992607-0003

DATATAPE®

13-547 DIRECT REPRODUCE AMPLIFIER

OPERATION AND MAINTENANCE MANUAL

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This manual describes the operation and maintenance procedures for the Type 13-547-1 and -3 Direct Reproduce Amplifiers, with serial numbers 2001 through 3999; and the Type 13-547-2 Direct Reproduce Amplifier, with serial numbers 3001 through 3999.

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SECTION I

GENERAL DESCRIPTION

1-1. GENERAL.

1-2. The 13-547-1, 13-547-2, or 13-547-3 Direct Reproduce Amplifier is designed to amplify instrumentation data recorded on magnetic tape using the direct method of recording.

1-3. Three circuit card configurations are used and are distinguished by dash numbers. The 13-547-1 amplifier is intended for use with intermediate bandwidth systems (600 kHz at 120 ips). The 13-547-2 amplifier is for use with a 2.0 MHz wide band system, and the 13-547-3 amplifier is for use with a 1.5 MHz wide band system.

1-4. FUNCTION AND USE.

1-5. In addition to amplifying the low level input from the reproduce head preamplifier, the amplifier provides amplitude-versus-frequency equalization and compensation to ensure linear phase response. Different amplitude equalization and phase compensation networks are automatically selected for each tape speed.

1-6. GENERAL EQUIPMENT DESCRIPTION.

1-7. The circuitry of the direct reproduce amplifier is contained on a double-sided printed circuit board measuring 6 x 14 inches. An aluminum shield is mounted on one side of the board to provide shielding between adjacent channels. The board inserts vertically into the amplifier mounting assembly. Electrical connections to and from the amplifier are made through a printed circuit receptacle at the rear of the mounting assembly.

1-8. TYPICAL PERFORMANCE CHARACTERISTICS.

1-9. Typical performance characteristics for the 13-547-1, 13-547-2, and the 13-547-3 Direct Reproduce Amplifiers are given in table 1-1.

CHARACTERISTIC	TYPICAL PERFORMANCE
Frequency Response	
13-547-1	100 Hz to 600 kHz
13-547-2	400 Hz to 2 MHz
13-547-3	400 Hz to 1.5 MHz
Input Impedance	
13-547-1 13-547-2 and 13-547-3	500 ohms, single ended

Table 1-1. Typical Performance Characteristics
(Sheet 1 of 2)

CHARACTERISTIC	TYPICAL PERFORMANCE
Signal Input	Output of reproduce head preamplifier (200 mv maximum at 200 kHz)
Output Level	0 to 4 volts peak-to-peak into 50 ohm load, single ended.
Power Requirements	
13-547-1	64.0 ma at +15 vdc 48.0 ma at -15 vdc
13-547-2	64.0 ma at +15 vdc 38.0 ma at -15 vdc
13-547-3	64.0 ma at +15 vdc 38.0 ma at -15 vdc

Table 1-1. Typical Performance Characteristics
(Sheet 2 of 2)

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. The 13-547 Direct Reproduce Amplifiers are positioned vertically in card guides within the 13-505 Amplifier Mounting Assembly. Card guide positions, numbered left to right, correspond to record/reproduce channel numbers. See Section II of the record/reproduce system manual for channel installation and system structuring information.

2-3. AMPLIFIER CARD INSTALLATION.

Note

Turn system power OFF before installing or removing amplifier cards from mounting assembly.

2-4. All electrical connections to the amplifier are complete when the card is placed, pin end first, into the card guides and the connector pins on the amplifier card are mated with the connector socket in the mounting assembly. A printed wiring board extractor is mounted near the upper edge of the card to facilitate its removal from the mounting assembly.

2-5. AMPLIFIER CARD PREPARATION.

2-6. Prior to installation, the amplifier cards should be inspected visually for impact damage, loose parts, moisture, corrosion, dust particles, and for any other condition which may impair the life of the amplifier or otherwise degrade its performance. In the event an undesirable condition is found, see paragraph 5-21 of this manual before proceeding with repairs.

SECTION III

OPERATION

3-1. GENERAL.

3-2. The 13-547 Direct Reproduce Amplifier is operative when it is inserted in a 13-505 or 13-505A Amplifier Mounting Assembly and the mounting assembly is connected to the rest of the system. The amplifier is turned on and operates when the system power and tape transport are turned on. Refer to Section V of this manual for calibration and maintenance procedures.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. The 13-547 Direct Reproduce Amplifier receives the signal from the reproduce head and preamplifier and provides amplification and amplitude-versus-frequency equalization. Amplitude equalization is necessary to compensate for the non-uniform output from the reproduce head due to flux rate of change $\frac{(d\Phi)}{(dt)}$ and high frequency losses. Figure 4-1 illustrates a typical reproduce head response, along with the required complementary reproduce amplifier response to ensure a uniform output at all frequencies within the passband. The equalization is automatically switched at each tape speed to optimize the system response for each bandwidth. Controls are provided to allow exactly the required amount of equalization, despite any variations between tracks.

4-3. In addition to amplitude equalization, additional compensation is included to ensure linear phase response. The phase compensation networks are also automatically switched by the speed select circuitry.

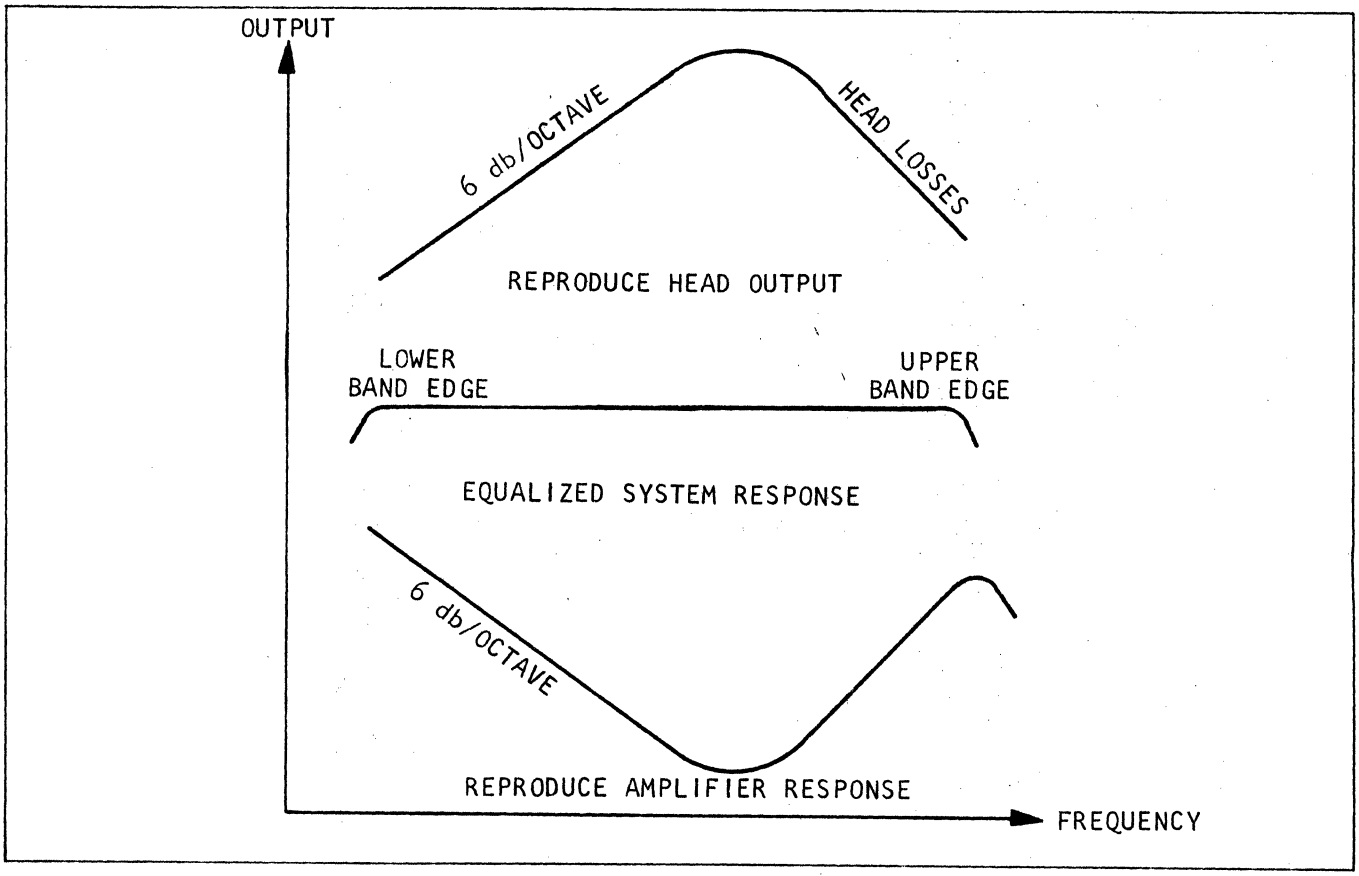


Figure 4-1. Reproduce Head and Amplifier Response Curves

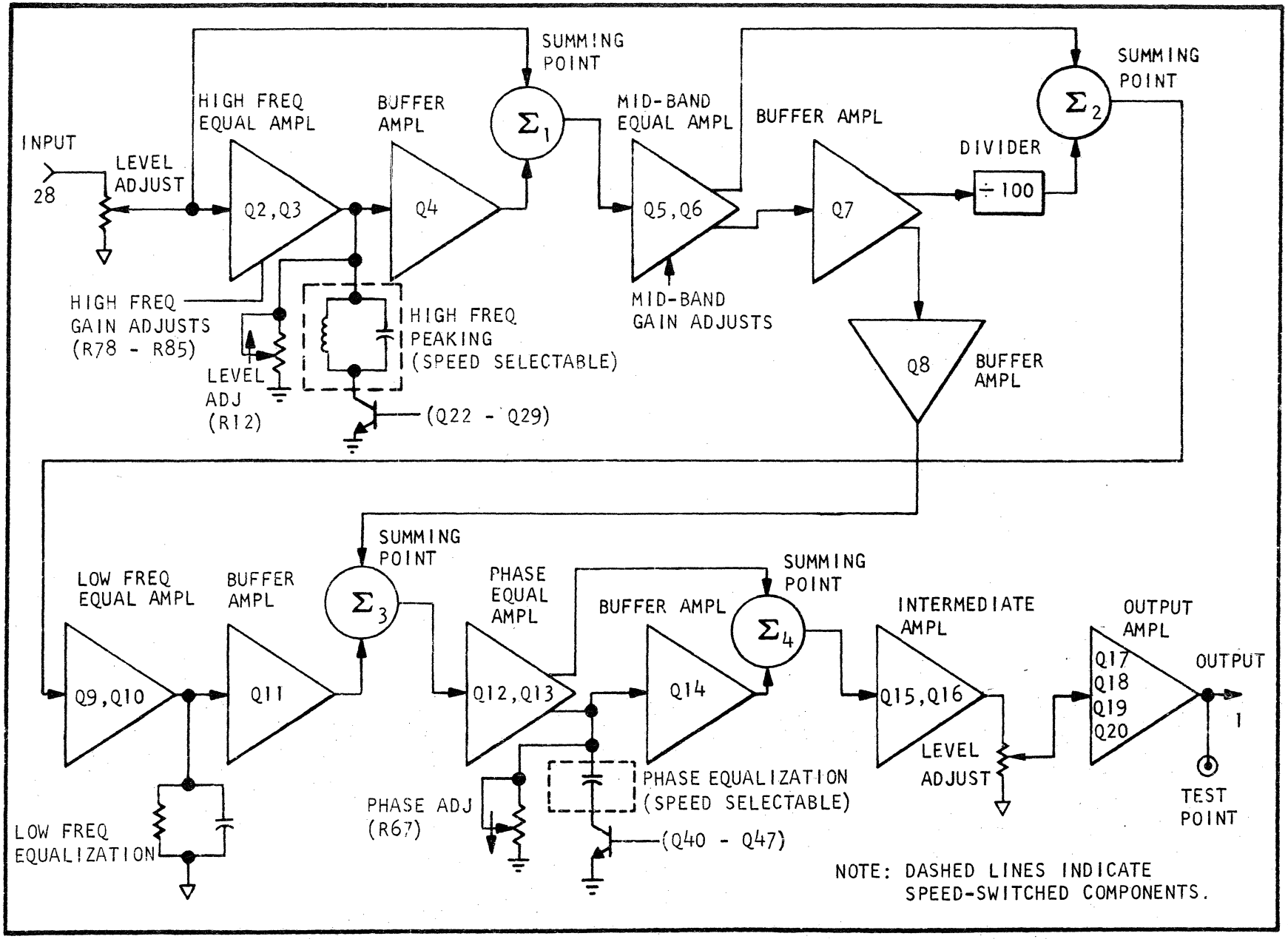


Figure 4-2. Block Diagram, 13-547 Direct Reproduce Amplifier

4-4. Figure 4-2 is a block diagram of the reproduce amplifier. The circuitry was designed mathematically by signal processing network synthesis techniques. This results in groups of amplifier stages with signals fed forward to summation points. In addition, there are a number of frequency sensitive LC or RC networks to achieve the desired amplitude and phase equalization. This design concept results in isolation between the low, middle, and high frequency equalization circuits so that one control does not load and mistune another. In order of signal progression, the 13-547 circuitry can be divided into the following functions: high frequency equalization, mid-band equalization, low frequency equalization, phase equalization, intermediate amplifier, and output amplifier. The circuitry is powered from +15 and -15 volt regulators in the amplifier mounting assembly. Complete schematic diagrams are contained in Section VII of this manual. Figure 7-1 is the schematic for the 13-547-1 Intermediate Bandwidth Reproduce Amplifier, figure 7-2 is the schematic for the 13-547-2 2 MHz Wide Band Reproduce Amplifier, and figure 7-3 is the schematic for the 13-547-3 1.5 MHz Wide Band Reproduce Amplifier.

