EAI®

580

ANALOG/HYBRID COMPUTING SYSTEM

MAINTENANCE SERIES

COMPUTING COMPONENTS

EAI® 580

ANALOG/HYBRID COMPUTING SYSTEM

MAINTENANCE SERIES

COMPUTING COMPONENTS

 • PRINTED IN U.S.A. • PUBL. NO. 00 800.2057-0 • MAY 1968

RELATED PUBLICATIONS

The table below lists other publications which may be of interest to the readers of this manual. Unless otherwise indicated by title or footnote, all are maintenance handbooks. Note that maintenance handbooks directly applicable to a particular system are normally supplied with the system.

Title	Publication Number
Handbook of Analog Computation	00 800.0001-3
Basics of Parallel Hybrid Computation	07 800.0016-0
580 Reference Handbook	00 800.2055-0
580 Console Components Manual	00 800.2056-0
580 Computing Components Manual	00 800.2057-0
580 Logic Expansion Group	00 800.2058-0
580/680 Digital Voltmeter, Model 26.268	00 800.2059-0
TR20/TR48 Repetitive Operation Display Units, Models 34.034 and 34.035	00 800.2024-1

NOTICE

In order to enable us to process your requests for spare parts and replacement items quickly and efficiently, we request your conformance with the following procedure:

1. Please specify the type number and serial number of the basic unit as well as the EAI part number and description of the part when inquiring about replacement items such as potentiometer assemblies or cups, relays, transformers, precision resistors, etc.

2. When inquiring about items as servo multipliers, resolvers, networks, printed circuit assemblies, etc., please specify the serial numbers of the major equipment with which the units are to be used, such as: Console, Type 8811, Memory Module, Type 4.204, Serial No. 000, etc. If at all possible, please include the purchase order or the EAI project number under which the equipment was originally procured.

Your cooperation in supplying the required information will speed the processing of your requests and aid in assuring that the correct items are supplied.

It is the policy of Electronic Associates, Inc. to supply equipment patterned as closely as possible to the requirements of the individual customer. This is accomplished, without incurring the prohibitive costs of custom design, by substituting new components, modifying standard components, etc., wherever necessary to expedite conformance with requirements. As a result, this instruction manual, which has been written to cover standard equipment, may not entirely concur in its content with the equipment supplied. It is felt, however, that a technically qualified person will find the manual a fully adequate guide in understanding, operating, and maintaining the equipment actually supplied.

Electronic Associates, Inc. reserves the right to make changes in design, or to make additions to or improvements in its product without imposing any obligation upon itself to install them on products previously manufactured.

Marketing Division

SALES OFFICE

EASTERN REGION

Eastern Regional Office: West Long Branch, N. J. 07764, Tel: 201-229-1100, TWX 710-722-6597, Telex 01-26655, Cable: PACE West Long Branch, N. J. 07764

Special System Department: West Long Branch, N. J. 07764, Tel: 201-229-1100, TWX 710-722-6597, Telex 01-26655, Cable: PACE West Long Branch, N. J. 07764

Customer Services: West Long Branch, N. J. 07764, Tel: 201-229-1100, TWX 710-722-6597, Telex 01-26655, Cable: PACE West Long Branch, N. J. 07764

Northeastern District Office: 875 Providence Highway, Dedham, Massachusetts 02026, Tel: 617-326-6756

Syracuse District Office: Pickard Building, Room 144-147, 5858 East Malloy Road, Syracuse, New York 13211, Tel: 315-455-5521

SOUTHEASTERN REGION

Southeastern Regional Office: 12260 Wilkins Avenue, Rockville, Maryland 20852, Tel: 301-933-4100

CENTRAL REGION

Central Regional Office: 33166 Des Plaines Ave., Des Plaines, Illinois 60018, Tel: 312-296-8171

Cleveland District Office: 6741 Ridge Road, Parma, Ohio 44129, Tel: 216-842-1840

SOUTHERN REGION

Southern Regional Office: 3514 Cedar Springs Road, Room 211, Dallas, Texas 75219, Tel: 214-528-4920

Houston District Office: 7007 Gulf Freeway, Room 128, Houston, Texas 77017, Tel: 713-MI 4-3678

Huntsville District Office: Holiday Office Center, Suite 2, 3322 South Memorial Parkway, Huntsville, Alabama 35801, Tel: 205-881-7031

WESTERN REGION

Western Regional Office: 1500 East Imperial Highway, El Segundo, California 90245, Tel: 213-322-3124, TWX 910-348-6284

San Francisco District Office: 4151 Middlefield Road, Palo Alto, California 94303, Tel: 415-321-0363, TWX 910-373-1241

Northwestern District Office: 1107 Northeast 45th St., Room 323, Seattle, Washington 98105, Tel: 206-632-7470

CUSTOMER SERVICES OFFICES

EASTERN REGION

Eastern U.S. Headquarters: West Long Branch, N. J. 07764, Tel: 201-229-1100, TWX 710-722-6597, Telex 01-26655, Cable: PACE West Long Branch, N. J. 07764

Northeastern District Office: 875 Providence Highway, Dedham, Massachusetts 02026, Telephone: 617-326-6756

Princeton, New Jersey: U.S. Route No. 1, P.O. Box 582, Princeton, New Jersey 08541, Telephone: 609-452-2900

Resident Field Engineers: Bedford, Mass./Florham Park, N. J./Washington, D. C./Baltimore, Md./Eatontown, N. J.

SOUTHEASTERN REGION

Southeastern Regional Office: 12260 Wilkins Avenue, Rockville, Maryland 20852, Telephone: 301-933-4100

CENTRAL REGION

Central Regional Office: 3166 Des Plaines Avenue, Des Plaines, Illinois 60018, Telephone: 312-296-8171

Cleveland District Office: 6741 Ridge Road, Parma, Ohio 44129, Telephone: 216-842-1840

Resident Field Engineers: Detroit, Michigan/Pittsburgh, Pennsylvania/Dayton, Ohio/Warren, Michigan

SOUTHERN REGION

Southern Regional Office: 3514 Cedar Springs Road, Room 211, Dallas, Texas 75219, Telephone: 214-528-4920

Houston District Office: 7007 Gulf Freeway, Room 128, Houston, Texas 77017, Tel: 713-MI 4-3678

Huntsville District Office: Holiday Office Center, Suite 2, 3322 South Memorial Parkway, Huntsville, Alabama 35801, Telephone: 205-881-7031

Resident Field Engineers: San Antonio, Texas/Alamogordo, New Mexico/Tulsa, Oklahoma/Houston, Texas

WESTERN REGION

Western U.S. Headquarters: CUSTOMER REPAIR FACILITY, 1500 East Imperial Highway, El Segundo, California 90245, Telephone: 213-322-3220, TWX 910-348-6284

Western U.S. Headquarters: CUSTOMER SERVICES FACILITY, 1500 East Imperial Highway, El Segundo, California 90245, Telephone: 213-322-3220, TWX 910-348-6284

San Francisco District Office: 4151 Middlefield Road, Palo Alto, California 94303, Tel: 415-321-0363, TWX 910-373-1241

Resident Field Engineers: Edwards, California/Pasadena, California/Moffet Field, California/Martin Marietta Corp., Denver, Colorado/Ryan Aeronautical, San Diego, California

CANADA

Toronto Office: Allan Crawford Associates, Ltd., 65 Martin Ross Avenue, Downsview Ontario, Canada, Tel: 416-636-4910

ANALYSIS AND COMPUTATION CENTERS

Princeton Analysis and Computation Center: U.S. Route No. 1, P. O. Box 582, Princeton, New Jersey 08541, Telephone: 609-452-2900

Los Angeles Analysis and Computation Center: 1500 East Imperial Highway, El Segundo, California 90245, Telephone: 213-322-3220, TWX 910-348-6284

San Francisco Analysis and Computation Center: 4151 Middlefield Road, Palo Alto, California 94303, Tel: 415-321-0363, TWX 910-373-1241

Washington, D. C. Analysis and Computation Center: 12260 Wilkins Avenue, Rockville, Maryland 20852, Tel: 301-933-4100

Houston Analysis and Computation Center: 7007 Gulf Freeway, Room 128, Houston, Texas 77017, Tel: 713 MI 4-3678

Engineering and Manufacturing Division

Engineering Department: West Long Branch, N. J. 07764, Tel: 201-229-1100, TWX 710-722-6597, Telex 01-26655, Cable: PACE West Long Branch, N. J. 07764

Manufacturing Department: West Long Branch, N. J. 07764, Tel: 201-229-1100, TWX 710-722-6597, Telex 01-26655, Cable: PACE West Long Branch, N. J. 07764

Other Departments, Divisions and Subsidiaries

Instrument Division: Long Branch, N. J. 07740, Tel. 201-229-4400, TWX 710-722-6597, Cable: PACE West Long Branch, N. J. 07740

Pacific Data Systems, Inc.: 644 Young Street, Santa Ana, California 92705, Tel. 714-540-3610, TWX 714-546-3049

Scientific Instruments Department: 4151 Middlefield Road, Palo Alto, California 94303, Tel: 415-321-7801, TWX 910-373-1241

INTERNATIONAL SALES & CUSTOMER SERVICES OFFICES

UNITED KINGDOM & SCANDINAVIA

Electronic Associates, Ltd.: Burgess Hill, Sussex, England, Tel: Burgess Hill (Sussex) 5101-10, 5201-5, Telex: 87183, Cable: PACE Burgess Hill

Northern Area Office: Roberts House, Manchester Road, Altrincham, Cheshire, Tel: Altrincham 5426

SWEDEN

EAI-Electronic Associates-AB: Hagavagen 14, Solna 3, Sweden, Tel: Stockholm 82-40-96; 82-40-97, 83-38-60, Telex Stockholm 10064, Cable: PACE STOCKHOLM

EUROPEAN CONTINENT

EAI-European Continental Regional Office: Centre International, 22nd Floor, Place Rogier, Brussels 1, Belgium, Tel: Brussels 18-40-04, Telex: 2.21-106, Cable: PACEBELG Brussels

FRANCE

EAI Electronic Associates SARL: 72-74, rue de la Tombe Issoire, Paris 14e, France, Tel: 535.01.07, Telex 27610

GERMANY

EAI-Electronic Associates GMBH: 5100 Aachen, Bergdriesch 37, West Germany, Tel: Aachen 2 60 42; 2 60 41, Telex 832.676 eai d

AUSTRALIA & NEW ZEALAND

EAI-Electronic Associates, Pty., Ltd.: 26 Albany St., Leonards, N.S.W. Australia, Tel: 43-7522, Cable: PACEAUS, Sydney

Victorian Office: 34 Queens Road, Melbourne S. C. 2, Australia, Tel: 26-1329, Cable: PACEAUS, Melbourne

JAPAN

EAI-Electronic Associates (Japan), Inc.: 9th Mori Building, 1-3 Shiba-Atago-cho, Minato-Ku, Tokyo, Japan, Tel: 433-4671, Telex: 7814285, Cable: EAIJAPACE

ENGINEERING AND MANUFACTURING

Electronic Associates, Ltd.: Burgess Hill, Sussex, England, Tel: Burgess Hill (Sussex) 5101-10, 5201-5, Telex: 87183, Cable: PACE BURGESS HILL

MEXICO

EAI-Electronic Associates, S.A. de C.V.: Darwin #142, Planta Baja, Col. Anzures, Mexico 5, D.F., Tel: 28-55-13, Cable: PACEMEX

COMPUTATION CENTERS

European Computation Center: Centre International, 22nd Floor, Place Rogier, Brussels 1, Belgium, Tel: Brussels 18-40-04, Telex: 2.21-106, Cable: PACEBELG Brussels

United Kingdom Computation Center: Electronic Associates, Ltd., Burgess Hill, Sussex, England, Tel: Burgess Hill (Sussex) 5101-10, Telex: 871-183, Cable: PACE BURGESS HILL

Australian Computation Center: 34 Queens Road, Melbourne S. C. 2, Australia, Tel: 26-1329, Cable: PACEAUS, Melbourne

EAI®
ELECTRONIC ASSOCIATES, INC. *West Long Branch, New Jersey 07764*

ADVANCED SYSTEMS ANALYSIS AND COMPUTATION SERVICES/ANALOG COMPUTERS/DIGITAL COMPUTERS/HYBRID ANALOG-DIGITAL COMPUTATION EQUIPMENT/ANALOG AND DIGITAL PLOTTERS/SIMULATION SYSTEMS/SCIENTIFIC AND LABORATORY INSTRUMENTS/INDUSTRIAL PROCESS CONTROL SYSTEMS/PHOTOGRAMMETRIC EQUIPMENT/RANGE INSTRUMENTATION SYSTEMS/TEST AND CHECK-OUT SYSTEMS/MILITARY AND INDUSTRIAL RESEARCH AND DEVELOPMENT SERVICES/FIELD ENGINEERING AND EQUIPMENT MAINTENANCE SERVICES.

Printed in U.S.A.

Bulletin No. IL-64104-10

CONTENTS

CONTENTS (Cont)

CONTENTS (Cont)

CONTENTS (Cont)

ILLUSTRATIONS

ILLUSTRATIONS (Cont)

SECTION 1

LINEAR COMPONENTS

CHAPTER 1

DUAL DC AMPLIFIER 6.614-1

1.1 INTRODUCTION

The Dual DC Amplifier Tray, Model 6.614-1 (Figure 1.1) is installed in the positions shown in Figure 1.2. The tray contains two etched-circuit boards; one contains two independent high-gain amplifiers, the other contains two independent precision resistor networks which provide input and feedback components for the two amplifiers. These amplifiers are transistorized and designed for optimum stability and frequency response. Each amplifier may be used in conjunction with its provided network to perform linear computations such as summation, integration, and multiplication by a constant. Accessory components allow use of the amplifier for operations such as multiplication and division of variables and the generation of analytic or arbitrary functions.

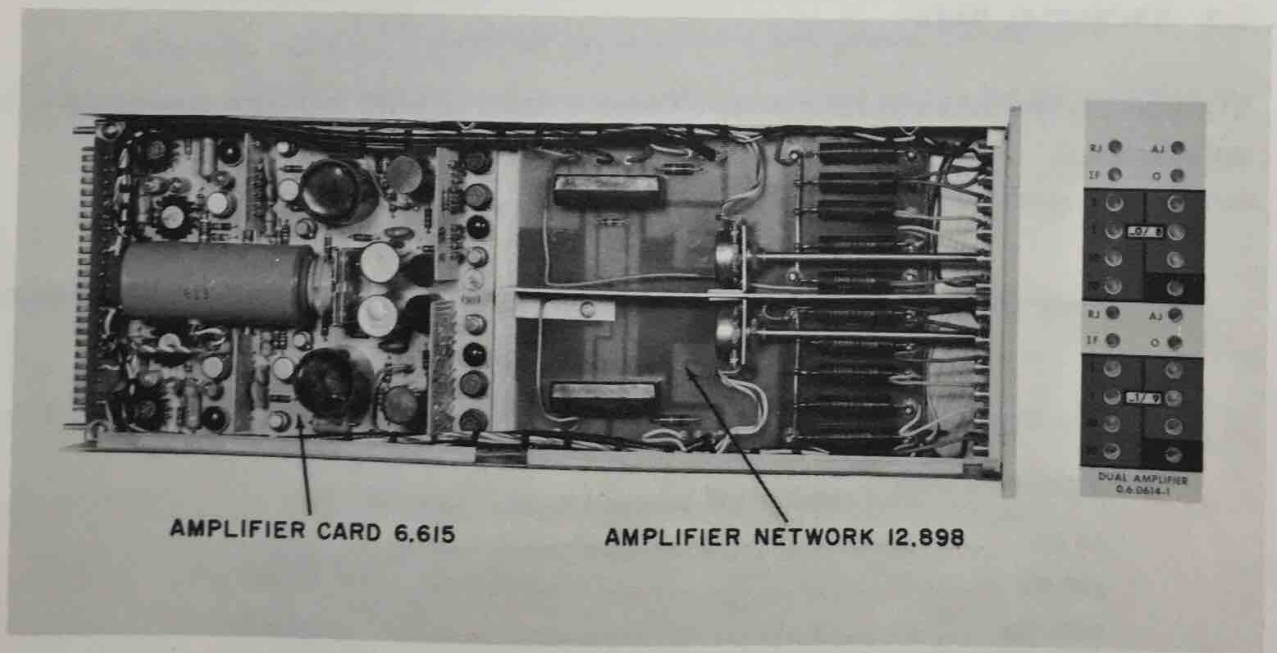


Figure 1.1. Dual DC Amplifier, Model 0.6.0614-1

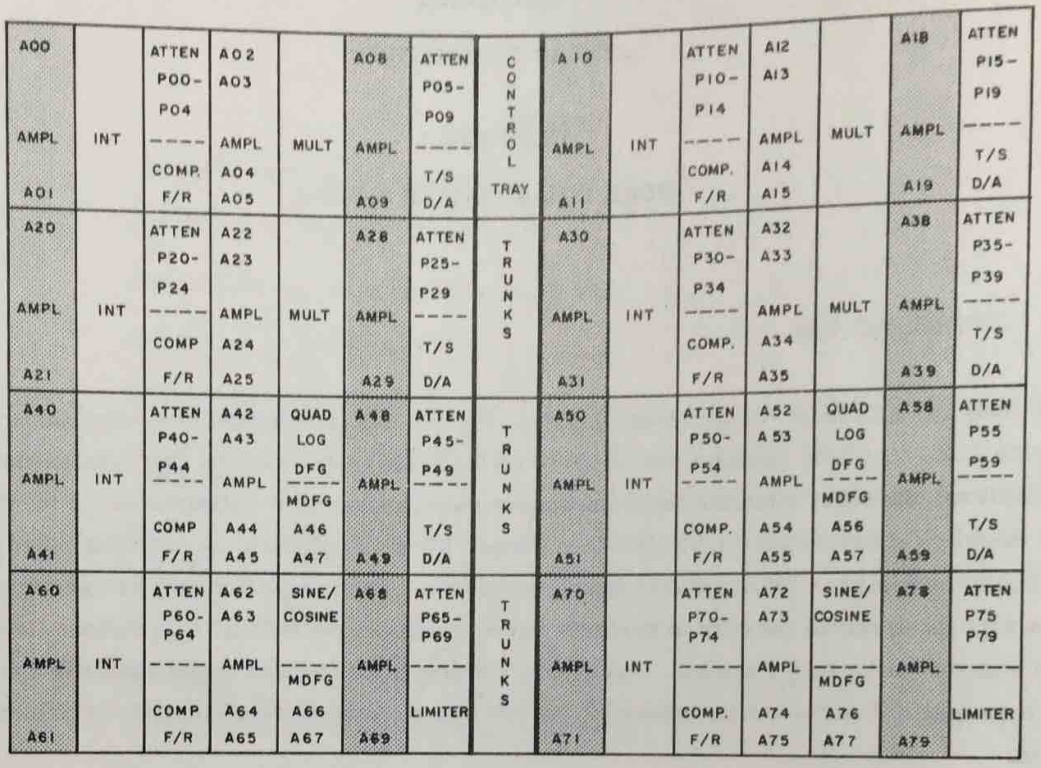


Figure 1.2. Location of Dual DC Amplifiers

1.2 TECHNICAL DATA

The following specifications refer to the complete 6.614-1 Dual DC Amplifier when operated in the computer.

