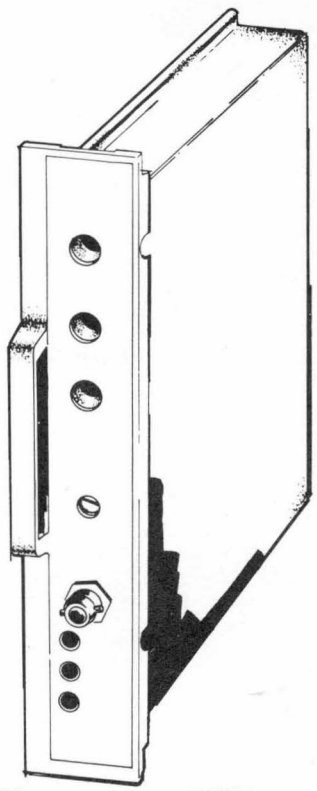
PRELIMINARY MANUAL



ES-100

SIGNAL ELECTRONICS

AMPEX CORPORATION REDWOOD CITY, CALIFORNIA

104001

104002

CONTENTS

LIST OF ILLUSTRATIONS

SAFETY NOTICE

Disassembly and servicing of the ES-100 equipment should be performed only by qualified and authorized personnel.

Precautionary steps should be taken against electrical shock, especially when servicing the power circuits.

1. REMOVE THE INPUT POWER PLUG WHEN SERVICING ANY COMPONENT IN THE TRAY ASSEMBLY.

2. DO NOT SERVICE THE EQUIPMENT EXCEPT IN THE PRESENCE OF A SECOND PERSON CAPABLE OF RENDERING ASSISTANCE IN CASE OF ELECTRIC SHOCK.

ES-100 ELECTRONICS SYSTEM

GENERAL

The ES-100 system is a general purpose, instrumentation product of interchangeable transistorized signal electronics, equipped with associated card files and trays that permit its use with a wide variety of recording systems. System design is of commercial instrumentation quality with major emphasis on performance and reliability. The design concept permits ready interchange of analog recording and reproducing modes such as DIRECT, FM and PDM with additional provisions for adding servo speed control equipment and service aids. The system is divided into individual components which permit adaptation to both portable and fixed rack installation.

Amplifiers

The basic amplifiers can be used in either manually speed compensated amplifiers or six-speed automatically compensated amplifiers, thus retaining consistency of electrical specification and components in both applications.

The compact electronic amplifier consists of integral connector contacts and components mounted directly to an etched circuit card, the assembly of which is labeled and protected on the front by a simple one-piece panel and handle. The card is then mechanically and electrically shielded by a metal cover that also supports the electronic assembly.

Card File

To provide perfect electrical isolation from surrounding hardware and other assemblies, the amplifier is supported in its connected position by insulated card guides made of durable fire-retardent, polycarbonate plastic and mounted in a card file. The card file is capable of accommodating 14 channels of amplifiers plus three auxiliary modules. Vacancy panels are provided to cover empty slots in the card file until such time as the space is needed for amplifiers or service modules.

Tray Assembly

The electronics tray designed for mounting in fixed or mobile racks is provided with a simple guide and quick-release fastener to permit the tray to slide forward and be suspended for maintainance or cabling from the front of the rack. The tray can also easily be lifted out of the guides for workbench servicing or instantaneous replacement with a standby tray to avoid system down-time during necessary periodic maintenance. For permanent mounting the fasteners and plastic bracket faces can be removed from the tray and screws used in the holes already provided to bolt the tray brackets into a rack.

Harnessing

The electrical harnessing of the system has been designed for crimp-on contacts of poke-home varieties to increase reliability and to permit quick, solderless maintenance and alteration of the system. This allows additional updating of a given system in the field without unnecessary down-time. Most connections are made with identical connectors, eliminating need of a great variety of spare parts for cables and connectors.

The data signal input and output harnesses are equipped with a new 50-ohm subminiature bayonet connectors to provide improved connector density on panels and permit use of smaller diameter, easy-to-handle coaxial cabling than previous systems utilized.

Preamplifiers

The purpose of the preamplifiers is to amplify low level signals from the tape before they are applied to the reproduce amplifiers to permit reduction of noise pick-up in the long cable from the tape transport.

Preamplifier assemblies are of etched circuit construction and are mounted two to a circuit card for compactness. They are housed in a small metal shield assembly that can be mounted in the vicinity of the reproduce heads at the rear of a tape transport mechanism. Power for the preamplifiers is provided by the main system power supply through a simple decoupling network built into the preamplifier housing assembly.

Power Supply

The power supply used is physically and electrically compatible to both portable cabinets and tray assemblies. The electrical specifications provide adequate capacity and stabilization to handle considerable system overload without depreciating performance of the amplifiers. A failsafe power cut-off system is provided for protection against transistor overheating or short circuit conditions.

ES-100 DIRECT SYSTEM

GENERAL

Designed to combine the basic advantages of solid-state operation with space-saving convenience, the ES-100 Direct System Electronics provide recording capability of 300 cps to 300 Kc at 60 ips. A complete 7-track record/reproduce system (7 record and 7 reproduce modules plus 3 auxiliary modules such as control, extender, or control track modules) mounts in a card file occupying only 5-1/4 inches of rack space. A complete 14-track record/reproduce system requires only two files or a rack space height of 10-1/2 inches. ES-100 plug-in modules can be quickly interchanged in the file when selecting another recording technique. A block diagram of the system is shown in Fig. 1.

Standard equipment in the Ampex FR-1300, FR-100C and FL-300 Instrumentation Recorders, these advanced ES-100 electronics are also available for modernization of existing FR-100, FR-100A, FR-100B and FL-200 Recorders.

PHYSICAL

Each record or reproduce module measures 4-3/8 inches by 6-5/8 inches with a front panel 7/8 inch wide. These modules plug directly into a card file which provides mounting facilities for up to 14 record or reproduce modules plus three auxiliary modules. Circuitry and components are constructed on etched-wiring cards. A metal cover provides physical protection and shielding from other channels. Direct reproduce equalizers, which must be changed with tape speed, are built into small individual subassemblies. These plug into the amplifier modules and can be changed easily for any type speed. The speed-compensating equalizers are color coded and numbered according to tape speed to allow quick, positive visual identification through a hole in the front panel.

Each module has a molded combination handle and front panel which contains all test and adjustment points. Input, output and power connections between cards and rack are automatically made through a connector at the rear of the card when it is plugged in. System input and output connectors are located on the front panel of each module, and are duplicated at the rear of the module file (for rack-mounted models) or at the top for the portable version.

ELECTRICAL

One dual ±12 volt power supply is provided with the Direct Record/Reproduce System Electronics. This supply is mounted in a tray assembly, and will provide the power requirements for any ES-100 system including a full 14-track record/reproduce system. Modernization kits for earlier Ampex recorders include a power cable for ES-100 Electronics use with existing power sources.

Record Amplifier

Wideband direct-record signals are linearly mixed with a 2-Mc bias signal to drive the record head. The 2-Mc bias of each amplifier is synchronized with others in the system for synchronized operation. A bias frequency disable circuit permits adjustment/monitoring of data record current. To insure a constant-amplitude signal for reproduction, a 3-db

pre-emphasis, which provides constant flux recording, is built into the record amplifier. Negative current feedback minimizes the effects of power-supply variations, component aging, and other factors which affect stable recording characteristics.

Reproduce Amplifier

Reproduction of each data track requires a reproduce preamplifier and amplifier. The preamps are mounted in a shielded card housing directly behind the heads at the rear of the tape transport. Direct reproduce amplifiers plug into the card file of the tray assembly. They accept data from the preamps, amplify the signal and provide frequency equalization, as well as phase correction. Plug-in equalizer subassemblies are available for each of six tape speeds.

ES-100 SPECIFICATIONS

HEADS

Gap Scatter:	Trailing edges for record heads (or gap centers for reproduce heads) within a band 100 microinches wide (0.001 inch).
Gap Azimuth:	All stacks with 1 minute of arc perpendicular to head base plate.
Track Dimensions:	Track width is 0.050 inch; tape track spacing 0.070 center (IRIG Standard). Other heads on special order.
Number of Tracks:	7 on 1/2 inch; 12 on 1 inch (IRIG Standard). Other heads on special order.
Interstack Spacing:	1.5 (±0.0005) inches, gap to gap.

DIRECT RECORD/REPRODUCE SYSTEM

Frequency Response:

Tape Speed (ips)	Bandwidth (cps)	Bandpass Filtered*	Unfiltered
60	300 cps to 300 kc ±3 db	32	28
30	150 cps to 150 kc ±3 db	32	28
15	100 cps to 75 kc ±3 db	30	25
7-1/2	50 cps to 38 kc ±3 db	26	18
3-3/4	50 cps to 19 kc ±3 db	25	18
1-7/8	50 cps to 10 kc ±3 db	25	18

*Measured at output of bandpass filter having 18 db/octave attenuation beyond limits stated.

RMS Signal-to-Noise Ratio:	See Table.
Harmonic Distortion:	Less than 1.0% total of a 1 kc signal recorded at 60 ips.
Input Level:	1.0 volt rms nominal (0 dbv) to produce normal recording level; adjustable from 0.1 to 10 volts rms by input potentiometer.
Input Impedance:	Minimum 20 k ohms resistive.
Output Level:	1.0 volt rms nominal (0 dbv) across a 600 ohms or greater impedance.
Output Impedance:	Less than 50 ohms.

ENVIRONMENT

Temperature:	Operating: -40° F to +125° F. Storage/non-operating: -20° F to +160° F.
Altitude:	Operating: 15,000 feet. Non-operating: 50,000 feet.
Relative Humidity:	5 to 95%, non-condensing, both operating and non-operating.
Vibration:	Operating: nil. Non-operating: normal handling and transportation only.

POWER REQUIREMENTS

Voltage:	105 to 125 volts, single phase, 58 to 62 cps AC (48 to 52 cps AC on special order).
Power Consumption:	Approximately 500 watts for a 14-track record/reproduce system.

DIRECT SYSTEM ADJUSTMENT PROCEDURES

The direct record and reproduce amplifiers must be adjusted as a system. The system must include the record and reproduce heads operating from the recording tape. The manner in which the system is to be interconnected for operating adjustment is shown in Fig. 2. Refer to the direct record and reproduce sections for further detailed information.

Equipment Required (or equivalent):

1) Signal Generator, Hewlett-Packard 200 CD

2) A-c VTVM, Hewlett-Packard 400D

3) Wave Analyzer, Donner 2100

* 4) Oscilloscope, Hewlett-Packard 130

5) Special Equalizer Adjusting Tool #69672-10

NOTE

Prior to performing system adjustments, rotate the equalizer potentiometers R3 and R4 fully counterclockwise and fully clockwise respectively to prevent a misadjusted amplifier from oscillating.

RECORD AMPLIFIER

Bias Level Adjustment

While simultaneously recording and reproducing a 150-kc sine wave signal at 60 ips with approximately 0.5v rms input level, adjust the BIAS ADJ control for maximum amplitude of the reproduced signal (Fig. 3).

Record Level Adjustment

With a 1.0v rms, 1,000 cps sine wave signal and a tape speed of 60 ips, adjust the RECORD LEVEL control to obtain a reproduced signal with 1.0% third harmonic distortion.

*Not mandatory.

REPRODUCE AMPLIFIER

Amplitude Equalizer Adjustment

With a 1,000 cps, 1.0v rms nominal input signal, adjust the output control to obtain a reference level output (1.0v rms nominal) while the transport is operating at the desired tape speed. Adjust L1, where applicable, for maximum output level, then adjust R4 and R3 for the reference output level at the frequencies indicated in the following table. Check the output level and readjust R4 and R3 as many times as necessary to obtain essentially flat frequency response (±3 db) over the specified band for the operating tape speed.

Tape Speed	Adjustment Frequency L1	R4	R3	Frequency Band
60 ips	300 kc	280 kc	160 kc	300 cps - 300 kc
30 ips	150 kc	140 kc	80 kc	150 cps - 150 kc
15 ips	-----	70 kc	40 kc	100 cps - 75 kc
7-1/2 ips	-----	37 kc	20 kc	50 cps - 38 kc
3-3/4 ips	-----	18.5 kc	10 kc	50 cps - 19 kc
1-7/8 ips	-----	9.5 kc	5 kc	50 cps - 10 kc

PHASE EQUALIZER GAIN ADJUSTMENT

The phase equalizer gain adjustment R13 (Fig. 3) is a factory adjustment and requires no attention except when some component in the direct reproduce amplifier is replaced. To adjust R13:

Step 1. Set the TAPE SPEED selector switch, on the transport, to the desired operational tape speed. Place the system in the RECORD mode.

Step 2. Set the oscillator output at 500 cps.

Step 3. With the amplitude equalizer inserted in the reproduce amplifier, connect a 100 uf capacitor across C1. The negative side of the capacitor must be in the same direction as capacitor C1.

Step 4. Adjust control R13 so that the output level shows no change when the capacitor is alternately removed from and replaced across C1.

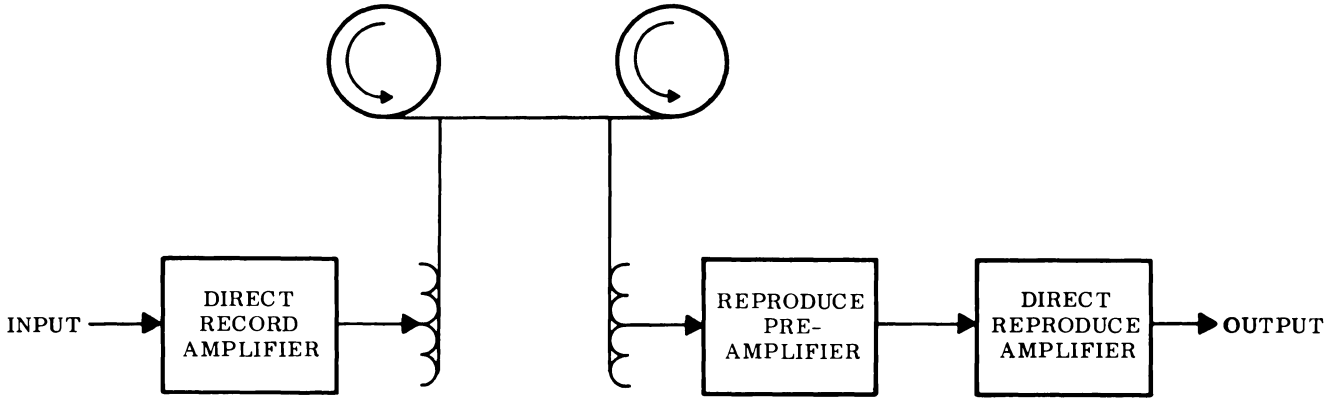
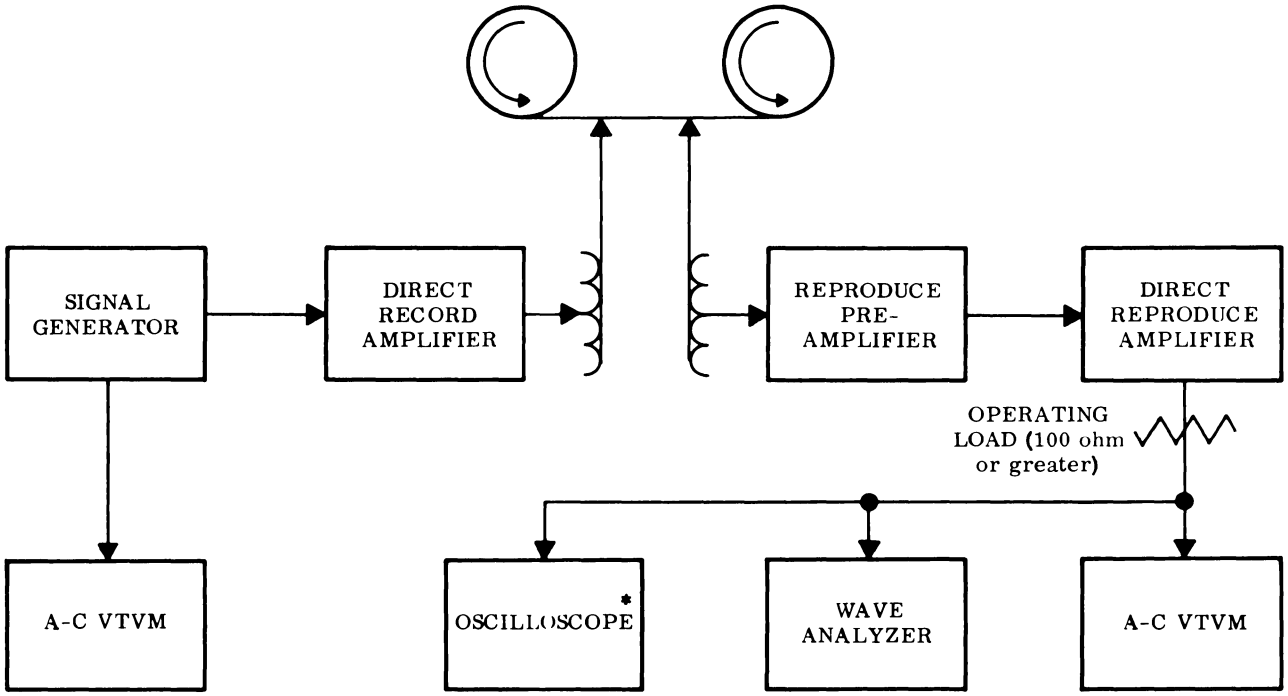
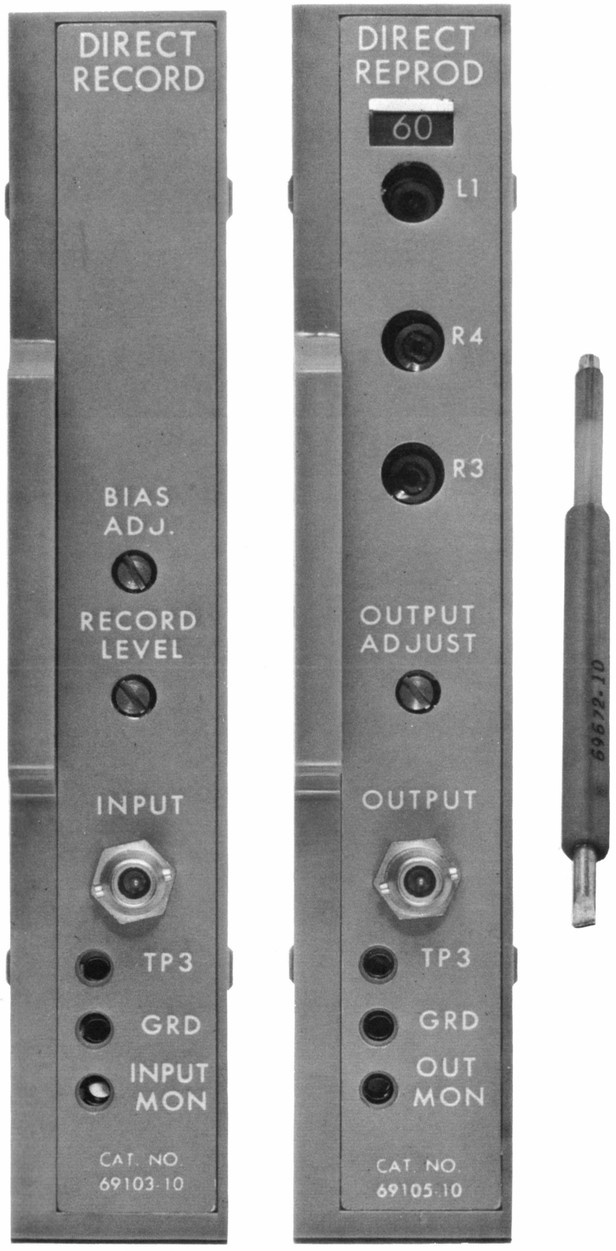


Fig. 1. ES-100 Direct Record/Reproduce System Block Diagram 50667



*Not Mandatory

Fig. 2. ES-100 Direct Record/Reproduce System Test Set-Up Block Diagram 50668



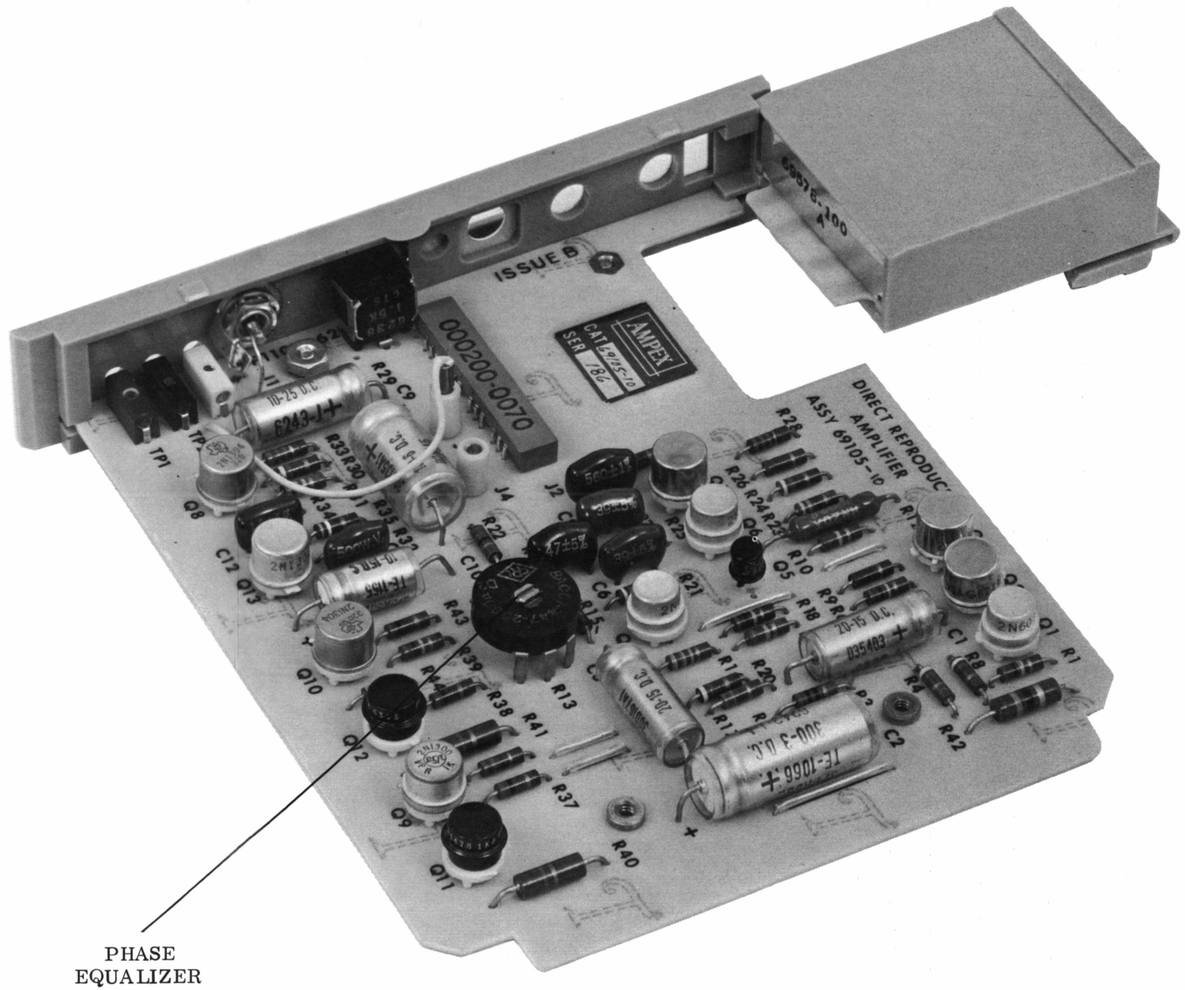


Fig. 3. ES-100 Direct Record/Reproduce System Adjustments and Equalizer Adjusting Tool

50712

ES-100 DIRECT RECORD AMPLIFIER

DESCRIPTION

The direct record amplifier accepts an alternating frequency signal and mixes it with a bias frequency to drive a recording head. One record amplifier is required to record each data track on tape.

Each direct record amplifier incorporates provisions for insertion of an amplitude-modulated carrier signal to be used as a control track signal with a servo tape speed control system. The control track signal is connected by adding a resistor to the printed circuit card. Only one direct record amplifier is connected to a control track generator for a system operation.

All components of the record amplifier are mounted on a plug-in type etched circuit card (Fig. 1). The cards are inserted in the ES-100 tray assembly card file with as many as fourteen amplifiers being accommodated in one tray. Power and input connections are made at the rear edge of the card through etched contacts and the internal wiring harness of the tray assembly.

Test points and adjustment controls are located on the front panel of the amplifier card. Test point TP1 connected through J1 provides a means of monitoring signal input. Test point TP2 provides a test ground connection while test point TP3 is a roving test connector used to check various circuits of the reproduce amplifier. The test pin of TP3 can be inserted into any of the various test jacks on the printed circuit card to provide "in-system" surveillance of the circuitry. Two potentiometers provide bias adjustment and record level adjustment, from the front panel.

CIRCUIT DESCRIPTION

The direct record amplifier (Fig. 2 or Schematic 69103) consists of two basic circuits: a data signal amplifier and a bias oscillator. The direct record block diagram is shown in Fig. 3.

Data Signal Amplifier

The data signal amplifier (Fig. 4) is essentially a constant-current device; it is intended to produce an output current proportional to the input voltage regardless of any variable impedance presented by the record head. This constant current characteristic is obtained by using a large amount of negative current feedback.

Input impedance to the amplifier can be optionally modified by inserting a jumper between points C through E on the circuit card. Points C - D are provided for insertion of a series resistor to permit the use of higher voltage input signals. Points E - F are provided for insertion of a line matching resistor. Standard amplifiers have points C - D jumpered and points E - F open upon delivery.

The data signal input is connected through the module connector in the electronic tray assembly or through the coaxial connector on module panel. Included in the input circuit is a record level adjustment resistor R1, which is adjusted at the module face and by means of which incoming signals may be attenuated to any desired level (Fig. 1). The input impedance of the direct record module consists of the parallel resistances of R1 and the base of the emitter follower transistor Q1. The series coupling capacitor C2 is placed in the input circuit to block any d-c components present in the data signal.

The output of emitter follower Q1 is direct coupled to the base of voltage amplifier transistor Q3. Resistor R6 and capacitor C4 in the emitter circuit of Q2 establish the maximum sensitivity of the record amplifier.

The output of Q2 is coupled through capacitor C3 to the base of transistor Q3 which functions as a phase inverter. The base of Q3 also receives a portion of the output signal in the form of negative feedback which is used to stabilize the circuit. Capacitor C6 in the emitter circuit of Q3 determines the frequency response at the high end. Resistors R9 and R10 act as load resistors for Q3. The output of Q3 is applied to the head current amplifier.

The head current amplifier is composed of transistors Q4 and Q5 with resistors R12 and R13 serving as current limiters for the series connected output stage. The output of Q4 and Q5 is coupled to the record head through parallel resonant circuit L1 and C8 which blocks the 2-Mc bias frequency from entering the data signal amplifier. Resistor R14 is incorporated to cause the amplifier to act as a constant current generator.

If a control track generator is used, the signal from the generator is coupled through resistor R5 to the base of Q3 and mixed with the output of Q2.

Bias Oscillator

The bias oscillator is a self-starting push-pull sinusoidal oscillator consisting of transistors Q6 and Q7 and operates at a nominal frequency of 2 Mc/s. The primary winding inductance of transformer T1 and the value of C10 determine the frequency of oscillation. Resistor R16 is used to ensure reliable starting of the oscillator. When two or more direct record amplifiers are used in a single system, the operating frequencies of the several oscillators are synchronized through decoupling resistor R8 and transformer T1 to establish a single record bias frequency.

The record bias current level is set by variable resistor R15 which is located on the module face.

The outputs of the data signal amplifier and the bias oscillator are mixed at the junction of L1, C8, and R15 and the composite signal is fed to the record head.

ADJUSTMENTS AND TROUBLE-SHOTS

There are no internal adjustments in the Direct Record amplifier and in normal use, there should be no need to remove the shield from the card. If, however, it becomes necessary to explore internal circuits, a trouble shooting assembly drawing (Fig. 5) is included which shows both the components and printed circuit on the amplifier card. In the corresponding parts list which follows, the electronic parts are referenced by their schematic reference number and the mechanical parts are referenced sequentially.

ES-100 Direct Record Amplifier AC Voltages Table
Schematic Ref: C-69279

Test Point Number	Location	Voltage (Volts, RMS)	
1	Q1 Base	0.10 (Set)	
2	Q2 Base	0.15 ±20%	
3	Q2 Coll.	0.11 ±10%	
4	Q2 Emit.	0.16 ±20%	
5	Q3 Base	0.11 ±10%	
6	Q3 Coll.	0.46 ±20%	
7	Q3 Emit.	0.11 ±10%	
8	Q4 Coll.	0	
9	Q4 Emit.	0.11 ±10% * 0.85 ±20% **	
10	Q5 Emit.	0	
11	Q6 Base	1.9 ±20%	2 mc Bias Freq. Sig.
12	Q7 Base	1.9 ±20%	
13	Q6 Coll.	18 ±10%	
14	Q7 Coll.	18 ±10%	
15	Q7 Emit.	3.2 ±20%	

Measurement Conditions

1. 1.0v rms, 1000 cps input signal.
2. Input Level Control set for 0.1v rms at Q1 Base.
3. System in RECORD mode.
4. Measurements made with ACVTVM, (HP 400D or Equiv.)
5. Ampex 69121 Dual Power Supply.

*Bias Osc. OFF
**Bias Osc. ON

ES-100 Direct Record Amplifier DC Voltages Table
Schematic Ref: C-69279

Test Point Number	Location	Voltage (Volts, D.C.)
1	Q1 Base	+0.80 ±50%
2	Q2 Base	+2.0 ±50%
3	Q2 Coll.	-7.2 ±10%
4	Q2 Emit.	+2.2 ±50%
5	Q3 Base	+ 10 ±10%
6	Q3 Coll.	+2.0 ±10%
7	Q3 Emit.	+ 10 ±10%
8	Q4 Coll.	- 10 ±10%
9	Q5 Coll.	+2.1 ±10%
10	Q5 Emit.	+ 10 ±10%
11	Q6 Base	+9.5 ±20%
12	Q7 Base	+ 10 ±10%
13	Q6 Coll.	- 12 ± <1% (P.S.)
14	Q7 Coll.	- 12 ± <1% (P.S.)
15	Q6 Emit.	+7.3 ±10%

Measurement Conditions

1. Short Ckt Input.
2. Record Level Control Full CW.
3. Output Loaded with Record Head & Cable Capacitance.
4. Ampex 69121 Dual Power Supply.
5. 20,000Ω/Volt D. C. Meter (Simpson 262 or Equiv.)

DIRECT RECORD AMPLIFIER CATALOG NO. 69103-10

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			CAPACITORS									
C1	030-178		Fixed, Ceramic, 47 uf, ±20% tol, 50 vdc	1								
C2	030-178		Same as C1	1								
C3	031-141		Fixed, Electrolytic, 10 uf, ±20% tol, 15 vdc	1								
C4	031-141		Same as C3	1								
C5	034-359		Fixed, Mica, 33 pf, 2% tol, 500 vdc	1								
C6	034-153		Fixed, Mica, 1000 pf, 5% tol, 500 vdc	1								
C7	031-211		Fixed, Electrolytic, 35 uf, $^{+100\%}_{-10}$ tol, 25 vdc	1								
C8	034-250		Fixed, Mica, 620 pf, 1% tol, 300 vdc	1								
C9	034-242		Fixed, Mica, 470 pf, 1% tol, 30 vdc	1								
C10	034-242		Same as C9	1								
C11	034-359		Same as C5	1								
			CONNECTOR JACK									
J1	147-140		Connector, Coax, Miniature	1								
			TEST JACKS									
J2	148-064		Vertical Black, .187 in. dia. x .312 in.	1								
J3	148-064		Same as J2	1								
J4	148-065		Vertical Yellow, .187 in. dia. x .312 in.	1								
J5	148-065		Same as J4	1								
J6	148-065		Same as J4	1								
J7	148-065		Same as J4	1								
			INDUCTOR									
L1	540-013		Fixed, 10 uh, 10%	1								
			TRANSISTORS									
Q1	014-140		Germanium, PNP, 2N1300	1								
Q2	014-029		Germanium, PNP, 2N414	1								
Q3	014-029		Same as Q2	1								
Q4	014-106		Germanium, PNP, 2N1478	1								
Q5	014-106		Same as Q4	1								
Q6	014-031		Germanium, PNP, 2N1065	1								
Q7	014-031		Same as Q6	1								

AMPEX

DIRECT RECORD AMPLIFIER CATALOG NO. 69103-10

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			RESISTORS									
R1	044-332		Variable, Carbon, 50k ohms, ±20% tol	1								
R2	041-331		Fixed, Carbon, 3,300 ohms, 5% tol, 1/2 watt	1								
R3	041-239		Fixed, Carbon, 2,200 ohms, 5% tol, 1/2 watt	1								
R4	041-013		Fixed, Carbon, 4,700 ohms, 5% tol, 1/2 watt	1								
R5			Value Selected, Used for C.T.G. Only	1								
R6	041-245		Fixed, Carbon, 1k ohms, 5% tol, 1/2 watt	1								
R7	041-278		Fixed, Carbon, 2,700 ohms, 5% tol, 1/2 watt	1								
R8	041-003		Fixed, Carbon, 100 ohms, 5% tol, 1/2 watt	1								
R9	041-405		Fixed, Carbon, 1,200 ohms, 5% tol, 1/2 watt	1								
R10	041-405		Same as R9	1								
R11	041-014		Fixed, Carbon, 10k ohms, 5% tol, 1/2 watt	1								
R12	041-004		Fixed, Carbon, 222 ohms, 5% tol, 1/2 watt	1								
R13	041-004		Same as R12	1								
R14	041-003		Same as R8	1								
R15	044-323		Variable, Carbon, 1k ohms, ±20% tol, 1/8 watt	1								
R16	041-028		Fixed, Carbon, 330k ohms, 5% tol, 1/2 watt	1								
R17	041-001		Fixed, Carbon, 5,100 ohms, 5% tol, 1/2 watt	1								
R18	041-001		Same as R17	1								
R19	041-004		Same as R12	1								
			TRANSFORMER									
T1	69152-10		Bias	1								
			TEST POINTS									
TP1	148-057		Green, .410 in.lg. x .203 in.dia., .156 in.dia. mounting hole	1								
TP2	148-059		Black, .410 in.lg. x .203 in.dia., .156 in.dia. mounting hole	1								

DIRECT RECORD AMPLIFIER CATALOG NO. 69103-10				QUANTITY REQUIRES PER VERSION								
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	10	20	30	40	50	60	70	80	90
			TEST POINTS (cont'd)									
TP3	148-063		Yellow, .410 in. lg. x .203 in. dia., .156 in. dia. mounting hole	1								
			HARDWARE									
1	69281-10		Circuit Board, Printed Wiring	1								
2	69225-10		Panel, Direct Record Front	1								
3	69162-10		Module Shield Assy	1								
4	69196-10		Label, Panel	1								
5	69609-10		Test-Pin	2								
6	67688		Label, Ser. No., Part No., and Trade Mark	1								
7	471-059		Screw, #4-40 x 3/16, Pan Hd, Phil Dr, Stl. Cad.	2								
8	471-326		Screw, #4-40 x 1/4, Flt Hd, Phil Dr, Stl. Cad.	1								
9	471-327		Screw, #4-40 x 5/16 Flt Hd	1								
10	492-008		Nut, Hex, #4-40, Stl., Cad Pl	1								
11	498-059		Nut, Insertable, #4-40 x Stl. Cad. Pl.	3								
12	502-013		Washer, Lock, #4-40, Int. Tooth, Stl., Cad.	3								
13	615-002		Wire, Bare, #22 AWG, Solid Copper, Tinned (A/R)									
14	611-312		Wire, Stranded, Ins. Blk #24 AWG (A/R)									
15	611-348		Wire, Stranded, Ins. Yel #24 AWG (A/R)									
16	172-022		Lug, Solder									
17	144-139		Connector, Female, Coax for 0.155 dia. Cable	1								

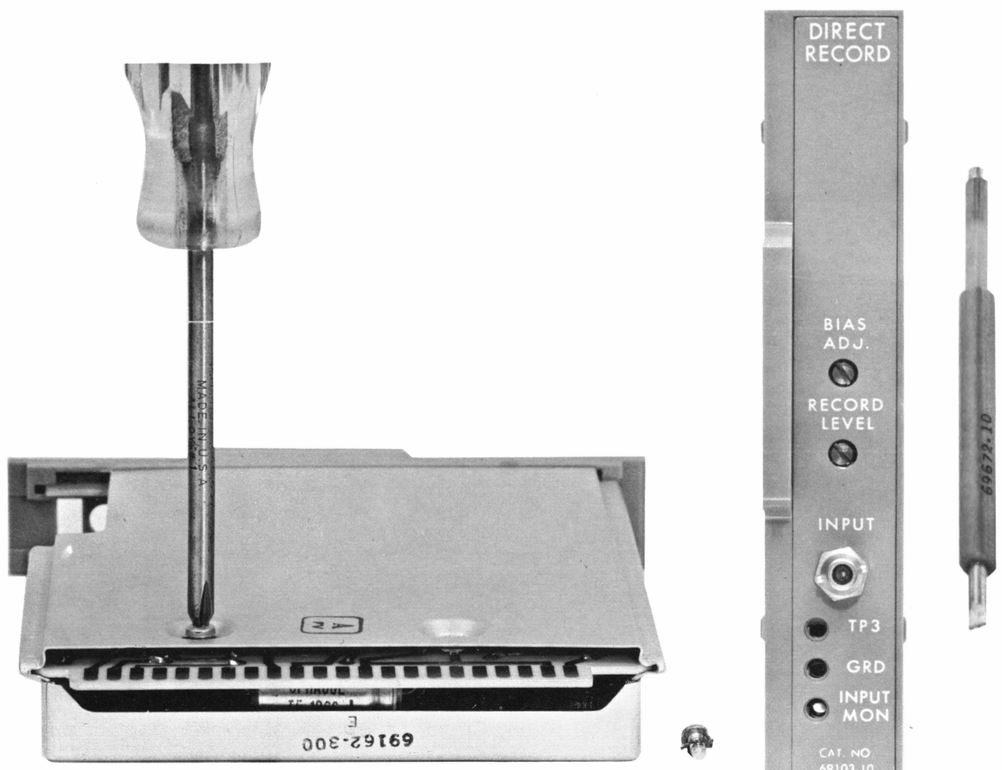
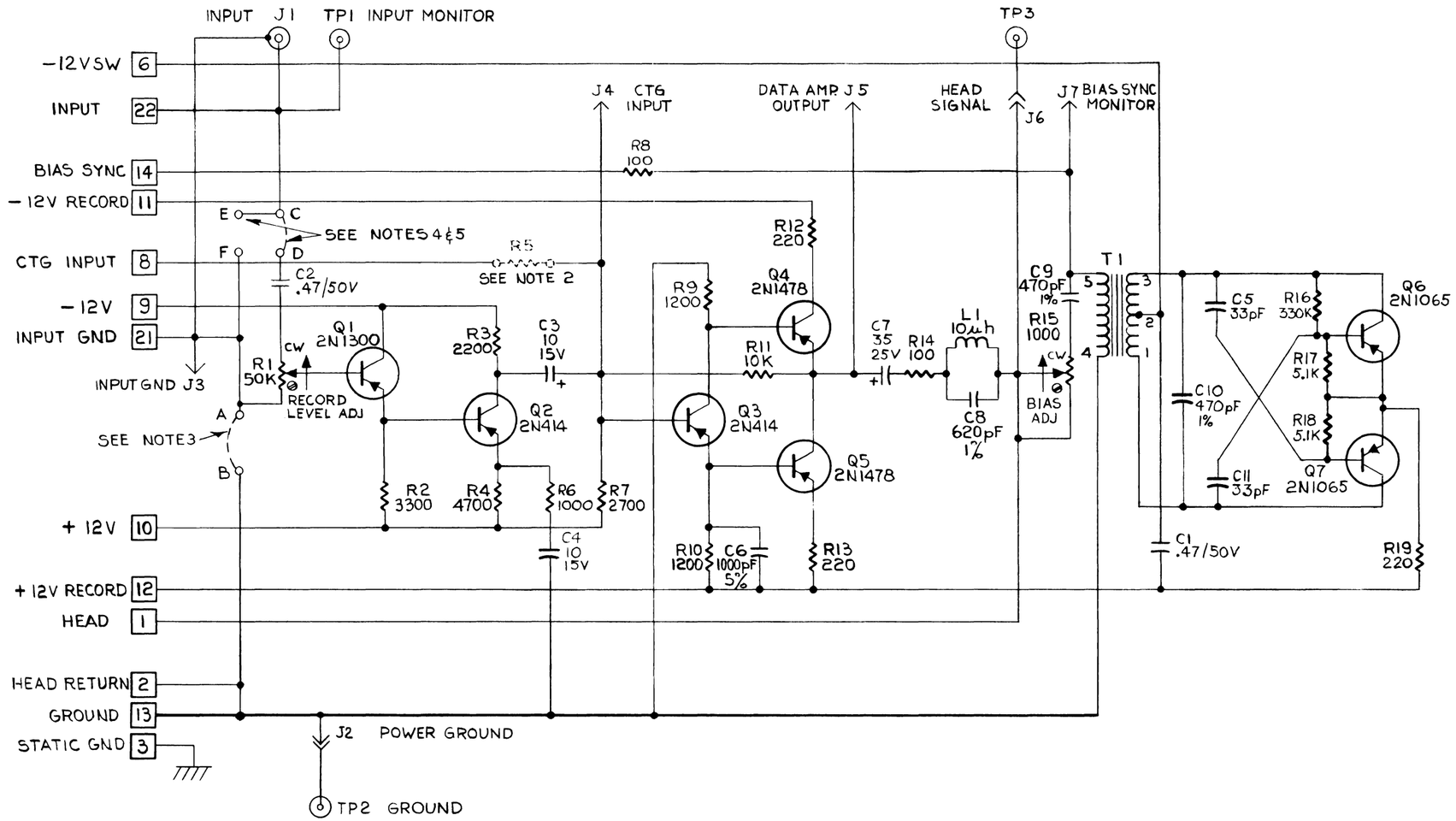