4-5. HIGH FREQUENCY EQUALIZATION.

4-6. The reproduced signal from the preamplifier enters the direct reproduce amplifier circuit at terminal 28 of the printed circuit connector. From this point, it is capacitively coupled by C1 through a bias trap to input level potentiometer R137. The bias trap consists of L1 and C2, which are parallel resonant at 8 MHz to prevent any reproduced bias from entering the amplifier. The wiper of potentiometer R137 is connected through R6 to the base of transistor Q2. Transistors Q2 and Q3 form a two stage direct coupled amplifier, with ac negative feedback through C3 and R7 for stability. The response of this stage is increased at frequencies near upper band edge by a parallel resonant circuit serving as a collector load for Q3. Since the upper band edge frequency depends upon the selected tape speed, a different parallel resonant collector load is selected for each speed by switching transistors Q22 to Q29. When a speed is selected at the transport, the associated speed select line (terminals 5 to 12) will be at a +15 volt potential. One of the switching transistors will then be turned on and an LC network connected between the collector of Q3 and ground. Each reproduce head has a slightly different peak frequency roll off characteristic. Notice that potentiometer R12 is in parallel with (across) the parallel resonant circuit and, therefore, can vary the Q of the circuit. Consequently, the adjustment of R12 allows the slope (bandwidth) of the high frequency gain to be varied. The potentiometer is usually adjusted at 120 ips or the highest selectable tape speed and normally does not need to be adjusted for the lower speeds. Figure 4-3 shows a family of response curves representing the peaking effect for various tape speeds.

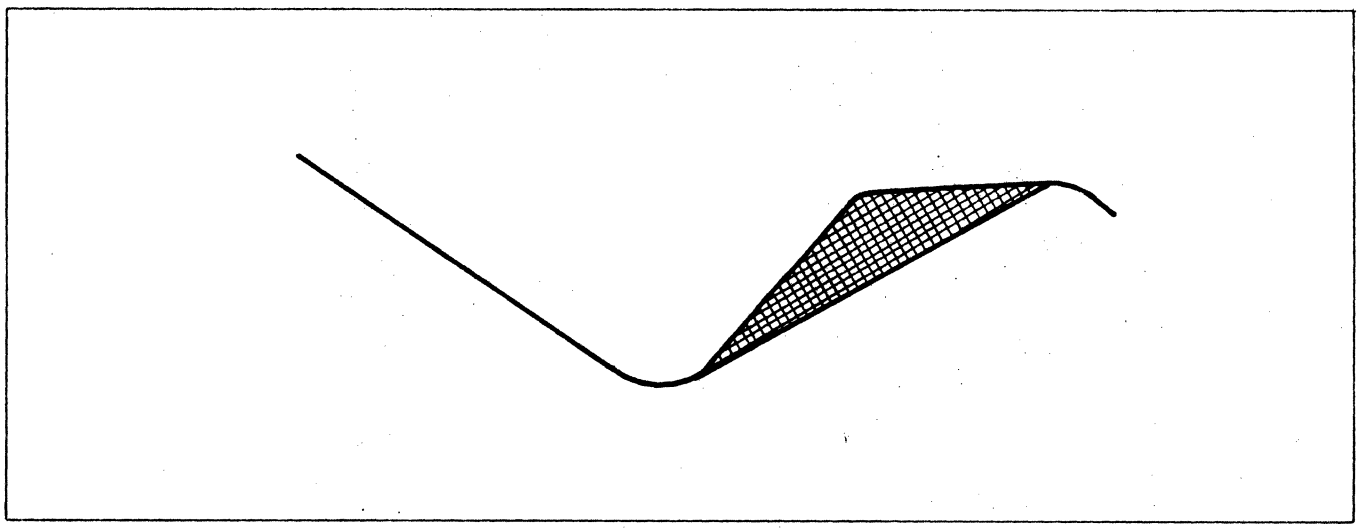


Figure 4-3. High Frequency Peaking

4-7. The gain of the high frequency equalization amplifier may be adjusted for each tape speed with potentiometers R78 through R85. One of the potentiometers is connected between the emitter of Q3 (via C4 and R11) and ground by one of the switching transistors Q31 to Q38. The gain is controlled by the amount of ac bypass around emitter resistor R10. With higher potentiometer resistance, there is less bypass, more degeneration, and less gain. Figure 4-4 shows a typical range of gains that may be obtained with the adjustment for each speed. These controls are adjusted to produce the proper amount of gain to compensate for high frequency reproduce head losses and ensure a flat amplitude response. See Section V for a detailed adjustment procedure.

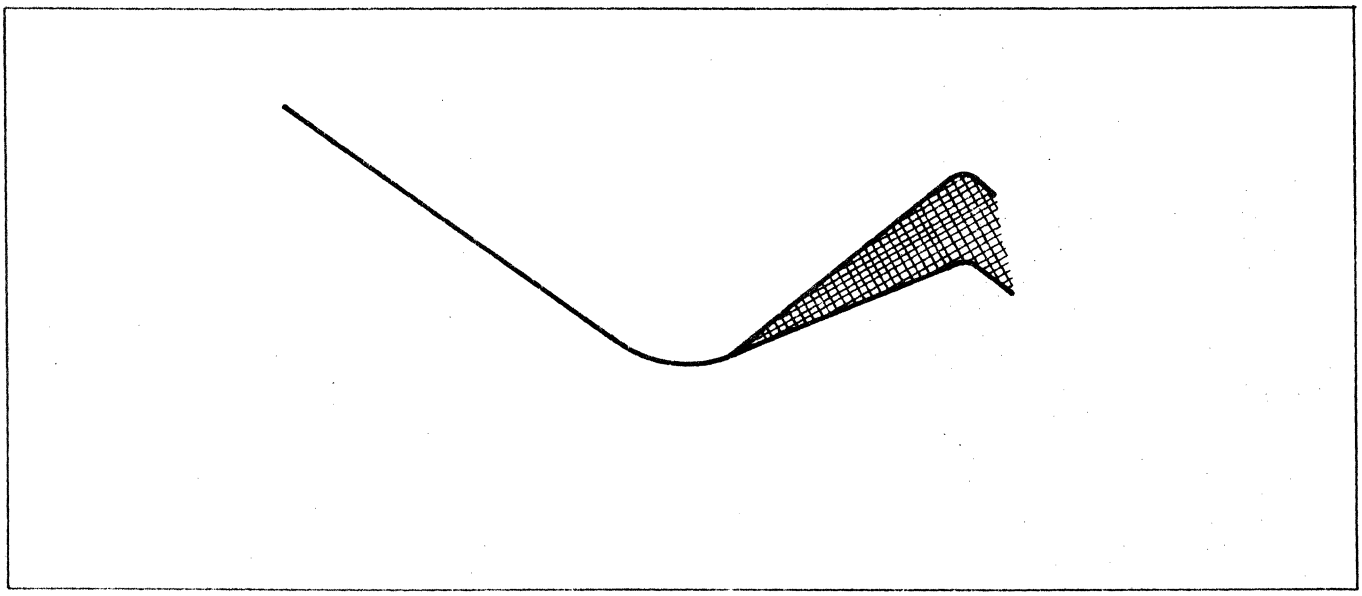


Figure 4-4. High Frequency Gain Control

4-8. The output of the high frequency equalization amplifier is taken from the collector of Q3 and routed to an emitter follower buffer amplifier stage Q4. The output from the buffer amplifier is linearly added to the unequalized input signal at summing point 1 (Σ_1), which is the junction of R5 and R15. The combined signal is fed to the mid-band equalization amplifier circuit.

4-9. MID-BAND EQUALIZATION.

4-10. The signal from summing point 1 goes to the base of transistor Q5. Transistors Q5 and Q6 form a two stage direct coupled amplifier, with ac negative feedback through C6 and R16 for stability. The gain of the amplifier is inversely proportional to the tape speed. The speed select lines determine the gain by selecting both the collector load resistance and emitter ac bypass of transistor Q6. Switching transistors Q49 to Q52 select the collector resistance. Potentiometer R133 controls the amount of ac bypass around emitter resistor R19 for all tape speeds. Potentiometer R134 is switched in parallel with R133 by transistor Q53 when operating at the four lowest speeds to provide a separate adjustment. With high potentiometer resistances, there is less emitter ac bypass, more degeneration, and less gain. The mid-band gain of the wide band amplifier is optimized at one-tenth the upper band edge frequency. Mid-band gain of the intermediate bandwidth amplifier is optimized at one-fourth the upper band edge frequency. See Section V for a detailed adjustment procedure. Figure 4-5 illustrates a typical range of mid-band level control.

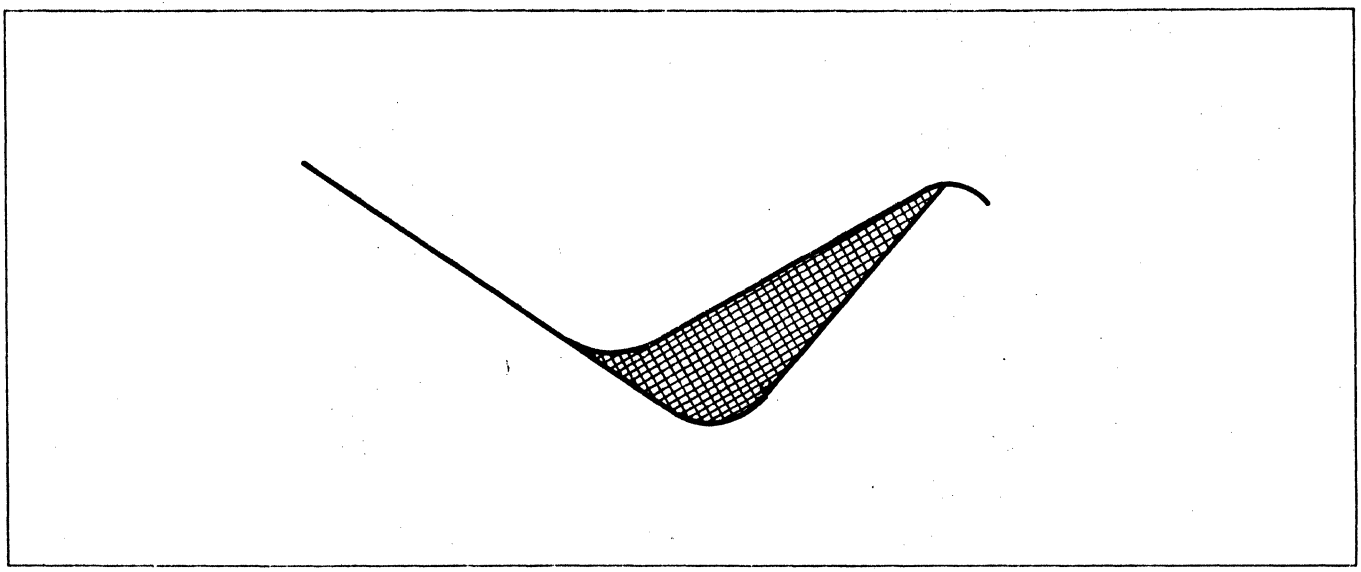


Figure 4-5. Mid-Band Level Control

4-11. One output of the mid-band equalization amplifier is taken from the collector of Q6 and routed to buffer amplifier Q7. A second output is capacitively coupled from the emitter of Q6 and linearly added to the signal from the emitter of Q7 at summing point 2 (Σ_2). The signal from the emitter of Q7 is effectively reduced in amplitude by 1/100 by R27. The junction of R26 and R27 form the summing point. The combined signal is fed to the low frequency equalization circuit.