Offset

Unity-Gain Inverter ..... 20 Microvolts, Maximum

Noise

Full Bandwidth ..... 1.5 Microvolts, Peak-to-Peak

Low Frequency Gain

10 Hz ..... 86 db
100 Hz ..... 80 db
1000 Hz ..... 70.6 db

Frequency Response (3 db) for Unit Gain Inverter

With 10k ..... 400 kHz, Minimum
With 100k ..... 125 kHz, Minimum

1.3 OPERATING CONSIDERATIONS

The data in this paragraph is general operating information. The maintenance personnel should be familiar with this material to assist in rapidly isolating amplifier troubles and to eliminate causes of apparent faults due to improper amplifier usage.

1.3.1 Amplifier Balancing

The amplifiers should be periodically balanced to assure computer accuracy. Under normal circumstances, the amplifier will remain balanced for periods of weeks. However, at intervals it is desirable to check this condition, and if an amplifier is found to be unbalanced, then an adjustment should be made. The period between balance checks depends to a large extent on the application of the amplifier. For uses which might be unusually sensitive to amplifier unbalance, maintenance personnel should recognize the fact that most amplifier and network malfunctions can be detected by checking amplifier balance. Consequently, it is recommended that a check of amplifier balance be made once a week. If the check indicates that the amplifier balance is within tolerance, no adjustment need be made.

To balance an amplifier, proceed as follows:

1. Place the computer in the *SP* mode and remove the pre-patch panel.
2. Rotate the voltmeter FUNCTION switch to the A BAL (balance) position.
3. Depress the A Selector button, and the Address selector buttons for the amplifier to be balanced.
4. Vary the appropriate balance potentiometer until the meter shows the least deflection.

NOTE

Initially, more frequent balancing of amplifiers may be required. Movement of the computer to different areas with extreme change in ambient conditions (or extreme change at the same location) may also necessitate amplifier balancing.

Overload of an unassigned amplifier will neither damage the amplifier nor affect the problem solution. The fact that one or more unassigned amplifier overload lamps are lit, however, may cause the operator to overlook overloading of an assigned amplifier. This will cause an erroneous problem solution, thus defeating the purpose of the overload alarm system.

When power is initially applied to the computer, all of the overload lamps light; after a few seconds all of the lamps should go out. The lamps may also momentarily flicker when switching from *set pot* to some other computer mode.

1.3.2 Amplifier Patching

The input and output terminations of the dual high-gain amplifiers and the dual resistor networks are terminated at the pre-patch panel and arranged for patching ease. The non-linear components are also located in close proximity to the amplifiers for ease of patching and short patch cord runs or use of bottle plugs.

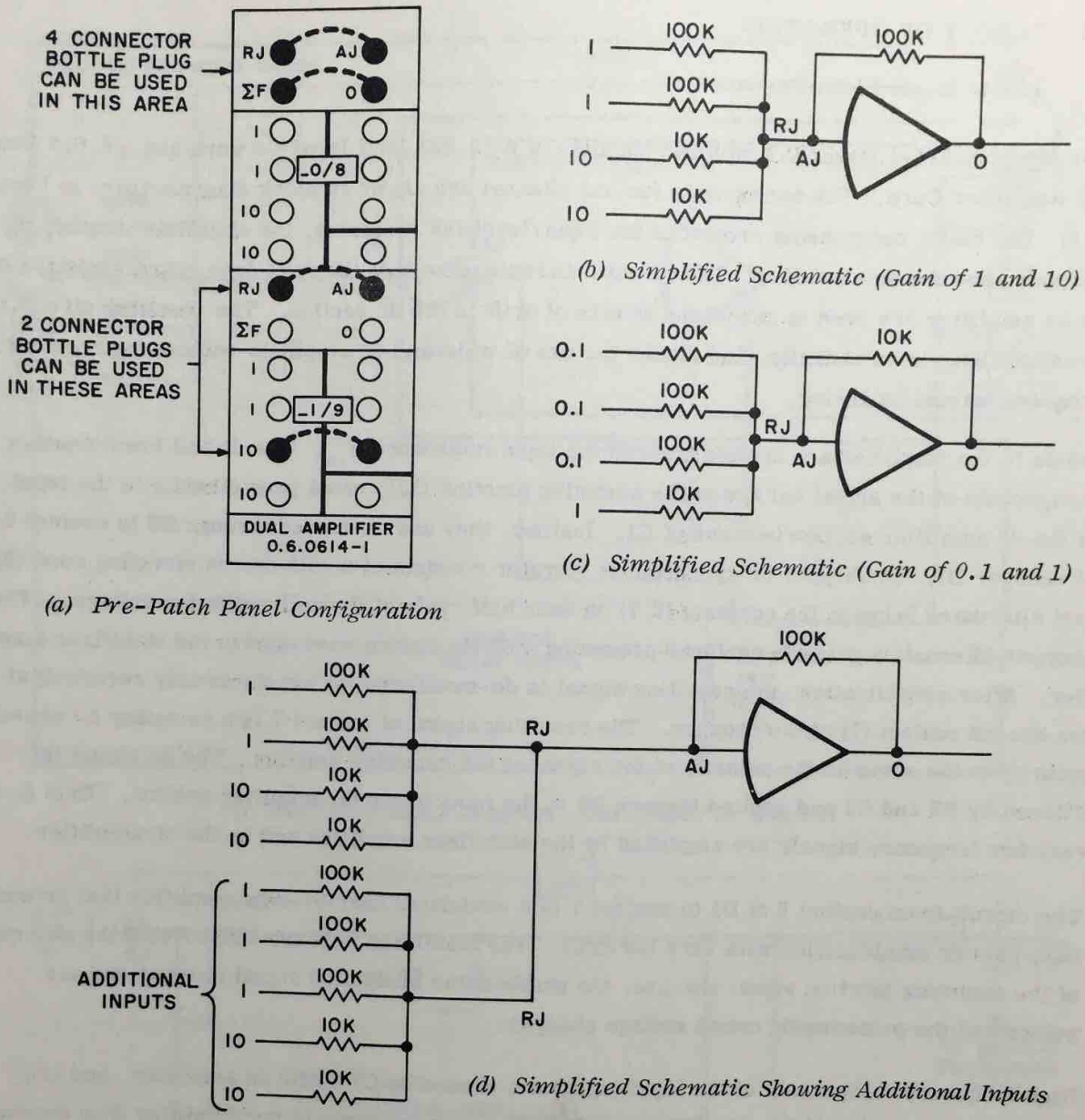
Patching, when using an amplifier in conjunction with an integrator network, track/store network, or one of the non-linear components, is covered in the chapters describing these units. This section is therefore limited to the description of an amplifier used in conjunction with a resistor network.

Figure 1.3a illustrates two of the more common amplifier patching arrangements. The upper amplifier makes use of the standard 4-connector bottle plug and provides a summing circuit as shown schematically in Figure 1.3b. This configuration has two gain-of-one and two gain-of-ten inputs for summing, inversion, or multiplication.

The lower amplifier of Figure 1.3a is shown patched for one gain-of-one and three gain-of-one tenth inputs by using two, 2-connector bottle plugs. The simplified schematic of the configuration is shown in Figure 1.3c. By connecting the RJ terminals of different amplifier resistor networks together, additional inputs are made available, as shown in Figure 1.3d.

As previously indicated, these are only two of many possible amplifier configurations. An important point to note is that *all amplifiers*, whether used (assigned) or unused (unassigned) for a particular problem solution, *must be provided with feedback*. Failure to provide a feedback circuit for an amplifier will cause that amplifier to overload as soon as the computer is switched to any mode other than *SP*.

The dc operational amplifiers are rated for normal linear operational outputs of ±10 volts maximum. Thus the amplifier patching arrangements, regardless of the application, should be such that the output level does not exceed either plus or minus 10 volts. (The amplifiers are capable of slightly higher linear outputs to allow for minor scaling discrepancies.)



(a) Pre-Patch Panel Configuration

(b) Simplified Schematic (Gain of 1 and 10)

(c) Simplified Schematic (Gain of 0.1 and 1)

(d) Simplified Schematic Showing Additional Inputs

Figure 1.3. Amplifier Patching, Typical Configuration

1.3.3 Amplifier Overload

The overload system provides a visual indication to the operator when an amplifier summing junction error exceeds a tolerable limit. The overloading of an assigned amplifier indicates that an error is induced in the problem solution at the instant of overload. An overload may be due to improper scaling or patching; in some cases, a momentary overload may not induce appreciable error and the operator may choose to neglect the indication. Prolonged overload *will not* damage the amplifier unless caused by excessively high voltages other than those normally obtainable from the computer itself, or unless carelessly allowed to continue for several hours.

1.4 THEORY OF OPERATION

1.4.1 Basic Block Diagram

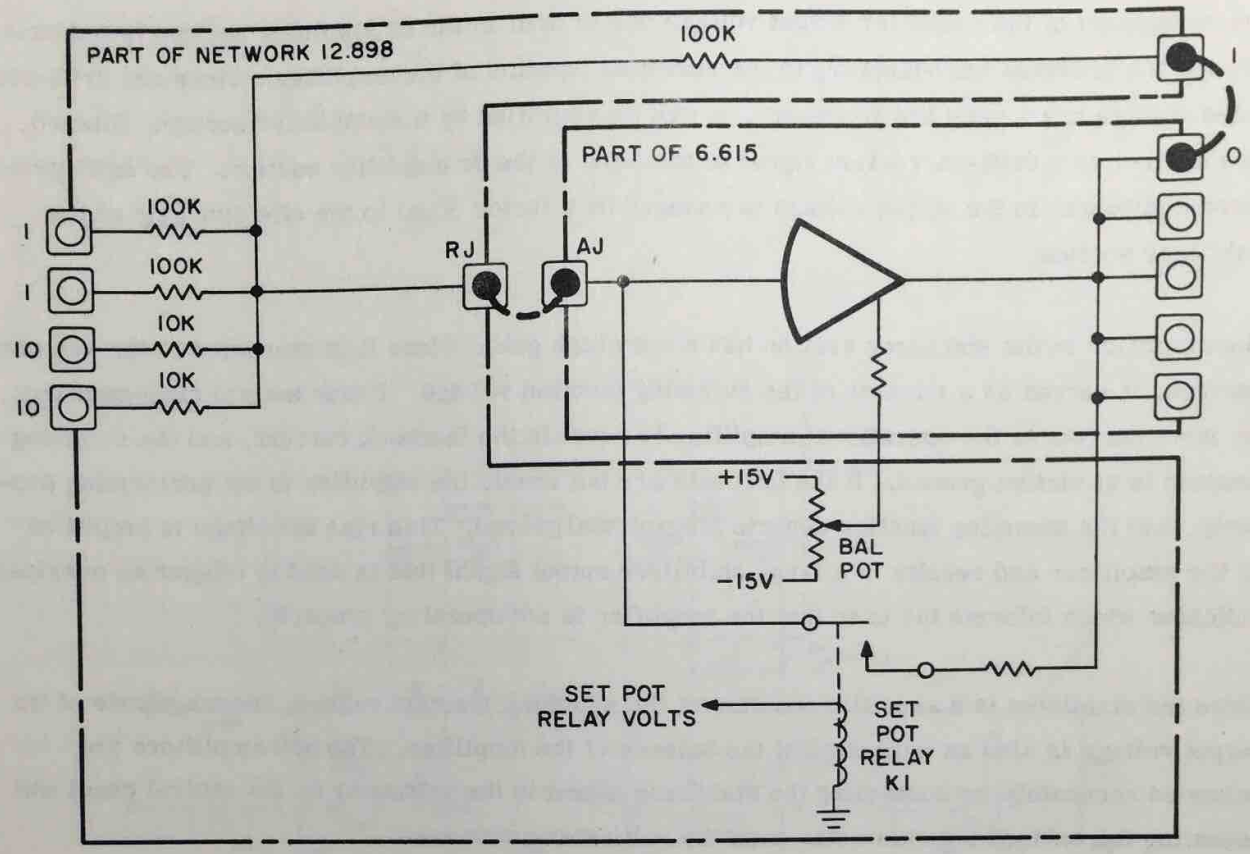
The Model 6.614-1 Dual DC Amplifier consists of a 12.898 Dual Input Network and a 6.615 Dual DC Amplifier Card. The components for one channel are shown in block diagram form in Figure 1.4. The major components consist of the input/feedback resistors, the stabilizer amplifier, the chopper, and the dc amplifier. The circuit is arranged so that the drift-free characteristics of an ac amplifier are used to cancel the effects of drift in the dc section. The resulting circuit has excellent long-term stability, and allows the use of wideband dc amplifier without the necessity of frequent manual balancing.

Inputs to the amplifier are applied through the input impedance Z_{in}. The dc and low frequency components of the signal voltage at the summing junction (SJ) cannot pass directly to the input of the dc amplifier section because of C1. Instead, they are connected through R3 to contact 9 of chopper D1. (A chopper or synchronous vibrator consists of a coil-driven vibrating reed (8) that alternates between the contacts (9,7) on each half cycle of the coil excitation voltage.) The chopper alternately grounds contact 9 producing a 60 Hz square wave input to the stabilizer amplifier. After amplification, the resulting signal is de-modulated (or synchronously rectified) at the second contact (7) of the chopper. The resulting signal at contact 7 is a pulsating dc whose polarity is the same as the polarity of the signal at the summing junction. The dc signal is filtered by R6 and C2 and applied through R5 to the input to the dc amplifier section. Thus dc or very low frequency signals are amplified by the stabilizer amplifier and by the dc amplifier.

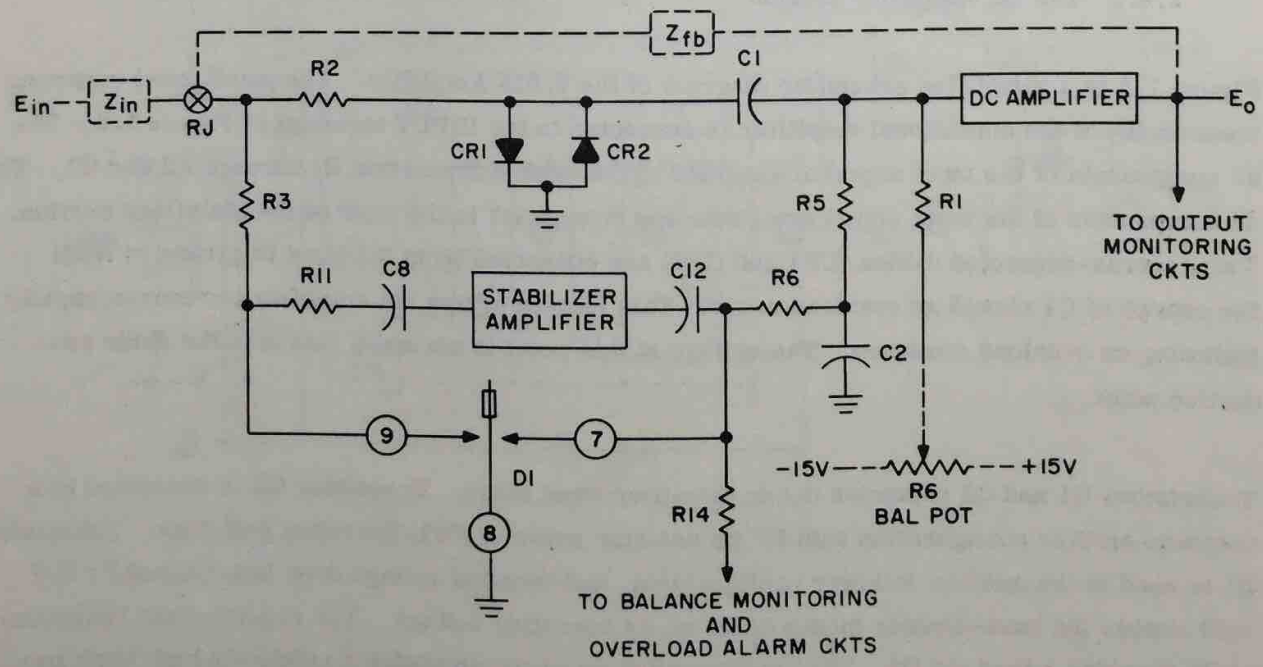
The circuit from contact 9 of D1 to contact 7 is a modulated carrier-type amplifier that provides high-gain dc amplification with very low drift. The stabilizer is phase sensitive; if the polarity of the summing junction signal changes, the phase of the modulated signal changes and the polarity of the pulsating dc output voltage changes.

High frequency components of the input signal are passed by C1 to the dc amplifier, and are amplified by the gain of the dc amplifier only. The open loop gain of the amplifier thus depends on the frequency of the input signal. At very low frequencies, the gain is extremely high because the stabilizer amplifier is placed in series with the dc amplifier. At higher frequencies, the gain is decreased but remains high enough to satisfy all expected computer operations.

One of the criteria for a high quality operational amplifier is that the output voltage be zero when the input voltage is zero. This zero correspondence between input and output voltages is called amplifier balance. The manual adjustment process to insure this correspondence is called balancing and it must be accurately made, following the procedure described in Sub-Paragraph 1.3.1. The amplifier would require more frequent balancing without stabilization. The drift compensation produced by chopper stabilization allows the amplifier to be used for weeks without attention.



(a) Simplified Block Diagram, One Amplifier Channel



(b) 6.615 Amplifier Card, Simplified Block Diagram, One Channel

Figure 1.4. 0.6.0614-1 Amplifier, Block Diagram

Any component of the amplifier output voltage due to drift in the dc amplifier section is fed back through the feedback impedance Z_f to the summing junction of the amplifier. Since any drift-produced voltage has a very low frequency, it will be amplified by the stabilizer section, filtered, then applied as a drift-correction signal to the input of the dc amplifier section. The drift-produced component in the output voltage is reduced by a factor equal to the effective gain of the stabilizer section.

The amplifier in the stabilizer section has a very high gain. Since it is connected to the summing junction, it serves as a monitor of the summing junction voltage. Under normal circumstances, the input current of the operational amplifier is equal to the feedback current, and the summing junction is at virtual ground. If the currents are not equal, the amplifier is not performing properly, and the summing junction departs from virtual ground. This rise in voltage is amplified by the stabilizer and results in a large stabilizer output signal that is used to trigger an overload indicator which informs the user that the amplifier is not operating properly.

Since the stabilizer is a sensitive monitor of the summing junction voltage, the magnitude of its output voltage is also an indication of the balance of the amplifier. The 580 amplifiers are balanced accurately by connecting the stabilizer output to the voltmeter on the control panel and adjusting the balance potentiometer until the voltmeter reads zero.

1.4.2 The DC Amplifier Section

Figure 1.5 is a simplified schematic diagram of the 6.615 Amplifier. The patch panel summing junction (B) of the operational amplifier is connected to the INPUT terminal of Figure 1.5. The ac components of the input signal are applied to the base of transistor Q1 through R2 and C1. The dc components of the input signal are connected through R3 to the input of the stabilizer section. Two reverse-connected diodes (CR1 and CR2) are connected from the input to ground to limit the charge of C1 should an overload occur. This feature allows the amplifier to recover rapidly following an overload condition. The voltage at this point is normally less than the diode conduction point.

