control, Radio Channel Console, Rear View

CHAPTER 2
FUNCTIONING OF EQUIPMENT

Section I. FUNCTIONAL DESCRIPTION

SECTION CONTENTS

2-1. GENERAL

The C-10931(P)/FRC includes three major units:

a. Headset/Microphone Jack Panel
b. Audio Unit
c. Selector Unit

These units are housed in an aluminum chassis (fig. 1-1) and are removable from this chassis.

The system comprises a complete radio control operator's position with the capability of controlling from 1 to 8 radio channels. This chapter contains first, a brief functional, block diagram description of the system operation, followed by a more detailed theory of operation of the circuitry within the system.

2-2. FUNCTIONAL DESCRIPTION OF MAJOR CIRCUITS

What follows is a working description of the major blocks that constitute the radio channel control system. They are: dc power distribution, transmitting circuits, keying and interlock circuits, receiving circuits, telephone interface, recorder-mixer and monitor, and lamp display.

a. DC Power Distribution. Refer to figure 2-1 and figure FO-1. Power for the system is obtained from a regulated dc power supply (not furnished) which delivers +24 vdc via pin A of connector J105 located in the rear of the audio unit to power switch S101 and fuse F1201 located on the front panel of the microphone amplifier/lamp brightener module assembly. The fuse holder XF1201 contains a built-in incandescent lamp DS1201 which glows if the fuse opens. From the fuse, power is distributed to the voltage regulator in the microphone amplifier/lamp brightener assembly and the other modules via connector J106. A filter consisting of choke L101 and capacitor C101 provides filtered 24 vdc to the headset/ microphone jack panel assembly as well as the amplifiers on all the modules. The output voltage of the lamp bus regulator circuit is set by

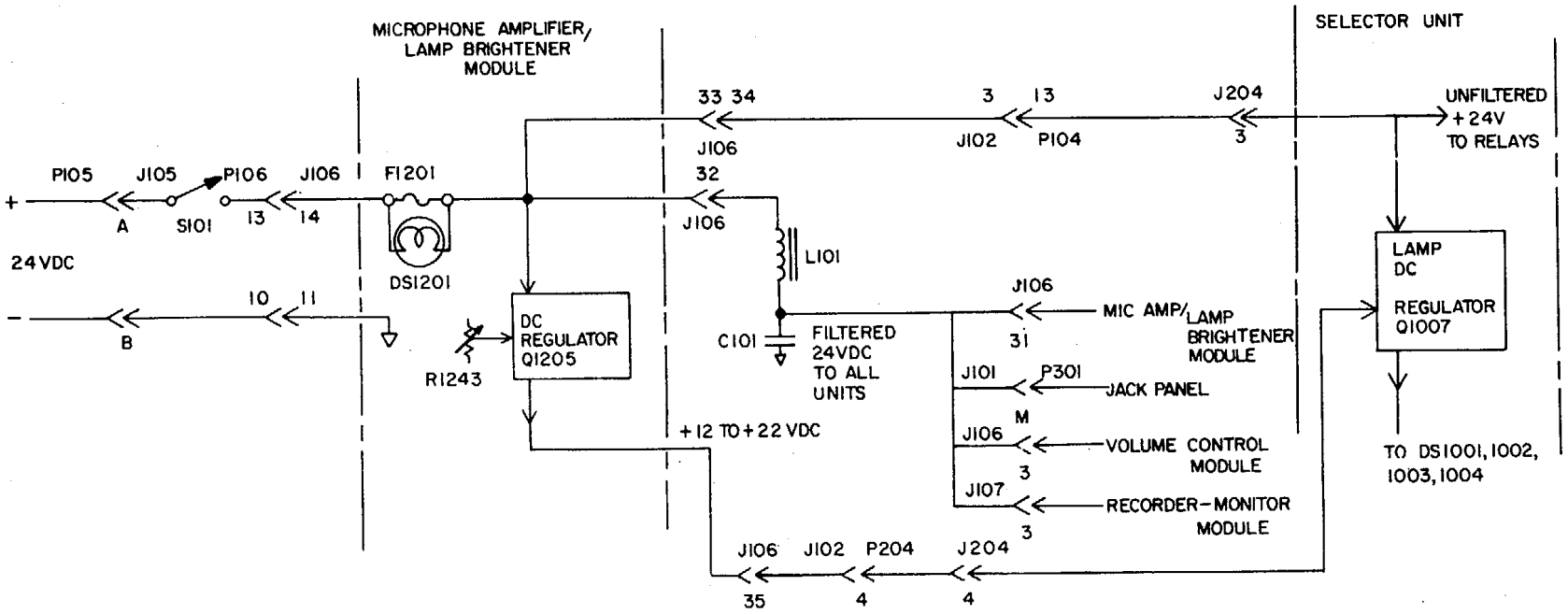

Figure 2-1. DC Power Distribution

means of the lamp brightener control R1243 located on the front panel of the microphone amplifier/lamp brightener control module assembly, and is variable between +12 and +22 volts. This output is delivered to the selector module assembly voltage control regulator which supplies the panel lamps in that module. The power supply return is connected to J105-B, and is extended to each module.

b. Transmitting Circuits. Refer to figures 2-2, FO-1 and FO-2. We see that the audio signal originates at one of three microphones: the headset microphone, low-level microphone or the high-level microphone. The signal proceeds from the jack panel to the microphone amplifier to the selector module before reaching the transmitter where it serves to modulate the carrier. Beginning at the headset/microphone jack panel, the signal enters the panel via either jacks J301 and J302, J303, or J305, depending on which microphone is used. Keying is accomplished by a switching transistor circuit. From the headset/microphone jack panel, the signal is delivered via connectors P301 and J101 to input transformer T1201, input level adjust potentiometer R1202, and preamplifier stage U1201. The preamplified signal is then fed to an operational amplifier stage U1202 via a resistor and a gain control shunt FET transistor Q1201. Q1201 is controlled by the dc output of U1204 which rectifies and filters the signal output of U1202. This arrangement results in the U1202 output remaining fairly constant despite a wide range of audio input levels. This regulated signal is further amplified by stages U1203, Q1202, Q1203, U1205B and Q1204 and drives the transmitter audio bus common to all of the selector modules at the operator's position. Transmit level adjust potentiometer R1230 adjusts the audio level. Amplifier stage U1205B is gated by the transmitter channel status signal so that its output is blocked unless one or more transmitters are being keyed by the operator at this position. At each selector module transmitter audio is fed to the input of the channel's radio transmitter via buffer amplifier stage Q1010, Q1011, transformer T1002 and a pair of contacts on relay K1001. The relay is energized, passing the output signal only when the channel is keyed from this operator's position. The audio signal is also routed to the headset via gated stage U1205D plus additional circuitry in the volume control module assembly, when one or more transmitters are keyed. This sidetone signal gives the operator a sense of "presence" when he speaks, as well as confirmation that the equipment has been keyed into the transmitting mode. A portion of the microphone signal is also diverted via U1205C to tape recorder output terminals in the recorder monitor module (if used) from the microphone amplifier module.

c. Keying and Interlock Circuits. Refer to figure 2-3 and figure FO-1. Closure of the microphone push-to-talk (P/T) switch grounds P301-C. The four sections of integrated circuit U1001 are interconnected to perform as logic gates and provide required interlocking and status indication functions. The selected channel is enabled by moving front panel switch S1002 from its center-off position to either the NONLOCK or the LOCK position. The switch may be locked in the LOCK position but in

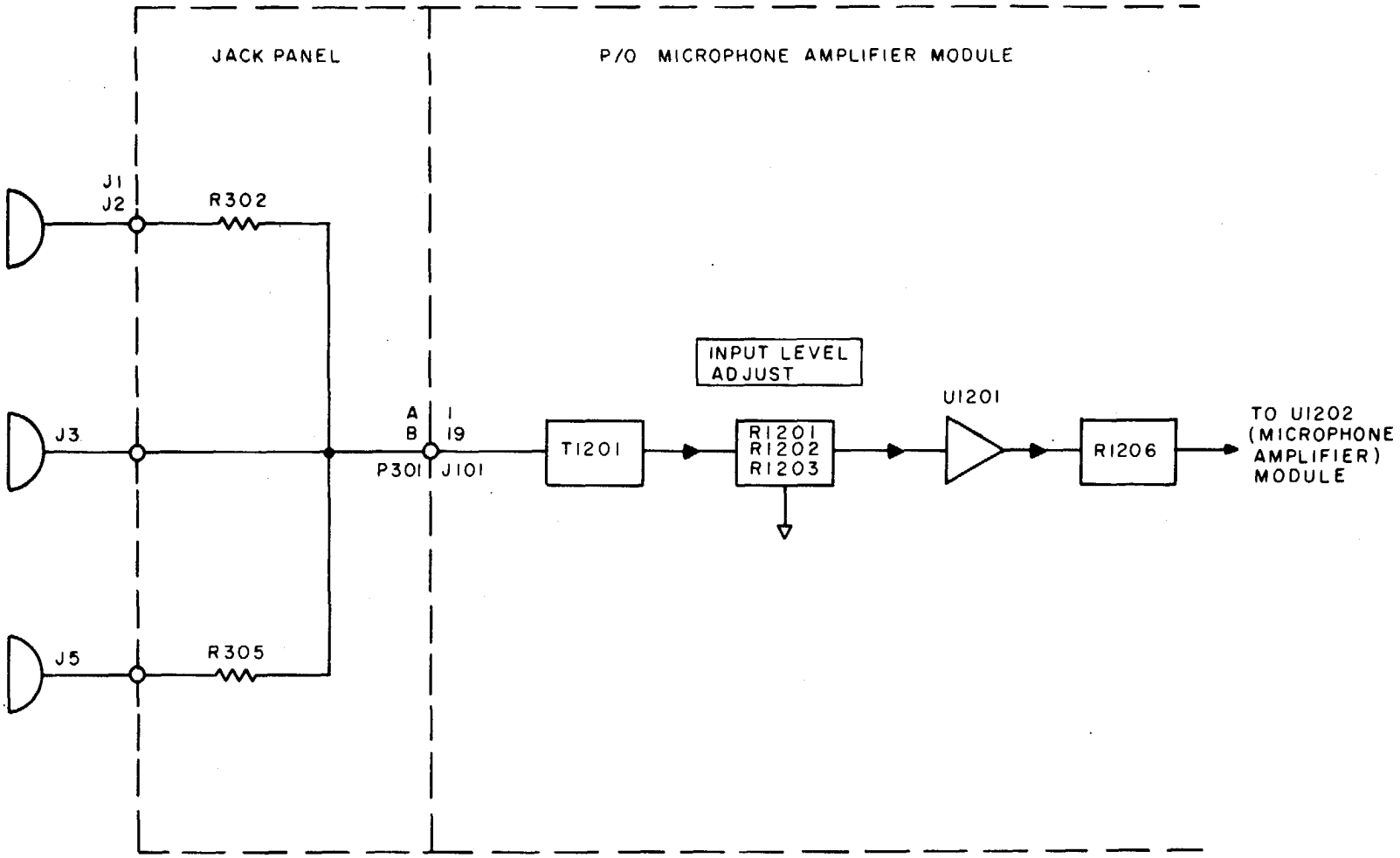

Figure 2-2. Transmit Audio Circuits Functional Diagram (Sheet 1 of 3)

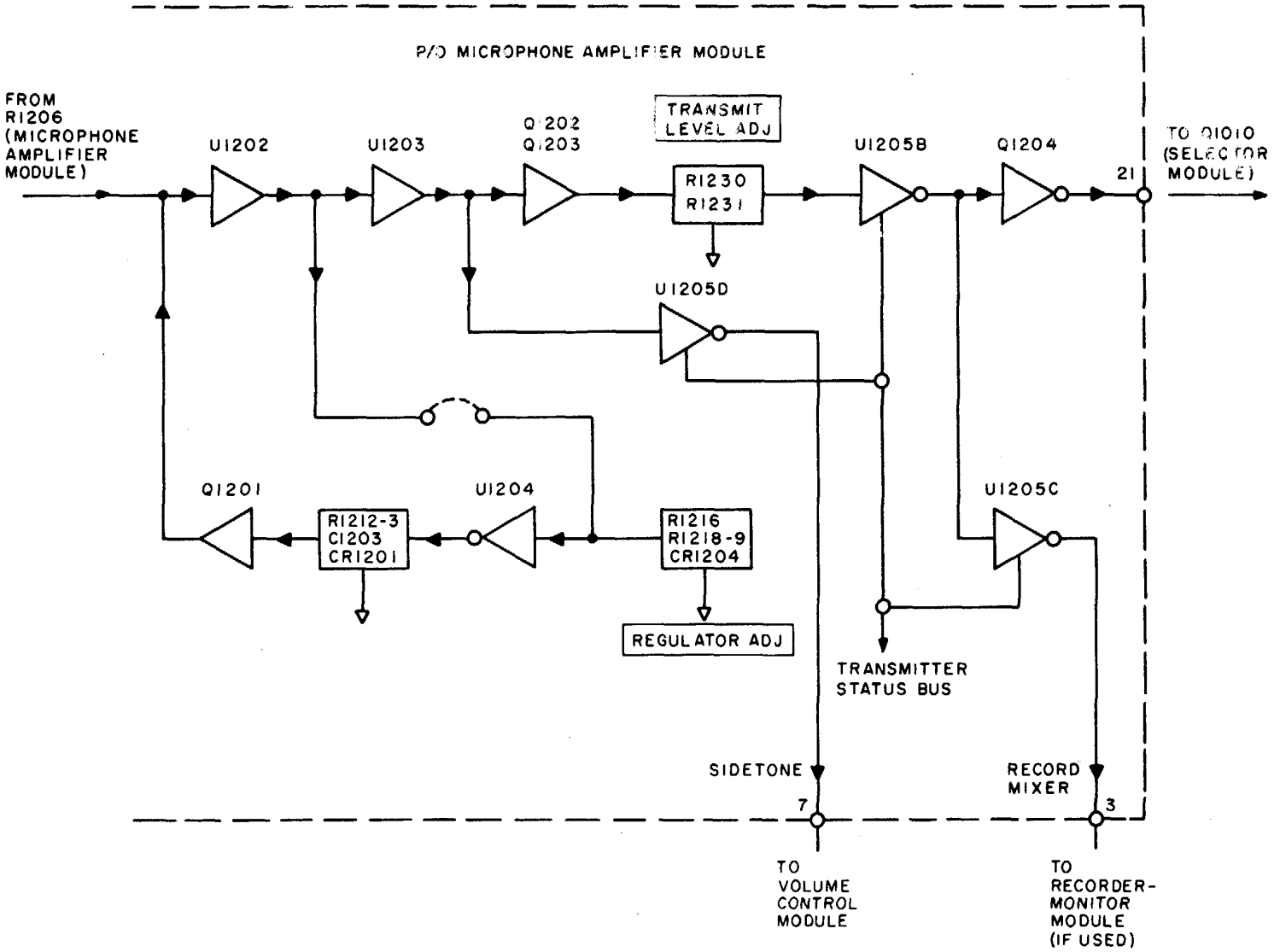

Figure 2-2. Transmit Audio Circuits Functional Diagram (Sheet 2 of 3)

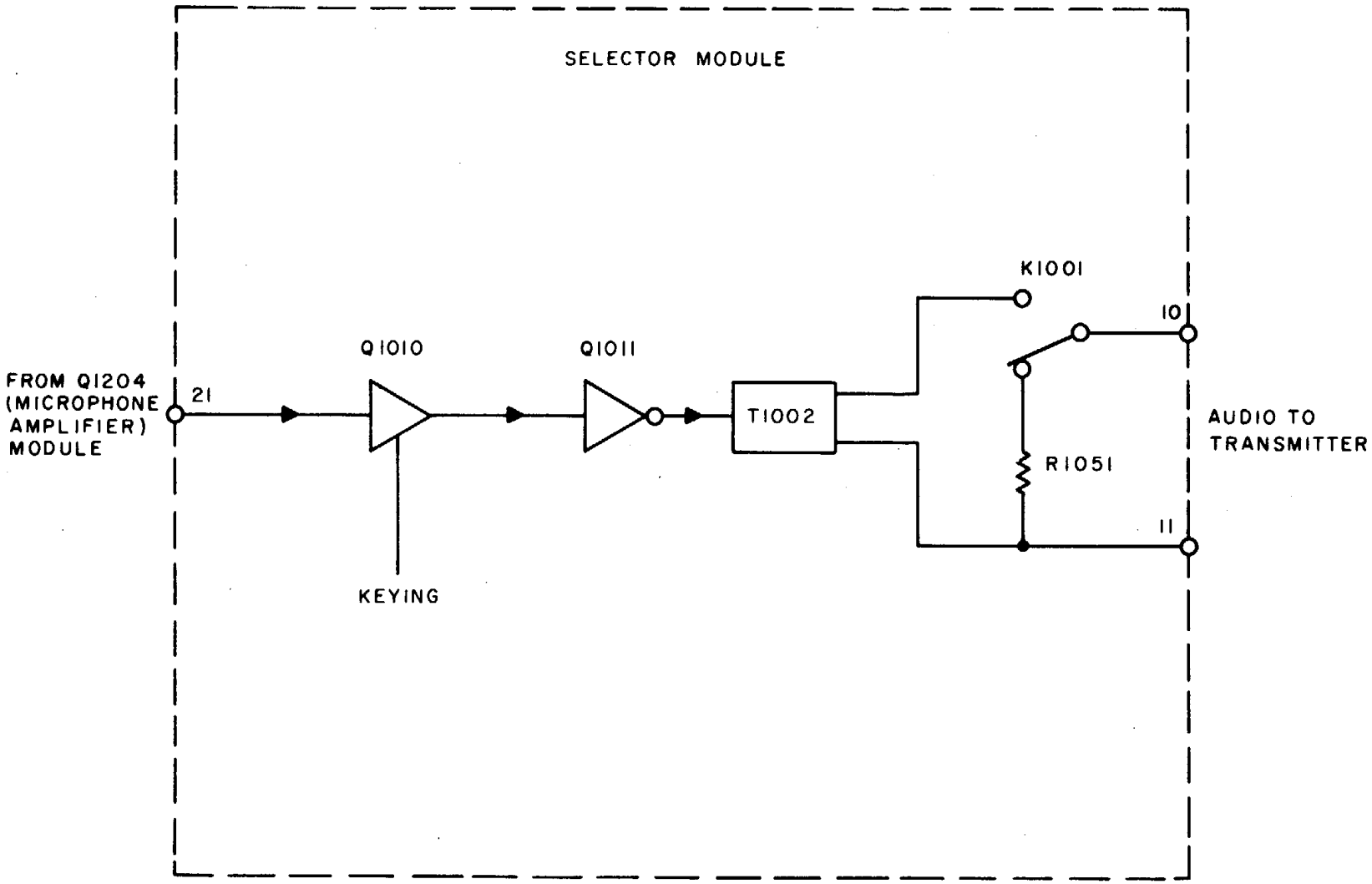

Figure 2-2. Transmit Audio Circuits Functional Diagram (Sheet 3 of 3)

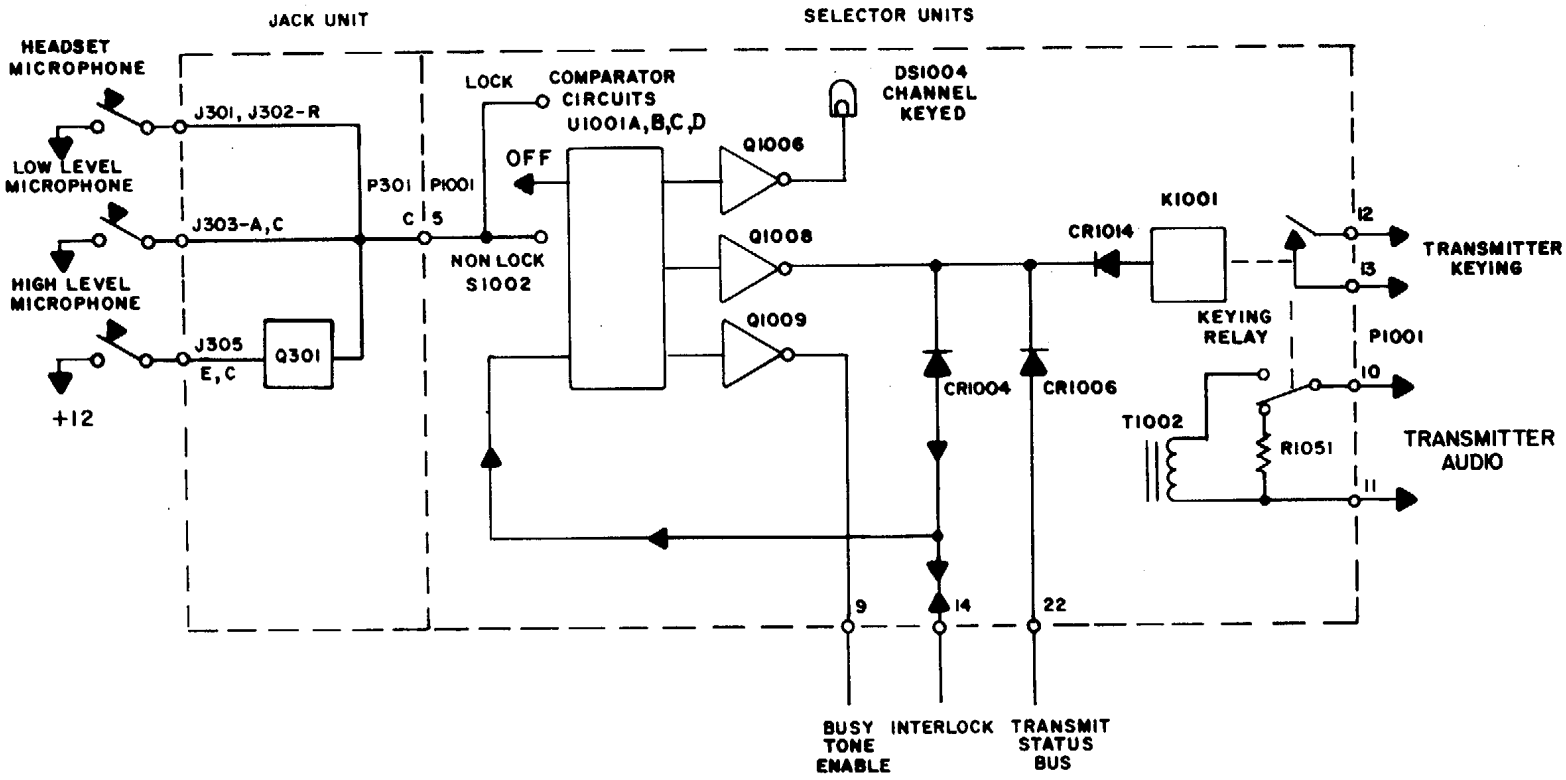

Figure 2-3. Keying and Interlock Functions

the NONLOCK position it must be held to maintain contact. In either case, S1002 must be off the center position before closure of the P/T switch can control the action of U1001. Closing the P/T switch causes the output of U1OO1C to go high if, at the same time, the voltage on the interlock bus is also high. The interlock bus is common to all selector modules and allows no more than one operator to work the transmitter at any time. The interlock bus voltage will be low if another operator has keyed on the transmitter. When the U1OO1C output is high Q1008 conducts, energizing relay K1001. This closes a set of contacts through P1001 pins 12, 13, keying on the transmitter. A second set of contacts on K1001 connects the audio line to the transmitter via T1002 and P1001 pins 10, 11. When the relay is deenergized, the transmitter audio line is connected to 620 ohm terminating resistor, R1051. U10OO1D, B are also high when U1OO1C is high causing Q1006 to illuminate DS1004, the channel keyed indicator and also opening Q1009 which disables the busy tone generator. The function of this generator is to sound a buzz in the operator's headphone only if the transmitter is engaged by another operator.

d. Receiving Circuits. Refer to figures 2-4, FO-1 and FO-2. Voice signal appearing at the channel's radio receiver output, is delivered to the pin pair 15 and 16 of the selector module assembly assigned to this channel at the operator's position. This signal is transmitted via transformer T1001 to a lamp driver circuit consisting of transistors Q1001, Q1003 and Q1004, causing amber indicating lamp DS1002 to flash at a rate comparable to the interval between speech syllables and referred to as the syllabic rate. This gives a visual indication of audio from the receiver, if present. The threshold at which received audio is capable of flashing the lamp may be adjusted through potentiometer R1003. The received signal is also delivered to the HEADSET/LOUDSPEAKER selector switch S1001 via amplifier stages Q1002 and Q1005. S1001 is located on the selector module assembly front panel. This toggle switch is a three position, center-off type which allows the operator to route received audio to either the headset amplifier bus or the loudspeaker amplifier pins. Q1002 is gated by the interlock bus voltage so that received signals are blocked whenever the transmitter of this channel is keyed. The amplifier stages U11O1D and U1105 located in the volume control module, are fed respectively by the headset and loudspeaker amplifier buses. These amplifiers are of the operational type in a fixed gain configuration and are capable of receiving and amplifying the sum of the audio signals delivered from all the selector modules engaged. The total headset audio signal at the output of U1OO01D is fed to amplifier U1102 via a resistor and shunt FET transistor Ql101. The conductivity of Ql101 is controlled by U1104 so that the output remains fairly constant over a wide range of audio input levels. This regulated signal is further amplified by stages U1103, U11O1B, Q1102, Q1103, and Q1104 and fed via pins E and F of connector J101 to the jack panel and to the connected headset. The HEADSET VOLUME control, located on the module's front panel, permits the operator to adjust the headset sound level. The total loudspeaker signal at the output U1105 is adjusted by the SPEAKER VOLUME

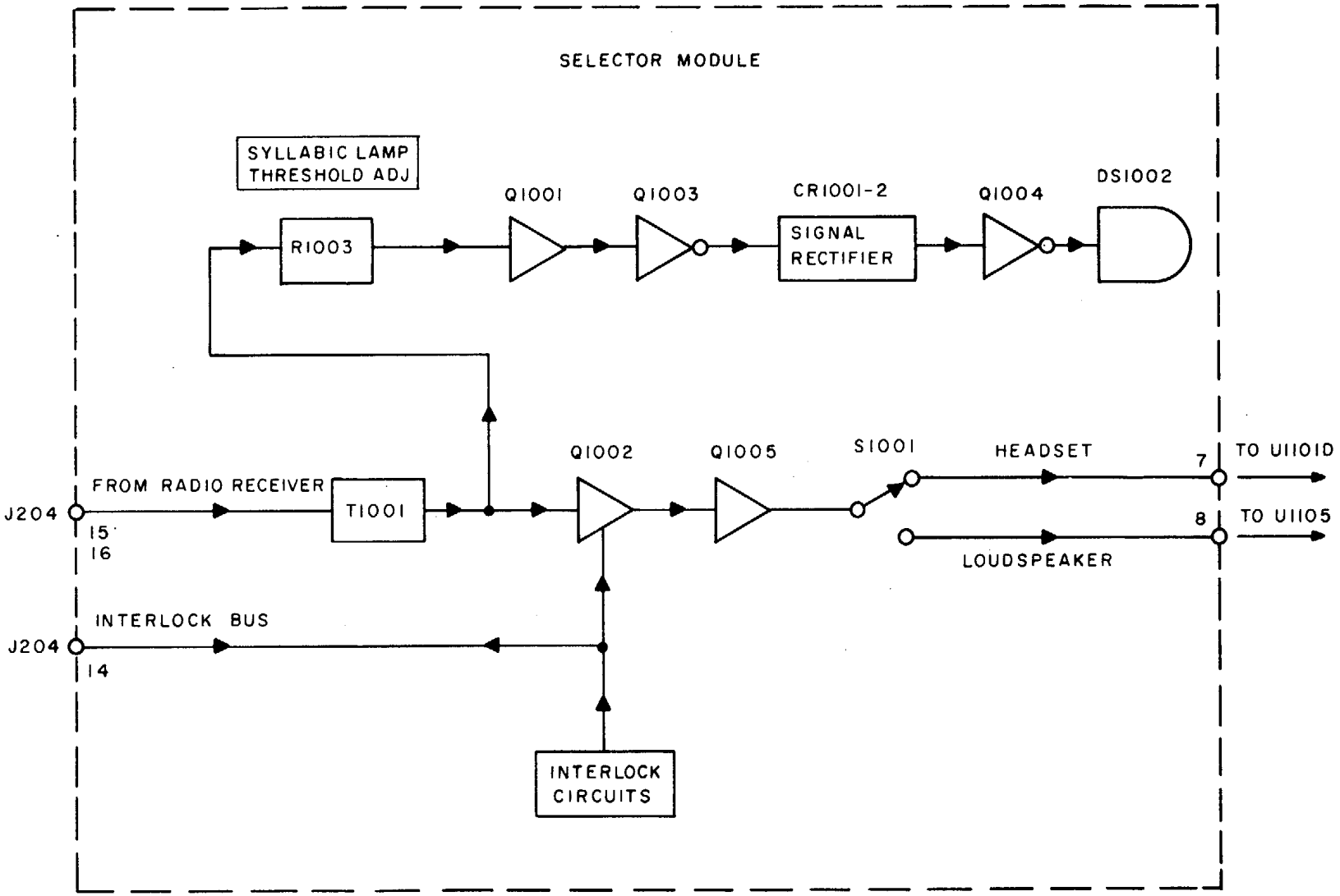

Figure 2-4. Receive Circuits Functional Diagram (Sheet 1 of 3)