4-12. LOW FREQUENCY EQUALIZATION.

4-13. The signal from summing point 2 goes to the base of transistor Q9. Transistors Q9 and Q10 form a two stage direct coupled amplifier, with ac negative feedback for stability. An RC network consisting of C15 and R32 at the collector of Q10 causes the amplifier response to roll off at a 6 db/octave rate beginning at the lower band edge frequency. This compensates for the 6 db/octave increase from the reproduce head due to the differentiating effect of flux rate of change, $\frac{(d\Phi)}{(dt)}$. The effect of the roll off is canceled by the mid-band equalization at approximately one-tenth upper band edge frequency in the wide band amplifiers and about one-fourth upper band edge frequency in the intermediate bandwidth amplifiers. The time constant of C15 and R32 determines the lower band edge.

4-14. The output of the low frequency equalization amplifier is taken from the collector of Q10 and routed to an emitter follower buffer amplifier stage Q11. The output from the emitter of Q11 is coupled through C16 and R37 to summing point 3 (Σ_3). The other summing point input is from emitter follower Q8, through C12 and R36. Transistor Q8 receives a signal from the collector of Q7. The combined signal is fed to the phase equalization circuit.

4-15. PHASE EQUALIZATION.

4-16. Phase equalization is not related to amplitude-versus-frequency equalization but is necessary to ensure proper reproduction of complex waveforms. Phase equalization is introduced to provide a linear phase response with respect to frequency so that the relative timing of the complex waveform harmonics with respect to the fundamental will not be altered.

4-17. The signal from summing point 3 goes to the base of transistor Q12. Transistors Q12 and Q13 form a two stage direct coupled amplifier, with ac negative feedback through C18 and R40 for stability. Eight phase compensation capacitor networks are connected between the base of Q14, the collector of Q13, and ground by one of eight switching transistors Q40 to Q47, depending on the tape speed selected. Potentiometer R67 is shunted across the tape speed selected capacitor. Since the capacitive reactance decreases as the frequency increases, the gain falls off as the frequency increases, thus the need to switch in the smaller capacitors at the higher speeds. The higher frequencies of a complex waveform can be peaked or attenuated by adjusting potentiometer R67, thus allowing the trailing edge of the square wave to be adjusted for the desired wave shape.

4-18. One output of the phase equalization amplifier is taken from the collector of Q13 and routed to an emitter follower buffer amplifier stage Q14. A second output, from the emitter of Q13, is capacitively coupled through C19 to summing point 4 (Σ_4). It is then linearly added to the signal from the emitter of Q14. The junction of R45 and R46 form the summing point. The combined signal is fed to the intermediate amplifier circuit.

4-19. INTERMEDIATE AMPLIFIER.

4-20. The signal from summing point 4 goes to the base of transistor Q15. Transistors Q15 and Q16 form a two stage direct coupled amplifier, with ac negative feedback through C20 and R47 for stability. Emitter resistor R50 is ac bypassed by C23 and R52. The output from the intermediate amplifier is taken from the collector of Q16 and capacitively coupled by C26 to the output level control R53. This control provides a range of output voltages (up to 4 volts peak-to-peak). The wiper of R53 is connected to the input of the output amplifier circuit.

4-21. OUTPUT AMPLIFIER.

4-22. The wiper of output level potentiometer R53 is connected to the base of transistor Q17. Transistors Q17 and Q18 form a two stage direct coupled amplifier. The signal from the collector of Q18 is applied to the base of Q19 and, through CR1, CR2, and R57, to the base of Q20. Transistors Q19 and Q20 are connected as a complementary symmetry push-pull amplifier. The resultant current gain and low impedance output allow operation of the 13-547 into loads as low as 50 ohms. Negative ac feedback through C29 assures stable operation. The output is coupled by capacitor C32 to terminal 1 on the printed circuit card. The signal is also routed to TP1 at the front of the card for convenience when performing adjustments.

SECTION V

CALIBRATION AND MAINTENANCE

5-1. PREVENTIVE MAINTENANCE.

5-2. Preventive maintenance consists of general cleaning and periodic inspection. Accumulation of dust, dirt, grit, and/or grease on the circuit boards is harmful and should be guarded against by periodic inspection and cleaning. Every six months, under normal laboratory conditions, inspect the units for signs of deterioration, loose connections, insecurity of mounting, and foreign matter. The period of cleaning depends on the particular operating environment and should be determined by inspection. As necessary, clean the circuit board with a soft brush, low air pressure, or suitable solvent, being careful not to damage the printed circuitry.

5-3. CALIBRATION ADJUSTMENTS.

5-4. The 13-547 Direct Reproduce Amplifiers are initially adjusted at the factory. The final adjustments are determined by the magnetic characteristics of the recording tape and by the magnetic head and record amplifier characteristics of each individual channel. Readjustment may be required for optimum performance when changing tape or heads, or when moving an amplifier to a different channel.

5-5. CONTROLS. Table 5-1 describes the function of each control on the direct reproduce amplifier. Adjustments are provided for input and output levels and for amplitude and phase equalization. Figure 5-1 shows the relative physical locations of the control and test points.

CONTROL	FUNCTION
R12	Adjusts level at 120 ips.
R53	Adjusts output signal level, up to 4 v p-p into 50 ohms.
R78	120 ips — High Frequency Gain Adjustments
R79	60 ips
R80	30 ips
R81	15 ips
R82	7 1/2 ips
R83	3 3/4 ips
R84	1 7/8 ips
R85	15/16 ips
R133	Adjusts mid-band gain at all tape speeds.
R134	Adjusts mid-band gain at 15/16, 1 7/8, 3 3/4, and 7 1/2 ips.
R137	Adjusts input level.
R67	Adjusts phase at all tape speeds.

Table 5-1. Controls, Direct Reproduce Amplifiers

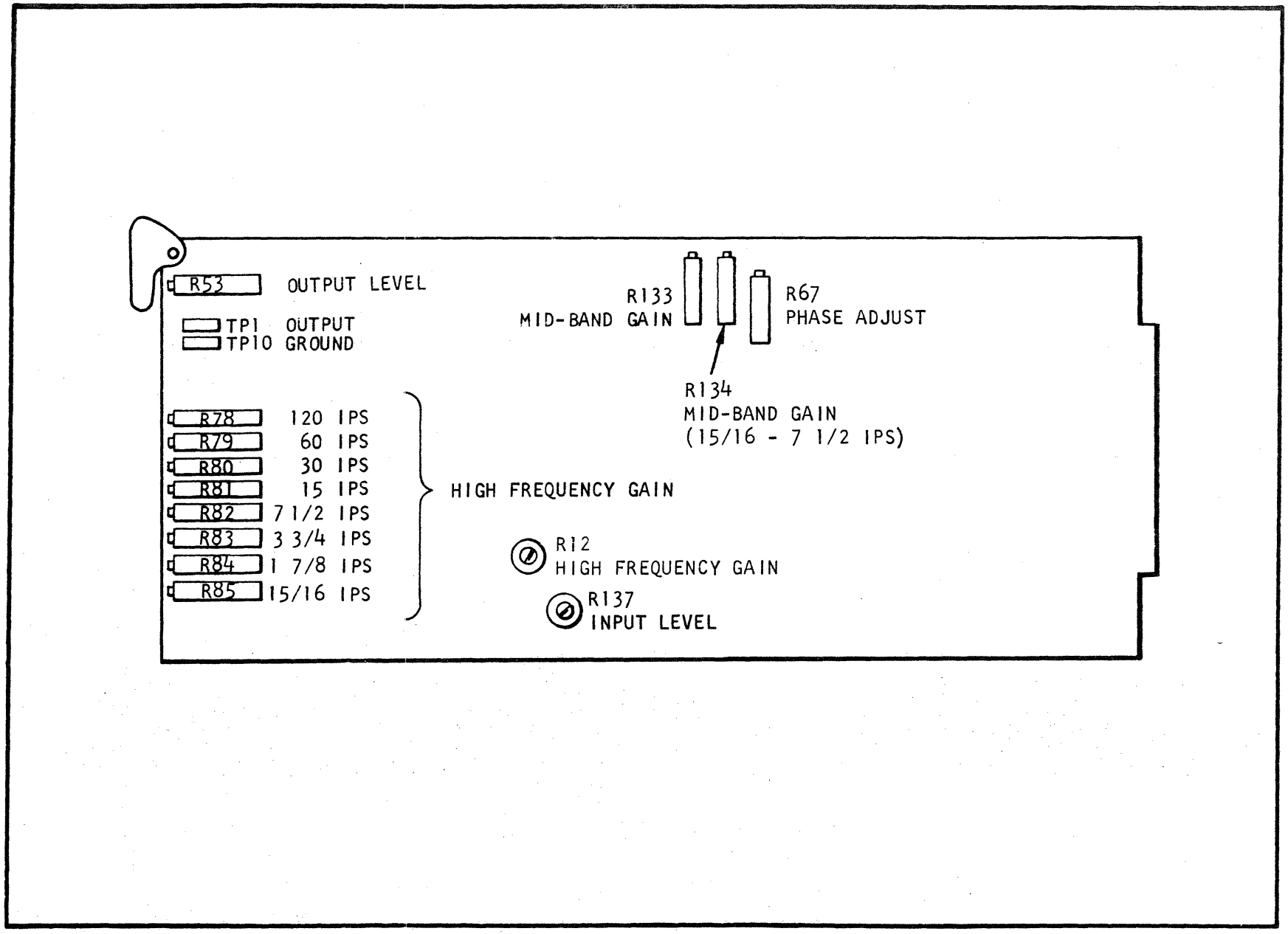


Figure 5-1. Control and Test Point Locations, 13-547 Direct Reproduce Amplifier

5-6. PROCEDURE. Figure 5-2 illustrates the operational adjustment setup and associated test equipment. Table 5-2 is a list of recommended test equipment.

EQUIPMENT	USE
Sine Wave Generator: Hewlett-Packard 651B, or equivalent	Test frequency source.
Square Wave Generator: Hewlett-Packard 211B, or equivalent	Test frequency source.
AC Voltmeter: Hewlett-Packard 400FL, or equivalent	Input and output level setting.
Wave Analyzer: Hewlett-Packard 310A, or equivalent	Establishing normal record level.
Oscilloscope: Tektronix 545B/1A1,or equivalent	Output waveform monitoring.
Multimeter: Triplett 630, or equivalent	Making resistance checks.

Table 5-2. List of Test Equipment

5-7. Since performance is determined by the magnetic tape characteristics, head characteristics, and channel assignments, the adjustment must be performed while recording and reproducing.

5-8. The appropriate signal generator is used to provide test frequencies to the direct record amplifier. For sine wave equalization an AC voltmeter is employed to accurately measure the record amplifier test frequency input voltage. The 13-547 output is terminated with a 50 ohm resistor between TP1 (brown) and TP10 (black). Test point TP1 is also connected to an AC voltmeter, wave analyzer, and oscilloscope for monitoring output level and percent distortion.

5-9. If the controls on the 13-547 Direct Reproduce Amplifier are suspected of being far out of alignment or if components in the amplifier have been changed, the controls should be preset using an ohmmeter for the values shown in table 5-3.