Fig. 1. ES-100 Direct Record Amplifier with Adjusting Tool 50669



NOTES:

1.— UNLESS OTHERWISE SPECIFIED:
ALL RESISTOR VALUES ARE IN OHMS, ½W, 5%.
ALL CAPACITOR VALUES ARE IN MICROFARADS.
2.- RESISTOR R5 TO BE USED FOR CONTROL TRACK GENERATOR ONLY. VALUE AS REQD. BY C.T.G.
3.- REMOVE JUMPER A—B TO COMPLETE INPUT CIRCUIT THROUGH SIGNAL SOURCE GROUND.
4.- REMOVE JUMPER C—D AND REPLACE WITH ½W, 5%, RESISTOR TO DECREASE INPUT SENSITIVITY.
5.- POINTS E—F PROVIDED FOR INPUT IMPEDANCE MATCHING.
6.- USED WITH ASS'Y D-69103-1

Dwg. No. 69279B

Fig. 2. ES-100 Direct Record Amplifier Schematic 50670

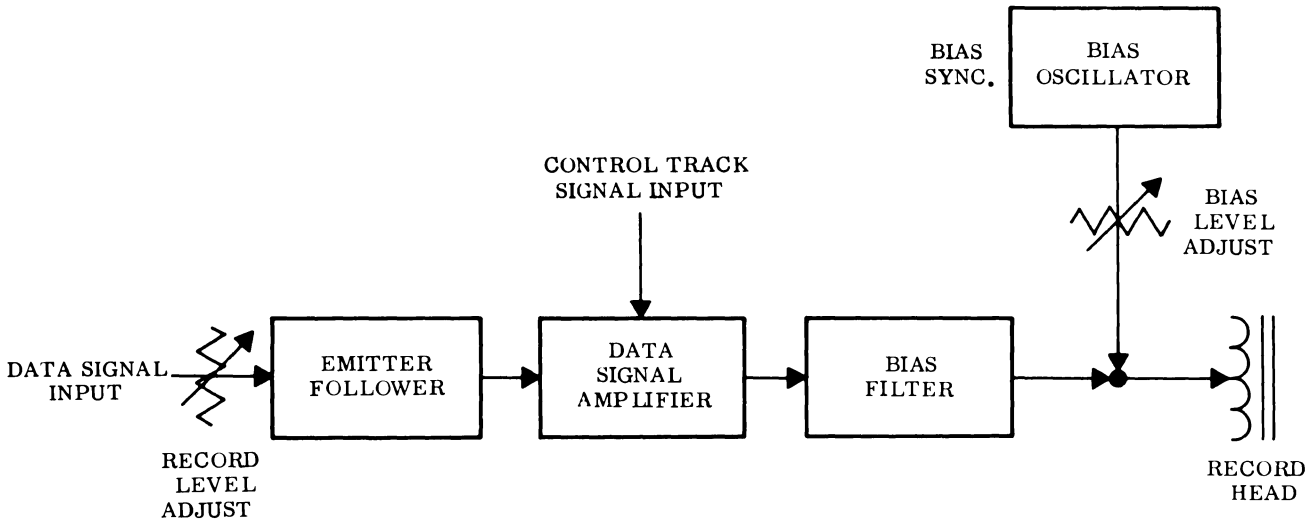


Fig. 3. ES-100 Direct Reocrd Amplifier Block Diagram 50671

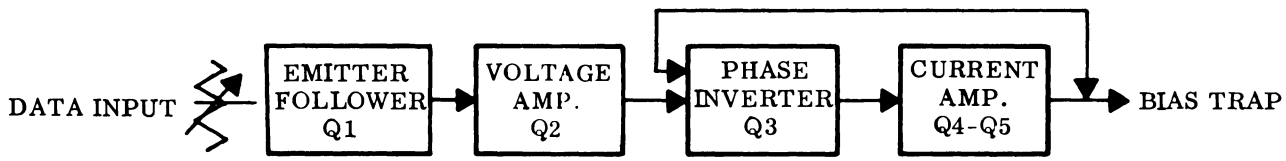
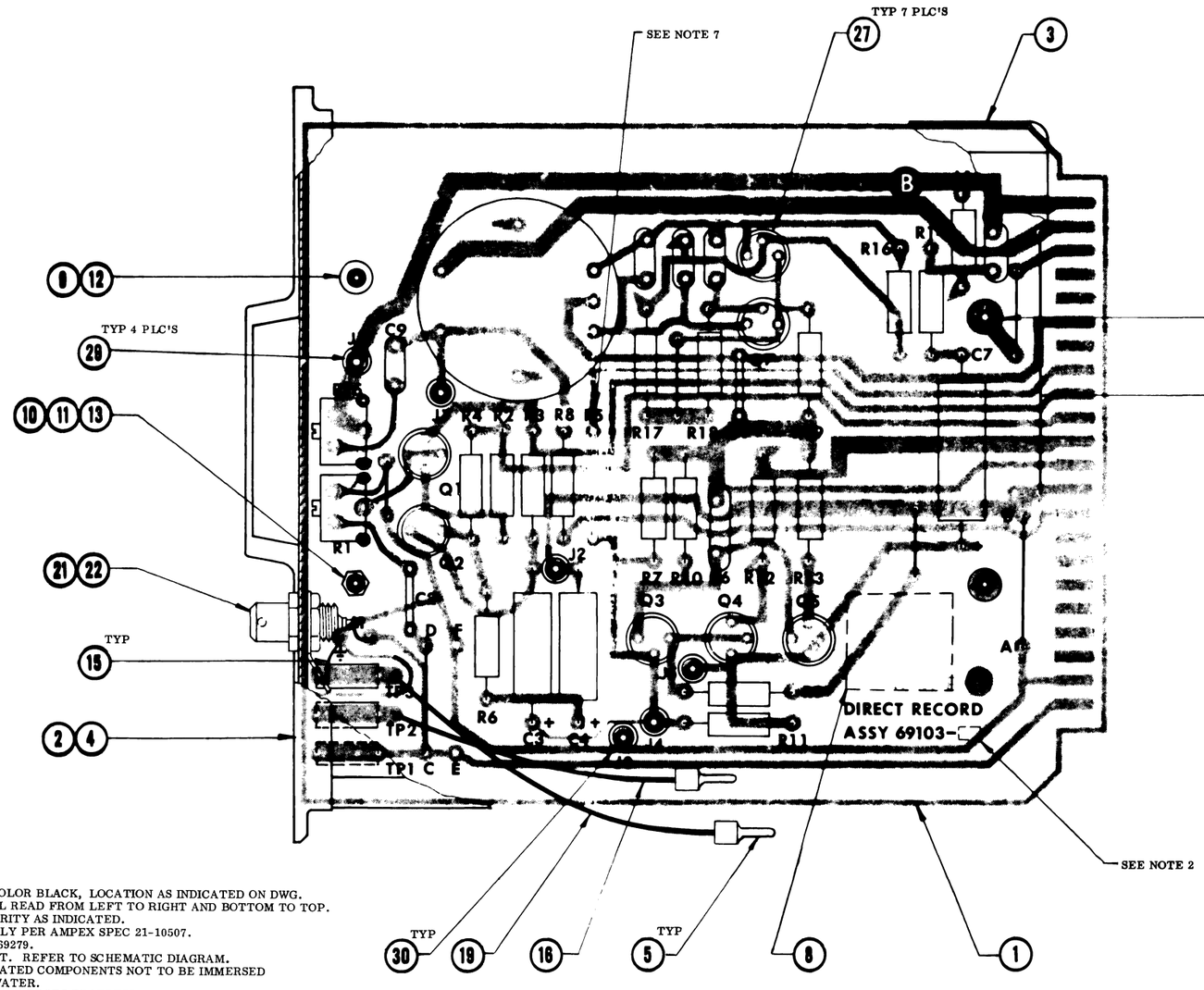


Fig. 4. ES-100 Direct Record Data Signal Amplifier Block Diagram 50672



NOTES:

1. PART NO. TO BE: 69103-10.
2. INK STAMP DASH NUMBER, COLOR BLACK, LOCATION AS INDICATED ON DWG.
3. RESISTOR COLOR CODE SHALL READ FROM LEFT TO RIGHT AND BOTTOM TO TOP.
4. CAPACITOR AND DIODE POLARITY AS INDICATED.
5. DIP SOLDER CIRCUIT SIDE ONLY PER AMPEX SPEC 21-10507.
6. SCHEMATIC REFERENCE: C-69279.
7. R5 USED ONLY FOR CTG INPUT. REFER TO SCHEMATIC DIAGRAM.
8. ADJ. RESISTORS AND WAX COATED COMPONENTS NOT TO BE IMMERSED IN CLEANING SOLVENTS OR WATER.
9. COMPONENT LEADS AND SOLDER DROPS PROTRUDING FROM CIRCUIT SIDE OF P.C. BOARD TO BE LIMITED TO 1/16" HEIGHT ABOVE BASE MATERIAL.
10. ITEM 23 TO BE PACKAGED SEPARATELY FOR SHIPMENT.

Fig. 5. ES-100 Direct Record Amplifier Assembly Drawing 50673

ES-100 DIRECT REPRODUCE AMPLIFIER

The direct reproduce amplifier (Fig. 1) accepts signal data from the reproduce pre-amplifier, amplifies the signal, and provides frequency equalization and phase correction to compensate for changes introduced by the recording process.

Data recorded on magnetic tape may be reproduced at any one of six standard tape speeds by merely inserting an appropriate equalization network. A plug-in equalizer is available for each tape speed. Each individual equalization network is inserted from the top side of the amplifier card and mates with an internally mounted receptacle connector. It plugs into jack J2 near the front of the panel of the amplifier card; the operator can identify the equalizer in use by observing the numeral through an opening in the module face panel. Each equalizer is also color coded for easy tape-speed recognition. The code is:

1-7/8	3-3/4	7-1/2	15	30	60
Brown	Red	Orange	Yellow	Green	Blue

All components of the reproduce amplifier are mounted on a pluggable printed circuit card. The cards are inserted in the ES-100 tray assembly card file which accommodates as many as fourteen reproduce amplifiers per tray. Power and input connections are made at the rear edge of the card through the internal wiring harness of the tray assembly.

Test points and adjustment controls are located on the front panel of the amplifier card. Output jack J1 and test point TP1 provide a means of monitoring signal output. Test point TP2 provides a ground connection while test point TP3 is a floating test connector used to check various circuits of the reproduce amplifier. The floating test pin of TP3 is inserted into various test jacks on the printed circuit card. Output level and equalizer adjustments are provided by resistors R3, R4, R29, and inductor L1.

CIRCUIT DESCRIPTION

The direct reproduce amplifier consists of four basic circuits: An input stage and amplitude equalizer, phase equalizer, voltage amplifier, and output amplifier. The schematic is shown in Fig. 2; the block diagram in Fig. 3.

Input Stage and Amplitude Equalizer

The signal output of the pre-amplifier appears at pin 1 of the module connector. This input to the Direct Reproduce module is made through the printed circuit connector. A quasi-differential input, one side of which consists of resistors R7 and R42, reduces formation of ground loops with the pre-amplifier. The remainder of the input stage consists of transistors Q1 and Q3 in a common-emitter common-collector configuration. Transistor Q2 constitutes the collector load of Q1, providing desired low d-c resistance in combination with a high a-c impedance. A feedback loop consisting of resistors R4 and R8 provides d-c stabilization. The signal is filtered from this loop by capacitor C2.

The equalizer assembly provides proper compensation for linear amplitude response throughout the direct record/reproduce system. Figure 4 shows a typical equalizer response curve (the shape of the curve is the same for all frequencies). The response is adjustable only in two areas, but the relationship of the other components is considered as a matter of interest:

(1) Area A is controlled by the value of R1.

(2) Area B, the depth of mid-band attenuation, is controlled by the value of R2.

(3) The shape of the curve in Area C is controlled by the ratio of R2 to R3 (R3 being variable). Within Area C, a decrease in the resistance of R3 will result in increased amplitude.

(4) The point D peaking frequency is determined by the values of C3 and L1. For high frequency equalizers inductor L1 is variable. The special tool shown in Fig. 1 is used to adjust L1.

(5) Area E, the elevation of point D, is controlled by the value of variable damping resistor R4. An increase in the value of this resistor will increase the elevation of the peak.

Phase Equalization

Phase equalization, or phase correction is achieved by differentiating a portion of the amplitude equalizer output, rotating the phase 180° through transistor Q4, and re-combining this signal with the equalizer output as applied to the following stage. The phase linearity thus achieved permits transmission of square waves with a minimum over-shoot and without significant degradation of amplitude response over the specified bandwidth.

Voltage Amplifier

The voltage amplifier raises the level of the output from the amplitude equalizer and the phase equalizer sufficiently to drive the output amplifier. The voltage amplifier consists of three direct coupled common emitter stages, transistors Q5, Q6, and Q7. The output from the voltage amplifier is taken from the wiper of potentiometer, R29, which supplies the collector load for transistor Q7. A compensated feedback loop, consisting of resistors R21, R22, and R27, and capacitors C5, C6, and C7, provides both signal and d-c feedback around the voltage amplifier.

Output Amplifier

The output amplifier is designed to provide power to drive low-impedance lines. Input to the section is through a direct coupled, complimentary pair of transistors, Q8 and Q13. The output of transistor Q13 is then capacitance coupled to transistor Q10, which acts as a variable feedback impedance between the output and the phase inverter transistor Q9. The output of the phase inverter is direct coupled to series connected transistors Q11 and Q12. Resistors R40 and R41 provide current limiting to protect transistors Q11 and Q12.

ADJUSTMENTS AND TROUBLE-SHOTS

The reproducer amplifier must be adjusted as a system. The procedure is outlined in the Direct System description. The amplifier contains but one internal adjustment; this adjustment is made only when some part in the amplifier has been replaced.

Figure 5 is an assembly drawing showing both the components and the printed circuit on the amplifier card. In the corresponding parts list, which follows, the electronic parts are referenced by their respective schematic reference number; the mechanical parts are referenced sequentially.

SPECIAL TOOL FOR ADJUSTING DIRECT REPRODUCE EQUALIZERS

A special tool is required for adjusting the direct reproduce equalizers. This tool is a modified version of a Cambion adjusting tool, Catalog No. 2033. The modification consists of reducing the outer diameter of the female end down to 5/32 in. dia. for a length of 1-inch.

DIRECT REPRODUCE AMPLIFIER (300kc) CATALOG NO. 69105-10 & 20											
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			CAPACITORS									
C1	031-169		Fixed, Electrolytic, 20 uf $^{-10}_{+100}$ % tol, 15 vdc	1								
C2	031-199		Fixed, Electrolytic, 300 uf, 3 vdc	1								
C3	031-169		Same as C1	1								
C4	034-181		Fixed, Mica, 47 pf, 5% tol, 500 vdc	1								
C5	031-166		Fixed, Electrolytic, 100 uf, $^{-10}_{+250}$ % tol, 6 vdc	1								
C6	034-180		Fixed, Mica, 39 pf, 5% tol, 500 vdc	1								
C7	034-180		Same as C6	1								
C8	034-309		Fixed, Mica, 560 pf, 1% tol, 300 vdc	1								
C9	031-148		Fixed, Electrolytic, 10 uf, $^{-10}_{+100}$ % tol, 25 vdc	1								
C10	031-141		Fixed, Electrolytic, 10 uf, 15 vdc	1								
C11	034-182		Fixed, Mica, 56 pf, 5% tol, 500 vdc	1								
C12	034-963		Fixed, Mica, 15 pf, 5% tol, 500 vdc	1								
			CONNECTOR JACKS									
J1	147-140		Connector, Coax, Miniature	1								
J2	168-036		Connector, P.C. 15 Contact, Min.	1								
J3	148-065		Vertical, Yellow, .187 in.dia. x .312 in.	1								
J4	148-065		Same as J3	1								
			TRANSISTORS									
Q1	014-032		Germanium, PNP, 2N603	1								
Q2	014-030		Germanium, NPN, 2N446A	1								
Q3	014-030		Same as Q2	1								
Q4	014-031		Same as Q1	1								
Q5	014-154		Germanium, PNP, T2040	1								
Q6	014-032		Same as Q1	1								
Q7	014-030		Same as Q2	1								
Q8	014-105		Germanium, NPN, 2N1304	1								
Q9	014-140		Germanium, PNP, 2N1300	1								
Q10	014-105		Same as Q8	1								
Q11	014-106		Germanium, PNP, 2N1478	1								
Q12	014-106		Same as Q11	1								
Q13	014-095		Germanium, PNP, 2N1304	1								

DIRECT REPRODUCE AMPLIFIER (300kc) CATALOG NO. 69105-10 & 20

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			RESISTORS									
R1	041-408		Fixed, Carbon, 10k ohms, 5% tol, 1/4 watt	1								
R2	041-408		Same as R1	1								
R3	041-406		Fixed, Carbon, 22k ohms, 5% tol, 1/4 watt	1								
R4	041-412		Fixed, Carbon, 4700 ohms, 5% tol, 1/4 watt	1								
R5	041-409		Fixed, Carbon, 15k ohms, 5% tol, 1/4 watt	1								
R6	041-408		Same as R1	1								
R7	041-496		Fixed, Carbon, 10 ohms, 5% tol, 1/4 watt	1								
R8	041-412		Same as R4	1								
R9	041-414		Fixed, Carbon, 2200 ohms, 5% tol, 1/4 watt	1								
R10	041-406		Same as R3	1								
R11	041-538		Fixed, Carbon, 6200 ohms, 5 % tol, 1/4 watt	1								
R12	042-220		Fixed, Carbon, 10k ohms, 1% tol, 1/2 watt	1								
R13	044-394		Variable, Carbon, 2500 ohms, 1/10 watt	1								
R14	041-412		Same as R4	1								
R15	041-412		Same as R4	1								
R16	041-518		Fixed, Carbon, 33k ohms, 5% tol, 1/4 watt	1								
R17	041-413		Fixed, Carbon, 6800 ohms, 5% tol, 1/4 watt	1								
R18	041-408		Same as R1	1								
R19	041-409		Same as R5	1								
R20	041-412		Same as R4	1								
R21	041-412		Same as R4	1								
R22	041-426		Fixed, Carbon, 680 ohms, 5% tol, 1/4 watt	1								
R23	041-584		Fixed, Carbon, 4300 ohms, 5% tol, 1/4 watt	1								
R24	041-412		Same as R4	1								
R25	041-428		Fixed, Carbon, 470 ohms, 5% tol, 1/4 watt	1								
R26	041-414		Same as R9	1								
R27	041-412		Same as R4	1								
R28	041-429		Fixed, Carbon, 680 ohms, 5% tol, 1/4 watt	1								
R29	044-324		Variable, Carbon, 1500 ohms, 20% tol, 1/8 watt	1								
R30	041-412		Same as R4	1								
R31	041-518		Same as R16	1								
R32	041-482		Fixed, Carbon, 12k ohms, 5% tol, 1/4 watt	1								

DIRECT REPRODUCE AMPLIFIER (300kc) CATALOG NO. 69105-10 & 20

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			RESISTORS (cont'd)									
R33	041-429		Same as R28	1								
R34	041-412		Same as R4	1								
R35	041-511		Fixed, Carbon, 3900 ohms, 5% tol, 1/4 watt	1								
R36	041-413		Same as R17	1								
R37	041-410		Fixed, Carbon, 1000 ohms, 5% tol, 1/4 watt	1								
R38	041-410		Same as R37	1								
R39	041-408		Same as R1	1								
R40	041-004		Fixed, Carbon, 220 ohms, 5% tol, 1/2 watt	1								
R41	041-004		Same as R40	1								
R42	041-433		Fixed, Carbon, 27 ohms, 5% tol, 1/4 watt	1								
R43	041-410		Same as R37	1								
R44	041-427		Fixed, Carbon, 330 ohms, 5% tol, 1/4 watt	1								
			TEST POINTS									
TP1	148-057		Green, .410 in.lg. x .203 in.dia., .156 in.dia., mounting hole	1								
TP2	148-059		Black, .410 in.lg. x .203 in.dia., .156 in.dia., mounting hole	1								
TP3	148-063		Yellow, .410 in.lg. x .203 in.dia., .156 in.dia., mounting hole	1								
			HARDWARE									
1	69269-10		Circuit Board, Printed Wiring	1								
2	69225-20		Panel, Direct Reproduce Front	1(10)								
3	69162-30		Module Shield Assy.	1(10)								
4	69196-20		Label, Panel	1								
5	69609-10		Test Pin	1								
6	67688-11		Label, Ser. No., Part No. and Trade Mark	1								
7	471-059		Screw, No. 4-40 x 3/16, Pan Hd, Phil Dr, Stl. Cad	2								
8	471-968		Screw No. 4-40 x 5/32, Flt. Hd, Phil. Dr, Stl. Cad.	1								
9	471-326		Screw, No. 4-40 x 1/4, Flt. Hd., Phil. Dr. Stl. Cad.	1								
10	492-008		Nut, Hex, No. 4-40, Stl. Cad. Pl.	1								
11	598-059		Nut, Insertable, No. 4-40 Stl. Cad. Pl.	2								

DIRECT REPRODUCE AMPLIFIER (300kc) CATALOG NO. 69105-10 & 20

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			HARDWARE (cont'd)									
12	310-100		Nut, Insertable, No. 4-40, Stl. Cad. Pl.	1								
13	502-013		Washer, Lock, No. 4-40, Ext. Tooth, Stl. Cad.	3								
14	615-002		Wire, Bare, No. 22 AWG, Solid Copper Tinned (as required)									
15	611-348		Wire, Stranded, Ins., Yel., No. 22 AWG (as required)									
16	172-022		Lug, Solder	1(10)								
17	144-139		Connector, Female, Coax, for .155 dia. cable	1(10)								
18	280-998		Pad, Transistor	13								

DIRECT REPRODUCE EQUALIZERS CATALOG NOS. 69117-10(60 ips) -20(30 ips) -30(15 ips) -40(7-1/2 ips) -50(3-3/4 ips) -60(1-7/8 ips)

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			CAPACITORS									
C1	033-080		Fixed, Mylar, .01 uf, 3% tol, 100 vdc	1	1	1	1	1	1			
C2	033-086		Fixed, Mylar, .022 uf, 10% tol, 100 vdc	1	1			1	1			
C2	033-087		Fixed, Mylar, .033 uf, 10% tol, 100 vdc			1	1					
C3	034-367		Fixed, Mica, 91 pf, 1% tol, 500 vdc	1								
C3	034-297		Fixed, Mica, 180 pf, 1% tol, 500 vdc		1							
C3	034-220		Fixed, Mica, 150 pf, 1% tol, 500 vdc			1						
C3	034-287		Fixed, Mica, 300 pf, 1% tol, 500 vdc				1					
C3	034-253		Fixed, Mica, 330 pf, 1% tol, 500 vdc					1				
C3	034-371		Fixed, Mica, 510 pf, 1% tol, 300 vdc						1			
C4	034-214		Fixed, Mica, 470 pf, 5% tol, 300 vdc	1								
C4	034-217		Fixed, Mica, 910 pf, 5% tol, 100 vdc		1							
C4	033-082		Fixed, Mylar, 1800 pf, 5% tol, 100 vdc			1						
C4	033-083		Fixed, Mylar, 3900 pf, 5% tol, 100 vdc				1					
C4	033-084		Fixed, Mylar, 8200 pf, 5% tol, 100 vdc					1				
C4	033-085		Fixed, Mylar, 15,000 pf, 5% tol, 100 vdc						1			
			INDUCTORS									
L1	69593-10		Variable, 3 mh	1								
L1	69593-20		Variable, 8 mh		1							
L1	540-034		Fixed, 20 mh, 1% tol			1						
L1	540-035		Fixed, 50 mh, 1% tol				1					
L1	540-037		Fixed, 200 mh 1% tol					1				
L1	540-038		Fixed, 500 mh, 1% tol						1			
			RESISTORS									
R1	041-562		Fixed, Carbon, 43k ohms, 5% tol, 1/4watt	1								
R1	041-543		Fixed, Carbon 82k ohms, 5% tol, 1/4 watt		1							
R1	041-575		Fixed, Carbon, 130k ohms, 5% tol, 1/4watt			1						
R1	041-469		Fixed, Carbon, 330k ohms, 5% tol, 1/4watt				1					
R1	041-767		Fixed, Carbon, 620k ohms, 5% tol, 1/4watt					1	1			
R2	042-297		Carbon, Film, 1150 ohms, 1% tol, 1/2 watt	1								
R2	042-361		Carbon, Film, 1780 ohms, 1% tol, 1/2 watt		1							
R2	042-217		Carbon, Film, 3320 ohms, 1% tol, 1/2 watt			1						
R2	042-287		Carbon, Film, 6810 ohms, 1% tol, 1/2 watt				1					
R2	042-290		Carbon, Film, 12.1k ohms, 1% tol, 1/2 watt					1				
R2	042-295		Carbon, Film, 22.6k, 1% tol, 1/2 watt						1			

DIRECT REPRODUCE EQUALIZERS CATALOG NOS. 69117-10(60 ips) -20(30 ips) -30(15 ips) -40(7-1/2 ips) -50(3-3/4 ips) -60(1-7/8 ips)

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION 6 10	20	30	40	50	60	70	80	90
			RESISTORS (cont'd)									
R3	044-395		Variable, Composition, 20k ohms, 20% tol, 1/10 watt	1	1	1	1					
R3	044-391		Variable, Composition, 50k ohms, 20% tol, 1/10 watt					1	1			
R4	044-391		Variable, Composition, 50k ohms, 20% tol, 1/10 watt	1								
R4	044-392		Variable, Composition, 100k ohms, 20% tol, 1/10 watt		1		1					
R4	044-393		Variable, Composition, 200k ohms, 20% tol 1/10 watt			1		1	1			
			HARDWARE									
1	D69270-10		Printed Circuit Board			1	1	1	1			
2	D69270-20		Printed Circuit Board	1	1							
3	D69147-10		Case Equalizer	1	1	1	1	1	1			
4	C69578-10		Cover Assy.	1	1							
5	C69576-20		Cover Assy.			1	1	1	1			
6	C69239		Spacer	2	2	2	2	2	2			
7	492-063		Nut, Hex, No. 0-80, Brass	4	4	4	4	4	4			
8	502-096		Washer, Split, No. 0-80	4	4	4	4	4	4			
9	471-875		Screw, Binder Hd., No. 2-56 x 1/8 lg.	2	2							
10	502-023		Washer, Lock, Int. Teeth, No. 2-56	2	2							
11	471-634		Screw, Bd. Hd. No. 4-40 x 5/16 lg.	1	1	1	1	1	1			
12	497-039		Nut, Speed, "U" Type	1	1	1	1	1	1			
13	D69579-10		Label, Module	1								
14	D69579-20		Label, Module		1							
15	D69579-30		Label, Module			1						
16	D69579-40		Label, Module				1					
17	D69579-50		Label, Module					1				
18	D69579-60		Label, Module						1			
19	615-018		Wire, Bare, No. 26 Solid, Tinned (as required)									
20	600-037		Tubing, Insul., No. 26 Clear (as required)									

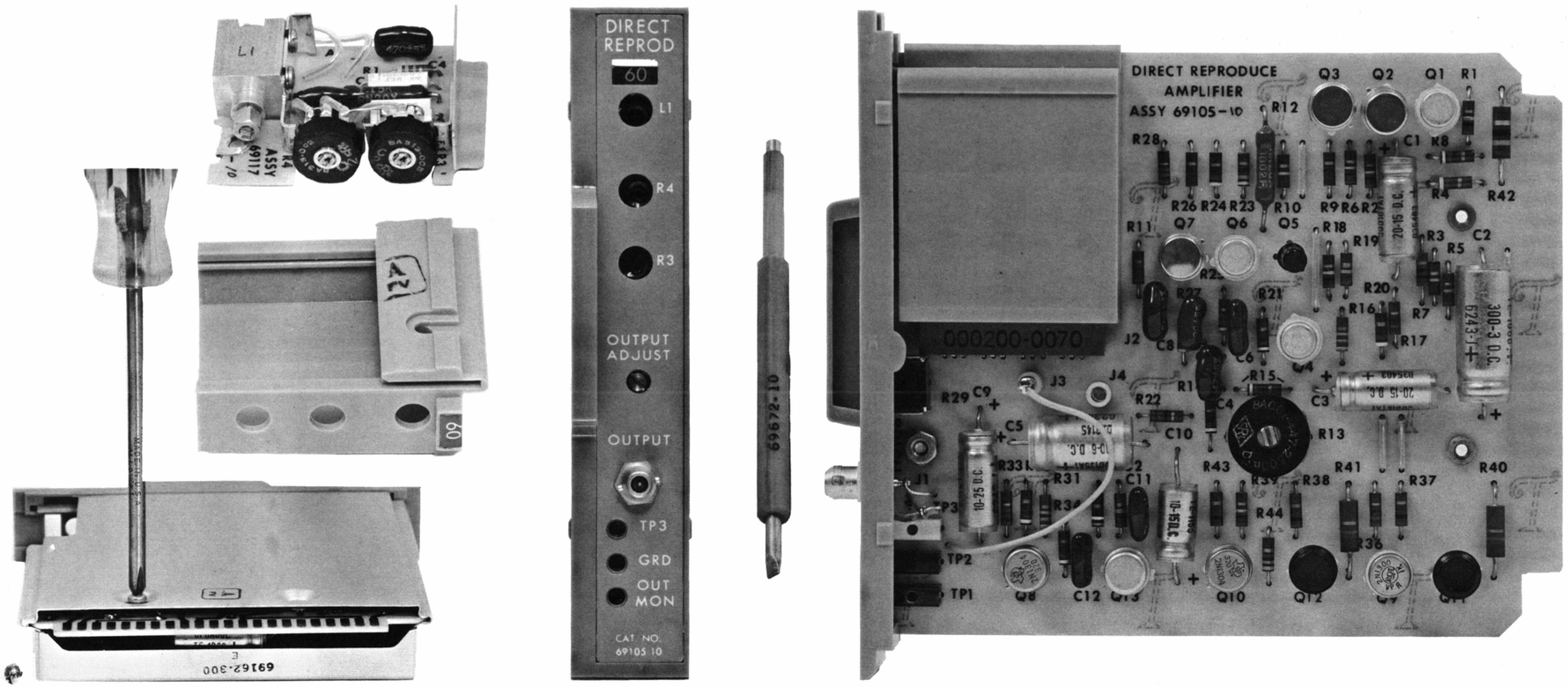


Fig. 1. ES-100 Direct Reproduce Amplifier with Adjusting Tool 50674

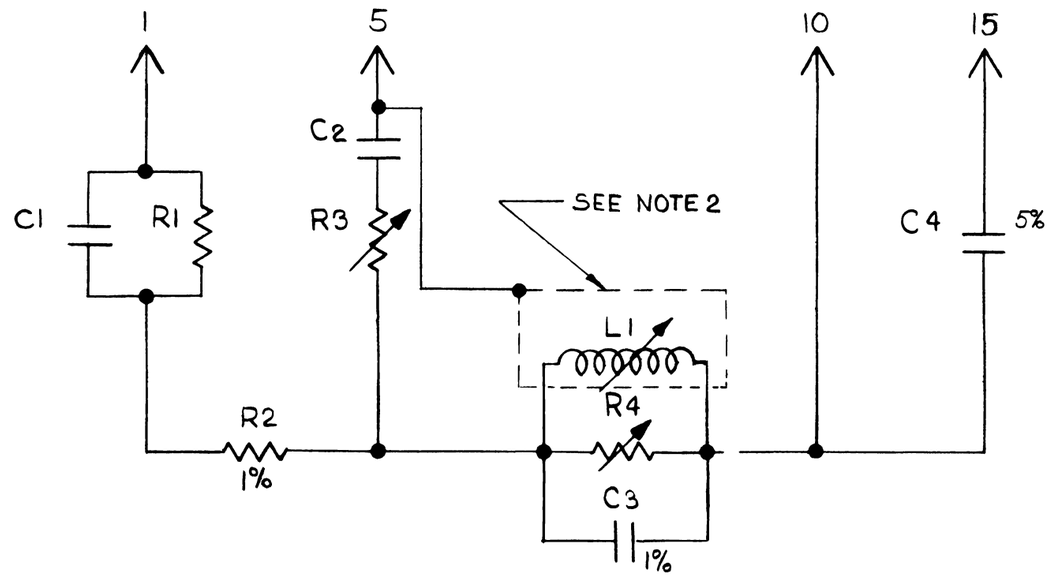


TABLE A

TAPE SPEED	VALUE OF: R1	R2	R3	R4	C1	C2	C3	C4	L1	USED WITH ASSY:
60 IPS	43K	1150	20K	50K	.01, 3%	.022, 10%	91 pf	470pf	3 mh	69117-10
30 IPS	82 K	1.78K	20K	100K	↑	.022, 10%	180 pf	910pf	8mh	↑ -20
15 IPS	130K	3320	20K	200K	↑	.033, 10%	150pf	1800pf	20mh	↑ -30
7½ IPS	330K	6810	20K	100K	↑	.033, 10%	300pf	3900pf	50mh	↑ -40
3¾ IPS	620K	12.1K	50K	200K	↓	.022, 10%	330 pf	8200pf	200mh	↓ -50
1⅞ IPS	620K	22.6K	50K	200K	.01, 3%	.022, 10%	510 pf	15000pf	500mh	69117-60

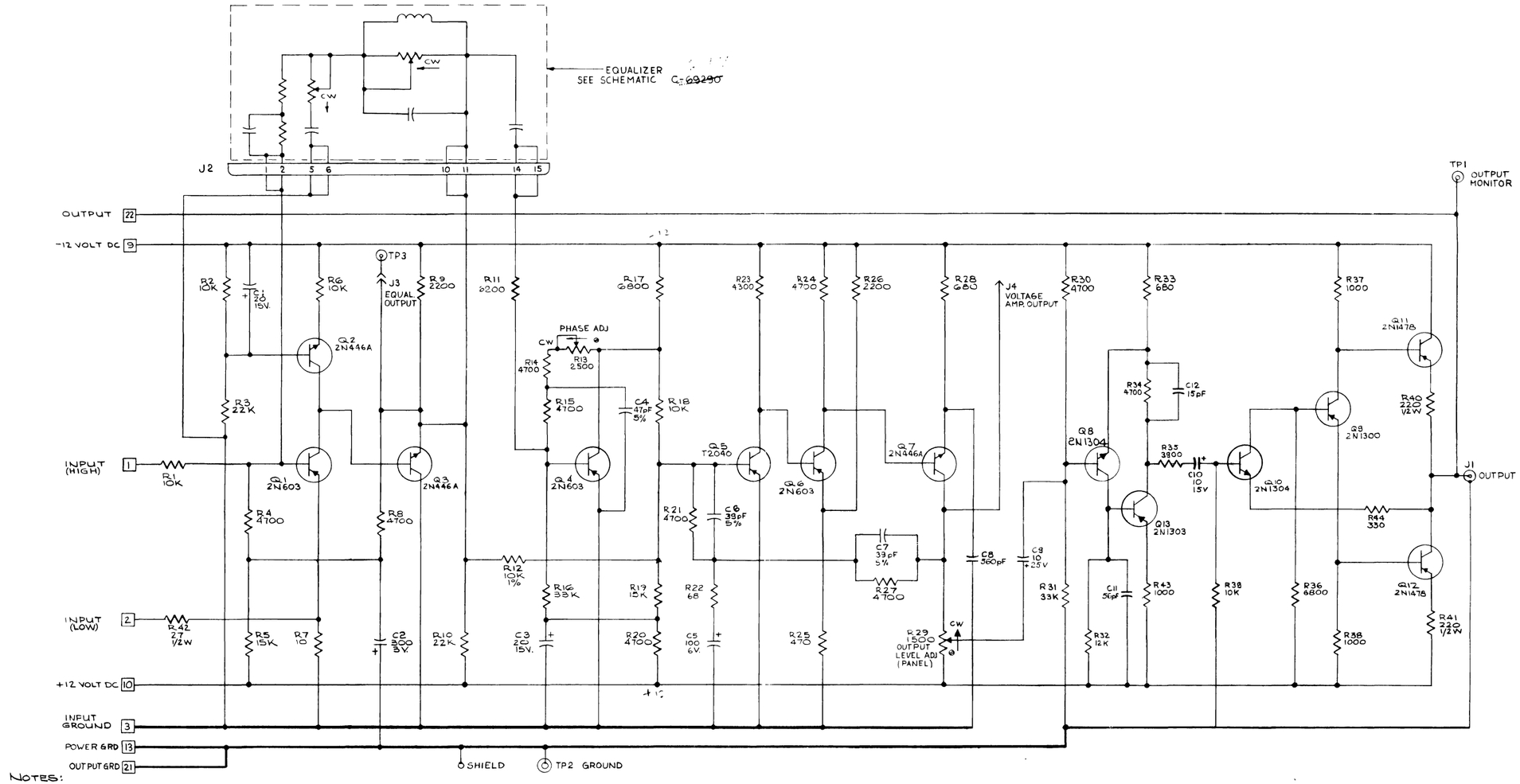
SEE NOTE 2

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS IN OHMS 1/4W, 5%.
   ALL CAPACITORS IN MICROFARADS.
2. INDUCTOR L1 TO BE VARIABLE FOR -10 & -20 VERSION ONLY.
3. USED WITH ASSY. D-69117

Dwg No. 69290B

Fig. 2 (Sheet 1 of 2). ES-100 Direct Reproduce Equalizer Schematic 50675



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 1/4 W, 5 %; ALL CAPACITORS ARE IN MICROFARADS.
2. USED WITH ASS'Y D69105