Transistors Q1 and Q2 comprise the dc amplifier input stage. Transistor Q2 is connected in a common-emitter configuration with R7 (in resistor network NW1) providing self-bias. Transistor Q1 is used in the emitter-follower configuration, and uses the voltage drop (approximately 0.3 volt) across the base-emitter diodes of Q2 as its operating voltage. The emitter-base resistance of Q2 provides a load for Q1. This configuration gives the amplifier a relatively high input impedance. The base circuit of Q1 is completed through R1, and the balance potentiometer. These components form a voltage divider between -15 volts and +15 volts. The balance potentiometer sets the optimum operating point for Q1, as indicated by a zero output from the stabilizer section.

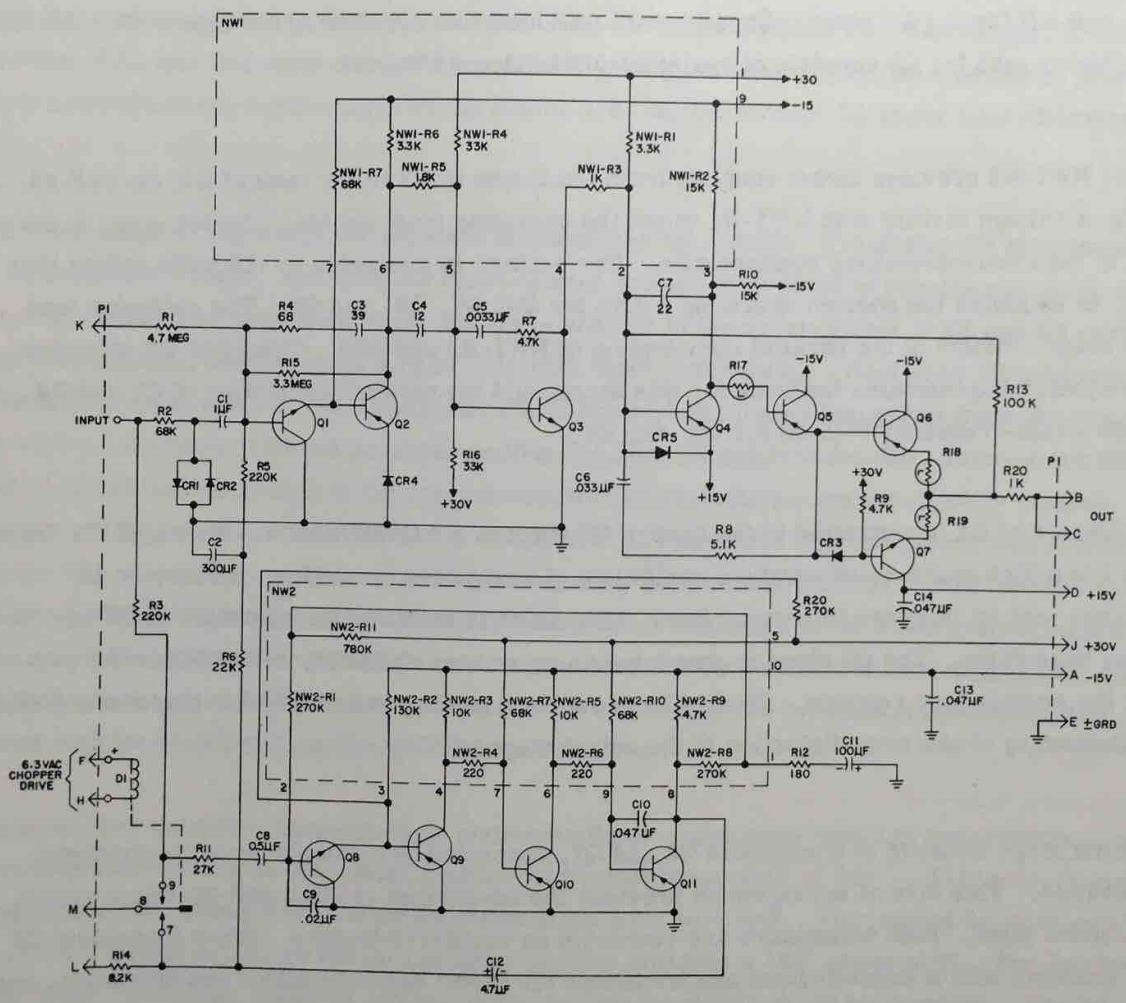


Figure 1.5. 0.6.0615 Amplifier Card, Simplified Schematic

The high-frequency roll-off of the input stage is controlled by C3 and R4, which provides an increasing degenerative feedback from the collector of Q2 to the base of Q1 with an increase in frequency. A dc feedback is provided by R15 which tends to keep the collector of Q2 at the same potential, regardless of temperature variations which affect the conductivity of Q1 and Q2. The stabilizer output is connected through R6 and R5 to the input of Q1.

The output of Q2 is coupled to the base of Q3 through NW1-R5. Bias for Q3 is provided by NW1-R4, NW1-R5, and R16. The feedback network consisting of R7 and C5 provides high-frequency roll-off for the Q3 stage. Capacitor C4 provides correct phasing for higher frequencies. The collector load for Q3 consists of resistors NW1-R3 and NW1-R1

Resistor NW1-R3 provides direct coupling from the output of Q3 to the base of Q4, as well as forming a voltage divider with NW1-R1 to set the operating point for Q4. The Q4 stage is connected in the common-emitter configuration. The emitter is connected to +15 volts rather than ground, to establish the correct operating points for Q4, Q5, Q6, and Q7. The collector load for the stage consists of the parallel combination of NW1-R2 and R10. Capacitor C7 provides high-frequency degenerative feedback for this stage, and the network consisting of C6 and R8 provides a high-frequency roll-off for Q4, and Q5.

The collector of Q4 is connected to the base of Q5 through a current limiting device, R17. This device has a high positive temperature coefficient of resistance, providing an increase in resistance with an increase in current flow. This helps to stabilize the operation of Q5 by limiting base drive. The Q5 stage is connected as an emitter-follower, with resistor R9 providing the emitter load resistor. Diode CR3 provides a small forward bias for output transistor Q7, eliminating cross-over distortion in the output stage.

The output stage consists of transistors Q6 and Q7, connected in a complementary-symmetry configuration. This circuit arrangement provides the advantages of push-pull operation with a single-ended input. Both transistors are connected as emitter-followers. Since transistor Q6 (PNP) conducts with a *negative* input and transistor Q7 (NPN) conducts with a *positive* input, one of the transistors delivers current to the load regardless of input polarity. With a zero input, both transistors conduct equally, and the voltage drop across the load is zero. Current limiting devices R18 and R19 perform a function similar to that of R17; by providing an increase in resistance with an increase in current, they protect the output transistors from excessive current flow. Resistor R13 provides a dc feedback to the base of Q4 which tends to keep the output of the amplifier at zero volt with a zero input and compensates for minor transistor and temperature variation.

1.4.3 The Stabilizer Section

The stabilizer section consists of a four stage direct-coupled amplifier (Q8, Q9, Q10, and Q11), input and output coupling capacitors (C8 and C12 respectively), and a 60 Hz chopper (D1). The stabilizer pre-amplifies the dc and very low frequency components of the signal appearing at the amplifier summing junction, and applies the resulting signal as an input to the dc amplifier section.

1.4.3.1 *The Stabilizer Amplifier.* The stabilizer amplifier receives its input from the summing junction through resistors R3, R11 and capacitor C8. The chopper grounds the junction of R3 and R11 sixty times each second, making the input appear as a series of pulses between ground and the input level. These pulses are coupled through C8 to the base of transistor Q8.

The input stage of the stabilizer consists of transistor Q8 and Q9. Transistor Q8 is connected as an emitter-follower, and uses the base-emitter voltage drop of Q9 to provide operating voltage. The circuit arrangement of Q8 and Q9 is similar to the arrangement of Q1 and Q2 in the dc amplifier section, and provides a relatively high input impedance. Resistors NW2-R1 and NW2-R11 provide bias for Q8. Capacitor C9 filters high frequency transients from the input waveform. Resistor NW2-R2 provides emitter load for Q8 and bias for Q9. Transistors Q9, Q10, and Q11 are connected in the common-emitter configuration, and are directly coupled through resistors NW2-R4 and NW2-R6. Capacitor C10 provides high-frequency degeneration for the Q11 stage, removing unwanted high frequency components from the output waveform. Resistor NW2-R8 provides a feedback to the junction of NW2-R1 and NW2-R11, adjusting the bias on Q8 to maintain the stabilizer amplifier transistors at the correct operating point. The network consisting of R12 and C11 provides phase correction for very low frequencies, and filters high frequencies from the NW2-R8 feedback loop.

The stabilizer amplifier consists of an emitter-follower input stage which is non-inverting, and three common-emitter stages which provide an overall phase shift of 540°. This would constitute an apparent 180° phase shift, or an inversion from input to output. This cannot be tolerated by the overall amplifier, since the dc amplifier section provides a 180° phase shift. Any feedback under these conditions would be regenerative, and the amplifier would be unusable. For this reason, contacts 7 and 8 of the chopper demodulate the output of the stabilizer amplifier, to provide a pulsed output to the filter network (R6 and C2) having the *same* polarity as the input. This is accomplished as described below.

1.4.3.2 *The Chopper.* The chopper used in the 6.615 Amplifier is a specially designed high-speed relay. It consists of a double-pole armature assembly which is driven by a 60 Hz ac source, and which alternates in position from one set of contacts to the other at this rate.

Figure 1.4 shows how one pole of the chopper (pin 8) alternately grounds the stabilizer input (pin 9) and the stabilizer output (pin 7). The closing of contacts 8 and 9 at a 60-cycle rate causes the stabilizer input to appear as a series of pulses as described previously. This permits amplification of very low frequencies or dc levels, while isolating the amplifier operating levels through the use of a coupling capacitor. Contacts 8 and 7 effectively shift the phase of the output by providing a short RC charge or discharge time for C12 when closed, and a longer time (through R6) when open. This operation is more easily understood with the use of examples.

If the input to the summing junction tends to go positive, the input to the stabilizer amplifier consists of a series of positive pulses. The output waveform at the collector of Q11 then consists of a series of negative going pulses. Note, however, that during the time that the input pulse is present (positive), the output (negative) at the junction of C12 and R6 is connected to ground through contacts 7 and 8 of the chopper. This allows C12 to charge rapidly to the level at the collector of Q11. The chopper arm then closes to contact 9, driving the stabilizer input to ground.

The collector of Q11 goes from its negative level toward ground at this time, and the positive *change* is coupled through C12 and R6 to the input of the dc amplifier. The dc restoring action of contact 7 and the arm of the chopper thus makes the apparent output a series of positive pulses which are filtered by C2 and R6 and provide a dc input to the dc amplifier through R5.

If the input to the summing junction tends to go negative, the stabilizer input is a series of negative pulses. The output at the collector of Q11 is a series of pulses from a negative level toward ground. In this case, the chopper provides a short time constant discharge path for C12 when the collector of Q11 is close to ground. As contacts 8 and 9 of the chopper break and contacts 8 and 7 close, the collector of Q11 goes negative and the *change* is coupled through C12 and R6 to the filter capacitor, C2.

1.4.3.3 *The Stabilizer Filter.* The stabilizer output filter, consisting of capacitor C2 and resistor R6, has a time constant of three seconds. This is extremely long with respect to the stabilizer output waveform, consequently reducing the ripple at the junction of R6 and R5 to a negligible level.

1.4.3.4 *Stabilizer Functions.* The stabilizer performs the apparently dual functions of (a) pre-amplifying dc and very low frequency input signals, and (b) maintaining the amplifier summing junction at a point very close to ground potential over wide variations in amplifier balance. When the amplifier feedback loop is closed (as it must be), and no input is applied, the amplifier output should be zero volt. Any departure of the amplifier output from this point is coupled through the feedback resistor to the summing junction. This causes the

stabilizer to generate a correction voltage which returns the amplifier output, and consequently, the summing junction, to zero. If an input signal is applied to the summing junction, the stabilizer again generates a voltage. In this case, however, the output of the dc amplifier is *shifted* from ground potential, to produce an output with a polarity opposite to that of the input, and a magnitude equal to the input voltage multiplied by the ratio of the feedback resistance to the input resistance. This output produces a potential at the summing junction equal in magnitude and opposite in polarity to the input signal, returning the absolute potential at the summing junction to a point very close to ground. It is in this way that the stabilizer attempts to keep the summing junction at ground regardless of input voltage changes or variations within the dc amplifier.

1.5 MAINTENANCE AND TEST PROCEDURES

The 6.614-1 DC Amplifier is ruggedly constructed from top quality commercial grade components. All components are operated well below ratings to assure a long, trouble-free equipment life.

The test procedures outlined below are designed to provide a maintenance technician with simple and convenient procedures for monitoring amplifier performance on a regular basis.

1.5.1 Frequency Response (Closed Loop)

A check of the frequency response of the operational amplifier is accomplished by applying a fixed amplitude, variable frequency input to the amplifier and observing the output amplitude with an oscilloscope. Proceed as follows:

1. Patch the amplifier for unity gain using 100k ohms resistor (Figure 1.6).

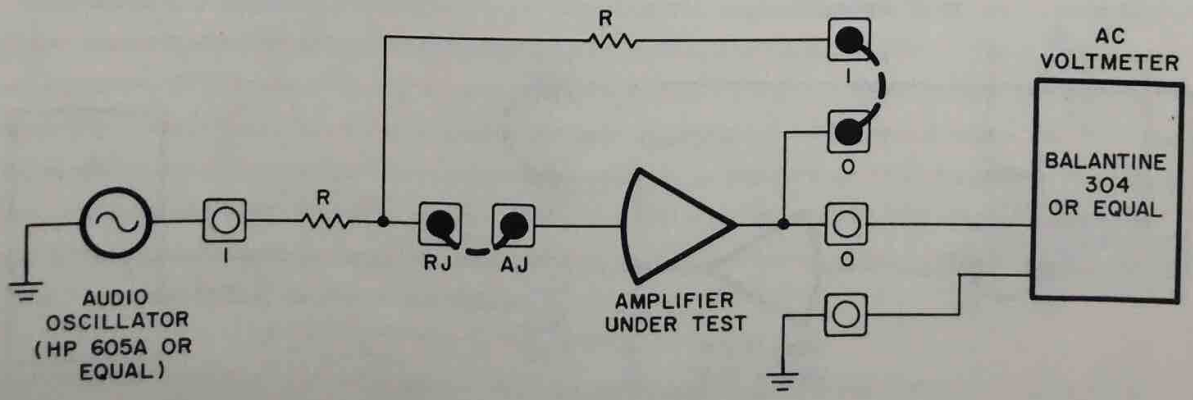


Figure 1.6. Frequency Response Test Circuit

2. Connect the output of a well-regulated audio oscillator to the amplifier input. Connect an ac voltmeter to the oscillator output. Vary the oscillator frequency from a few cycles to about 200 kc. Be certain that the amplitude of the oscillator output remains constant over the frequency range. If it does not stay constant, the oscillator amplitude control must be adjusted for each frequency check point.
3. There must be less than 0.5 db peaking at any frequency (6% amplitude increase). The 3 db rolloff frequency (minimum) should be 125 kHz for 100k/100k and 400 kHz for 10k/10k input and feedback resistors.
4. If the operational amplifier fails this test, it is probably due to a malfunction in the dc amplifier section.

1.5.2 Offset Measurement

Periodic checks for excessive amplifier offset are performed by monitoring the amplifier summing junction using standard feedback components. The offset measurement is made utilizing a Hewlett-Packard 425A (or equivalent) microvoltmeter.

Proceed as follows:

1. After a warm-up period of at least one half hour, carefully balance the amplifier under test using the standard procedure.
2. Using standard feedback connections, measure the offset at the amplifier summing junction with respect to high quality ground.
3. If the amplifier is operating properly, the offset should not exceed ±20 microvolts.

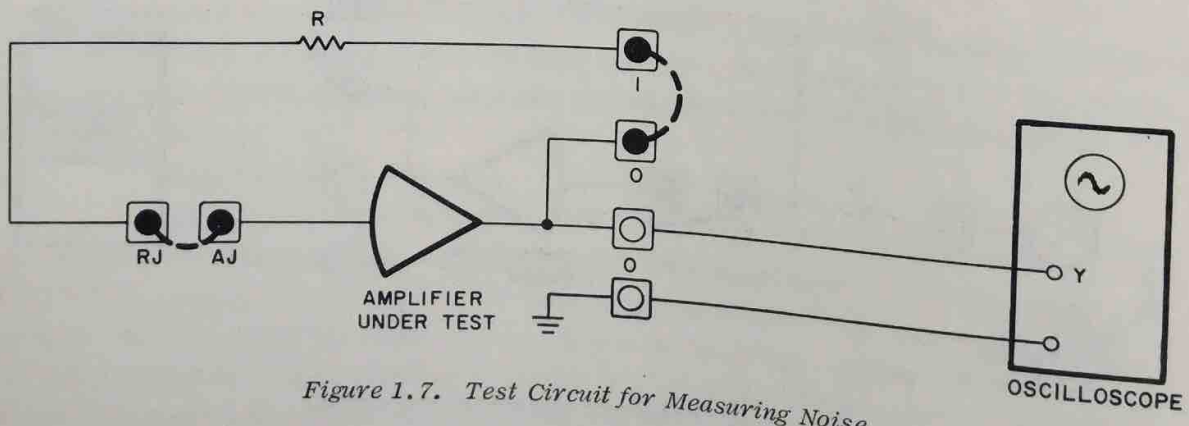


Figure 1.7. Test Circuit for Measuring Noise

1.5.3 Noise Measurement

The noise content of the amplifier can be observed with the circuit shown in Figure 1.7. Balance the amplifier and observe the output on the oscilloscope. The rms noise should be less than 1.5 millivolts peak-to-peak in either the gain of one or the gain of 10 configuration.

1.5.4 Output Current Capability

The amplifier's ability to deliver rated current is checked with the circuit in Figure 1.8. The load resistor need not be a precision resistor.

1. Place switch FR1 in the R position and measure the amplifier output voltage. The output should measure +10 volts.
2. Place FR1 in the S position. The output should measure -10 volts.
3. If the amplifier is not supplying approximately 20 ma of current, the output voltage will be less than ±10 volts.