CONTROL	SETTING
R12	1.9K ohms
R53	2.7K ohms
R67	700 ohms
R133	450 ohms
R134	30 ohms
R137	Fully clockwise

Table 5-3. Resistance Settings for Controls

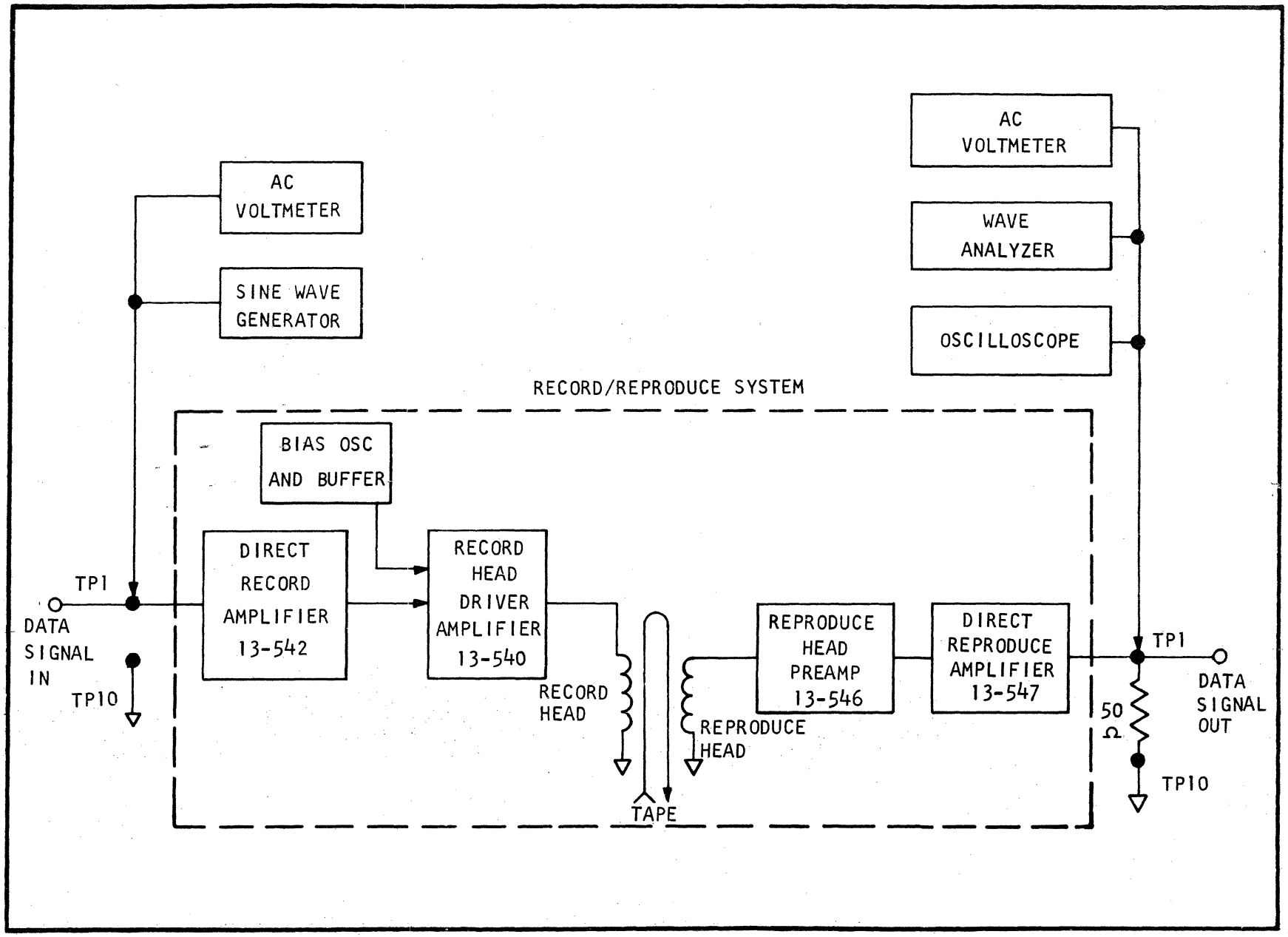


Figure 5-2. Setup for Direct Reproduce Amplifier Operational Adjustments

5-10. The test equipment should be set up as shown in figure 5-2, then all equipment turned on and allowed to warm up for 15 minutes.

5-11. The direct record amplifier should be aligned before beginning the reproduce amplifier adjustments (refer to the operational and adjustment procedures in the direct record amplifier manual). Mount the reproduce amplifier to be adjusted on a circuit extender card (part number 471755-1) to permit access to all controls.

CAUTION

To prevent damage to the amplifiers, always turn off system power before removing an amplifier card from or replacing a card in the mounting assembly.

5-12. The following adjustments are based on a top tape speed of 120 ips. If 120 ips is not available on the subject machine, use the highest speed available and vary the adjustments accordingly. Refer to table 5-4 for the appropriate test frequencies per tape speed.

TAPE SPEED (ips)	INTERMEDIATE BANDWIDTH		WIDEBAND OPTION A		WIDEBAND OPTION B	
	UBE (kHz)	1/4 UBE (kHz)	UBE (kHz)	1/10 UBE (kHz)	UBE (kHz)	1/10 UBE (kHz)
120	600	150	1500	150	2000	200
60	300	75	750	75	1000	100
30	150	37.5	375	37.5	500	50
15	75	18.75	187	18.7	250	25
7 1/2	38	9.5	93	9.3	125	12.5
3 3/4	19	4.75	46	4.6	62	6.2
1 7/8	10	2.5	23	2.3	31	3.1
15/16	5	1.25	12	1.2	15	1.5
UBE = UPPER BAND EDGE FREQUENCY						

Table 5-4. Frequencies for Operational Adjustments

5-13. ADJUSTMENTS, 13-547-1 INTERMEDIATE BAND (600 kHz), 13-547-2 (2.0 MHz), OR 13-547-3 (1.5 MHz) WIDEBAND AMPLIFIER. To adjust the amplifiers, proceed as follows:

a. Rotate the reproduce amplifier input level control (R137) fully clockwise.

b. Place the system in the record mode at 60 ips and simultaneously record and reproduce a square wave of 15 kHz (600 kHz), 37 kHz (1.5 MHz), or 50 kHz (2.0 MHz).

c. Adjust the oscilloscope for observation of two square wave cycles and adjust the reproduce amplifier output level control (R53) for approximately 2.8 volts peak-to-peak.

d. Refer to figure 5-3 and adjust R67, the phase adjustment control on the reproduce amplifier, for approximately 10% pre-ring at the trailing edge of the square wave. Avoid a setting of R67 which affects the leading edge of the square wave.

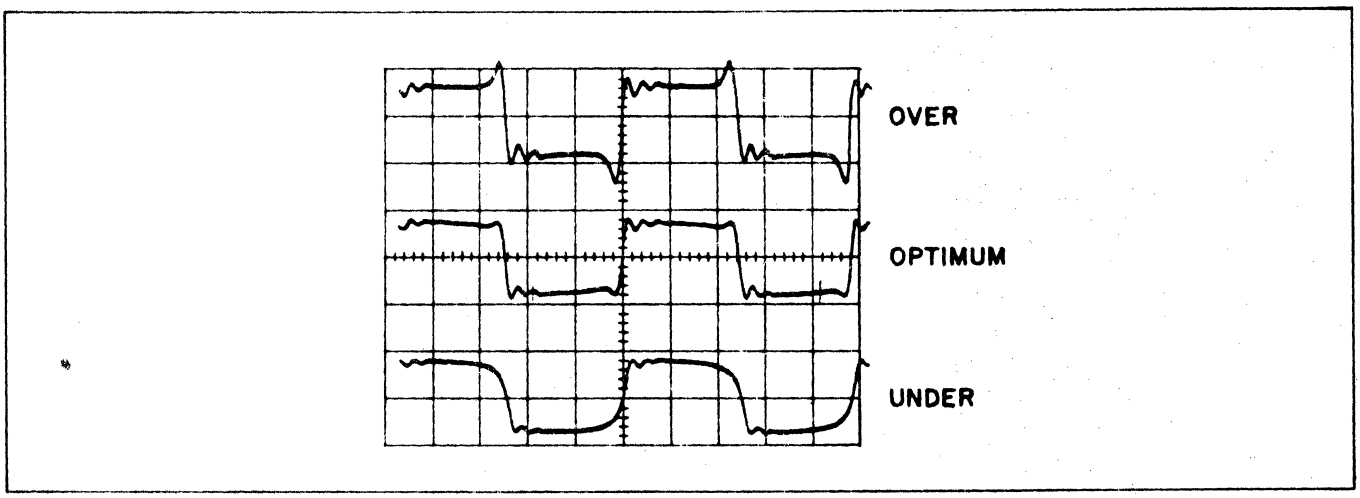


Figure 5-3. Phase Adjustment

e. Place the system in the record mode at 120 ips or the highest tape speed available on the machine, and adjust the sine wave generator for normal record level at 1/100 upper band edge frequency.

Note

The normal record level is the data voltage level at the input of the direct record amplifier which produces 1% third harmonic distortion.

f. Adjust the reproduce output level (R53) for 1 vrms as indicated on the AC voltmeter.

g. Adjust the sine wave generator for normal record input level at 1/4 upper band edge frequency (600 kHz), or 1/10 upper band edge frequency (1.5 MHz or 2.0 MHz).

h. Adjust the reproduce amplifier mid-band gain control (R133) for 1.0 vrms output as indicated on the AC voltmeter.

i. At the sine wave generator, increase the record input +3 db. If signal breakup occurs, turn the reproduce amplifier input level control (R137) counterclockwise until a normal waveform is restored.

j. At the sine wave generator, reset the record input to normal level and readjust the reproduce amplifier output level control (R53) for 1.0 vrms output.

k. Adjust the sine wave generator for upper band edge frequency at the normal record input level. Adjust the 120 ips high frequency gain control (R12) for 0 db (600 kHz) output or -2 db (1.5 MHz or 2.0 MHz referenced to 1.0 vrms) output as indicated on the AC voltmeter.

Note

If 120 ips is not available on the subject machine, set the sine wave generator for normal record input level at upper band edge frequency for the highest tape speed available (see table 5-4).

m. Repeat steps b through k.

n. Adjust the 120 ips high frequency gain control (R78) for -1 db (600 kHz) or 0 db (1.5 MHz or 2.0 MHz) at 2/3 upper band edge.

p. Repeat step k and check for proper level at upper band edge frequency.

q. Stop the transport and adjust the sine wave generator for normal record input level at 1 kHz.

r. Select a tape speed of 7 1/2 ips and place the system in the record mode.

s. Adjust the reproduce amplifier output level control (R53) for 1.0 vrms output.

t. Adjust the sine wave generator for normal record level at 1/4 upper band edge frequency (600 kHz), or 1/10 upper band edge frequency (1.5 MHz or 2.0 MHz). Adjust the low speed mid-band gain control (R134) for 0 db.

u. Adjust the sine wave generator for normal record input level at upper band edge frequency. Adjust the 7 1/2 ips high frequency gain control for 0 db (600 kHz), or -3 db (1.5 MHz or 2.0 MHz as referenced to 1.0 vrms).

v. Repeat step s and check for proper output level.

w. Stop the transport, then turn off system power. Remove the reproduce amplifier from the circuit extender card and remove the extender card from the amplifier mounting assembly. Replace the amplifier in the mounting assembly and turn on power.

x. Adjust all other high frequency gain controls (R79 through R85) at the appropriate tape speed and upper band edge frequency for normal output level as indicated on the AC voltmeter. Normal output level is 0 db (600 kHz), or -2 db (1.5 MHz or 2.0 MHz as referenced to 1.0 vrms) for speeds of 120 ips through 15 ips. For speeds of 7 1/2 ips through 15/16 ips, normal output level is 0 db (600 kHz), or -3 db (1.5 MHz or 2.0 MHz).

Note

After accomplishing steps r through v, before a tape speed of 120 ips through 15 ips can be selected, it will be necessary to readjust the output level as in steps e and f.

5-14. Proper adjustment of the 13-547-1, 13-547-2, or 13-547-3 controls will be evidenced by a uniform amplitude-versus-frequency response (±3 db) over the system bandwidth for each tape speed.

5-15. TROUBLESHOOTING AND CORRECTIVE MAINTENANCE.

5-16. Before attempting repair of a unit suspected of malfunctioning, verify that the symptom is not caused by malfunction of associated equipment such as the power supply, the mounting assembly, intercabling errors, etc. This can be done by substituting a known good unit for the suspected unit, or making continuity checks from unit to unit. If such a check eliminates the associated equipment as a source of trouble, check the adjustments which are detailed in previous portions of this section.

5-17. Once the existence of a defective unit has been established, check it for obviously damaged components, such as burned resistors, or incorrect seating of components. The next step is to verify that the proper supply voltage is reaching the unit. If the supply voltage is correct, the faulty stage within the unit can be located by tracing signals from stage to stage.

5-18. To aid in identification of a defective stage, a test frequency may be applied to the input of the reproduce amplifier. This is accomplished by temporarily disconnecting the coaxial cable from the reproduce head preamplifier at the BNC connector on the rear of the amplifier mounting assembly. The test frequency should be within the passband of the amplifier for the tape speed selected and the level should be less than 100 mv to prevent overloading the input stage. By following the schematic diagram (figure 7-1, 7-2, or 7-3), an oscilloscope and an extender board (part number 471755-1) may be employed to trace the test frequency through the circuit until the defective component is isolated.

5-19. Once the defective stage has been located, the defective component in that stage can be determined by reference to the schematic diagram, and by making continuity, voltage, and/or resistance measurements about the suspected components. The prime exception to this is open coupling capacitors, which should be checked by substitution, or by adding a test capacitor in parallel.

5-20. Typical dc voltages found in the 13-547-1, 13-547-2, and 13-547-3 Direct Reproduce Amplifiers are listed in tables 5-5 and 5-6. These voltages are observable at the emitter, base, and collector of each transistor stage. The bracketed components in the tables, e.g. (R9/C5-), indicate the circuit component or components which are common to the specified transistor element. The voltage readings may vary somewhat from unit to unit, but will approximate the values indicated.

