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DATATAPE®

13-544-2 BIAS BUFFER & REFERENCE AMPLIFIER

OPERATION AND MAINTENANCE MANUAL

INSTRUMENTS DIVISION
360 Sierra Madre Villa, Pasadena, California 91109

BELL & HOWELL

This manual describes the operation and maintenance procedures for the Type 13-544-2 Bias Buffer and Reference Amplifier with circuit board number 471749-G.

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SECTION I

GENERAL DESCRIPTION

1-1. GENERAL.

1-2. The Type 13-544-2 Bias Buffer and Reference Amplifier is installed in a Type 13-505-4 Amplifier Housing on the rear of the 13-501 transport plate. It is used in conjunction with Type 13-540A Record Head Driver Amplifier modules, which are also installed in the amplifier housing.

1-3. The 13-544-2 module contains two independent circuits: a bias buffer amplifier and a reference signal amplifier. The bias buffer amplifies the bias signal from the transport and feeds it to the individual record head driver amplifiers. This section is necessary for all direct recording operations. The reference amplifier section is used only when a reference signal is to be recorded on a data channel. It can be set up in two configurations: to feed only the reference signal to the record head driver amplifier and thence to the record head; or to mix the reference signal with a data signal and feed the mixture to the driver amplifier. Power, bias output, and monitor connections are completed when the module is installed in the amplifier housing. Signal connections (bias input, reference and data signal inputs, and mixed output) are made at BNC connectors on the front of the module.

1-4. ELECTRICAL CHARACTERISTICS.

1-5. Electrical characteristics of the bias buffer and reference amplifier are shown in table 1-1.

ELECTRICAL CHARACTERISTICS	
Bias	8 MHz
Bias Input Level	5 v p-p
Power Requirements	+20 vdc, 21 ma per module -20 vdc, 28 ma per module

Table 1-1. 13-544-2 Electrical Characteristics

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. The 13-544-2 Bias Buffer and Reference Amplifier is installed with up to four 13-540A Record Head Driver Amplifier modules in a 13-505-4 Amplifier Housing located on the rear of the transport plate.

2-3. INSTALLATION.

2-4. The 13-544-2 Bias Buffer and Reference Amplifier plugs into connector J5 of the 13-505-4 Amplifier Housing. Connector J5 is the last module location on the right side of the housing. The module is installed by sliding it into the housing guide slots until it mates firmly with connector J5.

2-5. ELECTRICAL CONNECTIONS.

2-6. All electrical connections except for the four BNC connectors are made when the module is installed in the housing and the housing is connected to the remainder of the system.

2-7. The four BNC connectors on the module panel are designated as follows: J1, bias frequency input (from transport); J2, combined data and reference output; J3 and J4, data signal and reference frequency inputs. The bias frequency is necessary for all direct recording operations. The reference and data connections are discussed in Section III.

SECTION III

OPERATION

3-1. GENERAL.

3-2. The module is energized when the system is turned on. Since there are no controls or indicators, no adjustments are required.

3-3. CONNECTIONS FOR RECORDING SERVO REFERENCE.

3-4. A servo reference frequency may be recorded by itself on any track, or it may be mixed with data before recording.

3-5. Make the following connections to record the servo reference frequency:

a. Disconnect the data signal cable from the input to the record head driver amplifier for the channel to be used for recording the reference signal.

b. Connect a jumper cable from connector J2 of the bias buffer and reference amplifier to the input of the head driver selected in step a.

c. The square wave reference frequency (from connector J409 on the transport relay chassis) may be recorded by itself. However, if the reference frequency is to be mixed with data, the optional sine wave reference at connector J408 must be used in order to avoid harmonic interference with the data. Connect the appropriate reference frequency to connector J4 (or J3) of the bias buffer and reference amplifier.

d. If the data signal is to be mixed with the reference, connect the data signal cable detached in step a to connector J3 (or J4) of the bias buffer and reference amplifier.

3-6. Refer to the system manual for additional information pertaining to reference frequency recording techniques.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. This section describes the theory of operation of the 13-544-2 Bias Buffer and Reference Amplifier. The bias buffer and reference amplifiers are located on the same printed circuit module, however, they have separate functions and will be discussed separately. A block diagram of the 13-544-2 and an associated head driver amplifier is shown in figure 4-1.