Dwg. No. 69271A

Fig. 2 (Sheet 2 of 2). ES-100 Direct Reproduce Amplifier Schematic 50676

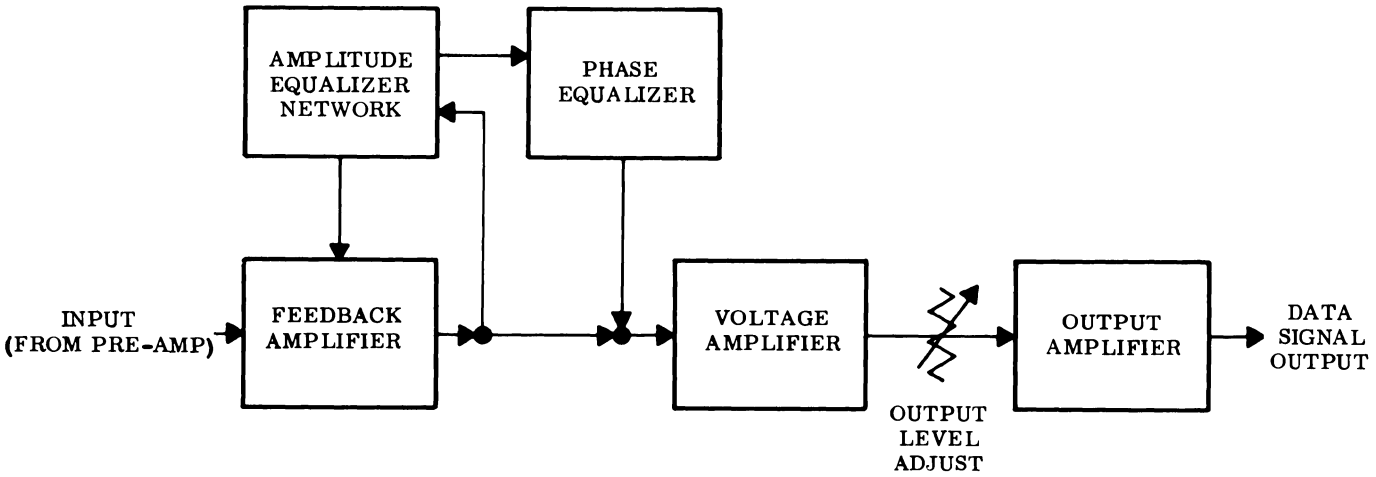


Fig. 3. ES-100 Direct Reproduce Amplifier Block Diagram 50677

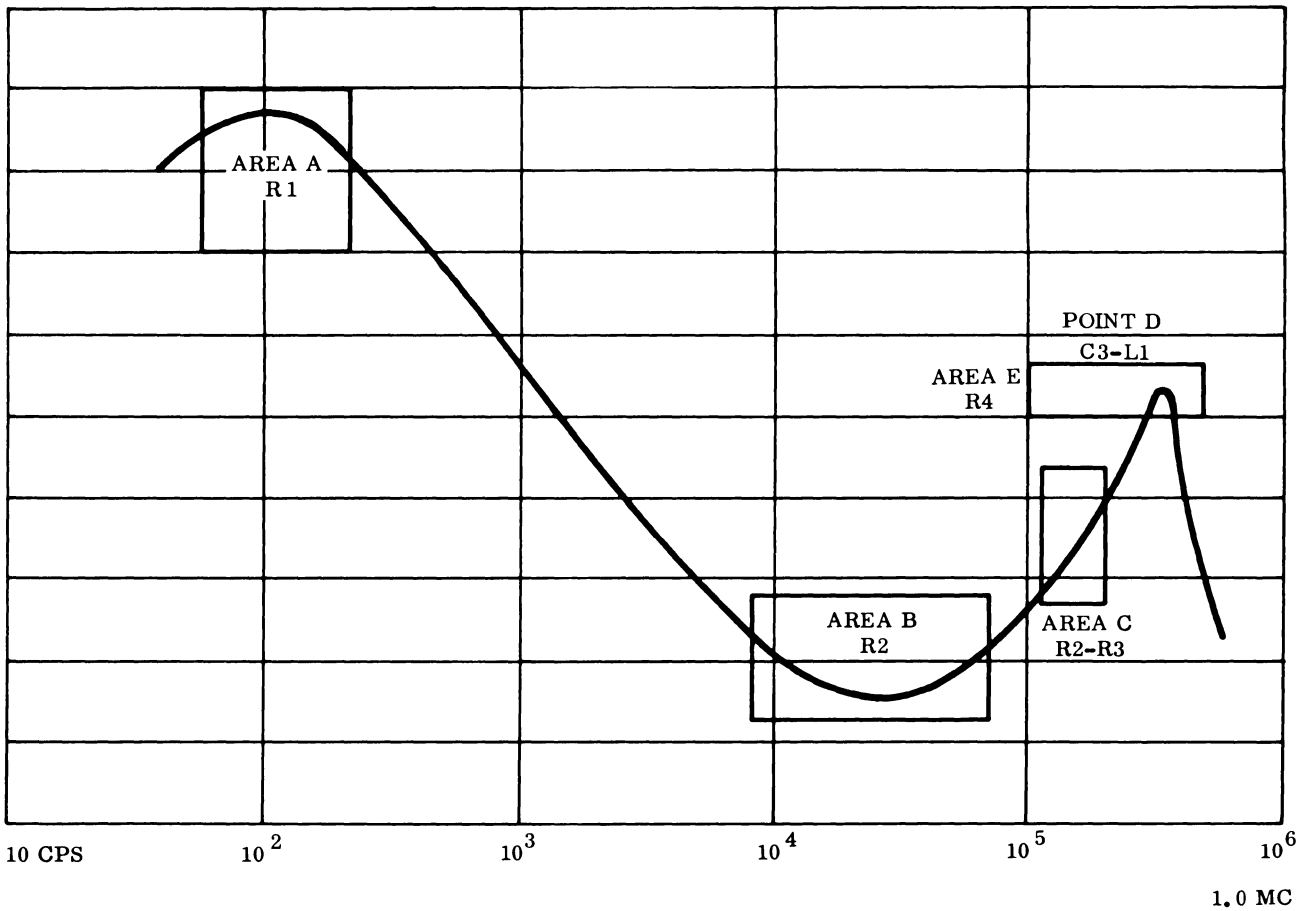
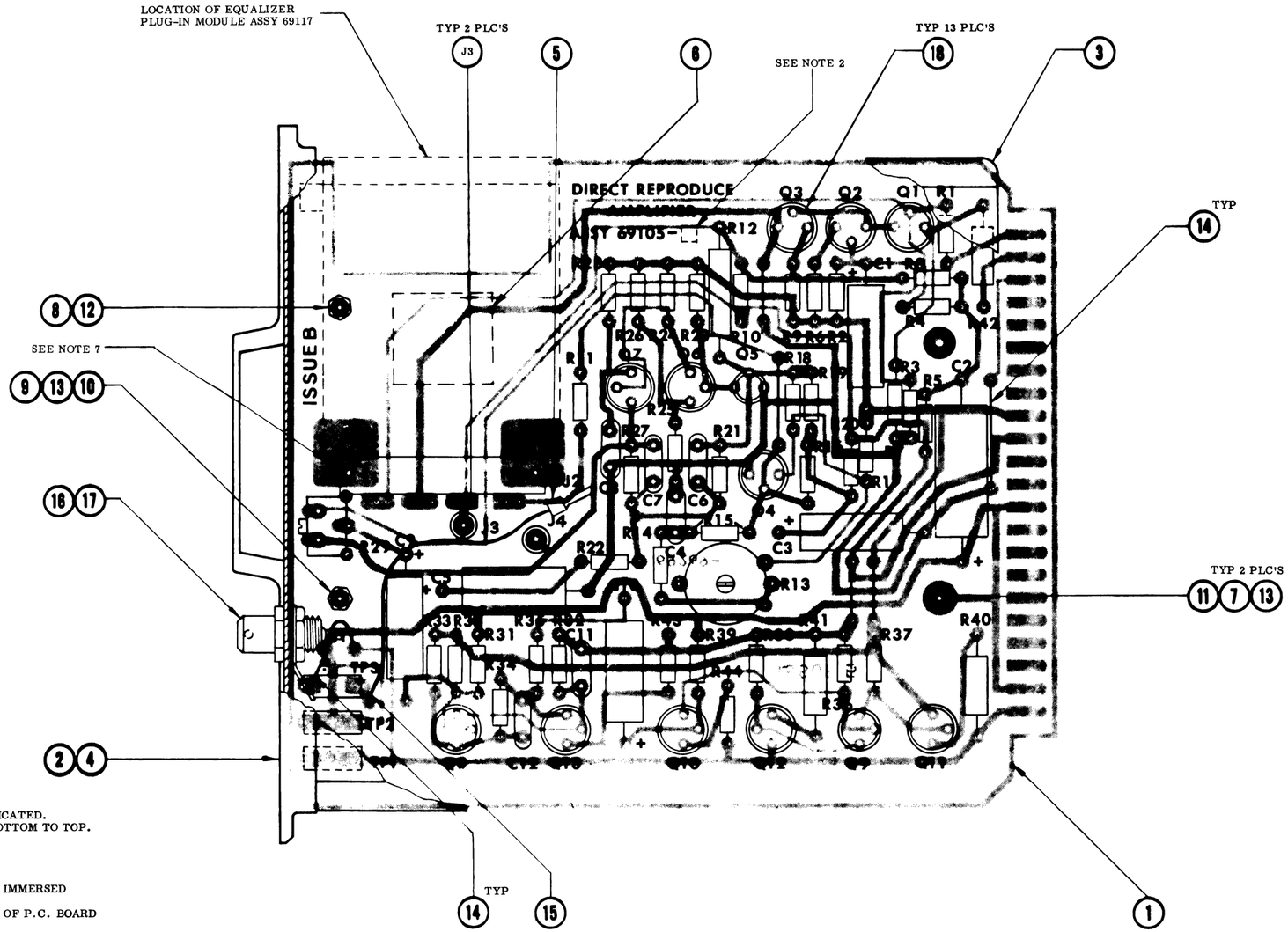


Fig. 4. Typical Response Curve for ES-100 Direct Reproduce Amplifier 50678



NOTES:

1. PART NUMBER TO BE: 69105-10 or 69105-20.
2. INK STAMP DASH NUMBER, COLOR BLACK, LOCATED AS INDICATED.
3. RESISTOR COLOR CODE READS FROM LEFT TO RIGHT AND BOTTOM TO TOP.
4. CAPACITOR AND DIODE POLARITY AS INDICATED.
5. DIP SOLDER CIRCUIT SIDE ONLY PER AMPEX SPEC 21-10507.
6. SCHEMATIC REFERENCE: D-69271.
7. REMOVE CONTACTS 4, 8 AND 12 PRIOR TO DIP-SOLDERING.
8. ADJ. RESISTORS AND WAX COATED COMPONENTS NOT TO BE IMMERSED IN CLEANING SOLVENTS OR WATER.
9. COMPONENT LEADS AND SOLDER DROPS FROM CIRCUIT SIDE OF P.C. BOARD TO BE LIMITED TO 1/16" HEIGHT ABOVE BASE MATERIAL.
10. ITEM 23 TO BE PACKAGED SEPARATELY FOR SHIPMENT.

Fig. 5. ES-100 Direct Reproduce Amplifier Assembly Drawing 50679

ES-100 FM SYSTEM

GENERAL

Recording performance to 20 Kc is combined with the basic advantage of solid-state design and space-saving convenience in the ES-100 FM System Electronics modules (Fig. 1). These compact electronics plug into a module file which requires only 5-1/4 inches of rack space height and will accommodate a full 7-track record/reproduce system, with space remaining for three auxiliary modules such as control, extender or control track modules. A complete 14-track record/reproduce system requires only two files, or a total rack space height of only 10-1/2 inches. Plug-in ES-100 modules can be replaced quickly when selecting another recording technique.

The Ampex ES-100 Electronics, standard equipment in the Ampex FR-1300, FR-100C, and FL-300 Instrumentation Recorders, are also available for modernization of existing FR-100, FR-100A, FR-100B and FL-200 Recorders.

PHYSICAL

Each record or reproduce module measures 4-3/8 by 6-5/8 inches with a front panel 7/8 inches wide. Circuitry and components are constructed on etched wiring cards. A metal cover completely surrounds the amplifier for physical protection and shielding from other channels. The FM record amplifier contains all elements for six-speed operation. Any of the six center carrier frequencies is selected by means of a manually-operated six-position switch. On the FM reproduce amplifiers, output filters are built-in individual subassemblies which plug into the module and can be changed easily for a different tape speed.

Each module has a molded combination handle and front panel which contains all test and adjustment points. Input and power connections between modules and module file are automatically made through a connector at the rear of the card when it is plugged in. System input and output connectors are located on the front panel of each module, and are duplicated at the rear of the module file (for the FR-100 series and other rack-mounted models) or at the top for the FR-1300 portable version.

ELECTRICAL

One dual ±12 volt power supply is provided with the FM or Direct Record System Electronics (see data sheet ES-100 Solid-State Direct Electronics) for operation of any ES-100 system including a complete 14-track record/reproduce system. Modernization kits include power cable for ES-100 Electronics to use with existing power sources.

Record Amplifier

The FM record amplifier circuit consists of four main sections: Dc amplifier, voltage-controlled oscillator for producing the carrier signal, a square wave generator and head driver. The d-c amplifier acts as a buffer between the d-c input and the voltage-controlled oscillator. By controlling the charging current to a highly stable relaxation oscillator, the frequency, in turn, is controlled. The signal then drives the squarewave generator which in turn supplies the signal to the head driver.

Reproduce Amplifier

The reproduce amplifier demodulates data signals from the preamplifiers and provides output for accurate data reproduction. The preamps are mounted in a shielded card housing directly behind the heads in the rear of the tape transport. Preamp output signals may be monitored at a test jack on the front panel of the reproduce module, which mounts in the standard module file. The reproduce amplifier produces a nominal 1.0 volt rms output. Cutoff frequency for each band is determined by tape speed and a plug-in data filter that can be easily changed to correspond to each of the tape speeds.

ES-100 SPECIFICATIONS

HEADS

Gap Scatter:	Trailing edges for record heads (or gap centers for reproduce heads) within a band 100 microinches wide (0.001 inch).
Gap Azimuth:	All stacks with 1 minute of arc perpendicular to head base plate.
Track Dimensions:	Track width is 0.050 inch; tape track spacing 0.070 center (IRIG Standard). Other heads on special order.
Number of Tracks:	7 on 1/2 inch; 14 on 1 inch (IRIG Standard). Other heads on special order.
Inter Spacing:	1.5 (±0.0005) inches, gap to gap.

FM RECORD/REPRODUCE SYSTEM

Frequency Response:

Tape Speed	Frequency Response (within 1.0 db)	RMS S/N Ratio	Total Harmonic Distortion
60 ips	0 to 20,000 cps	44 db	1.5%
30 ips	0 to 10,000 cps	44 db	1.5%
15 ips	0 to 5,000 cps	42 db	1.5%
7-1/2 ips	0 to 2,500 cps	42 db	1.5%
3-3/4 ips	0 to 1,250 cps	40 db	2.0%
1-7/8 ips	0 to 625 cps	40 db	2.0%

RMS Signal-to-Noise (at center carrier):	(See table.)
Harmonic Distortion:	(See table.)

Dc Drift:	Less than ±0.5% of full deviation over a four-hour period after warmup (10 minutes). Less than 2% in 8 hours with temperature vairations between +40° F and +125° F.
Record/Reproduce Voltage Linearity:	±1.0% of full band, of a zero-based straight line.
Input Level:	Input of 1 volt rms (0 dbv) to produce ±40% deviation; adjustable from 0.5 to 25 volts rms by input potentiometer.
Input Impedance:	Minimum 20 K ohms resistive.
Output Level:	1.0 volt rms (nominal) into 10 K ohms or greater load impedance.
Output Impedance:	1,000 ohms, unbalanced to ground.

ENVIRONMENT

Temperature:	Operating: -40° F to +125° F. Storage/non-operating: -20° F to +160° F.
Altitude:	Operating: 15,000 feet. Non-operating: 50,000 feet.
Relative Humidity:	5 to 95%, non-condensing, both operating and non-operating.
Vibration:	Operating: nil. Non-operating: Normal handling and transportation only.
Voltage:	105 to 125 volts, single phase, 58 to 62 cps ac (48 to 52 cps ac on special order).
Power Consumption:	Approximately 500 watts for a 14-track record/reproduce system.

ES-100 FM SYSTEM ADJUSTMENTS

The FM Record/Reproduce System may be adjusted with the AMPEX TC-10 calibration unit or with standard laboratory equipment. The following procedures give complete instructions using either method. For further detailed information refer to the sections relating to FM record and FM reproduce amplifiers.

SYSTEM ADJUSTMENTS USING THE AMPEX TC-10 CALIBRATION UNIT

Equipment Required

1) AMPEX TC-10 calibration unit.

2) Screwdriver with 1/8 inch blade.

3) Test Patch Cord.

4) Service Module Type 1 or Type 3.

Step 1. Connect the equipment as shown in Fig. 2

Step 2. Rotate CARRIER FREQUENCY selector switch S1 to the desired carrier frequency for a given tape speed to be used.

Step 3. Connect the test patch cord between TP3 (connected to J6) of the record amplifier and TP3 (connected to J3) of the reproduce amplifier.

Step 4. Connect the record dc receptacles on the TC-10 to TP1 or jack J1 of the record amplifier.

Step 5. Connect the reproduce dc receptacle on the TC-10 to TP1 or J1 of the reproduce amplifier.

Step 6. Place the tape transport controls to the RECORD mode, or energize record amplifiers using item 4 above.

Step 7. Set the operating controls of the TC-10 to the following positions:

Center Carrier Frequency	See table below
Operating Mode	Record
%Deviation Frequency	0
%Deviation Voltage	0
Modulation Range	Off

Tape Speed (ips)	Center Carrier Frequency (kc)	+40% Deviated Frequency (kc)	-40% Deviated Frequency (kc)	± Deviation (kc)
WIDE BAND				
60	108	151.2	64.8	±43.2
30	54	75.6	32.4	±21.6
15	27	37.8	16.2	±10.8
7-1/2	13.5	18.9	8.1	± 5.4
3-3/4	6.75	9.45	4.05	± 2.7
1-7/8	3.38	4.73	2.03	± 1.35
NARROW BAND				
60	54	75.6	32.4	±21.6
30	27	37.8	16.2	±10.8
15	13.5	18.9	8.1	± 5.4
7-1/2	6.75	9.54	4.5	± 2.7
3-3/4	3.38	4.73	2.03	± 1.35
1-7/8	1.69	2.36	1.01	± .675

Step 8. Adjust the Carrier Frequency control on the front panel of the record amplifier until a zero beat is obtained. As proper adjustment is neared, the tone becomes a series of clicks, spaced farther and farther apart, as the center frequency is approached. In addition, an error signal may also be observed on the frequency meter. The error signal is indicated by a perceptible oscillation of the meter needle when a zero beat is neared and finally returns to zero when the frequencies coincide.

Step 9. Reset the TC-10 operating mode to reproduce and adjust the Zero Adjust control on the reproduce amplifier for a zero indication of the Voltage Difference meter. Use the "HI" position of the Sensitivity switch for maximum accuracy.

Step 10. Reset the TC-10 operating controls to the following positions:

Operating Mode	Record
% Deviation Frequency	-40
% Deviation Voltage	40

Range and Polarity	-2
Non-Linearity	0

Step 11. Adjust the Working Voltage control for a "0" reading on the voltage difference meter.

Step 12. Adjust the Coarse and Fine deviation controls on the front panel of the record amplifier for a zero beat in the loudspeaker or a zero indication on the frequency difference meter.

Step 13. Reset the operating controls of the TC-10 to the following positions:

% Deviation Frequency	+40
% Range and Polarity	+ 2.0

Step 14. Adjust the Working Voltage control for a zero indication from the loudspeaker or a zero indication on the Frequency Difference meter.

Step 15. Adjust the Non-Linearity control for a zero reading on the Voltage Difference meter and observe the amount and direction of non-linearity. The Non-Linearity control is calibrated directly in units of percentage of bandwidth.

Step 16. Reset the TC-10 operating controls to the following positions:

Operating Mode	Reproduce
% Deviation Frequency	+40
% Deviation Voltage	40
Range and Polarity	+ 2.0
Non-Linearity	0

Step 17. Adjust the Gain control on the FM reproduce amplifier for a zero indication on the Voltage Difference meter.

Step 18. Reset the operating controls of the TC-10 to the following positions:

% Deviation Frequency	-40
% Deviation Voltage	40
Range and Polarity	- 2.0
Non-Linearity	0

Step 19. Adjust the Non-Linearity control for a zero indication on the Voltage Difference meter. The Non-Linearity control reads directly in percentage of full band voltage. If the reading is within specifications, no further adjustment is required. If the reading is not within specifications or if greater accuracy is required, the following steps should be taken:

Step 20. Set the Non-Linearity control halfway between its present setting and zero. Readjust the Gain control on the reproduce amplifier for a zero indication on the Voltage Difference meter.

Step 21. Recheck the +40% deviation as in step 15.

ADJUSTMENTS USING STANDARD LABORATORY EQUIPMENT

Equipment Required

1) Audio Oscillator, Hewlett-Packard 200 CD. (or equivalent)
2) A-c VTVM, Hewlett-Packard 523B. (or equivalent)
3) Digital Voltmeter, Non-Linear Systems 401. (or equivalent)
4) Counter, Hewlett-Packard 400D. (or equivalent)
5) Oscilloscope, Hewlett-Packard 130. (or equivalent)
6) D-c voltage source.
7) Service module type No. 1.

Step 1. Connect the equipment as shown in Fig. 3. The test patch card is connected between TP3 (connected to J6) of the record amplifier and TP3 (connected to J3) of the reproduce amplifier.

Step 2. Rotate the Carrier Frequency selector switch S1 to the desired carrier frequency for a given tape speed to be used.

Step 3. Short the input to the record amplifier by jumpering the input to position 1.

Step 4. Insure that the center carrier frequency shown on the counter corresponds with the Selected Center Carrier Frequency (see Table 1-1). Adjust the Carrier Frequency control on the record amplifier to obtain this reading.

Step 5. Adjust the Zero Adjust control on the reproduce amplifier for a 0. volt dc output reading on the oscilloscope.

Step 6. Disconnect the jumper from the input. Connect the dc voltage source (position 2) to the input of the record amplifier. Adjust the voltage for -1.414 dc input voltage

NOTE

If the system is to be aligned to produce ±40% deviations with inputs greater or less than 1.0 volt rms sinewave, the desired applied voltage should be used in place of the 1.414 volts indicated above.

Step 7. Observe the deviated frequency shown on the counter. The frequency must correspond to the figure shown in Table 1-1 for a -40% deviation. Adjust the Coarse and Fine adjustment on the record amplifier to achieve this reading.

Step 8. Reverse the battery polarity making certain that the voltage is not changed. Read the frequency shown on the counter and compare this frequency with +40 column in Table 1-1. Observe the amount and direction of error.

Step 9. Disconnect the dc voltage source and connect the oscillator (position 3) to the input of the record amplifier. Set the oscillator frequency so that it corresponds to about 20% of the filter cut-off frequency (see frequency response in FM System specifications).

Step 10. Adjust the Gain control on the reproduce amplifier so that the output voltage will equal the voltage introduced at the input of the record amplifier.

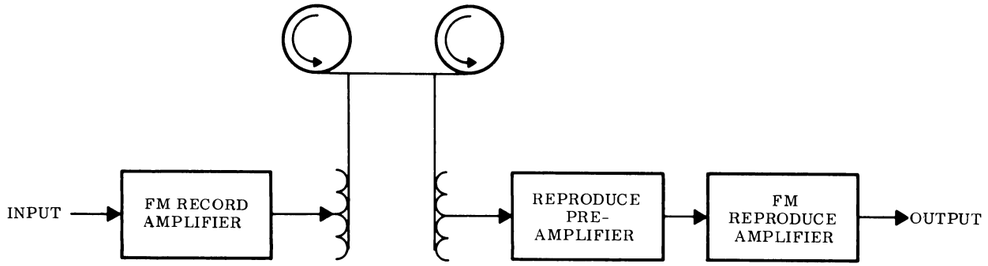


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Fig. 1. ES-100 FM System Block Diagram

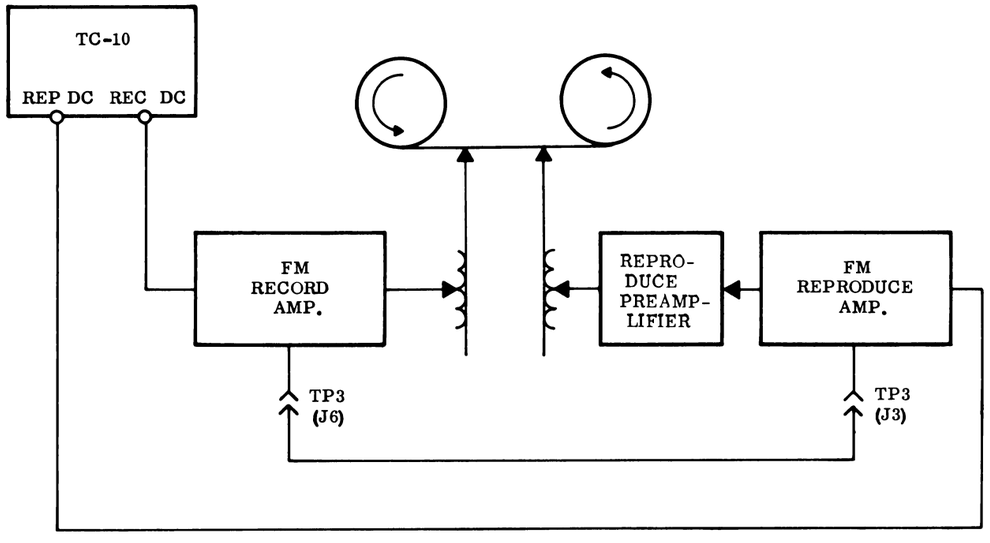

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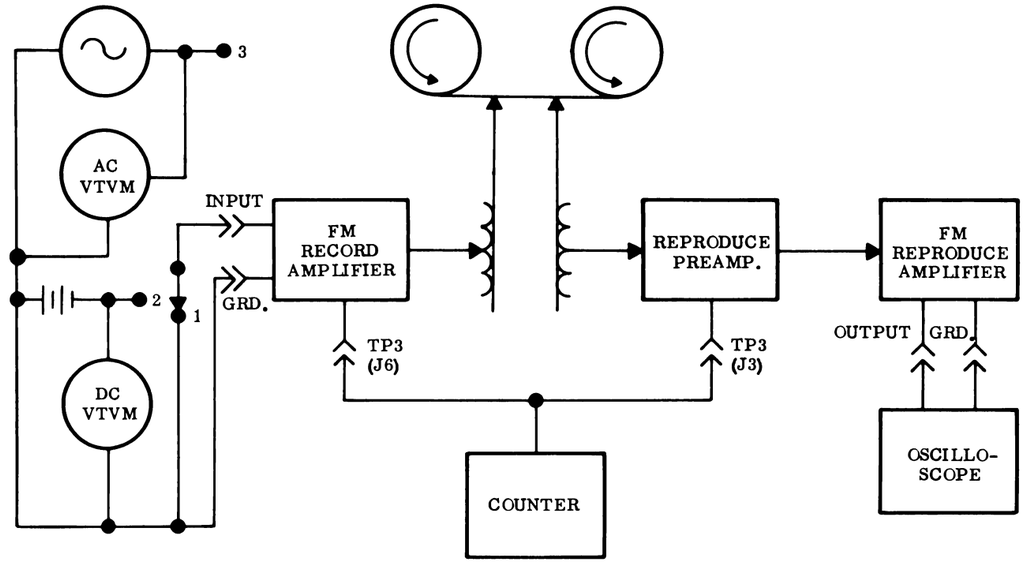
Fig. 2. ES-100 FM System Test Set-up Block Diagram
Using Ampex FM Calibration Unit TC-10



NOTES:
POSITION 1 FOR SETTING RECORD CENTER CARRIER FREQUENCY ADJUST AND REPRODUCE ZERO ADJUST
POSITION 2 FOR DEVIATION FREQUENCY
POSITION 3 FOR ADJUSTING REPRODUCE OUTPUT LEVEL

Fig. 3. ES-100 FM System Test Set-Up Block Diagram
Using Standard Laboratory Equipment

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ES-100 FM RECORD AMPLIFIER

The FM record amplifier provides a frequency modulated signal output which corresponds to the data signal introduced at the input. This output signal is then used to drive the record head. The frequency of the output signal is determined by a carrier frequency selector switch that selects a frequency which coincides with the desired tape speed. The selector switch is located at the side of the amplifier and can be positioned at any one of six different speeds.

All components of the amplifier are mounted on a plug-in type etched circuit card (Fig. 1). The card is inserted into the ES-100 tray assembly which can accommodate as many as fourteen amplifiers in one tray card file. Power and input connections are made at the rear edge of the card through the internal wiring harness of the tray assembly.

Test points and operating adjustment controls are located on the front panel of the amplifier card. Input jack J1 and test point TP1 provide a means of monitoring the input signal. Test point TP2 provides a ground connection. Test point TP3 is a roving test connector, used to check various amplifier circuits. The roving test pin of TP3 can be inserted into any one of several test jacks on the printed circuit card. In addition there are three screw driver adjustments consisting of a Carrier Frequency adjustment, a Fine Deviation adjustment and a Coarse Deviation adjustment.

CIRCUIT DESCRIPTION

The following circuit description divides the FM record circuitry into three major sections: A voltage to frequency converter, a bistable multivibrator, and a head driver. The schematic is shown in Fig. 2; the block diagram in Fig. 3.

Voltage to Frequency Converter

The voltage-to-frequency converter consists of two stages: a differential amplifier and a relaxation oscillator. The function of the converter is to provide an output frequency that changes in direct proportion to the data input signal.

The input signal is impressed across Deviation Control resistors R1 and R2 and applied to the base of transistor Q1. The signal is then coupled through resistors R7 and R9 from the emitter of transistor Q1 to the emitter of transistor Q2. Diode CR1 and its associated resistors shunt R7 and R9 during positive input signals causing the gain of transistors Q1 and Q2 to increase. This increase effectively compensates for any non-linearity that may occur in the switching action of the relaxation oscillator. Transistors Q1 and Q2 constitute a differential amplifier that has changing collector currents corresponding to the input data signal. Zero bias for the base of Q1 is established by potentiometer R4-A and resistor R5, thereby preventing d-c flow through the deviation controls R1 and R2. Coupling and current limiting for the emitters of Q1 and Q2 are provided through R3 to the positive voltage supply. Temperature stabilization is accomplished by resistors R4-B, R4-C and diode CR2. Resistors R8 and R20 compensate for differences in component value by altering the average current level through Q2.

The current flowing from the collector of Q2 is applied to a timing capacitor causing it to charge in a positive linear direction. Any one of six timing capacitors (C2, C3, C4, C5, C6, or C7) can be selected at the carrier frequency selector switch S1. The selected capacitor is coupled thus to the emitter of Q3 and to collector of Q2.

Transistor Q3 and Q4 constitute a relaxation oscillator which functions as a voltage triggered switching circuit to discharge the timing capacitor instantly. The frequency of the switching action is changed by varying the charging current to the capacitor and by the value of capacitance. The characteristics of the switch are such that as long as the voltage across the timing capacitor is less than a reference voltage at the base of Q3, the switch is open. The reference voltage for the oscillator is established by resistors R17, R18, and R19. When the voltage across the capacitor becomes greater than the reference voltage, the emitter-base junction of Q3 is forward biased and collector current flows. The collector current of Q3 is coupled to the base of Q4 causing that transistor to turn on.

When Q4 turns on, the reference voltage decreases and Q3 conducts heavily. Therefore the turn-on action is regenerative causing Q3 and Q4 to go into a state of high conduction rapidly; this helps the capacitor to discharge rapidly.

When the voltage across the timing capacitor is low enough that the emitter base junction of Q3 is no longer heavily forward biased, the base current of Q4 is reduced. Reducing the base current of Q4 decreases its conduction allowing the reference voltage and the base voltage of Q3 to return to normal. This effectively stops conduction of the transistors and the capacitor again will start charging and continue to charge until the voltage across it is greater than the reference voltage. The output of the switch is a negative pulse which is generated each time the switch turns on. This pulse is then coupled through capacitor C8 to two steering diodes used to trigger a bistable multivibrator.

Bistable Multivibrator (Flip-Flop)

The function of the multivibrator is to accept short negative-going pulses from the output of the relaxation oscillator and convert these pulses into rectangular waves paced by the pulses.

The oscillator is intentionally running at double the output frequency, so that pulses from it may be used to drive the flip-flop in alternate directions. The negative-going pulses from the relaxation oscillator are capacity coupled through C8 to charging diode CR4 and steering diodes CR3 and CR5 to the bases of transistors Q5 and Q6. The steering diodes conduct the leading edge of the negative pulses to both transistors of the flip-flop causing the "ON" state transistor to change state. The flip-flop therefore, makes one complete cycle to each pair of trigger pulses from the oscillator. Capacitor C9 and resistor R24 couple the load to the flip-flop. The output of the flip-flop is applied to the head driver amplifier.

Head Driver

The function of the head driver is to provide a modulated driving current for the recording head.

The output of the multivibrator is coupled to the bases of complementary transistor pair Q7 and Q8 through a "speed-up" circuit consisting of capacitors C10, C11, and resistor R25. Transistors Q7 and Q8 act as a complementary electronic switch, alternately driven to complete saturation or complete cut-off. Current limiting and inter-coupling for the emitter and collector circuits of Q7 and Q8 is provided by resistors R26, R27, R28, and R29.

Decoupling networks are provided to confine the signal currents within specified circuit areas. The components that make up the decoupling networks are C1, C12, C13, C14, C15, and L1, L2, L3.

ES-100 FM RECORD AMPLIFIER OPERATING ADJUSTMENTS

The operating adjustments must be performed prior to starting any new data gathering run or whenever a new tape speed is selected. These adjustments using either standard laboratory equipment or the portable AMPEX TC-10 FM Calibration Unit are given in the following procedures.

ADJUSTMENT OF FM RECORD AMPLIFIER USING AMPEX TC-10 CALIBRATION UNIT

The following equipment is required to adjust the FM record amplifier by means of the Ampex TC-10 Calibration Unit. The procedure assumes the amplifier to be in place and operating in a system (Fig. 4).

Equipment Required

1) Ampex TC-10 Calibration Unit with cable set.

2) Screwdriver with 1/8 inch blade.

3) Type 1 Service Module, Catalog No. 69116-10.

Step 1. Rotate speed select switch S1 to the desired tape speed.

Step 2. Connect the RECORD DC receptacle on the AMPEX TC-10 to the appropriate INPUT jack on the front panel of the amplifier.

Step 3. Set the operating controls of the AMPEX TC-10 to the following positions:

Mode	Record
Center Carrier Frequency	See table
% Deviation Frequency	0
% Deviation Voltage	0
Modulation Range	Off

Step 4. Insert the service module and place the record switches in the ON position. If a service module is not available, place the tape transport controls to the RECORD mode.

Step 5. Adjust the Carrier Frequency control on the front panel of the record amplifier until a zero beat is obtained. As proper adjustment is neared, the tone becomes a series of clicks, evenly dying away, as the center frequency is approached. In addition, an error signal may also be observed on the frequency difference meter. The error signal is indicated by a perceptible oscillation of the meter needle when a zero beat is neared.

WIDE BAND

Tape Speed (ips)	Center Carrier Frequency (KC)	Deviated Frequency (KC) +40%	Deviated Frequency (KC) +30%	Deviated Frequency (KC) -40%	± Deviation (KC) 40%	± Deviation (KC) 30%
60	108.	151.2	140.4	64.8	±43.2	±32.4
30	54.	75.6	70.2	32.4	±21.6	±16.2
15	27.	37.8	35.1	16.2	±10.8	± 8.1
7-1/2	13.5	18.9	17.55	8.1	± 5.4	± 4.05
3-3/4	6.75	9.45	8.775	4.05	± 2.7	± 2.025
1-7/8	3.375	4.725	4.3875	2.025	± 1.35	± 1.0126

NARROW BAND

60	54	75.6	70.2	32.4	±21.6	±16.2
30	27	37.8	35.1	16.2	±10.8	± 8.1
15	13.5	18.9	17.55	8.1	± 5.4	± 4.05
7-1/2	6.75	9.45	8.775	4.05	± 2.7	± 2.025
3-3/4	3.375	4.725	4.3875	2.025	± 1.35	± 1.0125
1-7/8	1.687	2.362	2.1931	1.012	± .675	± .5061

Step 6. Reset the operating controls of the AMPEX TC-10 to the following positions:

% Deviation Frequency	-40
% Deviation Voltage	40
Range and Polarity	- 2
Non-Linearity	0

Step 7. Adjust the Working Voltage control for a "0" reading on the voltage difference meter.

Step 8. Adjust the Coarse and Fine deviation controls on the front panel of the record amplifier for a zero beat in the loudspeaker or a zero indication on the frequency difference meter.

Step 9. Reset the operating controls of the TC-10 to the following positions:

% Deviation Frequency	+40
Range and Polarity	+ 2.0

Step 10. Adjust the Working Voltage control for a zero indication from the loudspeaker or a zero indication on the frequency difference meter.

Step 11. Adjust the Non-Linearity control for a zero reading on the voltage difference meter and observe the amount and direction of non-linearity. The Non-Linearity control is calibrated directly in units of percentage of bandwidth.

Step 12. Reset the operating controls of the TC-10 to the following positions:

% Deviation Frequency	+30
% Deviation Voltage	30

Step 13. Adjust Working Voltage control for a zero indication from the loudspeaker or a zero indication on the frequency difference meter.

Step 14. Adjust the Non-Linearity control for a zero reading on the voltage difference meter and observe the amount and direction of non-linearity. The amount of non-linearity should be approximately the same as that given in Step 11, but in the opposite direction.

NOTE

If the readings obtained in Steps 11 and 14 are not within the specified tolerance, perform Steps 15 thru 18.

Step 15. Set the Non-Linearity control half-way between the readings observed in Steps 11 and 14.

Step 16. Reset the operating controls of the TC-10 as follows:

% Deviation Frequency	-40
% Deviation Voltage	40
Range and Polarity	- 2

Step 17. Adjust the Working Voltage control for a zero reading on the voltage difference meter.

Step 18. Adjust the Coarse and Fine deviation control on the front of the amplifier card for a zero beat.

ADJUSTMENT OF ES-100 FM RECORD AMPLIFIER USING STANDARD LABORATORY INSTRUMENTS

The following equipment is required to adjust the FM record amplifier with standard laboratory instruments.

1) Digital voltmeter, Non Linear systems 481 (or equivalent)

2) Counter, Hewlett-Packard 523B (or equivalent)

3) Voltage Divider Network

4) Dry Cell Battery, 1.5 volt

NOTE

The adjustment instructions given below assume a full ±40% deviation for a 1.0 volt rms sine wave input. If desired, the FM record amplifier may be adjusted to produce a ±40% deviation with an input voltage greater or less than 1.0 volt rms. The FM record system may be adjusted to produce full frequency deviation with as little as .25 volt rms.

Step 1. Connect the equipment as shown in Fig. 5. The input is connected to jack J1 or test point TP1 on the front panel of the amplifier card. The output of the amplifier is available at test point TP3 which is also on the front panel.

Step 2. Rotate speed select switch S1 to the desired tape speed.

Step 3. Observe the center carrier frequency shown on the counter. The frequency must correspond with the selected center carrier frequency as shown in the preceding table. Adjust the Carrier Frequency control on the front panel of the amplifier to obtain this reading.

Step 4. Connect the battery input to the FM record amplifier and adjust the voltage divider for -1.414 volts d-c input.

NOTE

If the system is to be aligned to produce ±40% deviations with inputs greater or less than 1.0 volt rms sinewave, the desired applied voltage should be used in place of the 1.414 volts indicated above.

Step 5. Observe the deviated frequency shown on the counter. The frequency must correspond to the figure shown in the table for -40% deviation. Adjust the Coarse and Fine adjustment on the controls on the front panel of the record amplifier to achieve this reading.

Step 6. Reverse the battery polarity making certain that the voltage is not changed. Read the frequency shown on the counter and compare this frequency with +40 column in the table. Observe the amount and direction of error.

Step 7. Reset the voltage for 75% of the d-c voltage given in Step 6 (1.060 volts dc). Read the frequency shown on the counter and compare this frequency with +30 column in the table. Observe amount and direction of error.

NOTE

The errors observed in Steps 6 and 7 should be approximately equal in magnitude, but in opposite directions. If these errors are not within specification or a greater accuracy is desired, perform Steps 7 and 8.

Step 8. Determine the amount and direction of the difference in the errors obtained from Steps 6 and 7.

Step 9. Connect the battery for the same polarity and voltage as used in Step 4. Readjust the Coarse and Fine deviation controls to obtain an error that is equal to one half of the difference observed in Step 8, but in the opposite direction.

ES-100 FM RECORD SERVICE ADJUSTMENTS

Service adjustments (Fig. 1) must be performed during routine calibration or whenever a component has been replaced.

NOTE

Service adjustments shall be attempted only by a qualified technician or an authorized Ampex Service Engineer.

Equipment Required

1) AMPEX TC-10 Calibration Unit or standard laboratory equipment consisting of an adjustable d-c source, a measuring device with .01% accuracy and a switch to open and short the amplifier input circuit.

2) Counter, Hewlett-Packard 523-B (or equivalent).

3) A 100 ma ±12 volt power supply adjusted to 0.1% accuracy with drift confined to less than 0.25% (ES-100 power supply).

4) Type #2 service module, Catalog No. 69118 (when ES-100 is used as power source).

5) Thermostatically controlled oven capable of operating within the range of 25° centigrade and 60° centigrade.

6) Suitable connecting cables.

7) A modified module shield equipped with access holes for easy adjustment of resistors R4-A, R4-B, and R4-D.

Initial Settings

The following settings should be made on the record amplifier prior to attempting any service adjustments.

1) Speed Select switch to 60 ips.

2) Carrier Frequency control to mid-range.

3) Coarse deviation control (R1) 1/4 turn clockwise.

4) Fine deviation control (R2) to mid-range.

5) Bias null adjust (R4-A) 1/4 turn clockwise.

6) Temperature compensation adjust (R4-B) fully counterclockwise.

7) Linearity adjust (R4-D) fully counterclockwise.

8) Insert the test pin of TP3 into J5.

Method Using the AMPEX TC-10 FM Calibration Unit

Step 1. Make suitable connections to the power supply and counter, the counter being connected across the output of the record amplifier.

Step 2. Connect the amplifier input to the REPRODUCE DC receptacle on the TC-10.

Step 3. Set the operating controls of the TC-10 to the following positions:

Operating Mode - Record

% Deviation Voltage - "0"

(The Voltage Difference meter is now a very sensitive "0" center galvanometer.)

Step 4. Adjust resistor R4-A for a "0" reading on the voltage difference meter.

Step 5. Reconnect the amplifier input to the RECORD DC receptacle on the TC-10.

Step 6. Reset the operating mode to RECORD.

Step 7. Set the % Deviation control to "0" and note the carrier frequency.

Step 8. Place the amplifier in the oven for 1/2 hour at 60° centigrade.

Step 9. Remove the amplifier from the oven and note the new carrier frequency. Subtract this frequency from the carrier frequency observed in Step 7, to determine the amount of drift. Designate this difference in frequency as drift No. 1.

Step 10. While the amplifier is still at 60° centigrade, rotate the temperature compensation control (R4-B) fully clockwise and note the carrier frequency.

Step 11. Allow the amplifier to return to room temperature and note the new carrier frequency. Subtract this frequency from that obtained in Step 10, to determine the amount of drift. Designate this difference as drift No. 2.

Step 12. The total drift compensation is the sum of drift No's. 1 and 2. The desired drift compensation is derived from the formula drift $= \frac{\text{No. 1}}{\text{No. 1 + No. 2}}$. Set R4-B to approximately this fraction of its total resistance and readjust R4-A as previously described in Step 4.

NOTE

The module shield affects the carrier frequency; therefore a shield should be mounted and grounded on the printed circuit card whenever the carrier frequency is adjusted.

Step 13. Check to see that the Carrier Frequency control will deviate at least 3 Kc either side of 108 Kc. If necessary, switch the jumper on resistors R8 or R20. If jumper is moved, readjust R4-A.

Step 14. Adjust the Carrier Frequency control to obtain carrier frequency of 108.000 Kc.