5-21. REPAIR.

5-22. Repair of the unit should be attempted only by personnel experienced in printed wiring techniques. Recommended repair is limited to the replacement of defective parts and adjustments of controls. When removing and replacing defective parts, care should be exercised so as not to damage surrounding components or the circuit board. Replacement parts must be of the correct type and value, as listed in the parts list in Section VI. When installing a new part, place it in the exact position of the replaced part. After replacement, carefully inspect the circuit board for evidence of cold solder joints, solder splashes, and insecurity of mounting.

5-23. If the equipment is repaired, the amplifiers should be checked and, if necessary, adjusted as described in the calibration procedures of this section.

TRAN-SISTOR	EMITTER (volts)	BASE (volts)	COLLECTOR (volts)
Q2	(R9/C5-) -0.72	(R6/R7) 0 to +0.08	(R8) +3.1
Q3	(R10/C3+) +3.8	(R8) +3.1	(R12) +0.1
Q4	(R14/R15) -0.55	(R12) +0.1	(R13) +8.3
Q5	(R18/C8-) -0.96	(R16) -0.3	(R17) +3.3
Q6	(R19/C7+) +3.9 (8)	(R17) +3.3 (8)	(R123) +0.23 to +1.1 (8)
Q7	(R22/R27) -0.44 to +0.4 (8)	(R123) +0.23 to +11.1	(R21) +2.6 to +3.2 (8)
Q8	(R24) +3.3 to +3.9	(R21) +3.1	(R25) -8.7
Q9	(R30/C14-) -1.6	(R26/R27) -1.0	(R29) +6.8
Q10	(R31) +7.4	(R29) +6.8	(R32) +2.7
Q11	(R35/C16+) +3.4	(R32) +2.7	(R34) +12.7
Q12	(R39/C17-) -1.25	(R36/R40) +0.58	(R38) +9.8
Q13	(R41) +10.05	(R38) +9.8	(R102/C49) +0.98
Q14	(R44/R45) +0.33	(R102/C49) +0.98	(R43) +12.0
Q15	(R49/C24-) -0.33	(R45/R47) +0.32	(R48) +9.4
Q16	(C20+/C23+) +10.0	(R48) +9.4	(R51/C26-) -7.5
Q17	(C29-) -0.69	(R53-2) 0.0	(R54) +10.0
Q18	(R56) +10.6	(R54) +10.0	(CR1-A) -1.85
Q19	(R61) -2.5	(CR1-A) -1.85	(C30+) +14.5
Q20	(R62) -2.6	(R57/R58) -3.3	(C31-) -14.5
Q22 thru Q29 ON	(GND) 0.0	+0.77	+0.17
Q22 thru Q29 OFF	(GND) 0.0	0 to +0.1	+0.17
Q31 thru Q38 ON	(GND) 0.0	+0.77	+0.34
Q31 thru Q38 OFF	(GND) 0.0	0 to +0.1	+0.34
Q40 thru Q47 ON	(TP10) 0.0	+0.77	+0.05
Q40 thru Q47 OFF	(TP10) 0.0	0 to +0.1	+1.1
Q49 ON	(GND) 0.0	(R114/R115) +0.77	(R123) 0.0
Q49 OFF	(GND) 0.0	(R114/R115) 0 to 0.1	(R123) +0.23 to +1.1 (8)

Table 5-5. Typical DC Voltage Measurements, 13-547-1 Intermediate Bandwidth Direct Reproduce Amplifier (Sheet 1 of 2)

TRAN-SISTOR	EMITTER (volts)	BASE (volts)	COLLECTOR (volts)
Q50 ON	(GND) 0.0	(R116/R117) +0.77	(R124) 0.0 ⑧
Q50 OFF	(GND) 0.0	(R116/R117) 0 to +0.1	(R124) +0.23 to +1.1
Q51 ON	(GND) 0.0	(R118/R119) +0.77	(R125) 0.0 ⑧
Q51 OFF	(GND) 0.0	(R118/R119) 0 to +0.1	(R125) +0.23 to +1.1
Q52 ON	(GND) 0.0	(R120/R121) +0.77	(R126) 0.0 ⑧
Q52 OFF	(GND) 0.0	(R120/R121) 0 to +0.1	(R126) +0.23 to +1.1
Q53 ON	(GND) 0.0	(R129) +0.77	(R134-1) +0.05 ⑨
Q53 OFF	(GND) 0.0	(R129) 0.0	(R134-1) 0 to +0.65

CONDITIONS OF MEASUREMENT:

1. Amplifier installed on extender card in 13-505 or 13-505A Amplifier Mounting Assembly.

2. Control Settings: Amplifier adjusted for 1 volt output with system set up for normal record level; equalized for 600 kHz upper band edge.

3. Input connected to reproduce head via 13-546 Reproduce Head Preamplifier; no signal.

4. Output connected to 50 ohm load.

5. Reference Schematic: Figure 7-1.

6. Measurements were taken using a Hewlett-Packard Type 3439A Digital Voltmeter with a Type 3442A Plug-in.

7. The circuit locations shown in parentheses are common to the listed transistor emitter, base, or collector.

⑧ Voltage varies with tape speed. Voltage will be the same for two speeds: voltage at 120 ips will match that at 7 1/2 ips; voltage at 60 ips will match that at 3 3/4 ips; voltage at 30 ips will match that at 1 7/8 ips; voltage at 15 ips will match that at 15/16 ips.

⑨ When transistor is off, voltage varies with settings of R133 and R134.

Table 5-5. Typical DC Voltage Measurements, 13-547-1 Intermediate Bandwidth Direct Reproduce Amplifier (Sheet 2 of 2)

TRAN-SISTOR	EMITTER (volts)	BASE (volts)	COLLECTOR (volts)
Q2	(R9/C5-) -0.74	(R6/R7) 0 to +0.08	(R8) +5.3
Q3	(R10/C3+) +6.0	(R8) +5.3	(R12) +0.15
Q4	(R14/R15) -0.52	(R12) +0.15	(R13) +12.3
Q5	(R18/C8-) -0.97	(R16) -0.3	(R17) +5.2
Q6	(R19/C7+) +5.6 to +5.9 (8)	(R17) +5.2 (8)	(R123) +0.35 to +1.6 (8)
Q7	(R22/R27) -0.33 to +0.92 (8)	(R123) +0.35 to +1.6	(R21) +3.7 to +4.7 (8)
Q8	(R24) +4.3 to +5.2 (8)	(R21) +4.7	(R25) -13.0
Q9	(R30/C14-) -1.25	(R26/R27) -0.6	(R29) +10.0
Q10	(R31) 10.6	(R29) +10.0	(R32) +1.9
Q11	(R35/C16+) +1.22	(R32) +1.9	(R34) +12.0
Q12	(R39/C17-) -0.32	(R36/R40) +0.34	(R38) +9.5
Q13	(R41) +10.3	(R78) +9.5	(R102/C49) +1.1
Q14	(R44/R45) +0.4	(R102/C49) +1.1	(R43) +12.0
Q15	(R49/C24-) -0.25	(R45/R47) +0.4	(R48) +9.4
Q16	(C20+/C23+) +10.2	(R48) +9.6	(R51/C26-) -7.5
Q17	(C29-) -0.69	(R53-2) 0.0	(R54) +10.0
Q18	(R56) +10.6	(R54) +10.0	(CR1-A) -2.0
Q19	(R61) -2.6	(CR1-A) -2.0	(C30+) +14.5
Q20	(R62) -2.8	(R57/R58) -3.5	(C31-) -14.3
Q22 thru Q29 ON	(GND) 0.0	+0.77	+0.1
Q22 thru Q29 OFF	(GND) 0.0	0 to +0.1	+0.1
Q31 thru Q38 ON	(GND) 0.0	+0.77	+0.5
Q31 thru Q38 OFF	(GND) 0.0	0 to +0.1	+0.5
Q40 thru Q47 ON	(TP10) 0.0	+0.77	+0.5
Q40 thru Q47 OFF	(TP10) 0.0	0 to +0.1	+1.1
Q49 ON	(GND) 0.0	(R114/R115) +0.77	(R123) 0.0
Q49 OFF	(GND) 0.0	(R114/R115) 0 to +0.1	(R123) +0.35 to +1.6 (8)

Table 5-6. Typical DC Voltage Measurements, 13-547-2 and 13-547-3 Wide Band Direct Reproduce Amplifiers (Sheet 1 of 2)

TRAN-SISTOR	EMITTER (volts)	BASE (volts)	COLLECTOR (volts)
Q50 ON	(GND) 0.0	(R116/R117) +0.77	(R124) 0.0 ⑧
Q50 OFF	(GND) 0.0	(R116/R117) 0 to +0.1	(R124) +0.35 to +1.6
Q51 ON	(GND) 0.0	(R118/R119) +0.77	(R125) 0.0 ⑧
Q51 OFF	(GND) 0.0	(R118/R119) 0 to +0.1	(R125) +0.35 to +1.6
Q52 ON	(GND) 0.0	(R120/R121) +0.77	(R126) 0.0 ⑧
Q52 OFF	(GND) 0.0	(R120/R121) 0 to +0.1	(R126) +0.35 to +1.6
Q53 ON	(GND) 0.0	(R129) +0.77	(R134-1) +0.07 ⑨
Q53 OFF	(GND) 0.0	(R129) 0.0	(R134-1) 0 to +0.7

CONDITIONS OF MEASUREMENT:

1. Amplifier installed on extender card in 13-505 or 13-505A Amplifier Mounting Assembly.
2. Control Settings: Amplifier adjusted for 1 volt output with system set up for normal record level; equalized for 1.5 or 2.0 MHz upper band edge.
3. Input connected to reproduce head via 13-546 Reproduce Head Preamplifier; no signal.
4. Output connected to 50 ohm load.
5. Reference Schematics: Figures 7-2 and 7-3.
6. Measurements were taken using a Hewlett-Packard Type 3439A Digital Voltmeter with a Type 3442A Plug-in.
7. The circuit locations shown in parentheses are common to the listed transistor emitter, base, or collector.

⑧ Voltage varies with tape speed. Voltage will be the same for two speeds: voltage at 120 ips will match that at 7 1/2 ips; voltage at 60 ips will match that at 3 3/4 ips; voltage at 30 ips will match that at 1 7/8 ips; voltage at 15 ips will match that at 15/16 ips.

⑨ When transistor is off, voltage varies with settings of R133 and R134.

Table 5-6. Typical DC Voltage Measurements, 13-547-2 and 13-547-3 Wide Band Direct Reproduce Amplifiers (Sheet 2 of 2)

5-24. PARTS IDENTIFICATION.

5-25. Components of the 13-547 Direct Reproduce Amplifier are illustrated in Section VI of the manual, showing location and part designations. The parts list of Section VI itemizes the component parts in each assembly and provides a Bell & Howell part number for each.

5-26. FIELD REPAIR SERVICE.

5-27. Regular scheduled maintenance service is available from the Bell & Howell Instruments Division Sales and Service Office on a contract basis. If immediate service is required, it may be obtained on an emergency basis. Every effort is made to furnish the needed repair as soon as possible. For a complete description of Bell & Howell's maintenance service plans and their costs, contact the Instruments Division Sales and Service Office.

5-28. FACTORY REPAIR SERVICE.

5-29. If desired, instruments (or major assemblies) may be returned to the factory for repair. When an instrument or assembly is returned:

a. Indicate the symptom of defect. State as completely as possible, both on an instrument tag and on the order form, the nature of the problem encountered. Too much information is far better than too little. If the trouble is intermittent, please be specific in describing the instrument's performance history.

b. Give special instructions. If any changes in the instrument or assembly have been made, and it is desired to retain the modified form, please indicate this specifically.

c. State the desired invoicing procedure. In the first correspondence, indicate whether repair work may begin immediately with billing in accordance with the standard pricing system or whether Bell & Howell should secure prior approval of the price before proceeding with the repair. The price will be the same in both cases, but any delay will be minimized by permission to start work immediately. The order acknowledgment copy will, of course, always show the price.

d. Pack securely and label. Proper packaging saves money. The small amount of extra care and time it takes to cushion a part or instrument properly may prevent costly damage while in transit. Make certain that the address is both legible and complete; failure to do so often results in needless delay. Address all shipments and correspondence to:

Bell & Howell
Instruments Division
360 Sierra Madre Villa
Pasadena, California 91109
Attention: Repair Department

e. Show return address on repair correspondence. Please indicate clearly the exact address to which the equipment should be returned after repair is completed. All shipping costs will be borne by the owner of the equipment, not by Bell & Howell.