4-3. CIRCUIT DESCRIPTION, BIAS BUFFER AMPLIFIER.

4-4. This amplifier consists of three sections. These are the input coupling and biasing network, the class B push-pull amplifier, and the AGC circuit. These circuits are discussed individually in the following paragraphs. Refer to figure 7-1 for a circuit schematic.

4-5. INPUT COUPLING AND BIASING NETWORK. The 8 MHz bias signal is applied to the input transformer T1 through a filter network which eliminates all other frequencies. This series resonant filter network consists of L1 and C2.

4-6. Diode CR1 at the center tap of the secondary of T1 drops the +15 vdc to approximately +0.6 vdc which biases transistors Q2 and Q3 at cutoff, and establishes class B operation.

4-7. In the base circuit of both Q2 and Q3, diodes CR2 and CR3, respectively, are connected to ground to eliminate the negative half cycles of the applied signal.

4-8. PUSH-PULL AMPLIFIER. The amplifier, consisting of transistors Q2 and Q3, is biased at cutoff with no signal applied, therefore, its operation is class B. With a signal applied to the input and coupled across T1, each transistor will conduct only on the positive half cycle of the signal. For each period of time one transistor is conducting, the other is cut off. As each transistor alternately conducts, an amplified signal is developed across T2, resulting in a sine wave output.

4-9. The sine wave, or bias signal, is fed out on pin 12 of the bias buffer amplifier module and distributed through the connectors of the record head driver housing to each of the record head driver amplifier modules. The bias output is also fed via resistor R30 and pin 1 to external connector J7 for monitoring purposes.

4-10. AGC Circuit. The output signal of the bias buffer amplifier is maintained at a constant level by means of an Automatic Gain Control circuit. A negative voltage proportional to the bias output amplitude is developed across capacitor C21 by diode CR7. This voltage is applied to the inverting input of amplifier Z1, while the non-inverting input is maintained at -0.3 volts by zener diode VR3 and resistors R27 and R28. The output of the amplifier is connected through resistors R24 and R26 to the base of transistor Q6. An increase in bias output amplitude makes the dc voltage at the inverting input of amplifier Z1 more negative, which results in a more positive base voltage of transistor Q6, increasing its collector current.