Step 15. Set the TC-10 operating controls as follows:

% Deviation Voltage	40%
Polarity	- (minus)
Working Voltage	"0" (indication on voltage difference meter)

Step 16. Adjust Coarse and Fine deviation controls to obtain a carrier frequency of 64.8 Kc.

Step 17. Reset the TC-10 operating controls as follows:

Polarity	+
Working Voltage	"0" (indication on voltage difference meter)

Step 18. Adjust R4-D to obtain a carrier frequency of 151.050 Kc, to insure a minimum average linearity error.

NOTE

The preceding adjustments may be performed at all tape speeds.

Method Using Standard Laboratory Equipment

Step 1. Make suitable connections to power supply and counter. The counter being connected across the output of the record amplifier.

Step 2. Connect the switch across the amplifier input.

Step 3. Adjust R4-A, while alternately shorting and unshorting the amplifier input, until no change in carrier frequency occurs.

Step 4. Leave input shorted and note the carrier frequency.

Step 5. Place amplifier in oven for 1/2 hour.

Step 6. Remove the amplifier and note the new carrier frequency. Subtract this frequency from original carrier frequency to determine the amount of drift. Designate this frequency as drift No. 1.

Step 7. While the amplifier is still at 60° centigrade, rotate the temperature compensation control (R4-B) fully clockwise and note the carrier frequency.

Step 8. Allow the amplifier to return to room temperature and note the new carrier frequency. Subtract this frequency from that obtained in Step 7 to determine the amount of drift. Designate this drift as drift No. 2.

Step 9. The total drift compensation is the sum of drift No's. 1 and 2. The desired drift compensation is derived from the formula drift $= \frac{\text{No. 1}}{\text{No. 1} + \text{No. 2}}$. Set R4-B to approximately this fraction of its total resistance and readjust R4-A as described previously in Step 3.

NOTE

The module shield affects the carrier frequency; therefore, a shield should be mounted and grounded on the printed circuit card whenever the carrier frequency is adjusted.

Step 10. Check to see that the Carrier Frequency control will deviate the carrier frequency at least 3 Kc to either side of 108 Kc. If necessary, switch the jumper on resistors R8 and R20. If the jumper is moved readjust R4-A.

Step 11. Set the carrier frequency to 108 Kc.

Step 12. Apply a negative input signal approximately the value of the expected input signal (factory tests are made at 1.414 volts) and carefully adjust the Coarse and Fine deviation controls to obtain a carrier frequency of 64.800 Kc.

Step 13. Apply a positive input signal of exactly the same value. Adjust R4-D to obtain a carrier frequency of 151.050 Kc to insure a minimum average linearity error.

Step 14. Linearity at intermediate points may be checked by applying known portions of the original signal and noting the difference between the actual and calculated carrier frequencies.

Step 15. Linearity may be checked at other tape speeds by adjusting the Carrier Frequency and Deviation controls without input and with negative inputs and then determining the error in resultant carrier frequency at other input levels.

NOTE

The preceding adjustments may be performed at all tape speeds.

TROUBLESHOOTING

If it becomes necessary to explore internal circuits, a troubleshooting assembly drawing is included (Fig. 6) which shows the components and the printed circuit on the amplifier card.

FM-RECORD AMPLIFIER CATALOG NO. 69107-10 & 20

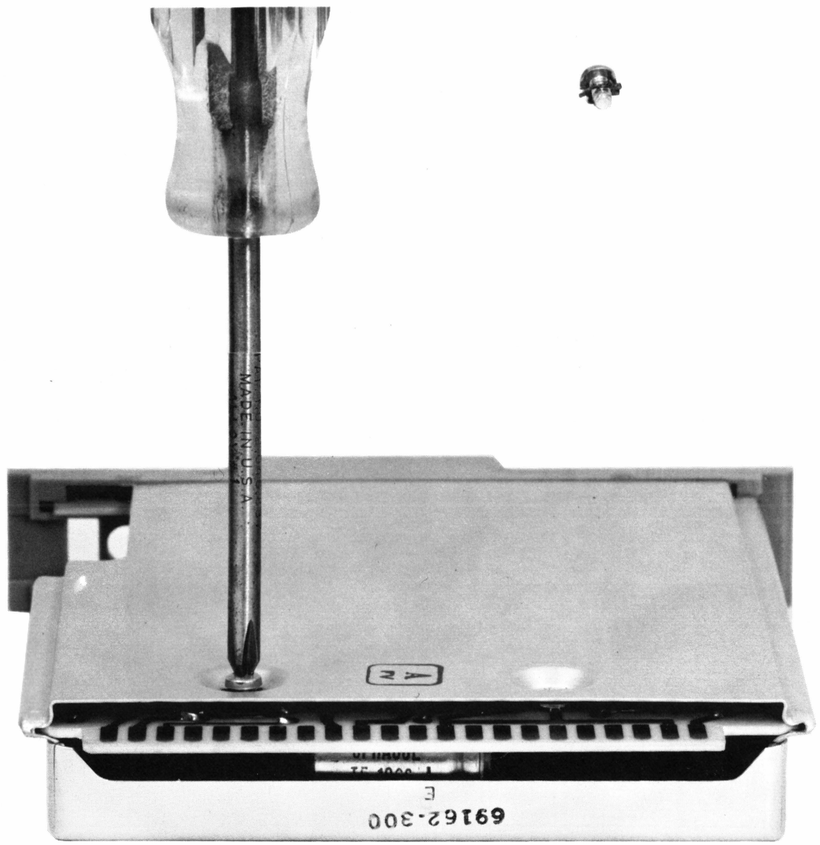
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			CAPACITORS									
C1	037-028		Fixed, Tantalum, 22 uf, 20% tol, 15 vdc	1	1							
C2	034-375		Fixed, Mica, 145 pf, 1% tol, 500 vdc	1	1							
C3	034-278		Fixed, Mica, 300 pf, 1% tol, 500 vdc	1	1							
C4	034-372		Fixed, Mica, 670 pf, 1% tol, 500 vdc	1	1							
C5	034-383		Fixed, Mica, 1260 pf, 1% tol, 500 vdc	1	1							
C6	034-381		Fixed, Mica, 2600 pf, 1% tol, 500 vdc	1	1							
C7	034-382		Fixed, Mica, 5300 pf, 1% tol, 500 vdc	1	1							
C8	034-239		Fixed, Mica, 130 pf, 5% tol, 500 vdc	1	1							
C9	034-299		Same as C8	1	1							
C10	035-325		Fixed, Mylar, .1 uf, 20% tol, 100 vdc	1	1							
C11	035-325		Same as C10	1	1							
C12	037-028		Same as C1	1	1							
C13	037-028		Same as C1	1	1							
C14	030-057		Fixed, Ceramic, Disc, .01uf, $^{+80\%}_{-20}$ tol, 50 vdc	1	1							
C15	030-057		Same as C14	1	1							
C16	030-057		Same as C14	1	1							
			DIODES									
CR1	013-039		Germanium, 1N497	1	1							
CR2	013-054		Crystal, 1N96	1	1							
CR3	013-054		Same as CR2	1	1							
CR4	013-054		Same as CR2	1	1							
CR5	013-054		Same as CR2	1	1							
			CONNECTOR JACK									
J1	147-140		Connector, Coax, Miniature	1								
			TEST JACKS									
J2	148-064		Vertical Black, .187 in.dia. x .312 in.	1	1							
J3	148-064		Same as J2	1	1							
J4	148-064		Same as J2	1	1							
J5	148-065		Vertical Yellow, .187 in.dia. x .312 in.	1	1							
J6	148-065		Same as J5	1	1							

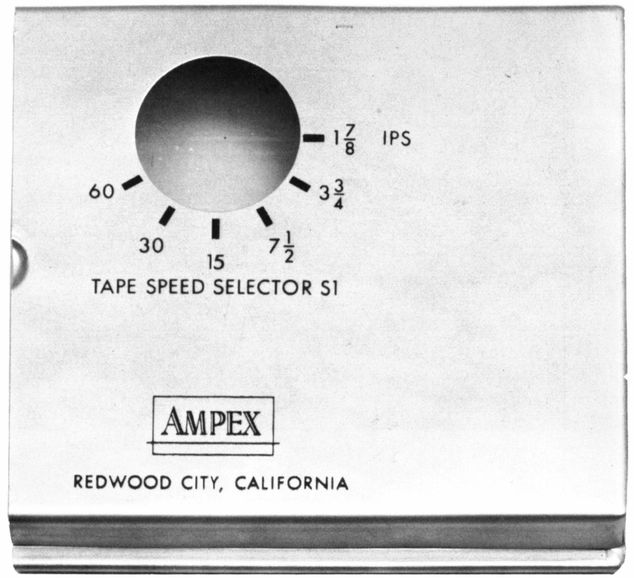
FM-RECORD AMPLIFIER CATALOG NO. 69107-10 & 20												
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.		PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
					10	20	30	40	50	60	70	80	90
				INDUCTOR									
L1	051-094			Fixed, Molded, 39 uh, 10% tol	1	1							
L2	051-094			Same as L1	1	1							
L3	051-094			Same as L1	1	1							
				TRANSISTORS									
Q1	014-188			Silicon, PNP, 2N1027	1	1							
Q2	014-188			Same as Q1	1	1							
Q3	014-138			Silicon, PNP, 2N863	1	1							
Q4	014-989			Silicon, NPN, 2N706A	1	1							
Q5	014-105			Germanium, NPN, 2N1304	1	1							
Q6	014-105			Same as Q5	1	1							
Q7	014-105			Same as Q5	1	1							
Q8	014-988			Germanium, PNP, 2N1305	1	1							
				RESISTORS									
R1	044-449			Variable, Carbon, 20k ohms, 20% tol, 1/8 watt	1	1							
R2	044-450			Variable, Carbon, 250 ohms, 1/8 watt	1	1							
R3	042-499			Carbon, Film, 21.5k ohms, 1% tol, 1/2 watt	1	1							
R4A	044-426			Variable, Carbon, 25k ohms	1	1							
R4B	044-426			Variable, Carbon, 250 ohms	1	1							
R4C	044-426			Fixed, Carbon, 1750 ohms	1	1							
R4D	044-426			Variable, Carbon, 75k ohms	1	1							
R5	042-388			Metal, Film, 261k ohms, 1% tol, 1/8 watt	1	1							
R6	042-384			Metal, Film, 10k ohms, 1% tol, 1/8 watt	1	1							
R7	042-382			Metal, Film, 1k ohms, 1% tol, 1/8 watt	1	1							
R8	042-382			Same as R7	1	1							
R9	042-382			Same as R7	1	1							
R10	041-406			Fixed, Carbon, 22k ohms, 5% tol, 1/4 watt	1	1							
R11	041-406			Same as R10	1	1							
R12	041-406			Same as R10	1	1							
R13	041-411			Fixed, Carbon, 47k ohms, 5% tol, 1/4 watt	1	1							
R14	041-431			Fixed, Carbon, 150k ohms, 5% tol, 1/4 watt	1	1							

FM-RECORD AMPLIFIER CATALOG NO. 69107-10 & 20												
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			RESISTORS (cont'd)									
R15	042-380		Metal, Film, 30.1 ohms, 1% tol, 1/8 watt	1	1							
R16	041-408		Fixed, Carbon, 10k ohms, 5% tol, 1/4 watt	1	1							
R17	042-382		Same as R7	1	1							
R18	044-450		Same as R2	1	1							
R19	042-381		Metal, Film, 619 ohms, 1% tol, 1/8 watt	1	1							
R20	042-382		Same as R7	1	1							
R21	041-412		Fixed, Carbon, 4700 ohms, 5% tol, 1/4 watt	1	1							
R22	041-414		Fixed, Carbon, 2200 ohms, 5% tol, 1/4 watt	1	1							
R23	041-414		Same as R22	1	1							
R24	041-430		Fixed, Carbon, 1500 ohms, 5% tol, 1/4 watt	1	1							
R25	041-411		Same as R13	1	1							
R26	041-282		Fixed, Carbon, 150 ohms, 5% tol, 1/2 watt	1	1							
R27	041-329		Fixed, Carbon, 330 ohms, 5% tol, 1/2 watt	1	1							
R28	041-329		Same as R27	1	1							
R29	041-282		Same as R26	1	1							
R30	041-002		Fixed, Carbon, 10 ohms, 5% tol, 1/2 watt	1	1							
			SWITCH									
S1	122-093		Rotary	1	1							
			TEST POINTS									
TP1	148-057		Green, .410 in. lg. x .203 in.dia., .156 in.dia. mounting hole	1	1							
TP2	148-059		Black, .410 in. lg. x .203 in.dia., .156 in.dia mounting hole	1	1							
TP3	148-063		Yellow, .410 in. lg. x .203 in. dia., .156 in.dia. mounting hole	1	1							
			HARDWARE									
1	69276-10		Circuit Board, Printed Wiring	1	1							
2	69225-10		Panel, FM Record, Front	1								
3	69162-40		Module Shield Assy.	1								
4	69196-40		Label, Panel	1								

FM-RECORD AMPLIFIER CATALOG NO. 69107-10 & 20

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			HARDWARE (cont'd)									
5	69607-10		Knob, Speed Switch	1								
6	69608-10		Base, Speed Switch	1								
7	69609-10		Test Pin	2	2							
8	280-991		Pad, Transistor	2	2							
9	280-998		Pad, Transistor	2	2							
10	90837-20		Label, Trade Mark	1	1							
11	90836-10		Label, Serial No.	1	1							
12	471-059		Screw, No. 4-40 x 3/16, Pan. Hd., Phil. Dr., Stl, Cad. Pl.	2	2							
13	471-326		Screw, No. 4-40 x 1/4, Flat Hd, Phil. Dr, Stl, Cad. Pl.	1	1							
14	471-327		Screw, No. 4-40 x 5/16, Flat Hd, Phil. Dr, Stl, Cad. Pl.	1	1							
15	471-104		Screw, No. 2-56 x 3/16, Binder Hd, Slotted, S. Stl.	2	2							
16	476-028		Screw, No. 4-40 x 3/16, Type F Pan. Hd, Slotted	1	1							
17	600-074		Tubing Electrical, 1."I.D x 9/16lg., Blk.	1	1							
18	492-008		Nut, Hex, No. 4-40, Stl, Cad. Pl.	1	1							
19	492-013		Nut, Hex, No. 2-56, S. Stl, Cad. Pl.	2	2							
20	498-059		Nut, Insertable, No. 4-40, Stl, Cad. Pl.	3	3							
21	502-013		Washer, Lock, No. 4-40, Ext. Tooth, Stl, Cad. Pl.	3	3							
22	502-007		Washer, Split, No. 2-56, S. Stl, Cad. Pl.	2	2							
23	501-008		Washer, Flat, No. 4-40, Stl, Cad. Pl.	1	1							
24	615-002		Wire, Bare, No. 22 AWG, Solid, Copper, Tinned (as required)									
25	611-312		Wire, Stranded, Blk, No. 24 AWG (as required)									
26	611-348		Wire, Stranded, Yel, No. 24 AWG (as required)									
27	91158-10		Printed Sub Circuit, PC1	1	1							
28	172-022		Lug, Solder	1								
29	150-103		Socket, Transistor	2	2							
30	435-038		Clip, Transistor	1	1							
31	144-139		Connector, Female Coax, For .155 dia. cable	1	1							





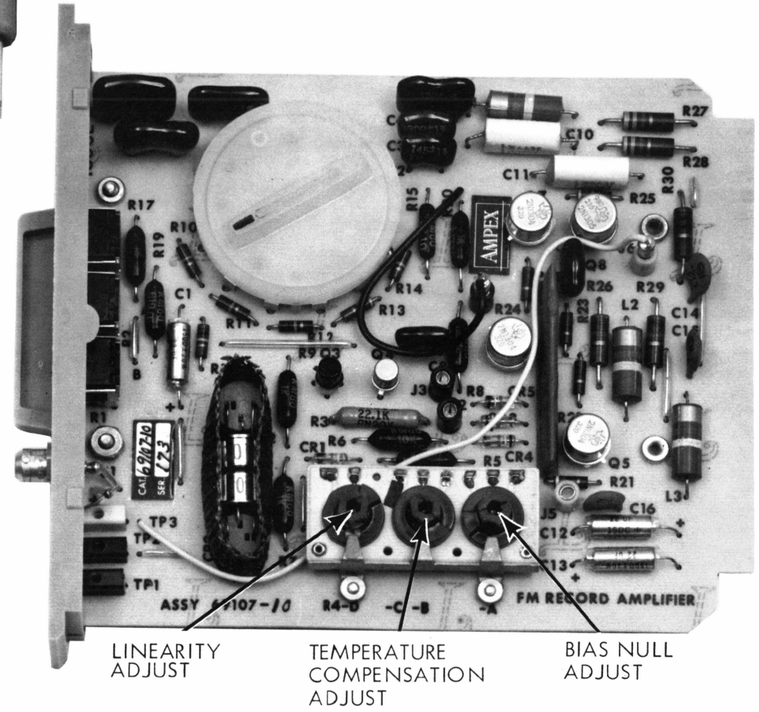
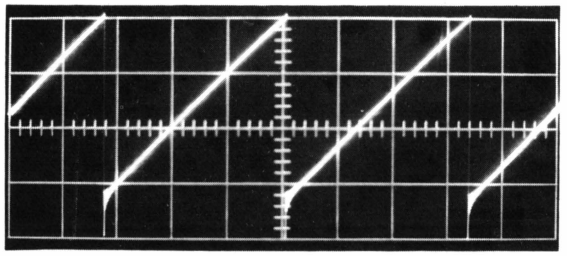


Fig. 1. ES-100 FM Record Amplifier with Adjusting Tool 50683

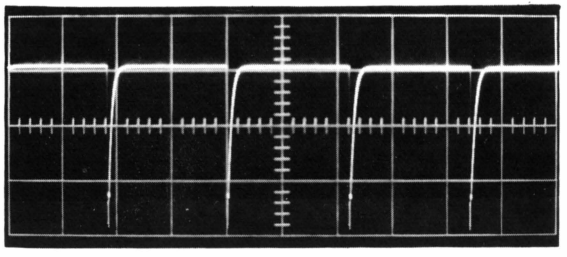
Typical Waveforms Taken From ES-100 FM Record Amplifier



Waveform #1

LEGEND

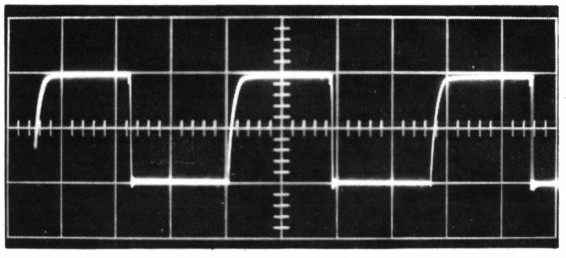
1. Waveform taken at emitter of Q3.
2. 5 usec/cm horiz., 2v/cm vert.



Waveform #2

LEGEND

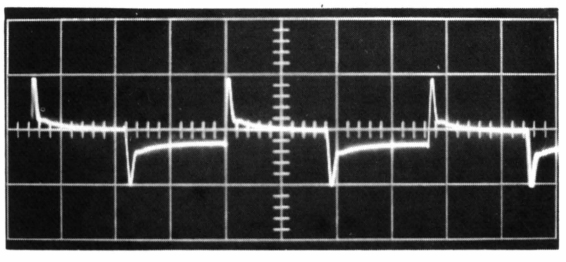
1. Waveform taken at collector of Q4.
2. 5 usec/cm, 2 volt/cm vert.



Waveform #3

LEGEND

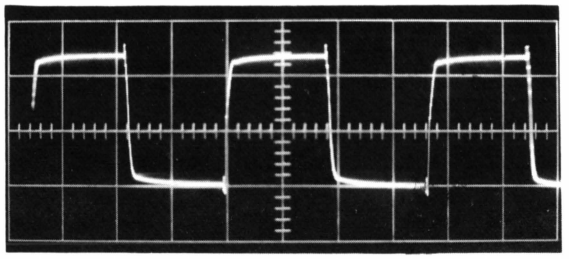
1. Waveform taken at collector of Q6.
2. 5 usec/cm, 5 volt/cm vert.



Waveform #4

LEGEND

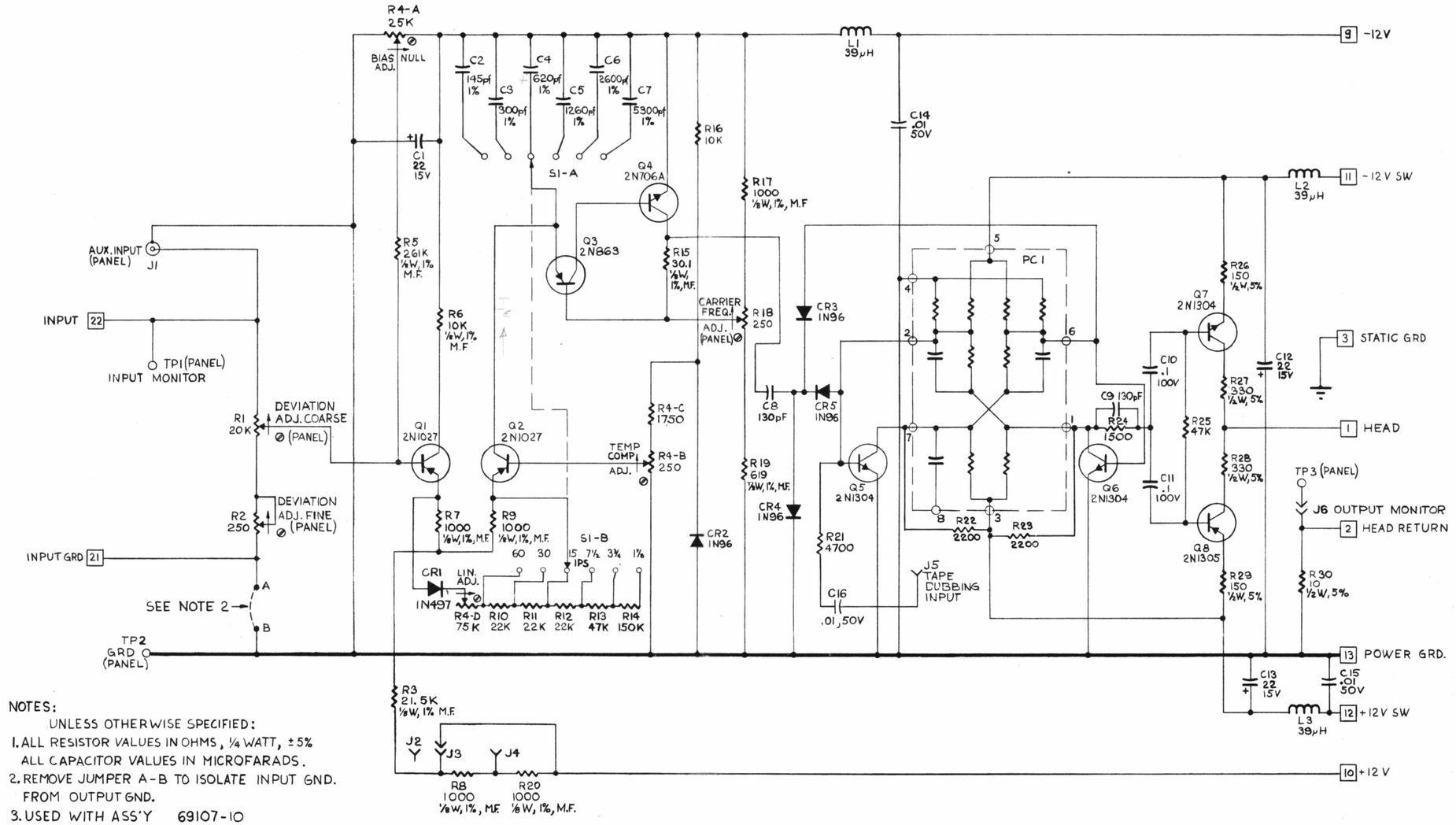
1. Waveform taken at pin #1 to head.
2. 5 usec/cm, 5 volts/cm vert.



Waveform #5

LEGEND

1. Waveform taken at pin #2 head return.
2. 5 usec/cm, 2 volts/cm vert.



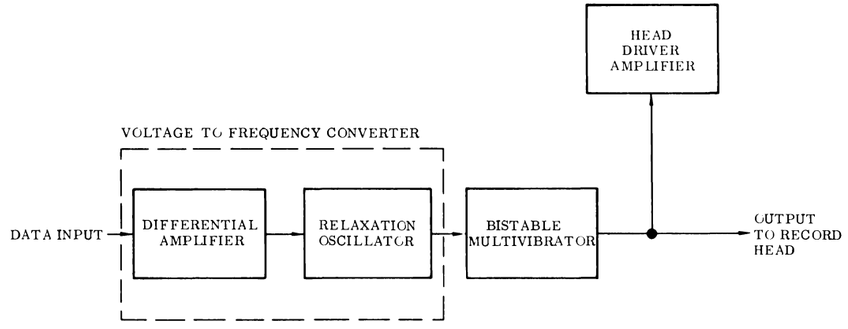
NOTES:

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTOR VALUES IN OHMS, ¼ WATT, ±5%
   ALL CAPACITOR VALUES IN MICROFARADS.
2. REMOVE JUMPER A-B TO ISOLATE INPUT GND. FROM OUTPUT GND.
3. USED WITH ASS'Y 69107-10

Dwg. No. 69277A

Fig. 2. ES-100 FM Record Amplifier Schematic 50684



50685

Fig. 3. ES-100 FM Record Amplifier Block Diagram

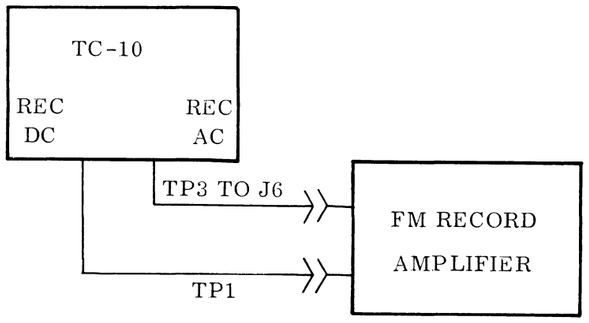


Fig. 4. ES-100 FM Record Amplifier Test Set-Up Block Diagram Using Ampex FM Calibration Unit TC-10

50686

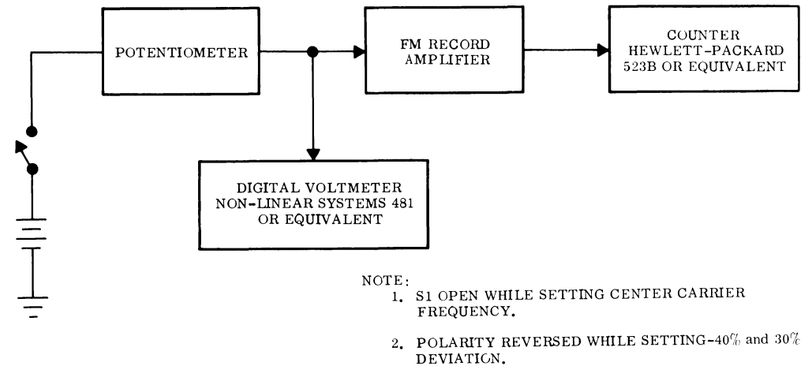
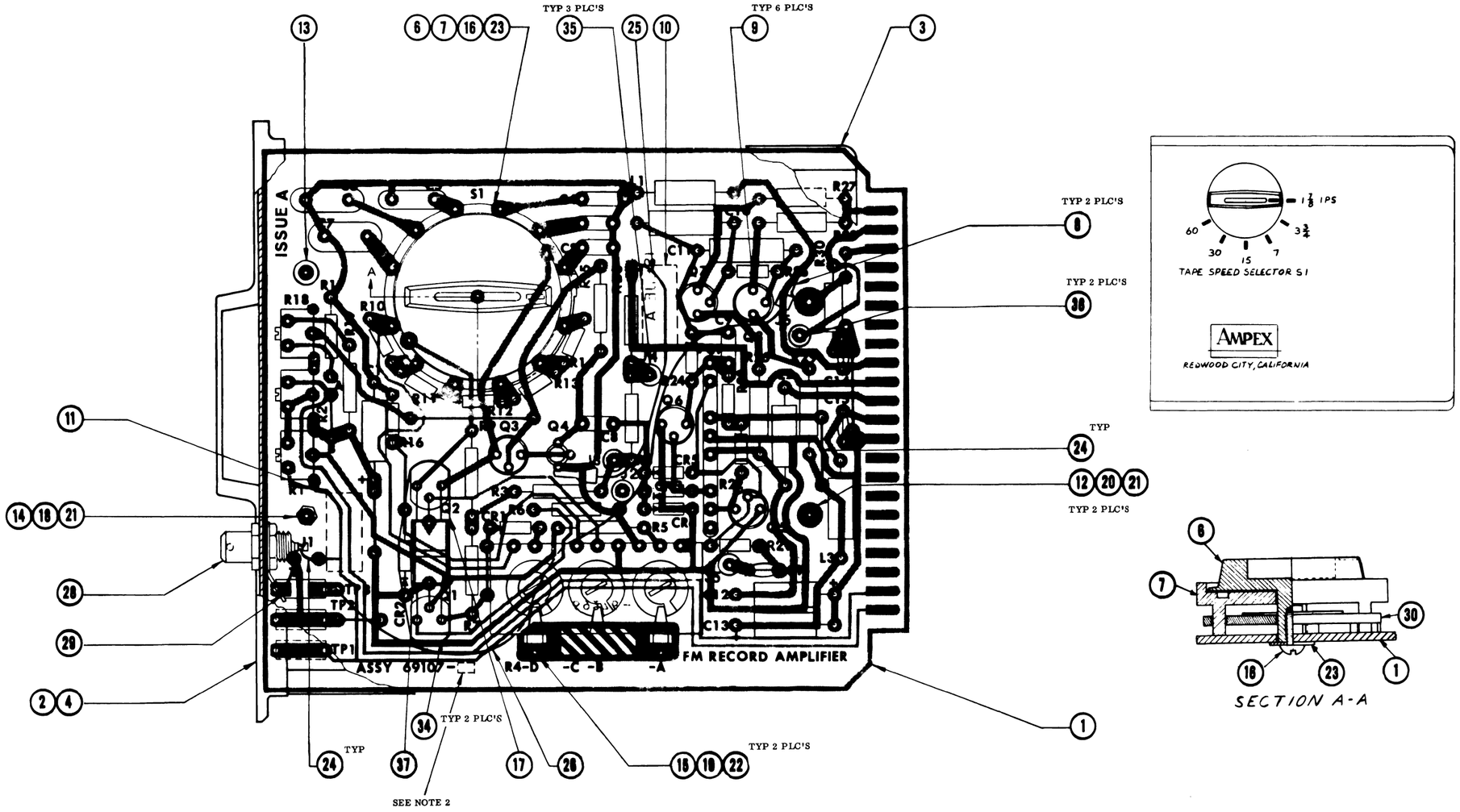


Fig. 5. ES-100 FM Record Amplifier Test Set-up Block Diagram Using Standard Laboratory Equipment

50687



NOTES:
1. PART NO. TO BE: 69107-10, 69107-20.
2. INK STAMP DASH NUMBER, COLOR BLACK, LOCATION AS INDICATED ON DRAWING.
3. RESISTOR COLOR CODE SHALL READ FROM LEFT TO RIGHT AND TOP TO BOTTOM.
4. CAPACITOR AND DIODE POLARITY AS INDICATED.
5. DIP SOLDER CIRCUIT SIDE ONLY PER AMPEX SPEC. 21-10507.
6. SCHEMATIC REFERENCE: D-69277.
7. ADJ. RESISTORS, WAX COATED COMPONENTS AND ADJ. INDUCTORS NOT TO BE IMMERSED IN CLEANING SOLVENTS OR WATER.
8. COMPONENT LEADS AND SOLDER DROPS PROTRUDING FROM CIRCUIT SIDE OF P.C. BOARD TO BE LIMITED TO 1/16" HEIGHT ABOVE BASE MATERIAL.
9. ITEM NO. 38 TO BE PACKAGED SEPARATELY FOR SHIPMENT. (SEE LM-69107)

Fig. 6. ES-100 FM Record Amplifier Assembly Drawing 50688

ES-100 FM REPRODUCE AMPLIFIER

DESCRIPTION

The FM (frequency modulated) reproduce amplifier accepts a frequency modulated signal from the reproduce preamplifier and demodulates this signal to provide an analog output. The amplifier produces a 1.0 volt rms output into a 10,000 ohm load, fed from an output impedance of 1,000 ohms. The frequency of the output extends from dc to cut-off frequency which is determined by the tape speed and the low pass data output filters. Separate filters are available for each tape speed. The table below shows the relationship between the center carrier frequency and the filter cut-off frequencies for each tape speed.

Tape Speed (ips)	Center Carrier Frequency (Kc)	±40% Deviation (Kc)	Nominal Data Bandwidth
60	108	±43.2	d-c to 20 Kc
30	54	±21.6	d-c to 10 Kc
15	27	±10.8	d-c to 5 Kc
7-1/2	13.5	± 5.4	d-c to 2.5 Kc
3-3/4	6.75	± 2.7	d-c to 1.25 Kc
1-7/8	3.375	± 1.35	d-c to .625 Kc

All components of the reproduce amplifier are mounted on a plug-in type printed circuit card (Fig. 1). The card is inserted into the ES-100 tray assembly which accommodates as many as fourteen amplifiers in one tray. Power and input connections are made at the rear edge of the card through the internal wiring harness of the tray assembly.

Test points and operating adjustment controls are located on the front panel of the amplifier card. Output jack J1 and test point TP1 provide a means of monitoring signal output. Test point TP2 provides a ground connection; test point TP3 is a floating test connector used to check various circuits of the reproduce amplifier. The floating test pin of TP3 is inserted into various test jacks on the printed circuit card. Two potentiometers provide a ZERO control adjustment and a GAIN control adjustment.

CIRCUIT THEORY

The circuit of the FM reproduce amplifier consists of six sections: limiter, frequency doubler, multivibrator, ramp generator, blocking oscillator, and output driver. The schematic is shown in Fig. 2; the block diagram in Fig. 3.

Limiter

The limiter amplifies and reshapes the output signal from the preamplifiers into a usable form. There are three stages. Each stage is a standard limiter circuit, providing an output signal 180° out of phase with the input signal.

Input resistor R1 prevents overloading and C1 provides d-c isolation from the pre-amplifier to the base of Q1. The first amplifier (Q1) is an emitter follower amplifier which drives a direct-coupled phase inverter-amplifier (Q2). Non-linear feedback is accomplished by the feedback network composed of CR1, CR2, C3, and R2. The output voltage at the collector of Q2 is fed back to the base of Q1. Negative feedback is employed and as a result an increase in the output voltage increases the conduction through the diodes, resulting in symmetrical limiting. Resistor R2 provides d-c stabilization for transistor leakage current changes. Resistors R6 and R8, of the amplifier stage, limit collector current and determine the operating point of Q2. Bypass capacitor C5 eliminates transient voltage on the emitter of Q2. This description includes only the first stage. The function performed by the components in the second and third limiter stages are the same as for the first limiter.

An input network (TEST INPUT jack TP3 through J2) at the base of Q3 permits the use of an external signal source with which to test the FM reproduce amplifier during operation.

Doubler

The doubler circuit provides a negative trigger pulse to the multivibrator at every crossover point of transient time of the input signal.

The output of the limiter stage is capacitively coupled to the base of Q7. The value of the capacitor is large enough to pass the lowest expected frequency of the signal. The negative-going pulse turns Q7 on driving the emitter to its more negative state. The emitters of Q7 and Q8 are capacitively coupled by C15. Therefore, the negative-going potential of Q7 is differentiated by this capacitor and a negative voltage spike is imposed on the emitter of Q8. The negative spike turns off Q8 completely for the duration of the spike. This causes the collector of Q8 to go negative, resulting in a negative pulse which forward biases diode CR7. The diode conducts, setting the multivibrator. At the same time the collector of Q7 goes more positive because of the "on" state of this transistor. The positive potential, however, is blocked by CR8, and the off transistor does not reset the multivibrator. The positive-going output of the limiter stage turns off transistor Q7, causing its collector to go more negative. This results in diode CR8 conducting to set the multivibrator. When Q7 is turned off its emitter goes positive. The positive voltage is differentiated by C15 imposing a positive spike on the emitter of Q8 which turns this transistor on. The collector of Q8 then goes more positive, although the more positive potential will not reset the multivibrator due to the blocking action of CR7. The result of this process is a negative pulse being imposed on the base of transistor Q9 during each transient time of the limiter stage. In the interval between the two negative pulses, the multivibrator is reset by the blocking oscillator. The final result is the doubling of the frequency out of the limiter stage.

Multivibrator

The multivibrator re-establishes the d-c levels for the trigger pulses out of the doubler and the blocking oscillator.

Negative pulses from the output of the doubler cause CR7 and CR8 to conduct and impose a negative voltage to the base of Q9. This turns the transistor off and the emitter voltage goes negative. Since the emitter is coupled through C19 in series with parallel resistor-capacitor network R38 and C22 to the base of Q12, this negative voltage turns Q12 on. When Q12 turns on, its collector voltage becomes positive. The positive voltage is coupled by R41 to the collector of Q9, which then goes positive. This positive voltage is coupled to the base of Q10 through the parallel RC network composed of C20 and R34, turning Q10 off.

When Q10 turns off, its collector goes negative. The negative voltage is coupled to the base of Q9 through the parallel RC network of R31 and C16, keeping Q9 off until a negative pulse from the blocking oscillator resets the multivibrator at the base of Q10. Therefore, the multivibrator is a bistable circuit set by a negative pulse from the doubler and reset by a negative pulse from the blocking oscillator. Resistor R29 is a current limiter for Q10, and supplies the off-bias signal to Q9. Diode CR11 is a clamping diode which prevents the input to the base of Q12 from being greater than +12 volts. Diode CR14 provides off-bias voltage to transistor Q12. The diode is actually a sensistor which is used because of its dynamic forward impedance characteristic. Resistor R39 performs the function of providing off-bias for transistor Q12. Capacitors C16, C20 and C22 provide overdrive to their respective transistor bases to speed up the transient times at these transistor outputs. The assymmetry of the output of the blocking oscillator to reset the multivibrator has a fixed delay time determined by the plug-in filter unit. Resistor R35 ensures that Q10 will turn on when the power supplies are initially turned on.

Ramp Generator

The output of the output driver is coupled to the ramp generator circuit. The ramp generator provides drive to the blocking oscillator at a fixed delay time. This time is determined by the value of resistors R48, R49 and R50 and the value of the plug-in filter unit.

The output of the driver stage is coupled to the base of the ramp generator transistor Q15 through a differentiating network composed of C27, R44 and CR18. Capacitor C27 has a different value for each speed and is included in the plug-in filter unit. Each value is selected to pass the lowest carrier frequency expected at each speed. Therefore, C27 provides d-c isolation from the output of the driver stage. Transistor Q15 is held on normally by the bias voltage provided by R40 which is connected to the -12 volt d-c supply. The voltage at the base of the transistor is determined by divider network composed of R40, R47, CR18 and R44. A positive portion of the square wave of the output driver stage is imposed on the base of Q15 through C27, C26, CR18 and R47 turning the transistor off. Transistor Q15 is held off by a network composed of R44, CR18, R47 and CR17. With transistor Q15 off the same positive voltage discharges C28 at a rate determined by the time constant of this capacitor and resistors R48, R49 and R50. Since C28 is initially charged to approximately -6 volts, the positive voltage tends to charge the capacitor toward the opposite polarity. But since the trigger to the blocking oscillator is referenced to ground potential, the output voltage of the ramp generator does not get much more positive than ground because the triggered blocking oscillator changes the state of the multivibrator which, in turn, changes the polarity of the output of the driver stage.

The change in the output stage polarity results in Q15 turning on. This is accomplished in the following manner: The negative voltage makes the junction of R44, C27 and CR18 temporarily negative. This reverse-biases CR18 and the base of Q15 is brought up to a negative potential through R40 turning Q15 on. With Q15 on, there is a low impedance

charging path to charge C28 to -6 volts. Since the collector of Q15 is connected to the zener reference voltage of CR15, the capacitor is charged to a relatively stable source. Also, an added charging path is provided from the output of the driver stage by a resistive network composed of R48, R49 and R50. The parallel value of R48 and R49 is 6.8k ohms and the value of each is selected for optimum temperature compensation. Transistor Q15 remains on until the multivibrator is set by the negative pulse out of the doubler stage. The cycle is then repeated.

Blocking Oscillator

The blocking oscillator provides the negative reset pulse for the multivibrator. The circuit provides a fast-rise-time pulse with a fixed pulse width.

The output from the ramp generator is coupled to the primary winding of the pulse transformer through CR12. This diode normally has reverse bias and therefore will not conduct until the ramp generator output approaches ground potential. CR13 provides the ground reference level for triggering the blocking oscillator. Since the triggering point of the blocking oscillator depends on the equality of the forward characteristics of these two diodes, the diodes are a matched pair and are encapsulated. As the ramp generator approaches ground potential, CR12 conducts driving the base of transistor Q11 more positive. This turns Q11 on and causes current to conduct through the secondary winding of the pulse transformer. The collector of Q11 then goes more negative. The current in the secondary winding is fed back positively to the base of the transistor. This regenerative action drives the base more positive, turning the transistor on harder. It is through this regenerative action that a fast rise time is obtained in the output. The duration of the pulse is determined by the inductance of the pulse transformer. Resistors R36 and R37 provide the bias voltage to keep transistor Q11 in its normally off condition. C14 stabilizes the emitter of Q11. R32 is a damping resistor. The negative-going pulse is coupled through C17 causing CR9 to conduct. This diode is attached to the base of Q10, and the negative pulse causes Q10 to turn on reseting the multivibrator.