SECTION VI

PARTS LISTS

6-1. GENERAL.

6-2. Appropriate parts lists and illustrations for the 13-547-1, 13-547-2, and 13-547-3 Direct Reproduce Amplifiers follow the instructions given below. The parts lists include the Bell & Howell Instruments Division part number, description, figure and index and/or schematic reference symbol, and where applicable, the manufacturer's or military part number for each component. Manufacturers are identified in the parts lists by code number in accordance with the Federal Supply Code for Manufacturers, Cataloging Handbook H4-2, and as listed in table 6-1. The components are illustrated in figure 6-1.

6-3. ORDERING REPLACEMENT PARTS.

6-4. Parts should be ordered through the nearest Bell & Howell Instruments Division Sales and Service Office. Price and delivery information on parts or complete instruments may be obtained there also. To assist in making this contact, a list of Sales and Service Offices is included in the front of this manual. Bell & Howell recommends that whenever possible, and particularly when an instrument is used in a critical application, the user maintain a minimum stock of spare parts. Instruments Division has specialized personnel ready to assist the user in making a selection of spares at any time. The same personnel are also ready and able to prepare or quote on the preparation of illustrated parts breakdowns (IPB's), provisioning parts breakdowns (PPB's), and other parts documentation that might be required.

6-5. When ordering parts, the following information should always be supplied to the field office engineers:

a. A description of the part or assembly, obtained from the parts list.

b. The Bell & Howell part or assembly number, also on the parts list, or on the component itself.

c. The figure and index, and/or reference symbol, given on the applicable diagram and on the parts list.

d. The part or type number of the major assembly, shown on the instrument nameplate.

e. The production serial number, also on the nameplate.

f. The Bell & Howell register number applying to the complete system or order.

CODE	MANUFACTURER
01121	Allen-Bradley Company Milwaukee, Wisconsin
03508	General Electric Company Semiconductor Products Department Syracuse, New York
04713	Motorola Semiconductor Products, Incorporated Phoenix, Arizona
05397	Union Carbide Corporation Materials Systems Division Cleveland, Ohio
06540	Mite Corporation Amatom Electronic Hardware Division New Rochelle, New York
20932	Illinois Tool Works, Incorporated Electro Materials Division San Diego, California
24546	Corning Glass Works Bradford, Pennsylvania
31433	Union Carbide Corporation Greenville, South Carolina
56289	Sprague Electric Company North Adams, Massachusetts
72136	Electro Motive Manufacturing Company, Incorporated Willimantic, Connecticut
76493	J. W. Miller Company Compton, California
80294	Bourns, Incorporated Trimpot Products Division Riverside, California
83330	Herman H. Smith, Incorporated Brooklyn, New York

Table 6-1. List of Manufacturers

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 1 of 8)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	475200-0001	Direct Repro Ampl (Mid-Band)	1	-	-	(13-547-1)		
2	475200-0002	Direct Repro Ampl (Wide Band 2 MHz)	-	1	-	(13-547-2)		
3	475200-0003	Direct Repro Ampl (Wide Band 1.5 MHz)	-	-	1	(13-547-3)		
4	475200	Printed Wiring Bd	1	1	1	6-1		
5	475560	Shield and Insulator Assembly	1	1	1			
6	471349	Shield, printed wiring bd	1	1	1			
7	249641-10	Post, elec-mech, equip. (2-56 x 1/8 lg)	5	5	5		06540	9505B-B-0256-14
8	475559	Insulator, shield	1	1	1			
9	70052-212	Cord, lacing	A/R	A/R	A/R			
10	471922-1022	Res, 1K ±2%, 1/4 w	2	-	-	R5,16	24546	C4-102G
11	471922-2022	Res, 2K ±2%, 1/4 w	-	3	3	R5,16,63	24546	C4-202G
12	471922-1022	Res, 1K ±2%, 1/4 w	14	14	14	R6,7,13,21, R22,25,28,34, R40,43,45,46, R47,56	24546	C4-102G
13	471922-5622	Res, 5.6K ±2%, 1/4 w	5	5	5	R8,17,29, R38,48	24546	C4-562G
14	471922-7522	Res, 7.5K ±2%, 1/4 w	2	2	2	R9,18	24546	C4-752G
15	471922-2022	Res, 2K ±2%, 1/4 w	4	-	-	R10,26,36,63	24546	C4-202G
16	471922-3322	Res, 3.3K ±2%, 1/4 w	-	1	1	R10	24546	C4-332G
17	471922-5102	Res, 51Ω ±2%, 1/4 w	4	4	4	R11,59,60,65	24546	C4-510G
18	366427-0007	Res, var, 1K ±20%, 1/2 w	1	-	-	R12	80294	3339P-1-102
19	366427-0009	Res, var, 5K ±20%, 1/2 w	-	1	1	R12	80294	3339P-1-502

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 2 of 8)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471922-2222	Res, 2.2K ±2%, 1/4 w	1	1	1	R15	24546	C4-222G
2	471922-5122	Res, 5.1K ±2%, 1/4 w	7	7	7	R14, 23, 24, 35, R44, 51, 55	24546	C4-512G
3	471922-3322	Res, 3.3K ±2%, 1/4 w	41	41	41	R19, 20, 31, 41, R50, 69 thru 76, R87 thru 94, R105 thru 112, R114 thru 121, R129 thru 132	24546	C4-332G
4	471922-1022	Res, 1K ±2%, 1/4 w	-	2	2	R26, 36	24546	C4-102G
5	471922-2042	Res, 200K ±2%, 1/4 w	1	-	-	R27	24546	C4-204G
6	471922-1042	Res, 100K ±2%, 1/4 w	-	1	1	R27	24546	C4-104G
7	471922-1532	Res, 15K ±2%, 1/4 w	3	3	3	R30, 39, 49	24546	C4-153G
8	471922-8222	Res, 8.2K ±2%, 1/4 w	1	-	1	R32	24546	C4-822G
9	471922-9122	Res, 9.1K ±2%, 1/4 w	-	1	1	R32	24546	C4-912G
10	471922-3912	Res, 390Ω ±2%, 1/4 w	1	-	-	R33	24546	C4-391G
11	471922-2012	Res, 200Ω ±2%, 1/4 w	-	1	1	R33	24546	C4-201G
12	471922-7512	Res, 750Ω ±2%, 1/4 w	1	-	-	R37	24546	C4-751G
13	471922-5112	Res, 510Ω ±2%, 1/4 w	-	1	1	R37	24546	C4-511G
14	471922-1032	Res, 10K ±2%, 1/4 w	3	3	3	R42, 66, 128	24546	C4-103G
15	471922-2412	Res, 240Ω ±2%, 1/4 w	1	1	1	R52	24546	C4-241G
16	471573-0820	Res, var, 5K ±20%, 1/3 w	1	1	1	R53	01121	NP502M
17	471922-1822	Res, 1.8K ±2%, 1/4 w	1	1	1	R54	24546	C4-182G
18	471922-2002	Res, 20Ω ±2%, 1/4 w	1	1	1	R57	24546	C4-200G
19	471922-2722	Res, 2.7K ±2%, 1/4 w	1	1	1	R58	24546	C4-272G

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 3 of 8)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471922-1002	Res, 10Ω ±2%, 1/4 w	2	2	2	R61, 62	24546	C4-100G
2	471922-1012	Res, 100Ω ±2%, 1/4 w	2	2	2	R64, 123	24546	C4-101G
3	378770-0008	Res, var, 2K ±10%, 3/4 w	2	2	2	R67, 133	80294	3009P-1-202
4	471573-0520	Res, var, 1K ±20%, 1/3 w	8	8	8	R78 thru 85	01121	NP102M
5	471922-1812	Res, 180Ω ±2%, 1/4 w	1	1	1	R124	24546	C4-181G
6	471922-3012	Res, 300Ω ±2%, 1/4 w	1	1	1	R125	24546	C4-301G
7	471922-5612	Res, 560Ω ±2%, 1/4 w	1	-	-	R126	24546	C4-561G
8	471922-4712	Res, 470Ω ±2%, 1/4 w	-	1	1	R126	24546	C4-471G
9	471922-1002	Res, 10Ω ±2%, 1/4 w	1	-	-	R127	24546	C4-100G
10	378770-0004	Res, var, 100Ω ±10%, 3/4 w	1	1	1	R134	80294	3009P-1-101
11	471922-6222	Res, 6.2K ±2%, 1/4 w	-	1	1	R135	24546	C4-622G
12	471922-2032	Res, 20K ±2%, 1/4 w	1	-	-	R136	24546	C4-203G
13	366427-0006	Res, var, 500Ω ±20%, 1/2 w	1	1	1	R137	80294	3339P-1-501
14	471922-2012	Res, 200Ω ±2%, 1/4 w	2	-	-	R138, 139	24546	C4-201G
15	471863-0004	Cap, 10 μf ±20%, 20 vdc	10	10	10	C1, 5, 8, 10, 14, C17, 19, 24, 30, C31	31433	T320B106-M20 AS
16	70094-0016	Cap, 39 pf ±5%, 500 vdc	1	1	1	C2	72136	DM15E390J0500 WV5CR
17	471930-0003	Cap, 100 μf +75 -10%, 16 vdc	14	14	14	C3, 4, 6, 9, 11, C13, 18, 20, 21, C22, 23, 28, 29, C32	56289	500D107G016 DC7
18	471863-0006	Cap, 2.2 μf ±20%, 25 vdc	1	1	1	C7	31433	T320A225-M25AS
19	471863-0006	Cap, 2.2 μf ±20%, 25 vdc	-	2	2	C12, 16	31433	T320A225-M25AS
20	471863-0004	Cap, 10 μf ±20%, 20 vdc	2	-	-	C12, 16	31433	T320B106-M20AS

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 4 of 8)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	215095-0663	Cap, 0.047 μf ±5%, 80 vdc	1	1	1	C15	56289	192P4735R8
2	471863-0007	Cap, 1.2 μf ±20%, 35 vdc	1	1	1	C26	31433	T320A125-M35AS
3	70094-0004	Cap, 5 pf ±0.5 pf, 500 vdc	1	1	1	C27	72136	DM15C050D0 500WV5CR
4	70094-0063	Cap, 1100 pf ±5%, 500 vdc	2	-	-	C34, 56	72136	DM19F112J0 500WV5CR
5	70094-0020	Cap, 51 pf ±5%, 500 vdc	-	1	-	C34	72136	DM15E510J0 500WV4CR
6	70094-0030	Cap, 130 pf ±5%, 500 vdc	-	-	1	C34	72136	DM15E131J0 500WV5CR
7	471921-0005	Cap, 2200 pf ±5%, 50 v	1	-	-	C35	20932	302EJ200RC 222J
8	70094-0031	Cap, 150 pf ±5%, 500 vdc	-	1	-	C35	72136	DM15F151J0 500WV5CR
9	70094-0042	Cap, 390 pf ±5%, 500 vdc	-	-	2	C35, 56	72136	DM15F391J0 500WV5CR
10	471921-0009	Cap, 4700 pf ±5%, 50 v	1	-	-	C36	20932	302EJ100RC 472J
11	70094-0042	Cap, 390 pf ±5%, 500 vdc	-	2	-	C36, 56	72136	DM15F391J0 500WV5CR
12	70094-0050	Cap, 750 pf ±5%, 500 vdc	-	-	1	C36	72136	DM15F751J0 500WV5CR
13	215095-0583	Cap, 0.0082 μf ±5%, 80 vdc	1	-	-	C37	56289	192P8225R8
14	70094-0051	Cap, 820 pf ±5%, 300 vdc	-	1	-	C37	72136	DM15F821J0 300WV5CR
15	215095-0163	Cap, 0.0015 μf ±5%, 200 vdc	-	-	1	C37	56289	192P15252
16	215095-0513	Cap, 0.018 μf ±5%, 80 vdc	1	-	-	C38	56289	192P1835R8