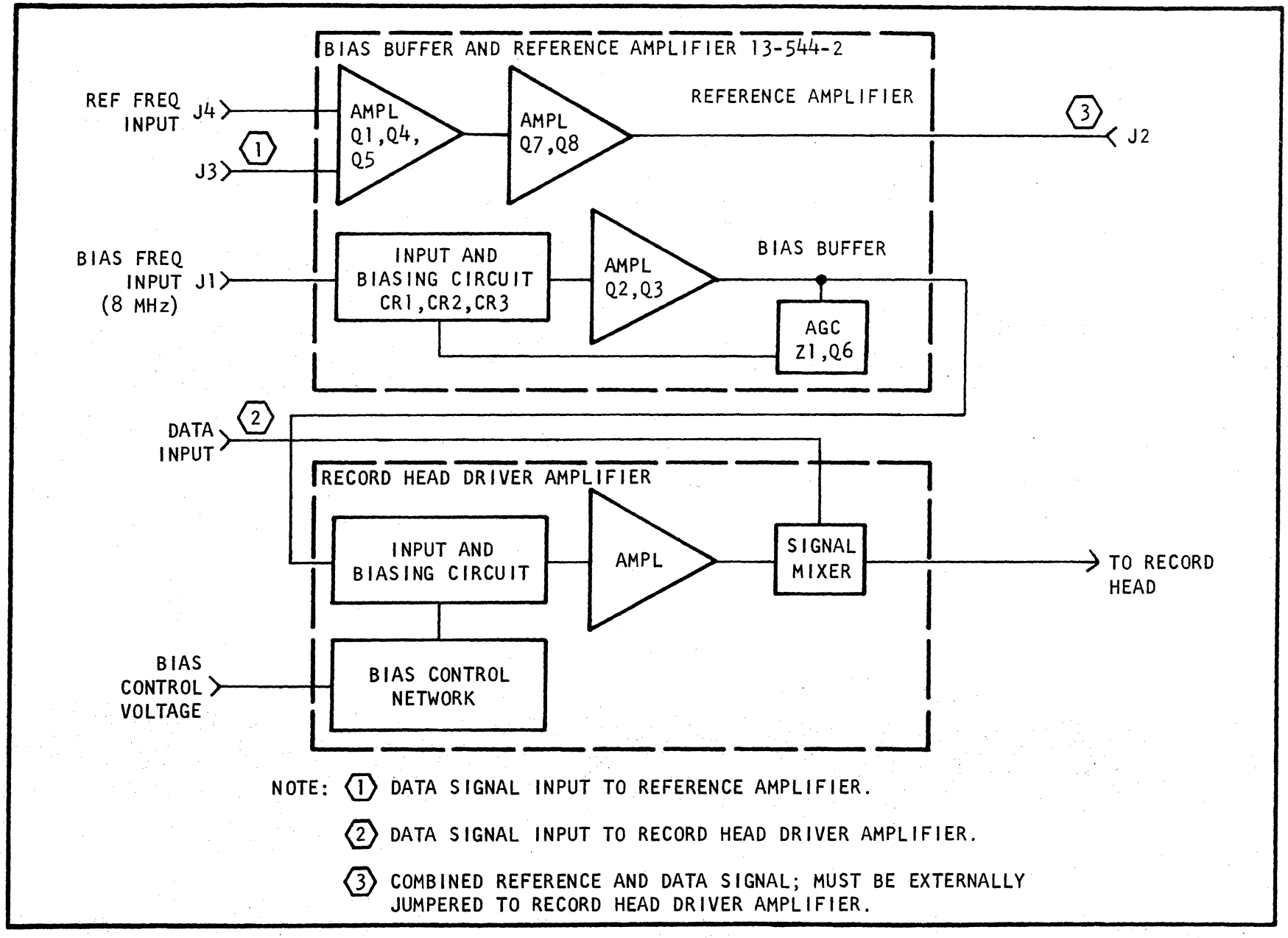


Figure 4-1. Block Diagram, 13-544-2 Bias Buffer and Reference Amplifier

4-11. The path of current flow for transistor Q6 is through diodes CR2 and CR3. As conduction through the diodes increases, the diode resistance decreases, causing the ac signal to be attenuated by series resistors R1 and R2. As the signal at transistors Q2 and Q3 is decreased, the output bias signal will decrease to its normal level. If the output bias signal should decrease, just the opposite will take place.

4-12. CIRCUIT DESCRIPTION, REFERENCE AMPLIFIER.

4-13. In a standard system, when a reference signal is to be used, the output from the reference amplifier is connected externally to one of the record head driver amplifier channels and replaces the data information for that particular channel. It is only possible to combine the reference signal with the data information if the optional 13-544-1 Sine Wave Reference Signal Generator has been included in the system. In the following circuit description, the reference signal and the data information are combined. However, the theory of operation will not change if the data information is omitted, as in a standard unit. Refer to figure 7-1 for a detailed circuit diagram.

4-14. INPUT AND AMPLIFICATION STAGES. The reference amplifier receives two inputs. They are the reference signal and one channel of data information. Both signals are connected to the reference amplifier through the external BNC connectors J3 and J4. Both points are the same electrically, therefore, there is no special order to follow when connecting the signal cables to the input connectors on the reference amplifier.

4-15. The two input signals are combined at the base of Q1. Amplifiers Q1, Q4, and Q5 are operated class A. After the combined signal has been amplified by the three class A amplifiers, it is applied to the complementary symmetry push-pull amplifier consisting of Q7 and Q8.

4-16. A complementary symmetry push-pull amplifier differs slightly from the normal parallel push-pull operation. Both the negative and positive half cycles of the applied signal are utilized by using one NPN and one PNP transistor. In this configuration, Q7, an NPN transistor, conducts on the positive half cycle; Q8, a PNP transistor, conducts on the negative half cycle. Because both transistors are operated as emitter-followers, phase inversion of the signal does not take place. The amplified, combined reference and data signal is connected through relay K1 to the output connector, J2. This relay opens the output line in the reproduce mode to prevent the reference signal from being recorded on top of the reproduced data.

4-17. Bias for transistors Q7 and Q8 is established by diodes CR4 and CR5. Negative feedback is established from the output of the push-pull amplifier through resistor R7 to the base of Q1. This is used to reduce any distortion and assures output stability.