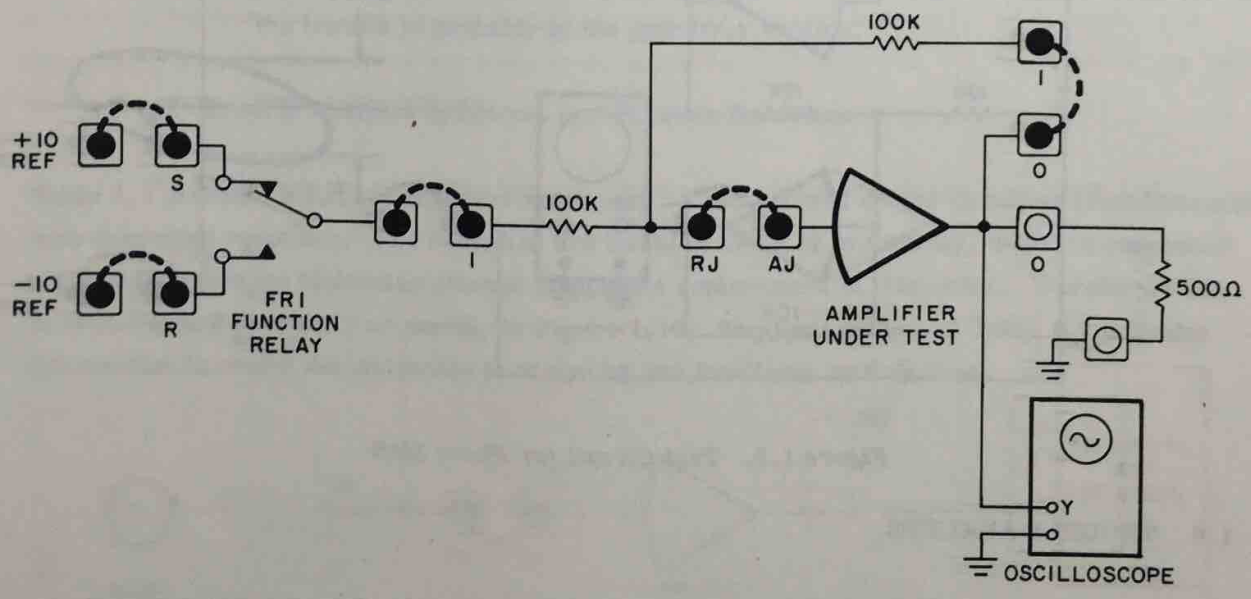


Figure 1.8. Output Current Test Circuit

1.5.5 Phase Shift

Connect the amplifier as shown in Figure 1.9, selecting R from the specification table below and using the top network resistor as the feedback resistor.

1. Set oscillator to 1000 Hz at 20 volts peak-to-peak; scope "Y" sensitivity to 20 millivolts/centimeter and "X" sensitivity to 5 volts/centimeter.
2. Read phase shift in millivolts. Read vertically on minor axis of ellipse 0.1° = 35 millivolts.

Phase Shift Specifications

R	Phase Shift
100k	0.4° Maximum (140 Millivolts)
10k	0.1° Maximum (35 Millivolts)

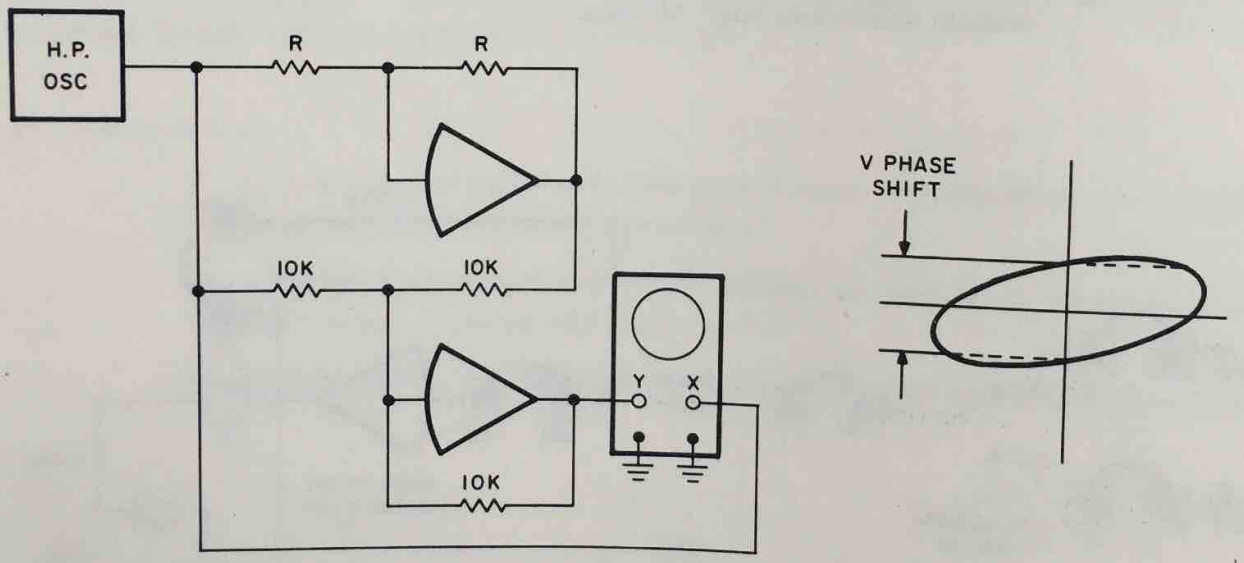


Figure 1.9. Test Circuit for Phase Shift

1.6 TROUBLE ANALYSIS

The amplifier is used with several different types of networks depending on the operation it must perform. Unsatisfactory performance by an operational amplifier could be due to a network malfunction. The malfunction can usually be isolated to a particular chassis by interchanging suspected modules with ones that are known to be good. Unlike most types of electronic equipment, a faulty operational amplifier usually identifies itself immediately. If a component in the

amplifier fails, the output voltage of the amplifier characteristically flops to its plus or minus limit (up to ±13 volts, depending on load).

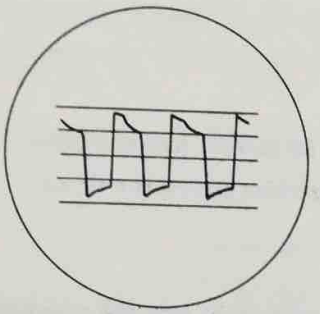
1.6.1 Failure to Balance

The most common indication of unsatisfactory amplifier operation is failure to balance properly. If an amplifier will not balance, the malfunction can be localized to either the dc or stabilizer section with the following procedure.

1. Mount the amplifier on a service shelf and plug the assembly into the amplifier's rack position. Patch a feedback resistor around the amplifier and remove all inputs.
2. Disable the stabilizer section by grounding the stabilizer output at pin 3 or 7 of the chopper (depending on which amplifier is malfunctioning).
3. Monitor the output voltage of the amplifier with an oscilloscope or voltmeter and slowly rotate the balance potentiometer.
4. The amplifier output should alternate between plus and minus limits (about ±13 volts) as the balance control is turned from one end to the other. A slight delay in response is normal. If the amplifier fails to do this, the malfunction is probably in the dc section of the amplifier. If the amplifier operates correctly, the trouble is probably in the stabilizer section.

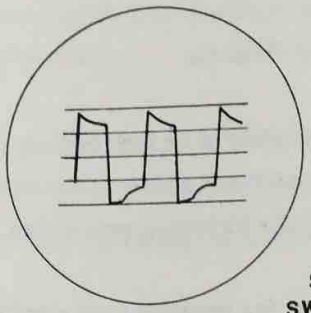
1.6.2 Trouble Analysis Symptoms and Possible Remedies

Table 1.1 provides a list of symptoms which may be encountered during amplifier troubleshooting, with suggested remedies. The remedies are listed in order of probability, and it is suggested that the maintenance technician attempt component replacement in this order. Waveforms are provided where necessary or useful, in Figure 1.10. The final column of Table 1.1 provides information to assist the technician in analyzing and localizing malfunctions.



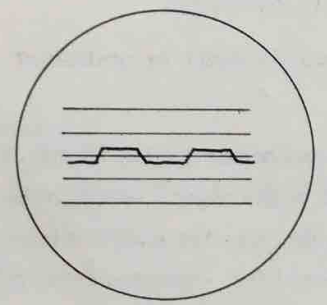
(a) Step 3

OR

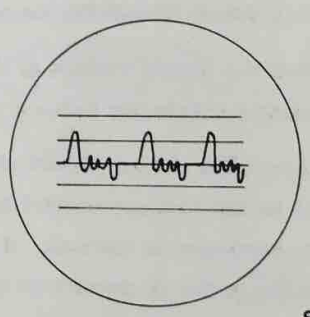


(b) Step 3

a. AND b.
SENSITIVITY=2v/CM
SWEEP SPEED=5ms/CM

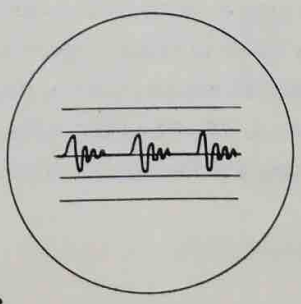


(c) Step 4



(d) Step 4

c. AND d.
SENSITIVITY=1mv/CM
SWEEP SPEED=5ms/CM



(e) Step 8

ALL WAVEFORMS TAKEN AT PIN 3 OR 7 OF THE CHOPPER (STABILIZER OUTPUT).

e.
SENSITIVITY=1mv/CM
SWEEP SPEED=5ms/CM

Figure 1.10. Amplifier Troubleshooting Waveforms

Table 1.1. Troubleshooting Symptoms

Step	Trouble	Waveforms (See Figure 1.9)	Possible Causes (In Order of Probability)	Comments
1	High Frequency Noise	----	Q1; Other DC Amplifier Transistors; CR3	H.F. noise is a problem characteristically caused by a dc amplifier component failure.
2	Low Frequency Noise	----	Q8;Q9;Q10;Q11	L.F. noise is generally caused by a stabilizer amplifier component failure.
3	No Balance - High Stabilizer Output(*Operate* Mode Only)	a OR b	Feedback resistor not patched correctly; R17, 18, 19, open; dc amplifier transistor Q1-Q5.	These symptoms indicate that the stabilizer is unable to correct the summing junction error; check feedback loop carefully, then dc amplifier components.
4	No Balance - No Stabilizer Output(*Operate* Mode Only)	c d	Stabilizer Transistors Q8-Q11 C8 Open	This problem is generally caused by a stabilizer amplifier component. Also examine the chopper and the stabilizer output filter.
5	No Balance (*Set Pot* Mode Only)	----	Relay K1-1 or K1-2; Resistor R7-1 or R7-2 (Depending on Amplifier), on 12.898 Card	These components close the feedback loop in *set pot* mode; also check connector pin U for relay volts (-20).
6	Excessive Output Current (R17, R18, R19, Illuminated)	----	Shorted Transistors Q5, Q6, Q7; CR3 Open, C12 Open	Assure that the output coax is not damaged. This type of failure can cause related failures - check output stage completely before returning amplifier to service.
7	Offset	----	C12; CR1, CR2	Offset is caused most frequently by leakage through C12. Shield diodes CR1 and CR2 from light when making offset measurements.
8	Ringing on Stabilizer Output	e	C11	Ringing on stabilizer output may cause an apparent offset or impair low frequency response; can be caused by a wide change in value or an open occurring in C11.
9	1 kHz Gain out of Tolerance -10 Hz and 100 Hz in Tolerance	----	Q1, Q2, C3, R15	If the 1 kHz gain is slightly out of tolerance Q1 or Q2, or R15 are the most probable causes; if the gain at this frequency is considerably out of tolerance, C3 is the most probable cause.
10	10 Hz, 100 Hz, and 1 kHz Gain Out of Tolerance	----	Q3, C5, R7	Check all phasing networks carefully.
11	Jitter on Balance Meter	----	C1 Open	----
12	Slow Overload Recovery	----	CR1 or CR2 Open	Slow recovery from + (input) overload, CR1 faulty; slow recovery from - (input) overload, CR2 faulty.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1		Connector Block: Lettered (DUAL AMPL 0.6.0614-1)	00 542.1547-1	B
2	J1	Connector Block: White	00 542.1544-2	B
		0.6.0615 DUAL DC AMPLIFIER CARD		
1	C1-()	Capacitor	00 521.0166-1	B
2	C2-()	Capacitor	00 516.0260-0	B
3	C3-()	Capacitor, Fixed, Ceramic: 39 pf ±5%, 1000V (Sprague 20C265(10TCC-Q39) or equal)	00 515.0103-0	A
4	C4-()	Capacitor, Fixed, Ceramic: 12 pf ±5%, 1000V (Sprague 40C502(10TCC-Q12) or equal)	00 511.1120-2 (00 515.0091-0)	A
5	C5-()	Capacitor, Fixed, Plastic: 0.0033 uf ±5%, 200V (Sprague 192P332S2 or equal)	00 522.1332-0 (00 521.0170-0)	A
6	C6-()	Capacitor, Fixed, Plastic: 0.033 uf ±5%, 200V (Gudeman 356 or equal)	00 522.2333-0 (00 521.0181-1)	A
7	C7-()	Capacitor, Fixed, Ceramic: 22 pf ±5%, 1000V (Sprague 19C411(10TCC-Q22 or equal)	00 515.0096-0	A
8	C8-()	Capacitor	00 521.0165-0	B
9	C9-()	Capacitor, Fixed, Ceramic: 20 nf -40% +60%, 150V (Centralab DDM-203 or equal)	00 515.0180-0	A
10	C10=()	Capacitor, Fixed, Ceramic: 47 nf ±20%, 25V (Sprague 3C15 or equal)	00 511.5473-4 (00 515.0234-0)	A
11	C11-()	Capacitor, Fixed, Electrolytic: 100 uf -10% +100%, 6V (Int. Elect. Ind. APS-102 or equal)	00 516.0261-0	A
12	C12-()	Capacitor	00 516.0264-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
DUAL DC AMPLIFIER

MODEL NO.
0.6.0614-1 Sh. 1 of 4 Sh.

DATE 10/ 11 /67

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
13	C13-(), 14-()	Capacitor, Fixed, Plastic: 0.047 uf ±5%, 200V (Sprague 192P47352 or equal)	00 522.2473-0 (00 521.0172-0)	A
14	CR1-(),2-()	Diode	00 614.0007-0	B
15	CR3-(),5-()	Diode (ITT G-187 or equal)	00 614.0043-0	A
16	CR4-()	Diode	00 614.0199-0	B
17	D1	Chopper: 6.3V, 60 CPS, 120 ohms Coil; DPDT (James C4215 or equal)	00 530.0065-0	A
18	NW1-()	Integrated Circuitry: Resistor Network	00 592.0062-0	B
19	NW2-()	Integrated Circuitry: Resistor Network	00 592.0063-0	B
20	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-23 or equal)	00 542.0419-0	A
21	Q1-(),3-(), 8-()	Transistor: (Amperex ME901 or equal)	00 686.0238-0	A
22	Q2-()	Transistor	00 686.0109-0	B
23	Q4-()	Transistor	00 686.0129-0	B
24	Q5	Transistor	00 686.0325-0	B
25	Q6-()	Transistor (GE 4JX1C1286 or equal)	00 686.0091-0	A
26	Q7-()	Transistor (Texas Inst. N558 or equal)	00 686.0093-0	A
27	Q9-()	Transistor	00 686.0248-0	B
28	Q10-() 11-()	Transistor	00 686.0111-0	B
29	R1-()	Resistor, Fixed, Composition: 4.7 megohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0475-0	A
30	R2-()	Resistor, Fixed, Composition: 68K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0683-0	A
31	R3-(),5-()	Resistor, Fixed, Composition: 220K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0224-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10 / 11 / 67

UNIT TITLE
DUAL DC AMPLIFIER

MODEL NO.
0.6.0614-1 Sh. 2 of 4 Sh.

1-1-24

M446

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
32	R4-()	Resistor, Fixed, Composition: 68 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0680-0	A
33	R6-()	Resistor, Fixed, Composition: 22K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0223-0	A
34	R7-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0472-0	A
35	R8-()	Resistor, Fixed, Composition: 5.1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0512-0	A
36	R9-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0472-0	A
37	R10-()	Resistor, Fixed, Composition: 15K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0153-0	A
38	R11-()	Resistor, Fixed, Composition: 27K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0273-0	A
39	R12-()	Resistor, Fixed, Composition: 180 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0181-0	A
40	R13-()	Resistor, Fixed, Composition: 100K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0104-0	A
41	R14-()	Resistor, Fixed, Composition: 8.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0822-0	A
42	R15-()	Resistor, Fixed, Composition: 3.3 megohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0335-0	A
43	R16-()	Resistor, Fixed, Composition: 33K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0333-0	A
44	R17-() 19-()	Resistor, Non-Linear	00 646.0065-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10 / 11 / 67

UNIT TITLE
DUAL DC AMPLIFIER

MODEL NO.
0.6.0614-1 Sh. 3 of 4 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
45	XD1	Socket, Electron Tube: 9 Contacts (Elco 05-4008 or equal)	00 650.0075-0	A
46	XQ1-(), 3-(),8-()	Socket	00 650.0162-0	A
47	XQ2-(), 4-(),thru 7-(),9-(), 10-(), 11-()	Socket, Transistor: 3 Contacts (Augat 8069-1G1 or equal)	00 650.0121-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 4/ 29 / 68

UNIT TITLE

DUAL DC AMPLIFIER

MODEL NO.

0.6.0614-1 Sh. 4 of 4 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1	Diode (ITT G-187 or equal)	00 614.0043-0	A
2	K1-()	Relay	00 618.0189-0	B
3	R6	Potentiometer	00 642.0587-0	B
4	R7-()	Resistor, Fixed, Composition: 100 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0101-0	A
5		Resistor, Precision (Matched Set)	00 640.0027-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
AMPLIFIER NETWORK CARD

MODEL NO.
0.12.0898 Sh. 1 of 1 Sh.