Output Driver

The output of the multivibrator is directly coupled to the output driver stage. This stage performs the function of current amplification and voltage amplitude limiting of the output voltage to the filter.

Transistors Q13 and Q14 are a complementary pair which provide a positive and negative level output voltage. This level change is required to provide a positive and negative d-c voltage output from the filter. The bases of the two transistors are common. A positive voltage at its base causes Q14 to conduct bringing the output voltage to a positive level of 6 volts as determined by the zener reference diode CR16. A negative voltage imposed on its base will cause Q13 to conduct and transistor Q14 to cut off bringing the output to a negative level of -6 volts as determined by the zener reference diode CR15. Resistor R42 provides the current for the zener diode CR15 and also limits the collector current through Q13. Resistor R43 performs the same function for the complementary transistor Q14. The output is fed into an integrating filter with a d-c output that is a function of the amplitude and dissymmetry of the output driver voltage. Resistor R46 is a variable potentiometer which adjusts the d-c output voltage level. The sensistors R50 and R51 are used for temperature compensation. The temperature coefficient of the sensistor is such that higher temperatures result in increasing its resistance value, thus compensating for the

change of the resistance value of the inductors in the filter. Capacitors C23 and C24 bypass large transient voltages across the zener reference diodes thereby stabilizing the reference voltage.

The power supply to the limiter stages is de-coupled from other sections of the FM Reproduce Amplifier by a network composed of R21, R24, C13, C18 and C21.

The plug-in filter unit contains capacitors C14, C27 and C28, and a three stage integrating filter composed of inductors and capacitors.

Capacitor C28 is selected for close tolerances due to its function as a timing capacitor in the ramp generator. A printed circuit ground shield is provided on the amplifier to prevent interaction between the module and the printed circuit.

FM REPRODUCE AMPLIFIER OPERATIONAL ADJUSTMENTS

The following adjustment procedures are used primarily as a performance check to ensure the amplifier operates within given specification. These procedures must be performed prior to starting any new data gathering run.

ALIGNMENT OF FM REPRODUCE AMPLIFIER USING AMPEX TC-10 FM CALIBRATION UNIT

The following equipment is required to align the FM reproduce amplifier with TC-10 FM Calibration Unit. The procedure assumes the amplifier to be in place and operating in a system.

1) Ampex TC-10 FM Calibration Unit with cable set.

2) Screwdriver with 1/8 inch blade.

CAUTION

The floating test pin of TP3 must be inserted into test jack J3 prior to performing the alignment procedure.

Step 1. Connect the Reproduce a-c receptacle on the TC-10 to test point TP3 on the front panel of the FM reproduce amplifier. Connect the Reproduce d-c receptacle on the TC-10 to TP1 or OUTPUT jack on the front panel of the amplifier. The normal output load of the FM reproduce amplifier system must either be connected or simulated (10k ohms).

Step 2. Plug in the filter unit for the tape speed to be used.

Step 3. Set the operating controls of the TC-10 to the following positions:

Mode	Reproduce
Center Carrier Frequency	See Table
% Deviation Frequency	0
% Deviation Voltage	0
Modulation Range	Off

Tape Speed (ips)	Center Carrier Frequency (kc)	+40% Deviated Frequency (kc)	-40% Deviated Frequency (kc)	± Deviation (kc)
WIDE BAND				
60	108	151.2	64.8	±43.2
30	54	75.6	32.4	±21.6
15	27	37.8	16.2	±10.8
7-1/2	13.5	18.9	8.1	± 5.4
3-3/4	6.75	9.45	4.05	± 2.7
1-7/8	3.38	4.73	2.03	± 1.35
NARROW BAND				
60	54	75.6	32.4	±21.6
30	27	37.8	16.2	±10.8
15	13.5	18.9	8.1	± 5.4
7-1/2	6.75	9.54	4.5	± 2.7
3-3/4	3.38	4.73	2.03	± 1.35
1-7/8	1.69	2.36	1.01	± .675

Step 4. Adjust the ZERO ADJ control on the front panel of the FM reproduce amplifier for a zero indication of the VOLTAGE DIFFERENCE meter. Use the HI position of the SENSITIVITY switch for maximum accuracy.

Step 5. Reset the operating controls of the TC-10 to the following positions:

% Deviation Frequency	+40
% Deviation Voltage	40
Range and Polarity	+2.0
Non-Linearity	0

Step 6. Adjust the GAIN control on the FM reproduce amplifier for a zero indication on the VOLTAGE DIFFERENCE meter.

Step 7. Reset the operating controls of the TC-10 to the following positions:

% Deviation Frequency	-40
% Deviation Voltage	40
Range and Polarity	-2.0
Non-Linearity	0

Step 8. Adjust the Non-Linearity control for a zero indication on the Voltage Difference meter. The Non-Linearity control reads directly in percentage of full band voltage. If the reading is within specifications, no further adjustment is required. If the reading is not within specifications or if greater accuracy is required, the following steps should be taken:

Step 9. Set the Non-Linearity control halfway between its present setting and zero. Readjust the GAIN control on the reproduce amplifier for a zero indication on the Voltage Difference meter.

Step 10. Re-check the +40% deviation as in Step 5.

ALIGNMENT OF FM REPRODUCE AMPLIFIER USING STANDARD LABORATORY INSTRUMENTS

The following equipment (or its equivalent) is required to align the FM reproduce amplifier using standard laboratory instruments. The procedure assumes that the amplifier is operating in a complete system.

1) Audio Oscillator, Hewlett-Packard 200CD

2) Digital Voltmeter, Non-Linear Systems 401

3) Counter, Hewlett-Packard 523B

4) A-c VTVM, Hewlett-Packard 400D

CAUTION

The floating test pin of TP3 must be inserted into test jack J3 prior to performing the alignment procedure.

Step 1. Connect the equipment as shown in Fig. 5. Insure that the normal output load of the FM reproduce system is either connected or simulated.

Step 2. Plug in the filter unit for the tape speed to be used.

Step 3. Connect the oscillator output to test point TP3 on the front panel of the FM reproduce amplifier. Set the oscillator frequency at the center carrier frequency corresponding to the tape speed, as shown in the table. The output level of the oscillator should be adjusted to 250 millivolts.

Step 4. Adjust the Zero Adj control on the front panel of the reproduce amplifier for a 0 volt d-c output.

Step 5. Readjust the oscillator frequency to the +40% deviation frequency shown in the table above. Adjust the Gain control on the front panel of the reproduce amplifier for a +1.414 volt d-c output.

Step 6. Readjust the oscillator frequency to the -40% deviation frequency shown in the table. Adjust the Gain control for minimum error in the +40% and -40% deviation outputs.

ALIGNMENT OF FM REPRODUCE AMPLIFIER USING LABORATORY INSTRUMENTS AND PRE-ALIGNED FM RECORD AMPLIFIER

The following equipment is required to align the FM reproduce amplifier using laboratory instruments and a pre-aligned FM record amplifier. The procedure assumes that the amplifier is operating in a complete system.

1) Correctly aligned FM record amplifier

2) Digital Voltmeter

3) Potentiometer

4) Battery, 1.5 volt

CAUTION

The floating test pin of TP3 must be inserted into test jack J3 prior to performing the alignment procedure.

Step 1. Connect the test equipment and FM record amplifier as shown in Fig. 6. The output of the FM record amplifier should be jumpered from test point TP3 on the front panel of the record amplifier, to test point TP3 on the front panel of the reproduce amplifier.

Step 2. Disconnect the input to the FM record amplifier. The digital voltmeter now reads the output voltage of the FM reproduce amplifier, which should be 0 volt d-c ±1 mv. Adjust the Zero Adj control to achieve this reading.

Step 3. Connect the battery as shown and, using the digital voltmeter, adjust the input to the FM record amplifier to +1.414 volts.

Step 4. Using the digital voltmeter, check the output of the FM reproduce amplifier, which should read +1.414 volts d-c. Adjust the Gain control on the reproduce amplifier front panel to achieve this reading.

Step 5. Reverse the polarity of the input to the FM record amplifier, making sure that the voltage does not change. Read the voltage output of the FM reproduce amplifier, which should read -1.414 volts d-c. Adjust the Gain control on the front panel for a minimum error in the +1.414 and -1.414 volt readings.

Drift Check

When the FM reproduce module has been properly aligned, drift may be checked in the following manner:

CAUTION

The floating test pin of TP3 must be inserted into test jack J3 prior to performing the alignment procedure.

Step 1. Connect a stable frequency input to test point TP3.

Step 2. Monitor the d-c output at the OUTPUT jack on the front panel of the reproduce amplifier.

NOTE

If the AMPEX TC-10 FM Calibration Unit is used to check drift, the test must be made around the +10% or -10% frequency deviations. Drift around zero deviation cannot be measured with the Non-Linearity control of the TC-10.

TROUBLESHOOTING

If it becomes necessary to explore internal circuits, a troubleshooting assembly drawing is included (Fig. 6) which shows the components and the printed circuit on the amplifier card.

FM-REPRODUCE AMPLIFIER CATALOG NO. 69108-10 & 20														
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.		PART DESCRIPTION	QUANTITY REQUIRES PER VERSION									
					10	20	30	40	50	60	70	80	90	
				CAPACITORS										
C1	037-065			Fixed, Tantalum, 4.7 uf, 20% tol, 10 vdc	1									
C2	037-055			Fixed, Tantalum, 1.8 uf, 10% tol, 15 vdc	1									
C3	037-065			Same as C1	1									
C4	030-240			Fixed, Mica, 220 pf, 5% tol, 500 vdc	1									
C5	037-028			Fixed, Tantalum, 22 uf, 20% tol, 15 vdc	1									
C6	037-055			Same as C2	1									
C7	037-065			Same as C1	1									
C8	037-028			Same as C5	1									
C9	037-055			Same as C2	1									
C10	037-065			Same as C1	1									
C11	037-028			Same as C5	1									
C12	037-055			Same as C2	1									
C13	037-028			Same as C5	1									
C14	037-028			Same as C5	1									
C15	035-296			Fixed, Mylar, .01 uf, 3% tol, 100 vdc	1									
C16	034-238			Fixed, Mica, 47 pf, 10% tol, 500 vdc	1									
C17	030-102			Fixed, Ceramic, 2200 pf, 10% tol, 500 vdc	1									
C18	037-028			Same as C5	1									
C19	037-055			Same as C2	1									
C20	034-238			Same as C16	1									
C21	037-028			Same as C5	1									
C22	034-238			Same as C16	1									
C23	037-065			Same as C1	1									
C24	037-065			Same as C1	1									
C25				Etched on Printed Circuit board	1									
C26	034-177			Fixed, Mica, 100 pf, 5% tol, 500 vdc	1									
				DIODES										
CR1	013-155			Silicon, 1N625	1									
CR2	013-155			Same as CR1	1									
CR3	013-155			Same as CR1	1									
CR4	013-155			Same as CR1	1									
CR5	013-155			Same as CR1	1									
CR6	013-155			Same as CR1	1									
CR7	013-200			Germanium, 1N116	1									
CR8	013-200			Same as CR7	1									
CR9	013-201			Silicon, 1N914	1									
CR10	013-200			Same as CR7	1									

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ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			DIODES (cont'd)									
CR11	013-200		Same as CR7	1								
CR12												
CR13	46443		Diode, Matched pair assembly	1								
CR14	013-203		Silicon, Stabistor, HD6161	1								
CR15	013-202		Silicon, Zener, 5% tol, 6.2V 1N825	1								
CR16	013-202		Same as CR15	1								
CR17	013-200		Same as CR7	1								
CR18	013-200		Same as CR7	1								
			CONNECTOR JACK									
J1	147-140		Connector, Coax, Miniature	1								
			TEST JACKS									
J2	148-065		Vertical, Yellow, .187 in.dia. x .312	1								
J3	69629-10		Vertical	1								
J4	148-065		Same as J2	1								
J5	169-116		Contact, Strip	1								
J6	148-065		Same as J2	1								
J7	148-065		Same as J2	1								
			TRANSISTORS									
Q1	014-029		Germanium, PNP, 2N414	1								
Q2	014-032		Germanium, PNP, 2N603	1								
Q3	014-029		Same as Q1	1								
Q4	014-032		Same as Q2	1								
Q5	014-029		Same as Q1	1								
Q6	014-032		Same as Q2	1								
Q7	014-109		Germanium, PNP, 2N1499A	1								
Q8	014-109		Same as Q7	1								
Q9	014-137		Silicon, NPN, 2N708	1								
Q10	014-109		Same as Q7	1								
Q11	014-137		Same as Q9	1								
Q12	014-109		Same as Q7	1								
Q13	014-245		Silicon, PNP, 2N861	1								
Q14	014-210		Silicon, NPN, 2N2218	1								
Q15	014-245		Same as Q13	1								

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ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			RESISTORS									
R1	041-410		Fixed, Carbon, 1000 ohms 5% tol, 1/4 watt	1								
R2	041-411		Fixed, Carbon, 47k ohms 5% tol, 1/4 watt	1								
R3	041-408		Fixed, Carbon, 10k ohms, 5% tol, 1/4 watt	1								
R4	041-407		Fixed, Carbon, 3300 ohms, 5% tol, 1/4 watt	1								
R5	041-436		Fixed, Carbon, 22k ohms, 5% tol, 1/4 watt	1								
R6	041-407		Same as R4	1								
R7	041-410		Same as R1	1								
R8	041-412		Fixed, Carbon, 4700 ohms, 5% tol, 1/4 watt	1								
R9	041-411		Same as R2	1								
R10	041-409		Fixed, Carbon, 15k ohms, 5% tol, 1/4 watt	1								
R11	041-408		Same as R3	1								
R12	041-408		Same as R3	1								
R13	041-412		Same as R8	1								
R14	041-410		Same as R1	1								
R15	041-430		Fixed, Carbon, 1500 ohms, 5% tol, 1/4 watt	1								
R16	041-409		Same as R10	1								
R17	041-408		Same as R3	1								
R18	041-408		Same as R3	1								
R19	041-412		Same as R8	1								
R20	041-430		Same as R15	1								
R21	041-559		Fixed, Carbon, 120 ohms, 5% tol, 1/4 watt	1								
R22	041-532		Fixed, Carbon, 910 ohms, 5% tol, 1/4 watt	1								
R23	041-430		Same as R15	1								
R24	041-559		Fixed, Carbon, 120 ohms, 5% tol, 1/4 watt	1								
R25	041-560		Fixed, Carbon, 2k ohms, 5% tol, 1/4 watt	1								
R26	041-532		Same as R22	1								
R27	041-559		Same as R21	1								
R28	041-560		Same as R25	1								
R29	041-538		Fixed, Carbon, 6200 ohms, 5% tol, 1/4 watt	1								
R30	041-410		Same as R1	1								
R31	041-482		Fixed, Carbon, 10k ohms, 5% tol, 1/4 watt	1								
R32	041-505		Fixed, Carbon, 620 ohms, 5% tol, 1/4 watt	1								
R33	041-505		Same as R32	1								
R34	041-562		Fixed, Carbon, 43k ohms, 5% tol, 1/4 watt	1								
R35	041-563		Fixed, Carbon, 240k ohms, 5% tol, 1/4 watt	1								
R36	041-561		Fixed, Carbon, 5100 ohms, 5% tol, 1/4 watt	1								

FM-REPRODUCE AMPLIFIER CATALOG NO. 69108-10 & 20

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			RESISTORS (cont'd)									
R37	042-386		Metal, Film, 31.6k ohms, 1% tol, 1/8 watt	1								
R38	041-408		Same as R3	1								
R39	041-408		Same as R3	1								
R40	041-406		Fixed, Carbon, 18k ohms, 5% tol, 1/4 watt	1								
R41	041-531		Fixed, Carbon, 750 ohms, 5% tol, 1/4 watt	1								
R42	041-505		Same as R32	1								
R43	041-429		Fixed, Carbon, 680 ohms, 5% tol, 1/4 watt	1								
R44	042-385		Metal, Film, 15k ohms, 1% tol, 1/8 watt	1								
R45	043-523		Fixed, Wirewound, 1k ohms, 1% tol, 1/5 watt	1								
R46	044-321		Variable, Wirewound, 1k ohms, 5% tol, 1 watt	1								
R48	043-524		Fixed, Wirewound, 7500 ohms, 1% tol, 1/5 watt	1								
R49	042-387		Metal, Film, 56.2k ohms, 1% tol, 1/8 watt	1								
R50	044-321		Same as R46	1								
R51	046-011		Sensistor, 1000 ohms, 10% tol, 1/8 watt	1								
R52	046-011		Same as R51	1								
			TRANSFORMER									
T1	46442-1		Pulse	1								
			TEST POINTS									
TP1	148-057		Green, .410 in.lg. x .203 in.dia., .156 in.dia. mounting hole	1								
TP2	148-059		Black, .410 in.lg. x .203 in.dia., .156 in.dia. mounting hole	1								
TP3	148-063		Yellow, .410 in.lg. x .203 in.dia., .156 in.dia. mounting hole	1								
			HARWARE									
1	69285-10		Circuit Board, Printed Wiring	1								
2	69225-10		Panel, FM Reproduce, Front	1(10)								
3	69162-20		Module Shield Assy.	1(10)								
4	69196-51		Label, Panel	1(10)								
5	69609-10		Test Pin	1								
6	67688-11		Label, Cat. No., Ser. No., Trade Mark	1								

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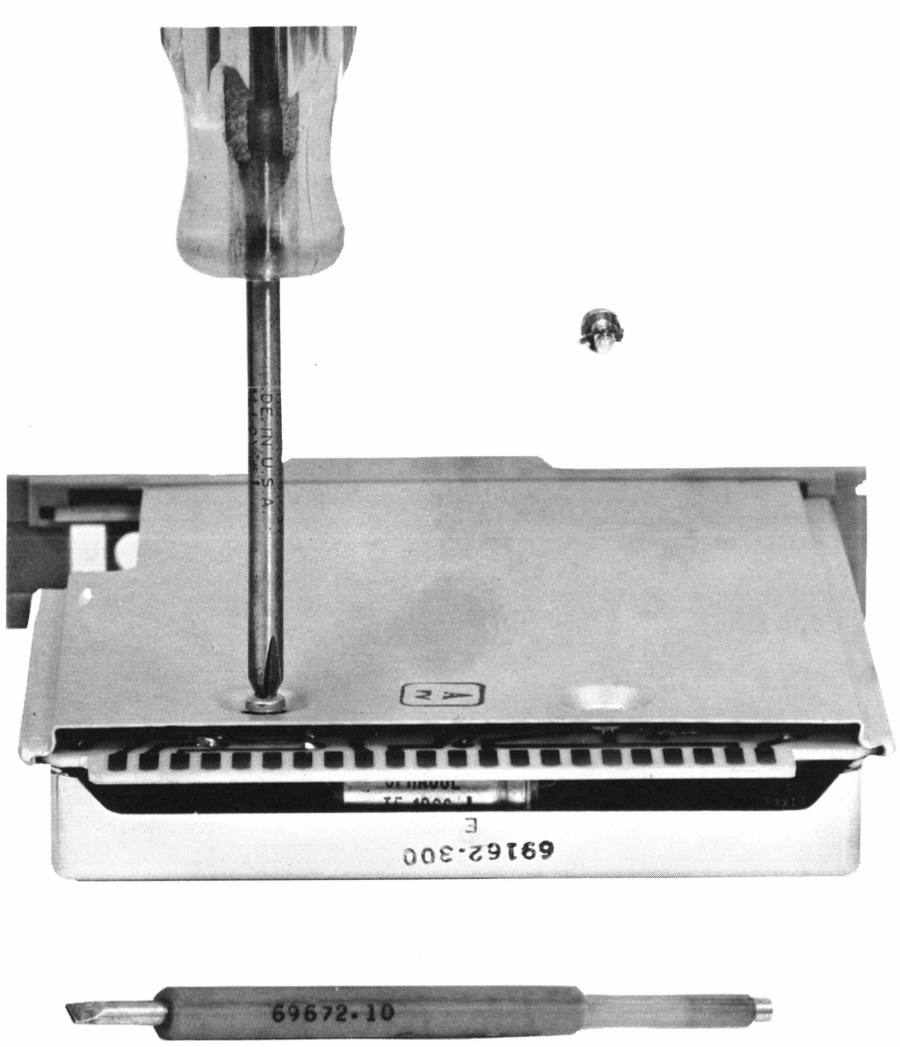
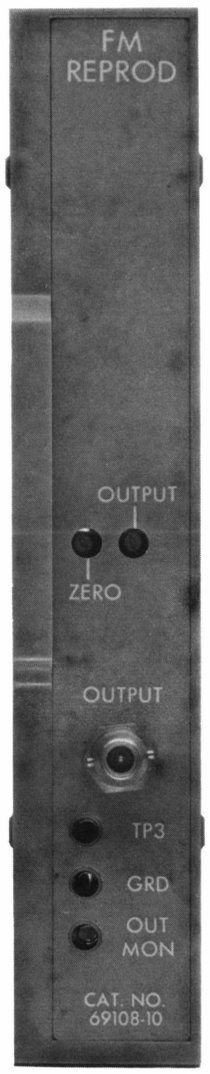
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			HARDWARE (cont'd)									
7	475-001		Screw, Sems, No. 4-40 x 3/16, Pan Hd, Phil. Dr, Stl, Cad. Pl.	2								
8	471-968		Screw, No. 4-40 x 5/32, Flat hd, Phil Dr, Stl, Cad. Pl.	1								
9	471-326		Screw, No. 4-40 x 1/4, Flat hd, Phil Dr, Stl, Cad. Pl.	1								
10	471-890		Screw, No. 2-56 x 9/16, Pan. Hd, Slotted Stl, Cad. Pl	2								
11	492-008		Nut, Hex, No. 4-40, Stl. Cad. Pl.	1								
12	492-007		Nut, Hex, No. 2-56, Stl, Cad. Pl.	2								
13	498-059		Nut, Insertable, No. 4-40, Stl, Cad. Pl	2								
14	310-100		Nut, Insertable, No. 4-40, Stl, Cad. Pl.	1								
15	502-013		Washer, Lock, No. 4-40, Ext. Tooth, Stl, Cad. Pl.	3								
16	502-023		Washer, Lock, No. 2-56, Int. Tooth, Stl, Cad. Pl.	2								
17	615-002		Wire, Bare, No. 22 AWG, Solid, Copper Tinned (as required)									
18	611-348		Wire Stranded, Ins. Yel. No. 24 AWG (as required)									
19	172-022		Lug, Solder	1(10)								
20	280-998		Pad, Transistor	11								
21	280-991		Pad, Transistor	4								
22	144-139		Connector, Female, Coax, for .155 Dia. Cable (Not Shown)	1(10)								
			LOW PASS FILTERS									
1	46390-11		60 ips	1								
2	46390-21		30 ips	1								
3	46390-31		15 ips	1								
4	46390-41		7-1/2 ips	1								
5	46390-51		3-3/4 ips	1								
6	46390-61		1-7/8 ips	1								





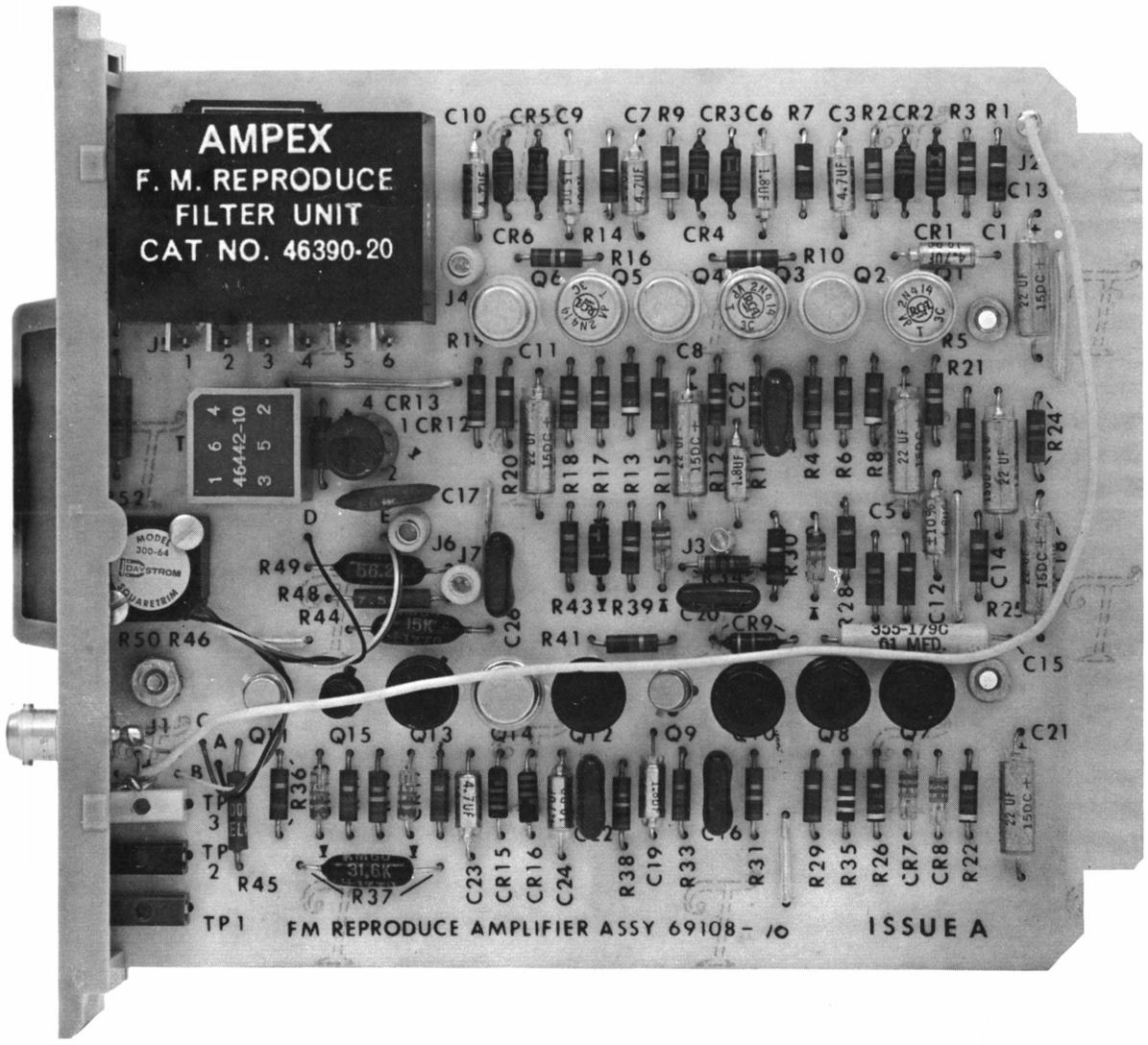
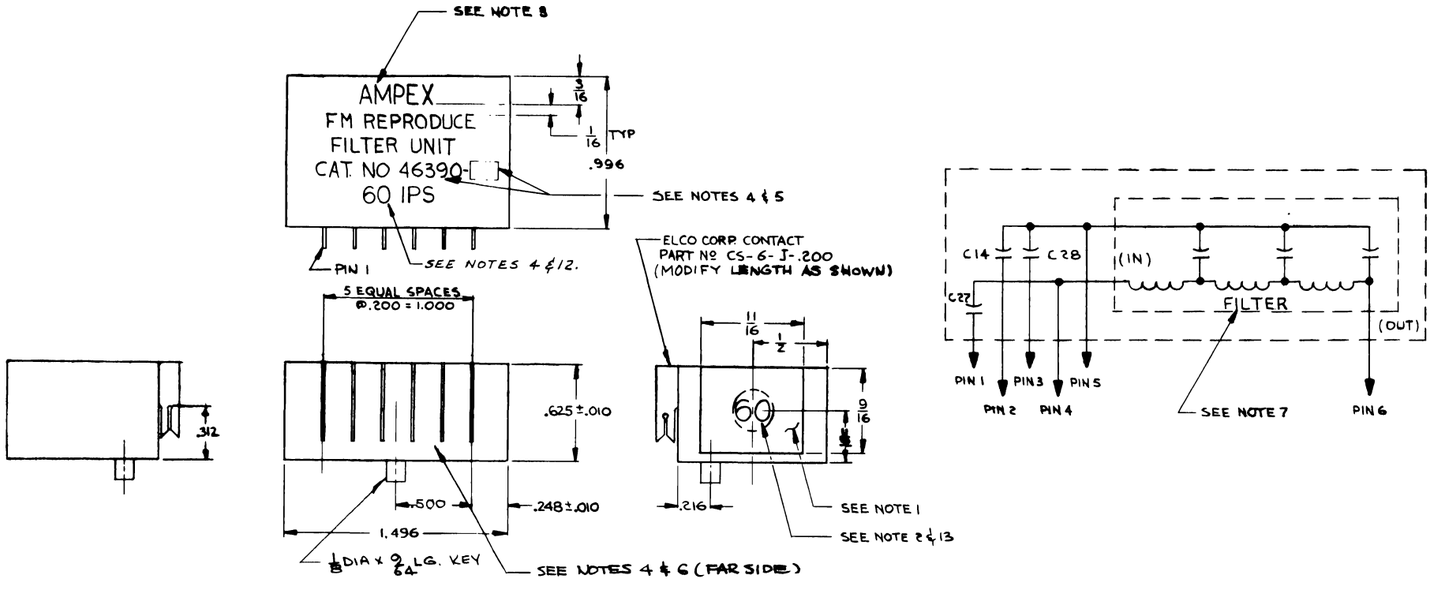


Fig. 1. ES-100 FM Reproduce Amplifier with Adjusting Tool 50689



NOTES:

1. COLOR THIS SURFACE PER TABLE I. CENTER 11/16 x 9/16 AREA WHERE SHOWN.
2. MARK TAPE SPEED CHARACTERS PER TABLE I. CHARACTERS TO BE 1/8 HIGH; FRACTIONS 3/32 HIGH. CHARACTERS TO BE WHITE, EXCEPT FOR -3 & -4 WHICH ARE TO BE BLACK. CENTER CHARACTERS AS SHOWN. MARK AS SHOWN.
3. MARK WITH 1/8 HIGH CHARACTERS WHERE SHOWN. COLOR TO BE WHITE.
4. MARK WITH 3/32 HIGH CHARACTERS WHERE SHOWN. COLOR TO BE WHITE.
5. CAT. NO. TO BE PER TABLE 2.
6. MARK MANUFACTURER'S PART Nº ON SURFACE INDICATED.
7. FOR FILTER SPECIFICATIONS SEE SHEET 2.
8. CAPACITORS TO BE PER AMPEX SPEC. B-49421.
9. FOR SUGGESTED SUPPLIERS SEE LV-46390
10. ELECTRICAL REQUIREMENTS OF CAPACITORS ARE NOT TO BE ALTERED BY THE MECHANICAL ENCLOSURE.
11. USED WITH CAT. Nº 46280-10 & 69108-10 (FM REPRODUCE AMPLIFIER).

RECORDER SYSTEM CARRIER FREQUENCY.

TABLE I

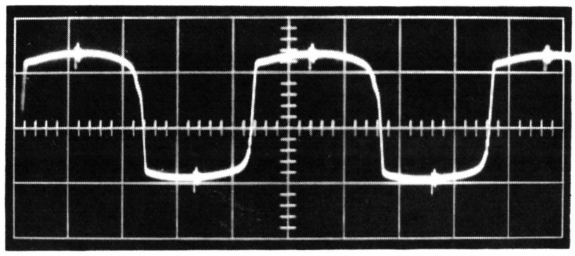
DASH Nº	AMPEX CAT. Nº	TAPE SPEED	SURFACE COLOR AND AMPEX SPEC. NO.	CAPACITOR VALUES (SEE NOTE 10) C27 (5%)	C14 (10%)	C28 (SEE NOTE 8)	FDU F.	BANDWIDTH.
-11	46390-11	60 I.P.S.	BROWN PER SPEC. NO. 13-183	.00015 UF	.001 UF	.000420 UF	108 K.C.	20 K.C.
-21	46390-21	30 I.P.S.	RED PER SPEC. Nº 13-138	.00033 UF	.002 UF	.000880 UF	54 K.C.	10 K.C.
-31	46390-31	15 I.P.S.	ORANGE PER SPEC. Nº 13-182	.00068 UF	.0039 UF	.00180 UF	27 K.C.	5 K.C.
-41	46390-41	7 1/2 I.P.S.	YELLOW PER SPEC. Nº 13-158	.0015 UF	.0082 UF	.00360 UF	13.5 K.C.	2.5 K.C.
-51	46390-51	3 3/4 I.P.S.	GREEN PER SPEC. Nº 13-137	.0027 UF	.016 UF	.00725 UF	6.75 K.C.	1.25 K.C.
-61	46390-61	1 7/8 I.P.S.	BLUE PER SPEC. Nº 13-139	.0047 UF	.033 UF	.0145 UF	3.375 K.C.	.625 K.C.

12. MARK TAPE SPEED CHARACTERS PER TABLE 1.
13. TAPE SPEED CHARACTERS MUST FIT WITHIN A 9/32 DIA CIRCLE.

Dwg. No. 69636A

Fig. 2 (Sheet 1 of 2). ES-100 FM Reproduce Low Pass Filter Schematic 50713

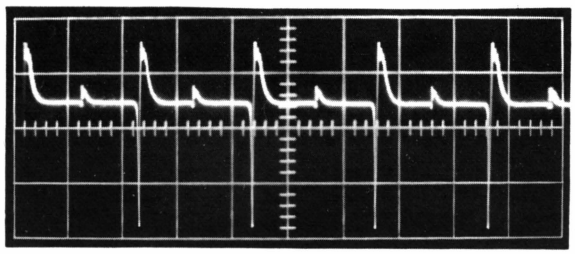
Typical Waveforms Taken From ES-100 FM Reproduce Amplifier



Waveform #1

LEGEND

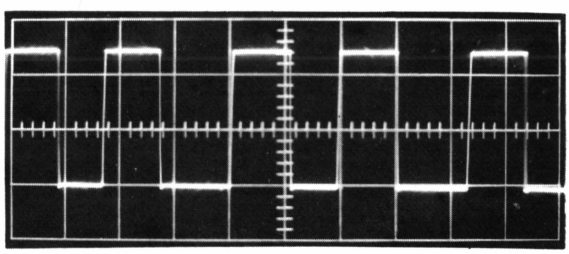
1. Waveform taken at test point J4.
2. 2 usec/cm, .5 volt/cm vert.



Waveform #2

LEGEND

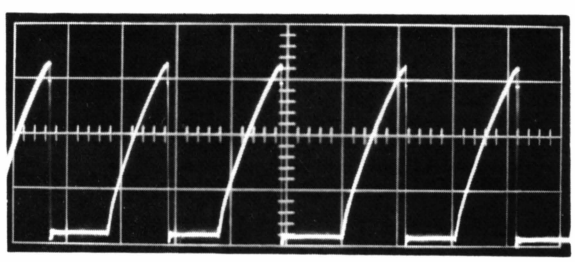
1. Waveform taken at diode CR9.
2. 2 usec/cm, 1 usec/cm vert.



Waveform #3

LEGEND

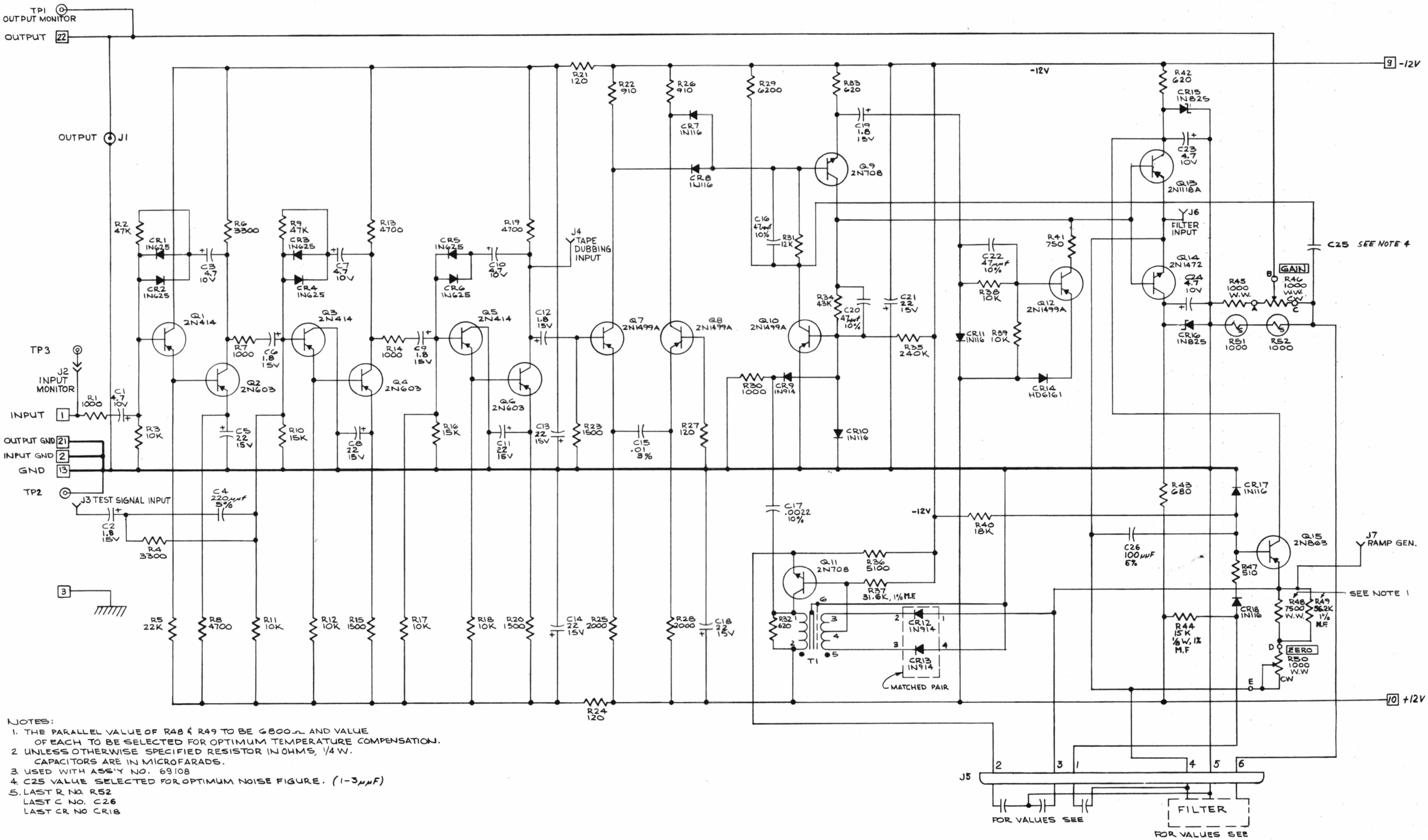
1. Waveform taken at test point J6.
2. 2 usec/cm, 5 volt/cm vert.