SECTION V

MAINTENANCE

5-1. PARTS IDENTIFICATION.

5-2. The parts list of Section VI lists and describes the components of each assembly and provides a part number for each component.

5-3. PREVENTIVE MAINTENANCE.

5-4. The record head driver amplifier housing assembly should be inspected and cleaned at six month intervals to prevent accumulation of dirt, grit, and/or grease. However, the interval between inspections may be increased, as determined by the particular operating environment. Remove all modules and inspect printed circuit boards for breaks or loose connections. When cleaning boards, use a soft brush, low pressure air, or a suitable solvent, such as Freon TF. Clean all connectors with a clean rag and solvent. Use care during handling to prevent damage to printed circuitry.

5-5. TROUBLESHOOTING.

5-6. Before attempting the repair of a unit suspected of malfunction, first, visually inspect the unit for obvious damage such as burned resistors, improper connections, or poor seating of connectors. Next, verify that the symptom is not caused by an associated component such as the power supply or an amplifier.

5-7. The following test equipment is required for troubleshooting the bias buffer and reference amplifier. The circuit extender card listed below is also shown in figure 7-2.

Oscilloscope, Tektronix 545B/1A1, or equivalent.

Volt-Ohm-Milliameter, Triplett 630, or equivalent.

Circuit extender card, Bell & Howell part number 472155-1.

5-8. Figure 7-1 is a detailed schematic diagram. An oscilloscope may be used for signal tracing. The input to the bias buffer amplifier will be approximately a 2 volt peak-to-peak waveform. The output signal should be a sine wave of approximately 5 volts peak-to-peak.

5-9. REPAIR.

5-10. Repair of the assembly should be attempted only by qualified personnel experienced in printed wiring techniques. Be sure replacement parts are known to be good and that they are of the correct type and value as shown in the parts list. After new parts are installed, inspect for cold solder joints, solder splashes, and improper mounting.

SECTION VI

PARTS LISTS

6-1. GENERAL.

6-2. An appropriate parts list and illustration for the Type 13-544-2 Bias Buffer and Reference Amplifier covered by this manual follow the instructions given below. The parts list includes the Bell & Howell Instruments Division part number, description, figure and index and/or schematic reference symbol, and where applicable, the manufacturer's or military part number for each component. Manufacturers are identified in the parts list by code number in accordance with the Federal Supply Code for Manufacturers, Cataloging Handbook H4-2, and as listed in table 6-1. The components are illustrated in figure 6-1.

6-3. ORDERING REPLACEMENT PARTS.

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

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

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

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

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

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

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

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

6-6. FIELD SERVICE.

6-7. Regular scheduled maintenance service is available from the Bell & Howell Instruments Division Sales and Service Office on a contract basis. If immediate service is required, it may be obtained on an emergency basis. Every effort is made to furnish the needed repair as soon as possible. For a complete description of Bell & Howell's maintenance service plans and their costs, contact the Instruments Division Sales and Service Office.

6-8. FACTORY REPAIR SERVICE.

6-9. If desired, instruments (or major assemblies) may be returned to the factory for repair. When an instrument or assembly is returned:

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

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

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

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

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

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

CODE	MANUFACTURER
01295	Texas Instruments, Incorporated Semiconductor & Components Division Dallas, Texas
03508	General Electric Company Semiconductor Products Department Syracuse, New York
04713	Motorola Semiconductor Products, Incorporated Phoenix, Arizona
13715	Fairchild Camera and Instrument Corporation Semiconductor Division Diode Plant San Rafael, California
14028	Bell & Howell Instruments Division Pasadena, California
24546	Corning Glass Works Bradford, Pennsylvania
42451	Union Carbide Corporation Carbon Products Division New York, New York
56289	Sprague Electric Company North Adams, Massachusetts
72136	Electro Motive Manufacturing Company, Incorporated Willimantic, Connecticut
76493	J. W. Miller Company Compton, California
78488	Stackpole Carbon Company St. Marys, Pennsylvania
96918	Kings Electronic Company, Incorporated Microwave Division Tuckahoe, New York