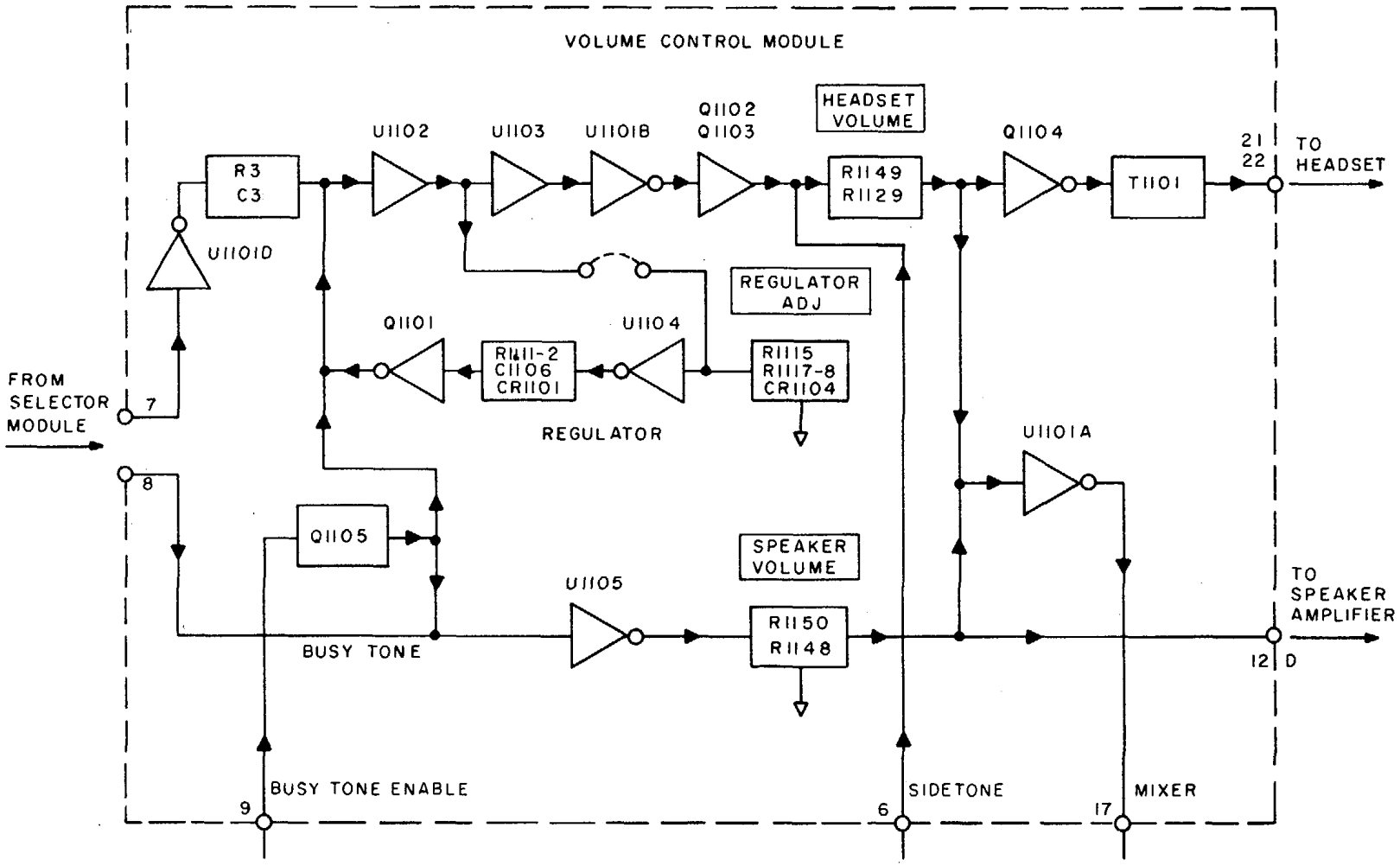

Figure 2-4. Receive Circuits Functional Diagram (Sheet 2 of 3)

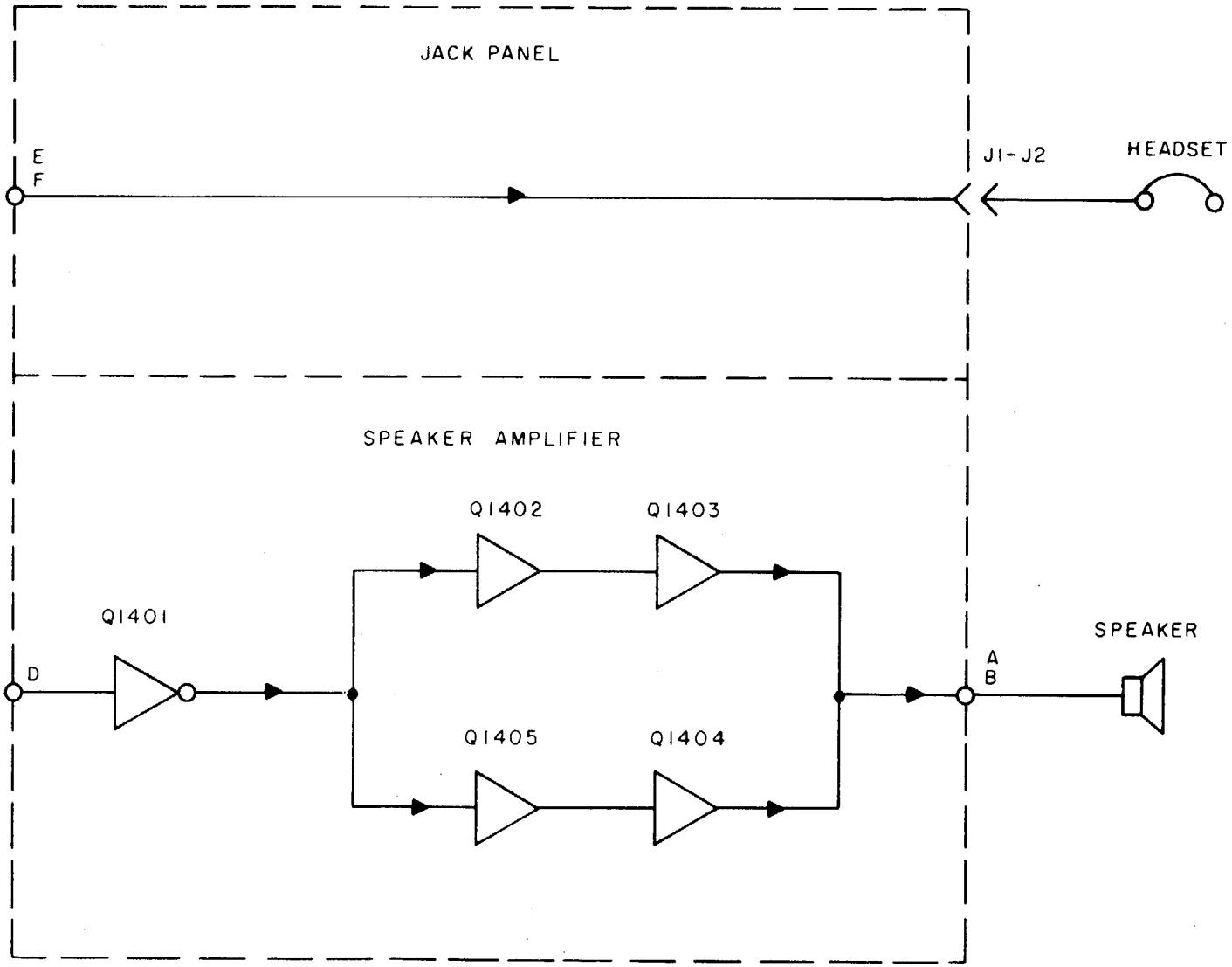

Figure 2-4. Receive Circuits Functional Diagram (Sheet 3 of 3)

control R1150, which is also located on the module's front panel. The signal is then delivered to the audio unit's built-in speaker via the speaker amplifier assembly. This is a separate plug-in assembly located inside the audio unit and consists of a five-transistor power amplifier Q1401 through Q1405. Note that the busy tone oscillator is located in the volume control module and when enabled, injects the busy tone into both U1102 and U1105 insuring the operator receives the tone either in the headset or loudspeaker.

e. Telephone Interface. Connections from the headset amplifier output are brought out to terminal pair E, F of connector J103 for connection to a telephone circuit (if used) carrying this function. Two additional terminal pairs A, B and C, D on J103 are provided for connection of incoming auxiliary signals to the input of the amplifier U1301 in the recorder-monitor module.

f. Recorder-Mixer and Monitor Functions. Refer to figure 2-5. Amplifier U1301 is an operational amplifier connected in a summing (mixing) mode to enable it to receive, in this application, signals from three separate sources and still keep these sources isolated one from the other. These sources are the headset and loudspeaker amplifiers, the microphone amplifier, and two auxiliary inputs (if used). The output of U1301 is delivered via transformer T1803 and pin pair 5, 6 to pins H and J of J104 to which the recorder input terminals are connected. The monitor output terminals of the recorder (not furnished) deliver a replica of the mixer amplifier U1301 output signal being recorded to the input of the monitor lamp driver circuit, Q1301 and Q1303, via J104-B, C and transformer T1303. This signal causes the indicator lamp on the front panel of the recorder-monitor module assembly to flash at a syllabic rate with an intensity corresponding to the input signal level. If not required, the recorder-monitor module assembly may be left out with no effect on system operation.

g. Indicator Lamps. There are three miniature incandescent lamps mounted on the front panel of the selector unit in a multi-section indicator lamp display. These lamps are DS1001 (green), DS1002 (amber) DS1004 (red). At the top left of the display, DS1001 turns on whenever the enabling switch S1002 is positioned either in the LOCK or NONLOCK position. Lamp DS1004 is located in the upper right part of the display. When the interlock bus drops low during channel transmitter keying, DS1004 is turned on. DS1002 occupies the lower left part of the display. This lamp is referred to as the syllabic indicator lamp because the lamp flashes at a slow rate to indicate the presence of incoming audio from the receiver. The lamp intensities are adjustable using the LAMP BRIGHTNESS control mounted on the front panel of the audio unit.

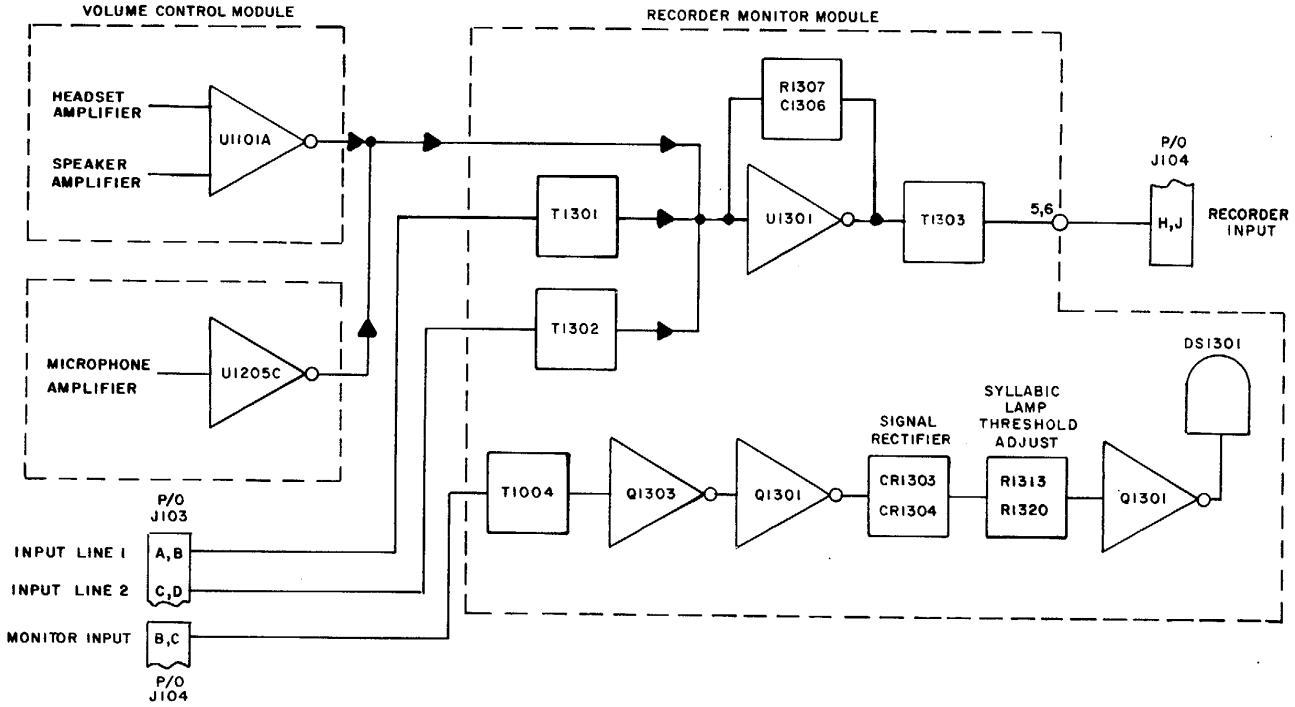

Figure 2-5. Recorder Mixer and Monitor Functions

Section II. DETAILED THEORY OF OPERATION

SECTION CONTENTS

2-3. GENERAL

This section contains the detailed theory of operation of the replaceable units and modules contained in the console. They are the following: headset/microphone jack panel assembly, audio unit assembly, microphone amplifier/lamp brightener module assembly, selector unit assembly, selector module assembly, volume control module assembly, speaker amplifier assembly, and recorder-monitor module.

a. Headset/Microphone Jack Panel Assembly. Refer to figure FO-4. For the sake of brevity, the basic component part numbers are used in place of the actual part numbers. On this unit, the basic number if added to 300, results in the actual part number. Thus, connector P1 is actually P301. The jack panel consists of a panel in which are mounted receptacles for the microphone or headset to be used. The assembly includes a circuit board. The circuit board mates with the audio unit assembly via a cable card connector P1. The connectors and associated circuitry are as follows:

(1) Telephone Jacks J1 and J2. These are standard twin three wire plugs (JAN type PJ-511). The associated circuits are intended for operation with a Plantronics HS-O111 or equivalent headset. Resistor R1 in conjunction with the microphone bias circuits provides a matching 50 ohm load for the microphone. Capacitor C1 prevents the passage of dc from the biasing circuit through R1. Resistors R3 and R4 provide the bias current for the headset microphone. The microphone is connected to the tip terminals, and the earphone to the sleeve terminals of the phonejacks. The twin plug may be inserted either way into J1 and J2.

(2) Connector J3. This is a 5-pin connector for use with an M-80C low level (-50 dBm) microphone which requires no bias current. The microphone connects to the 200 ohm side of the microphone matching transformer T1201 located in the microphone amplifier/lamp brightener module, via J3-D and P1-A. The transmitter keying switch on the microphone connects to J3-A. Pin C is the common return.

(3) Connector J5. This is a 5 pin connector for use with a type NT-409985A or equivalent M-109 headset having a transistor preamplifier and requiring a voltage source for the preamp. The voltage source (+12 vdc) is derived from zener diode CR1 and current limiting resistor R8 connected to the +24 v supply. Decoupling is provided by R7 and C5. Resistor R6 provides the required 30 ohm microphone load while capacitor C4 blocks dc from passing through R6. Connector J5 may also be used with an M-109 microphone equipped with a matching 5 pin connector. Isolation between the high level microphone and the headset microphone as well as attenuation of these microphone signals to the correct level for input to the microphone amplifier circuit is provided by resistor R2 and R5. Capacitors C2 and C3 are dc blocking capacitors. When the keying switch of the transistorized high level microphone is depressed, +12 v is applied to the base of Q1 via R9, saturating Q1 and effectively grounding terminal P1-C.

b. Audio Unit Assembly. Refer to figure FO-6. Connectors J101 through J105, located on the rear panel provide for connection to the headset/microphone jack panel assembly, the selector unit assembly, external telephone circuits (if used), a tape recorder (if used), and the 24 vdc power. Receptacles J106, J107, and J108 are located within the enclosure and mate with the audio unit modules as follows:

(1) Connector J106, located near the loudspeaker, connects to the microphone amplifier/lamp brightener module assembly.

(2) J107 is for a recorder-monitor module (if used).

(3) J108 connects the volume control module assembly.

(4) The speaker amplifier board assembly, not accessible from the front panel as are the other modules, uses connector J109.

DC power is delivered to the audio unit assembly via decoupling resistor R101. Capacitor C103, insures the loudspeaker blocks the dc present at the driver amplifier output. Filter choke L101 and capacitor C101 make a low pass filter which removes any residual noise or hum from the dc supply voltage before it is delivered to the circuits in the various modules. Switch S101 located on the front panel, allows the operator to switch the 24 v power at his position. Indicator lamp DS101 goes on when power is present.

c. Microphone Amplifier/Lamp Briqhtener Module Assembly. See figure FO-8. This module is located in the audio unit enclosure. For the sake of brevity, the basic component part numbers will be used in place of the actual part numbers. On this module, the basic number is added to 1200 to form the actual number. For instance, the module connector

referred to as P1 in this subparagraph, is actually P1201. The following circuits found in this module will be examined in detail:

Microphone amplifier (U1)
Regulated amplifier (U2, U4, Q1)
Buffer amplifiers (Q2, Q3, Q4, U5-B, C, D)
Lamp supply bus regulator

(1) Microphone Amplifier. Refer to figure FO-8. Low level audio signals from the jack panel assembly are supplied via pins 1 and 19 to microphone transformer T1001. Potentiometer R2 provides for adjustment of the level of the signal entering amplifier stage U1 and can supply up to 20 db of signal attenuation. U1 is configured as a non-inverting amplifier with a voltage gain of close to four as set by resistors R4 and R5. The dc output voltage of U1 is +12 v to permit control element Q1 to operate properly.

(2) Regulated Amplifier. Refer to figure 2-6. U2, Q1 and U4 act as an automatic gain control or regulating loop that serves to prevent undesirably large variations in audio output signal fed to the transmitter from the microphone amplifier despite a wide variation in microphone audio input amplitude. R6 and field effect transistor Q1 form a dynamic voltage attenuator. Q1 is operated as a variable shunt resistance, so that its drain to source resistance decreases as the positive dc gate voltage increases. The purpose of U4 is to precisely half-wave rectify the audio signal received via C2, filter the signal after rectification and deliver this positive dc voltage to the gate of Q1. Then, if the U2 output signal attempts to increase because of an increase in microphone audio the drain to source resistance of Q1 is decreased, increasing the attenuation of the R6, Q1 divider. The net result then, is the regulator circuit maintains the U2 audio output fairly constant. Diode CR2 supplies the half-wave rectification so that only positive excursions appear at the U4 output. Capacitor C3 and resistor R12 filter this rectified output providing smooth dc to the gate of Q1. Resistor R18 is a threshold control which provides a maximum positive bias voltage of 7 vdc on the Q1 gate in the absence of signal. This voltage determines the level of signal at which the regulator circuit becomes effective. The smaller the bias voltage the greater the signal level is required before Q1 attenuator action is initiated, and the regulator circuit becomes activated. Note that the filter capacitor C3 is allowed to charge much faster (through R13) than it can discharge (through R12). This prevents any significant decay of voltage on the capacitor between spoken words which would have the effect of increasing the noise level in the audio circuit since the gain of the regulator would increase between spoken words.

on those installations where the speech regulator action is not desired the jumper between E21 and E22 may be removed.

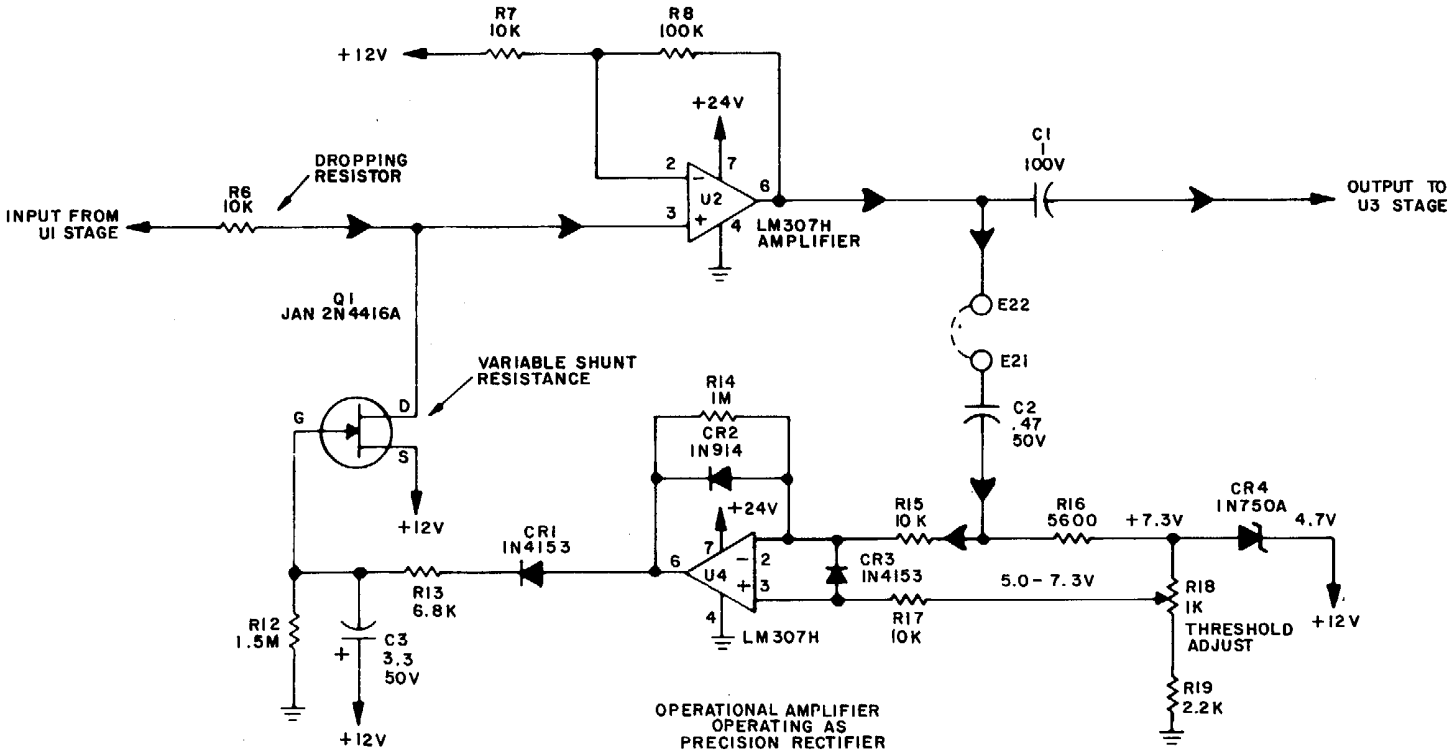

Figure 2-6. Regulator Circuit

(3) Buffer Amplifiers. Refer to figure FO-8. The regulated audio signal is fed to amplifier U3 which has a non-inverting gain close to 20 as set by the complementary pair Q2, 03. This complementary emitter follower is used to set the module's audio output level. One audio signal path bypasses Q2, Q3 and potentiometer R30. Buffer amplifier U5D receives the regulated audio out of U3 directly. U5D has unity gain, and its output is fed to the headset amplifier as a sidetone signal. Resistor R23 serves to isolate the output of U5D from the headset amplifier in the volume control module.

(4) Amplifier U5B is another buffer amplifier (gain is less than unity). The output of U5B is ac coupled to driver stage Q4 and another buffer amplifier U5C. Q4 is a PNP transistor operated as a common emitter with the collector load resistor R38, grounded. The regulated audio output of Q4 is sent to the selector unit via connector P1-21. The output of U5C is sent to mixer amplifier U1301 in the recorder-monitor module via isolating resistor R42 and P1-3. Note that all three buffer amplifiers U5B,C,D, are gated by the transmitter status bus signal. When the bus is high, indicating the transmitter is not keyed on, the 24 v bus level is brought directly to the non-inverting inputs of amplifiers via CR6 and CR7. This forces each of the three outputs to cut-off (+24 v) or a gated off condition. When the bus drops low (transmitter keyed on) then the amplifier outputs will drop below 24 v and the amplifiers are gated on. Bias current is drawn through the 2.2 megohm resistors R24, R34 and R41 into the respective non-inverting terminals which forces the amplifier outputs below 24 v, back into their active region.

(5) Lamp Supply Bus Regulator. Refer to figure FO-8. Transistor Q5 is an emitter follower whose base voltage may be varied between +12 and +24 v by LAMP BRIGHTNESS control potentiometer R43. The emitter voltage is distributed via P1-35 and the lamp load bus, to the various selector modules to be used for the indicator display lamps. Transistor Q5 also furnishes lamp current to DS1301, the syllabic indicator in the recorder-monitor module.

d. Selector Unit Assembly. This unit is the same size as the audio unit assembly for installation into the console. The unit contains one air selector module assembly and seven blank panels. The positioning of the polarizing pins prevents installation of any audio unit modules into the enclosure. The schematic diagram of the selector unit assembly is shown in figure FO-15. This unit houses one selector module assembly and engages one only of the receptacles J204 through J211, located within the enclosure. Pins 3, 4, 5, 7, 8, 9, 19 through 23, and 26 of these receptacles carry power, supply, control or signal functions common to both the selector module and the audio unit assembly. These functions are bussed to the interunit cable, extending from the rear panel of the unit and terminate at connector P204. From the pin group, 10 through 16, on the module receptacle, connections are extended to pin groups on receptacles J201 and J202, so that individual radio channel functions provided

by the selector module assembly may be accessed by the radio channel equipment. J201 and J202 are identical receptacles each having 32 contacts arranged in a 2 x 16 array. This array is divided along its length into four 2 x 4 contact groups which for purposes of identification shall be referred to as Group I, II, III and IV. Group I contains contacts 1 through 4 and 17 through 20. Group II contains contacts 5 through 8 and 21 through 24. Group III contains contacts 9 through 12 and 25 through 28. Group IV contains contacts 13 through 16 and 29 through 32. Seven conductors extending from the module receptacles to each contact group carry the transmitter audio pair, the receiver audio pair, the transmitter keying pair and the interlock bus conductor. Because of its small size and short cable runs therein, the audio pair of the wiring within the selector unit assembly are twisted but not shielded. Therefore, there is no connection present to the eighth contact of each group (2, 6, 10 and 14). These contacts are used, however, in the mating connectors of the interposition cable assembly to carry through connections from the shields surrounding the audio pairs of the cables to suitable terminators at the radio channel equipment.

e. Selector Module Assembly. Refer to figure FO-17. For brevity of discussion the basic component numbers shown on the diagram will be used, although their actual designation numbers are the basic numbers added to 1000 so that module plug shown as P1 is actually P1001. Power supply voltage from the audio unit assembly is delivered unfiltered to pin P1-3 and via the audio unit's filter to pin P1-23, with returns for the unfiltered and filtered supply loops brought to pins P1-20 and P1-19. This serves to isolate fluctuations of power supply current, caused by operation of lamps and relays from the amplifier supply buses, minimizing noise in the audio circuits. On the module front panel are two switches and a multisection indicator light. Switch S1 is a three position toggle switch which is off when in the center position. It can be set to the upper or lower position to route received audio signals to the loudspeaker or headset amplifiers. Switch S2 is a three-position toggle switch which is off when in the center position. It can be set in the upper LOCK position to enable selection of the channel controlled by the module. It can be moved downward to NONLOCK to accomplish the same function but it will not lock there, and returns to center as soon as the handle is released. The remaining circuits in this module perform the following functions: lamp display, audio signal circuits, syllabic indicator lamp driver, and interlock circuits.

(1) Lamp Display. Refer to figure 2-7. Three lamps are located in the indicator assembly. One illuminates the green quarter-section, one illuminates the red-quarter-section and one illuminates the amber lower half-section. Transistor Q7 is an emitter follower which supplies current to the lamps at a voltage which is established by the setting of the brightness control of the microphone amplifier/lamp brightener module assembly in the audio unit assembly. The range of the lamp voltage is

approximately 12 to 22 volts, suitable for ambient light conditions ranging from darkness to daylight. The green lamp DS1 is illuminated whenever switch S2 is moved to the LOCK or NONLOCK positions; the amber and red lamps, DS2 and DS4, are illuminated by the conduction of transistors Q4 and Q6 respectively. In the absence of conduction through the switch or transistor Q6, resistors R29 and R28 allow backlighting current to flow through lamps DS1 and DS4. This current causes the lamps to glow dimly with respect to their intensity when actuated, but the dim glow is sufficient to facilitate location and identification of the selector module in darkness.