Waveform #4

LEGEND

1. Waveform taken at test point J7.
2. 2 usec/cm, 2 volts/cm vert.



NOTES:
1. THE PARALLEL VALUE OF R48 & R49 TO BE 6800Ω AND VALUE OF EACH TO BE SELECTED FOR OPTIMUM TEMPERATURE COMPENSATION.
2. UNLESS OTHERWISE SPECIFIED RESISTOR IN OHMS, 1/4 W. CAPACITORS ARE IN MICROFARADS.
3. USED WITH ASS'Y NO. 69108
4. C25 VALUE SELECTED FOR OPTIMUM NOISE FIGURE. (1-3 μμF)
5. LAST R NO. R52
   LAST C NO. C26
   LAST CR NO CR18

Dwg. No. 69284A

Fig. 2 (Sheet 2 of 2). ES-100 FM Reproduce Amplifier Schematic 50690

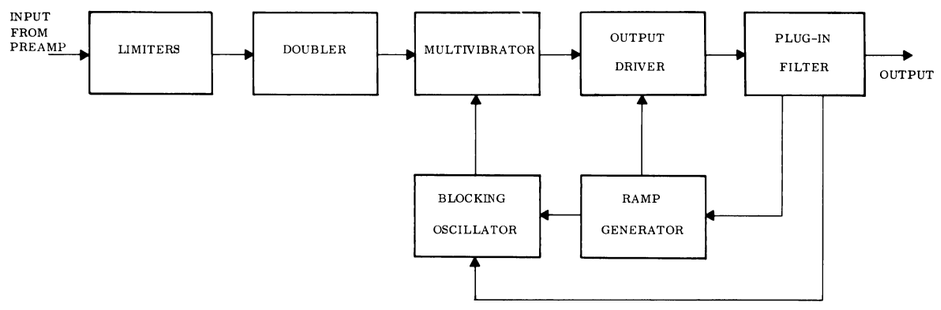


Fig. 3. ES-100 FM Reproduce Amplifier Block Diagram 50691

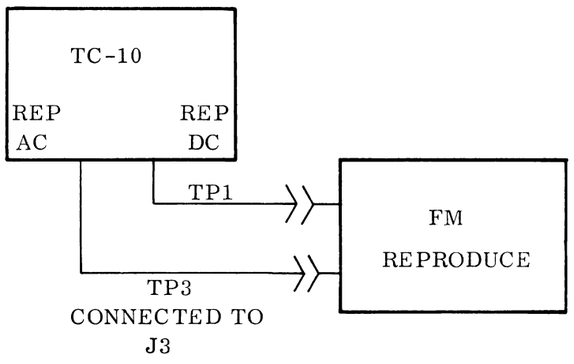


Fig. 4. ES-100 FM Reproduce Amplifier Test Set-Up Block Diagram Using Ampex FM Calibration Unit TC-10 50692

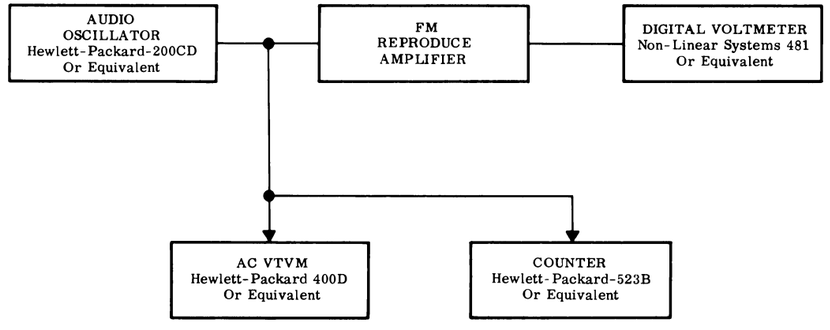


Fig. 5. ES-100 FM Reproduce Amplifier Test Set-Up Block Diagram Using Standard Laboratory Equipment 50715

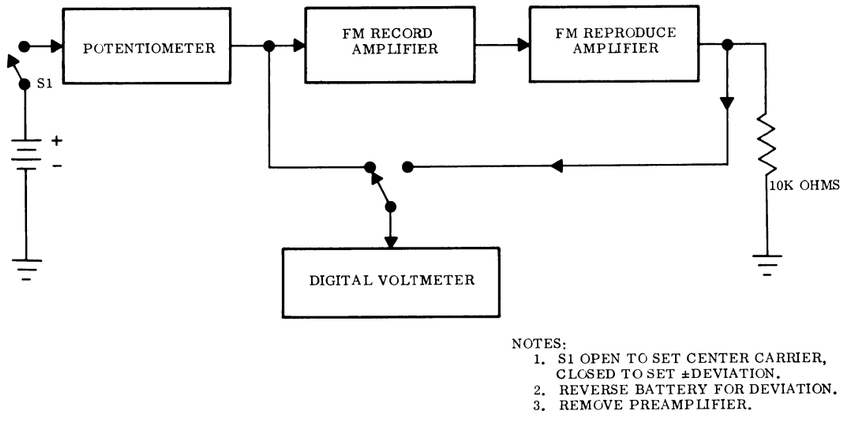


Fig. 6. ES-100 FM Reproduce Amplifier Test Set-Up Using Calibrated FM Record Amplifier 50716

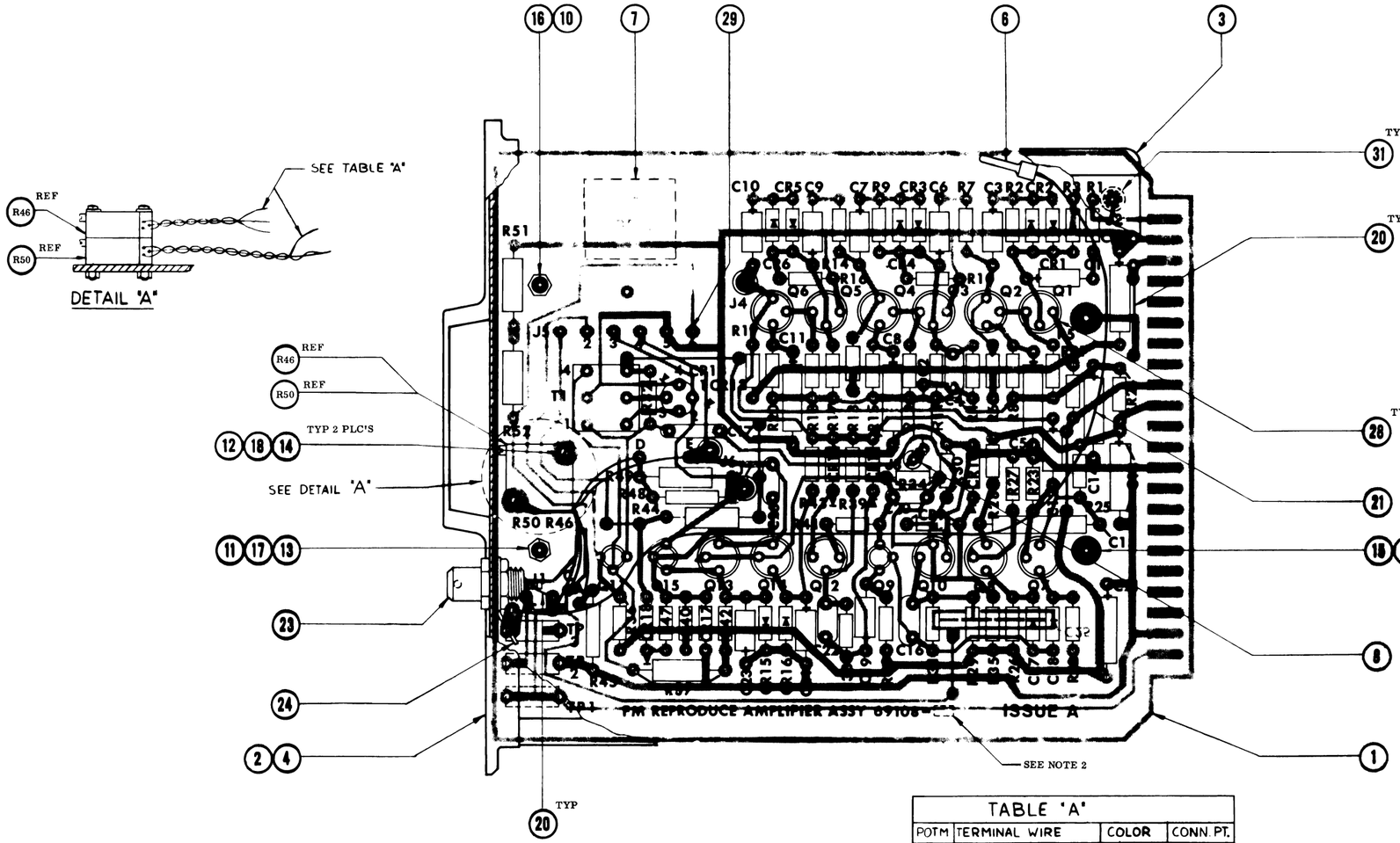


TABLE 'A'			
POTM	TERMINAL WIRE	COLOR	CONN. PT.
R46	LOW END		'D'
	WIPER		'E'
	HIGH END (CW)		'F'
R50	LOW END		'A'
	WIPER		'B'
	HIGH END (CW)		'C'

NOTES:
1. PART NO. TO BE: 69108-10, 69108-20.
2. INK STAMP DASH NUMBER, COLOR BLACK, LOCATION AS INDICATED ON DRAWING.
3. RESISTOR COLOR CODE SHALL READ FROM LEFT TO RIGHT AND BOTTOM TO TOP.
4. CAPACITOR AND DIODE POLARITY AS INDICATED.
5. DIP SOLDER CIRCUIT SIDE ONLY PER AMPEX SPEC. 21-10507.
6. SCHEMATIC REFERENCE: D-69284.
7. ADJ. RESISTORS, WAX COATED COMPONENTS AND ADJ. INDUCTORS NOT TO BE IMMERSED IN CLEANING SOLVENTS OR WATER.
8. COMPONENT LEADS AND SOLDER DROPS PROTRUDING FROM CIRCUIT SIDE OF P.C. BOARD TO BE LIMITED TO 1/16" HEIGHT ABOVE BASE MATERIAL.
9. ITEM 30 TO BE PACKAGED SEPARATELY FOR SHIPMENT.

Fig. 7. ES-100 FM Reproduce Amplifier Assembly Drawing 50693

ES-100 HEADS AND PREAMPLIFIERS

HEAD ASSEMBLIES

Description

Head Assemblies are available for both recording and reproducing (Fig. 1). Analog Head Assemblies are available in IRIG 7-track and 14-track staggered head stack configurations. In addition, AMPEX track configurations are available on special order. The head assemblies are operated within a frequency of 50 cycles to 300 Kc. When operating at 300 Kc in the direct reproduce mode, close azimuth alignment of the record and reproduce head gaps is required in all track configurations.

CAUTION

(1) The mounting base plate has a precision face which matches similarly finished surfaces on the tape transport mechanism. These faces, on both the head assembly and the tape transport, must be kept clean and free of grease, dirt, and other contamination. Care should be taken to avoid marring these surfaces, or orientation of the head may be affected.

(2) The individual head stacks are factory-aligned and should not be loosened from or moved on the precision mounting base. Should any head stack be moved inadvertently, return the entire assembly to the manufacturer for proper realignment.

The head assembly is electrically connected to the head cables in the tape transport mechanism through mating connectors.

REPRODUCE PREAMPLIFIER

General Description

The reproduce preamplifier is used to amplify the signal from the reproduce head before it is presented to the reproduce amplifier. The preamplifier does not incorporate equalization and therefore can be used for all reproducing techniques.

Two of these reproduce preamplifiers are assembled on a single printed circuit card (Fig. 2) which is inserted into the preamplifier housing. Power and grounding for the operation of the preamplifier is provided by the ±12-volt d-c power supply via a decoupling

network mounted in the preamplifier housing. The input signal to the preamplifier is taken directly from the reproduce head. This input signal varies between several microvolts and several millivolts, depending on the tape speed and frequency.

The preamplifier housing (Fig. 3) which is located at the rear of the tape transport mechanism is equipped with either 4 or 7 preamplifier circuit connectors (designated as J301 through J307), depending upon the size of the system. The harness wiring for the preamplifiers is shielded twisted pairs assembled into cables.

An additional circuit is carried through the preamplifier housing to permit utilization of the tape edge voice track systems designed to use this feature. A preamplifier is not used.

Circuit Description

The reproduce preamplifier (Fig. 4, schematic) is a three stage unit, utilizing a transistor, Q1, in a common collector configuration at the input, followed by two common emitter stages.

The incoming signal is applied to the base of the common collector stage Q1, which provides an impedance match between the reproduce head and the two stage feedback amplifier Q2 and Q3. Resistor R1, across the input to ground, is used to flatten the peak resulting from resonance of head inductance and head cable capacitance.

The output of Q1 is taken from the junction of R3 and R4 and is fed to the base of Q2, the first stage of the feedback amplifier. Transistor Q2 amplifies the signal and applies it to the base of the output transistor Q3. The feedback from the output of Q3 is returned through R10 and C4 to the emitter of Q2, with the feedback ratio determined by R10 and R7. The gain of the amplifier is held constant at 40 db ±2 db by the fixed value of R7.

The decoupling network (assembly No. 69243) prevents ripple that might be generated elsewhere in the system from entering the preamplifier. This network consists of storage capacitors C1 and C2, resistors R1 and R2 and diodes CR1 and CR2.

Adjustment

There is no adjustment on the reproduce preamplifier.

DEMAGNETIZATION OF HEADS

A high second-harmonic content in a reproduced signal usually indicates that a head contains residual magnetism. This condition is caused by heavy transients entering the record windings or large magnetic fields enveloping the head stack and therefore may occur in one track, several tracks or an entire band of tracks. To relieve this condition the heads must be removed from the tape transport and demagnetized.

There are several devices that can be used to demagnetize head assemblies. A convenient device is a bulk tape eraser of the open face type. A typical unit is the Ampex Model 111 demagnetizer which provides the additional advantage of having a plastic cover over the Electro magnet to safe guard against head damage. A satisfactory method for demagnetizing the heads using the above device is outlined in the following steps.

CAUTION

While performing the following demagnetizing procedure, extreme care should be taken to prevent the head assemblies from being pulled into the poles of the magnet. Allowing the heads to be pulled against the pole pieces of the magnet could result in serious damage to the head face and gaps.

Step 1. Remove the head assembly from the tape transport.

Step 2. Place a strip of pressure sensitive tape over the face of the head stack to prevent damage by bumping.

Step 3. Introduce the head assembly into the magnetic field of the electro magnet.

Step 4. Slowly withdraw the head assembly to a distance of several feet from the poles of the magnet.

Step 5. Replace the head assembly using tools demagnetized in a fashion similar to that described above.

TROUBLESHOOTING

If it becomes necessary to explore internal circuits, a troubleshooting assembly drawing is included (Fig. 5) which shows the components and the printed circuit on the amplifier card.

REPRODUCE PREAMPLIFIER HOUSING CATALOG NO. 69222-11(14 track) -21(7 track) -31(14 track)														
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.		PART DESCRIPTION	QUANTITY REQUIRES PER VERSION									
					10	20	30	40	50	60	70	80	90	
1	D69217-10			Pre-Amp Box Assy.	1	-	1							
2	D69217-30			Pre-Amp Box Assy.	-	1	-							
3	C69213-10			Cover, Pre-Amp Box	1	1	1							
4	C69220-10			Harness Assy.	2	-	2							
5	C69220-20			Harness Assy.	-	1	-							
6	C69221-10			Cable Assy.	2	-	2							
7	C69221-20			Cable Assy.	-	1	-							
8	C69218-11			Head Cable Box	1	1	1							
9	B15679-01			Cover, Head Cable Box	1	1	1							
10	B18916-01			Support Head Cable	2	2	2							
11	B18918-01			Cable Clamp	2	2	2							
12	B11751-01			Plate, Identification	1	1	1							
13	146-129			Connector, Female, Continent, SM20-20S, (or equivalent)	2	2	2							
14	471-075	MS-35208-31		Screw, Mach, 6-32 x 1 lg, Pan Hd, Phil., Cad. Plt.	2	2	2							
15	502-025	MS-35333-37		Washer, Lock, Int. Tooth, No. 6, Cad. Plt.	10	10	10							
16	493-002			Nut, Hex, Self Locking, No. 6, Nylon insert, Cad. Plt.	4	4	4							
17	471-067	MS-35208-23		Screw, Mach, 6-32 x 1/4 lg, Pan Hd, Phil, Cad. Plt.	8	8	8							
18	470-020	MS-35457-8		Screw, Cap, 6-32 x 1/2 lg, Hex. Soc. Hd, Cad. Plt.	2	2	2							
19	502-003	MS-35338-41		Washer, Spring Lock, No. 6, Cad. Plt.	2	2	2							
20	280-013			Spacer, 1/4 x 1/4 x 1	2	2	2							
21	069-243			Pre-Amp Filter Assy.	1	1	1							
22	471-060	MS-355208-12		Screw, 4-40 x 1/4 lg, Ph. Dr, Pan Hd, Cad. Plt.	4	4	4							
23	502-024	MS-35333-36		Washer, Lock, Int. Tooth, No. 4, Cad Plt	4	4	4							
24	611-556			Wire, 22 AWG, STRD, Ins, Per MIL-W-16878, Color 92 (as required)										
25	611-252			Wire, 22 AWG, STRD, Ins, Per MIL-W-16878, Color (as required)										
26	611-541			Wire, 22 AWG, STRD, Ins, Per MIL-W-16878, Color 97 (as required)										
27	502-013	MS-35333-29		Washer, Lock, Ext. Tooth, No. 4, Cad. Plt.	4	4	4							

REPRODUCE PREAMPLIFIER HOUSING CATALOG NO. 69222-11(14 track) -21(7 track) -31(14 track)

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
28	269-007		Rubber, Extrusion (as required)									
29	611-547		Wire, 22 AWG, STRD, Ins, Per MIL-W-16878, color 95 (as required)									
30	611-544		Wire, 22 AWG, STRD, Ins, Per MIL-W-16878, color 9 (as required)									
31	260-018		Grommet, Elastic	1	1	1						
32	501-008	MS-15795-204	Washer, Flat, No. 4, Cad. Plt.	4	4	4						
33	C69215-11		Base, Preamp Box	1	1	1						

DUAL ANALOG PREAMPLIFIER CATALOG NO. 69101-10

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION 10	20	30	40	50	60	70	80	90
			CAPACITORS									
C1	031-244		Fixed, Electrolytic, 50 uf, $^{-10}_{+100}$% tol, 3 vdc	2								
C2	030-057		Fixed, Ceramic, .01 uf, $^{-20}_{+80}$% tol, 50 vdc	2								
C3	031-400		Fixed, Electrolytic, 200 uf, +100% tol, 3 vdc	2								
C4	034-215		Fixed, Mica, 10 pf, 5% tol, 500 vdc	2								
C5	031-141		Fixed, Electrolytic, 10 uf, 15 vdc	2								
			TRANSISTORS									
Q1	91021-10		Germanium, PNP, (Selected) 2N522A	2								
Q2	014-029		Germanium, PNP, 2N414	2								
Q3	014-032		Germanium, PNP, 2N603	2								
			RESISTORS									
R1	041-409		Fixed, Carbon, 15k ohms, 5% tol, 1/4 watt	2								
R2	041-406		Fixed, Carbon, 22k ohms, 5% tol, 1/4 watt	2								
R3	041-412		Fixed, Carbon, 4700 ohms, 5% tol, 1/4 watt	2								
R4	041-415		Fixed, Carbon, 68k ohms, 5% tol, 1/4 watt	2								
R5	041-414		Fixed, Carbon, 2200 ohms, 5% tol, 1/4 watt	2								
R6	041-406		Same as R2	2								
R7	041-419		Fixed, Carbon, 100 ohms, 5% tol, 1/4 watt	2								
R8	041-408		Fixed, Carbon, 10k ohms, 5% tol, 1/4 watt	2								
R9	041-412		Same as R3	2								
R10	041-408		Same as R8	2								
			HARDWARE									
1	69274-10		Circuit Board, Printed Wiring	1								
2	52528-01		Handle	1								
3	280-030		Spacer, Transistor	6								
4	615-002		Wire, Bare, No. 22 AWG, Solid Copper Tinned (as required)									

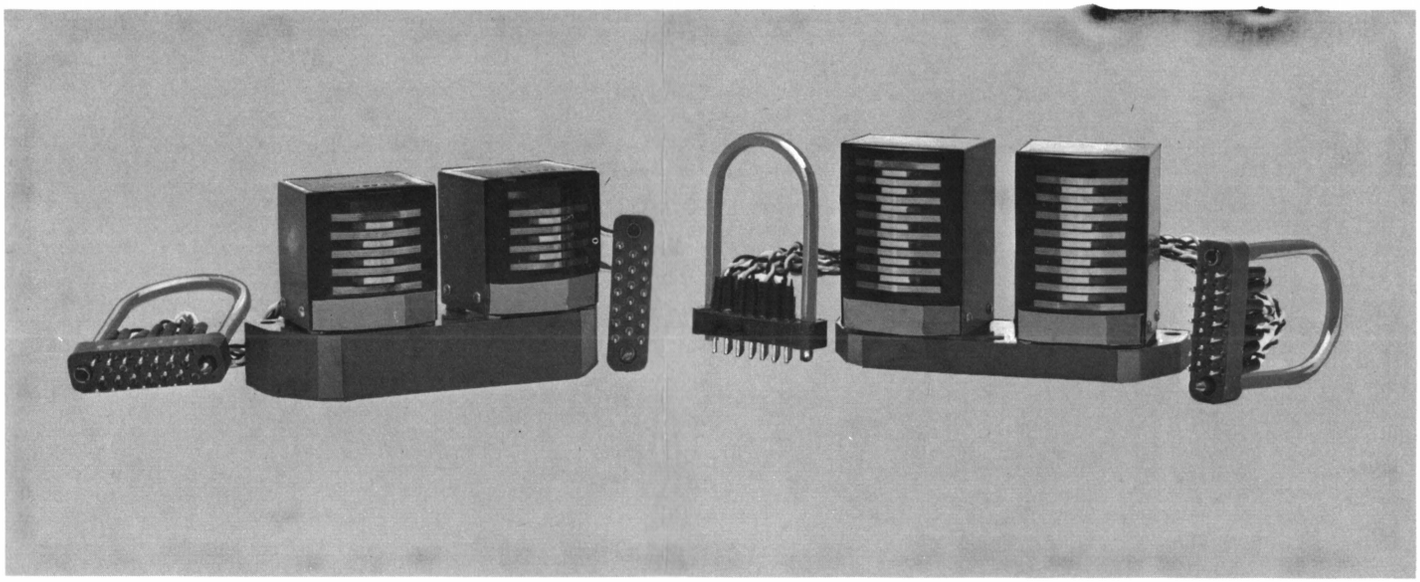


Fig. 1. Typical ES-100 Analog Head Assemblies (7 and 14 Track) 50694

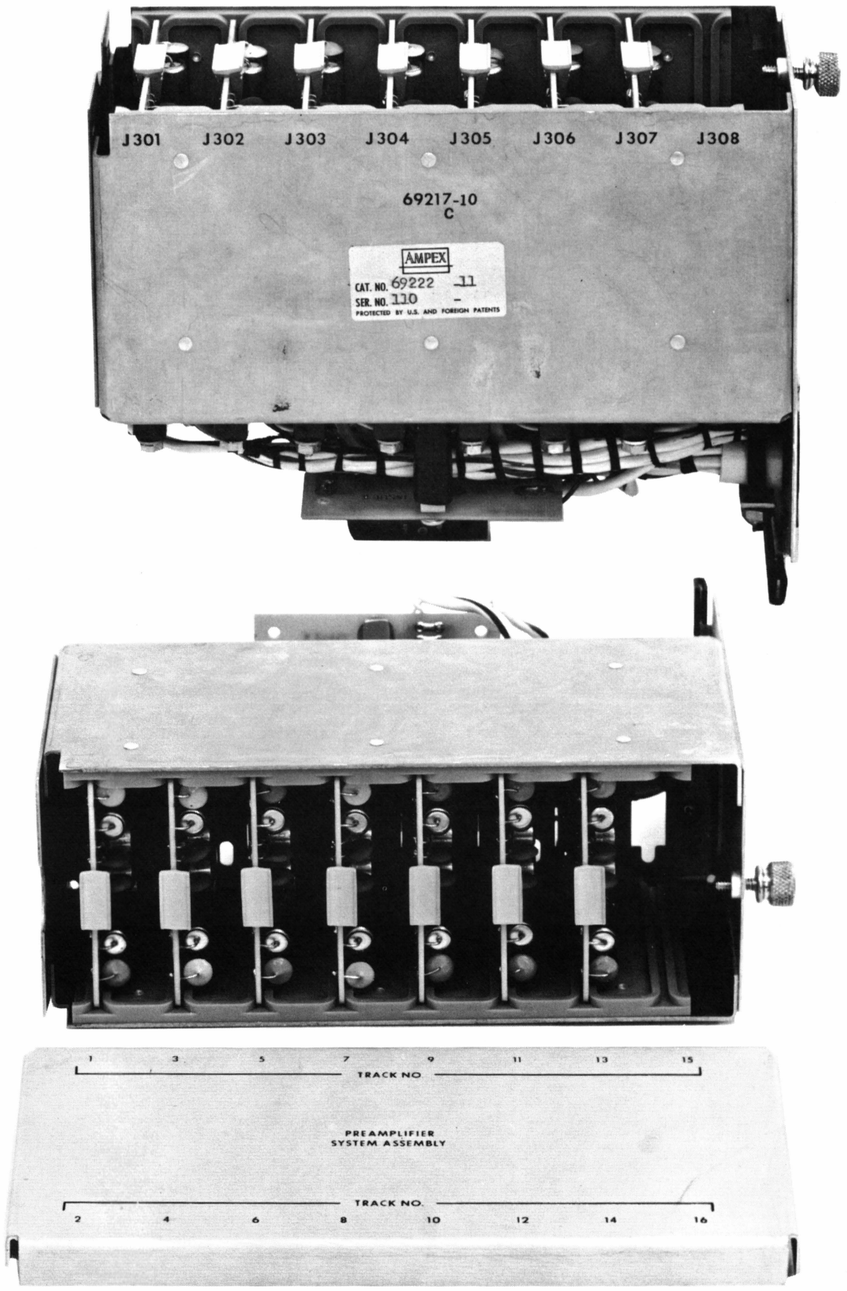


Fig. 2. ES-100 Reproduce Preamplifier 50695

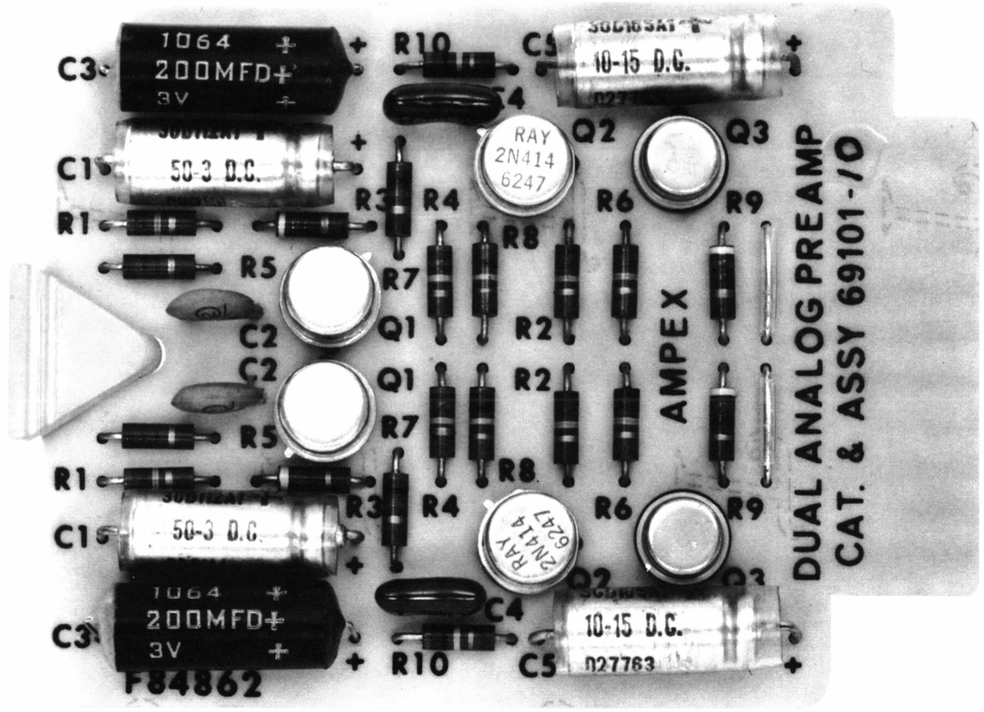
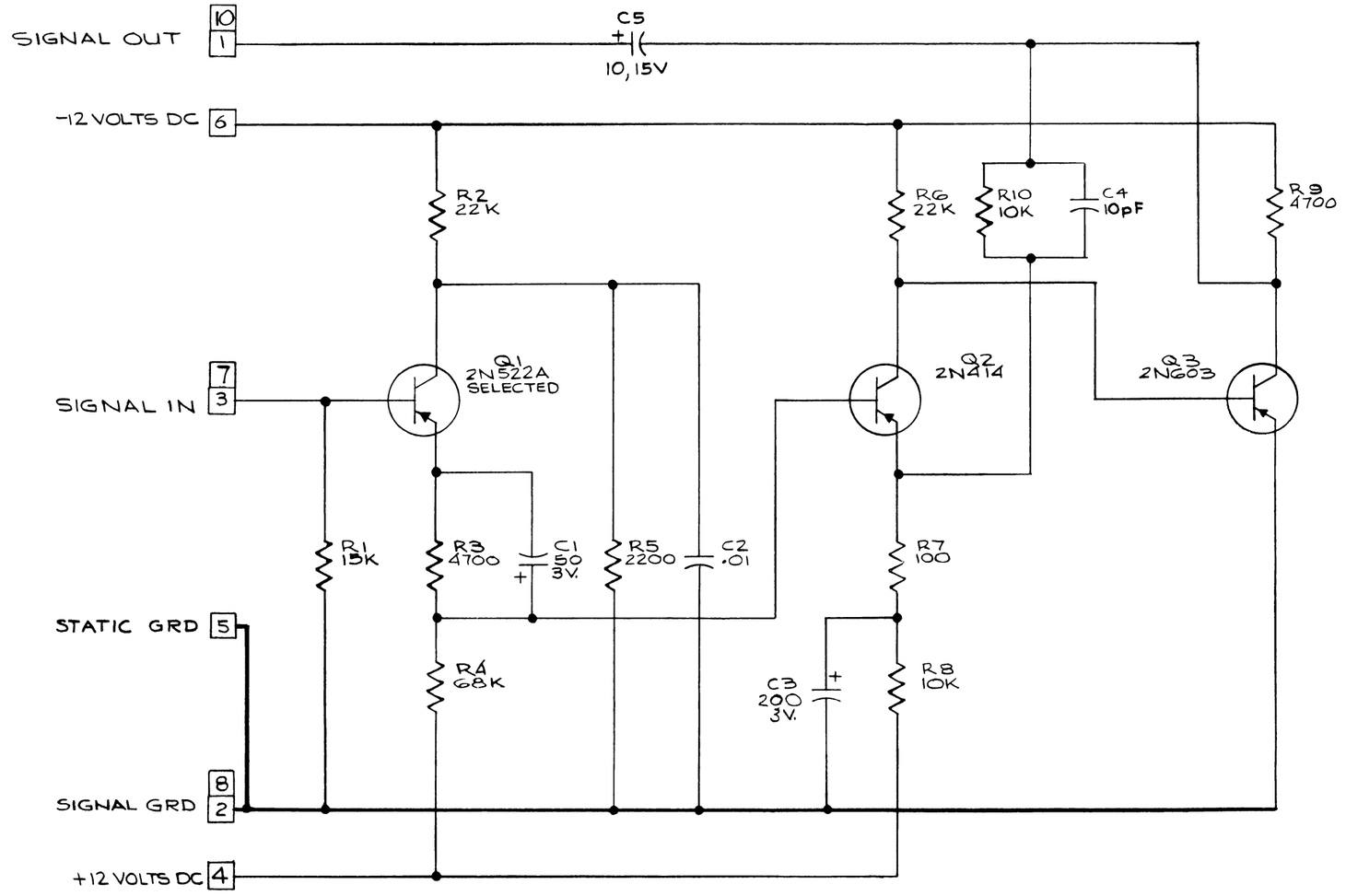


Fig. 3. ES-100 Reproduce Preamplifier Housing 50696

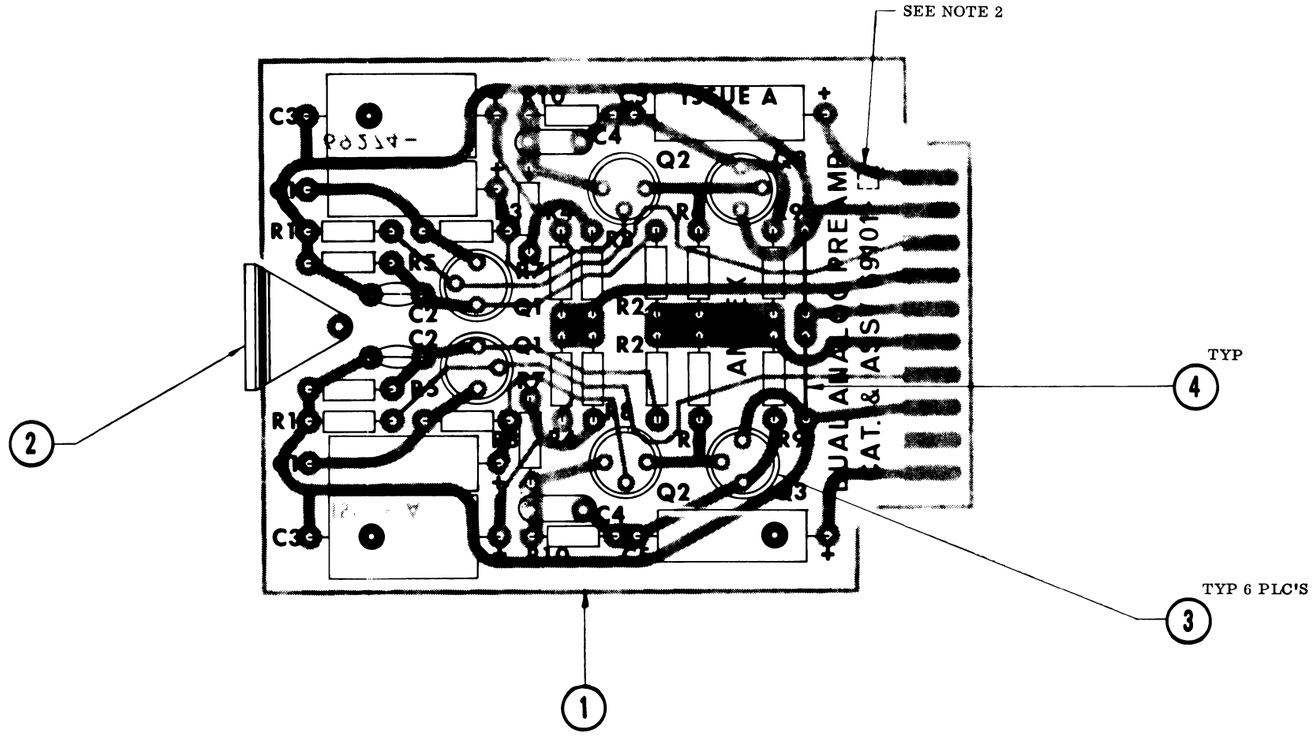


NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS, ¼W, 5%; ALL CAPACITORS ARE IN MICROFARADS.
2. USED WITH ASS'Y D-69101-10.
3. ASS'Y D-69101-10 CONTAINS TWO OF THESE CIRCUITS PER CARD. TERMINALS 4, 5, & 6 ARE COMMON TO BOTH CIRCUITS.

Dwg. No. 69273B

Fig. 4. ES-100 Dual Analog Reproduce Preamplifier Schematic 50697



NOTES:
1. PART NUMBER TO BE: 69101-10.
2. INK STAMP DASH NUMBER, COLOR BLACK, LOCATION AS INDICATED ON DRAWING.
3. RESISTOR COLOR CODE SHALL READ FROM LEFT TO RIGHT AND TOP TO BOTTOM.
4. CAPACITOR AND DIODE POLARITY AS INDICATED.
5. DIP SOLDER CIRCUIT SIDE ONLY PER AMPEX SPEC 21-10507.
6. SCHEMATIC REFERENCE: C-69273.

Fig. 5. ES-100 Dual Analog Reproduce Preamplifier Assembly Drawing 50698

ES-100 TRAY ASSEMBLY

The tray assembly is designed to mount into slide brackets (provided with each tray assembly) or in a fixed location on any standard 19 inch rack assembly. Two quarter-turn fasteners are used to lock the slide mounted tray in place. The design features of this tray are such that it can be pulled either straight forward or supported in the open position (Fig. 1). This feature allows access to the system components and cable connectors of the tray assembly from the front of the tape transport cabinet.

The tray provides a means of mounting and housing the ES-100 record/reproduce modules, dual power supply and associated system components. In addition, the tray also supplies all operating power and input and output signal connections for these modules.

Each tray assembly is capable of accommodating record and/or reproduce modules in either a "single speed" or multirange (automatically switched for 6 tape speeds) configuration and three auxiliary or service modules. The tray assembly may be divided into two basic configurations: a basic tray assembly and a system tray assembly which is modified by additional components to provide several modes of operation. Both tray assemblies will be discussed individually in subsequent paragraphs.

BASIC TRAY

The basic tray (Fig. 2) consists of a card file, a signal harness, and a power and control harness, all of which are mounted on a welded tray assembly. The individual tray components will be discussed as follows:

Card File

The card file serves as a housing for the record/reproduce modules. Contained within the file (Fig. 3) is a 17-slot module guide which positions and supports individual modules. A connector array which is part of the signal harness, slides into a channel at the rear of the card file and supplies power, input and output connections, and signal grounding for the modules.

Signal Harness

The signal harness provides the necessary input and output connections and grounding system for the ES-100 modules. It is comprised of a module connector array, a signal connector panel, a grounding system, and preamplifier and record head connectors, all of which are interconnected by the harness wiring. The connector array is a printed circuit card on which all signal, power and grounding connections for the record/reproduce modules are made. Power and control connections are made through a connector at the end of the connector array. The connector panel is an insulated mounting board located at the rear of the tray assembly; it contains all the input and output signal connectors required for a system operation. The grounding system provides a central ground for the ES-100 record/reproduce system. The grounding is made through the connector array to a terminal strip which can be grounded to the metal tray assembly or to the users sytem ground. The connections to the preamplifier and record/reproduce heads are made through connectors J5 and J6.

There are two types of signal harnesses; one is used for single speed operation and the other for multirange operation (automatically switched for 6 tape speeds). These two harnesses differ only in the number of their signal wiring connections. The signal connections necessary for individual modes of operation are discussed in the system tray description.

Power Harness

The power and control harness serves as an interconnection between the power and control input, power supply and the connector array on the card file. It also supplies power to the preamplifier connectors. The harness is comprised of a flag type etched circuit connector, a power supply output connector, a power input receptacle, and interconnecting wiring. The flag connector connects the harness to the end of the connector array. The power supply output connector mates with a female connector on the power supply or with female jumper plug assembly. The female jumper assembly is mounted at the rear of the tray, and is used when a power supply is not installed in the tray. The power and control input receptacle is mounted at the rear of the tray and connects to an external a-c power and control cable. A fuse located directly below the input receptacle provides overload protection for the a-c power circuitry.

SYSTEM TRAY

The system tray assembly (Fig. 3) contains the additional ES-100 components necessary for a given mode of system operation. A typical tray assembly consists of a power supply or power distribution kit, a cooling fan, record relay, record/reproduce modules and a nomenclature strip, all of which are mounted on a basic tray assembly. The installation of the individual components and their associated sub-components are discussed separately in the subsequent paragraphs.

Power Supply and Power Distribution Kit

Operating power for the tray assembly is supplied by a dual power supply, which is mounted near the rear of the tray. A-c operating power for the power supply is connected to J1 through a jumper cable assembly (Catalog No. 69245) which is inserted into an a-c distribution block (Fig. 3). The distribution block is mounted on the side of the tray adjacent to the power supply. Power to the block is supplied through the power and control harness.

The power supply is capable of supplying power to several trays simultaneously, through a power distribution kit (Catalog No. 69119, Fig. 4). The kit consists of a female jumper plug assembly (Catalog No. 69675) and inter-tray connection cable 69193. The female jumper plug is mounted at the rear of the tray assembly in the vacant power supply location and is mated with the plug-in connector of the power and control harness. The inter-tray connecting cable provides a means of distributing control power between tray assemblies. The cable is routed through the power receptacle J4 to the female jumper plug assemblies, and power supply.

Cooling Fan

A cooling fan (Fig. 5) is required whenever a power supply is to be installed in a tray assembly. The fan is mounted at one side of the tray assembly, adjacent to the power supply, to provide cooling air for that unit. Part of this air is continuously recirculated through air vents located in the fan shroud. An electrostatic air filter mounted in the inlet fan-port prevents foreign particles from entering the tray and provides an access for exchange air drawn from the outside.

The operating power for the fan is supplied through the fan harness wiring which is connected to the a-c distribution block. To prevent a-c magnetic field spray from introducing noise into the system, the fan motor is provided with a magnetic shielding.

A cover plate is provided for covering the fan-port when a fan is not installed in a tray.

Record Relay

A record relay is installed in a tray assembly whenever a system is to be used in the record mode. It is mounted on a bracket attached to one side of the tray assembly and is adjacent to the a-c distribution block. The relay is energized by the record function switch of the associated tape transport. Energizing the relay causes operating current to be applied to record amplifier output stages and bias oscillators. This operating current is received from the power supply output connector and is applied to the connector array through the flag connector P217.

Record/Reproduce Modules

The record and reproduce modules are inserted into the card file of the tray assembly. The input and output signal connections for the modules are made at the connector panel located on the rear of the tray assembly or at the front panel of each module. A correct signal connection for a given module is made by comparing the jack numbers on the connector panel with those given at the connector array on the inside of the card file (Fig. 6). (The last two digits of the jack numbers on the connector panel should coincide with the last two digits of those inside the card file.)

Amplifier modules for direct or FM modes of operation can be interchanged or intermixed in a given system, without modification of the system. The various modes in which they can be operated in a single tray are given in the following table.

System Mode	No. of Channels	Tape Speed
Record, Direct or FM	1 thru 14	single speed (manual speed change)
Reproduce, Direct or FM	1 thru 14	single speed (manual speed change)
Record and Reproduce	1 thru 7	single speed (manual speed change)
Direct Record	1 thru 14	single speed or six speed
FM Record	1 thru 7	six speed (multirange)*
Direct Reproduce	1 thru 7	six speed (multirange)*
FM Reproduce	1 thru 7	six speed (multirange)*

*Multirange - automatically switched for six speeds.

Nomenclature Strip

The nomenclature strip describes the function and channel for which a tray has been selected. In addition, the strip gives the necessary information for introducing an amplifier into the system for which the tray has been organized.

PERIODIC MAINTENANCE

The following maintenance procedures must be performed whenever the cooling fan and air filter are installed in a tray assembly.

1. Add 1 or 2 drops of instrument oil (3 in 1 oil or equivalent) after every 500 hours of continuous operation. This procedure can be performed at six month intervals, if the fan is not run continuously.

NOTE

Some earlier model fan motors were of the self lubricating type and therefore do not require periodic lubrication.

2. Clean the air filter every 30 days as follows:

   (a) Remove the filter by pressing fingers lightly against the screen and lift up gently.

   (b) Remove the dust from the filter, and wash thoroughly with a solution of warm water and household detergent.