Table 6-1. List of Manufacturers

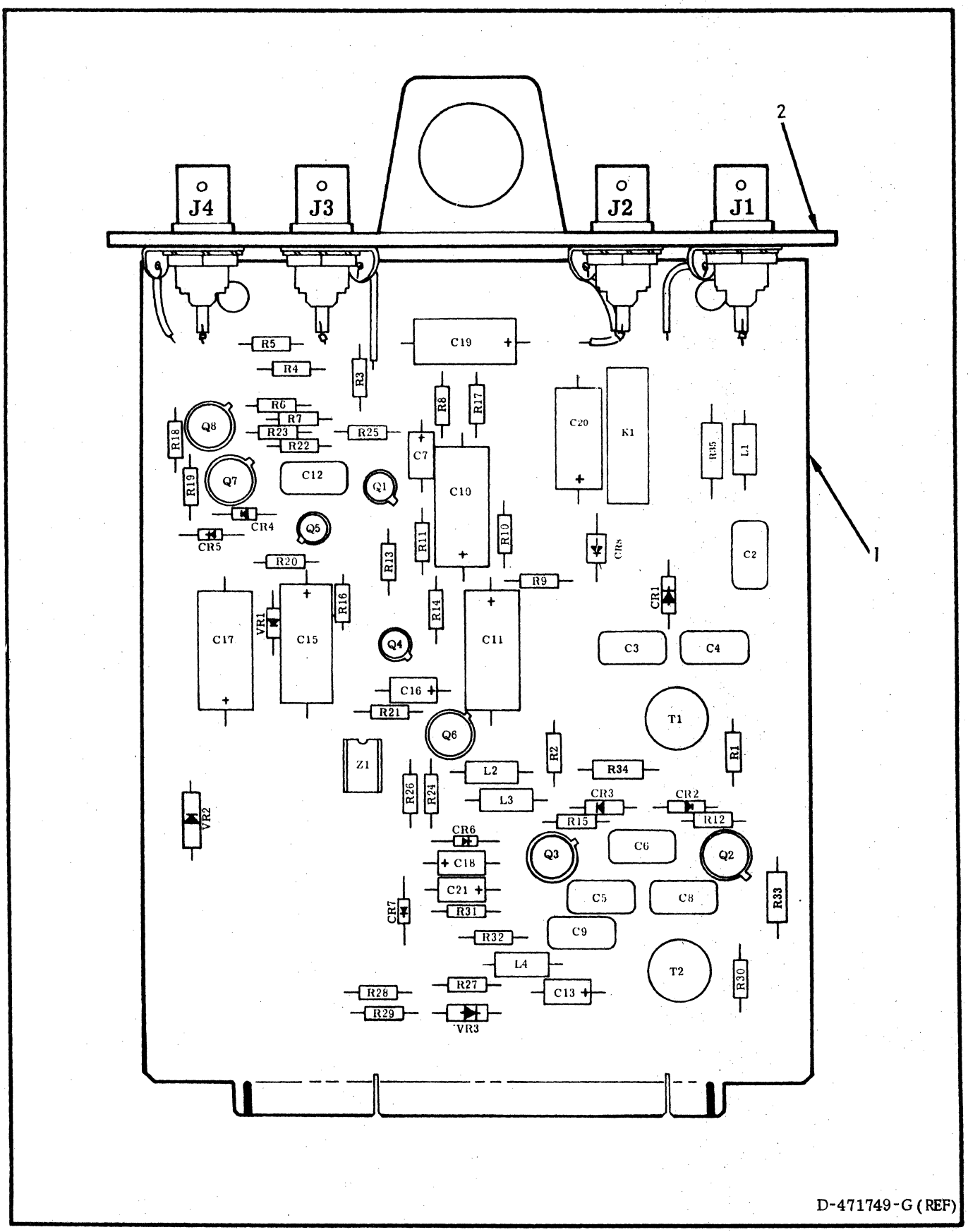


Figure 6-1. 13-544-2 Bias Buffer and Reference Amplifier

Table 6-2. Parts List for the 13-544-2 Bias Buffer and Reference Amplifier (Sheet 1 of 2)

ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	471749-1	Amplifier, bias buffer & reference	1	6-1		
2	471749	Printed Wiring Board	1	6-1/1		
3	471922-1222	Res, 1.2K ±2%, 1/4 w	1	R16	24546	C4-122G
4	471922-5122	Res, 5.1K ±2%, 1/4 w	3	R9,11,14	24546	C4-512G
5	471922-1022	Res, 1K ±2%, 1/4 w	11	R3,4,5,6,17,20, R21,28,29,31,32	24546	C4-102G
6	471922-3612	Res, 360Ω ±2%, 1/4 w	2	R1,2	24546	C4-361G
7	471922-1522	Res, 1.5K ±2%, 1/4 w	1	R7	24546	C4-152G
8	471922-5102	Res, 51Ω ±2%, 1/4 w	3	R13,27,30	24546	C4-510G
9	7138-9115	Res, 910Ω ±5%, 1/2 w	1	R35	78488	RC20GF911J
10	471922-2002	Res, 20Ω ±2%, 1/4 w	1	R18	24546	C4-200G
11	471922-2722	Res, 2.7K ±2%, 1/4 w	2	R10,19	24546	C4-272G
12	471922-1002	Res, 10Ω ±2%, 1/4 w	4	R12,15,22,23	24546	C4-100G
13	471922-2412	Res, 240Ω ±2%, 1/4 w	2	R8,25	24546	C4-241G
14	471922-2022	Res, 2K ±2%, 1/4 w	2	R24,26	24546	C4-202G
15	7138-5105	Res, 51Ω ±5%, 1/2 w	2	R33,34	78488	RC20GF510J
16	70094-8	Cap, 18 pf ±5%, 500 v	1	C2	72136	DM15C180J0 500WV5CR
17	471863-4	Cap, 10 μf ±20%, 20 v	5	C7,13,16,18,21	42451	T320B106M020AS
18	471930-0002	Cap, 50 μf +75 -10%, 16 v	2	C19,20	56289	500D506G016CB7
19	471930-0003	Cap, 100 μf +75 -10%, 16 v	4	C10,11,15,17	56289	500D107G016DC7
20	70094-33	Cap, 180 pf ±5%, 500 v	1	C12	72136	DM15F181J0 500WV5CR
21	70094-15	Cap, 36 pf ±5%, 500 v	2	C3,4	72136	DM15E360J0 500WV5CR

Table 6-2. Parts List for the 13-544-2 Bias Buffer and Reference Amplifier (Sheet 2 of 2)