2

DATE 4 / 29 / 68

1-1-27/28

APPENDIX 2

DRAWINGS

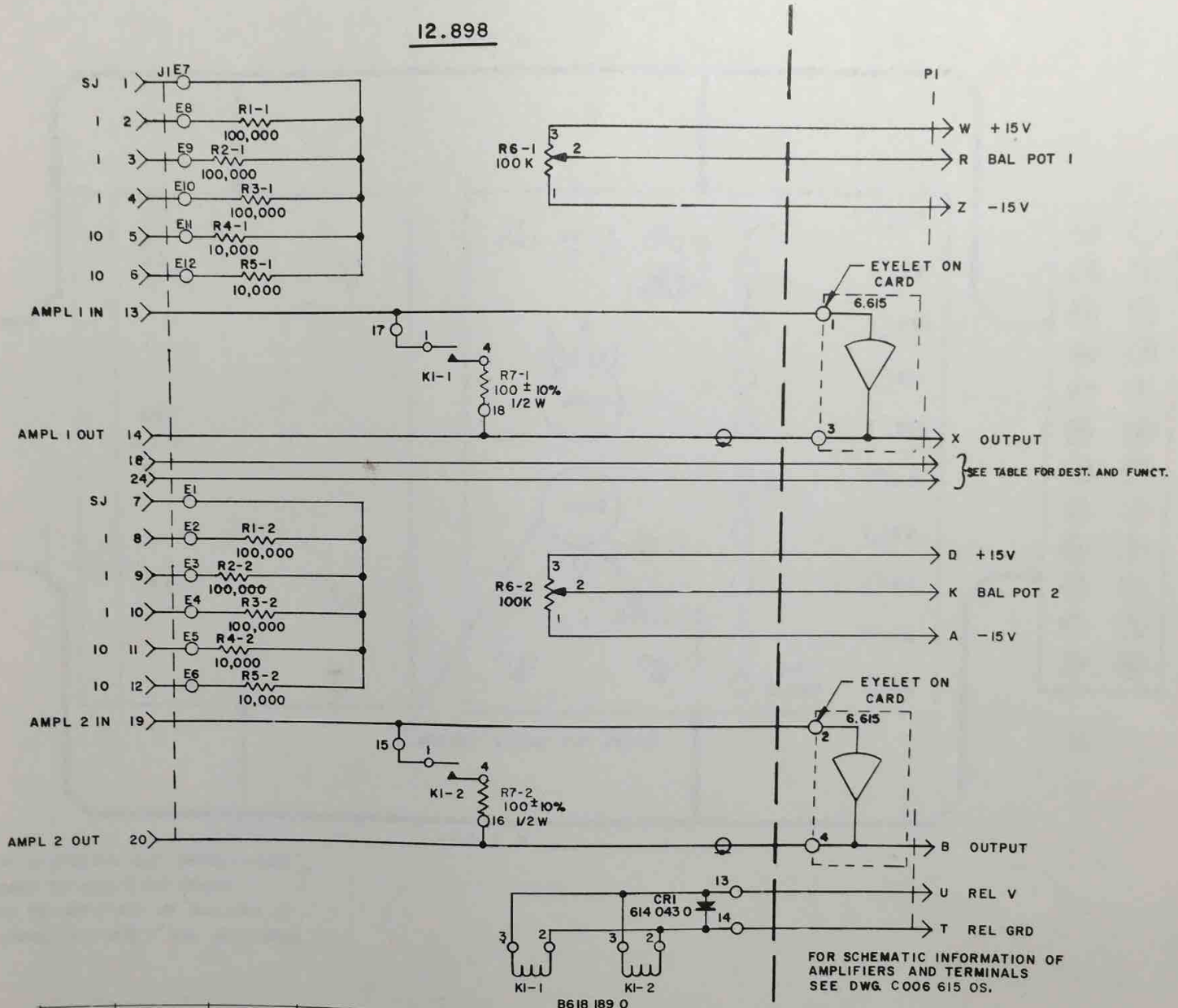
This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

INDEX

Unit or Component	Type of Drawing	Drawing Number
6.614 Dual DC Amplifier	Schematic Wiring	C006 614 0S B006 614 0W (Sheets 1 and 2)
6.615 Dual DC Amplifier Card	Schematic	C006 615 0S

12.898



FOR SCHEMATIC INFORMATION OF AMPLIFIERS AND TERMINALS SEE DWG. C006 615 OS.

B618 189 0

UNIT NUMBER	NUMBER	PARTS LIST & NEXT ASSY.	FUNCTION	TERM	DEST.	PARTS LIST USED ON:	PROJECT NUMBER
			DESCRIPTION				
.0.6.614-1	006 614-1S	006 614-1P	±GRD	J1-24	P1-E	——	ERN 16,508
			±GRD	J1-18	P1-V		
.0.6.614	8006 614-0S	A006 614 0P	HQGRD	J1-24	P1-M	——	19007
			HQGRD	J1-18	P1-N		

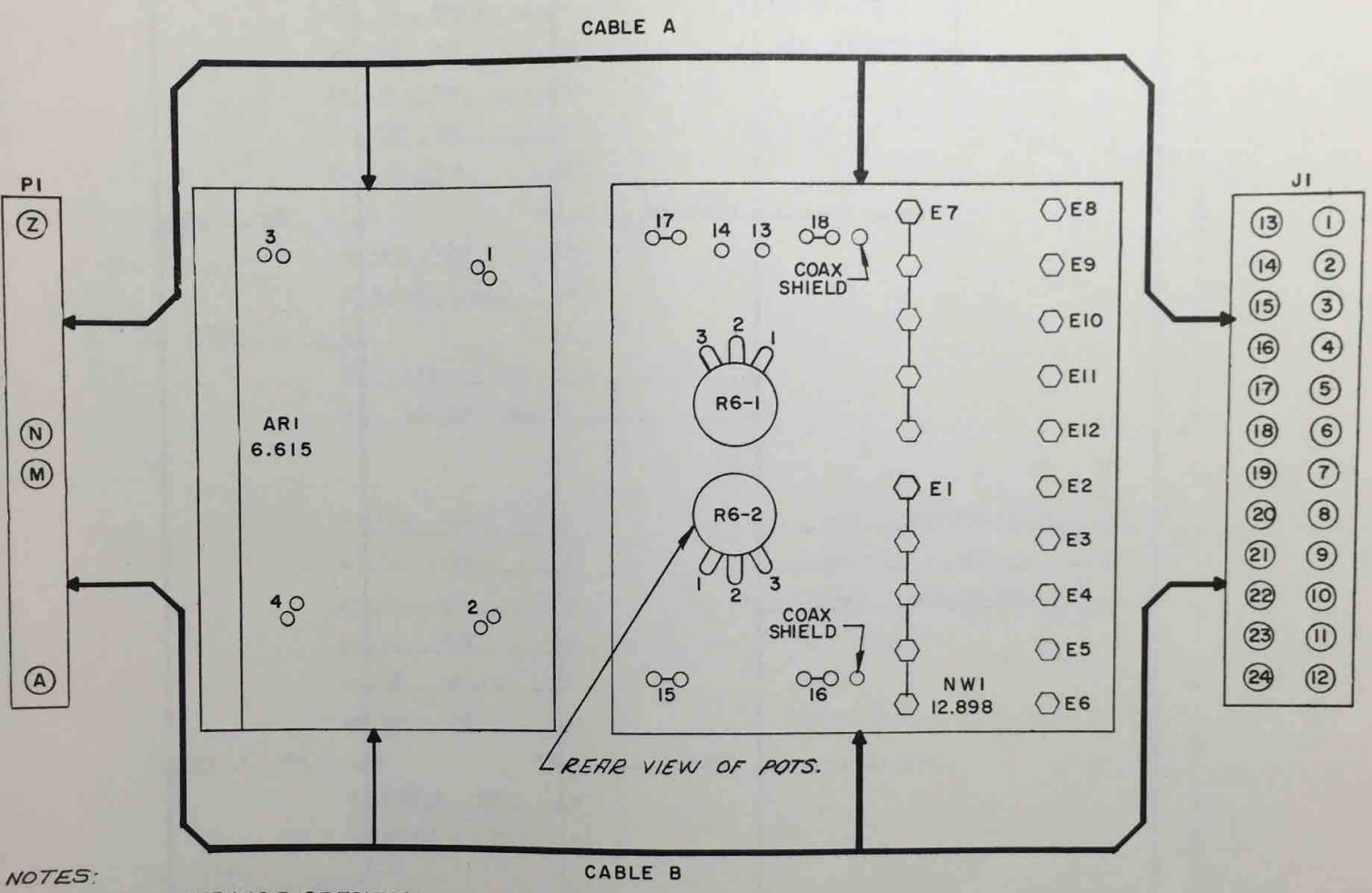
TABLE OF UNIT NUMBERS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN pf
RESISTANCE IS IN OHMS
TOLERANCE ON
FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ±
*TOL. OF MATERIAL SUPPLIED

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SCHEMATIC
DUAL DC AMPL

SHT. NO.	
SIZE	
REV. NO.	
PROJECT	19007 C 006 614 0S
SHEET	OF SHEETS

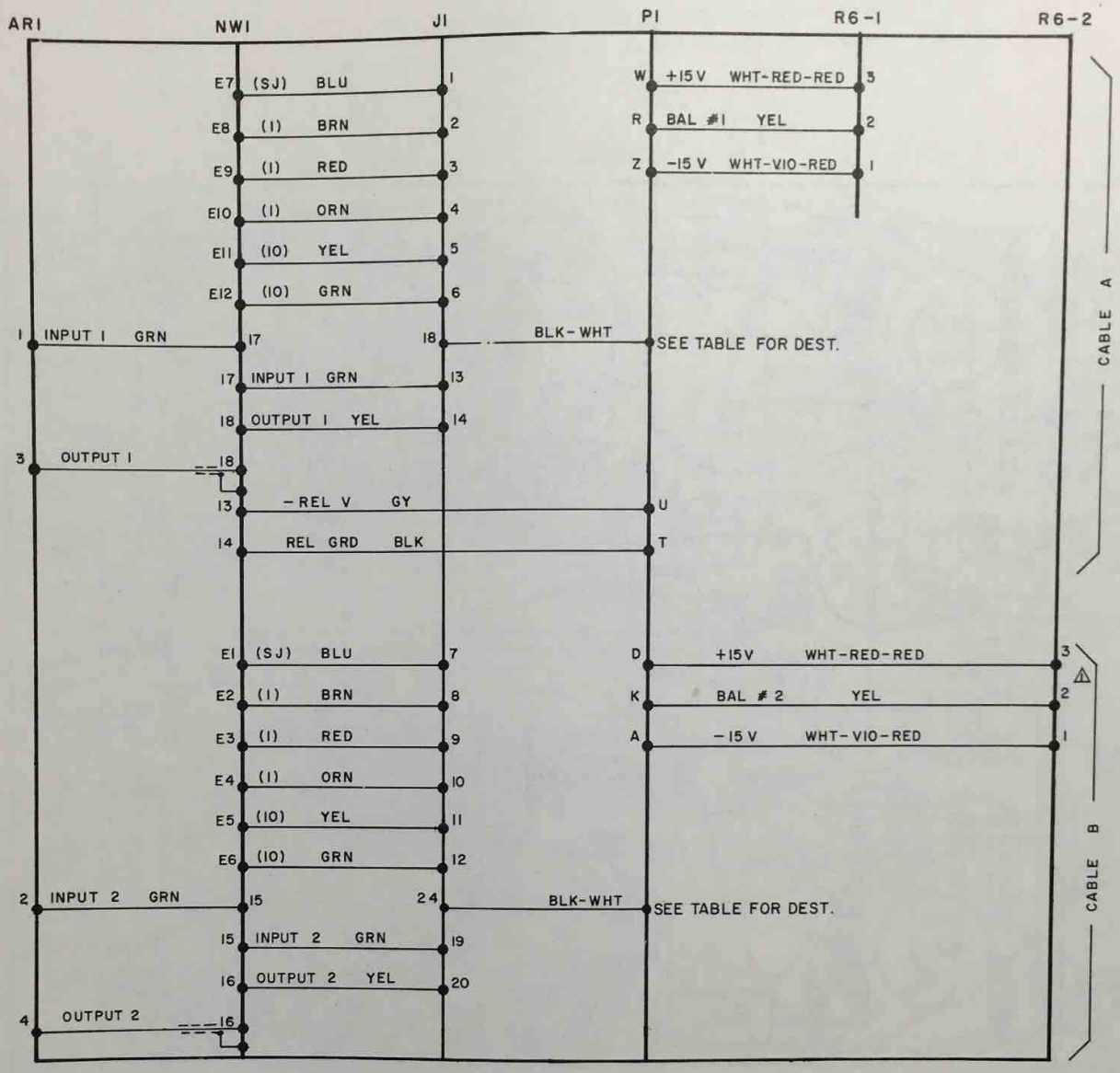


3

NOTES:

1. UNLESS OTHERWISE SPECIFIED
   a. WIRES TO BE #22 PHU
   b. COAX TO BE PER B 916 001 0
   c. JUMPERS TO BE #22 SD-BUS

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
WIRING DUAL DC AMPL.	
SHT. NO.	2
SIZE	C
REV. NO.	
PROJECT 19007	B006 614 0W
SHEET	OF 2 SHEETS



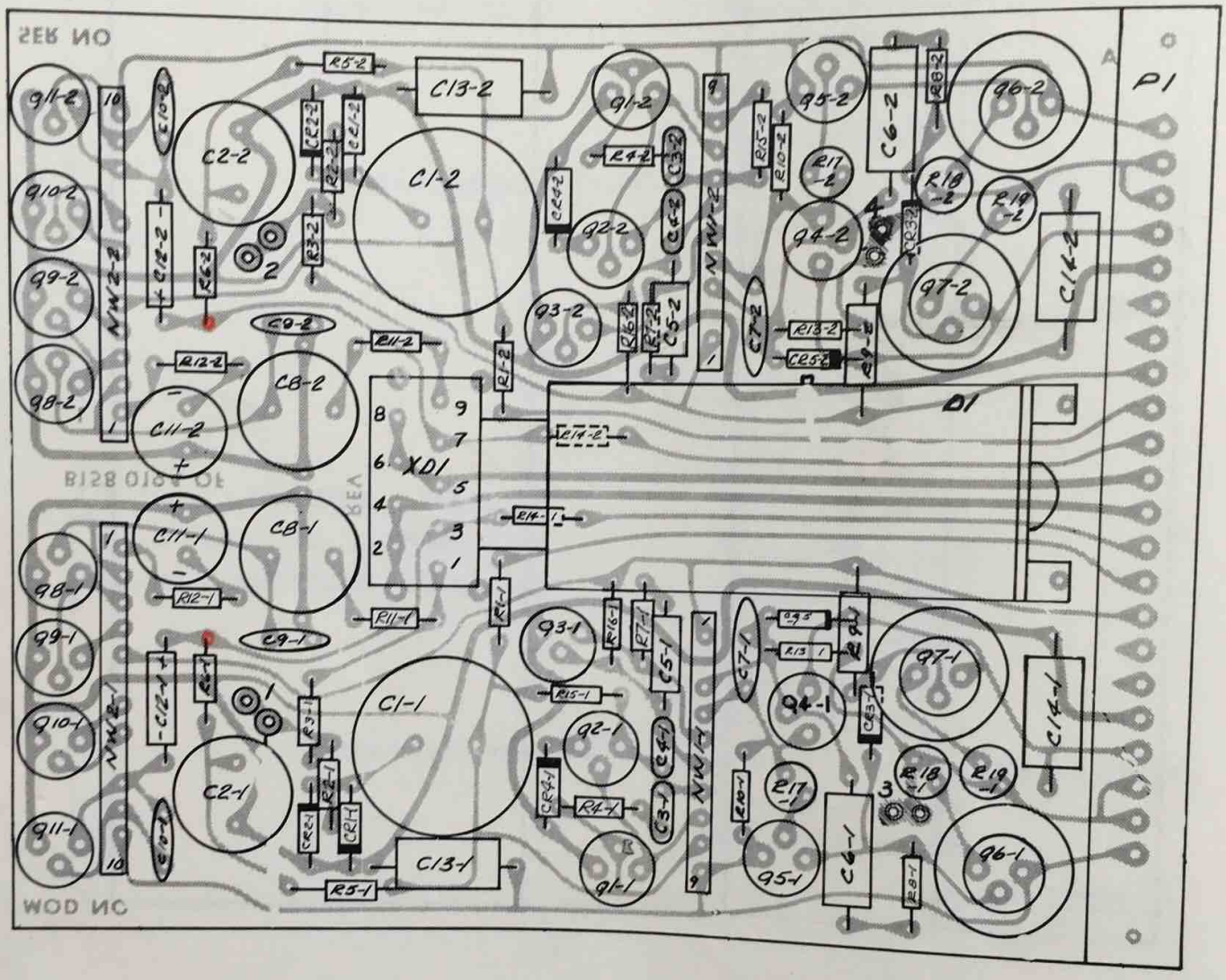
6-614-1	006 614-1W	006 614-1P	±GRD	J1-24	P1-E	———	ERN 10994
			±GRD	J1-18	P1-V		
6-614	B006 614-0W	A006 614 0P	HQ GRD	J1-24	P1-M	———	19007
			HQ GRD	J1-18	P1-N		
			FUNCTION	TERM.	DEST.		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN pf
RESISTANCE IS IN OHMS
TOLERANCE ON
FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ±
*TOL. OF MATERIAL SUPPLIED

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

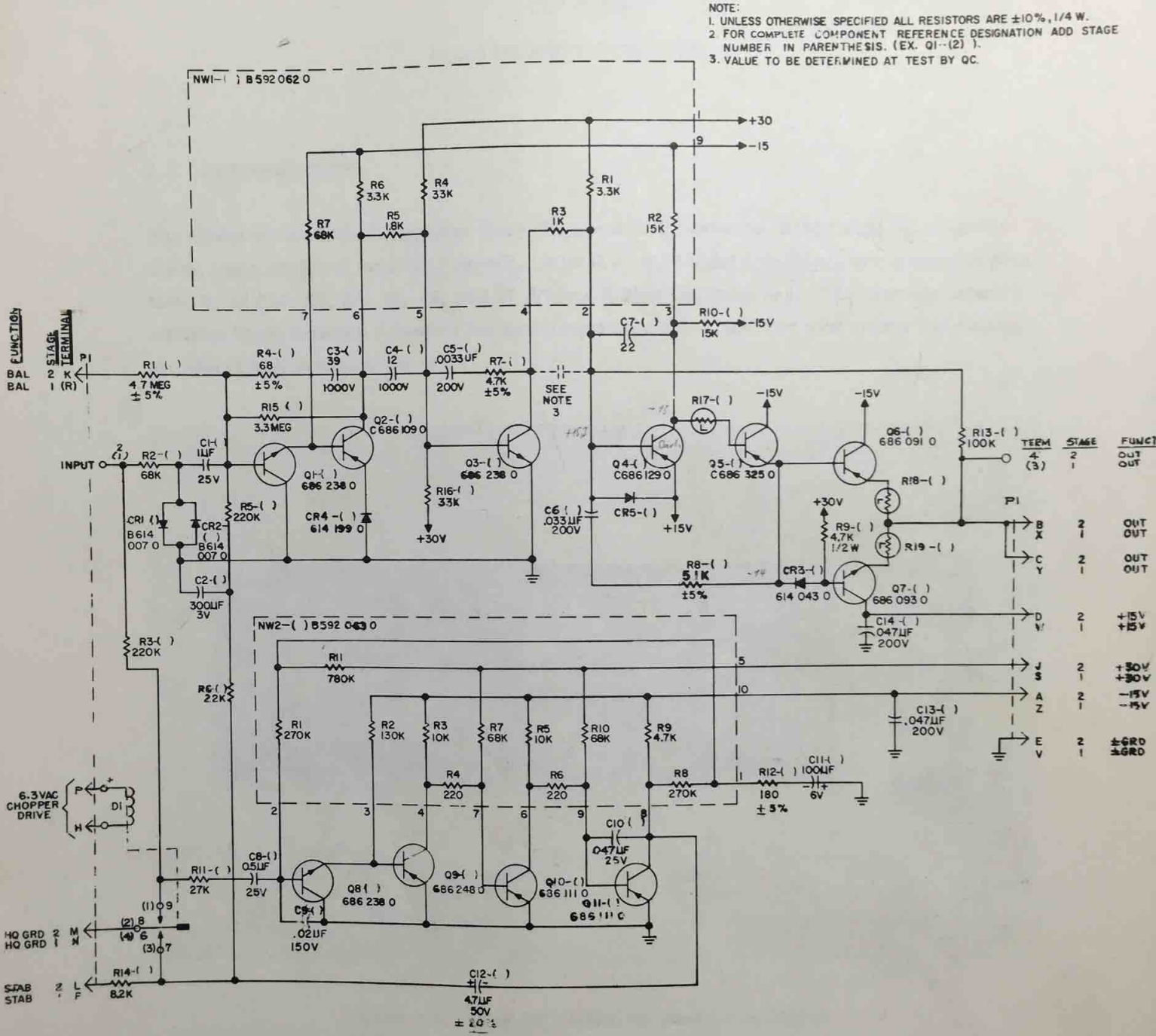
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19007	C006 614 0W