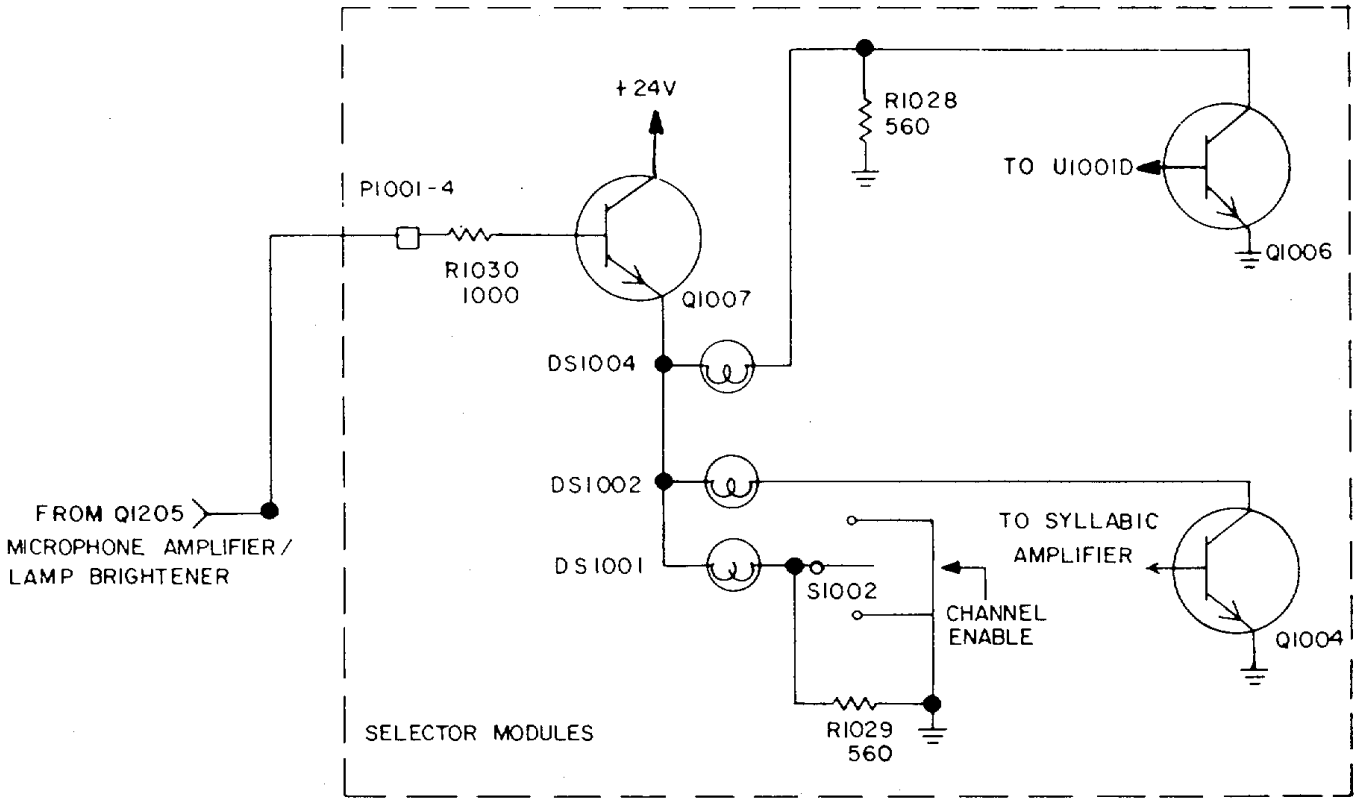

Figure 2-7. Indicator Lamp Circuits

(2) Audio Signal Circuits (Transmitting). Refer to figure FO-17. The regulated microphone signal distributed from the audio unit assembly to P1-21 is coupled to emitter follower stage Q10, which in turn drives Q11, whose output resistance is a nominal 600 ohms, due to resistor R37. This signal is supplied via transformer T2 to P1 pins 10, 11 via a form C contact set of the relay K1. When the operator is transmitting, K1 is energized, completing the circuit through normally-open contact. Otherwise, the transmitter audio line is terminated by resistor R51 through the normally-closed contact. It is wired to a pair of terminals rather than the printed wiring of the circuit board.

(3) Audio Signal Circuits (Receiving). Refer to figure FO-17. Signals from the channel receiver enter at pins P1-15, 16 and are coupled via transformer T1 and capacitor C2 to JFET transistor switch Q2 which, when its gate voltage is high (+12 v) is turned on and passes the signal onto the base of transistor Q5. The gate voltage is controlled by the interlock bus at P1-14 which is low when the channel's transmitter is being keyed. If keying is taking place, received signals are blocked by Q2. The output of Q5 is then fed, via capacitor C7 and resistor R22, to the arm of switch S1 which may be set to deliver the resulting signal current to either the headset amplifier bus at P1-7 or the loudspeaker amplifier bus at P1-8.

(4) Syllabic Indicator Lamp Driver. Refer to figure FO-17. Received signals present at pins P1-15, 16 are also fed to buffer amplifier stage transistor Q1 via adjustment potentiometer R3 which permits as much as 20 dB of attenuation to be introduced. The output of transistor Q1 is coupled via capacitor C3 to emitter follower Q3. The lamp driver transistor Q4 is biased just below the threshold of conduction by R16 and R17. When the signal level becomes sufficient to cause conduction of diode CR2 on the positive excursions of the Q3 collector voltage, capacitor C5 receives additional charge, and the base current of Q4 increases. This causes the lamp DS2 to glow perceptibly. On the negative excursions of the Q3 collector signal voltage, capacitor C4 receives charge through CR1 in such a direction as to further increase the base current of Q4. The diodes CR1, CR2 and capacitor C4 thus provide a voltage doubler action which increases the DS2 lamp intensity to a clearly visible level during the presence of receiver audio. Increased signal levels cause a corresponding increase in lamp intensity up to a point where Q4 saturates and the lamp is at full intensity. Potentiometer R3 determines the audio signal level required to bring the lamp to full brightness. The term syllabic rate derives from the fact that capacitor C5 charges to a peak value during the presence of receiver audio roughly coincident with the presence of syllables of speech and then discharges quickly through R17 and the base of Q4, the visible effect in the lamp appearing to flash at a syllabic rate.

(5) Interlock Circuits. Refer to figure 2-8. When switch S2 is moved to either the LOCK or NONLOCK position, the push-to-talk bus at P1-5 is extended to operational amplifier stages U1B and U1C. These stages are operated without feedback. Under this condition, small differences in current at the two input terminals causes the output to swing either to ground or +24 v level. That is, these devices now operate as comparators. When there is no path to ground on the P/T bus the (-) input terminals of U1B and U1C receive more bias current than do the (+) terminals. The result is, the outputs of these amplifiers are forced low (zero volts) and the transistors Q8 and Q9 driven by these outputs, remain off. The busy tone is disabled and the transmitter status bus remains high, both of which are consistent with an open path through either S2 or the P/T switch. If we now close S2 and ground the P/T bus

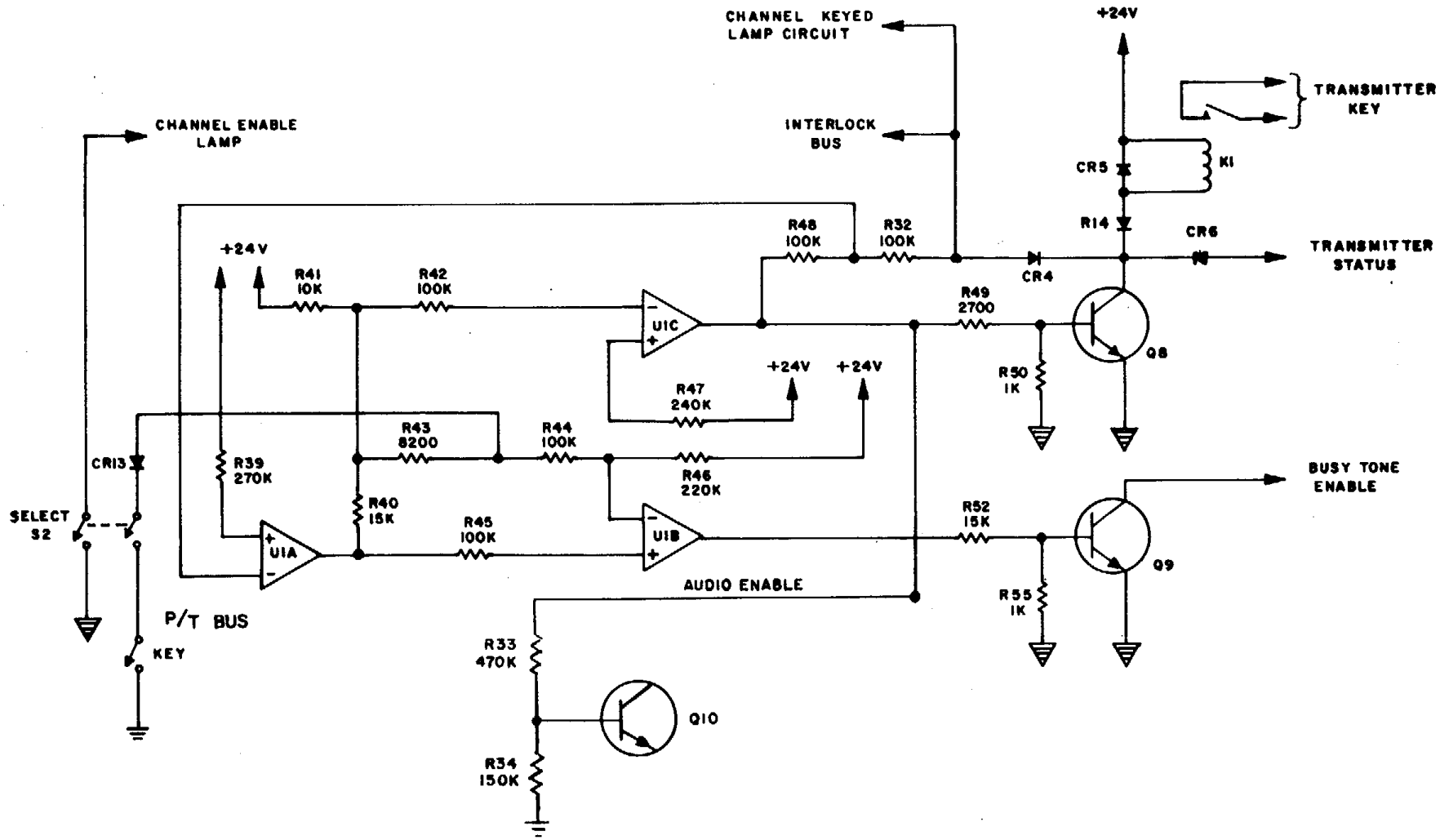

Figure 2-8. Keying Interlock Circuit.

(through the P/T switch) and at the same time the interlock bus is high the current into the (-) terminal of U1A is predominant, forcing U1A output low. Now the junction of R43 and R44 is low as well as the U1 output. As a result the current into the (-) terminal of U1C is reduced below that into the (+) terminal so U1C output goes high. Also, since R45 is now returned to ground potential through the U1A output, U1B output goes low. These conditions result in Q8 turning on and Q9 remains off. This is consistent with the initial conditions stated, the interlock bus high (transmitter not engaged by any other operator) but S2 and the key switch both closed which should and does result in busy tone disabled and transmitter status bus low. Note that K1 is energized which enables both transmitter keying and the transmitter audio output line. The high interlock bus and the low transmitter status bus enables the microphone audio signal path to the transmitter. If the interlock bus is low when S2 is closed and the P/T bus is grounded, U1A output is forced high. This in turn forces more current into the (-) terminal of U1C through R42 so the U1C output drops low. With U1A output high, 1B output is also forced high. These conditions result in Q8 off and Q9 on which corresponds to transmitter status bus high and busy tone oscillator enabled. This is consistent with the initial conditions stated. At the volume control module the low on Q9 collector will allow busy tone oscillator to turn on generating a tone that warns the operator the transmitter is already engaged. The low interlock bus and the high transmitter status bus keeps K1 de-energized and also blocks the microphone audio. The logic of the interlock circuit is represented by an equivalent logic circuit shown in figure 2-9 where the U1A,B,C amplifiers are shown as NOR gates and Q8 and Q9 are replaced by inverters. The bubble on one input to U1B represents an inversion of logic state of any input passing that point. Lamp DS4 turns on when the transmitter is keyed on by any operator. When either the interlock or transmitter channel status bus is low U1D output goes high saturating Q6 and providing full lamp current for DS4.

f. Volume Control Module Assembly. Refer to the schematic diagram of figure FO-10. This module is contained within the audio unit enclosure. For this module, the actual component designations are the basic numbers shown on the diagram, added to 1100. Thus, the module plug shown as P1 is actually P1101. For brevity of discussion, the basic numbers will be used. Power for this module is delivered from the lamp brightener module assembly to pin 3 of P1 via the filter choke and capacitor L101 and C101. Power is returned on pins P1-5 and P1-20. The volume control module contains the following circuits: headset and loudspeaker summing amplifiers, regulated amplifier, headset driver amplifier, and busy tone oscillator.

(1) Headset Summing Amplifier. Refer to figure 2-10. The total of the received audio signal currents that are routed by various selector modules to the headset amplifier bus which enters this module at P1-7 are

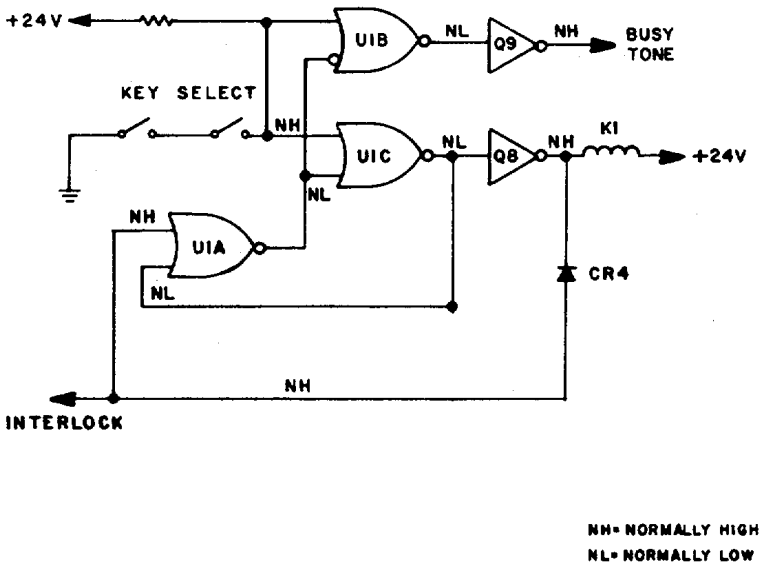

Figure 2-9. Interlock Logic Equivalent Circuit

matched at every instant by a current fed back from the output of operational amplifier stage U1D via resistor R2 to the inverting input terminal Ul-l1 of the operational amplifier. This terminal is thus maintained at a virtual null and thereby maintains at least 50 dB of isolation between the various selector modules connected to this point, preventing crosstalk between them. The audio voltage at the output of the operational amplifier U1D, being proportional to the current through resistor R2, represents the sum of all received signals contributing to the headset amplifier bus. Capacitor C2 in parallel with resistor R2, reduces the closed loop gain at frequencies beyond those handled by the channel radio equipment. Operational amplifier U1D is biased sufficiently to accommodate the largest expected signal excursion by the current through resistor R1.

(2) Loudspeaker Summing Amplifier. Refer to figure 2-10 and FO-10. U5 is an operational amplifier, wired in the inverting configuration, which functions the same way as operational amplifier stage U1D described in the headset summing amplifier. The total of the received signal currents that are routed by the various selector modules to the loudspeaker amplifier bus which enters this module at P1-8 are matched at every instant by the current fed back from the output through resistor R44. Consequently, the inverting output terminal is held at a virtual null, providing isolation between the various selector modules feeding this point, while the audio voltage at the output of operational amplifier U5 represents the sum of these signals. The quiescent voltage of this stage is held at +12 volts by the biasing network resistors R42, R45 and capacitor C21 to which the input resistors R43 and R46 are returned. Capacitors C22 and C24 serve to limit the open-loop and closed-loop gain at

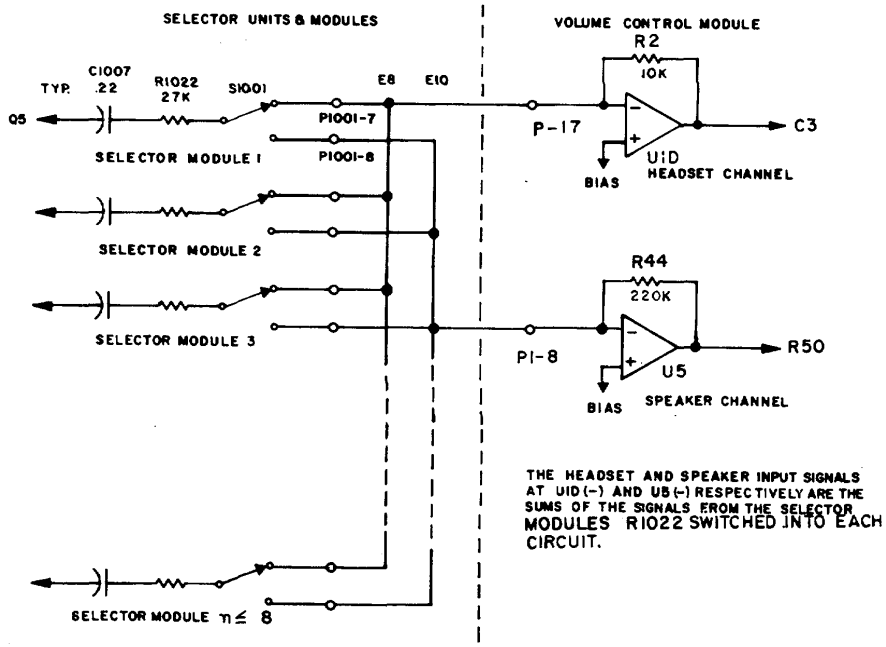

Figure 2-10. Summing Circuits in Speaker & Headset Amplifier Inputs

high frequencies. The output of operational amplifier U5 is then coupled via SPEAKER VOLUME control resistor R50, which provides for a 20 dB signal reduction when fully counterclockwise. Signals picked off the arm of resistor R50 are fed via capacitor C25 to pin 12 of connector P1 for input to the speaker amplifier board assembly. Resistor R47 is part of the input biasing network. The SPEAKER VOLUME control also supplies current through a second input resistor R32 to the summing point of operational amplifier U1A whose output, representing the sum of loudspeaker and headset signals, is fed via resistor R35 and pin 17, to the recorder circuits, if used.

(3) Regulated Amplifier. Refer to figure FO-10. The volume control module contains a regulated amplifier consisting of U2, U4, Q1, R3 and associated components. This amplifier is identical in performance to the regulated amplifier previously described in the paragraph on the microphone amplifier/lamp brightener module in this section.

(4) Headset Driver Amplifier. Refer to figure FO-10. The regulated signal at the output of operational amplifier U3 is fed to an

inverting operational amplifier stage U1B which in turn drives complementary emitter follower pair transistors Q2 and Q3. This latter stage provides a signal to the HEADSET VOLUME control potentiometer R49 which is located on the front panel. Resistor R49 is also fed with the sidetone signal current originating at the lamp brightener module assembly and entering on pin P1-6. This sidetone signal level is nominally -25 dBm. The signal picked off by resistor R49 which can be reduced as much as 20 dB when the control is fully counterclockwise, is then fed to two additional stages. One is Q4 which is a conventional class A transistor amplifier with a gain of unity when the transformer is terminated by the headset or any 600 ohm load. The second stage fed by the VOLUME CONTROL resistor R49 is U1A, an inverting operational amplifier stage which in turn supplies a signal current via resistor R35 and pin P1-7 to the recorder circuits, if used.

(5) Busy Tone Oscillator. Refer to figure FO-10. When the busy tone enable bus is driven low by the Q9 in the selector module assembly, the oscillator circuit consisting of resistors R26, R27, R28, and capacitor C13, and transistor Q5 is provided with a ground enabling it to operate. Q5 is a unijunction transistor and its negative resistance characteristics are utilized here. When the voltage at the emitter (E) with respect to base No. 1 (B1) is less than about 65% of the supply voltage to base No. 2 (B2), no current flows through the emitter, and capacitor C13 is charged up by current flowing through resistor R26. When the voltage reaches the 65% point (the standoff ratio) heavy conduction from (E) to (B1) is initiated, discharging C13 very rapidly until the voltage on C13 drops to 2 v at which time the emitter to base 1 path reopens and C13 proceeds to recharge to about 17 v (65% point). The resultant voltage waveform between emitter and ground is a sawtooth waveform with a steep falling slope. The period is determined by the time constant of resistor R26 and capacitor C13 and the standoff ratio. A busy tone of approximately 800 Hz is produced when the enable bus is grounded. Resistor R28 limits the peak current flow during discharge of capacitor C13 to safe values for the junction; resistor R27 is provided to limit current flow from the supply to (B2) during these breakdown periods. The sawtooth voltage is coupled to the input points of both the headset and speaker amplifiers by resistors R25 and R36 so that the busy tone will be heard regardless of which amplifier is being used.

g. Speaker Amplifier Assembly. Refer to the schematic diagram, figure 2-11. This assembly is contained within the audio unit enclosure. For this board, the actual component designation numbers are the basic numbers, shown on the diagram, added to 1400. Thus, the input transistor shown as Q1 is actually Q1401. For brevity of discussion the basic number will be used. Power is delivered to contacts F and H via resistor R101 (fig. FO-6) and returned via contacts K and L. Capacitor C1 on the module, in conjunction with resistor R101 (fig. FO-6), filters the

supply voltage and minimizes the effect on other circuits by supply current fluctuations in the output stage. A description of both input and output stages follows.

(1) Input Stage. Transistor Q1 is a class A amplifier whose base biasing network is completed to ground at contact D by resistor R1147 of the volume control module assembly when the latter is installed. Without the latter in place, transistor Q1 is cut off and no voltage appears at its collector to provide drive for the output stage. With resistor R1147 in the circuit, current flowing through resistor R1 through resistor R5 and R6 produce approximately 12 volts at the collector of transistor Q1.

(2) Output Stage. Output transistors Q3 and Q4 are arranged in a quasi-complementary configuration. When the collector of transistor Q1 is quiescent, the Darlington pair transistors Q2 and Q3 hold the output (contacts A and B) at about +11 volts. A capacitor in the audio unit enclosure is in series with the loudspeaker so no dc flows through the loudspeaker. Under quiescent conditions only a minimal current flows through resistor R5 and R6. Any tendency of this current to increase tends to cut off transistor Q5 and is then counteracted by the reduced base current supplied to transistor Q4. Diode CR1 compensates for the base-emitter drop of transistor Q5. When signal appears, positive swings at the collector of transistor Q1 cause transistor Q3 to conduct and "pull up" the output, driving current through the speaker via capacitor C103 (fig. FO-6). Since capacitor C103 is large, it does not charge up appreciably, even at the lowest voice frequencies, before the transistor Q1 collector swings below its quiescent point. This tends to cut off transistor Q2 and transistor Q3 but at the same time transistor Q5 is enabled to conduct. This, in turn, causes strong conduction of transistor Q4 whose collector "pulls down" the output, reversing the current in the speaker. The loudspeaker thus reproduces the audio signal arriving at the input.

h. Recorder-Monitor Module. Refer to figure FO-13. This module when present is contained in the audio unit enclosure. For this module, the actual component designation numbers are the basic numbers shown on the diagram added to 1300. Thus the module plug, shown as P1, is actually P1301. For brevity of discussion the basic numbers will be used. Filtered +24 vdc power is delivered from the microphone amplifier/lamp brightener module to P1-3 via L101 and C101 in the audio unit enclosure. The filtered 24 v return is brought to P1-20. Variable lamp voltage from the microphone amplifier/lamp brightener module is brought to P1-4.

I. Monitor Lamp Driver. Signals from the external recorder are delivered to the monitor input terminals P1-1 and 19 and are subsequently fed to class A amplifier stage Q3 via transformer T4. R9 maintains the overall input impedance to this circuit at approximately 600 ohms. The output from Q3 is fed to the base of Q1 which, in the absence of signals from T4, is continuously biased to saturation by current supplied from

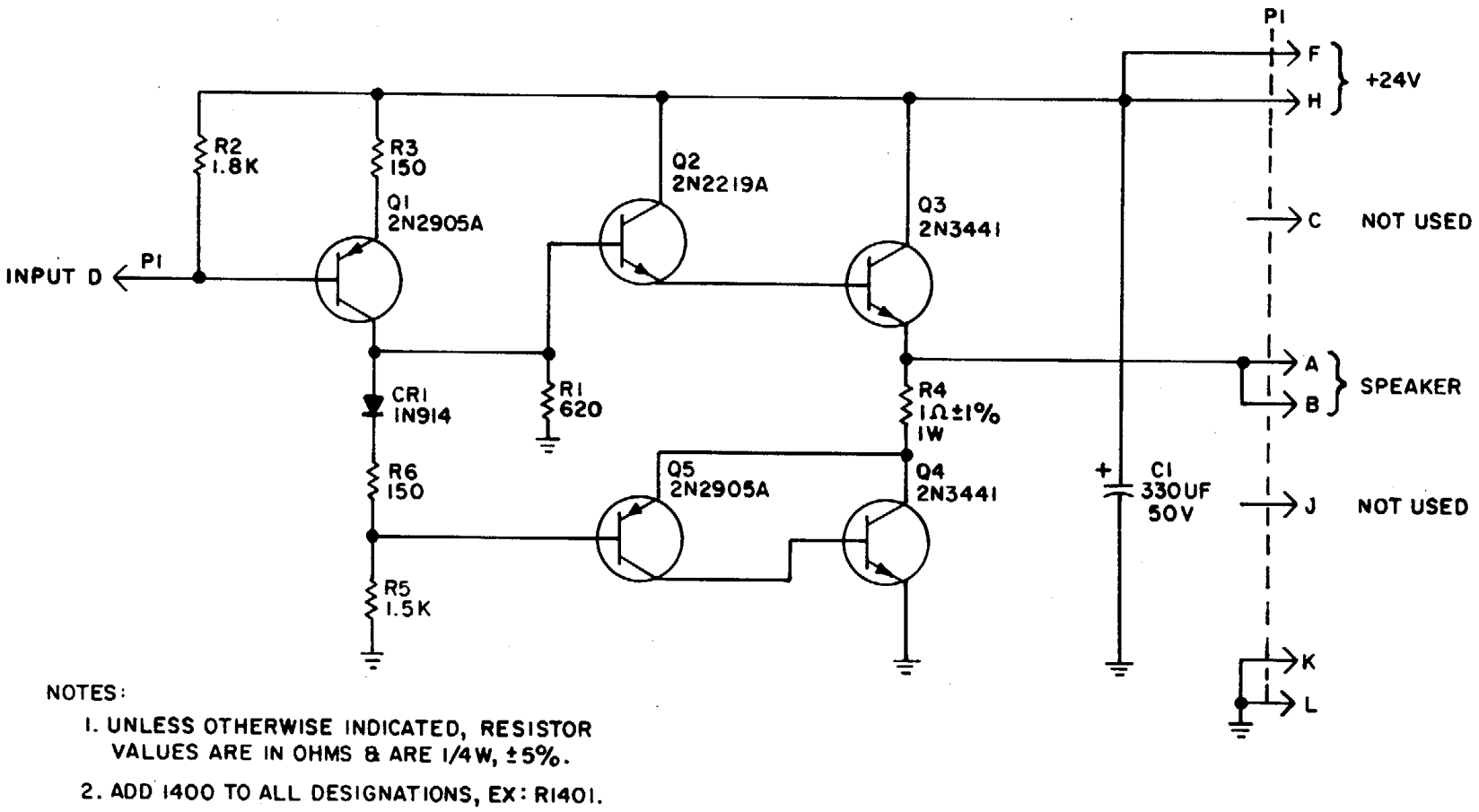

Figure 2-11. Speaker Amplifier Schematic

the 24 volt supply through R10. The lamp driver transistor Q2, is supplied with just enough base current in the absence of a signal from T4 to bring it up to, but not over, the threshold of conduction. Lamp DS1 thus remains dark. When the signal level at the input of T4 reaches or exceeds -30 dBm, however, Q1 is driven out of saturation during the negative half-cycles. The voltage variations appearing at the collection of Q1 are detected by the voltage-doubler circuit consisting of C3, C8, CR3 and CR4. This delivers additional current to the base of Q2, causing the lamp to glow perceptibly. Increased signal levels drive Q2 toward saturation, so that signal levels of -10 dBm cause the lamp to glow at the fullest brilliance permitted by the voltage present on the lamp bus. The threshold level for perceptible glow may be set by adjusting syllabic lamp threshold adjust R13. Capacitor C3, once charged, holds its charge between successive audio cycles, but this charge decays quickly compared to typical time intervals between syllables of speech, so that the lamp flashes at a syllabic rate.

CHAPTER 3

SERVICE UPON RECEIPT AND INSTALLATION

Section I. SERVICE UPON RECEIPT

SECTION CONTENTS **Page**

3-1. UNPACKING

Unpack the Radio Channel Control equipment, insuring that no damage or indentations have occurred in transit. Unpack the equipment on a level surface being careful not to drop the unit.

CAUTION

Any sudden or severe jarring of the equipment may possibly damage or detune sensitive circuits contained in the console.

3-2. CHECKING UNPACKED EQUIPMENT

a. Inspect the equipment for any damages incurred during shipment. If the equipment has been damaged, report the damage on SF 364.

b. Check the equipment against the component listing in the operator's and organization maintenance manual, TM 11-5895-1141-12, and the packing slip, to insure the shipment is complete. Report all discrepancies in accordance with the instructions in TM 38-750. The equipment should be placed in service even if a minor assembly or part that does not affect proper operation is missing.

c. Check to determine whether the equipment has an MWO number on the front panel, near the nomenclature plate. Also check if all currently applicable MWO's have been applied. Current MWO's applicable to the equipment are listed in DA PAM 310-4.

Section II. INSTALLATION INSTRUCTIONS

SECTION CONTENTS **Page**

3-3. SPECIAL TOOLS AND EQUIPMENT

There are no special tools or test equipment required for installation of the radio channel control.

3-4. INSTALLATION

The radio channel control is equipped with a headset/microphone jack panel assembly located below the audio and selector units. The audio unit assembly is located on the left side of the console front panel opening. The selector unit assembly fills the right side of the opening. The units are supported by angle brackets, slotted screws are supplied to be used for securing the units to the console. Place the screws through the corner mounting holes in each unit, the insert them into the console chassis captive nuts and tighten.