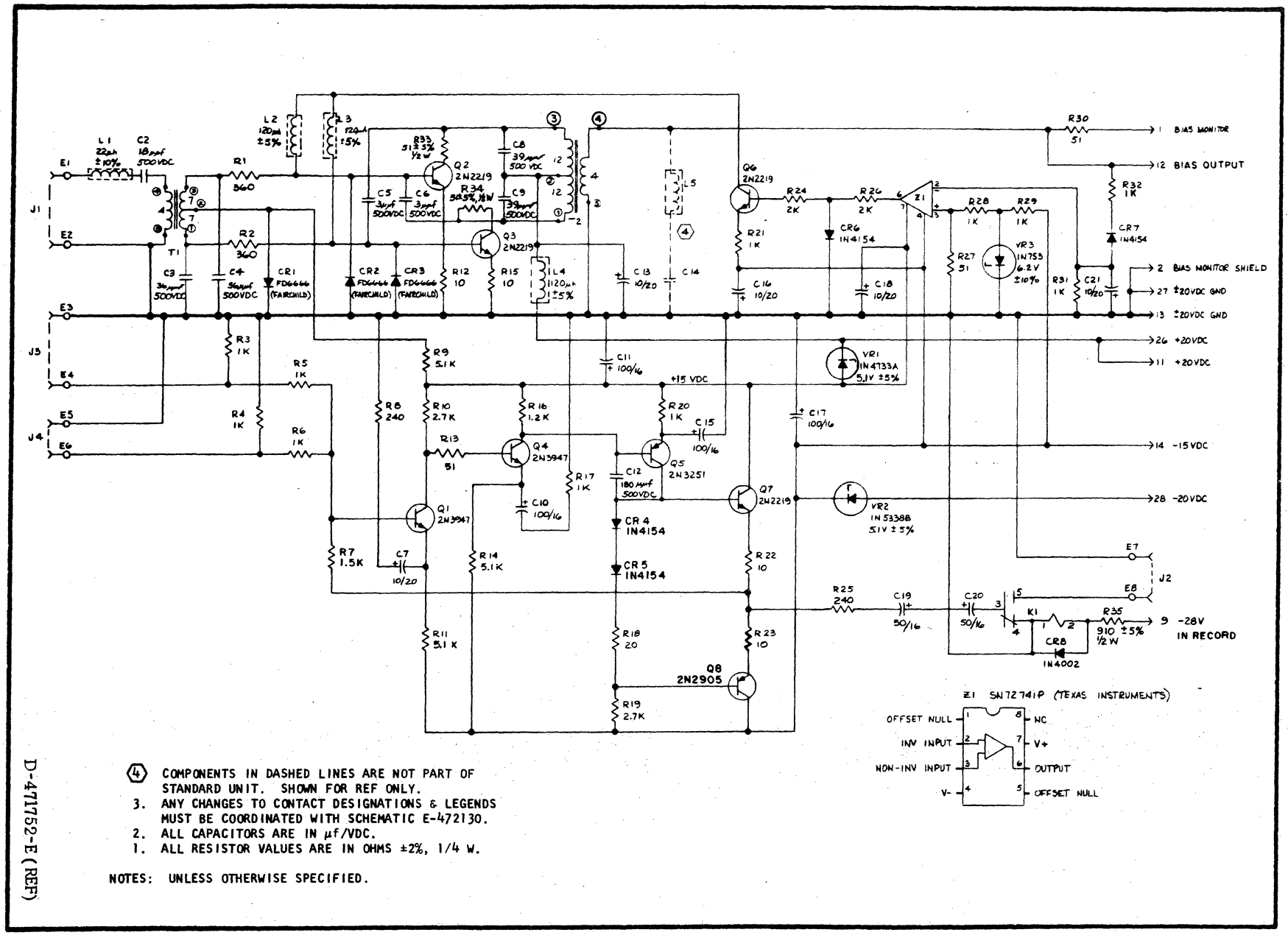
ITEM NO.	B&H PART NO.	DESCRIPTION 0 1 2 3 4 5	QTY	FIG./INDEX OR REF SYM	MFR CODE	MFR OR MIL PART NO.
1	70094-3	Cap, 3 pf ±0.5%, 500 v	2	C5, 6	72136	DM15C030J0 500WV5CR
2	70094-16	Cap, 39 pf ±5%, 500 v	2	C8, 9	72136	DM15E390J0 500WV5CR
3	471929	Diode, 50 v	3	CR1, 2, 3	13715	FD6666
4	378979-0006	Diode, zener, 1 w, 5.1 v ±5%	1	VR1	04713	1N4733A
5	246954	Diode	4	CR4, 5, 6, 7	03508	1N4154
6	471959-6	Diode, zener, 5 w, 5.1 v ±5%	1	VR2	04713	1N5338B
7	472466-23	Coil, 120 μh ±5%, 290 ma	3	L2, 3, 4	76493	9250-124
8	372295-1	Diode	1	CR8	01295	1N4002
9	215472-8	Diode, zener, 6.2 v ±10%, 400 mv	1	VR3	04713	1N753
10	472466-5	Coil, 22 μh ±10%, 600 ma	1	L1	76493	9250-223
11	471472	Transistor	2	Q1, 4	04713	2N3947
12	471927	Transistor	4	Q2, 3, 6, 7	04713	2N2219
13	471931	Transistor	1	Q5	04713	2N3251
14	471925	Transistor	1	Q8	04713	2N2905
15	471957	Integrated Circuit	1	Z1	01295	SN72741P
16	472071	Transformer	1	T1	14028	472071
17	246626-1	Relay	1	K1		
18	472072	Transformer	1	T2	14028	472072
19	471727	Bracket, electrical connector	1	6-1/2		
20	126732-31	Connector, BNC	4	J1, 2, 3, 4	96918	KC79-46
21	472132-6	Cable Assembly	1			

SECTION VII

DRAWINGS AND SCHEMATICS

7-1. GENERAL.

7-2. This section contains a schematic diagram for the 13-544-2 Bias Buffer and Reference Amplifier and a diagram for the circuit extender card.



4 COMPONENTS IN DASHED LINES ARE NOT PART OF STANDARD UNIT. SHOWN FOR REF ONLY.

3. ANY CHANGES TO CONTACT DESIGNATIONS & LEGENDS MUST BE COORDINATED WITH SCHEMATIC E-472130.
2. ALL CAPACITORS ARE IN μf/VDC.
1. ALL RESISTOR VALUES ARE IN OHMS ±2%, 1/4 W.