SHEET 2 OF SHEETS

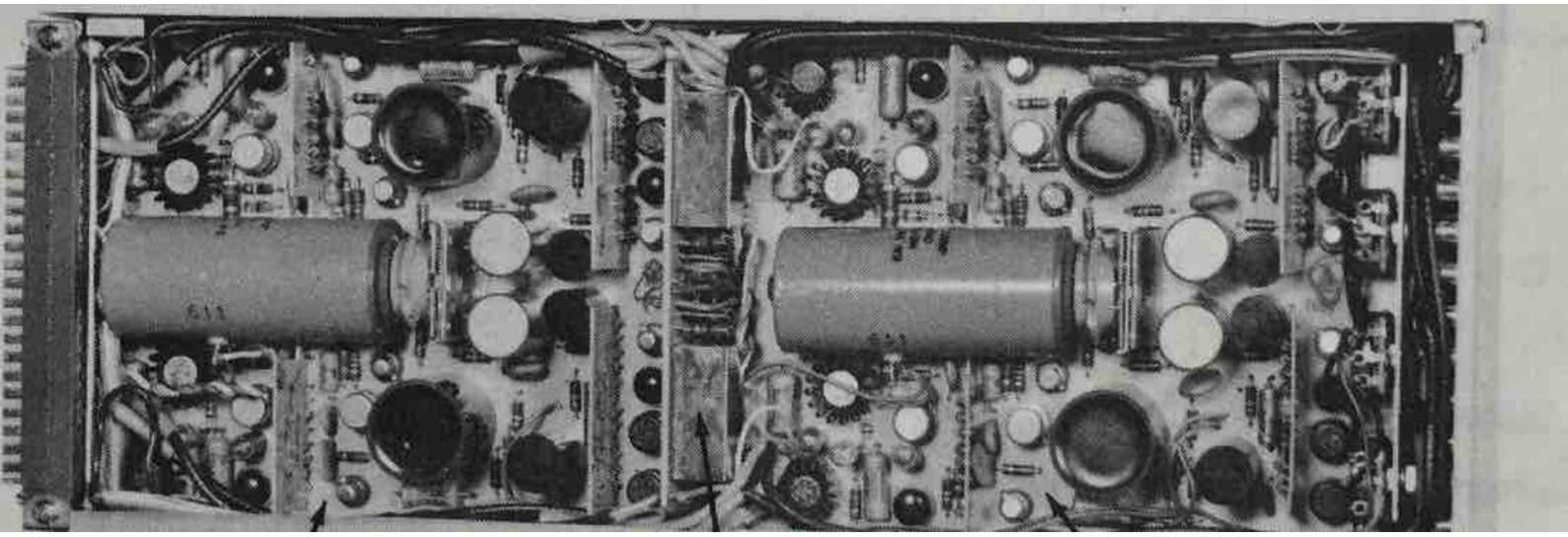


6.615 Dual DC Amplifier Card

NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE ±10%, 1/4 W.
2. FOR COMPLETE COMPONENT REFERENCE DESIGNATION ADD STAGE NUMBER IN PARENTHESIS. (EX. Q1--(2)).
3. VALUE TO BE DETERMINED AT TEST BY QC.



ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC DUAL DC AMPL	
SHT. No.	
SIZE	
REV. NO.	
PROJECT 19007	C006 615 0S
SHEET	OF SHEETS



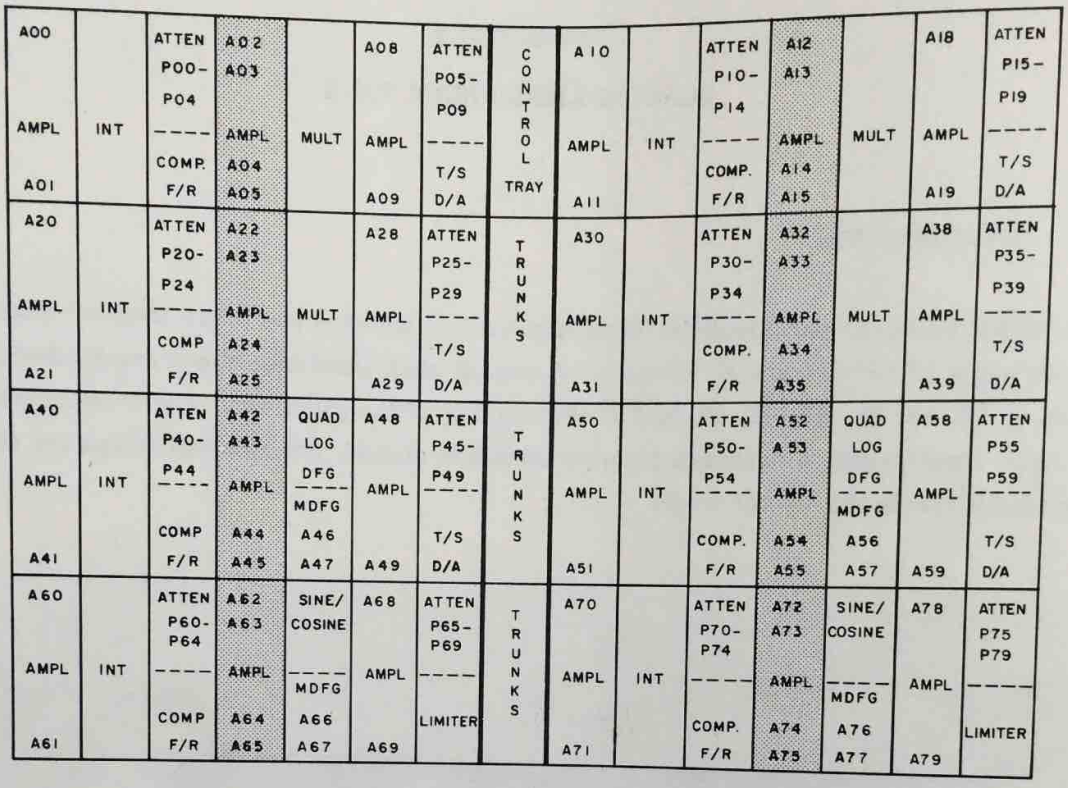


Figure 2.2. Location of 0.6.0704-2 Quad Amplifiers

2.3 OPERATING CONSIDERATIONS

The operating information in Section 1, Chapter 1, apply directly to the quad amplifiers. Refer to these sub-paragraphs for information concerning amplifier balancing and overload indication respectively.

The quad amplifiers may be used as inverters or high-gain amplifiers, depending on the patching connections. Figure 2.3 illustrates the internal connections of the amplifiers, and shows the patching required for operating one amplifier of a quad as an inverter.

2.4 THEORY OF OPERATION

The quad amplifier uses two 6.615 Dual DC Amplifier Cards; therefore, the theory of operation is the same as described in Section 1, Chapter 1.

2.5 MAINTENANCE AND TEST PROCEDURES

The tests provided in Section 1, Chapter 1 also apply to the quad amplifiers, and the test results should be identical.

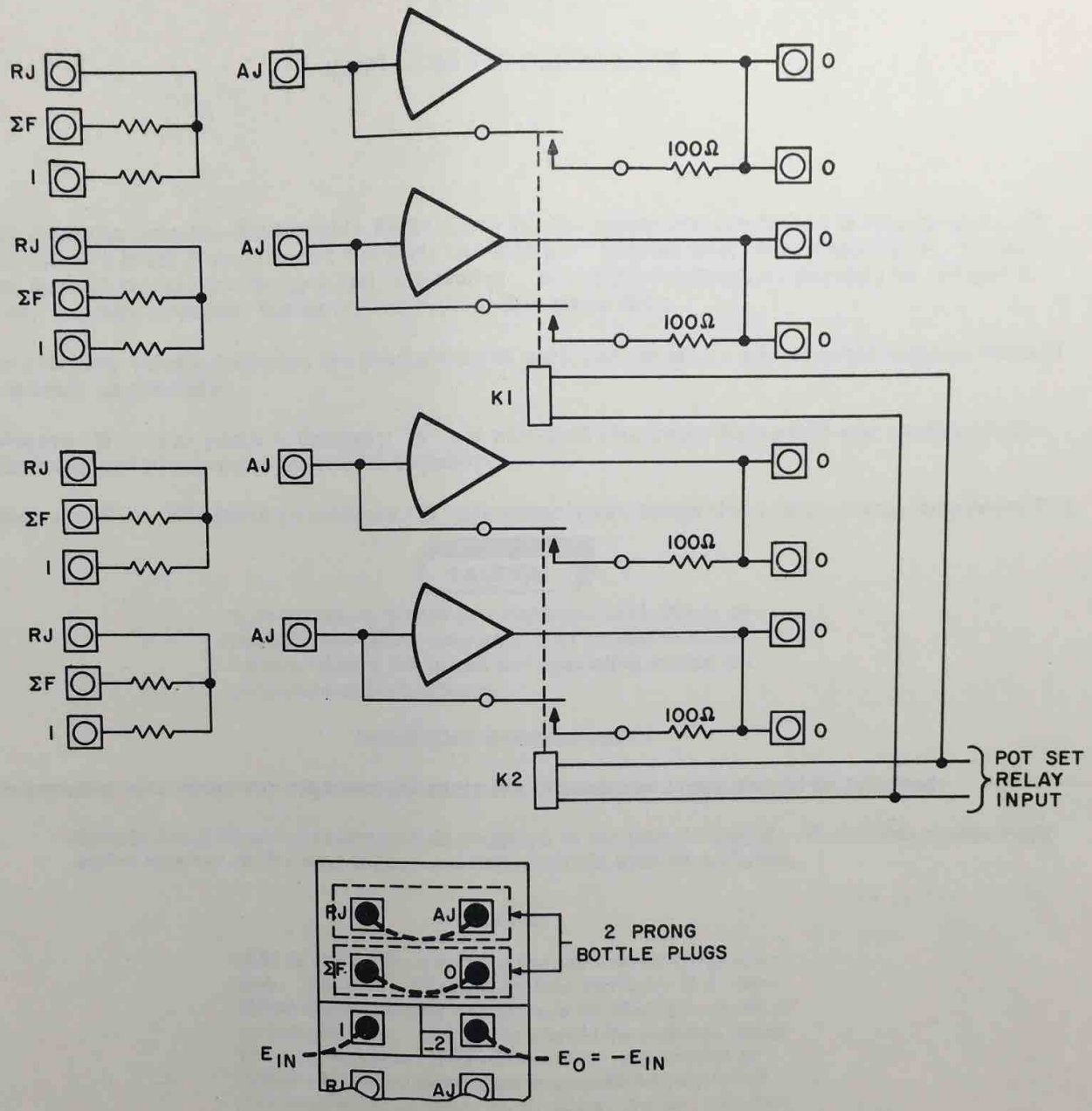


Figure 2.3. Quad Amplifier, Simplified Schematic and Patching

2.6 TROUBLE ANALYSIS

Since the same amplifier circuit is used for both the dual and quad amplifiers, the difficulties that may occur within the amplifiers are identical. The most common amplifier problems, together with their most common causes are listed in Table 1.1, located in Section 1, Chapter 1. Failures that may occur in the 12.981 Inverter Network are usually easy to identify by patching resistors from other amplifiers in place of suspected input or feedback resistors.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-43 or equal)	00 542.0488-0	A
2	R1 thru 4	Potentiometer	00 642.0587-1	B
3		Connector Block: Lettered (QUAD AMPLIFIER 0.6.0704-2)	00 542.1547-2	B
4		Connector Block: White	00 542.1544-2	B
		0.6.0615-1 DUAL DC AMPLIFIER CARD Identical with 0.6.0615 except Item 20 is deleted (see Book 2, Section 1, Chapter 1).		
		0.12.0981 INVERTER NETWORK CARD		
1	CR1	Diode (ITT G-187 or equal)	00 614.0043-0	A
2	K1,2	Relay	00 618.0285-0	B
3	R1-(),2-()	Potentiometer	00 640.0152-0	B
4	R3-()	Resistor, Fixed, Composition: 100 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0101-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: QUAD DC AMPLIFIER

MODEL NO.: 0.6.0704-2 Sh. 1 of 1 Sh.

9-13-3

DATE 10/ 11/ 67

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1-()	Capacitor	00 521.0166-1	B
2	C2-()	Capacitor	00 516.0260-0	B
3	C3-()	Capacitor, Fixed, Ceramic: 39 pf ±5%, 1000V (Sprague 20C265(10TCC-Q39) or equal)	00 515.0103-0	A
4	C4-()	Capacitor, Fixed, Ceramic: 12 pf ±5%, 1000V (Sprague 40C502(10TCC-Q12) or equal)	00 511.1120-2 (00 515.0091-0)	A
5	C5-()	Capacitor, Fixed, Plastic: 0.0033 uf ±5%, 200V (Sprague 192P332S2 or equal)	00 522.1332-0 (00 521.0170-0)	A
6	C6-()	Capacitor, Fixed, Plastic: 0.033 uf ±5%, 200V (Gudeman 356 or equal)	00 522.2333-0 (00 521.0181-1)	A
7	C7-()	Capacitor, Fixed, Ceramic: 22 pf ±5%, 1000V (Sprague 19C411(10TCC-Q22 or equal)	00 515.0096-0	A
8	C8-()	Capacitor	00 521.0165-0	B
9	C9-()	Capacitor, Fixed, Ceramic: 20 nf -40% +60%, 150V (Centralab DDM-203 or equal)	00 515.0180-0	A
10	C10-()	Capacitor, Fixed, Ceramic: 47 nf ±20%, 25V (Sprague 3C15 or equal)	00 511.5473-4 (00 515.0234-0)	A
11	C11-()	Capacitor, Fixed, Electrolytic: 100 uf -10% +100%, 6V (Int. Elect. Ind. APS-102 or equal)	00 516.0261-0	A
12	C12-()	Capacitor	00 516.0264-0	B
13	C13-(), 14-()	Capacitor, Fixed, Plastic: 0.047 uf ±5%, 200V (Sprague 192P47352 or equal)	00 522.2473-0 (00 521.0172-0)	A
14	CR1-(),2-()	Diode	00 614.0007-0	B
15	CR3-(),5-()	Diode (ITT G-187 or equal)	00 614.0043-0	A
16	CR4-()	Diode	00 614.0199-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
DUAL DC AMPLIFIER CARD

MODEL NO.
0.6.0615

13

DATE 5 / 20 / 68

Sh.1 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
17	D1	Chopper: 6.3V, 60 CPS, 120 ohms Coil: DPDT (James C4215 or equal)	00 530.0065-0	A
18	NW1-()	Integrated Circuitry: Resistor Network	00 592.0062-0	B
19	NW2-()	Integrated Circuitry: Resistor Network	00 592.0063-0	B
20	P1	Connector, Plug: 22 Contacts: Male (Amphenol 133-022-23 or equal)	00 542.0419-0	A
21	Q1-(),3-(),8-()	Transistor: (Amperex ME901 or equal)	00 686.0238-0	A
22	Q2-()	Transistor	00 686.0109-0	B
23	Q4-()	Transistor	00 686.0129-0	B
24	Q5	Transistor	00 686.0325-0	B
25	Q6-()	Transistor (GE 4JX1C1286 or equal)	00 686.0091-0	A
26	Q7-()	Transistor (Texas Inst. N558 or equal)	00 686.0093-0	A
27	Q9-()	Transistor	00 686.0248-0	B
28	Q10-(),11-()	Transistor	00 686.0111-0	B
29	R1-()	Resistor, Fixed, Composition: 4.7 megohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0475-0	A
30	R2-()	Resistor, Fixed, Composition: 68K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0683-0	A
31	R3-(),5-()	Resistor, Fixed, Composition: 220K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0224-0	A
32	R4-()	Resistor, Fixed, Composition: 68 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0680-0	A
33	R6-()	Resistor, Fixed, Composition: 22K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0223-0	A
34	R7-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen -Bradley CB or equal)	00 625.0472-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
DUAL DC AMPLIFIER CARD

MODEL NO.
0.6.0615

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
35	R8-()	Resistor, Fixed, Composition: 5.1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0512-0	A
36	R9-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0472-0	A
37	R10-()	Resistor, Fixed, Composition: 15K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0153-0	A
38	R11-()	Resistor, Fixed, Composition: 27K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0273-0	A
39	R12-()	Resistor, Fixed, Composition: 180 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0181-0	A
40	R13-()	Resistor, Fixed, Composition: 100K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0104-0	A
41	R14-()	Resistor, Fixed, Composition: 8.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0822-0	A
42	R15-()	Resistor, Fixed, Composition: 3.3 megohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0335-0	A
43	R16-()	Resistor, Fixed, Composition: 33K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0333-0	A
44	R17-() 19-()	Resistor, Non-Linear	00 646.0065-0	B
45	XD1	Socket, Electron Tube: 9 Contacts (Elco 05-4008 or equal)	00 650.0075-0	A
46	XQ1-(), 3-(),8-()	Socket	00 650.0162-0	A
47	XQ2-(), 4-() thru 7-(),9-(), 10-(), 11-()	Socket, Transistor: 3 Contacts (Augat 8069-1G1 or equal)	00 650.0121-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: DUAL DC AMPLIFIER CARD

MODEL NO. 0.6.0615

APPENDIX 2

DRAWINGS

This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

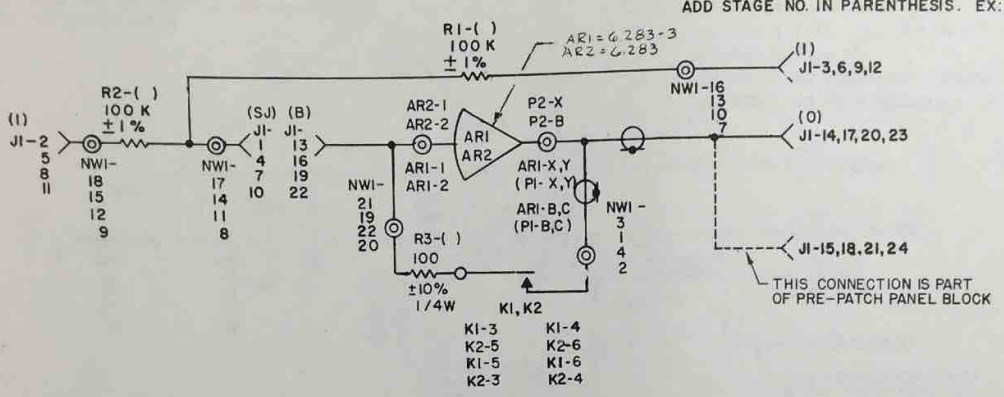
EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

INDEX

Unit or Component	Type of Drawing	Drawing Number
6.704 Quad Amplifier	Schematic	C006 704 0S (Sheets 1 and 2)
	Wiring	D006 704 0W (Sheets 1 and 2)