3-5. EQUIPMENT INTERCONNECTIONS

Installation consists of making connections between the equipment and the outside lines to the radio transmitters and receivers and then connecting the equipment to the +24 volt dc power supply source. See figure 3-1. If a recorder is to be used, it is connected to J104; the connections will be found in figure FO-6. There are two options for connecting the transmitter/receiver lines to the equipment; one requiring four wires per channel, the other six wires. In the four wire mode, jumpers are connected from terminals E15 to E16, E50 to E49, and E51 to E48 on selector unit assembly circuit board, figure FO-12. In this mode, the transmitter audio wire pair is operated in a phantom mode, the center tap of the output transformer T2 being grounded by keying relay K1 to the transmitter. The equipment is shipped, wired in the four wire mode. In the six wire mode, a separate pair of wires is used for keying the transmitter. The transmitter/receiver wires are connected to connectors P201 and P202 which mates the connectors J201 and J202 on the rear of the selector unit assembly. Up to eight channels may be accommodated and the channels to be used are connected in accordance with table 3-1. A radio channel selector module SA-2328/FRC is inserted in the selector unit assembly for each channel, any unused positions being covered with a blank panel. External power supply connections are made to connector J105 on the back of the audio unit assembly. Mating plugs P103, P104, P105 are furnished

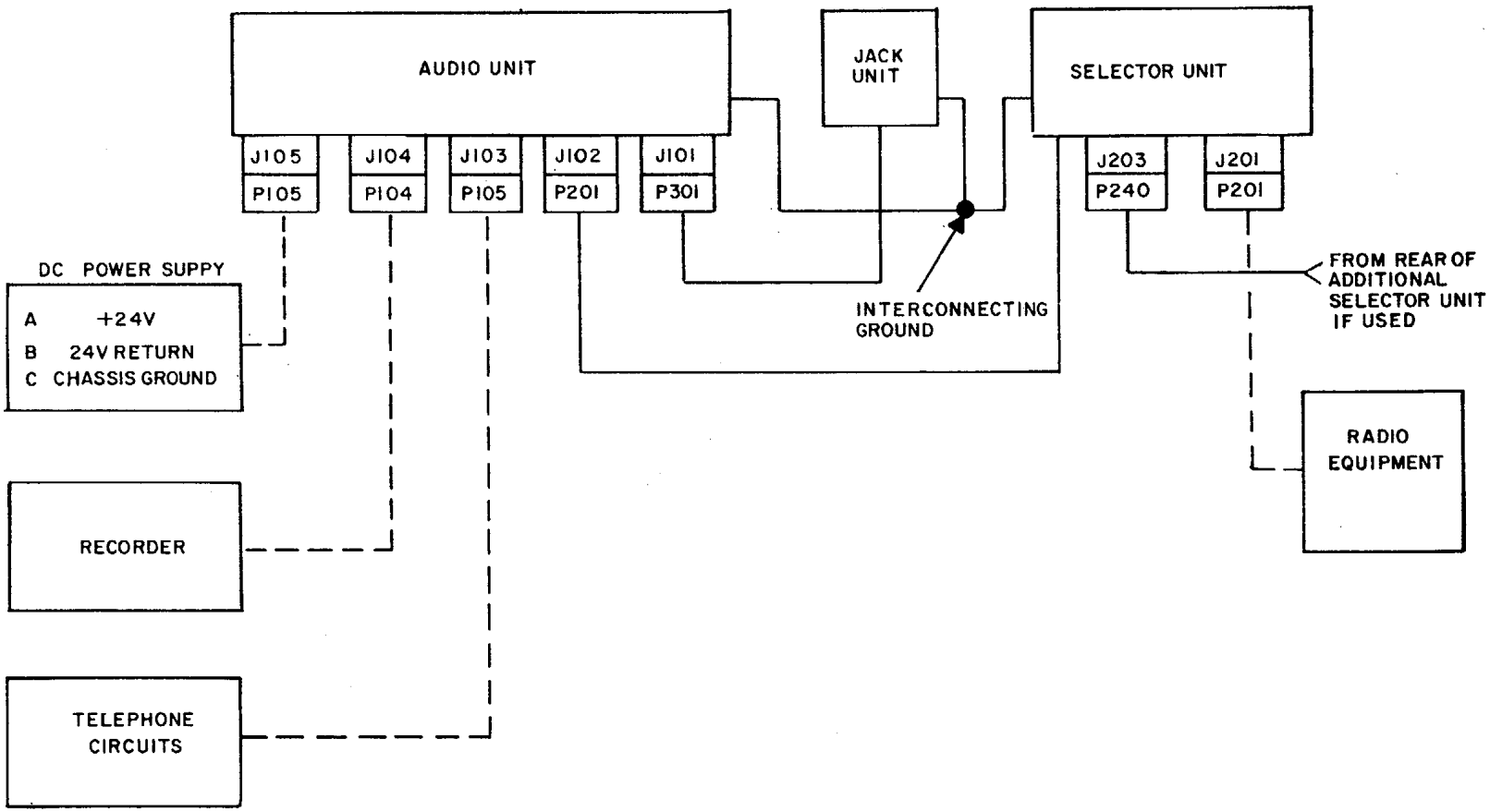

Figure 3-1. Unit Interconnections

Table 3-1. TRANSMITTER/RECEIVER CONNECTIONS

Channel	Transmit Audio	Receive Audio	Keying
1	J201-1 & 17	J201-3 & 19	J201-4 & 18
2	J201-5 & 21	J201-7 & 23	J201-8 & 22
3	J201-9 & 25	J201-11 & 27	J201-12 & 26
4	J201-13 & 29	J201-15 & 31	J201-16 & 30
5	J202-1 & 17	J202-3 & 19	J202-4 & 18
6	J202-5 & 21	J202-7 & 23	J202-8 & 22
7	J202-9 & 25	J202-11 & 27	J202-12 & 26
8	J202-13 & 29	J202-15 & 31	J202-16 & 30

NOTE

In the four wire mode operation, the keying wires are omitted.

with each audio unit; P201, P202 are furnished with each selector unit. The units must have a common chassis ground which is achieved by wiring each chassis together with 20 gauge bus wire by attaching the wire to the screw-on terminals located in the rear. Pin C on J105 connects the power supply ground to the audio unit chassis ground. 16 gauge wire should be used to connect the +24 v line from the power supply to J105.

3-6. TEST AND ADJUSTMENT OF EQUIPMENT

With the installation completed, the system test procedures should be performed, as described in chapter 4, section II. Following the system test, the following final adjustments should be made:

a. Transmitting Circuits. The equipment is placed in the transmitting mode of operation, with a 1000 Hz signal applied to the microphone input, and simulated load connected to the output at which the resulting signal is measured.

b. Set up the equipment to provide a 0 dBm transmitting output level with a microphone input level of -11 dBm, following the procedure in table 4-7, steps 1, 2, 3.

c. Reset the transmit level adjust control, R1230 (fig. FO-7), in the microphone amplifier/lamp brightness module assembly to provide the desired transmitting output level. This adjustment may be rechecked, and a finer adjustment made when the actual audio line to the transmitter is connected.

d. In many cases, the above are the only final adjustments that will be required. If it is desired to have the regulator take effect at a higher microphone input level, the input level adjust control R1202 (fig. FO-7) may be turned down, and the regulator adjust control, R1218 (fig. FO-7), readjusted to give 0 dBm output with the R1230 control at maximum. Some trial might be necessary to determine the best settings for the particular system.

e. Receiving Circuits. The equipment is placed in the receiving mode of operation with a 1000 Hz signal applied to the received signal input point, and a simulated headset load connected to the Jack panel assembly for measurement of the resulting output. There are no adjustments in the loudspeaker circuit.

f. Set up the equipment to provide a 0 dBm headset output with a signal input of 155 millivolts, following the procedure in table 4-6, steps 1, 2.

g. Set the input signal level to 49 millivolts, (-30 dBm input to the module) and observe the syllabic lamp, DS1002, in the selector module. Adjust the control R1003 (fig. FO-16) on the circuit board to the-point where the lamp just begins to glow visibly, a faint red. This adjustment may be made at a higher or lower input level, depending on the requirements of the system. This completes the final' receiving circuits adjustments.

3-7. CIRCUIT ALIGNMENT

The radio channel control requires no alignment in addition to the foregoing adjustments described in this section.

CHAPTER 4

MAINTENANCE INSTRUCTIONS FOR CONTROL, RADIO CHANNEL C-10931(P)/FRC

Section I. GENERAL INFORMATION

SECTION CONTENTS **Page**

4-1. INTRODUCTION

Repair of the equipment consists of replacing and repairing damaged or malfunctioning components found during preventive maintenance checks and services or troubleshooting procedures. Removal of assemblies or components is performed only to the extent necessary to accomplish the required repairs. Refer to the Maintenance Allocation Chart (MAC) given in TM 11-5895-1141-12 to determine the level of responsibility for maintenance functions. Refer to the Repair Parts and Special Tools List in TM 11-5895-1141-34P to determine support items required to operate and maintain the C-10931(P)/FRC. Table 4-1 lists the required parts and test equipment needed for the maintenance procedures described in this chapter.

4-2. COMMON TOOLS AND EQUIPMENT

For authorized common tools refer to the Maintenance Allocation Chart in TM 11-5895-1141-12.

4-3. SPECIAL TOOLS AND TEST EQUIPMENT

No special tools are required for maintenance of the radio channel control equipment. The MTS-2400 module test set is used to test the modules of the radio channel control equipment. Procedures for the use of the module test set are contained in this chapter.

4-4. REPAIR PARTS

Repair parts are listed and illustrated in the Repair Parts and Special Tools List covering this equipment.

Table 4-1. REQUIRED PARTS AND TEST EQUIPMENT FOR MAINTENANCE

Test Equipment/Part	Identifying Number/ Part Number	NSN
Electronic Voltmeter	ME-459/U	6625-00-229-0457
Attenuator	CN-1000/C (215-4931)	6625-00-215-4931
Signal Generator	AN/USM-181B (086-4271)	6625-00-086-4271
Distortion Analyzer	AN/URM-184A (802-8718)	6625-00-802-8718
Module Test Set	MTS-2400	
Multimeter	ME-518/U)	6627-01-031-0708
Connector	MT-332	
Connector	126-220	
Connector	26-4501-325	
Connector	414(MTS-2400)	
Resistor, 600 ohm, ±1%, 1/2 w	RNR 60 H 604 FR	
Resistor, 50 ohm, ±1%, 1/2 w	RNR 60 H 500 FR	
Capacitors (2), 200 μF, 35 v	MIL-C-39003	

Section II. SYSTEM CHECK PROCEDURE

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4-5. GENERAL

This section contains a check procedure which you will use to determine if the radio channel control equipment is operational. This procedure is to be used under the following conditions:

a. You have received a new radio channel control from a supply facility.

b. You have received a radio channel control from administrative storage and must check it out.

c. You wish to periodically check the performance of the radio channel control.

4-6. VOLTAGE MEASUREMENTS

With input power applied, dc voltage measurements can be made as shown in the following tables: 4-1, 2, 3, 4. These voltages should be present when the power is turned on at S101 of the audio unit assembly and where applicable, under the specified operating conditions. Illustrations are referred to in the tables to aid in locating the voltage test points. The measurements can be made using the multimeter.

4-7. RESISTANCE MEASUREMENTS

Certain resistance measurements can be made, as shown in table 4-6, as check on proper operation of the corresponding circuits. These apply under the conditions given in the table. Use the multimeter. See figure FO-12 to help find the specified locations.

Table 4-2. VOLTAGE MEASUREMENTS, JACK PANEL ASSEMBLY

Location	Condition of Operation	Voltage
R303-R308 junction to 24 v return	Any	24 ± 2 v
R308-CR301 junction to 24 v return	Any	12 + 1 v
Q301 collector to emitter	Keying switches open, channel select on LOCK or NONLOCK.	11 ± 1 v
Q301 collector to emitter	Any keying switch closed, channel select on LOCK or NON-LOCK	0.5 v Max.

NOTE

Refer to figure FO-3 for component locations.

Table 4-3. VOLTAGE MEASUREMENTS, MICROPHONE AMPLIFIER ASSEMBLY

Location	Condition of Operation	Voltage
E5, E9-13, E15-18 to E1-2	Any	+24 ± 2 v
E14 to E1	Any, LAMP BRIGHTNESS control rotated over range	14 to 22 v variable
C1204+ to E1	Any	+12 ± 0.6 v
CR1204 anode to E1	Any	7.3 ± 0.5 v

NOTE

Refer to figure FO-7 for component locations.

Table 4-4. VOLTAGE MEASUREMENTS, VOLUME CONTROL ASSEMBLY

Location	Condition of Operation	Voltage
C11001 to E3	Any	+24 ± 2 v
C1105 to E3	Any	+12 ± 0.6 v

NOTE

Refer to figure FO-9 for component locations.

Table 4-5. VOLTAGE MEASUREMENTS, SELECTOR MODULE ASSEMBLY

Location	Condition of Operation	Voltage
Q1007 collector to E12	Any	+24 ± 2 v
E7 TO E8	Any	+24 ± 2 v
Q1008 collector to E2	Channel Unkeyed	23.5 ± 2 v
Q1008 collector to E2	Channel Keyed	0.5 ± 0.3 v
E11 to E12	Channel Unkeyed	23.5 ± 2 v
E11 to E12	Channel Keyed	0.5 ± 0.3 v
Q1009 collector to E12	Channel Keyed after Keying at Position	0.5 ± 0.3 v
Q1009 collector to E12	Channel Unkeyed	23.0 ± 2 v
Q1009 collector to E12	Channel Keyed Before Keying at Another Position	23.0 ± 2 v

NOTE

Refer to figure FO-7 for component locations.

Table 4-6. RESISTANCE MEASUREMENTS, SELECTOR MODULE ASSEMBLY

Location	Condition of Operation	Resistance
E1 to E46	Channel Unkeyed	620 ± 31 Ohms
E1 to E46	Channel Keyed	40 ± 10 Ohms
E16 to E51	Channel Unkeyed	Open
E16 to E51	Channel Keyed	Continuity

Section III. PERFORMANCE CHECK

SECTION CONTENTS **Page**

4-8. SYSTEM TEST PROCEDURE

a. The test procedures that follow are used to periodically check the performance of the radio channel control system. Normal test data are provided as part of the test procedures. Check your test data against the normal data to determine the quality of the system performance.

b. Perform the tests listed in the charts that follow, step by step. The left hand column denotes the order (Step) in which the test must be performed. The next column (Operation) describes the test procedure. The Normal Indication column denotes the correct test result you should observe. In the event your test results do not conform to the Normal Indication, corrective action should be taken. Three charts are provided which allows you to perform separate tests on the transmitter circuits, receiver circuits, and where appropriate, the recorder/monitor circuits.

c. When performing these system test procedures following installation or following major changes in wiring between positions or between the radio channel control equipment and the lines to the radio equipment, the crosstalk tests described in table 4-9 should be performed in addition to the aforementioned test procedures.

NOTE

If an MTS-2400 module test set is available, then with the exception of the crosstalk tests, paragraph 4-8 should be ignored and the test procedure of paragraph 4-9 performed instead.

Table 4-7. TESTING RECEIVER CIRCUITS TEST PROCEDURE

Step	Operation	Normal Indication
1	Preliminaries. The receiving circuits are tested by applying an audio signal to the received signal pins of the selector unit connectors J201, J202. The resulting signals between the sleeve terminals of the headset jack pair (J301, J302) on the jack -panel are then measured. Before proceeding with the tests, perform the preliminary adjustments of 1a through 1e. a. Connect-external power source. Depress Power switch. b. Set S1002 (LOCK/NONLOCK) of first selector module to off (center) position. See the selector unit, front panel, figure 4-1. c. Set S1001 (HEADSET-LOUDSPEAKER switch) of first selector module to HEADSET position. d. Regulator jumper (E1121 to E1122 in volume control module) must be in place. See circuit board figure 4-2. e. Turn HEADSET and SPEAKER volume controls in the audio unit to maximum position. See audio unit, front panel, figure 4-3.	Power light is on.

Table 4-7. TESTING RECEIVER CIRCUITS TEST PROCEDURE (Cont'd)

Step	Operation	Normal Indication
2	Set the audio signal source to 1000 Hz and 155 millivolts as measured by voltmeter. This corresponds to an effective input level of -20 dBm. Refer to test connection diagram, figure 4-4.	With the 600 ohm load in place at the jack panel as shown in figure 4-5, a reading of 0 dBm should be obtained across the load. If necessary adjust threshold adjust pot B17 (fig. 4-2) in the volume control module to obtain 0 dBm.
3	Increase the signal input from 155 mv to 4.90 v at 1000 Hz.	The output across the 600 ohm load shown in test figure 4-5 should remain at 0 dBm ± 3 dBm.
4	Connect a distortion meter across the 600 ohm output load. Measure the percentage distortion at the following frequencies: 300, 1000, 3000 Hz. Input level is 4.9 v.	Distortion should not exceed 8%.
5	Reduce input signal to 155 mv at 1000 Hz.	Output level should return to 0 dBm (0.755 volts) across the 600 ohm load.
	Reduce frequency to 300 Hz maintaining the 155 mv input amplitude.	The output should not decrease more than 3 dB (0.707) of the output level at 1000 Hz.
	Increase the input frequency to 3000 Hz, maintaining the 155 mv input amplitude.	The output should not decrease more than 3 dB (0.707) of the output level at 1000 Hz.
6	Restore the condition of 0 dBm output for 155 mv input at 1000 Hz. Disconnect the audio oscillator and short circuit the attenuator output.	The output noise level in the absence of signal input should not be greater than -45 dBm.

Table 4-7. TESTING RECEIVER CIRCUITS TEST PROCEDURE (Cont'd)

Step	Operation	Normal Indication
7	Reconnect the audio oscillator. Remove the short circuit of step 6. Adjust the oscillator for 1000 Hz, 155 mv input. Remove the ac voltmeter from the 600 ohm load and place it across the loudspeaker voice coil in the audio-unit. Set the receive select switch to the Loudspeaker position. **NOTE** Access for the loudspeaker requires detaching front panel from the audio unit chassis by removing the mounting screws.	An output level of 1.1 v minimum should be obtained across the loudspeaker; record the output level.
8	Connect a distortion meter across the loudspeaker and measure the percentage distortion at 300 Hz, 1000 Hz and 3000 Hz, with the signal amplitude at 155 mv for each frequency.	The percentage distortion should not exceed 8%.
9	Measure the output voltage across the loudspeaker terminals at both 300 Hz and 3000 Hz using an input signal amplitude of 155 mv.	The output voltage should not be more than 3 dB below the output voltage measured at 1000 Hz in step 7.

Table 4-7. TESTING RECEIVER CIRCUITS TEST PROCEDURE (Cont'd)

Step	Operation	Normal Indication
10	Disconnect the audio oscillator and place a short circuit across the attenuator of test circuit. Measure the noise voltage across the loudspeaker terminals using the ac voltmeter.	The noise voltage should not exceed 1 mv.
11	Reconnect the audio oscillator and remove the short circuit across the attenuator. Repeat step 7.	The output across the loudspeaker should not exceed 1.1 v. Record the output voltage
	Set the channel select switch to the LOCK position and close the transmitter keying switch. The output from the loudspeaker should significantly decrease.	Read and record the output voltage across the loudspeaker terminals. The reading should be no more than 0.32% of the reading recorded in step 11.
12	For each additional channel used repeat step 1 through 11. Refer to figure FO-15 for connections to J201 and J202 for received signal input on other channels.	
13	Remove the test instruments and the test plug of the test figure 4-4. Remove the 600 ohm load.	