   (c) Thoroughly rinse and dry the filter before replacement.

NOTE

This is an electrostatic filter and therefore should not be sprayed with oil.

TRAY ASSEMBLY SYSTEM SERVICING

DISTRIBUTION CONNECTOR BLOCK

Insertion and Extraction of Contacts. The contacts for the connector block are of the poke-home type which do not require insertion or extraction tools.

Installation of Contacts. Contacts can be installed by using either a solder-on contact method or a crimp-on type method, both of which are discussed as follows.

Solder-On Contact Method. This method is accomplished by using standard soldering techniques and is recommended for replacement of contacts in the field.

Crimping Method. This method is accomplished by using the following special tool:

a. Burndy installation tool - Cat. No. M8ND - with Dieset Cat. No. N20PCT2.

FLAG CONNECTOR

Insertion and Extraction. The contacts of the connector are of the poke-home type and do not require an insertion tool. The contacts can be extracted from the connector body with the following extraction tool:

a. Contact extraction tool - Amp, Inc. Cat. No. 810992.

Installation of Contacts. Contacts can be installed by using either a solder-on contact method or a crimp-on type method as follows:

Solder-On Contact Method. This method is accomplished by using standard soldering techniques and is recommended for replacement of contacts in the field.

Crimping Method. This method is used for installing standard production contacts. The special tool named below is required when using the crimping method.

a. Hand crimping tool - Amp, Inc. Cat. No. 90027.

POWER SUPPLY A-C INPUT CONNECTOR

Insertion and Extraction. The contacts to the connector are of the poke-home type which do not require special insertion or extraction tools. These contacts can be removed by inserting a narrow bladed screwdriver behind the contact and lifting up on the barbed edge. These contacts are identified by the following number.

a. Amp, Inc. Cat. No. 42641-1 (Ampex 169-019).

Installation of Contacts. The contacts are installed by using standard soldering techniques.

POWER AND CONTROL INPUT AND OUTPUT CONNECTORS

Insertion and Extraction of Contacts. Contacts can be removed or installed with the use of the following tools:

a. Contact insertion tool - Winchester Cat. No. 107-1015.

b. Contact removal tool - Winchester Cat. No. 107-1015.

Installation of Contacts. Contacts can be installed by using either a solder-on contact method or crimp-on type method, both of which are discussed as follows.

Solder-On Contact Method. The replacement of contacts using this method is accomplished by using standard soldering techniques, with the following solder-on contacts:

a. Pin - Winchester No. 100-2514p (Ampex Part No. 169-278).

b. Socket - Winchester No. 100-2514s (Ampex Part No. 169-279).

Crimping Method. This method is used to install standard production contacts. The following special tool is required for this method:

SYSTEM TRAY, RECORD/REPRODUCE CATALOG NO. 69572-10

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
1	E-69104-10		Basic Tray, Assy.	1								
2	D-69121-10		Power Supply	1								
3	D-69122-10		Record Relay Assy.	1								
4	D-69600-10		Fan Assy.	1								
5	D-69599-10		Label, Record/Reproduce	1								
6	921-999		Cable Clamp	1								
7	471-080		Screw #8-32 NC-2A x 1/2, Phil. Pan Hd.	4								
8	471-327		Screw #4-40 NC-2A x 5/16 Phil. Fl. Hd.	1								
9	471-337		Screw #6-32 NC-2A x 7/16 Phil. Fl. Hd.	4								
10	496-001		Nut, #8-32 NC-2B KEPS	4								
11	496-004		Nut, #4-40 NC-2B KEPS	1								
12	496-005		Nut, #6-32 NC-2B KEPS	4								
13	501-008		Washer, Flat, #4	1								
14	C-24092-10		Label, Catalog	1								

SYSTEM TRAY, RECORD CATALOG NO. 69570-10 (Sgle. Speed 1-14 Track) -20 (Sgle. Speed 1-14 Track) -30 (6 Speed 1-7 Track) -40 (6 Speed 1-7 Track) -50 (6 Speed 8-14 Track)

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
1	E-69104-10		Basic Tray, Assy.	1	1	1	1	1				
2	D-69121-10		Power Supply	1	-	1	-	-				
3	D-69122-10		Record Relay Assy.	1	1	1	1	-				
4	LM-69600-10		Power Accessory Kit	1	-	1	-	-				
5	LM-69119		Power Distribution Kit	-	1	-	1	1				
6	D-69599-40		Label, Record	1	1	-	-	-				
7	D-69599-50		Label, Record	-	-	1	1	-				
8	D-69599-60		Label, Record	-	-	-	-	1				
9	C-24092-20		Label, Catalog	1	-	1	-	-				
10	C-24092-30		Label, Catalog	-	1	-	1	1				
11	471-080		Screw #8-32 NC-2A x 1/2, Stl. Cad. Plt. Phillips Pan Hd.	4	4	4	4	4				
12	471-327		Screw #4-40 NC-2A x 5/16, Phil. Fl. Hd.	1	1	1	1	1				
13	471-337		Screw #6-32 NC-2A x 7/16, Phil. Fl. Hd.	4	4	4	4	4				
14	496-001		Nut #8-32 NC-2B KEPS	4	4	4	4	4				
15	496-004		Nut #4-40 NC-2B KEPS	1	1	1	1	-				
16	496-005		Nut #6-32 NC-2B KEPS	4	4	4	4	4				
17	501-008		Washer, Flat #4	1	1	1	1	-				
18	921-999		Clamp, Cable	1	-	1	-	-				

AMPEX

SYSTEM TRAY, REPRODUCE CATALOG NO. 69571-10 (Sgle. Speed 1-14 Track) -20 (Sgle. Speed 1-14 Track) -30 (6 Speed 1-7 Track) -40 (6 Speed 1-7 Track) -50 (6 Speed 8-14 Track)

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
1	69104-10		Tray, Sub Assy.	1	1	1	1	1				
2	69121-10		Power Supply	1	-	1	-	1				
3	69600-10		Power Accessory Kit	1	-	1	-	1				
4	69119		Power Distribution Kit	-	1	-	1	-				
5	69599-20		Label, Reproduce	1	1	-	-	-				
6	69599-30		Label, Reproduce	-	-	1	1	-				
7	69599-70		Label, Reproduce	-	-	-	-	1				
8	24092-20		Label, Catalog	1	-	1	-	1				
9	24092-30		Label, Catalog	-	1	-	1	-				
10	921-999		Clamp, Cable	1	-	1	-	1				
11	471-080		Screw #8-32 NC-2A x 1/2, Phil. Pan Hd.	4	4	4	4	4				
12	471-337		Screw #6-32 NC-2A x 7/16, Phil. Fl. Hd.	4	4	4	4	4				
13	496-001		Nut #8-32 KEPS	4	4	4	4	4				
14	496-005		Nut #6-32 KEPS	4	4	4	4	4				

BASIC TRAY ASSEMBLY CATALOG NO. 69104-10 & 20												
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
1	D-69170-10		Card File Assy	1	1							
2	D-69185-10		Connector Array Harness Assy	1	-							
3	D-69597-10		Tray, Welded Assy	1	1							
4	D-69172-10		Guide, Module	2	2							
5	D-69172-20		Guide, Module	2	2							
6	C-69594-10		Cover	2	2							
7	085-001		Post, Fuse	1	1							
8	145-173		Connector Body	1	1							
9	169-119		Connector Block	2	2							
10	169-120		Conn. End Clamp Assy	2	2							
11	169-128		Receptacle Shell, Polarized	1	1							
12	921-999		Clamp, Cable, T & B TY-RAP	5	5							
13	310-088		Fastener Study Assy, Camloc 28S28-7 or equivalent	2	2							
14	310-090		Washer, Camloc 28S10-1 or equivalent	2	2							
15	435-051		Spring, U Clip, Tinnerman C22503-014-24 or equivalent	2	5							
16	471-069		Screw, #6-32 NC-2A x 3/8, Stl. Cad. Plt. Phillips Pan Hd.	9	9							
17	471-334		Screw, #6-32 NC-2A x 1/4, Stl. Cad. Plt. Phillips Fl. Hd.	8	8							
18	471-327		Screw, #4-40 NC-2A x 5/16	4	4							
19	D-69151-10		Bracket, Rack Mtg. (see Note 4)	2	2							
20	496-005		Nut, KEPS, #6-32 NC-2B, Stl. Cad. Plt., Shake Proof or equivalent	17	17							
21	497-026		Speednut #4-40 NC-2B, Tinnerman C-871-012-24 or equivalent	4	4							
22	497-040		Fastener, Push On, Stl. Cad. Plt., Tinnerman C-871-012-24 or equivalent	4	4							
23	180-141		Terminal Strip	1	1							
24	180-142		Terminal Strip, Shorting Jumper	1	1							
25	171-001		Space Lug #6 (Crimp Type)	3	3							
26	611-162		Wire #16 AWG, Type B, Black	AS REQ	AS REQ							
27	502-014		Lockwasher, #6 External Tooth	3	3							
28	492-009		Nut, Hex, #6-32	3	3							
29	501-009		Flat Washer #6	2	2							
30	471-072		Screw #6-32 x 5/8 lg, Pan, Phil. Stl. Cad.	2	2							
31	D-69185-20		Connector Array Harness Assy	-	1							
32	D-69123-1		Power Harness Assy	1	1							

BASIC TRAY ASSEMBLY CATALOG NO. 69104-10 & 20

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
33	D-69235-10		Nomenclature Bar	1	1							
34	471-451		Screw #12-24 NC-2A x 1/2, Phillips Pan Hd.	4	4							
35	471-089		Screw #10-32 NF-2A x 1/2, Phillips Pan Hd.	4	4							
36	476-003		Screw #4-40 x 1/4, Self Tapping - Slot Pan Hd.	5	5							
37	471-845		Screw #4-40 x 1/4, Truss Hd.	9	9							
38	D-69181-10		Cover, Top	1	1							
39	070-001		Fuse, 3AG, 3 Amp, Fast Blow	1	1							

FAN ASSEMBLY CATALOG NO'S. 69635-10 (For Earlier Models) OR 69691-10

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION						
				69635-10	69691-10	50	60	70	80	90
1	69602-10		Bracket, Fan	1	1					
2	69596-10		Bracket, Motor	2	-					
2	69668-10		Bracket, Motor	-	2					
3	69160-10		Harness, Fan	1	1					
4	69670-10		Shield, Motor	-	1					
5	591-048		Motor, 115 Volt AC, 50/60 CPS, EAD	1	-					
5	69690-10		Motor, 115 Volt AC, 50/60 CPS	-	1					
6	591-047		Fan	1	-					
6	69634-10		Fan	-	1					
7	035-218		Capacitor, Mylar, 1 uf, 10% tol; 400 vdc	1	-					
7	031-280		Capacitor, Electrolytic, 2 uf, +100 -10 % tol; 450 vdc	-	1					
8	471-075		Screw, #6-32 x 1, Pan Hd., Phil. Dr., Stl. Cad. Plt.		2					
9	471-061		Screw, #4-40 x 5/16, Pan Hd., Phil. Dr., Stl. Cad. Plt.	4	4					
10	475-037		Screw, SEMS #8-32 x 1/4, Pan Hd., Slotted Dr., Ext. Tooth, Stl. Cad. Plt.	4	-					
11	496-005		Nut, KEP, #6-32, Stl. Cad. Plt.		2					
12	496-004		Nut, KEP, #4-40, Stl. Cad. Plt.	4	4					
13	173-113		Terminal, Insulated, Feed Thru	2	2					
14	173-114		Terminal, Insulated, Stand-Off	1	1					
15	501-002		Washer, Flat, Brass		4					

AMPEX

POWER ACCESSORY KIT CATALOG NO. 69600
POWER DISTRIBUTION KIT CATALOG NO. 69119

ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			POWER ACCESSORY KIT									
1	69635-11		Fan, Assy (earlier models)	1								
2	69691		Fan, Assy	1								
3	69595		Spacer, Fan	1								
4	24003		Filter, Air	1								
5	69630-10		Test Tip Plug, Electronics - Red	1								
6	69630-20		Test Tip Plug, Electronics - Black	1								
7	69630-30		Test Tip Plug, Electronics - Green	1								
			POWER DISTRIBUTION KIT									
1	69193		Cable, Tray Interconnection	1								
2	69601		Cover, Fan Port	1								
3	69575		Plug, Jumper Assy	1								

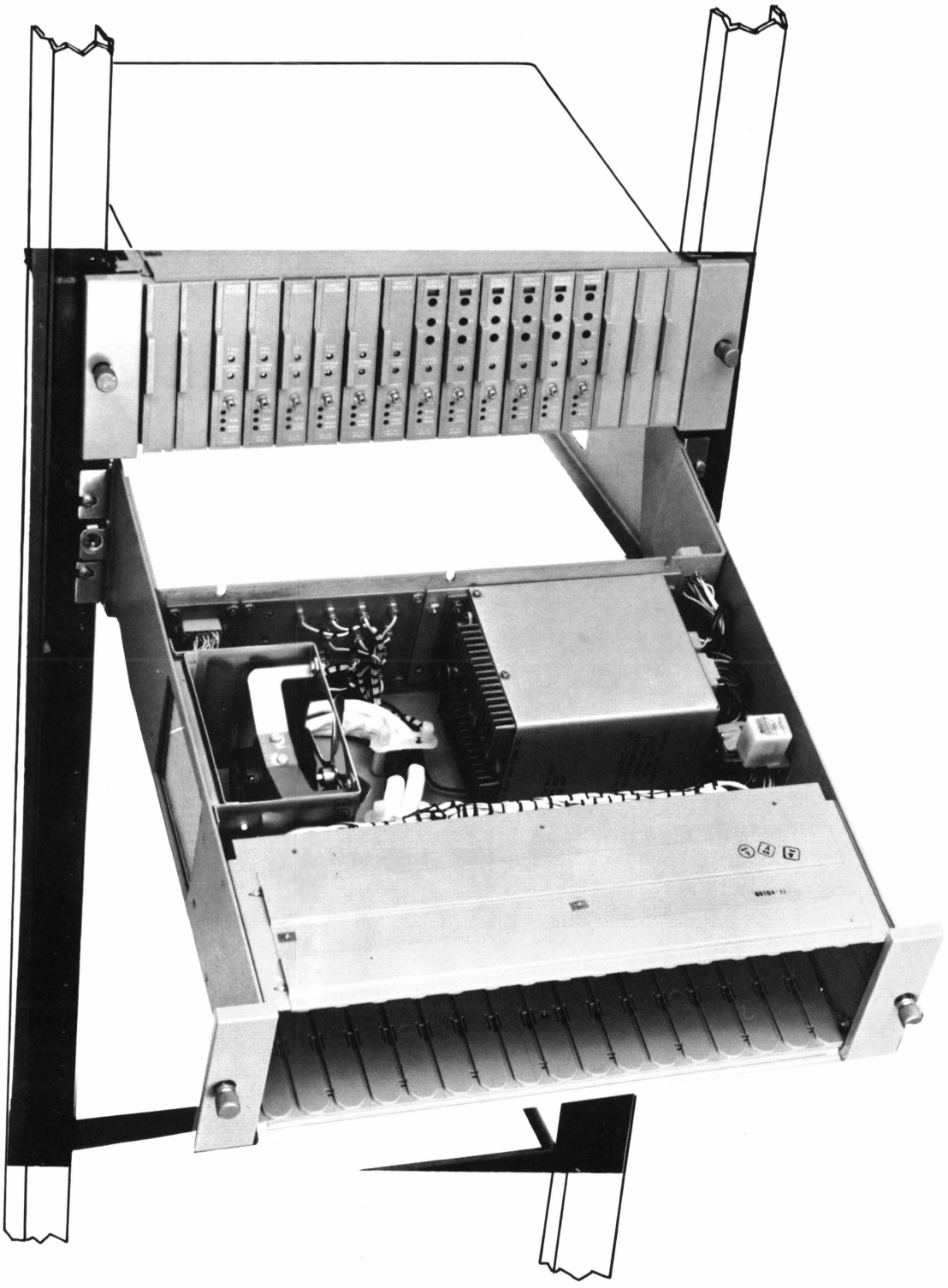


Fig. 1. ES-100 Tray In the Servicing Position 50699

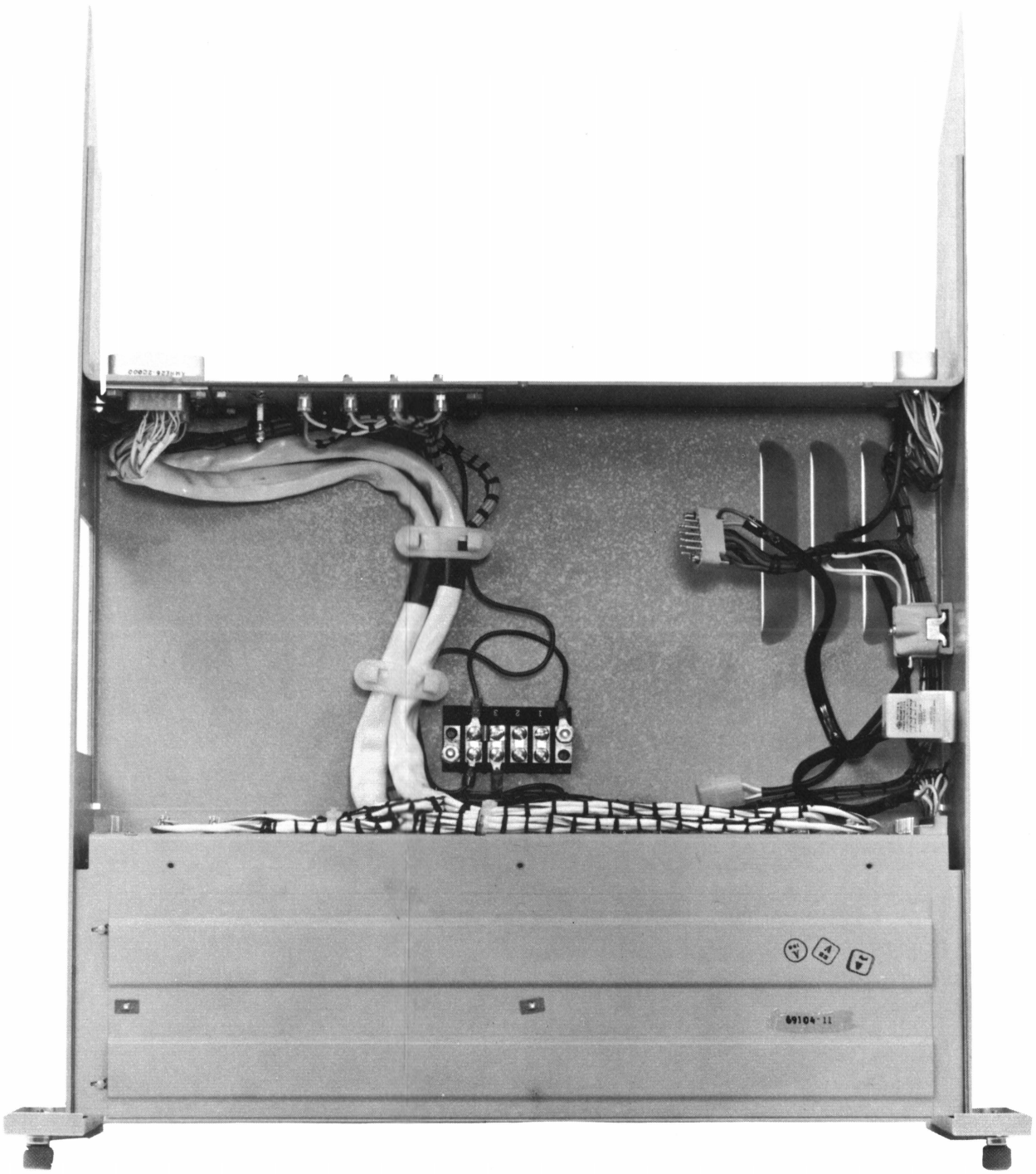


Fig. 2. ES-100 Basic Tray 50700

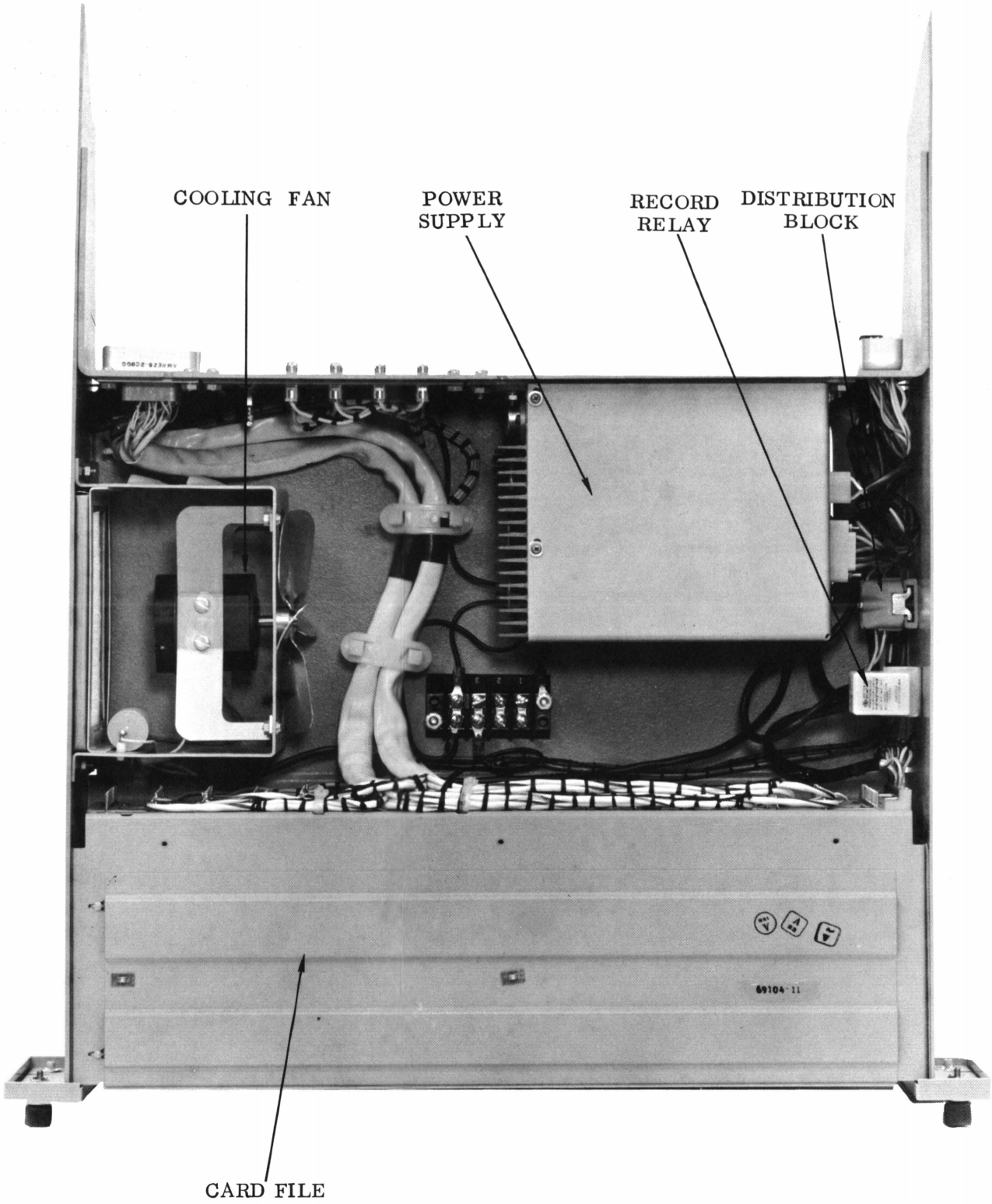


Fig. 3. ES-100 System Tray 50701

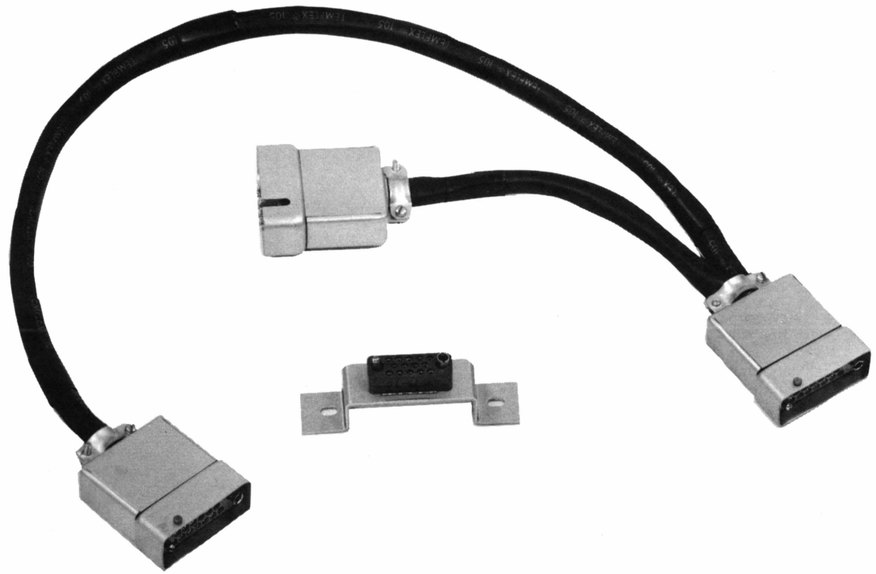


Fig. 4. ES-100 Power Distribution Kit 50702

Fig. 5. ES-100 System Tray Cooling Fan 50703

ES-100 DUAL POWER SUPPLY

DESCRIPTION

The dual power supply (Fig. 1) provides a regulated +12 volts and -12 volts power source (reference to the same common). The maximum operating current between the +12 volt and -12 volt terminals in 2.5 amperes, and the maximum unbalance current between the +12 volt and -12 volt terminals, with respect to the common terminal, is 1.25 amperes. An automatic protection circuit is provided to limit the output whenever the load demands more than 3 amperes.

THEORY OF OPERATION

The power supply consists of two basic sections: a 24 volt regulator and a voltage divider and regulator. The schematic is shown in Fig. 2 and a block diagram of the power supply system is shown in Fig. 3.

Voltage Regulator

The 24 volt regulator section is comprised of the following components: power transformer T1; full wave rectifiers, CR1-CR2 and CR4-CR5; half wave rectifier CR3; series regulator transistors Q1-Q2; emitter follower transistors Q3-Q4; current overload detector transistor Q5; the error detecting differential amplifier transistors Q6-Q7; and the voltage reference CR6. The line voltage is connected to the primary winding of the power transformer at pin 1 and pin 3 of the connector J1. A thermal switch, S1, is connected in series with the primary winding. This thermal switch, set to open at +75° centigrade, is mounted on the power transistor heat sink, and serves as a protection device for the series regulator transistors Q1-Q2, by opening the supply circuit at the maximum safe thermal operating limit in the event of cooling failure. The power transformer has two secondary windings. One winding contains the half wave rectifier CR3 and filter C1 and C4 to form a negative bias supply. This negative bias supply provides the collector voltage for Q6 of the differential amplifier. The Darlington connected emitter followers Q4-Q3, act as current amplifiers, and perform the function of controlling the series regulator Q1-Q2. The other secondary winding contains the full wave rectifiers CR1-CR2 and CR4-CR5. The network of rectifier CR1-CR2 forms a low power bias supply which is filtered and regulated by C2, R13, and CR7. CR7 is a 30 volt zener diode. This network provides a regulated voltage supply required by the differential amplifiers located in the voltage divider and regulator section. The power rectifiers CR4-CR5, act as a full-wave rectifier on the a-c voltage of the secondary winding by allowing only the negative half-cycle to pass. Capacitor C3 filters the full-wave rectified voltage. This d-c voltage is applied to the collectors of the series regulator transistors Q1-Q2. The regulator consists of two series stages connected in parallel in order to limit the power dissipation in the transistors. The parallel connected resistors, R5-R6 and R7-R8, in the emitters of the series regulator, perform the function of current equalization. These resistors tend to equalize the current through each series regulator stage even with variation in the gain parameter of the transistor in each stage. Therefore, power dissipation in each of these transistors is equalized. The series regulator is designed to maintain 24 volts across the resistor divider network, R15, R17 and R19. This resistor divider is connected to an error detecting differential amplifier Q7-Q6, through the potentiometer R17. The base of Q6 is tied to a fixed reference voltage established by the

8-volt zener diode CR6. The potentiometer, R17, is initially adjusted for 24 volts across the resistor divider network. Therefore, any variation from 24 volts is divided and placed on the base of Q7 constituting an error. An error signal on base of Q7 is compared to the reference voltage at the base of Q6 and is amplified. The signal on the collector of Q6 is fed to the Darlington connected current amplifiers Q4-Q3, which in turn control the series regulator Q1-Q2. Transistor Q5 is a current overload detector which protects the series regulator Q1-Q2 under overload conditions. This is accomplished by turning the series regulator transistors off. As the current increases through the series regulator, the voltage at the emitter of Q5 becomes more positive due to the increase in voltage drop across the current equalizing resistors R5-R6 and R7-R8. When the emitter voltage becomes more positive than the base voltage, transistor Q5 conducts. The base voltage level is adjusted by the trip level adjust potentiometer R9, so that transistor Q5 will turn ON at the desired maximum current through the series regulator. When Q5 conducts, its collector goes more positive. This positive-going voltage is applied to the base of the series regulator through the current amplifiers Q4-Q3, turning Q1 and Q2 off.

Voltage Divider and Regulator

The voltage divider and regular section is comprised of voltage divider resistors R20, R21 and R22; error detecting differential amplifier transistors Q8 and Q9; differential voltage amplifier transistors Q10 and Q11; shunt current limiters, transistors Q12 and Q15; shunt regulators, transistors Q13-Q14 and Q16-Q17. The base of Q9 in the error detecting differential amplifier is referenced to common. The base of Q8 is connected to the balance-adjust potentiometer R21, which is part of the voltage divider network R20, R21 and R22. The potentiometer, R21, is set to divide the regulated 24 volts across the voltage divider network in half, thereby obtaining the required +12 volt and -12 volt power supplies. Should an unbalance occur in either power supply, an error signal will be impressed on the base of Q8. This error signal is compared to the reference on the base of Q9, and is amplified by the differential voltage amplifier Q10-Q11. The value of the resistor, R26, in the collector network of this differential amplifier is set at the factory and only a typical value is shown in the dual power supply schematic. The collector of Q10 is directly coupled to the shunt regulator, Q13-Q14, of the -12 volt supply, and the collector of Q11 directly coupled to the shunt regulator, Q16-Q17, of the +12 volt supply. Therefore, the shunt regulators are controlled so as to restore balanced output from each supply. An unbalance in the power supply is caused by a difference in load impedances on each power supply. The shunt regulator is controlled so that the high impedance side is paralleled by the variable impedance of the shunt regulator until both power supplies are loaded equally. Transistors Q13 and Q16 of the shunt regulator networks are current driver stages. Transistors Q14 and Q17 are shunt regulators and normally do not draw current in the balanced condition. The shunt current limiters Q12 and Q15 protect the transistors Q1 and Q2 of the series regulator from excess power dissipation due to large shunt currents. The operation of the shunt current limiter is similar to the operation of the current overload detector, Q5, in the 24-volt regulator section. The operation of Q12 and Q15 is identical, and the following explanation covers only Q12. The shunt current in Q14 causes a voltage drop across resistor R34. As the shunt current is increased, the emitter of Q12 becomes more positive until the base to emitter becomes forward biased; at that time transistor Q12 conducts. This results in the collector going more positive. This positive-going voltage is applied to the base of the series regulator through the current amplifiers Q4 and Q3, turning Q1 and Q2 off. Design values of R30 and R31 are selected so that approximately 2 amperes of load unbalance can be tolerated. As the theory of operation has explained, a short circuit load will not damage the power supply. Should only one of the supplies (either +12 volts or -12 volts) become short-circuited, the series regulator, Q1 and Q2, will become non-conductive, and the output of the unshorted supply will be reduced to less than 3 volts. This condition will be

maintained until the short is removed. C11 and C12 are output filter capacitors which maintain a low output impedance at high frequency. Capacitors C5, C6, C7, and C10 are high frequency compensation capacitors which suppress high frequency oscillation.

The +12 volts is available at the output connector J2, from pins A, D, H, L, and P. The -12 volts is available at pins C, F, K, N and R. The common connection is made at pins B, E, J, and M.

ADJUSTMENT PROCEDURES

Step 1. Place a one (1) amp load between plus and minus 12 volt supplies. Do not connect to neutral.

Step 2. Set Trip Adjust R_9 so that it is not close to the trip point with one amp load. It should be set at approximately 3 amps.

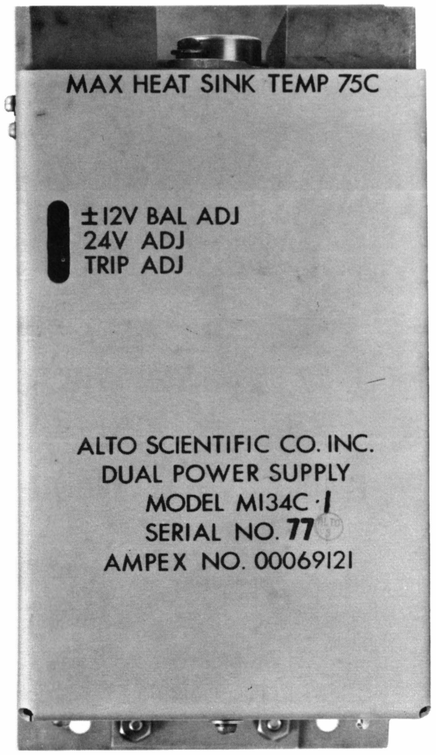
Step 3. Using 24 volts, adjust R_{17}; set the supply to 24 volts ±20 mv.

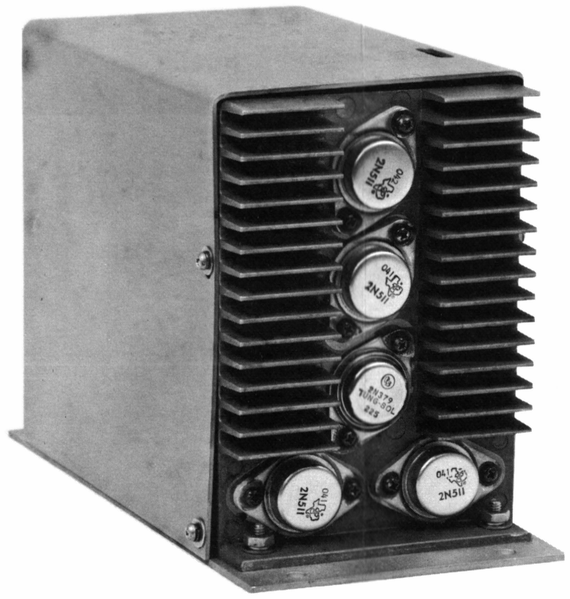
Step 4. Change the load to 3 amps and set Trip Adjust R_9 so that it reduces the 24 volt setting by approximately 1 volt without disturbing the 24 volt ±20 mv adjustment at the one amp load.

Step 5. Change to a balanced 2.5 amp load on each supply (unbalance current to be less than 100 ma) and set the ±12 balance control R_{21} so that the two voltages are equal within 20 mv.

SERVICING

This power supply should not be disassembled. Should service be required, please return the entire unit to the nearest Ampex service location.