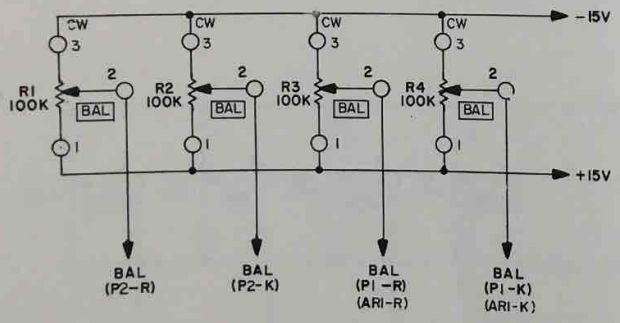
NOTES:

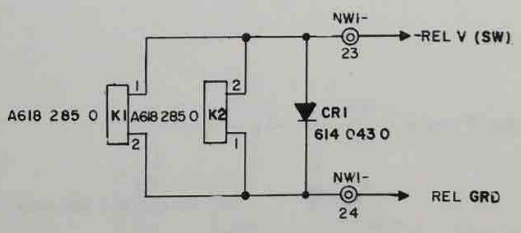
1. R1-( ) & R2-( ) ARE MATCHED TO ± 0.01%
2. R1-( ), R2-( ), R3-( ), K1 & K2 & CR1 ARE LOCATED ON "NW 1"
3. FOR COMPLETE COMPONENT REFERENCE DESIGNATION, ADD STAGE NO. IN PARENTHESIS. EX: R1-(4)



P1(ARI), P2

- Z −15V
- Y, X — OUTPUT
- W +15V
- V ±GRD
- U −REL V (SW), T REL GRD — P2 ONLY
- S +30V
- R BAL
- P STAB
- N, M — HQ GRD
- L STAB
- K BAL
- J +30V
- H, F — 6.3V A.C. CHOP. DR.
- E ±GRD
- D +15V
- C, B — OUTPUT
- A −15V





006 704 1S

UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
6.704-2	006 704 2S	006 704 2P	AS SHOWN SHT 2		
6.704-1	006 704 1S	006 704 1P	AS SHOWN SHT 1	——	19007
6.704	006 704 0S	006 704 0P	AS SHOWN SHT 2	——	19007

TABLE OF UNIT NUMBERS

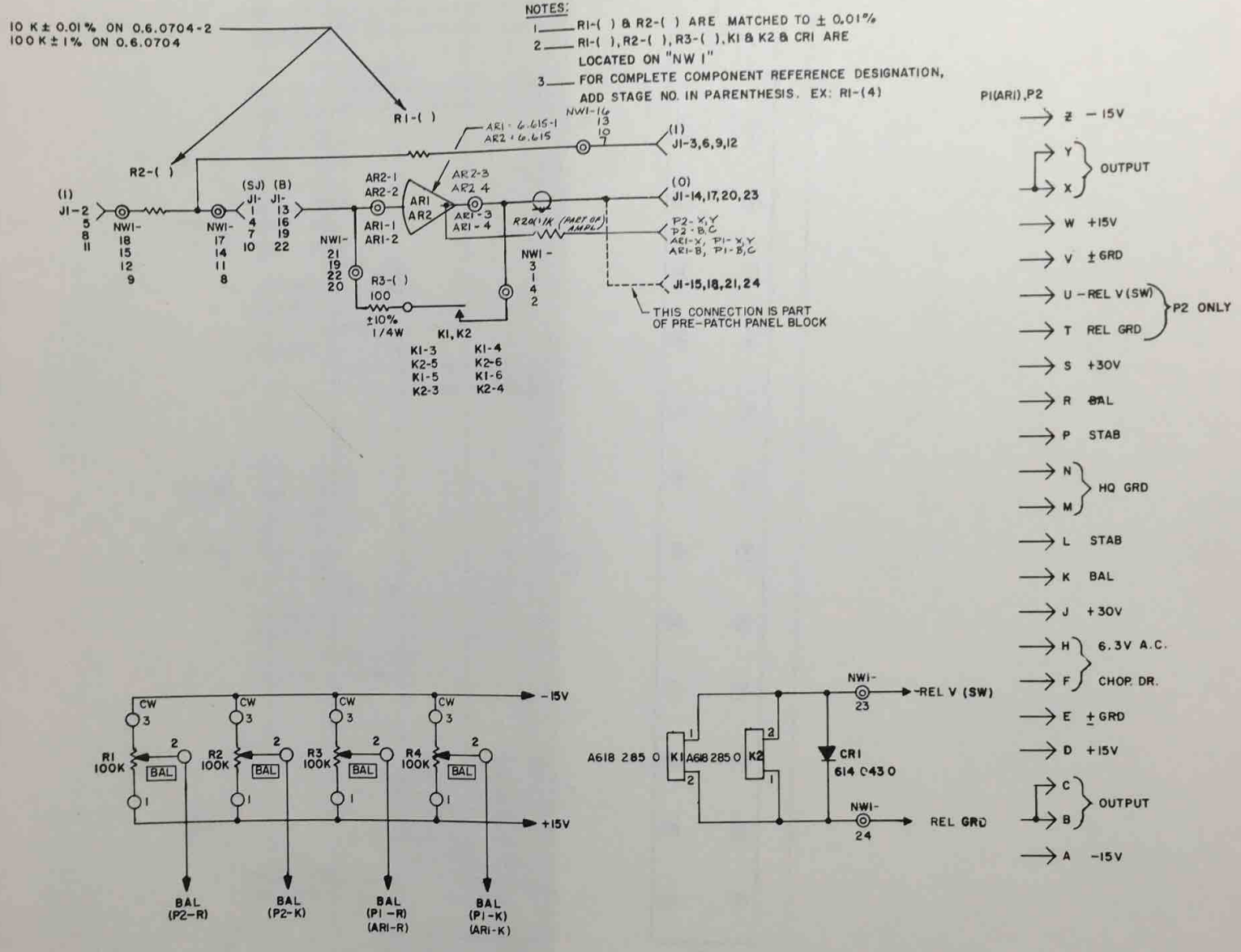
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN pf
RESISTANCE IS IN OHMS
TOLERANCE ON
FRACTIONS ± 1/64 | DECIMALS ± .005 | ANGLES ±
*TOL OF MATERIAL SUPPLIED

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SCHEMATIC
QUAD AMPL.

SHT. NO.	2
SIZE	C
REV. NO.	3
PROJECT	19007 C006 704 0S

SHEET 1 OF 2 SHEETS

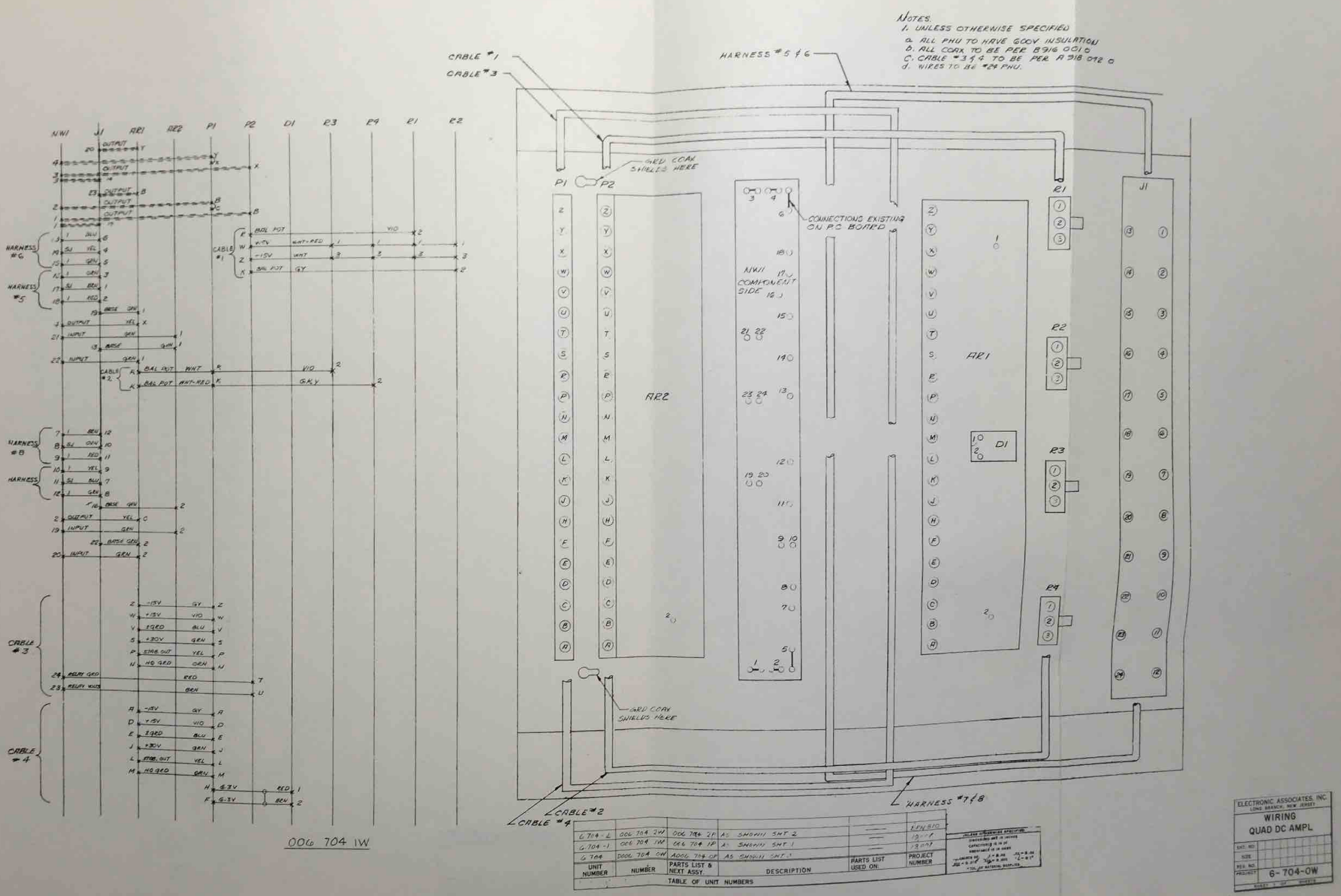


006 704 05
006 704 25

UNLESS OTHERWISE SPECIFIED		
DIMENSIONS ARE IN INCHES		
CAPACITANCE IS IN pf		
RESISTANCE IS IN OHMS		
TOLERANCE ON		
FRACTIONS	DECIMALS	ANGLES
± 1/64	± .005	±
*TOL. OF MATERIAL SUPPLIED		

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19007	C006 704 05
SHEET 2 OF SHEETS	



0006 704 1W

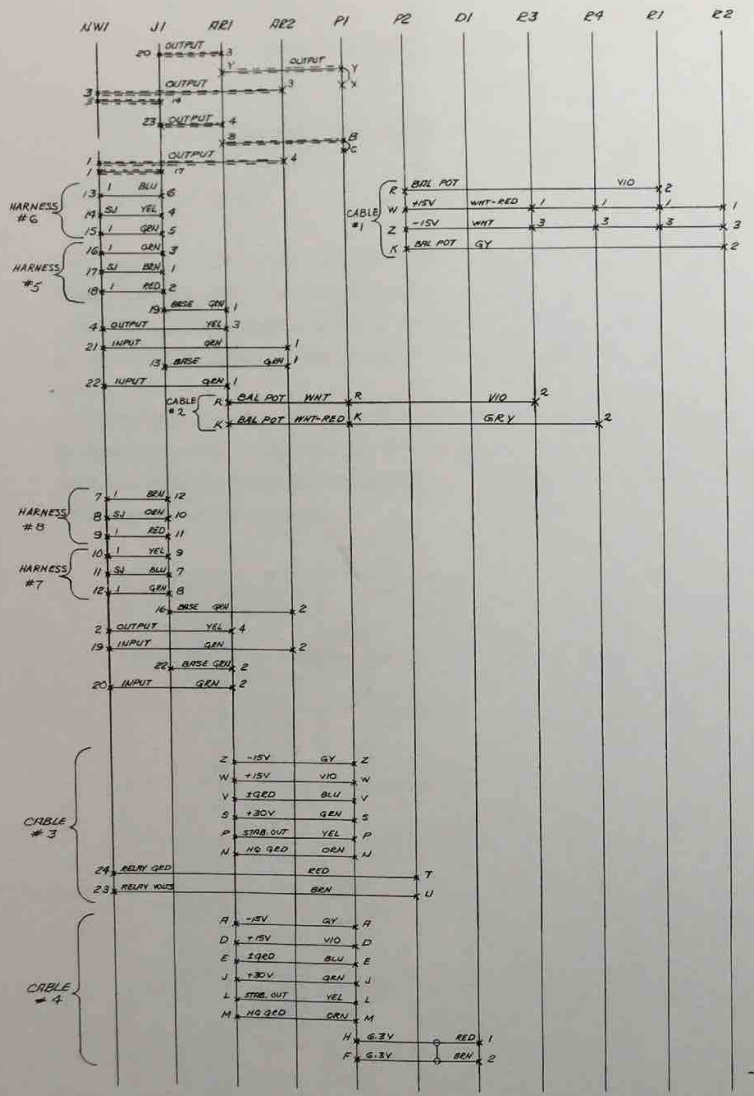
UNIT NUMBER	NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
G 704-2	0006 704 2W	0006 704 2P	AS SHOWN SHT 2		XENBIO
G 704-1	0006 704 1W	0006 704 1P	AS SHOWN SHT 1		-3 PHF
G 704	0006 704 0W	A006 704 0P	AS SHOWN SHT 3		

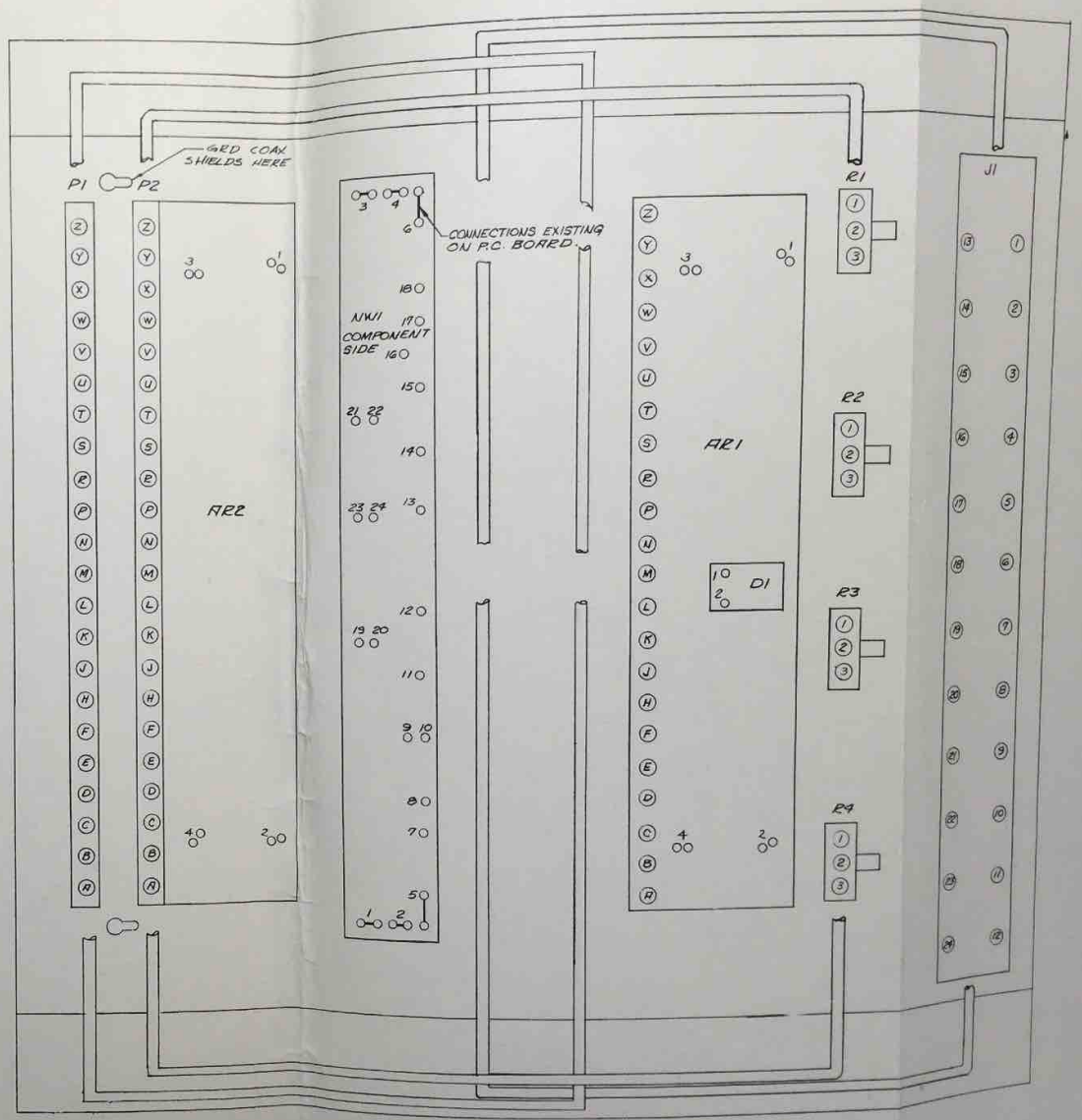
TABLE OF UNIT NUMBERS

UNLESS OTHERWISE SPECIFIED

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
WIRING
QUAD DC AMPL
SHT. NO.
SIZE
DWG. NO.
PROJECT
6-704-0W

NOTES.
1. UNLESS OTHERWISE SPECIFIED:
a. ALL PHU TO HAVE GOOV INSULATION
b. ALL COAX TO BE PER B9I6 001 0
C. CABLE #3 & 4 TO BE PER A 9I8 072 0
d. WIRES TO BE #24 PHU.





006 704 0W
006 704 2W

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
DWG. NO. D006 704

CHAPTER 3

DUAL INTEGRATOR TRAY, MODEL 0.12.1611

AND

POTENTIOMETER, INTEGRATOR TRAY, MODEL 0.12.1675

3.1 INTRODUCTION

This chapter describes the 0.12.1611 Dual Integrator Tray and the 0.12.1675 Potentiometer Integrator Tray which are installed in the positions shown in Figure 3.1. The 0.12.1611 Integrator Tray and its associated patch block is shown in Figure 3.2. In addition to the basic integrator circuits, logic circuits to control the operation of the integrators are also housed in the tray.

The integrator circuits in each of the trays are identical. The 0.12.1611 contains two of these integrator circuits, while the 0.12.1675 contains only one integrator. The patch terminals normally associated with the second integrator are used to provide patching connections to five assigned potentiometers.