NOTES: UNLESS OTHERWISE SPECIFIED.

Figure 7-1. Schematic, 13-544-2 Bias Buffer and Reference Amplifier

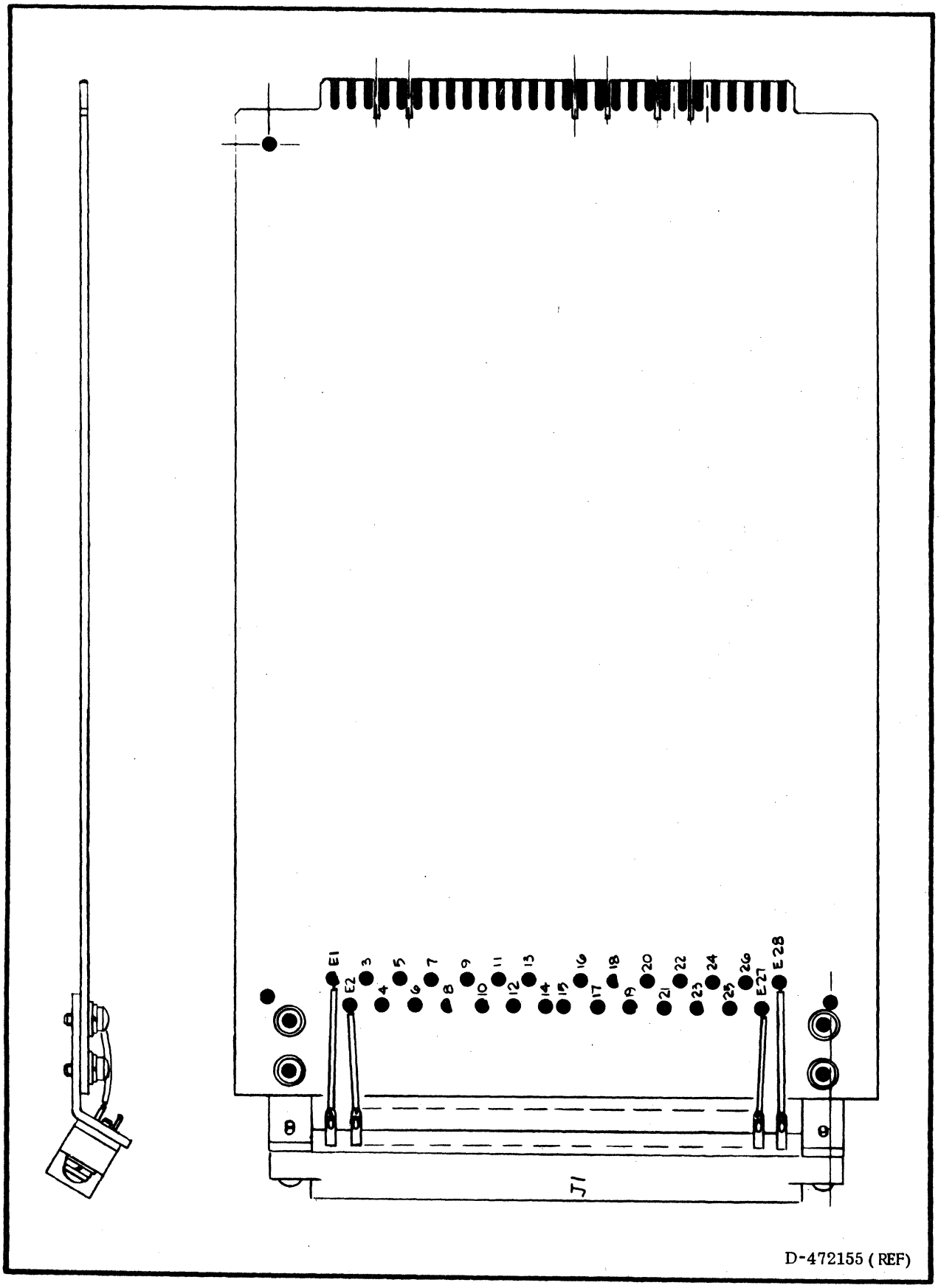


Figure 7-2. Circuit Extender Card