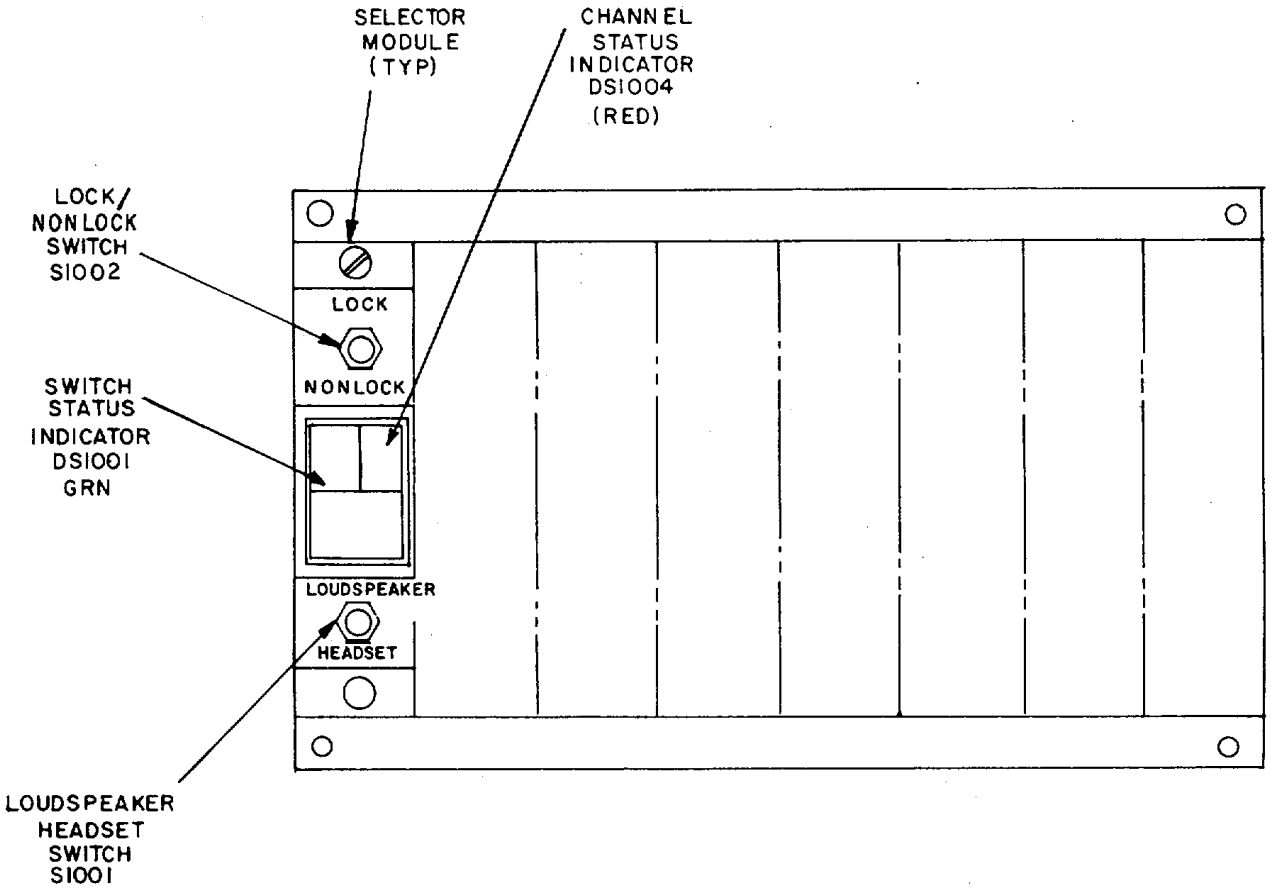

Figure 4-1. Selector Unit, Front Panel

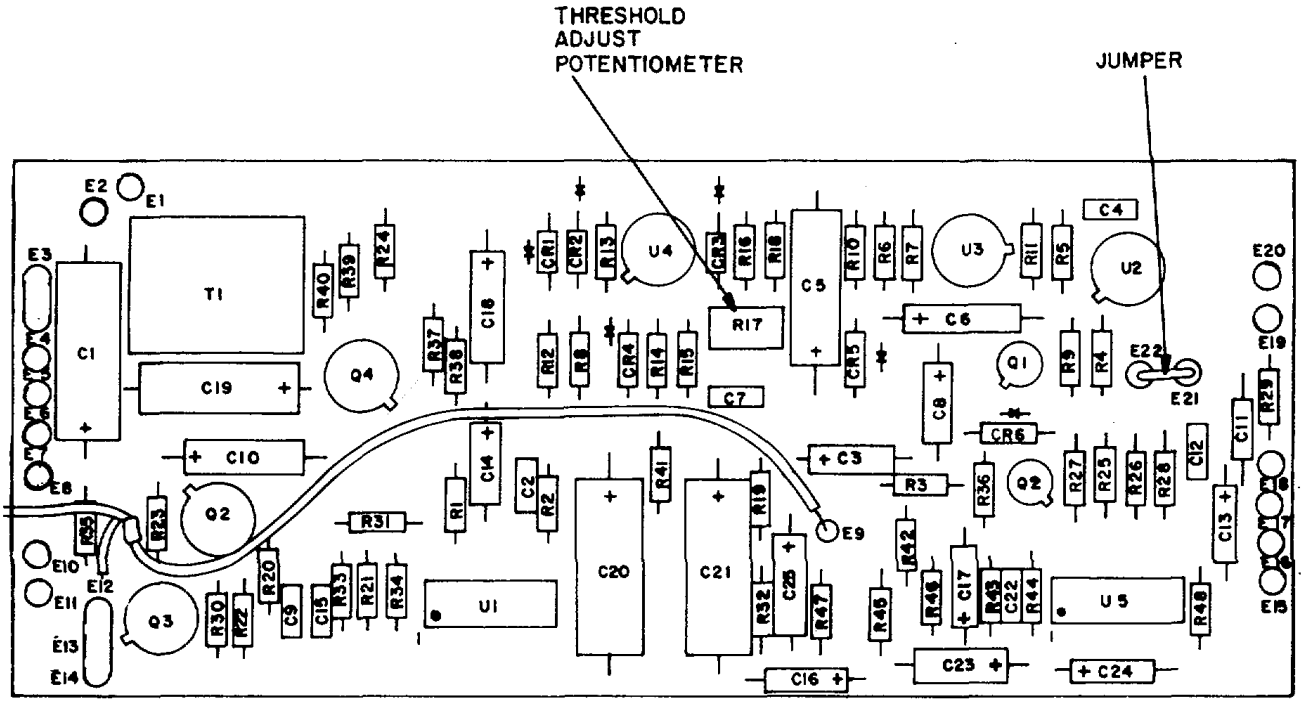

Figure 4-2. Volume Control Circuit Board

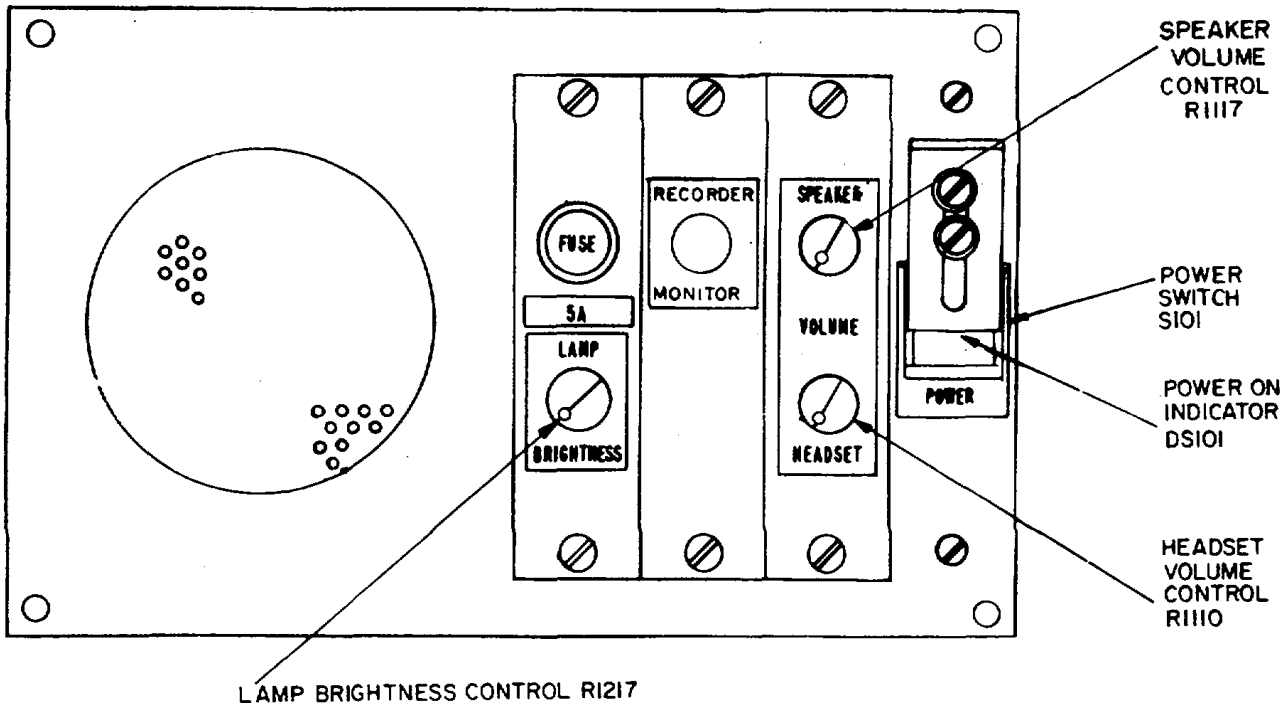

Figure 4-3. Audio Unit, Front Panel

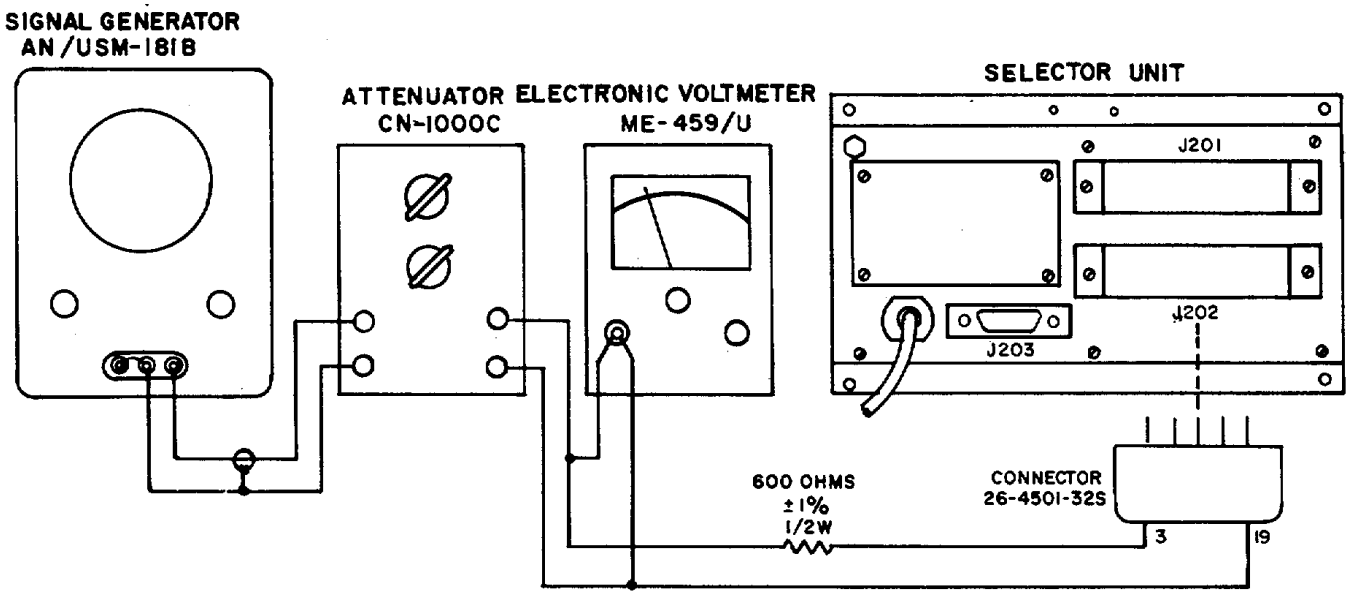

Figure 4-4. Receiving Test Connections to Selector Unit

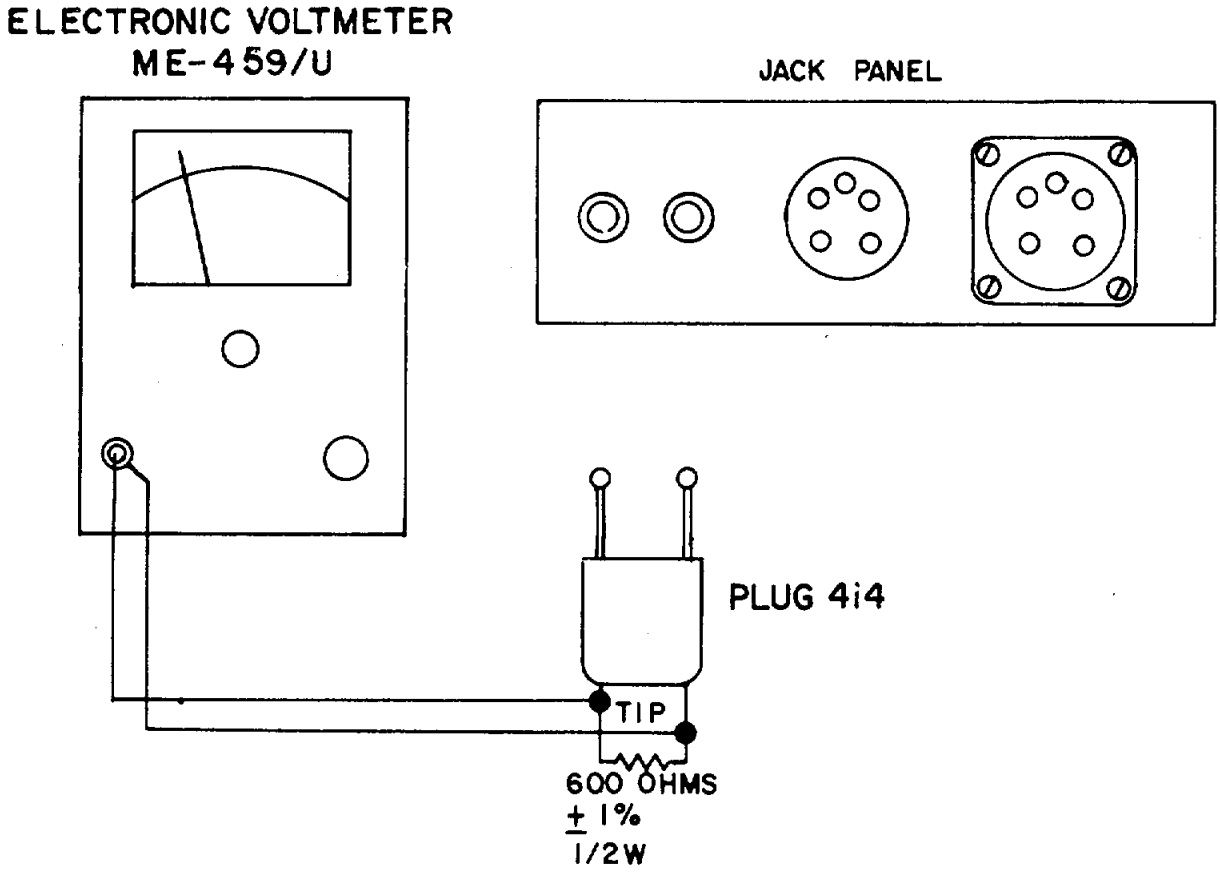

Figure 4-5. Receiver Test, Simulated Load on Jack Panel

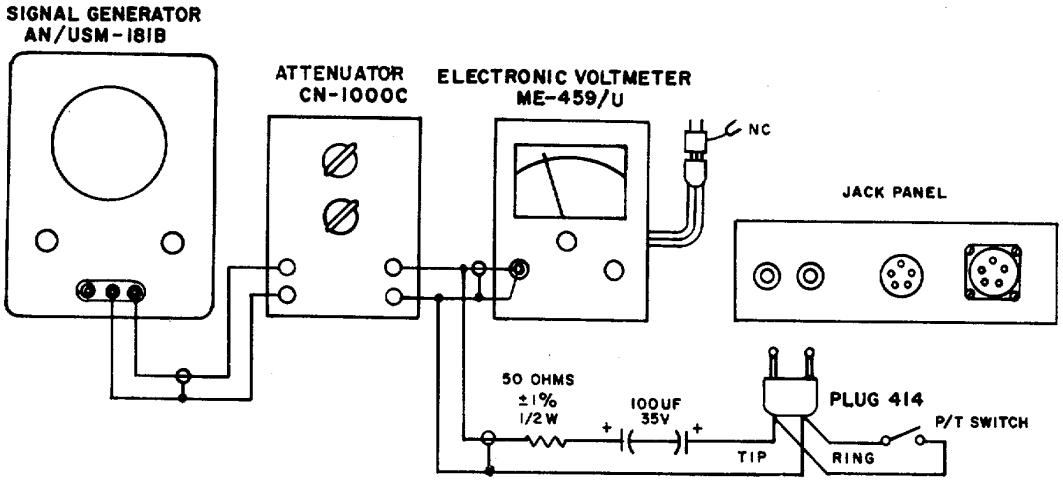

Figure 4-6. Jack Panel Test Connections

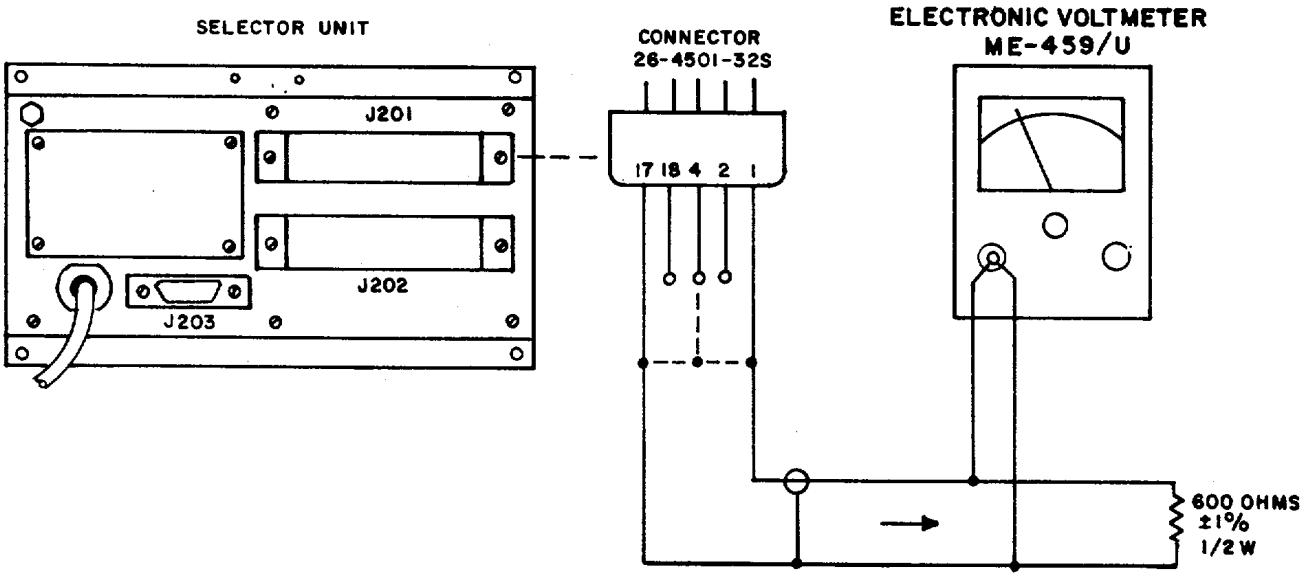

Figure 4-7. Transmitting Test Connections to Selector Unit

Table 4-8. TRANSMIT CIRCUITS TEST PROCEDURE

Step	Operation	Normal Indication
1	Use the test set-up of test figure 4-6 to introduce a measured audio test signal into the jack panel. Use the second test set-up figure 4-7 to measure transmitter audio output from the selector unit. After implementing both test set-ups, perform the preliminary procedures of steps1a through 1f.	
	a. Adjust external power source to +24 v. Set switch to POWER.	Power indicator lamp turns on.
	b. Position channel select switch to LOCK.	Green indicator lamp on selector module turns on.
	c. Turn Loudspeaker/Headset Switch to OFF (center) position.	
	d. Turn Lamp Brightness control to maximum value (clockwise).	
	e. Set R1202 (input level adjust) and R1230 (threshold adjust) in microphone amplifier to maximum value. See figure 4-3.	
	f. Insure that the regulator jumper E1221 to E1222 on microphone amplifier is in place.	

Table 4-8. TRANSMIT CIRCUITS TEST PROCEDURE (Cont'd)

Step	Operation	Normal Indication
2	Set the audio signal input to 1000 Hz and an ac voltmeter reading of 126 mv (-11 dBm).	
3	Close microphone P/T switch. Adjust threshold adjust potentiometer R1218 on microphone amplifier for 0 dBm.	Red indicator lamp on selector module turns on. Audio output level of 0 dBm obtained across 600 ohm output load resistor, shown in test figure 4-7.
4	Increase signal input level from 126 mv to 1.26 v, an increase of 20 db to 9 dBm.	Output signal across the 600 ohm load should remain at 0 dBm ± 3 dBm.
5	Connect a distortion meter across the 600 ohm load. Set oscillator to 300, 1000 and 3000 Hz, in sequence.	Distortion should not exceed 8% at these three frequencies.
6	Remove distortion meter and return input signal level to 126 mv at 1000 Hz.	The output level returns to 0 dBm.
7	Measure the output level at both 300 and 3000 Hz while maintaining the input signal level at 126 mv.	The output level should not decrease more than 3 db from the level at 1000 Hz.
8	Return the input signal frequency to 1000 Hz and 126 mv and connect an ac voltmeter to 600 ohm resistor between sleeve terminals on jack panel (fig. 4-8). Set Headset Volume control to maximum.	Transmitting sidetone signal should be -25 ±2 dBm.

Table 4-8. TRANSMIT CIRCUITS TEST PROCEDURE (Cont'd)

Step	Operation	Normal Indication
9	a. Reconnect ac voltmeter to transmitting output terminals, across 600 ohm load resistor (fig. 4-7). b. Disconnect audio oscillator. c. Connect a short circuit across attenuator output. d. With no signal applied measure transmitting output noise level.	Noise level should not exceed -50 dBm.
10	Check continuity to transmitter keying line using an ohmmeter.	Continuity should be indicated between pins 4, 18 or pins 1, 17 of J201.
11	For each additional channel used, repeat steps 1 through 10. Refer to figure FO-15 for connecting to J201 and J202 for transmitting audio and keying terminals on other channels.	
12	Remove the audio signal source from the microphone input leads to the dual plug upon completion of all tests.	

Table 4-9. RECORDER/MONITOR CIRCUITS TEST PROCEDURES

Step	Operation	Normal Indication
1	Repeat steps 1, 2, 3 of the transmit test procedure.	
2	Connect the mixer amplifier output test circuit (fig. 4-9) to J104 of the audio unit.	An output reading of 10 ± 2 dBm should be obtained across the 600 ohm load resistor.
3	Remove the test circuit and replace with the recorder-monitor test circuit (fig. 4-10). Apply a monitor input level of -30 dBm by setting the audio oscillator for an output of 49 millivolts at a frequency of 1000 Hz.	Turn the front panel lamp brightness control to maximum. The recorder monitor syllabic lamp on the audio unit front panel should be barely visible. If not, adjust R1313, the syllabic lamp threshold adjust to achieve this light level. See figure 4-11.
4	1 Increase the audio oscillator output to 0.49 v for an input of -10 dBm.	The syllabic lamp should be at full brightness.
5	If the installation instructions call for a threshold setting other than the -30 dBm of step 3 above reset the signal level in the test circuit. This completes the recorder/monitor test. Remove test circuit.	Adjust R1313 to achieve barely lighted condition of the syllabic lamp.

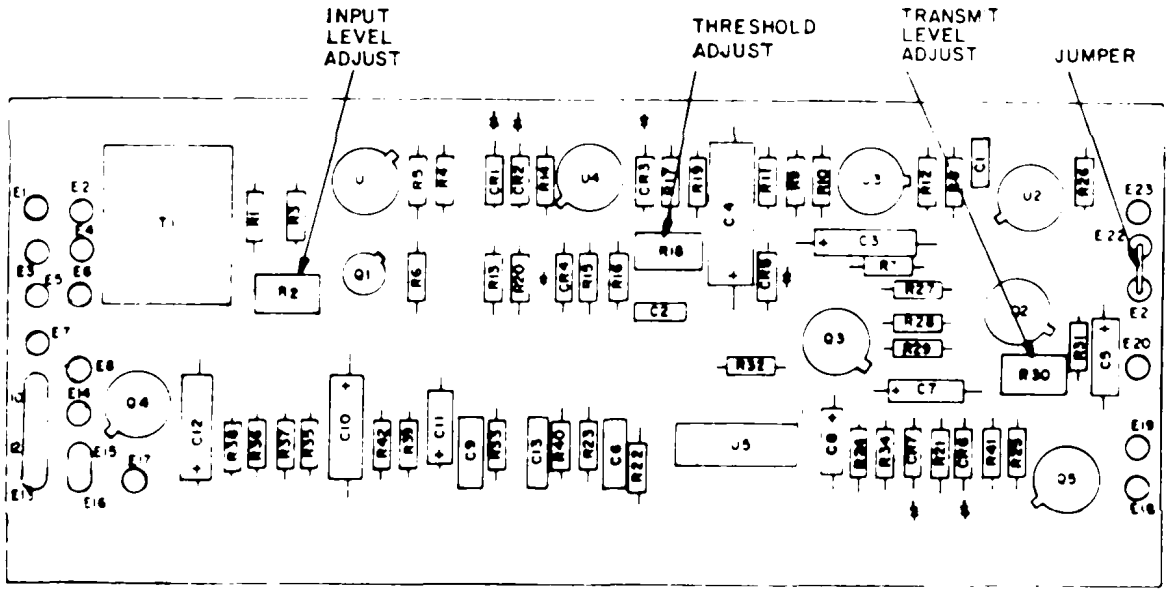

Figure 4-8. Microphone Amplifier/:amp Brightness Circuit Board

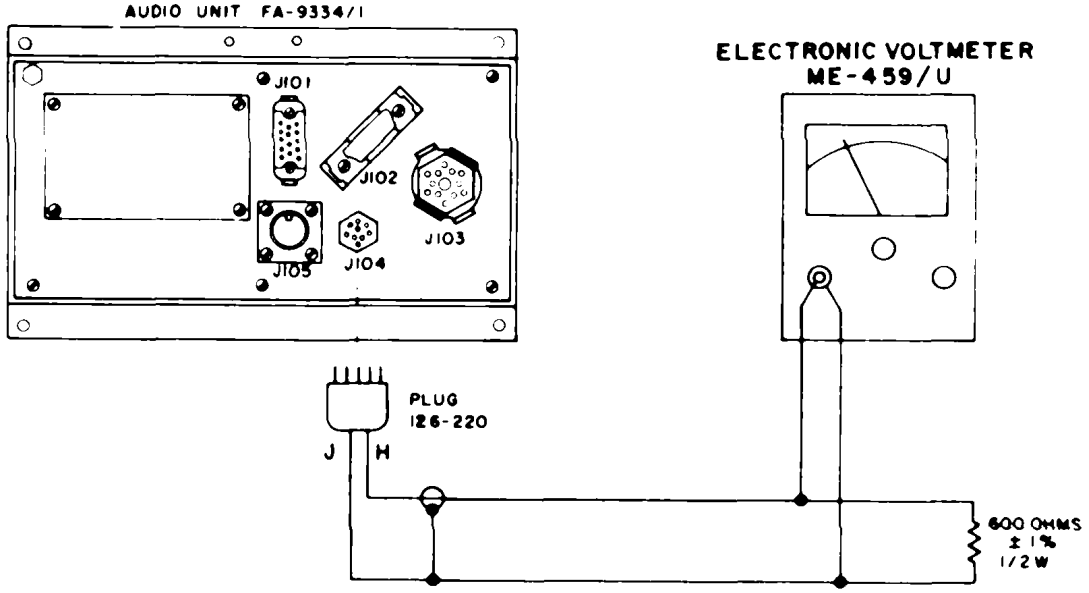

Figure 4-9. Audio Unit Connections for Mixer Amplifier Output Test

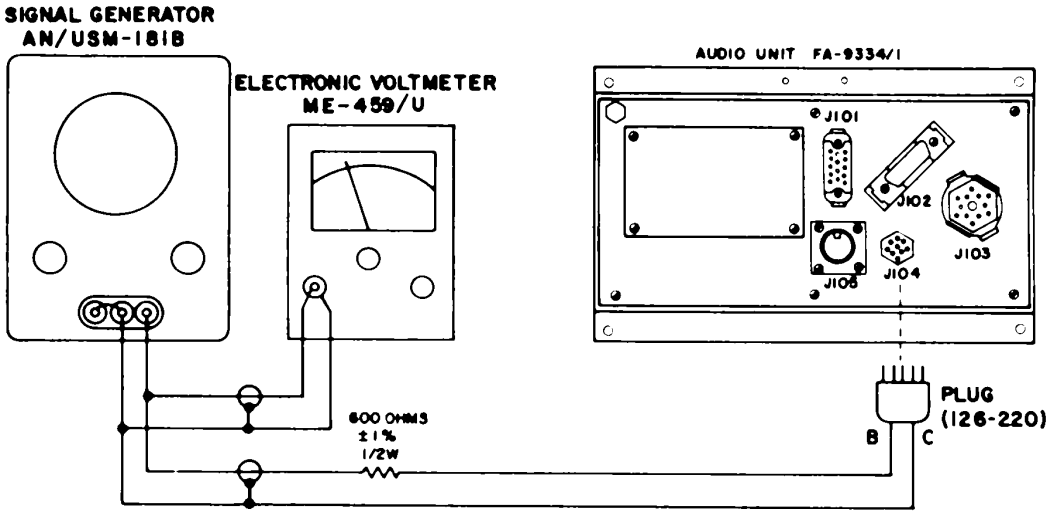

Figure 4-10. Audio Unit connections for Recorder Monitor Test

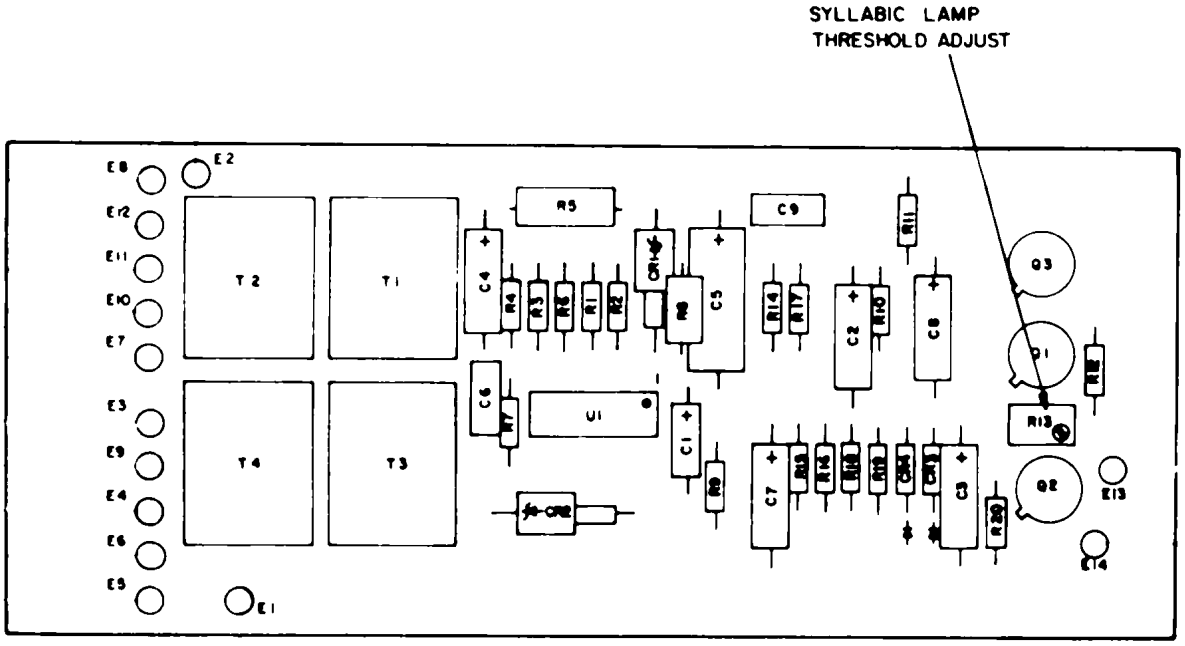

Figure 4-11. Recorder-Monitor Circuit Board

Table 4-10. CROSSTALK TESTS, TRANSMITTING AND RECEIVING CIRCUITS

Step	Operation	Normal Indication
1	Transmitting Crosstalk Test. Preliminary test set-up. The system installation must be complete and the transmitting circuit adjustments of chapter 3, section II must be completed. a. Connect the audio signal source to J301 and J302 of the jack panel as shown in test figure 4-6. b. Disconnect the lines to the radio transmitters where they first enter the radio channel control system wiring. Terminate each transmitting audio line pair with a 600 ohm ± 1%, 1/2 watt resistor. c. Connect the ac voltmeter to the 600 ohm termination of the first channel. d. Set the channel select switch of the first channel selector module to the LOCK position. Leave all remaining channel selector switches in the OFF position.	
2	Set the audio signal input level to 1.26 volts and 1000 Hz corresponding to an input level of +9 dBm. Close the transmitter keying switch.	Record the meter reading at the output termination of Step 1c.

Table 4-10. CROSSTALK TESTS, TRANSMITTING AND RECEIVING CIRCUITS (Cont'd)

Step	Operation	Normal Indication
3	Remove the ac voltmeter from the termination of the first channel and connect it in turn to each of the other channels used. Read the crosstalk level.	The crosstalk level should be at least 50 dB below the signal level of the active channel.
4	Connect the ac voltmeter across the loudspeaker terminals. On each channel in turn, set the receive select switch to the Loudspeaker position. Measure the crosstalk between the transmitting and receiving circuits.	The loudspeaker reading should not exceed 1 mv.
5	Repeat steps 2, 3, 4 with each of the receiving channels.	
6	Receiving Crosstalk Test. Preliminary test set-up. a. Disconnect the audio line pair from the radio receiver where they first eater the radio channel control system wiring. Connect the audio signal source in the receiving test figure 4-4 to the received input signal of the first channel. b. Replace the 600 ohm simulated load with a 50 ohm, 1% resistor.	

Table 4-10. CROSSTALK TESTS, TRANSMITTING AND RECEIVING CIRCUITS (Cont'd)

Step	Operation	Normal Indication
	c. Connect an ac voltmeter across the 50 ohm resistor. d. Set the switch S1001 of the first channel to the Headset position, leaving the switches of the other channels in the off position. Set all the channel select switches to the off position.	
7	Set the received signal source to a level of 310 mv which is equal to twice that normally used, allowing for a 6 dB drop in the terminating resistor.	Record the voltage across the 50 ohm headset load resistor.
8	Set the switch S1001 of the first channel to the off position. Set the switch S1001 of each of the remaining channels, one at a time, to the Headset position, measuring the crosstalk level at the headset load resistor. Do this for each channel in turn, with the switch S1001 of all the other channels set to off.	The crosstalk level at the headset output should be 50 dB below the reading of step 7.

Table 4-10. CROSSTALK TESTS, TRANSMITTING AND RECEIVING CIRCUITS (Cont'd)

Step	Operation	Normal Indication
9	Terminate the transmitting audio line pair of the first channel with a 600 ohm ± 1%, 1/2 watt resistor. Connect an ac voltmeter across the terminating resistor. Set the channel select switch of first channel to the LOCK position. Close the P/T switch.	
10	Measure the receive to transmit crosstalk level at the transmitter audio termination.	The crosstalk level should be at least 50 dB below the normal transmit level as determined in section II (Test and Adjustment of Equipment) of chapter 3.
11	Repeat step 10 with each of the other channels keyed in turn. Repeat the foregoing tests with the received signal input connected in turn to each of the used channels.	

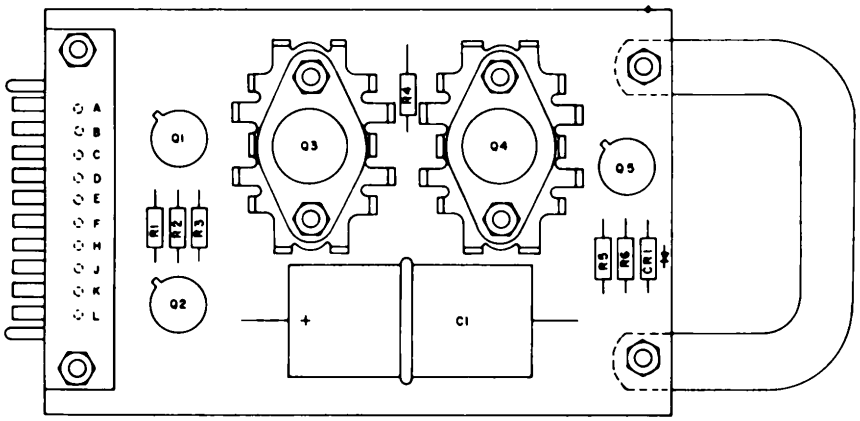

Figure 4-12. Speaker Amplifier Board Assembly Diagram

Section IV. TESTING MODULES USING THE MTS-2400 MODULE TEST SET

SECTION CONTENTS **Page**

4-9. DESCRIPTION OF THE MODULE TEST SET

a. Overall system testing can be greatly facilitated by the use of the MTS-2400 Module Test Set. The test procedures described in this paragraph are based on the use of the module test set.

b. The module test set includes one each of the following modules: audio unit module, selector module and speaker amplifier module. These modules are certified to meet the specified operating requirements. The receptacles for these modules are interconnected to each other and to simulate input sources and simulated output loads. The purpose of the test set is to represent the configuration of a single operator's position and single radio channel. Also included is a provision for testing the operation of the jack unit. Testing of a particular module is accomplished by simply installing the module under test, in place of the standard module. To facilitate module testing, a module test adapter is provided. Inserting one end of the adapter into the receptacle of the module test set and engaging its opposite end with the module under test, permits the interior of tested module to be accessed for diagnosis and adjustment. The module test set also includes a sinusoidal oscillator with three selectable fixed frequencies, a voltmeter covering the range from 3.5 millivolts, to 3.5 volts ac in five ranges as well as a 0 to 30 vdc on a single range, and a dc voltage supply variable from 22 to 26 volts. Input signals from external sources can also be applied for use by the test set. The test set output signals are available at a pair of output terminals for use with a distortion analyzer or oscilloscope.

c. A diagram of the module test set front panel is given in figure FO-11. The front panel functions are listed in Table 4-11.