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 5 of 8)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471921-0004	Cap, 1800 pf ±5%, 50 v	-	1	-	C38	20932	302EF200RC 182J
2	215095-0523	Cap, 0.0027 µf ±5%, 80 vdc	-	-	1	C38	56289	192P2725R8
3	215095-0643	Cap, 0.033 µf ±5%, 80 vdc	2	-	-	C39,49	56289	192P333R58
4	471921-0007	Cap, 3300 pf ±5%, 50 v	-	1	-	C39	20932	302EF100RC 332J
5	215095-0563	Cap, 0.0056 µf ±5%, 80 vdc	-	-	1	C39	56289	192P5625R8
6	215095-0503	Cap, 0.068 µf ±5%, 80 vdc	1	-	-	C40	56289	192P6835R8
7	471921-0011	Cap, 6200 pf ±5%, 50 v	-	1	-	C40	20932	302EJ100RC 622J
8	215095-0603	Cap, 0.012 µf ±5%, 80 vdc	-	-	1	C40	56289	192P1235R8
9	215095-0693	Cap, 0.12 µf ±5%, 80 vdc	1	-	-	C41	56289	192P1245R8
10	215095-0603	Cap, 0.012 µf ±5%, 80 vdc	-	1	-	C41	56289	192P1235R8
11	215095-0623	Cap, 0.022 µf ±5%, 80 vdc	-	-	1	C41	56289	192P2235R8
12	70094-0046	Cap, 510 pf ±5%, 500 vdc	1	-	-	C43	72136	DM15F511J0 500WV4CR
13	199985-0038	Cap, 270 pf ±5%, 300 vdc	-	1	-	C43	72136	DM10F271J0 300WV4CR
14	199985-0039	Cap, 300 pf ±5%, 300 vdc	-	-	1	C43	72136	DM10F301J0 300WV4CR
15	70094-0051	Cap, 820 pf ±5%, 300 vdc	1	-	-	C44	72136	DM15F821J0 300WV5CR
16	70094-0048	Cap, 620 pf ±5%, 300 vdc	-	1	1	C44	72136	DM15F621J0 300WV5CR
17	471921-0004	Cap, 1800 pf ±5%, 50 v	1	-	-	C45	20932	302EJ200RC 182J
18	471921-0002	Cap, 1200 pf ±5%, 50 v	-	1	1	C45	20932	302EJ200RC 122J

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 6 of 8)

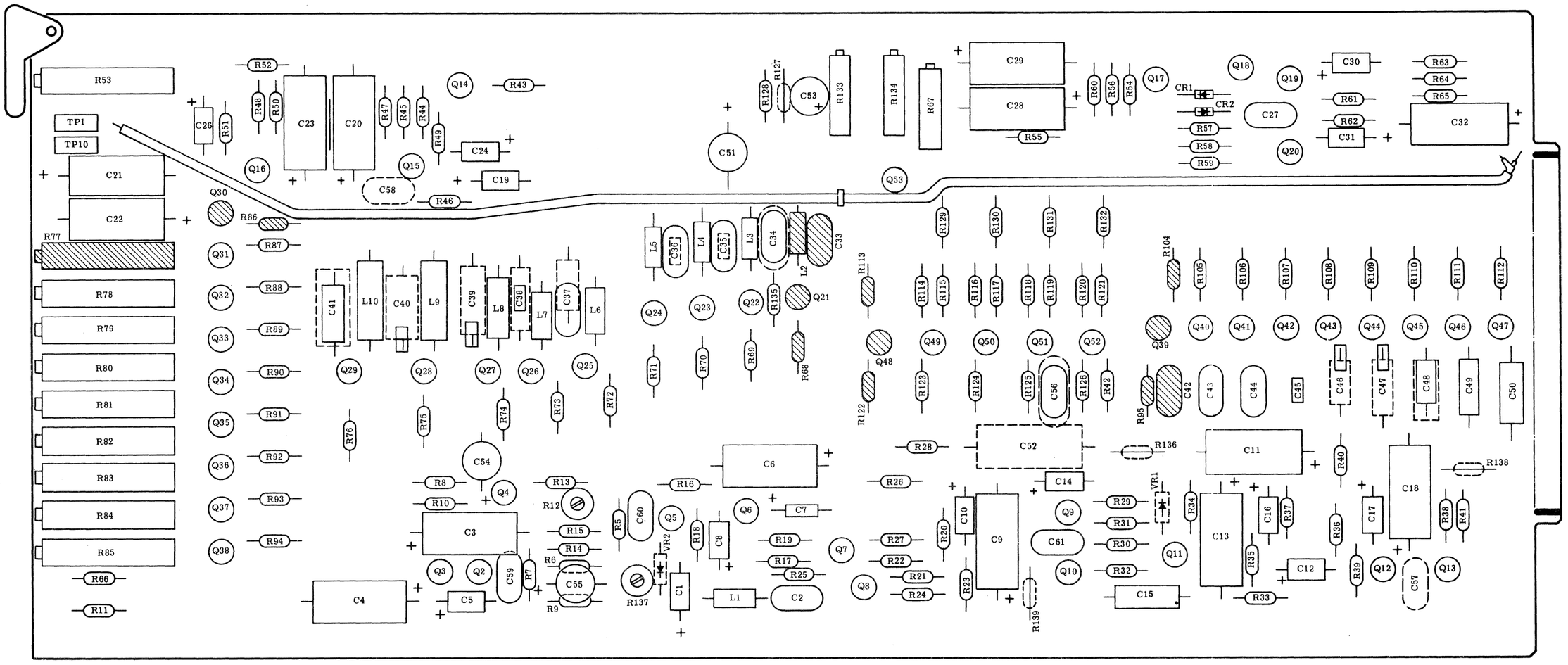
ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	215095-0543	Cap, 0.0039 µf ±5%, 80 vdc	1	-	-	C46	56289	192P3925R8
2	471921-0005	Cap, 2200 pf ±5%, 50 v	-	1	1	C46	20932	302EJ200RC 222J
3	215095-0583	Cap, 0.0082 µf ±5%, 80 vdc	1	-	-	C47	56289	192P8225R8
4	471921-0009	Cap, 4700 pf ±5%, 50 v	-	1	1	C47	20932	302EJ100RC 472J
5	215095-0613	Cap, 0.015 µf ±5%, 80 vdc	1	-	-	C48	56289	192P1535R8
6	215095-0593	Cap, 0.01 µf ±5%, 80 vdc	-	1	1	C48	56289	192P1035R8
7	215095-0623	Cap, 0.022 µf ±5%, 80 vdc	-	1	1	C49	56289	192P2235R8
8	215095-0673	Cap, 0.056 µf ±5%, 80 vdc	1	-	-	C50	56289	192P5635R8
9	215095-0653	Cap, 0.039 µf ±5%, 80 vdc	-	1	1	C50	56289	192P3935R8
10	471920-0005	Cap, 10 µf, 35 vdc	3	3	3	C51, 54, 55	05397	T362C106M0 35AS
11	215095-0443	Cap, 0.33 µf ±5%, 80 vdc	1	-	-	C52	56289	192P3345R8
12	471920-0006	Cap, 150 µf ±20%, 6 vdc	1	1	1	C53	05397	T362C157M0 06AS
13	70094-0002	Cap, 2 pf ±0.5 pf, 500 vdc	4	4	4	C57, 59, 60, 61	72136	DM15C020D0 500WV5CR
14	70094-0005	Cap, 10 pf ±5%, 500 vdc	1	1	1	C58	72136	DM15C100J0 500WV5CR
15	246954	Diode	2	2	2	CR1, 2	03508	1N4154
16	246008-0511	Diode, zener	2	-	-	VR1, 2	04713	1N961B
17	471472	Transistor, NPN	10	10	10	Q2, 4, 5, 7, 9, Q11, 12, 14, 15, Q17	04713	2N3947
18	471931	Transistor, PNP	7	7	7	Q3, 6, 8, 10, 13, Q16, 18	04713	2N3251

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 7 of 8)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471927	Transistor, NPN	1	1	1	Q19	04713	2N2219
2	471925	Transistor, PNP	1	1	1	Q20	04713	2N2905
3	471926	Transistor, NPN	29	29	29	Q22 thru 29, Q31 thru 38, Q40 thru 47, Q49 thru 53	04713	2N2369
4	204749-1008	Jack, tip, horiz, brn	1	1	1	TP1	83330	430-108
5	204749-1003	Jack, tip, horiz, blk	1	1	1	TP10	83330	430-103
6	9916-0022	Wire, elec, solid, 22 AWG	A/R	A/R	A/R			
7	70078-2209	Insulation, slvg	A/R	A/R	A/R			
8	126716-0174	Cable, RG174/U	A/R	A/R	A/R			
9	471788-0001	Coil, RF, 10 μh ±10%	1	1	1	L1	76493	9310-36
10	472466-0015	Coil, RF, molded, shielded, 56 μh ±5%	1	-	-	L3	76493	9250-563-5%
11	471788-0015	Coil, RF, 56 μh ±5%	-	1	1	L3	76493	9210-64
12	472466-0023	Coil, RF, molded, shielded, 120 μh ±5%	1	-	-	L4	76493	9250-124-5%
13	471788-0023	Coil, RF, 120 μh ±5%	-	1	1	L4	76493	9210-80
14	472466-0029	Coil, RF, molded, shielded, 220 μh ±5%	1	-	-	L5	76493	9250-224-5%
15	471788-0029	Coil, RF, 220 μh ±5%	-	1	1	L5	76493	9210-92
16	472466-0037	Coil, RF, molded, shielded, 470 μh ±5%	1	-	-	L6	76493	9250-474-5%
17	471788-0037	Coil, RF, 470 μh ±5%	-	1	1	L6	76493	9220-12
18	472466-0046	Coil, RF, molded, shielded, 1000 μh ±5%	1	-	-	L7	76493	9250-105-5%
19	471788-0046	Coil, RF, 1000 μh ±5%	-	1	1	L7	76493	9220-28

Table 6-2. Parts Lists for the Types 13-547-1, -2, and -3 Direct Reproduce Amplifiers (Sheet 8 of 8)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY -1	QTY -2	QTY -3	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	472466-0052	Coil, RF, molded, shielded 1800 μh ±5%	1	-	-	L8	76493	9250-185-5%
2	471788-0053	Coil, RF, 2000 μh ±5%	-	1	1	L8	76493	9220-42
3	472466-0060	Coil, RF, molded, shielded, 3900 μh ±5%	1	-	-	L9	76493	9250-395-5%
4	471788-0060	Coil, RF, 3900 μh ±5%	-	1	1	L9	76493	9220-56
5	472466-0069	Coil, RF, molded, shielded, 8200 μh ±5%	1	-	-	L10	76493	9250-825-5%
6	471788-0069	Coil, RF, 8200 μh ±5%	-	1	1	L10	76493	9220-72
7	175431-0203	Screw	5	5	5			
8	166497-2010	Washer	5	5	5			
9	9245-0001	Washer	5	5	5			



2. COMPONENTS SHOWN "CROSS-HATCHED" ( ) ARE NOT PART OF STD UNIT, SHOWN FOR REF ONLY.

1. COMPONENTS SHOWN IN DASHED LINES INDICATE ALTERNATE MTG HOLES.

NOTES:

E-475200-S (REF)

Figure 6-1. 13-547-1, 13-547-2, and 13-547-3 Direct Reproduce Amplifiers

SECTION VII

DRAWINGS AND SCHEMATICS

7-1. GENERAL.

7-2. Figure 7-1 is a schematic of the Type 13-547-1 Intermediate Bandwidth Direct Reproduce Amplifier.

7-3. Figure 7-2 is a schematic of the Type 13-547-2, 2 MHz Wide Band Direct Reproduce Amplifier.

7-4. Figure 7-3 is a schematic of the Type 13-547-3, 1.5 MHz Wide Band Direct Reproduce Amplifier.