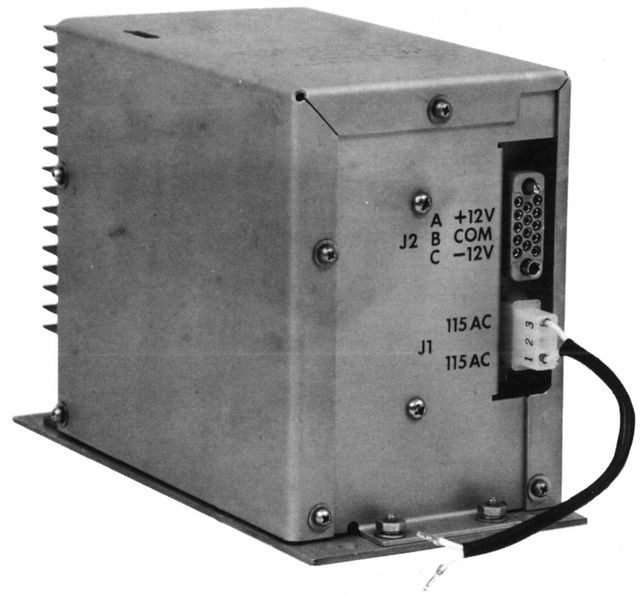
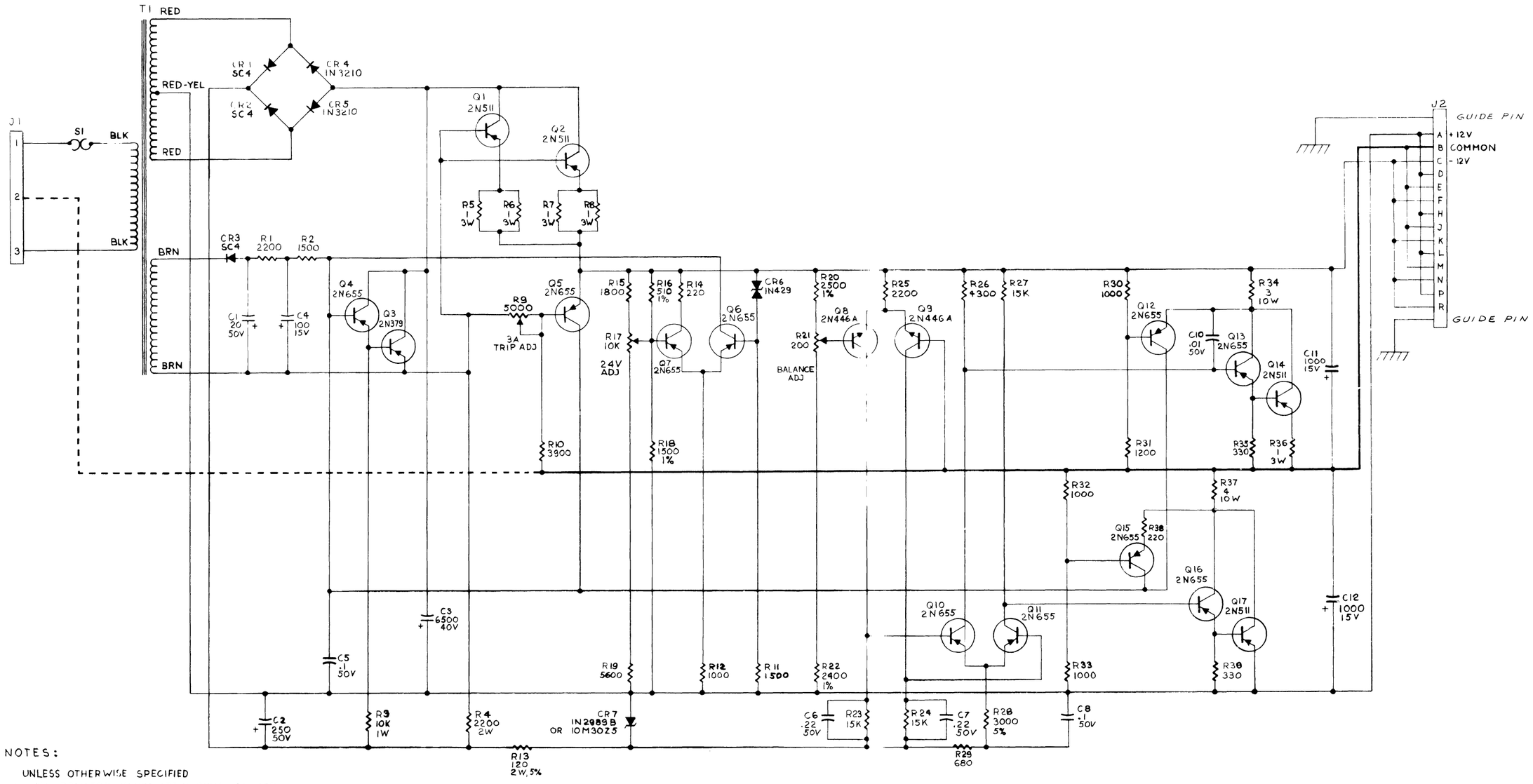


Fig. 1. ES-100 Dual Power Supply

50705



NOTES:

UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS, ½W, 10%.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. USED WITH ASS'Y D-69121

Dwg. No. 69161F

Fig. 2. ES-100 Dual Power Supply Schematic 50706

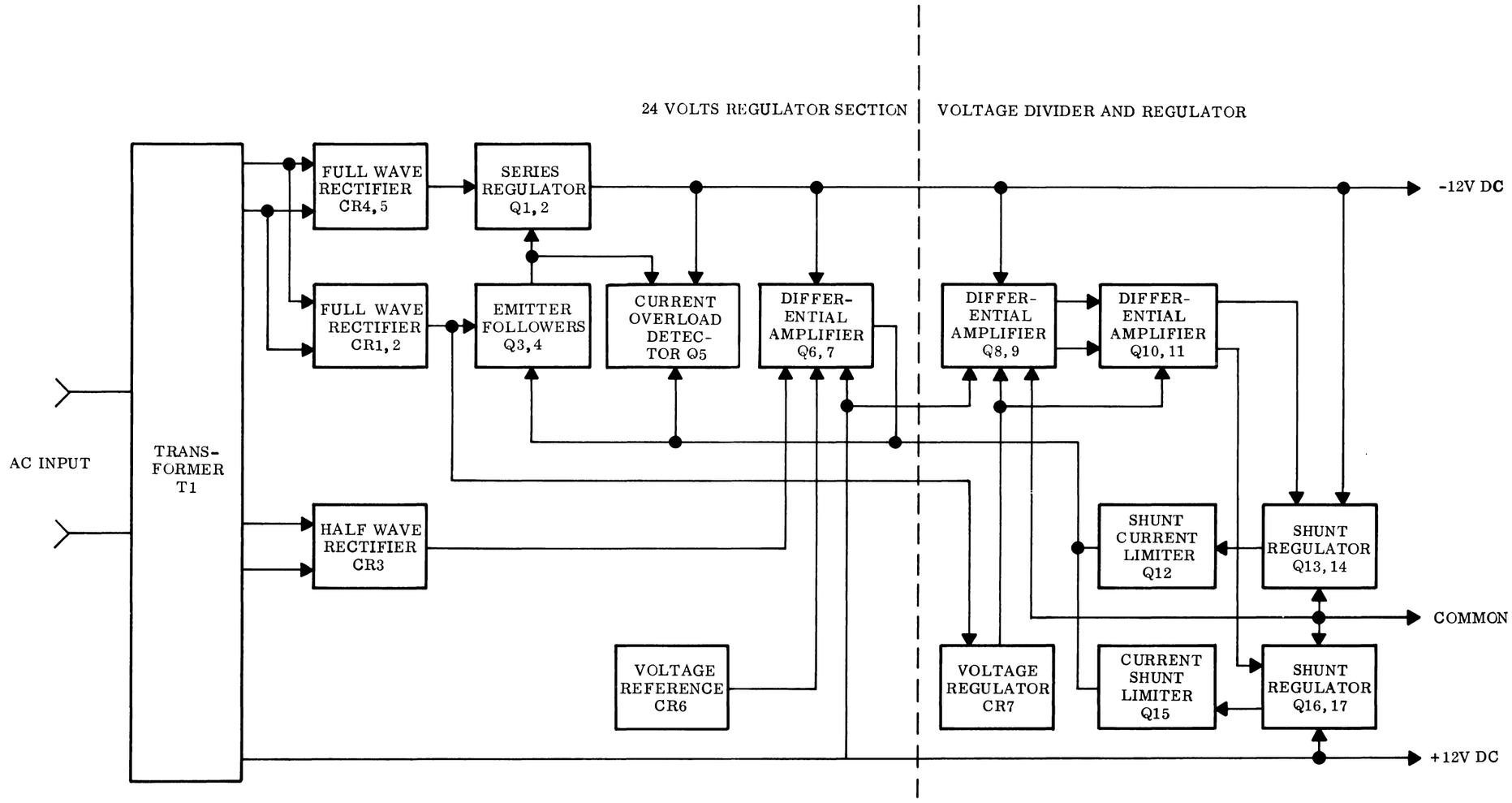


Fig. 3. ES-100 Dual Power Supply Block Diagram 50707

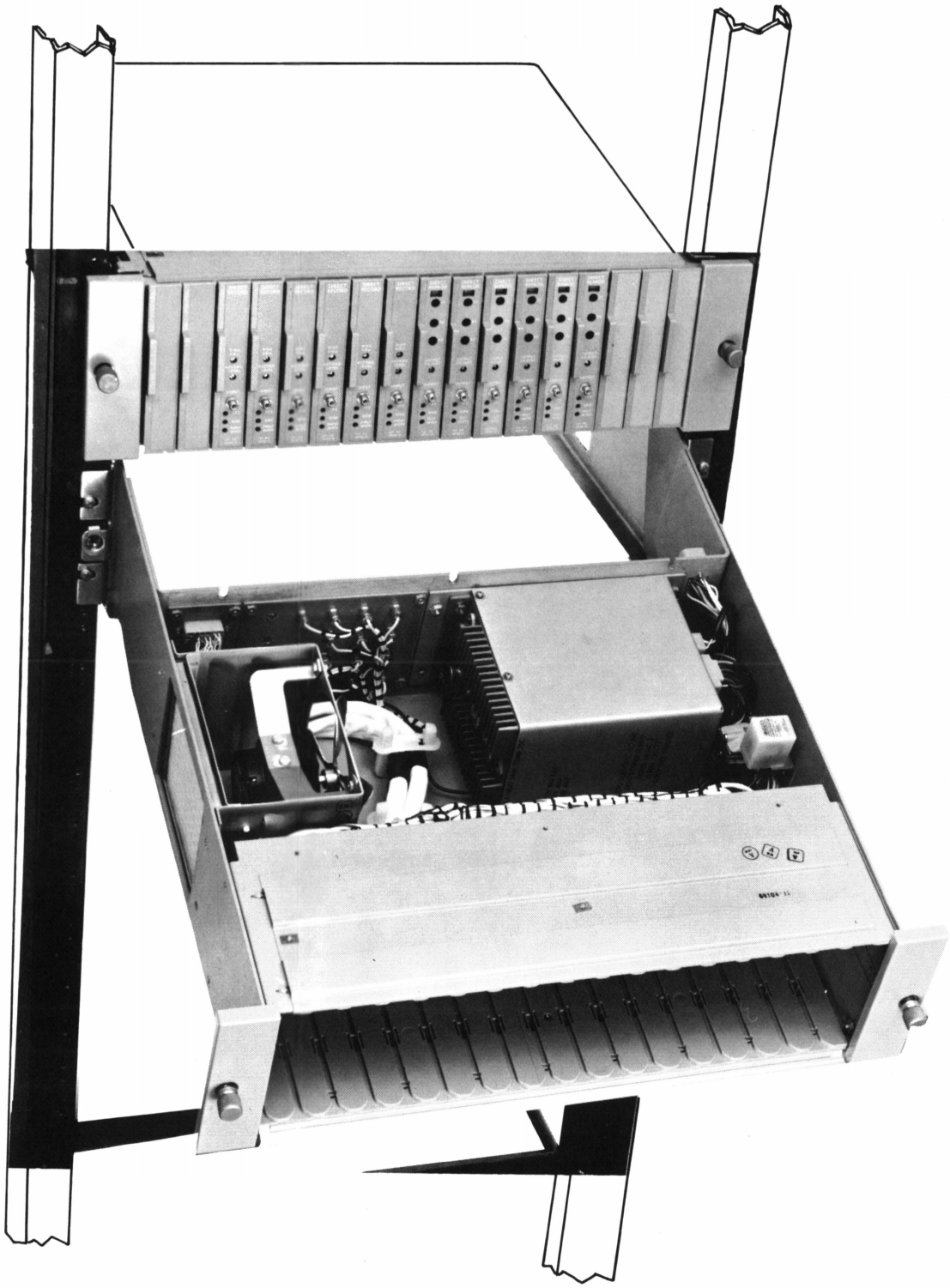


Fig. 1. ES-100 Tray In the Servicing Position 50699

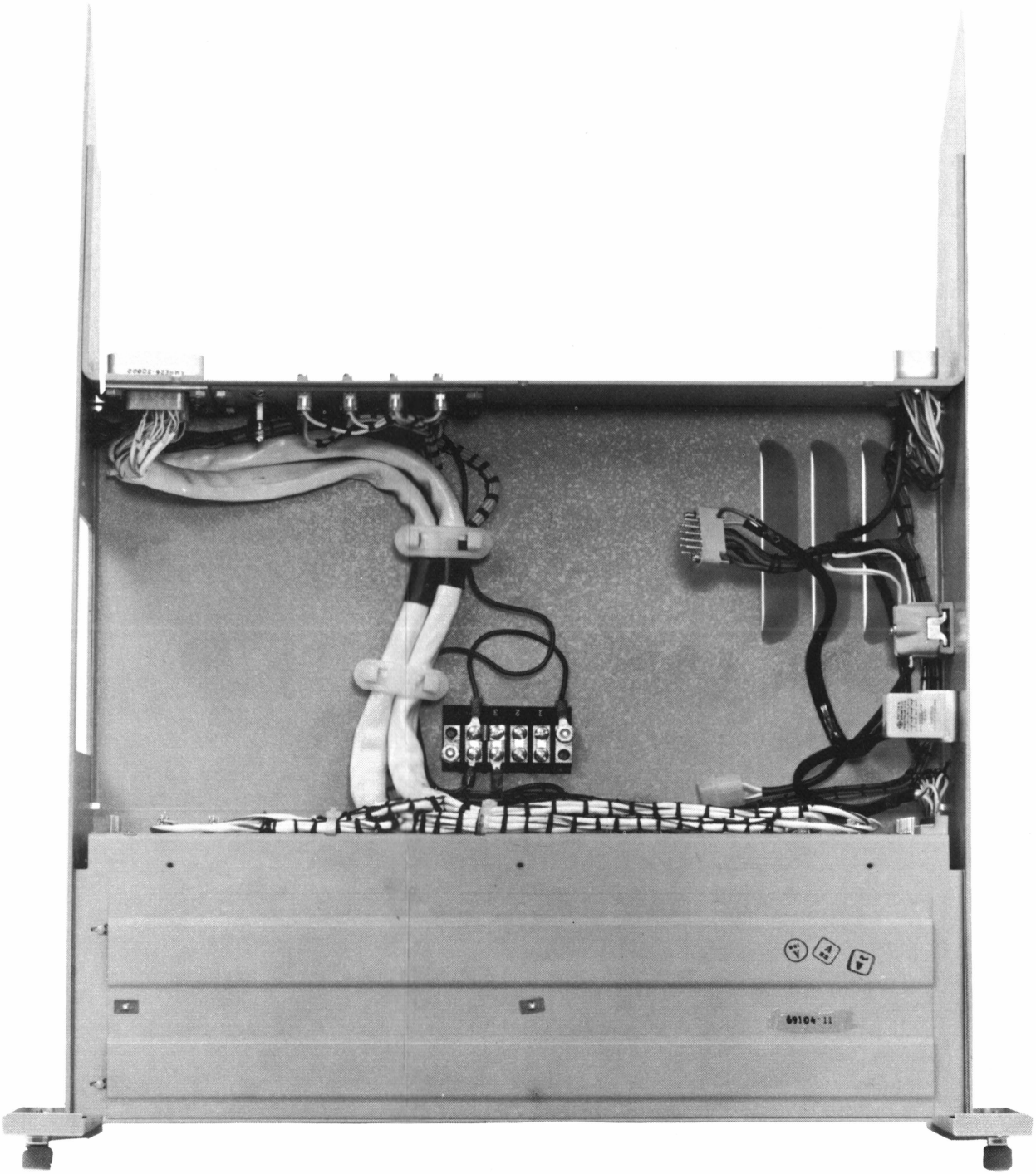


Fig. 2. ES-100 Basic Tray

50700

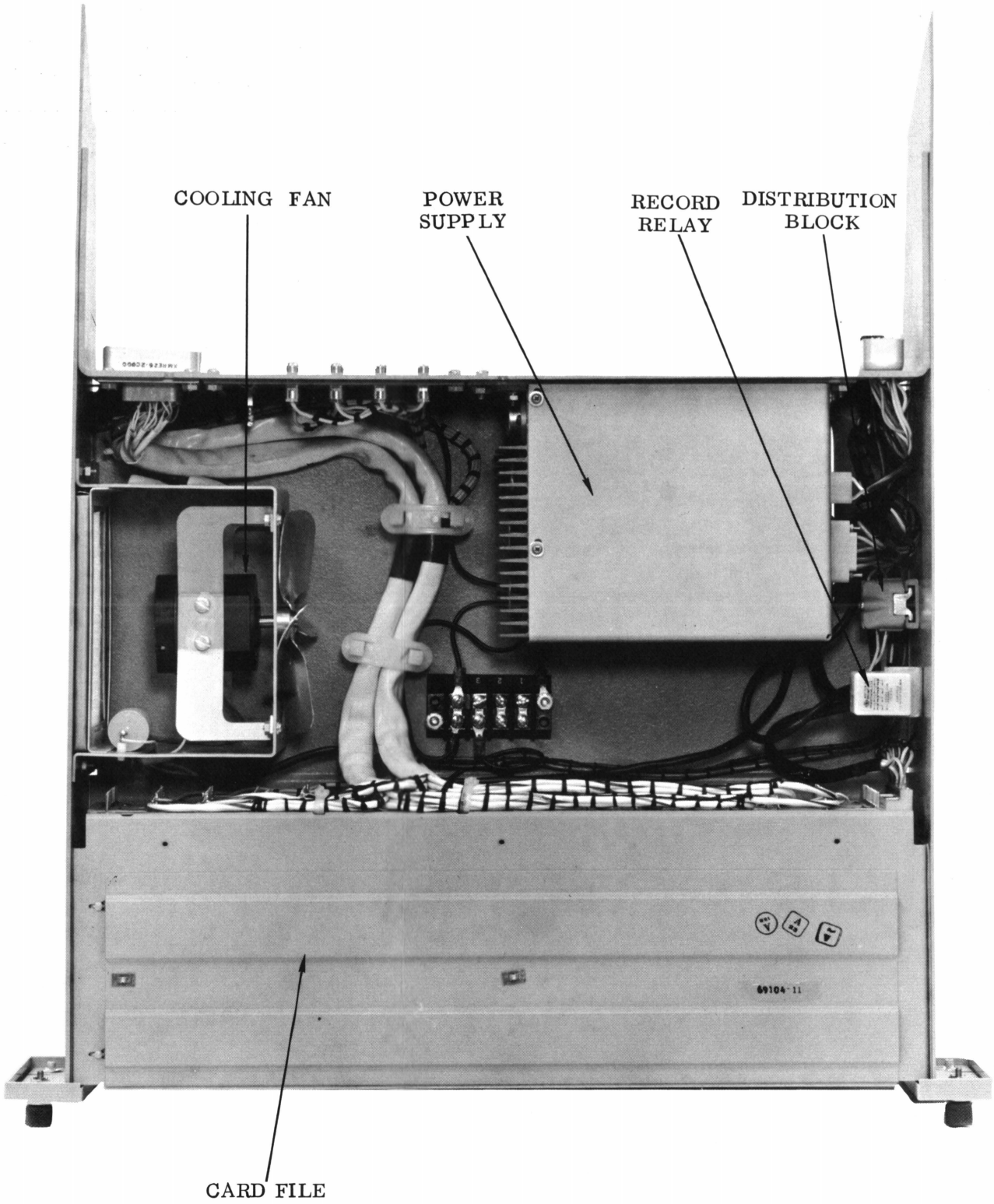


Fig. 3. ES-100 System Tray 50701

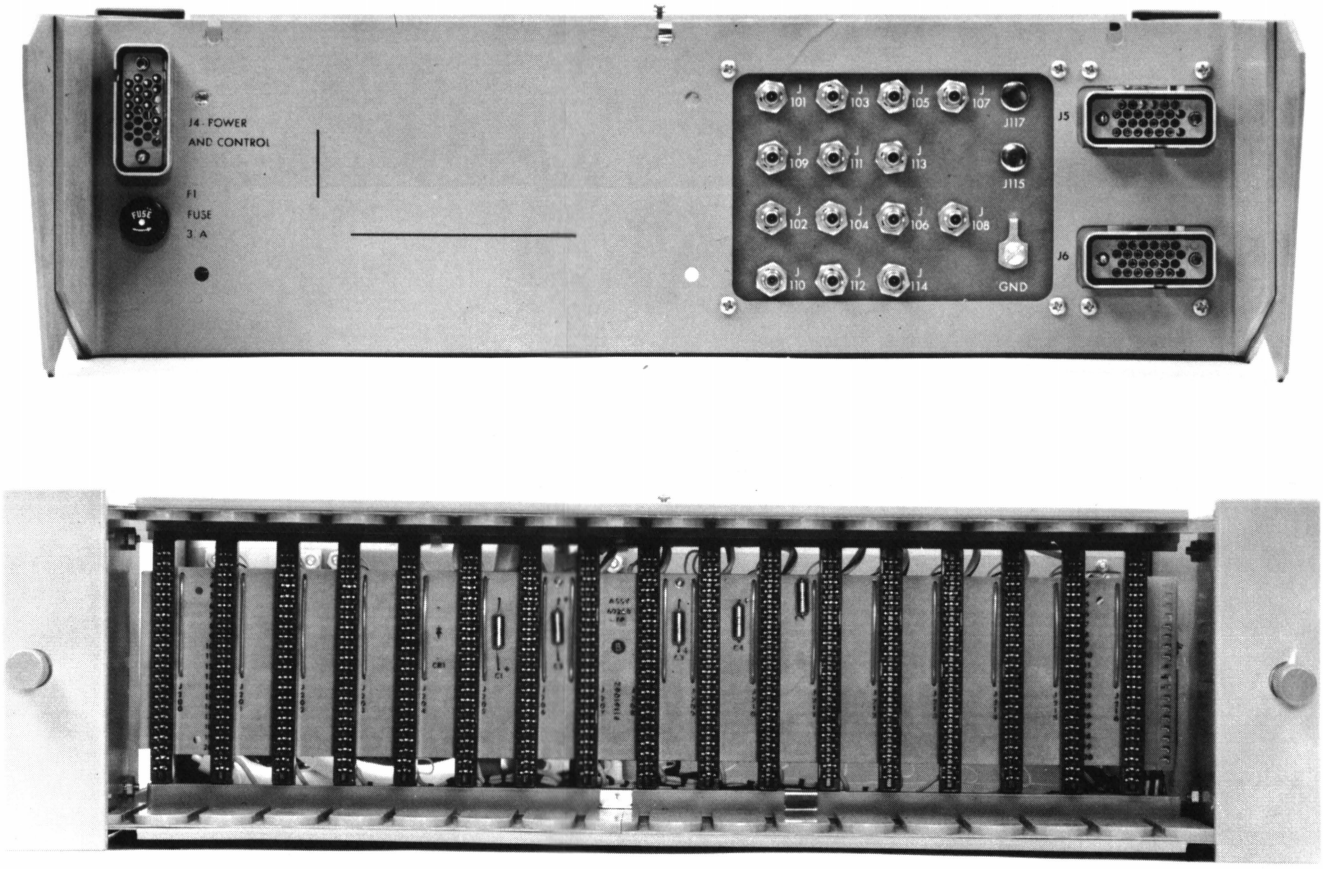


Fig. 6. Front and Rear View of ES-100 Tray 50704

ES-100 ACCESSORIES

ES-100 AUXILIARY MODULES

Service Modules

The service modules provide a convenient method of servicing and calibrating the ES-100 record and reproduce amplifiers. They can be inserted into the Auxiliary Slots of the card file when the need for servicing or calibrating exists. The modules are available in a Type 1, Type 2 and Type 3 service configuration, all of which will be discussed individually in the following paragraphs.

Type 1 Service Module. The Type 1 service module (Fig. 1) is used to control operating power to the record bias oscillator and the record amplifier when the tape transport is not pulling tape. Power connections to the oscillator and amplifier are switched on by two toggle switches located on the front panel of the module. An indicator lamp also located on the front panel lights when the module is in operation. The amplifier switch must be in the "ON" position before the BIAS switch can be used.

CAUTION

Do not pull tape when indicator is lighted.

Type 2 Service Module. The Type 2 service module is basically a printed circuit card extension used to support and connect a module outside the card file for test or repair. The extender (Fig. 2) is first inserted into the card file. An amplifier card is then inserted into the extender card, thereby allowing the amplifier to be serviced while operating in a system.

Type 3 Service Module. Except for the addition of a tape speed selector switch the Type 3 module is identical to the Type 1 module. The module is required when an older model system which does not incorporate master tape speed selector switch is to be operated with multirange (automatically switched to 6 speeds) amplifiers.

Vacancy Panels

Vacancy panels (Fig. 3) are used to cover vacant slots in the card file caused by the absence of either amplifier or auxiliary modules. The panels which are available in two sizes are capable of covering either a single slot or a continuous row of seven slots.

INSTALLATION OF COAXIAL CONNECTORS

Each record/reproduce module is provided with a female connector for the purpose of making an adaptor cable. This adaptor cable is then used as an interconnection between the ES-100 Electronics system and an independent electronics system. There are two types of

female coaxial connectors that can be used with ES-100 Electronics system. One is an Automatic Metal Products Corp. BSM connector and the other is an Industrial Products Co. MB connector. The procedures for installing these individual connectors are given in Figure

NOTE

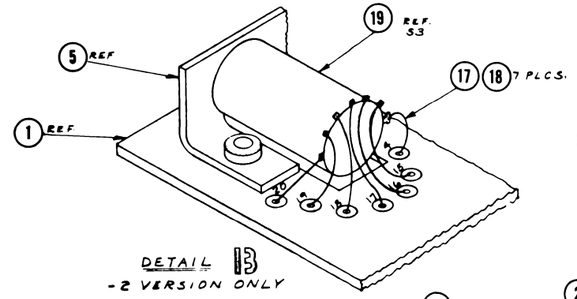
The installation procedures outlined in Fig. 4 may also be used for the male connectors located on the connector panel at the rear of the tray assembly.

SERVICE MODULES TYPE #1 & #3 CATALOG NO. 69116-10 & 20

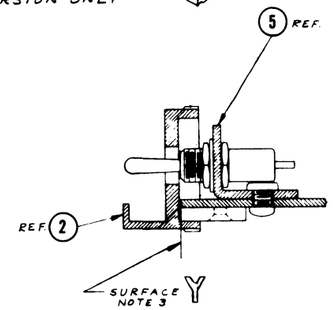
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
			SWITCHES									
S1	120-222		Toggle, D.P. DT	1	1							
S2	120-223		Toggle, S.P. DT	1	1							
S3	69681		Rotary		1							
			HARDWARE									
1	69675-10		Circuit, Board, Printed Wiring	1	1							
2	69678-10		Panel, Calibration Module	1	1							
3	69679-10		Label, Module Panel	1								
4	69679-30		Label, Module Panel		1							
5	69162-10		Module, Shield Assy.	1	1							
6	69677-10		Bracket, Switch, Mtg.	1	1							
7	060-098		Lamp, Plug-In Cartridge, 24v, Red	1	1							
8	435-069		Clip, Lamp Holder	1	1							
9	502-028		Washer, Lock, 1/4 Int. Tooth, Stl., Cad. Plt.		1							
10	492-046		Nut, Hex, 1/4 - 32 Brass, N, Plt.		2							
11	471-059		Screw, #4-40 x 3/16, Pan, Hd., Phil. Dr., Stl., Cad. Plt.	2	2							
12	498-059		Nut, Insertable, #4-40, Stl., Cad. Plt.	2	2							
13	502-013		Washer, Lock, #4, Ext. Tooth, Stl., Cad. Plt.	2	2							
14	471-324		Screw, #4-40 x 1/8, Flat, Hd., Phil. Dr., Stl., Cad. Plt.	2	2							
15	471-060		Screw, #4-40 x 1/4, Pan, Hd., Phil. Dr., Stl., Cad. Plt.	3	3							
16	310-100		Nut, Insertable, #4-40, S. Stl.	2	2							
17	615-018		Wire, Bare, #26, Solid Tinned (as req'd)									
18	600-037		Tubing, INSUL, #26, Clear, Teflon (as req'd)									
19	6000001-10		Knob		1							

SERVICE MODULE TYPE 2 CATALOG NO. 69118-10

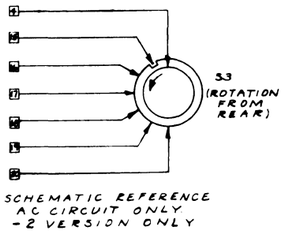
ITEM NO.	AMPEX PART NO.	VENDOR OR MIL. NO.	PART DESCRIPTION	QUANTITY REQUIRES PER VERSION								
				10	20	30	40	50	60	70	80	90
1	69660-10		Circuit, Board, Printed Wiring	1								
2	69162-50		Module Shield, Assy.	1								
3	69683-10		Connector, Service Module	1								
4	69662-10		Panel, Assy. Extender Card	1								
5	471-059		Screw, #4-40 x 3/16, Pan, Hd., Phil. Dr., Stl., Cad. Plt.	4								
6	502-013		Washer, Lock, #4, Ext. Tooth, Stl., Cad. Plt.	2								
7	498-059		Nut, Insert, #4-40, Stl. Cad. Plt.	2								
8	69682-10		Cover, Service Module	1								
9	69679-20		Label, Module Panel	1								
10	615-018		Wire, Bare, #26, Solid, Tinned	1								



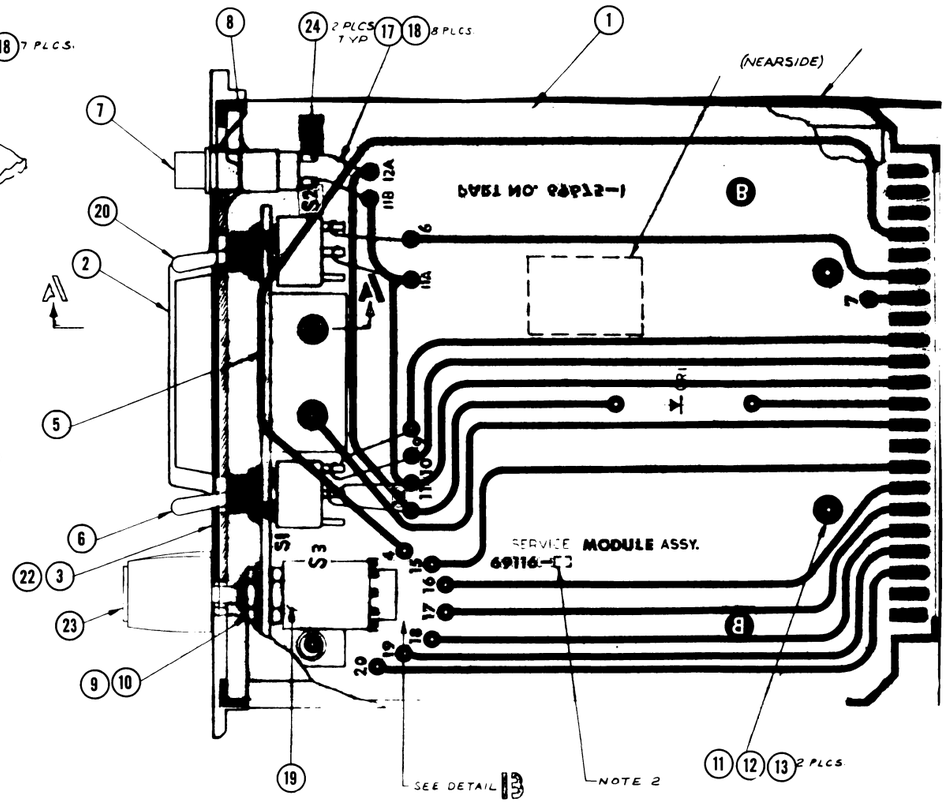
DETAIL B
-2 VERSION ONLY

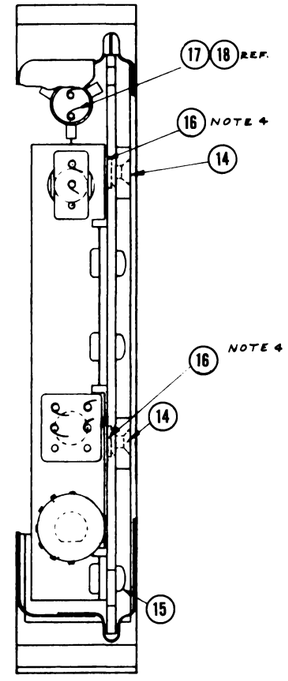


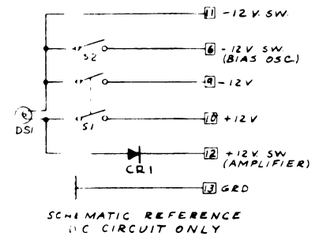
SECTION A1 - A1
NOTE 3



SCHEMATIC REFERENCE
AC CIRCUIT ONLY
-2 VERSION ONLY







SCHEMATIC REFERENCE
AC CIRCUIT ONLY

VERSION TABLE		
VERSION	APPLICATION	PART NO.
-1	SERVICE MODULE, TYPE 1	69116-11
-2	SERVICE MODULE, TYPE 3	69116-21

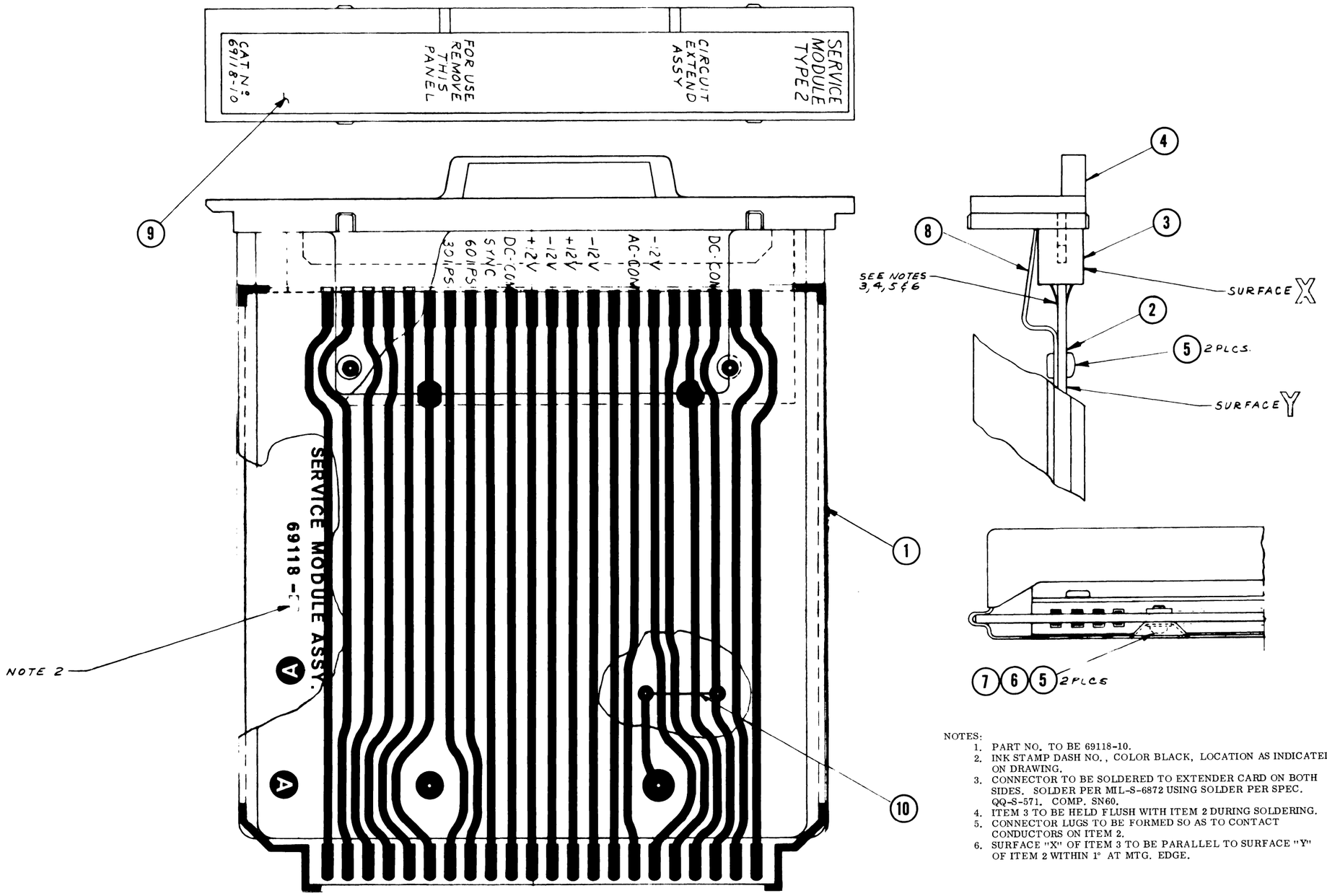
NOTES:

1. PART NO. TO BE 69116-11 & 69116-21.
2. INK STAMP DASH NO., COLOR BLACK, LOCATION AS SHOWN ON

NOTES:

1. PART NO. TO BE 69116-11 & 69116-21.
2. INK STAMP DASH NO., COLOR BLACK, LOCATION AS SHOWN ON DWG.
3. END OF TOGGLE SWITCH BUSHING TO BE FLUSH WITH EDGE OF PRINTED CIRCUIT BOARD (SURFACE "Y"), SEE SECTION A-A.
4. ITEM 16 TO BE INSERTED FROM COMPONENT SIDE OF ITEM 1 & INSTALLED FLUSH WITH SURFACE.
5. ITEMS 6 & 20 SUPPLIED EACH WITH 2 NUTS, 1 LOCK WASHER & 1 LOCKING RING.
6. DIP SOLDER CIRCUIT SIDE ONLY PER AMPEX SPEC. 21-10507.

Fig. 1. ES-100 Service Module Type 1 50708



NOTES:
1. PART NO. TO BE 69118-10.
2. INK STAMP DASH NO., COLOR BLACK, LOCATION AS INDICATED ON DRAWING.
3. CONNECTOR TO BE SOLDERED TO EXTENDER CARD ON BOTH SIDES. SOLDER PER MIL-S-6872 USING SOLDER PER SPEC. QQ-S-571. COMP. SN60.
4. ITEM 3 TO BE HELD FLUSH WITH ITEM 2 DURING SOLDERING.
5. CONNECTOR LUGS TO BE FORMED SO AS TO CONTACT CONDUCTORS ON ITEM 2.
6. SURFACE "X" OF ITEM 3 TO BE PARALLEL TO SURFACE "Y" OF ITEM 2 WITHIN 1° AT MTG. EDGE.

Fig. 2. ES-100 Service Module Type 2 50709

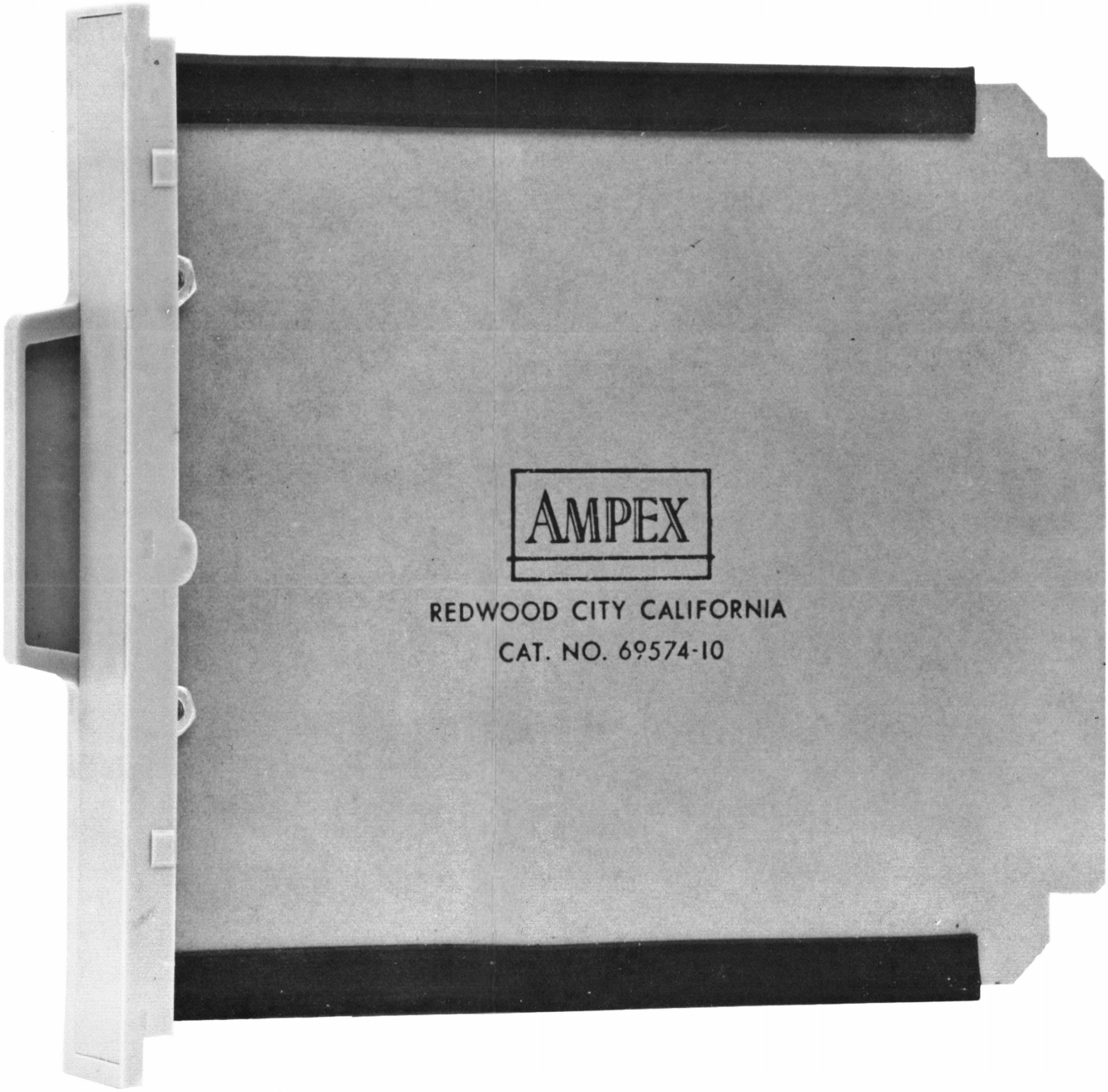
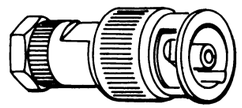
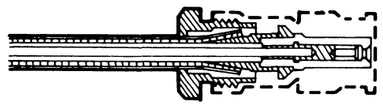


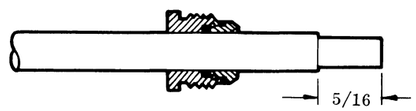
Fig. 3. ES-100 Vacancy Panel 50710

BSM Connector (Automatic Metal Products Cat. No. RF60701-809)



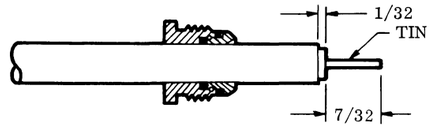


Cable Group 101

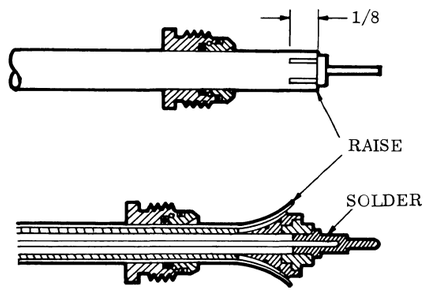


1. Slip nut assembly over cable. Cut off jacket and braid approximately 5/16" back from end of cable without damaging dielectric.*

*For RG-141, 142/U cables, wax or other sealing agent should be used to prevent the fraying of the fiberglas jacket.

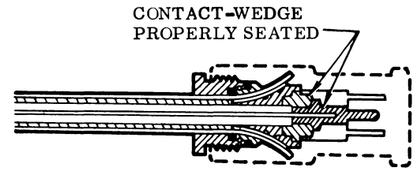


2. Cut off dielectric 1/32" from jacket and braid. Do not "nick" inner conductor. Tin inner conductor. Cut off inner conductor to 7/32" from dielectric.



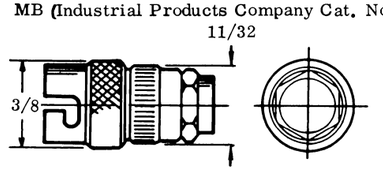
3. Cut 3 slits 1/8" long and 120° apart, in outer jacket only, without disturbing braid. Raise outer jacket and braid away from dielectric in order to facilitate the entry of contact-wedge assembly. Straighten inner conductor if necessary.

4. Slide contact-wedge assembly under braid and jacket. Push back as far as possible, making sure that inner conductor is visible through side hole of contact. Solder contact to inner conductor through side hole and make sure outside surfaces are free of solder. Avoid use of excessive heat.

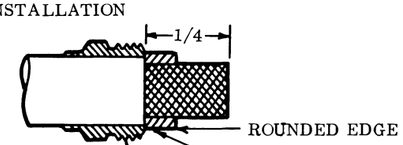


5. Insert cable and contact-wedge assembly into body assembly. Care should be taken to insure that contact-wedge assembly is properly seated in body assembly. Tighten nut securely to complete assembly.

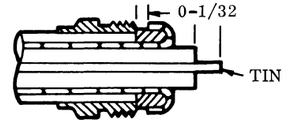
MB (Industrial Products Company Cat. No. 48850)



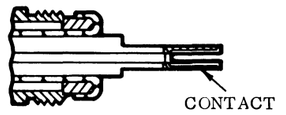
INSTALLATION



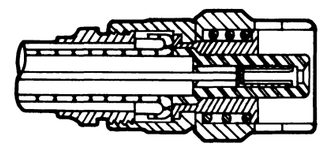
1. Remove cable jacket back to dimension shown. Insert clamp nut over cable jacket and braid clamp over braid wires.



2. Comb out braid wires, form back over braid clamp, and trim to length. Cut off cable dielectric as shown. Cut inner conductor to 5/64 and tin when used with solder type contacts.



3. Tin end of contact hole and sweat contact to conductor. Outside surface of contact must be free of solder. The 45000 has a solderless contact. The end with the shortest slot is inserted over the inner conductor of RG-58/U. It can be used only with this one cable.



4. Insert insulator over contact. Insert assembly less clamp nut into plug body and rotate slightly to make sure braid clamp is seated. Thread clamp nut into body and tighten nut by holding knurled portion of body with soft nosed pliers.

Fig. 4. ES-100 Coaxial Connector Installation Procedure 50711