Table 4-11. MODULE TEST SET CONTROLS AND INDICATORS

Controls/indicators or Connector	Function
SIGNAL OUTPUT terminals E5, E6	Connection of external measuring instruments to the signal selected by OUTPUT SELECT switch.
CHASSIS GROUND binding post E10	Chassis ground
METER SCALE switch S3	Establishes the full-scale voltage sensitivity of the ac meter circuit. In terms of decibels it establishes the range of levels which can be read on the meter. (The number to be added to the reading on the decibel scale has five positions):
METER SCALE switch S3 positions	35 mv, - 30 dB 110 mv, - 20 dB 350 mv, - 10 dB 1.1 v, - 0 dB 3.5 v, + 10 dB
"PRESS TO READ" switch S4	When pressed, disconnects the meter from the ac circuits and connects it to the module power supply to read its voltage on the 30-volt dc scale.
24 VDC SUPPLY VOLTAGE ADJ. control R24	Sets the voltage of the module power supply to a value between 22 and 26 volts dc .
3.2 Ω DUMMY LOAD/SPEAKER switch S13	In the upper position connects output of the module's loudspeaker amplifier to a 3.2 ohm resistor; in the lower position connects the output to the panel speaker.
Fuseholder XF1, 3/8 A SLO	Holds fuse which carries primary ac power for the test set. Should be equipped with a 3/8 ampere "slow-blow" fuse.

Table 4-11. MODULE TEST SET CONTROLS AND INDICATORS (Cont'd)

Controls/indicators or Connector	Function
INTERLOCK/OFF switch S8	Simulates keying of the channel at another operator's position.
CHANNEL BUSY indicator DS4	Lights to indicate simulated channel engagement - when INTERLOCK switch S8 is set to INTERLOCK or when selector module switch is ON and S7 is set to P/T KEY.
MUTE OTHERS/OFF switch S14	Not used in these tests - leave at OFF .
MUTE BUS ACTIVE indicator DS5	Not used in these tests.
CONTR/INST switch S15	Not used in these tests - leave at INSTR.
CHAN KEYED/CONTR headset switch S16	Not used in these tests - leave at OFF.
CHAN KEYED/TELCO switch S17	Not used in these tests - leave at OFF.
CONTR Headset Connector J7 and J11	The test signal appearing at this connector is cabled to the controller headset microphone input on the jack unit. When this jack is not plugged in the internal test set, signals will be routed directly to the microphone amplifier lamp brightener module input.
INSTR headset connector J8 and J9	The test signal appearing at this connector is cabled to the instructor headset input on the jack unit. When this jack is not plugged in the internal test set, signals will be routed directly to the microphone amplifier lamp brightener module input.

Table 4-11. MODULE TEST SET CONTROLS AND INDICATORS (Cont'd)

Controls/indicators or Connectors	Function
JACK UNIT connector J10	This connector provides the power input and control signals to the jack unit under test.
EXT SIGNAL INPUT binding posts E7, E8	Connection of external test signal source.
OSCILLATOR FREQUENCY switch S1	Sets frequency of the internal oscillator to one of three fixed frequencies: 300, 1000 or 3000 Hz.
OSCILLATOR LEVEL control R15	Continuous adjustment of oscillator output level between 0 and 1 volt.
INPUT SELECT switch S11	Routes the internally or externally generated test signal to one of the inputs of the module configuration. Has six positions: MICROPHONE (microphone amplifier input) TELCO (input to jack unit) TEL 1 (input to recorder mixer amplifier) TEL 2 (second input to recorder mixer amplifier) MONITOR (input to recorder monitor syllabic indicator) RCVR AUDIO (input to selector module)

Table 4-11. MODULE TEST SET CONTROLS AND INDICATORS (Cont'd)

Controls/indicators or Connector	Function
OUTPUT SELECT switch S12	Connects the meter circuit input and the SIGNAL OUTPUT binding posts to the test voltage source or to one of the outputs of the module configuration. Has five positions: OSCILLATOR (oscillator circuit output or externally applied input signal as selected by INPUT switch S5. Meter reading is not changed by setting of 20 dB switch S9). HEADSET (output of headset amplifier) LOUDSPEAKER (output of loudspeaker amplifier) MIXER AMPL (output of recorder mixer amplifier) XMTR AUDIO (output from selector module)
CHANNEL KEYED indicator DS3	Lights when P/T KEY switch S7 is turned on .
POWER switch S2	Turns the primary power on or off.
POWER ON indicator DS2	Lights up when primary power is on.
115 VAC INPUT connector J1	Receptacle 115 vac from line cord that is supplied with test set.
Meter M1	Displays voltage or decibel level of selected output signal.
Loudspeaker LS1 (located internally)	Reproduces signals at the output of the module's loudspeaker amplifier when switch 3.2 Ω DUMMY LOAD/SPEAKER S13 is in SPEAKER position.
Module Mounting Well	Tapped flanges are provided to accommodate locking screws of modules. Receptacle plate has keying holes to ensure that correct module type is installed in each position.

Table 4-11. MODULE TEST SET CONTROLS AND INDICATORS (Cont'd)

Controls/indicators or Connector	Function
PRESS FOR XMTR LOAD switch S6	When pressed, places the equivalent of 23 installed selector modules as an additional load upon the amplifier in the microphone amplifier/lamp brightener module.
600-Ω DUMMY LOAD switch S10	When positioned to IN, routes input signals to a 600 ohm resistor instead of to the INPUT SELECT switch.
20-dB	ATTENUATOR switch S9 When positioned to IN, attenuates input voltage by a factor of ten (20 dB).
EXTERNAL/INTERNAL INPUT switch S5	In EXTERNAL position, the input test signals are provided by a source connected to the EXT SIGNAL INPUT terminals. In INTERNAL position, the input test signals are provided by the oscillator circuit of the test set.
P/T KEY switch S7	With jack unit not connected for test, this switch simulates keying of selected channel by operator. With jack unit connected for test, this switch keys the transmitter and allows only the signal appearing at the instructor headset Jack of the Jack unit to be transmitted.

4-10. PROCEDURE FOR TESTING MODULES

This section includes tables detailing the procedure for using the MTS-2400 Test Set to test the following modules:

Microphone Amplifier/Lamp Brightener Module (Table 4-12)

Recorder-Monitor Module (Table 4-13)

Volume Control Module	(Table 4-14)
Selector Module	(Table 4-15)
Jack Panel Unit	(Table 4-16)
Speaker Amplifier Assembly	(Table 4-17)

Set-up and Initial Settings. Remove the cover from the test set case. After making sure the POWER switch is off, engage the power cord, which is stored in the cover, with the power inlet and plug into a standard ac outlet convenient to the work space. If more than one module is removed from the equipment for diagnosis, repair, or adjustment, install only one at a time in place of the test set's own standard modules. This will ensure localization of a fault to one module. The standard module may be reinserted at any time during the test procedure in order to compare performance under certain conditions. If the module under test requires adjustment, plug it into the Module Test Adapter with the plug end of the latter inserted in the Test Module. Following installation of the test module, position the controls as follows:

a. Meter Scale 3.5 v/+10 dB

b. SPEAKER/3.2 Ω DUMMY LOAD switch, to 3.2 ohm

c. 600 Ω DUMMY LOAD switch to IN

d. 20 dB ATTENUATOR switch to OUT

e. EXTERNAL INPUT/INTERNAL INPUT switch to INTERNAL

f. OSCILLATOR FREQUENCY to 1000 Hz

g. OSCILLATOR LEVEL fully CCW

h. INPUT SELECT switch to MICROPHONE

i. OUTPUT SELECT switch to OSCILLATOR

j. P/T KEY switch to OFF

k. INTERLOCK switch to OFF

l. MUTE OTHERS switch to OFF

m. LAMP BRIGHTNESS control fully CW

n. SPEAKER VOLUME control fully CCW

o. HEADSET VOLUME control fully CCW

p. LOCK/NONLOCK switch (on selector module) OFF

q. SPEAKER/HEADSET switch (on selector module) OFF

The module test adapter is shown in figure 4-13. This unit functions as a module extender permitting operation of any module with the circuit board exposed to facilitate testing and troubleshooting.

4-11. TURN-ON AND PRELIMINARY CHECKS

a. Turn the POWER switch on. The adjacent power indicator should light up. Except for dim backlight glow in the selector module indicator lamps, no other lamps should be on nor should any reading be present on the meter.

b. Press the PRESS TO READ 24 v switch and verify that the meter reads 24 volts ± 0.6 volts. Position the 24 VDC SUPPLY VOLTAGE ADJ. if necessary.

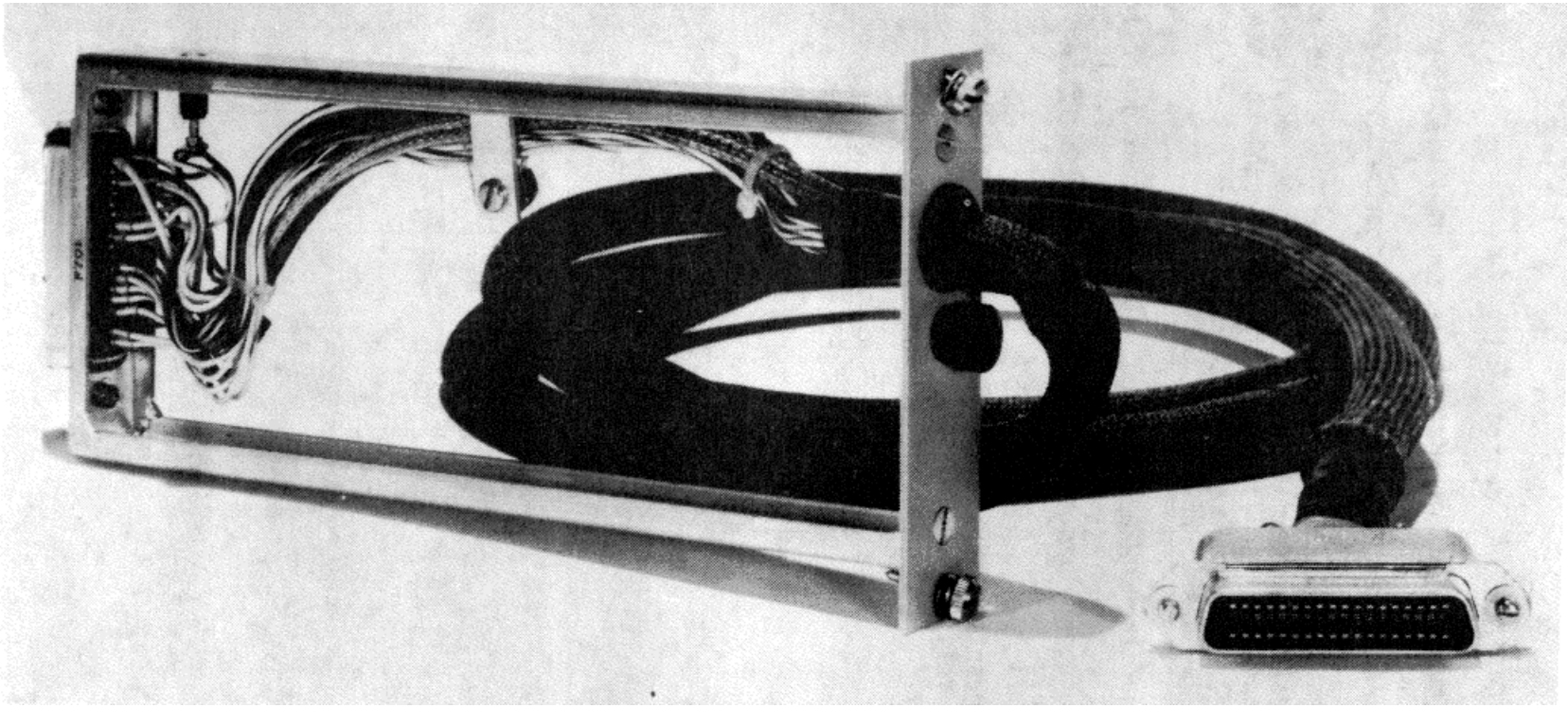

Figure 4-13. Module Test Adapter

Table 4-12. MODULE TEST SET, MICROPHONE AMPLIFIER/LAMP BRIGHTENER MODULE TEST

Step	Operation	Normal Indication
1	All module test set controls must be pre-set according to the procedure in paragraph 4-10.	
2	Set METER SCALE to 35 mv/-30 dB. Adjust OSCILLATOR LEVEL to -35 dBm.	
3	Set 20 dB ATTENUATOR switch to IN. This does not change meter reading signifi-cantly, but the input signal at T1201 in microphone amplifier is reduced to -55 dBm. Set 600 Ω DUMMY LOAD to OUT.	
4	Set METER SCALE to 1.1 v/O dB; OUTPUT SELECT to XMTR AUDIO; LOCK/NONLOCK switch to LOCK; P/T KEY switch to ON.	Observe the red and green lamps of the selec-tor module. They should come on brightly. Verify that they become dimmer as the LAMP BRIGHTENER control of the associated selector module is rotated counterclockwise, but still glows distinctly even at the CCW limit.
5	a. If a high degree of amplifier regula-tion is desired, the input level (R1202) and output level (R1230) adjustments should be at their maximum clockwise position.	The regulation level (R1218) adjust is posi-tioned for an output reading of between -5 dBm and 0 dBm, dependent on the installa-tion and site requirements. If the meter reading increases by more than 3 dB, R1218 should be adjusted to reduce the increase to no more than 3 dB.

Table 4-12. MODULE TEST SET, MICROPHONE AMPLIFIER/LAMP BRIGHTENER MODULE TEST (Cont'd)

Step	Operation	Normal Indication
	b. If no amplifier regulation was desired, the jumper between E21 - E22 may have been removed. If this is so, the regulation level (R1218) should be rotated fully clockwise. Flip the 20 dB ATTENUATOR switch to OUT. c. Regulating action other than the extremes described above (5a, 5b) may be required to suit a particular operating environment. If so, adjustments should be made in accordance with procedures established by authorized personnel.	The meter reading should be at least +10 dBm.
6	Press the XMTR LOAD switch.	Observe the meter reading. It should not drop more than 3 dB.
7	The microphone input should be unchanged (-55 dBm). Set the HEADSET VOLUME control fully clockwise. Set the INPUT SELECT switch to HEADSET and METER SCALE to 0.11 v/-20 dB.	The meter reading (sidetone signal) should be -25 $\pm$ 2 dBm.
8	Set METER SCALE to 0.35 v/-10 dB and the OUTPUT SELECT switch to MIXER ATIPL	The meter reading should be -10 $\pm$ 2 dBm.
9	Return all test set switching and controls to the initial positions indicated in paragraph 4-10.	

Table 4-13. MODULE TEST SET, RECORDER-MONITOR MODULE TEST

Step	Operation	Normal Indication
1	All module test set controls must be pre-set according to the procedure in paragraph 4-10.	
2	Set METER SCALE to 35 mv/-30 dB position. Adjust OSCILLATOR LEVEL to -30 dBm.	
3	Set INPUT SELECT switch to MONITOR and set 600 Ω DUMMY LOAD switch to OUT.	Syllabic indicator lamp should have a perceptable glow. If necessary, change the setting of the lamp threshold adjust R1313.
4	Set 600 Ω DUMMY LOAD SWITCH to IN; METER SCALE to 0.35 v/-10 dB. Adjust OSCILLATOR LEVEL DUMMY LOAD to -10 dBm.	
5	Set 600 Ω LEVEL DUMMY LOAD switch to OUT.	Syllabic indicator lamp should glow brightly. Also rapidly operate the test set INTERNAL/EXTERNAL switch back and forth to verify that the lamp flashes at a corresponding rate. Return switch to INTERNAL position.
6	Set INPUT SELECT switch to MICROPHONE. Set OUTPUT SELECT switch to OSCILLATOR. Set METER SCALE to 35 mv/-30 dB and the 600 n DUMMY LOAD switch to IN. Adjust OSCILLATOR LEVEL to -35 dBm.	
7	Set LOCK/NONLOCK (on selector module) to LOCK and P/T KEY switch to KEY.	

Table 4-13. MODULE TEST SET, RECORDER-MONITOR MODULE TEST (Cont'd)

Step	Operation	Normal Indication
8	Set 600 Ω DUMMY LOAD switch to OUT, METER SCALE to 0.35 v/-10 dB and OUTPUT SELECT switch to MIXER AMPLIFIER.	The meter should indicate -10 ± 2 dBm.
9	Return LOCK/NONLOCK switch and P/T switch to the OFF position. Set INPUT SELECT switch to RCVR-AUDIO and the OUTPUT SELECT switch to OSCILLATOR.	
10	Set 600 Ω DUMMY LOAD switch to IN, METER SCALE to 0.11 v/-20 dB and adjust OSCILLATOR LEVEL for -20 dBm. Set both volume controls on the front panel of the volume control module fully CW.	
11	Set 600 Ωn DUMMY LOAD switch to OUT, METER SCALE to 0.35 v/-10 dB and OUTPUT SELECT switch to MIXER AMPLIFIER.	
	a. Set the HEADSET/SPEAKER switch on the selector module to HEADSET.	The meter should read -10 ± 2 dBm.

Table 4-13. MODULE TEST SET, RECORDER-MONITOR MODULE TEST (Cont'd)

Step	Operation	Normal Indication
	b. Set HEADSET/SPEAKER select switch to SPEAKER. Set the OUTPUT SELECT switch to LOUDSPEAKER. Set METER SCALE to 3.5 v/ +10 dB. Turn LOUDSPEAKER VOLUME control on volume control module front panel CCW until meter reads 1.1 v. Turn the OUTPUT SELECT switch back to MIXER AMPLIFIER and the METER SCALE back to 0.35 v/-10 dB.	The meter should read -10 ± 2 dBm.
	c. Return HEADSET/SPEAKER select switch to center position.	Meter reading should be less than -47 dBm.
12	Set INPUT SELECT switch to TEL 1 and OUT-PUT SELECT switch to OSCILLATOR. Set 600 Ω switch to IN, METER SCALE to 35 mv/ -30 dB and adjust OSCILLATOR LEVEL to -30 dBm. Repeat step 8.	
13	Set INPUT SELECT switch to TEL 2.	Meter reading should remain at -10 ± 2 dBm.
14	Return all test set switches to the ini-tial position specified in paragraph 4-10.	

Table 4-14. MODULE TEST SET, VOLUME CONTROL MODULE TEST

Step	Operation	Normal Indication
1	All module test set controls must he preset according to the procedures in paragraph 4-10.	
2	Set METER SCALE to 1.1 v/O dB. Adjust OCILLATOR LEVEL to oddball. Set 20 dB attenuator switch to IN and INPUT SELECTOR switch to RCVR/AUDIO.	No significant change in meter reading but input signal reduced by 20 dBm.
3	OUTPUT SELECT switch to OUT. Set HEADSET/ SPEAKER switch of selector module to HEADSET. Set HEADSET VOLUME control on volume control module fully CW.	
4	a. If a high degree of regulation is required, first verify that the meter reading is between +1 dBm and -2 dBm. If necessary, adjust R1117 to achieve the meter reading. Then alternate the 20 dB attenuator switch from IN to OUT.	Meter reading should not increase more than 2 dB.
	b. If no regulation was required, the jumper from E22 to E21 may have been removed. If this is so, R1117 should be positioned fully CW. Set 20 dB attenuator switch to IN.	Meter reading should be at least +10 dBm as read on the highest range of METER SCALE Switch.

Table 4-14. MODULE TEST SET, VOLUME CONTROL MODULE TEST (Cont'd)

Step	Operation	Normal Indication
	c. Intermediate regulation levels may be required to suit the particular operating environment. In this case, the authorized personnel should establish the procedure.	
5	Turn HEADSET VOLUME control from full CW position to full CCW position.	Meter reading shows some decrease to verify operation of the control. Return control to full CW position.
6	Set 20 dB ATTENUATOR switch to IN, METER SCALE to 3.5 v/+10 dB and the OUTPUT SELECT switch to LOUDSPEAKER. Set HEADSET/SPEAKER switch on selector module to SPEAKER. Turn SPEAKER VOLUME control fully CW. Turn SPEAKER VOLUME control from full CW position to full CCW position.	Meter reading should be at least 1.1 v. Meter reading should decrease. Return SPEAKER VOLUME control to full CW position.
7	Set 20 dB ATTENUATOR switch to IN, INPUT SELECT switch to MICROPHONE and the OUTPUT SELECT switch to OSCILLATOR. Set METER SCALE to 35 mv/-30 dB and adjust OSCILLATOR LEVEL to obtain a meter reading of -35 dBm.	

Table 4-14. MODULE TEST SET, VOLUME CONTROL MODULE TEST (Cont'd)

Step	Operation	Normal Indication
8	Set the METER SCALE 0.11 v/-20 dB and the OUTPUT SELECT switch to HEADSET. Set the LOCK/NONLOCK switch on the selector module to the LOCK position and the P/T KEY switch to ON.	Meter should read -25 dBm ± 2 dBm (sidetone signal).
9	Turn P/T KEY switch to OFF and then the INTERLOCK switch to ON. Set the 3.2 Q DUMMY LOAD switch to SPEAKER and the METER SCALE to 3.5 v/+10 dBm.	
10	Turn the P/T KEY switch to ON.	Busy tone should be heard on the loudspeaker and a reading should be observed on the meter.
11	All switches and controls should be returned to the initial positions specified in paragraph 4-10.	Busy tone should be heard on the loudspeaker and a reading should be observed on the meter.

Table 4-15. MODULE TEST SET, SELECTOR MODULE TEST

Step	Operation	Normal Indication
1	All module test set controls must be preset according to the procedures in paragraph 4-10.	
2	Set METER SCALE to 35 mv/-30 dB. Adjust OSCILLATOR LEVEL to -35 dBm.	
3	a. Set METER SCALE to 1.1 v/O dB, OUTPUT SELECT to XMTR AUDIO. Set 600 Ω switch to OUT, P/T KEY switch to ON. Set LOCK/ NONLOCK switch first to LOCK, then NONLOCK position.	Meter reading should be identical to that observed in table 4-11, step 5. Both red and green indicator lamps in the upper part of the indicator display of the selector module should go ON. Also, the channel keyed and channel busy lamps on the test set should go on.
4	Place LOCK/NONLOCK switch on LOCK. On the test set, turn the P/T KEY switch to OFF and then turn the INTERLOCK switch to ON.	Channel busy lamp should light.
5	a. Turn LOUDSPEAKER VOLUME control on VOLUME CONTROL module fully CW. Set 3.2 Ω DUMMY LOAD switch to SPEAKER and the P/T KEY switch to ON at the test set.	A busy tone should be heard at the loud-speaker. No reading should appear on the meter. The selector module red and green lamps go on but the channel keyed lamp on test set should remain OFF.

Table 4-15. MODULE TEST SET, SELECTOR MODULE TEST (Cont'd)

Step	Operation	Normal Indication
	b. Turn LOCK/NONLOCK switch to off. Turn test set P/T KEY and INTERLOCK switches to OFF. Return 3.2 Ω DUMMY LOAD switch to 3.2 Ω. position.	
6	Set METER SCALE to 0.11 v/-20 dB, INPUT SELECT switch to RCVR AUDIO and OUTPUT SELECT switch to OSCILLATOR. Adjust OSCILLATOR LEVEL to 0.042 v.	The amber lamp (DS1002) on selector module should have a perceptible glow. If not Perceptible adjust R1003, the threshold adjust potentiometer until the lamp just glows.
7	Set METER SCALE to 1.1 v/O dB. Adjust OSCILLATOR LEVEL to 0.424 v.	DS1002 should now glow brightly.
	Rapidly operate the INTERNAL/EXTERNAL switch back and forth on the test set.	The lamp should flash at a corresponding rate.
8	Set METER SCALE to 0.35 v/-10 dB. Adjust OSCILLATOR LEVEL to 0.134 v. Set both levels of the volume control fully CW.	
	Set OUTPUT SELECT switch to HEADSET and METER SCALE to 1.1 v/O dB. Place HEADSET/ SPEAKER switch on selector module to HEADSET.	Meter should read 0 ± 1 dBm.

Table 4-15. MODULE TEST SET, SELECTOR MODULE TEST (Cont'd)

Step	Operation	Normal Indication
10	Set OUTPUT SELECT switch to LOUDSPEAKER. Set HEADSET/SPEAKER switch to LOUDSPEAKER.	Meter should read at least 1.1 v.
11	Return all test set switches and controls to the initial positions specified in paragraph 4-10.	

Table 4-16. MODULE TEST SET, JACK PANEL TEST

Step	Operation	Normal Indication
1	All module test set controls must he preset according to the procedure in paragraph 4-10.	
2	Using the cables provided, hook up the jack panel test set. a. Connect the twin plug cable between the INSTR jacks on the test set and the HEADSET jacks on the jack panel. b. Connect the jack panel cable plug to socket J10 on the test set.	
3	Set the METER SCALE switch to the 0.35 v/ -10 dB position; set the 600 Q DUMMY LOAD switch to the OUT position; set the CONTR-INSTR switch to the INSTR position and adjust the OSCILLATOR LEVEL to 0.18 volt. This results in -11 dBm input at 50 ohms to the jack panel.	
4	Set the OUTPUT SELECT switch to XMTR AUDIO; set the LOCK/NONLOCK switch on the selector module to the LOCK position. Turn the P/T KEY switch to ON.	A meter reading the same as in table 4-11, step 5 should be obtained. After taking the meter reading turn the P/T switch to OFF.

Table 4-16. MODULE TEST SET, JACK PANEL TEST (Cont'd)

Step	Operation	Normal Indication
5	With the Jack panel cables in place, set up the test set volume control module test described in table 4-14, steps 1 through 4.	As in step 4a of Table 4-13 the meter reading should be between +1 dBm and -2 dBm with the 20 dB ATTENUATOR switch at IN. The meter reading should not increase more than 2 dB with 20 dB ATTENUATOR switch at OUT.
6	Repeat steps 1 through 4 of this table except remove the twin plug cable from the Jack panel and connect a low level M-80C or equivalent microphone to connector J303. Operate the microphone key and whistle into the microphone.	The test set meter should jump to a reading close to 0 dBm.
7	Remove the low level microphone and connect an M-109 or equivalent headset to the high level microphone connector J305. As in step 6, key the headset and whistle into the microphone.	The meter reading should jump to a value close to 0 dBm.
8	All switches and controls should be returned to the initial positions specified in paragraph 4-10.	

Table 4-17. MODULE TEST SET, SPEAKER AMPLIFIER TEST

Step	Operation	Normal Indication
1	All module test set controls must be preset according to the procedure in paragraph 4-10.	
2	Set METER SCALE switch to the 1.1 v/O dB position. With the 600 Ω DUMMY LOAD switch to IN, set the OSCILLATOR LEVEL to 0 dBm.	
3	Set the 20 dB ATTENUATOR switch to IN; the INPUT SELECTOR switch to RCVR AUDIO; the OUTPUT SELECTOR switch to LOUDSPEAKER; the METER SCALE switch to 3.5 v/10 dB. Set the 600 Ω DUMMY LOAD switch to OUT position.	
4	Set the SPEAKER/HEADSET switch on the selector module to the SPEAKER position.	
5	Turn SPEAKER VOLUME control on volume control module to full CW position. Turn 3.2 Ω DUMMY LOAD switch on test set to the SPEAKER position.	A meter reading of 1.1 v minimum should be obtained. A clear tone should be heard.
6	All switches and controls on test set should be returned to the initial positions specified in paragraph 4-10.	

Section V. TROUBLESHOOTING

SECTION CONTENTS **Page**

4-12. GENERAL

a. Troubleshooting may be viewed as occurring at two distinct levels. The first level involves locating and repairing those malfunctions that result in an inoperative system which requires immediate attention. The symptoms are readily apparent and the fault must be localized to a particular module or assembly so as to facilitate repair. The faulty module may then be replaced to restore system operation, minimizing "down" time. The malfunctioning module may be installed in the MTS-2400 module test set for testing and troubleshooting.

b. The following tables in this chapter can be of assistance in localizing and locating the first level malfunctions:

c. Tables 4-1, 2, 3, 4. These tables contain normal voltage measurements taken at key points in the system modules. Comparison of voltage measurements can help to localize malfunctions.

d. Table 4-5. This table contains normal resistance measurements taken in the selector module.

e. Table 4-18. This table is located in this section and contains a comprehensive list of gross malfunctions that could occur in the system. The faults or symptoms resulting from these malfunctions as well as a tabulation of checks and procedures for troubleshooting them are included in the table. The malfunctions are localized to three board circuit areas; transmitting circuits, receiving circuits, and lamp displays.

f. A second level of troubleshooting involves those malfunctions that degrade system performance, but the system remains operational. These malfunctions can be detected and repaired using the system test procedures described in section II and section III of this chapter.

g. The circuit schematic diagrams, circuit board assembly and wiring diagrams and unit wiring diagrams provided in this manual (APPENDIX A) should all be used to facilitate module troubleshooting.

Table 4-18. TROUBLESHOOTING CHART

Item	Fault	Check/Corrective Action
General		
1	Equipment inoperative, fuseholder lamp is lit.	Fuse F1201 is open. Isolate cause of overload to particular module. Pull connectors J106, J107, J108 and J102.Replace F1201 and then reconnect the connectors in sequence until the fuse blows and the offending module is isolated. Trace the +24 v bus in that module until the "short" is located.
2	Equipment inoperative. No transmit or receive function.	a. Does DSLO1 the POWER ON indicator light on closing switch S101?. If not, check connector J105 for loose connection to P105. Also check for presence of +24 v from Dower source or a defective S101. b. If DS101 lights, then check connectors P301 and J101 for proper mating. Also check J102 and P204 for proper mating.
Lamp Monitors		
3	No indicator lamps operate in selector module. DS101 lit.	a. Check for presence of unfiltered +24 v in selector module. b. Check for open Q1007 in selector module.
4	Indicator lamps light but brightness cannot be controlled.	Check for shorted Q1205 for microphone amp/lamp brightness module.