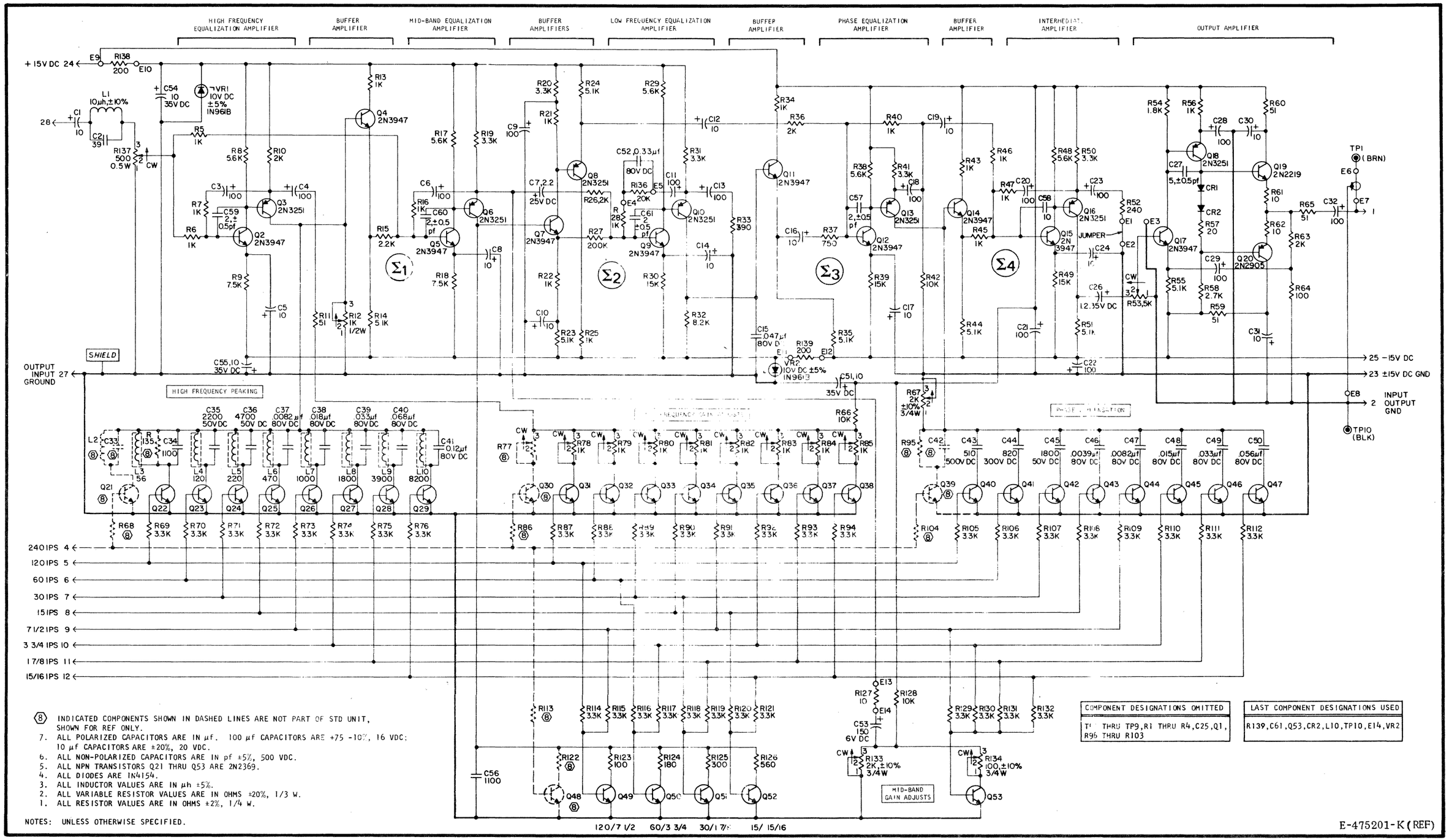
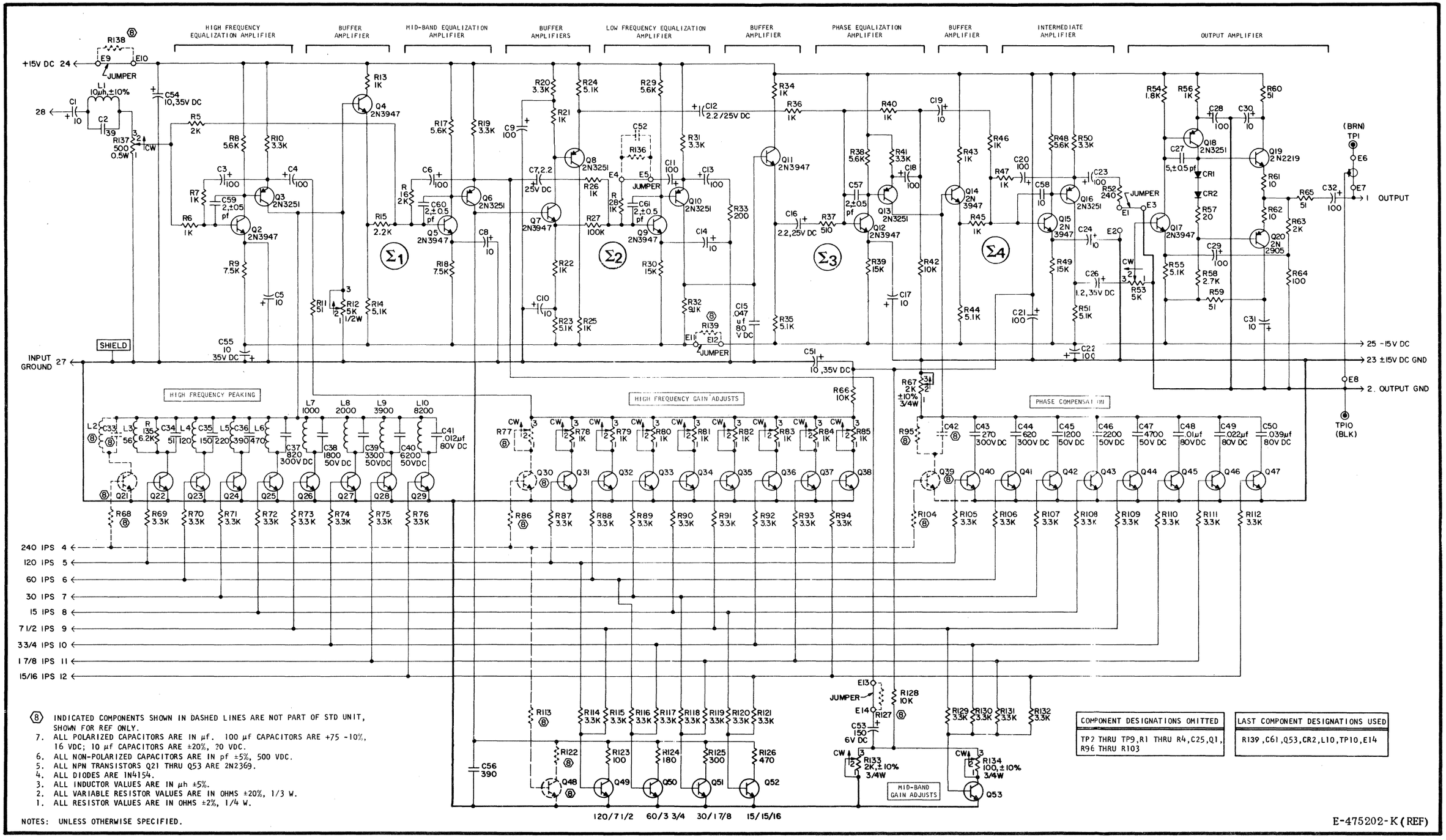


Figure 7-1. Schematic, 13-547-1 Intermediate Bandwidth Direct Reproduce Amplifier 7-3/7-4



(8) INDICATED COMPONENTS SHOWN IN DASHED LINES ARE NOT PART OF STD UNIT, SHOWN FOR REF ONLY.

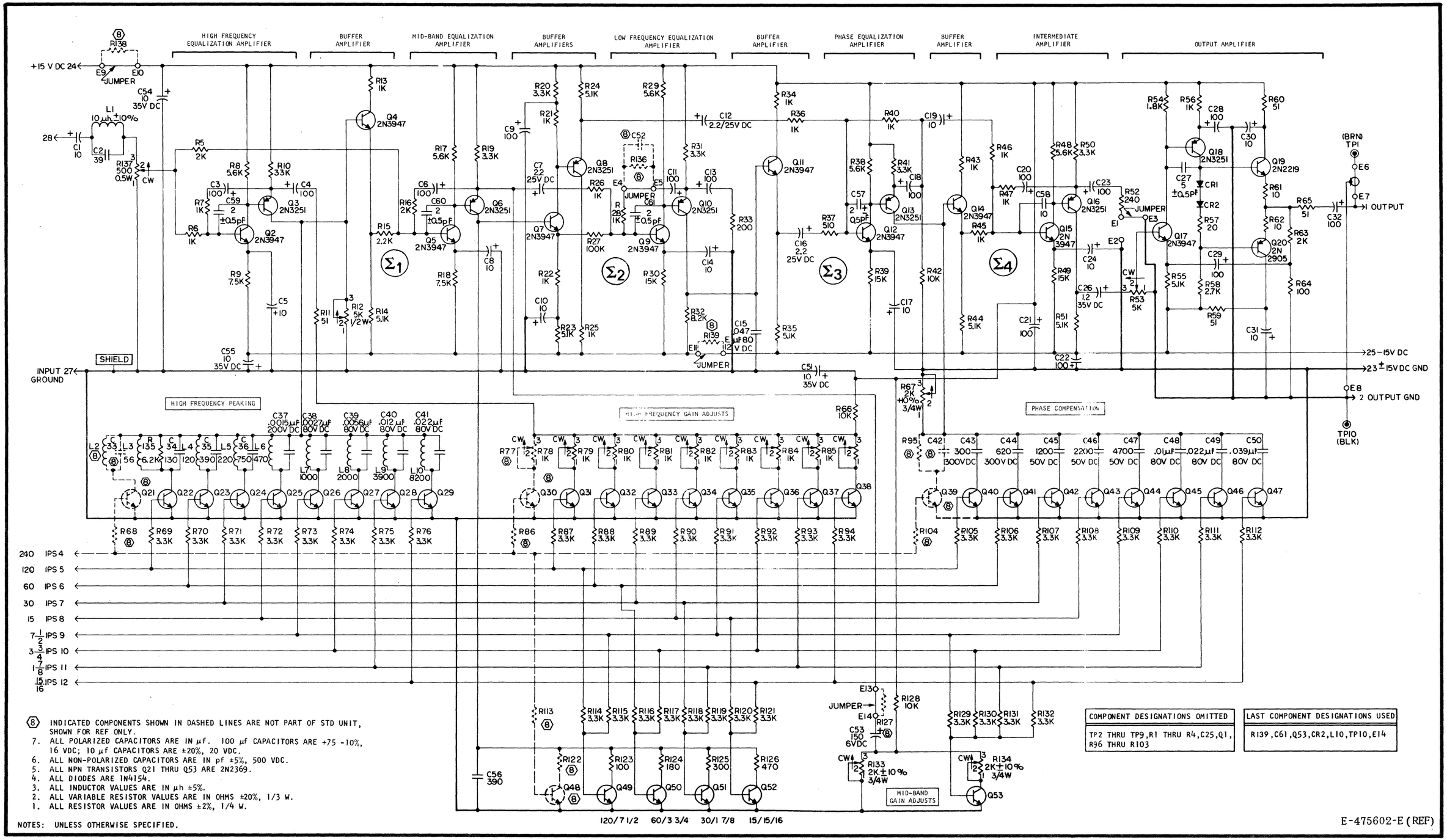
7. ALL POLARIZED CAPACITORS ARE IN µf. 100 µf CAPACITORS ARE +75 -10%, 16 VDC; 10 µf CAPACITORS ARE ±20%, 20 VDC.
6. ALL NON-POLARIZED CAPACITORS ARE IN pf ±5%, 500 VDC.
5. ALL NPN TRANSISTORS Q21 THRU Q53 ARE 2N2369.
4. ALL DIODES ARE 1N4154.
3. ALL INDUCTOR VALUES ARE IN µh ±5%.
2. ALL VARIABLE RESISTOR VALUES ARE IN OHMS ±20%, 1/3 W.
1. ALL RESISTOR VALUES ARE IN OHMS ±2%, 1/4 W.

NOTES: UNLESS OTHERWISE SPECIFIED.

COMPONENT DESIGNATIONS OMITTED	LAST COMPONENT DESIGNATIONS USED
TP2 THRU TP9, R1 THRU R4, C25, Q1, R96 THRU R103	R139, C61, Q53, CR2, L10, TP10, E14

E-475202-K (REF)

Figure 7-2. Schematic, 13-547-2, 2 MHz Wide Band Direct Reproduce Amplifier
7-5/7-6



⑧ INDICATED COMPONENTS SHOWN IN DASHED LINES ARE NOT PART OF STD UNIT, SHOWN FOR REF ONLY.

7. ALL POLARIZED CAPACITORS ARE IN μf. 100 μf CAPACITORS ARE +75 -10%, 16 VDC; 10 μf CAPACITORS ARE ±20%, 20 VDC.
6. ALL NON-POLARIZED CAPACITORS ARE IN pf ±5%, 500 VDC.
5. ALL NPN TRANSISTORS Q21 THRU Q53 ARE 2N2369.
4. ALL DIODES ARE 1N4154.
3. ALL INDUCTOR VALUES ARE IN μh ±5%.
2. ALL VARIABLE RESISTOR VALUES ARE IN OHMS ±20%, 1/3 W.
1. ALL RESISTOR VALUES ARE IN OHMS ±2%, 1/4 W.

NOTES: UNLESS OTHERWISE SPECIFIED.

COMPONENT DESIGNATIONS OMITTED	LAST COMPONENT DESIGNATIONS USED
TP2 THRU TP9, R1 THRU R4, C25, Q1, R96 THRU R103	R139, C61, Q53, CR2, L10, TP10, E14

E-475602-E (REF)

Figure 7-3. Schematic, 13-547-3, 1.5 MHz Wide Band Direct Reproduce Amplifier