Table 4-18. TROUBLESHOOTING CHART (Cont'd)

Item	Fault	Check/Corrective Action
5	Red lamp DS1004 does not light when channel is engaged or busy.	a. Check lamp for open filament. b. Check for defective stage U1001D c. Check for open Q1006
6	1 Audio is received but amber syllabic indicator lamp inoperative in selector module.	a. Check for open filament in DS1002 b. Check for open Q1004 c. Check for Q1001 or Q1003 defective d. Check for CR1001 or CR1002 defective
7	Recorder-monitor syllabic lamp indicator inoperative	a. Lamp filament open b. Transistors Q1 through Q3 may be defective c. Check diodes CR3, CR4
Transmitting Circuits		
8	No channels can be keyed. Green lamp but not red lamp lights on the selector unit.	a. Defective microphone P/T switch b. Diode CR301 shorted. Prevents keying when using high level microphone c. Loose connection between microphone or headset plug and the jack on the HEADSET/ MICROPHONE jack panel assembly. d. Plug P301 loose at jack J102

Table 4-18. TROUBLESHOOTING CHART (Cont'd)

Item	Fault	Check/Corrective Action
9	A channel cannot be keyed. Green lamp lights but red lamp does not on the associated selector unit.	a. Diode CR1013 open b. U1001 defective c. Q10OB defective
10	A channel cannot be keyed. Neither green nor red lamp lit on associated selector unit.	a. Switch S1002 defective b. Loose connection between selector unit plug P204 and audio unit jack J102 or selector unit jack J204
11	A channel cannot he keyed. Green and red lamp both lit on the associated selector unit.	a. Relay K1001 defective b. Loose or defective connection to radio channel equipment from the output of this channel.
Receiving Circuits		
12	No channels can be keyed. Green and red lamps on selector unit both lit.	a. Interlock bus shorted to ground Fault must be removes b. Defect in transmitting equipment.
13	No audio signal reaches the keyed transmitter.	a. Defective microphone, b. Loss of audio in microphone amplifier module. Check U1201, regulated amplifier (U1202, U1204, Q1201), Q1202, Q1203, and Q1205. c. Loss of audio in the selector unit. Check for Q1010, Q1011

Table 4-18. TROUBLESHOOTING CHART (Cont'd)

Item	Fault	Check/Corrective Action
		d. Transmitter channel status bus to U1205C is open. Check connections between selector unit assembly and audio unit assembly. Check for open diode CR1006.
14	No busy tone heard when attempting to key an already keyed channel.	a. Check for open busy-tone enable bus. Check for Q1009 or defective U1OO1B b. Defective busy-tone generator. Check Q1105.
15	No sidetone heard while transmitting but received audio functions properly.	Check stage U1205D.
16	No audio at headset from any receiving channel; loudspeaker audio functions properly.	a. Defective headphones b. Defective headset amplifier in volume control module. Check UllOl1, U1103, Q1103, Q1104 and the regulated amplifier (U1102, U1104, Ql101).
17	No audio at the loudspeaker from any receiving channel; headset audio functions properly.	a. Defective loudspeaker LS101 b. Stage U1105 in volume control module defective. c. Speaker amplifier defective. Check for Q1401, Q1402, Q1403, Q1404, Q1405.
18	No audio at loudspeaker or headset from any receiving channel. Syllabic lamp DS1002 flashing. No channel can be keyed to transmit.	Interlock bus shorted to ground. Locate and remove fault.

Table 4-18. TROUBLESHOOTING CHART (Cont'd)

Item	Fault	Check/Corrective Action
19	No audio at loudspeaker or headset on a single channel. Syllabic lamp lighting.	Check for defective Q1002 or Q1005.

APPENDIX A

REFERENCES

A-1. SCOPE

The pertinent reference publications mentioned below are relevant to material covered in this technical manual. The indexes referred to should be consulted frequently for the latest changes or revisions of references given in this appendix.

A-2. INDEXES AND FORMS

Index of Technical Publications ..... DA PAM 310-4
Recommended Changes to DA Publications ..... DA Form 2028-2

A-3. PUBLICATIONS

Painting and Preservation of Supplies Available for
Field Use for Electronics Command Equipment ..... SB 11-573
Preservation, Packaging, Packing and Marking Materials,
Supplies, and Equipment used by the Army ..... SB 38-100
The Army Maintenance Management System (TAMMS) ..... TM 38-750
Administrative Storage of Equipment ..... TM 740-90-1
Procedures for Destruction of Electronics Materiel to
Prevent Enemy Use (Electronics Command) ..... TM 750-244-2

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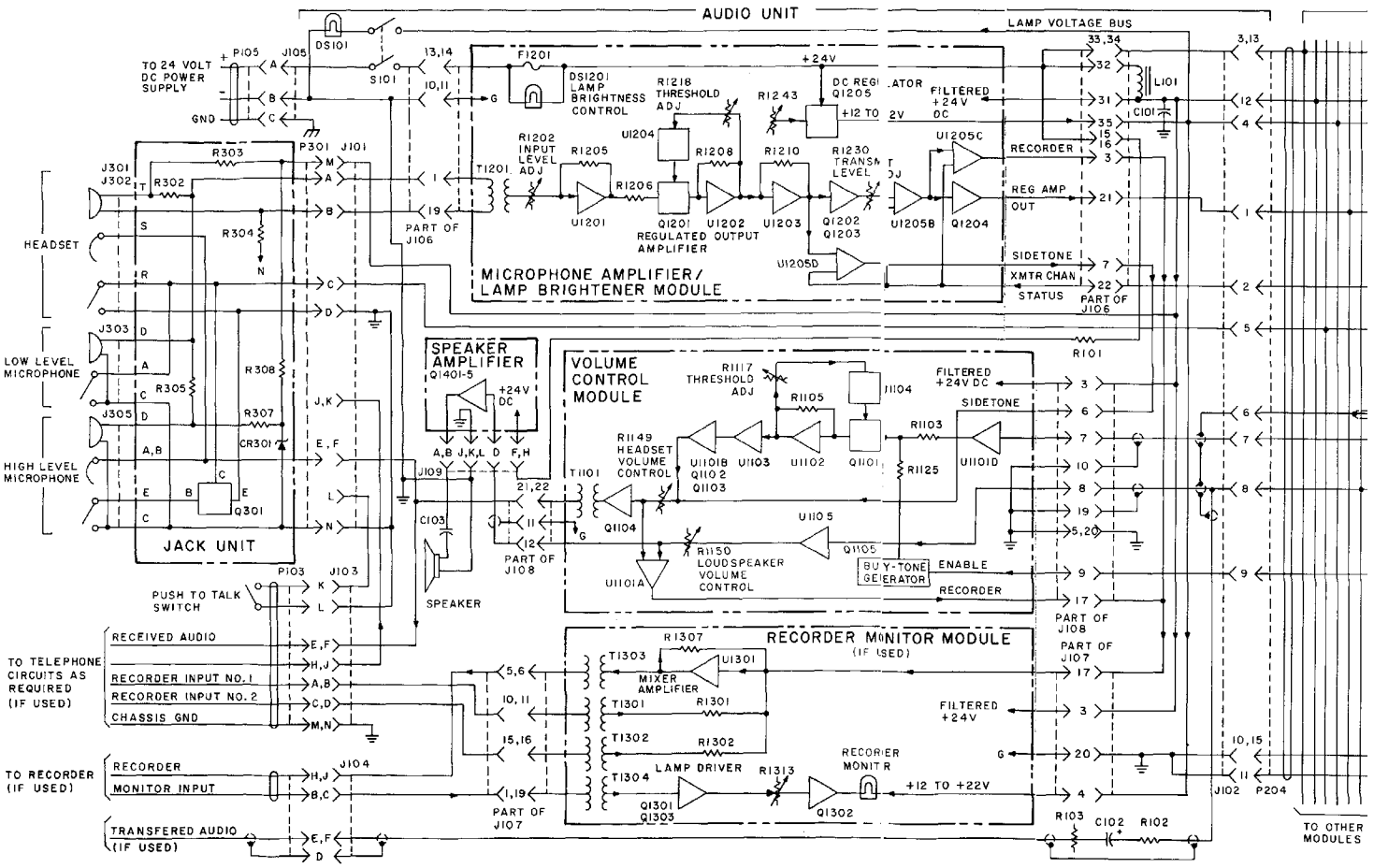

Figure FO-1. Operator's Block Diagram

Change 1

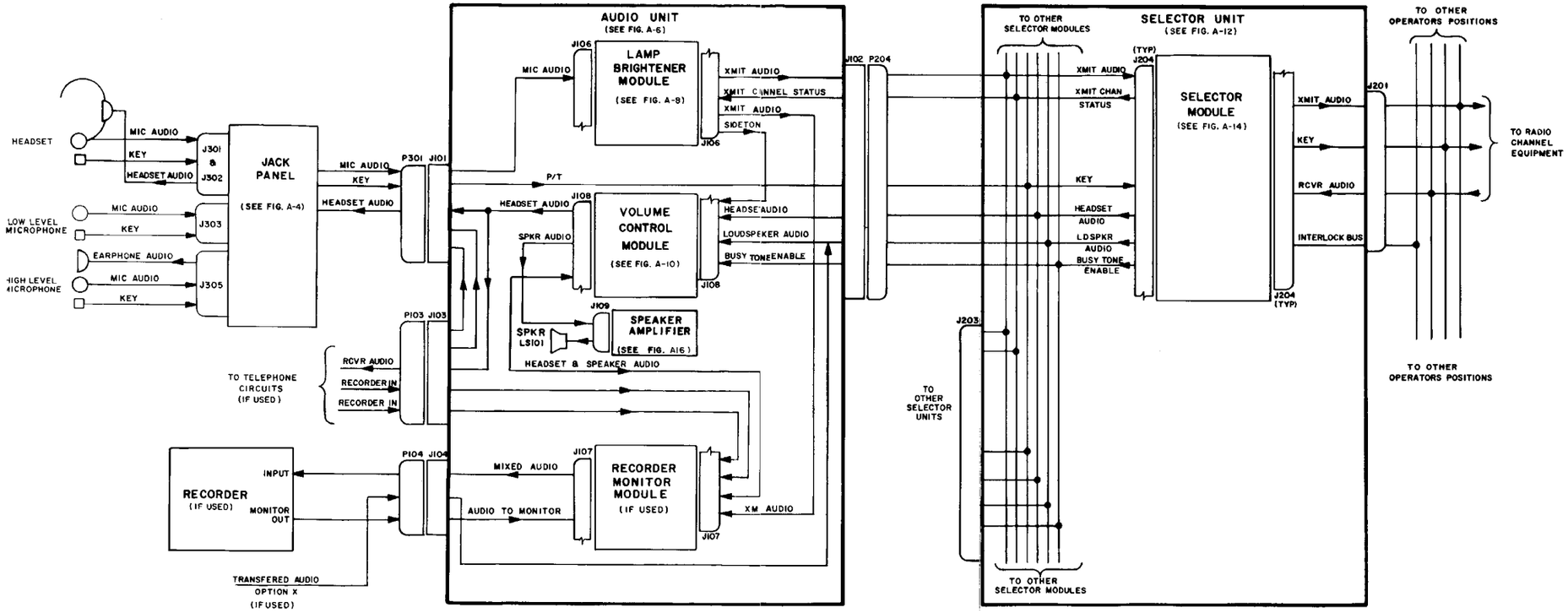

Figure FO-2. Operator's Position Signal Flow Diagram

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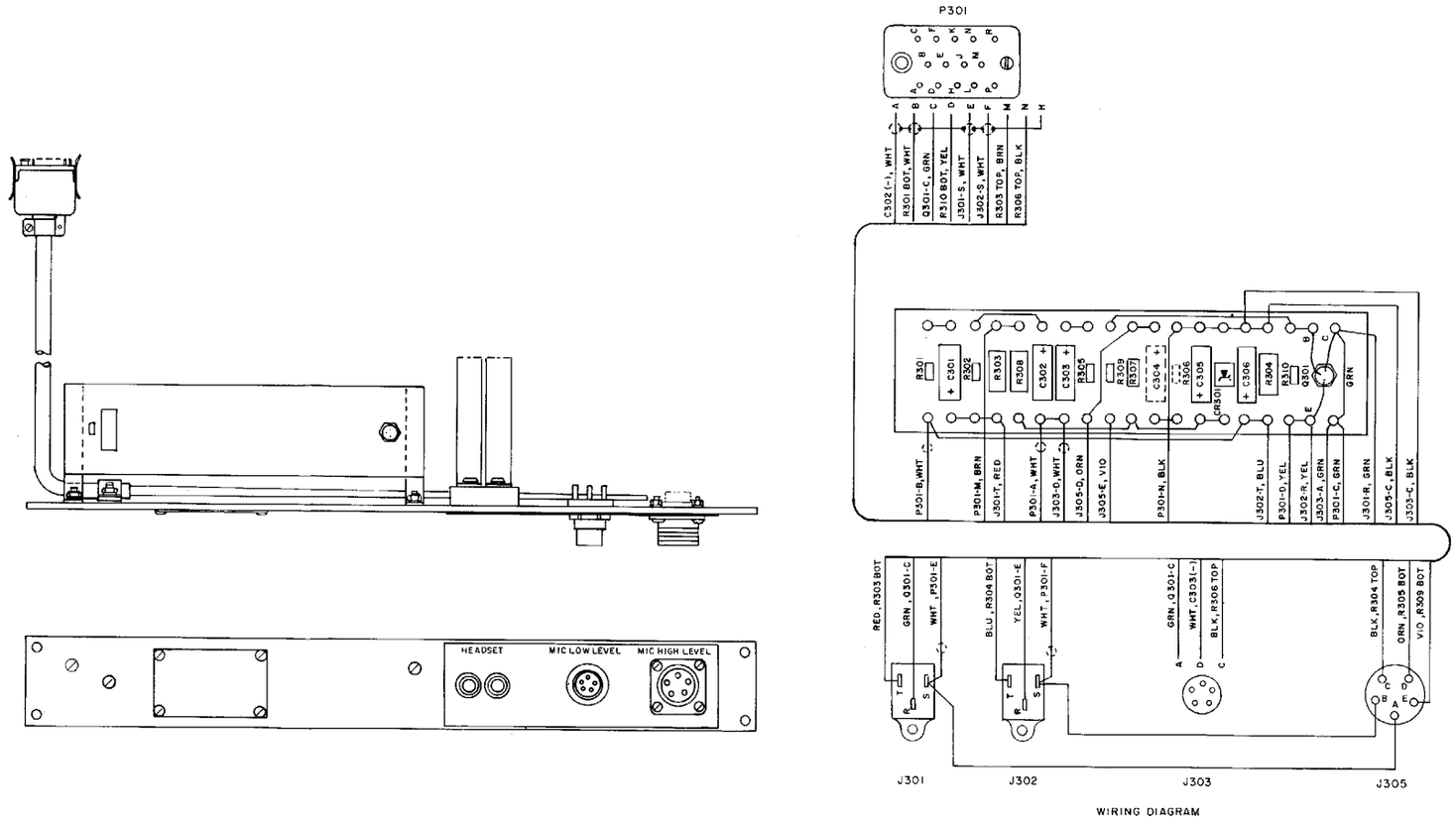

Change 1

Figure FO-3. Jack Panel Board Assembly and Wiring Diagram

Change 1

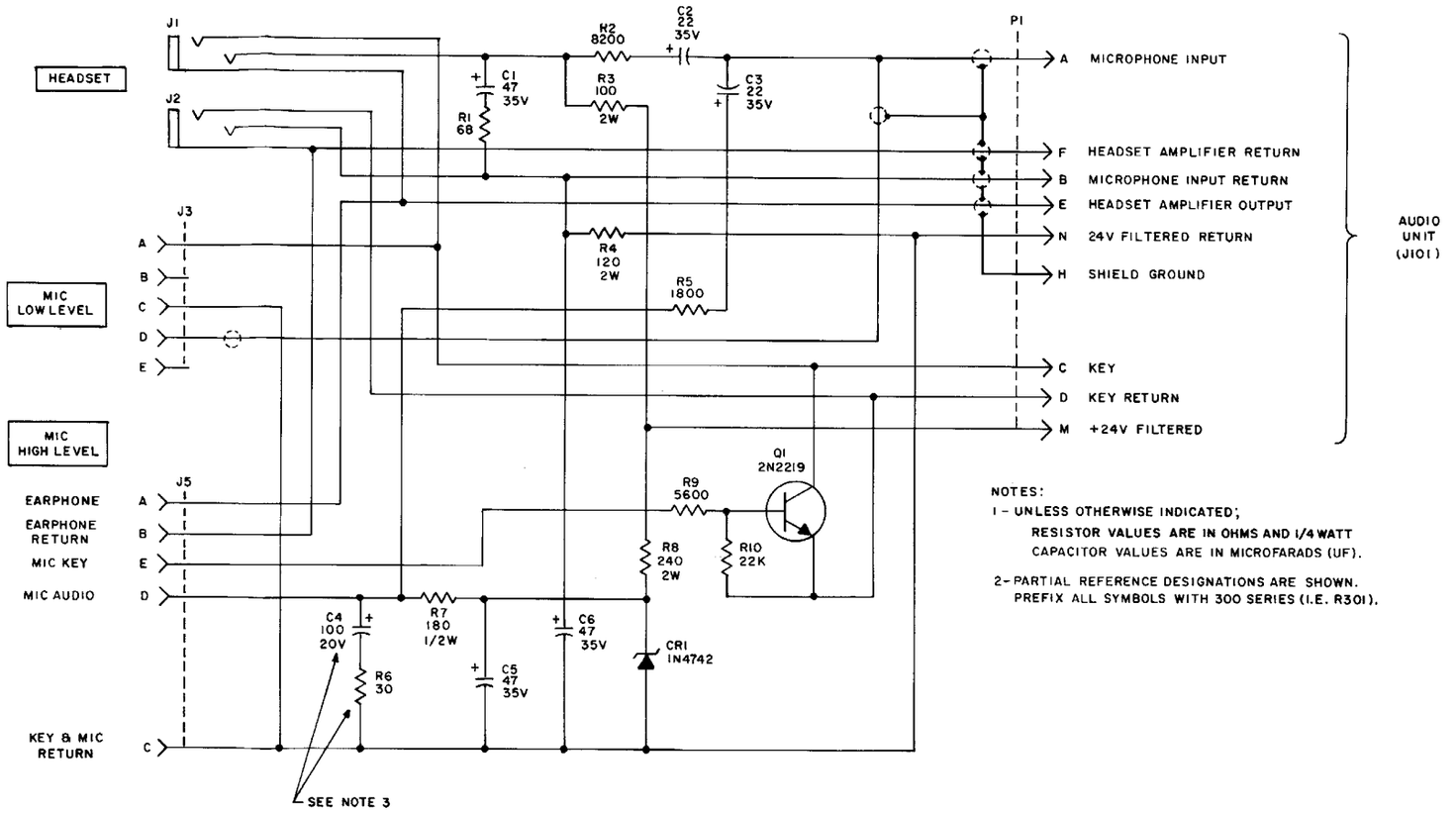

Figure FO-4. Jack Panel Schematic

Change 1

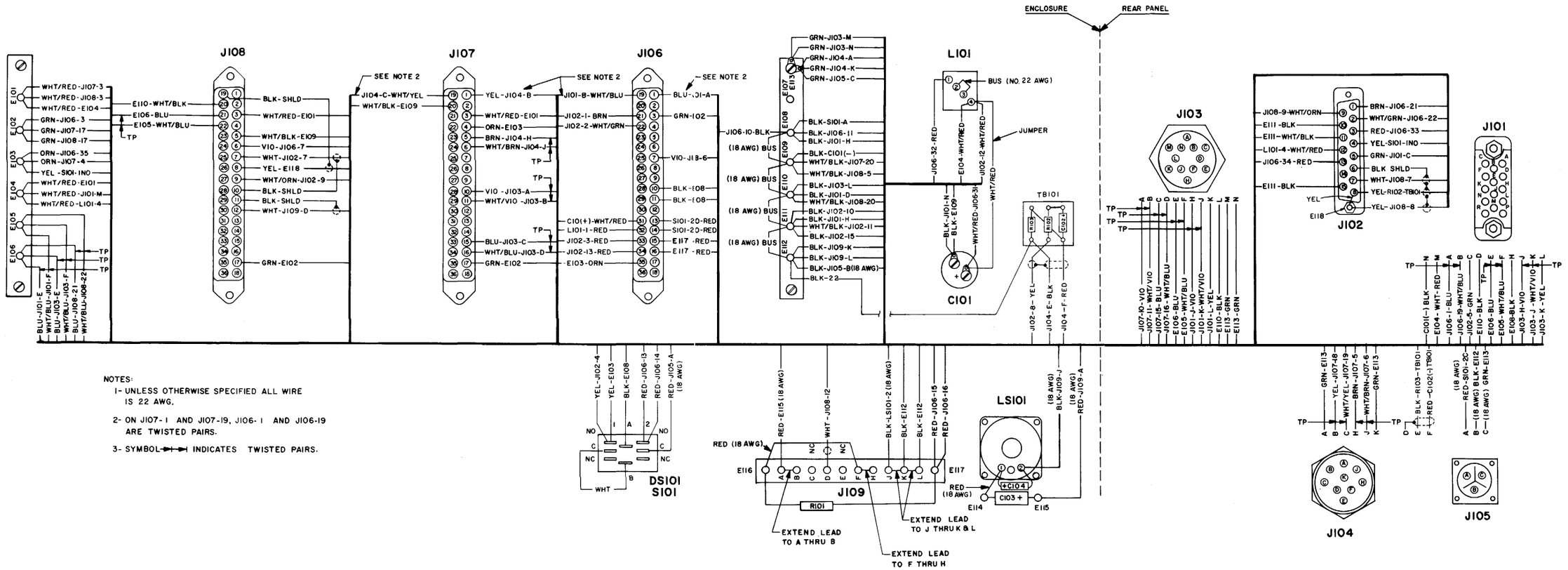

Figure FO-5. Audio Unit Wiring Diagram

Change 1

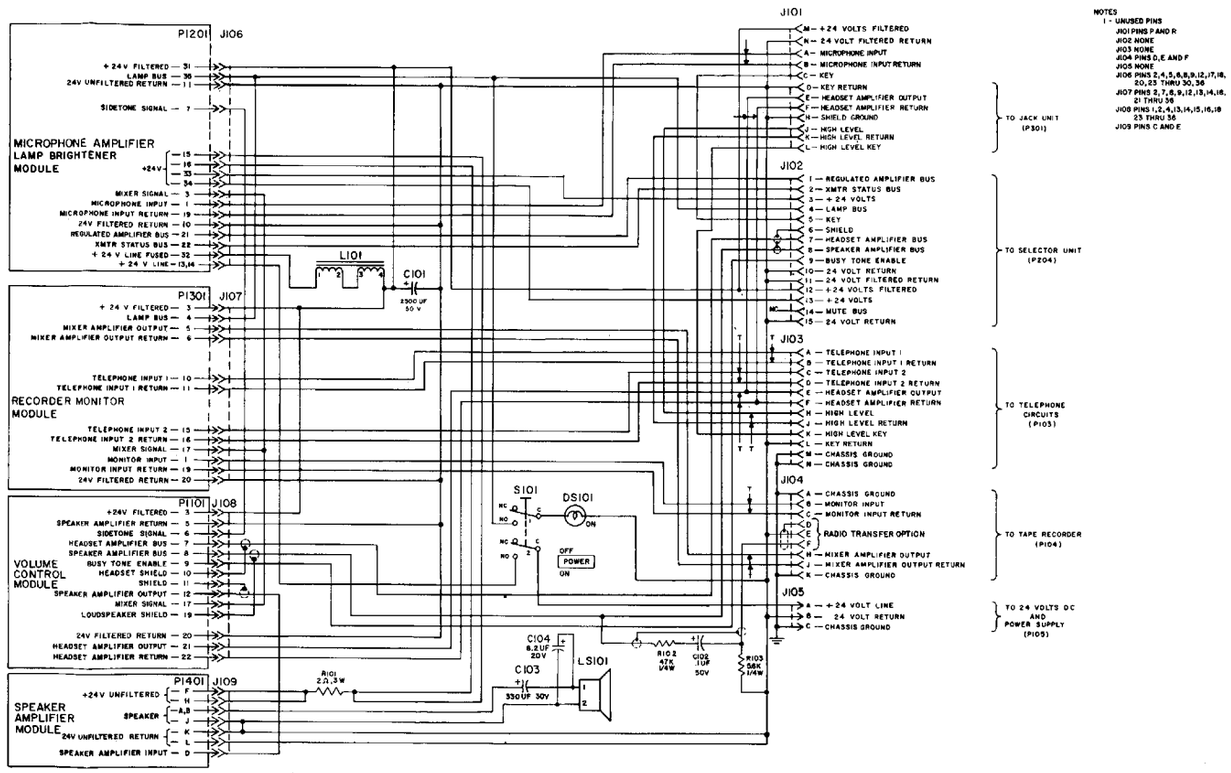

Figure FO-6. Audio Unit Schematic Diagram

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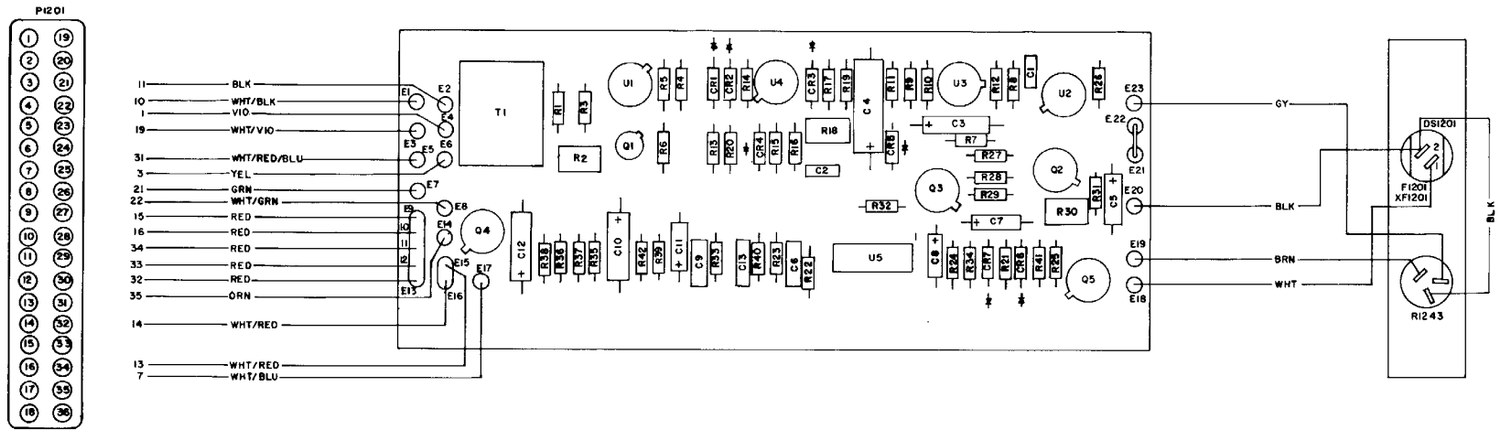

Figure FO-7. Microphone Amplifier/Lamp Brightness Module Board Assembly and Wiring Diagram

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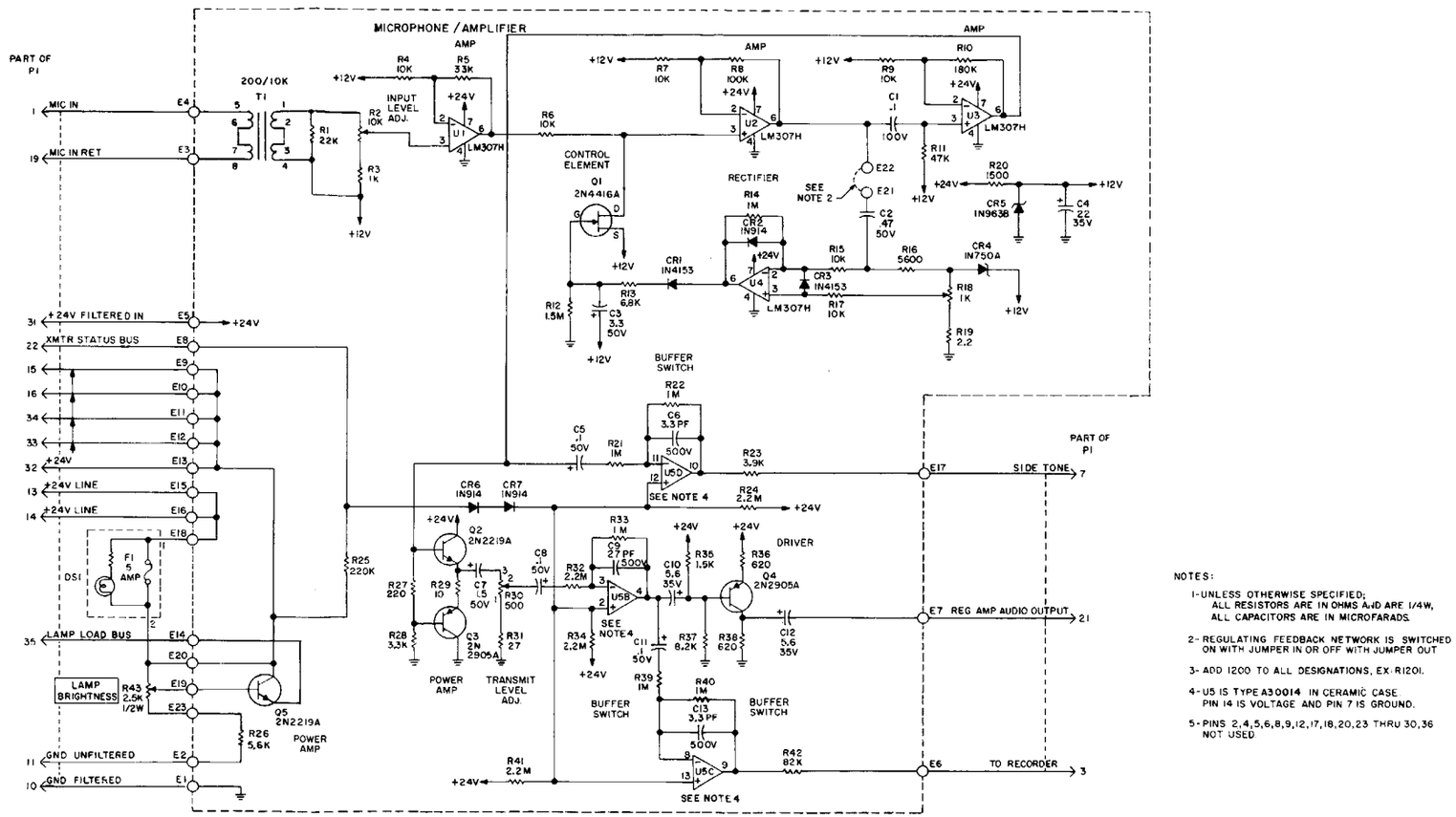

Figure FO-8. Schematic diagram - Microphone Amplifier - Lamp Brightener Module

Change 1

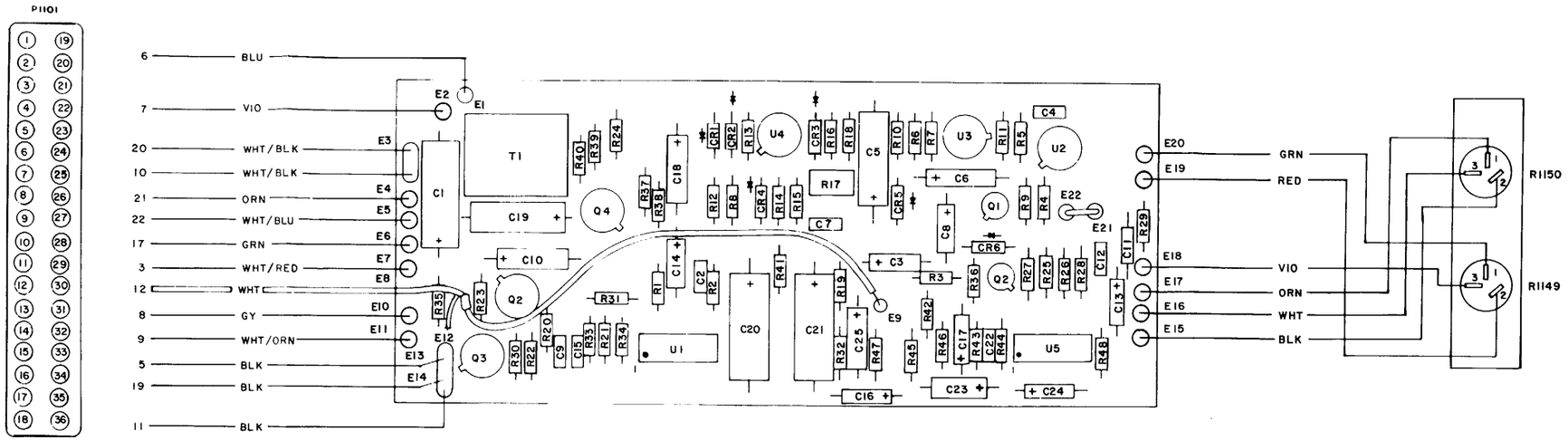

Figure FO-9. Volume Control Module Board Assembly and Wiring Diagram

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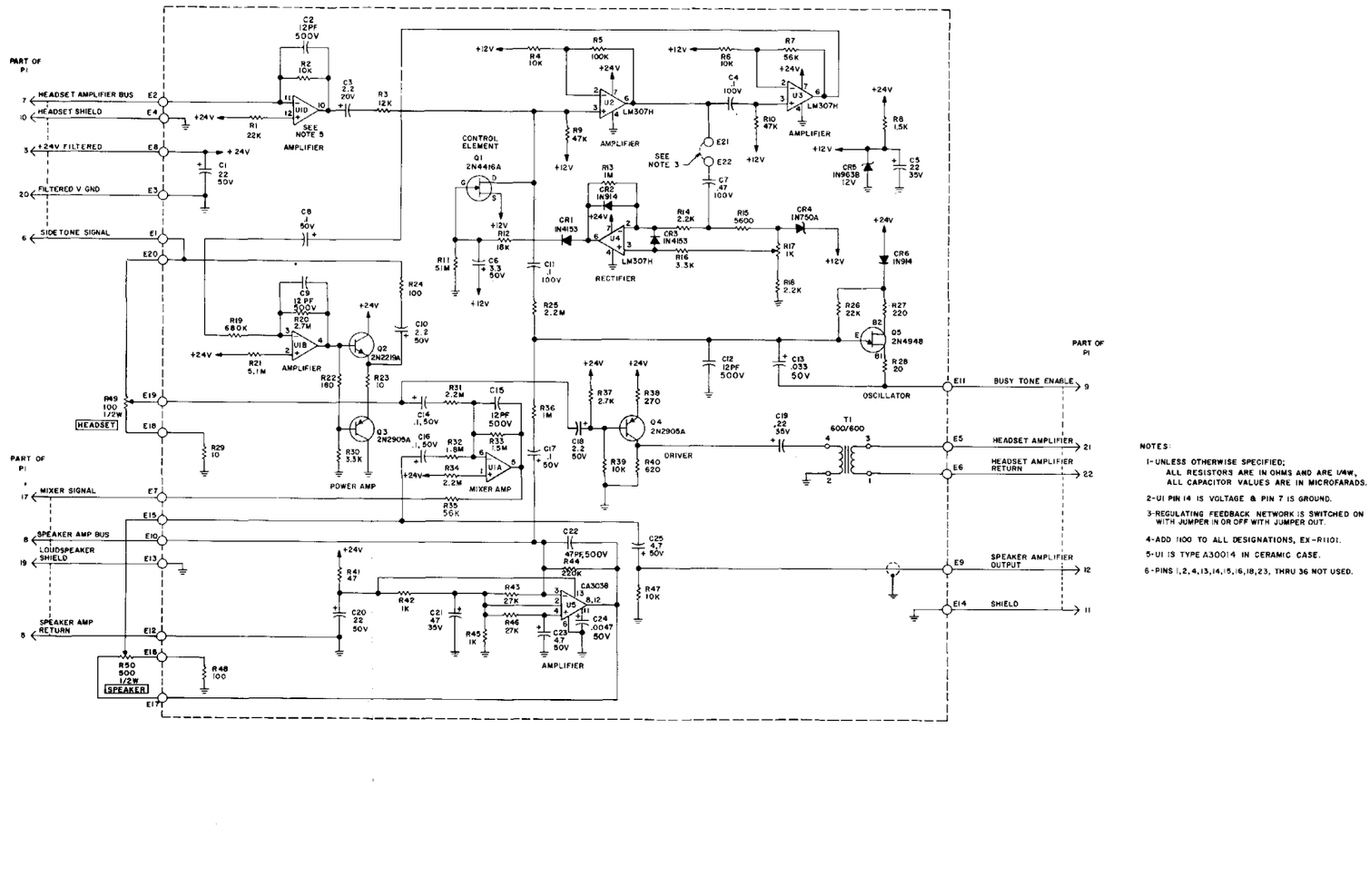

Figure FO-10. Schematic Diagram
Volume Control Module

Change 1

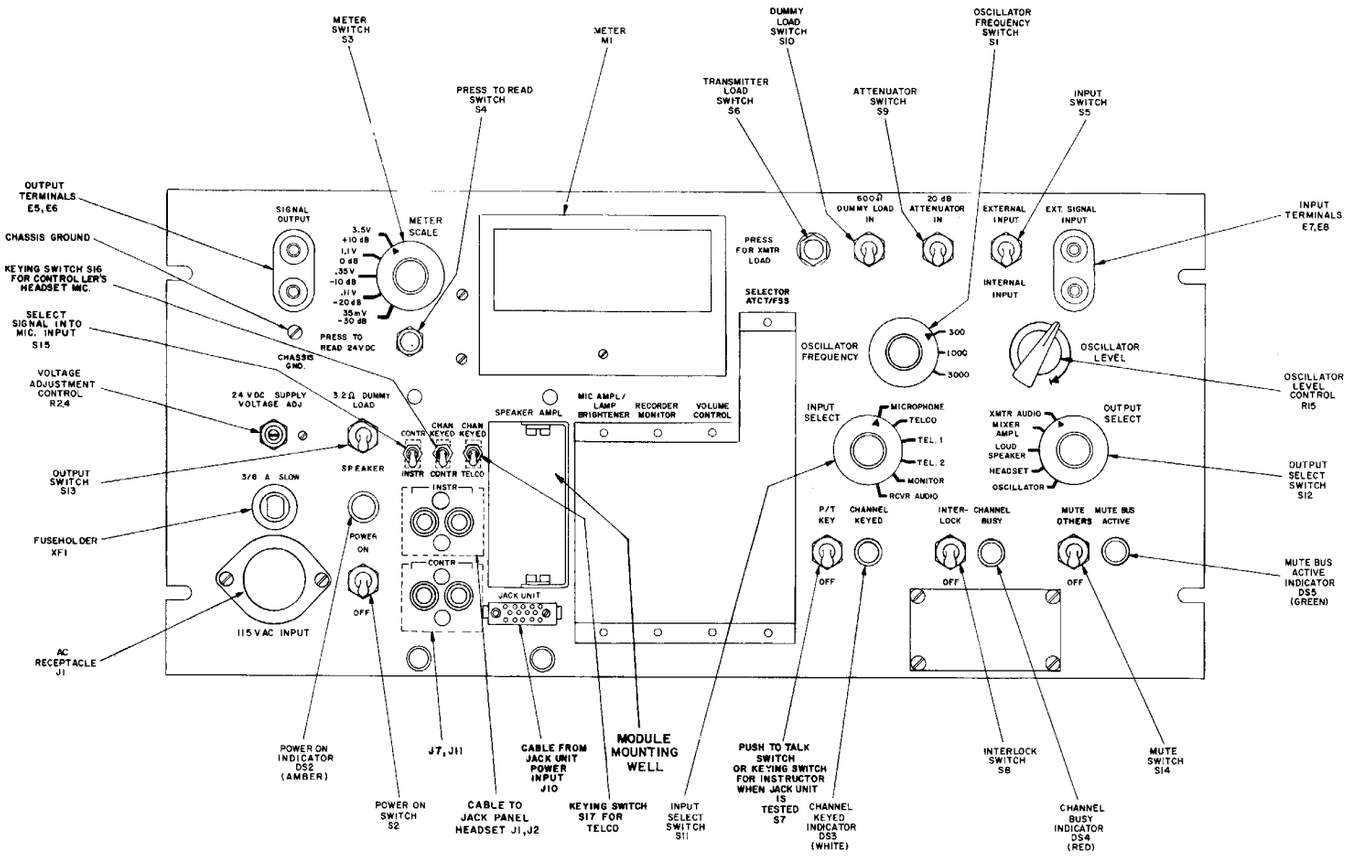

Figure FO-11. Controls and Indicators Module Test Set

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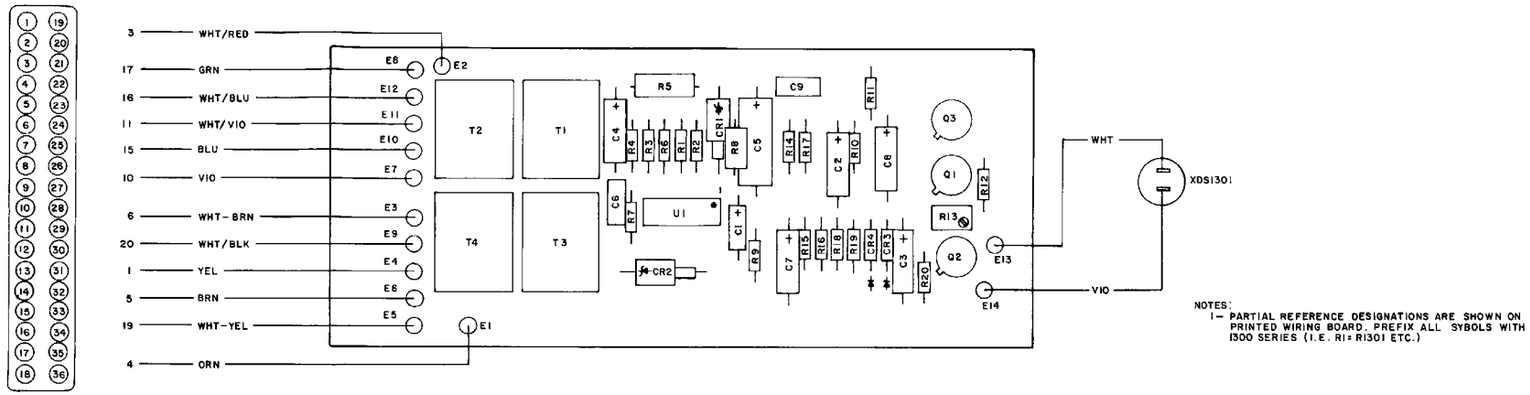

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Figure FO-12. Recorder Monitor Module Board Assembly and Wiring Diagram

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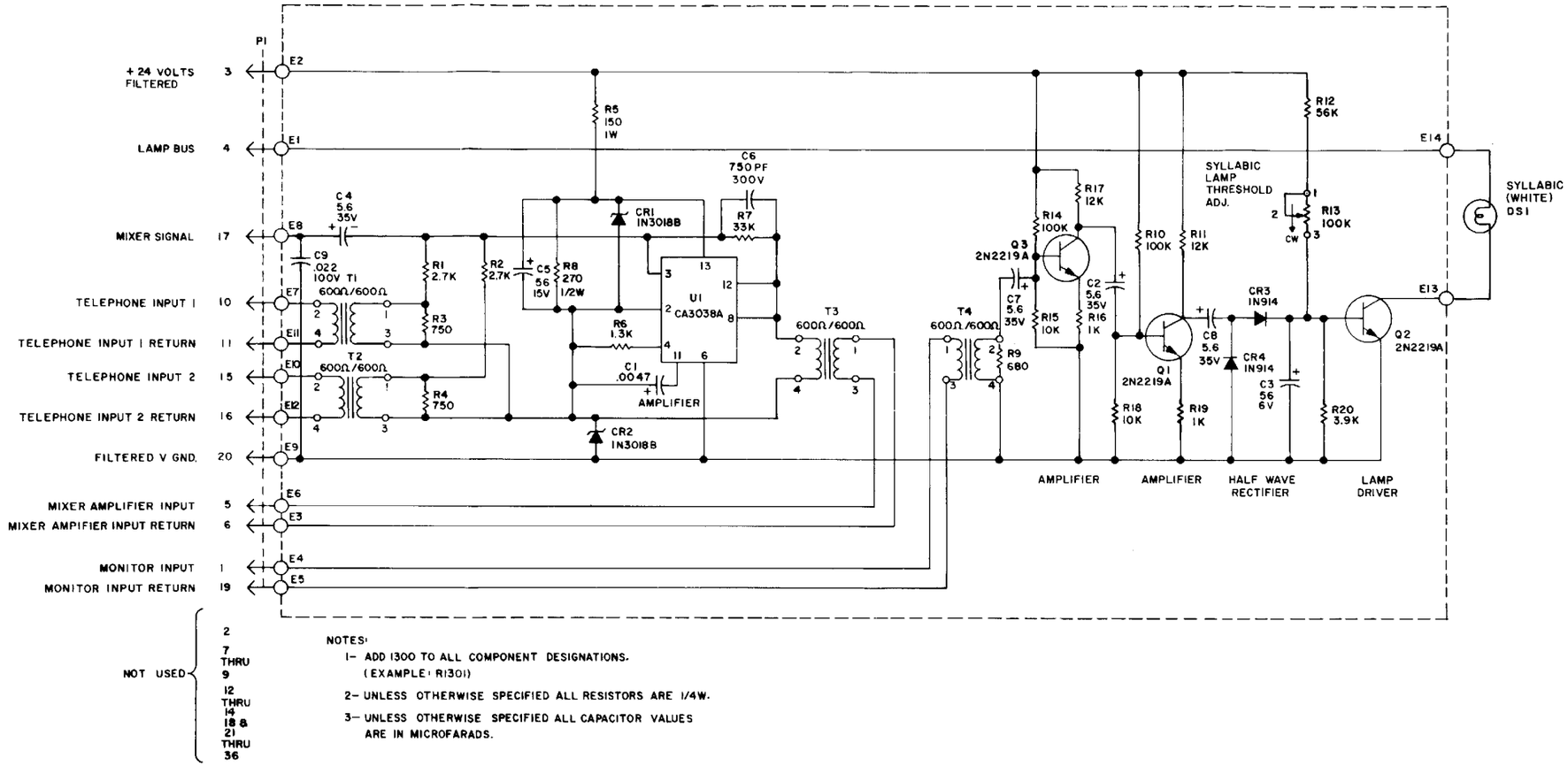

Figure FO-13. Schematic Diagram - Recorder Monitor Module

Change 1

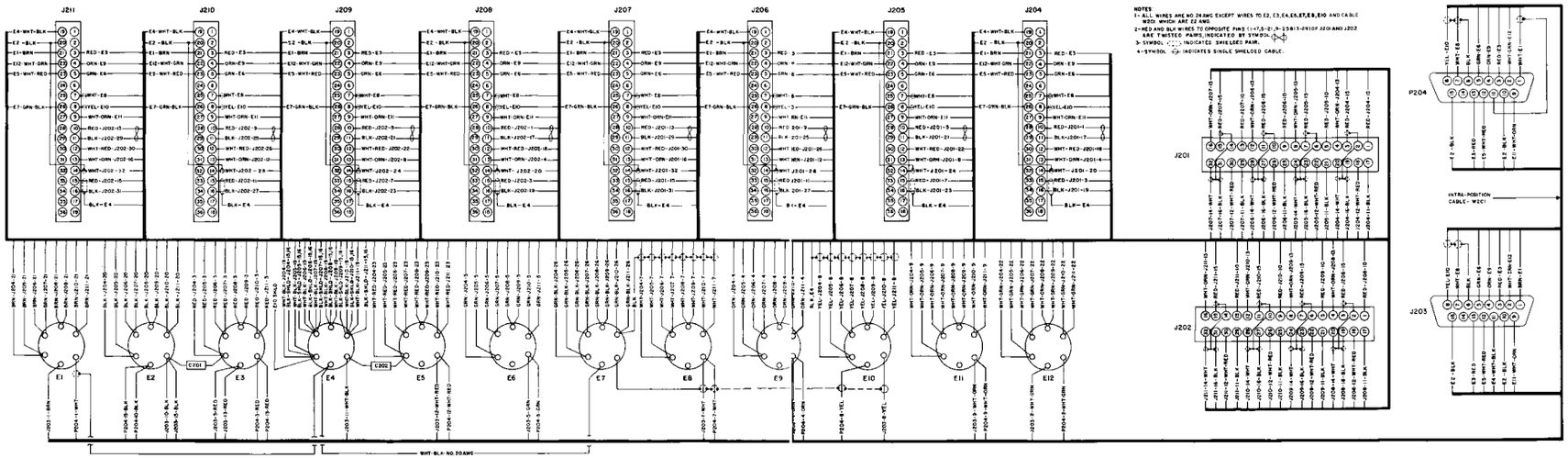

Figure FO-14. Selector Unit Wiring Diagram

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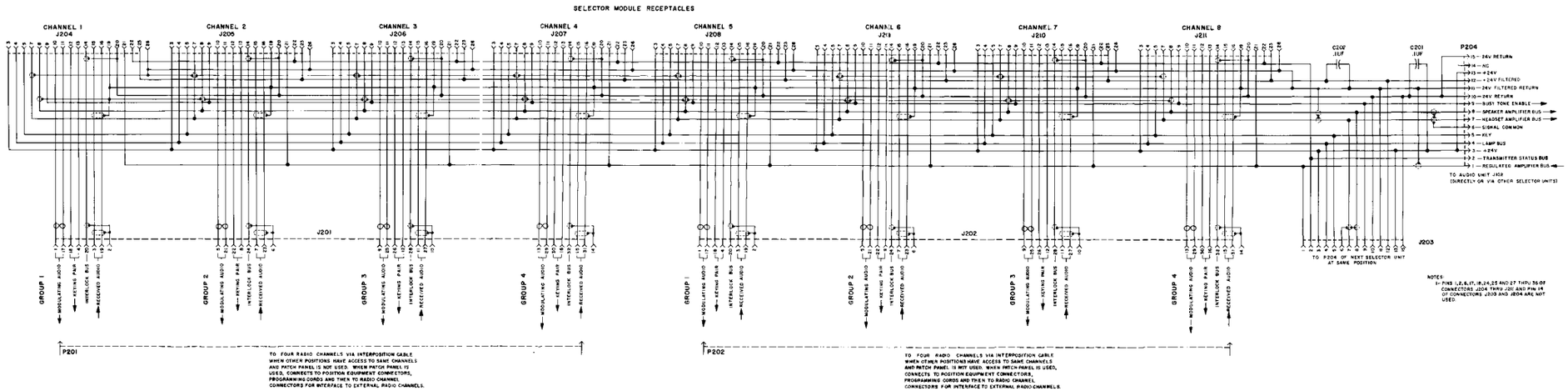


Figure FO-15. Selector Unit Schematic Diagram

Change 1

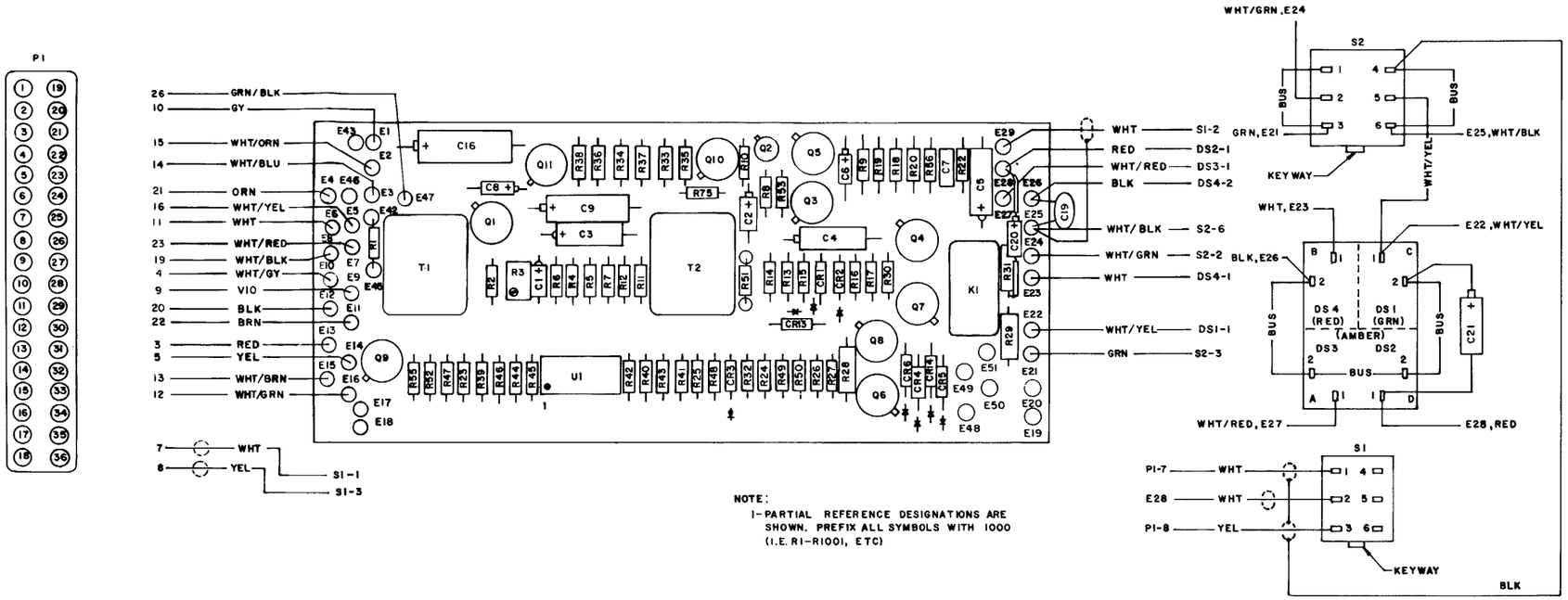
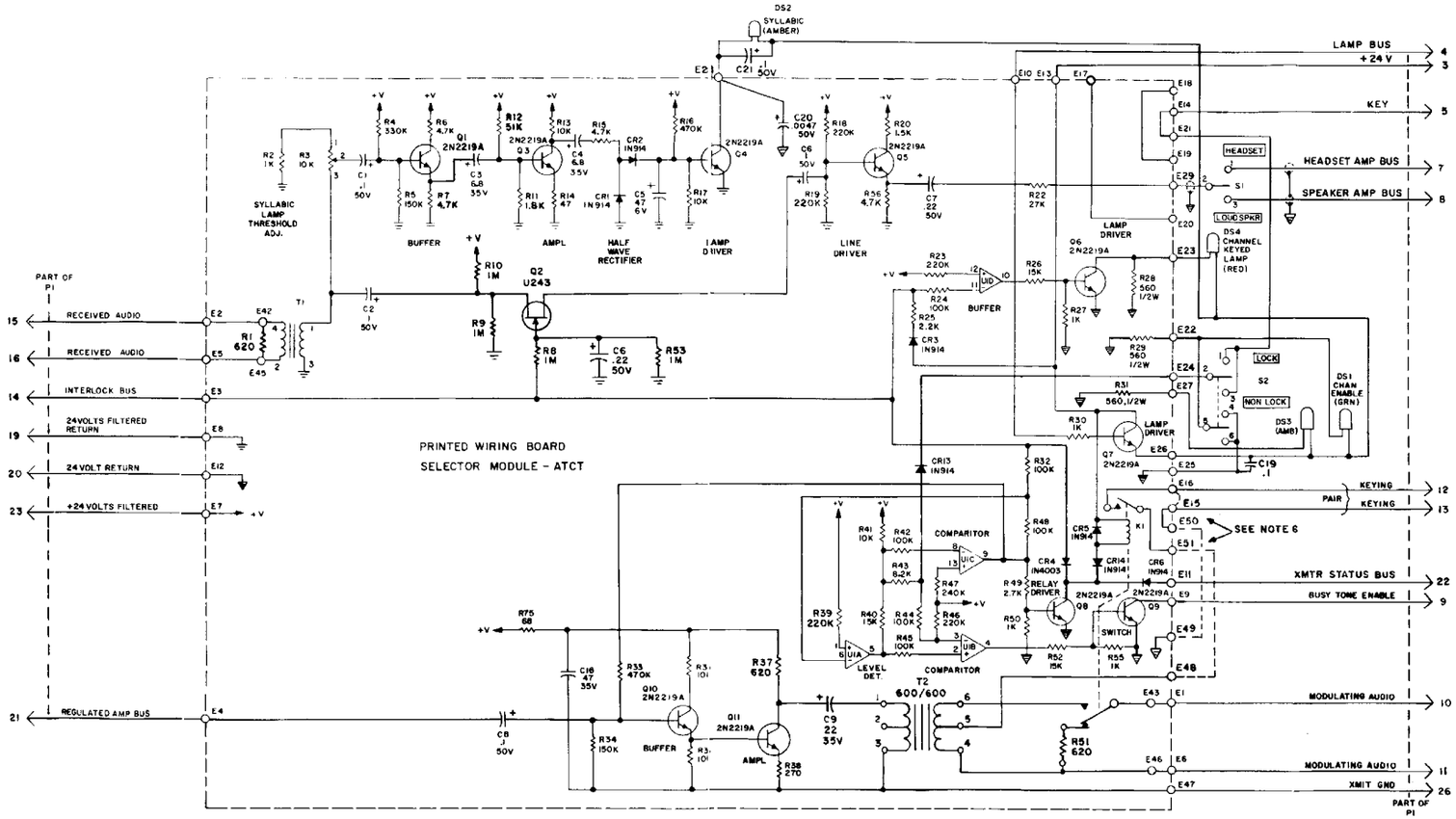


Figure FO-16. Selector Module Board Assembly and Wiring Diagram

Change 1



NOTES:

1- UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS, 1/4W.
ALL CAPACITOR VALUES ARE IN MICROFARADS

2- ADD 1000 TO ALL COMPONENT DESIGNATIONS, EXAMPLE = C1001.

3- U1 PIN 14, IS CONNECTED TO +24V FILTERED. U1 PIN 7 IS CONNECTED TO 24 VOLT RETURN.

4- P1 PINS 1, 2, 6, 17, 18, 24, 25, & 27 THRU 36 NOT USED.

5- U1 IS TYPE A30014 IN A CERAMIC CASE.

6- 4 WIRE SIMPLEX, INTERNAL GROUND. (FACTORY WIRED) E15 TO E16, E50 TO E49, E51 TO E48.
4 WIRE SIMPLEX, EXTERNAL GROUND. REMOVE STRAP FROM E49 TO E50 AND CONNECT GROUND TO PINS 18, 22, 26 & 30 OF BOTH J201 & J202.
6 WIRE OPERATION, REMOVE STRAPS FROM E49 TO E50, E48 TO E51 & E15 TO E16. STRAP E50 TO E51.

Figure FO-17. Selector Module Schematic diagram

Change 1

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