* POT-INTEGRATOR TRAY, MODEL 0.12.1675

A00 AMPL A01	INT	ATTEN P00-P04 COMP. F/R	A02 A03 AMPL A04 A05	MULT	A08 AMPL A09	ATTEN P05-P09 * T/S D/A	CONTROL TRAY	A10 AMPL A11	INT	ATTEN P10-P14 COMP. F/R	A12 A13 AMPL A14 A15	MULT	A18 AMPL A19	ATTEN P15-P19 * T/S D/A
A20 AMPL A21	INT	ATTEN P20-P24 COMP F/R	A22 A23 AMPL A24 A25	MULT	A28 AMPL A29	ATTEN P25-P29 * T/S D/A	TRUNKS	A30 AMPL A31	INT	ATTEN P30-P34 COMP. F/R	A32 A33 AMPL A34 A35	MULT	A38 AMPL A39	ATTEN P35-P39 * T/S D/A
A40 AMPL A41	INT	ATTEN P40-P44 COMP F/R	A42 A43 AMPL A44 A45	QUAD LOG DFG MDFG A46 A47	A48 AMPL A49	ATTEN P45-P49 T/S D/A	TRUNKS	A50 AMPL A51	INT	ATTEN P50-P54 COMP. F/R	A52 A53 AMPL A54 A55	QUAD LOG DFG MDFG A56 A57	A58 AMPL A59	ATTEN P55 P59 T/S D/A
A60 AMPL A61	INT	ATTEN P60-P64 COMP F/R	A62 A63 AMPL A64 A65	SINE/COSINE MDFG A66 A67	A68 AMPL A69	ATTEN P65-P69 LIMITER	TRUNKS	A70 AMPL A71	INT	ATTEN P70-P74 COMP. F/R	A72 A73 AMPL A74 A75	SINE/COSINE MDFG A76 A77	A78 AMPL A79	ATTEN P75 P79 LIMITER

Figure 3.1. Patch Panel Layout, Showing Integrator Tray Locations

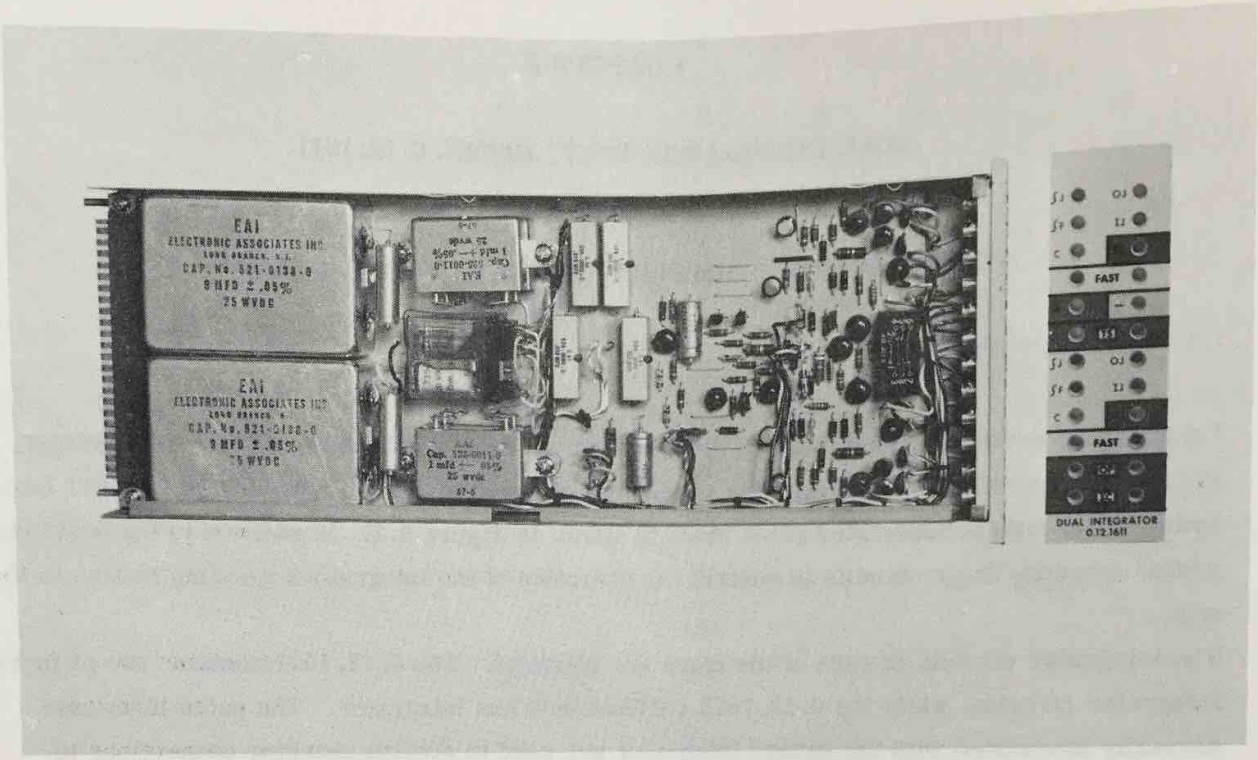


Figure 3.2. Model 0.12.1611 Integrator Tray and Patching Area

3.2 TECHNICAL DATA

Integrator Drift (*Hold* Mode) with Second Time Scale Selected	25 Microvolts/SEC, Maximum
Integrator Reset Time (from Full Scale)	
Milliseconds Time Scale	30 Microseconds to 1%
Seconds Time Scale	2 Milliseconds to 1%
Bandwidth in *IC* Mode with Fast-Milliseconds Time Scale Selected	300 kHz, Minimum
Total Instantaneous Dynamic Error Fast-Milliseconds Time Scale	0.08% at 200 Hz 0.4% at 1 kHz

3.3 OPERATING CONSIDERATIONS

Figure 3.3 shows typical patching for integrator operations. Additional patching and operating information is given in the 580 Reference Handbook (EAI Publication Number 00 800.2055-0). Patching for the 0.12.1675 Pot-Integrator tray is identical to the lower integrator patching in Figure 3.3.

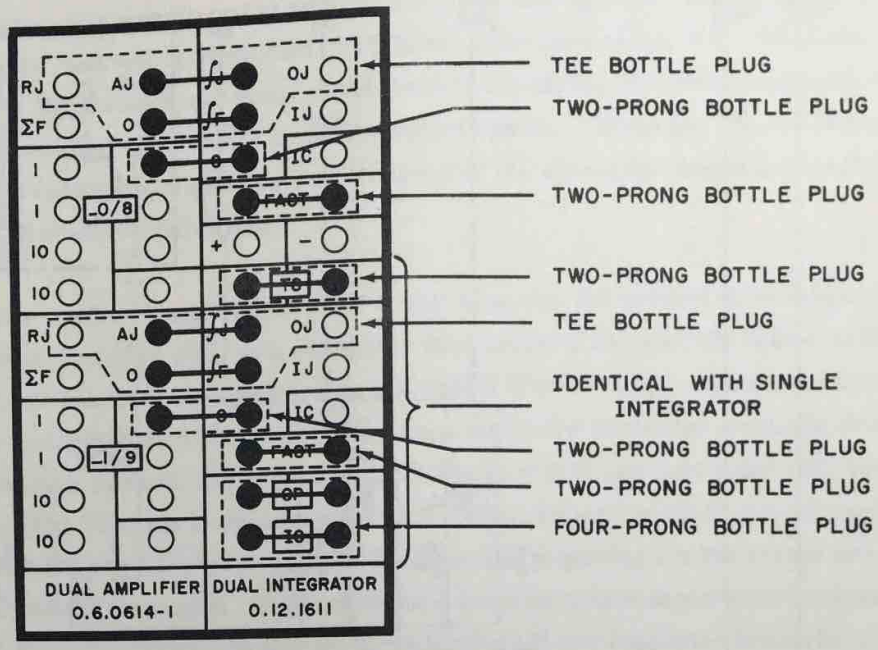


Figure 3.3. Typical Integrator Patching

3.4 THEORY OF OPERATION

Both the 0.12.1611 Integrator Tray and the 0.12.1675 Pot, Integrator Tray include the operate and initial condition electronic switches, the integrator feedback capacitors, and the logic control circuits (see Figure 3.4). Since the -0 and -1 integrators in the 0.12.1611 and the integrator in the 0.12.1675 are identical only the -0 integrator and its control circuits are described in this section.

The level-shifter/drivers (transistors Q9-Q12) develop complementary drive signals, at the correct levels for the electronic switches, from the Mode Select signal. The electronic switches each consist of a field-effect transistor (FET) and a PNP transistor. Each switch is analogous to a "form-C" relay contact; the input signal is connected to the "arm", the "normally-closed" contact is grounded, and the "normally-open" contact is connected to the input of the amplifier. The transistor is equivalent to the normally-closed contact, and the FET is the equivalent of the normally-open contact; the input signal is connected to the junction between the emitter of the transistor and the source terminal of the FET. The transistor and the FET in each switch are complementary. When the drive signal to the switch is low, the transistor is saturated, grounding the input signal, and the FET is cut off. When the drive signal goes high, the FET conducts, coupling the input signal to the operational amplifier, and the transistor is cut off. Since the drive signal to the operate and initial condition electronic switches are complementary, only one switch couples a signal to the amplifier at any time.

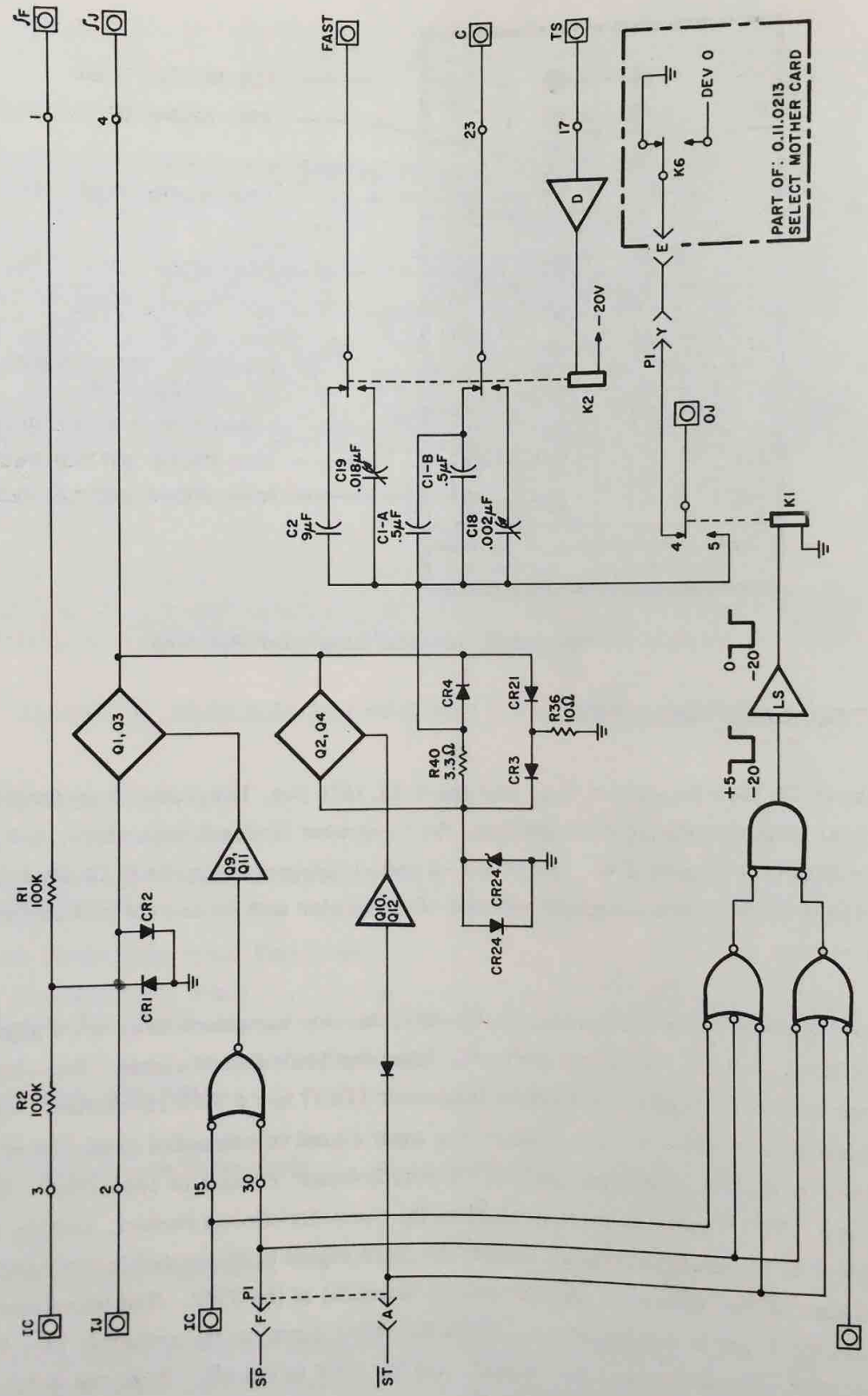


Figure 3.4. Integrator Tray, Simplified Schematic

In normal integrator operation, the summation of the analog input current is patched to the OJ terminal. This terminal is connected to the arm of the hold relay, K1. When the hold relay is de-energized, the OJ terminal is grounded through the normally-closed contacts of the hold relay and the readout relay in the amplifier select system. When the tray is addressed for readout, the readout relay is energized, connecting the normally-closed terminal of the hold relay to the derivative readout bus.

The integrator feedback capacitors, all of which mount on the printed circuit board, consist of a 9 microfarad capacitor (C2), two adjustable capacitors (C18 and C19) valued at 0.002 microfarad and 0.018 microfarad respectively, and dual 0.5 microfarad capacitors (C1A and C1B) packaged in a single sealed enclosure. The capacitors are connected from the FAST and C terminals through contacts on the time scale (TS) relay (K2) and hold relay (K1) to the OJ terminal. When the TS relay is de-energized (1 S Mode), capacitor C2 (9 microfarad) is connected between the FAST and OJ terminals, and C1A and C1B (equaling 1 microfarad) are connected between the C and OJ terminals. In the energized state (2 microsecond mode) adjustable capacitors C18 (0.002 microfarad) and C19 (0.018 microfarad) are connected from the C and FAST terminals respectively to the OJ terminal. The table below indicates the value of the feedback capacitors in the different operating modes.

Table 3.1. Integrator Feedback Capacitor Values

Fast Terminals	Time Scale	Feedback Capacitor Value
Bottled	1 SEC	10 μF
Bottled	2 MS	0.02 μF
Not Bottled	1 SEC	1 μF
Not Bottled	2 MS	0.002 μF

The network consisting of diodes CR3, CR4, and CR21 is designed to provide rapid initializing of the integrator without overloading the amplifier. For example, if a positive initial condition is being set, the transient current through the feedback capacitors causes diodes CR4 and CR21 to conduct through R36. The resultant positive voltage at the junction of CR4 and CR21 is fed to the amplifier input as an inverse feedback. Similarly, if a negative initial condition is being set, the transient current through the feedback capacitors causes diode CR3 to conduct through R36. The resultant negative voltage at the junction of R36 and CR3 is coupled through CR21 as an inverse feedback signal. The value of R36 is selected so that the amplifier receives a feedback signal only when its transient current capacity nears a maximum value. Thus the integrator can be initialized in a very short time without causing amplifier overloading.

Diodes CR23 and CR24 protect the operate electronic switch from damage during peak capacitor charging currents, or if a signal is inadvertantly patched directly to the OJ terminal instead of being coupled through an input resistor. Diodes CR1 and CR2 protect the initial condition electronic switch in the same way, against low-impedance signal sources patched to the IJ terminal.

Logic control of the integrator tray is accomplished using a series of AND and OR gates which in turn control the TS and HOLD relays and the electronic switches.

The IC switch is controlled by OR-1 and the Q9, Q11 level shift/driver circuits. When either the IC patch terminal or the $\overline{SP}$ line goes low, the base of Q11 goes low, the transistor conducts and the base of Q9 goes high. With its base high, transistor Q9 conducts and a -20 volt drive signal is connected to the gate base junction of Q1 and Q3. The negative drive voltage causes the FET (Q3) to conduct coupling the input signal to the amplifier and causes Q1 to cut off lifting the ground from the IJ terminal. When the IC terminal and the $\overline{SP}$ line both go high, FET Q3 is cut off and transistor Q1 conducts grounding the IJ terminal.

Operation of the OP switch is identical with the IC switch except that it takes one input ($\overline{ST}$) to control the OP switch.

The HOLD relay is controlled by two OR gates (OR-2 and OR-3), an AND gate (AND-1) and a level shifter (LS). The HOLD relay is normally in the energized state. If the $\overline{SP}$, $\overline{ST}$ or IC and OP signals go low the outputs of OR gates 2 and 3 go low. Transistors Q14 and Q15 form an AND gate (AND-1) whose output goes high if both inputs are low. With the output of the AND gate high the input to the level shifter is at +5 volts and its input is at 0 volt and the relay is de-energized. If none of the inputs to OR gates 1 and 2 go low the relay remains energized.

The operation of the time scale relay depends on the logic level at the TS patch terminal. When the signal at the patch terminal goes low, the base of Q16 is negative and the transistor conducts. When Q16 conducts pin 4 of relay K2 is grounded and the relay is energized. If the signal at the TS patch terminal goes high, the driver Q16 does not conduct and the relay is in the de-energized state.

3.5 CIRCUIT DESCRIPTION

Refer to Schematic D00 012 1612 0S or D00 012 1684 0S for the following description of the circuit.

Transistor Q9-Q12 form the level-shifter/driver circuit for the electronic switches, Q1-Q3 and Q2-Q4. Transistor Q11 receives the mode select signal as an input. The Q11 stage is

connected as a phase inverter, developing complementary signals at its collector and emitter. The inverted signal at the collector of Q11 is connected to the base of inverter Q9. The collector of Q9 provides the drive signal to the initial condition electronic switch, Q1-Q3. The non-inverted signal from the emitter of Q11 is coupled to common-base buffer Q12. The non-inverted signal at the collector of Q12 is connected to the base of Q10, and the signal at the collector of Q10 drives the operate electronic switch.

The operate and initial condition electronic switches are identical. The operate electronic switch, consisting of Q2 and Q4, receives a drive signal from the collector of Q12. This signal is connected directly to the gate terminal of Q4, and through R4 to the base of Q2. When the drive signal is low, Q4 is cut off and Q2 is saturated. The conducting of Q2 effectively grounds the operate analog signal through R6. When the drive signal goes high, Q2 is reverse biased and Q4 couples the operate signal to the ∫J terminal.

Diodes CR17 and CR18 form an OR gate used as the input to the drive B (IC switch drive) circuit. Diodes CR10, CR17 and CR18 form an OR gate which along with the OR gate formed by diodes CR11, CR15 and CR29, and the AND gate consisting of Q14 and Q15 serve as an input circuit for level shifter Q13. The emitter of Q13 is connected to pin 1 of relay K1. Transistor Q16, connected as a driver stage, controls the operation of the time scale (TS) relay.

3.6 MAINTENANCE AND TROUBLESHOOTING

Apparent malfunctions in the integrator tray are frequently due to patching errors. Before attempting to troubleshoot, assure that the patching is correct.

The second step in troubleshooting requires isolation of the problem to the integrator sections or the control section. Remove the malfunctioning integrator and insert a test shelf. Mount the integrator tray on the test shelf, and using Figure 3.4, check for control signals, driver outputs, etc. A schematic component location diagram for each of the integrator cards is provided in the integrator or control sections, standard troubleshooting procedures can be used to determine which component is malfunctioning.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LISTS INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	J1	Connector Block: White	00 542.1545-2	B
2		Connector Block: Lettered (DUAL INTEGRATOR 0.12.1611)	00 542.1547-7	B
		0.12.1612 DUAL ELECTRONIC INTEGRATOR CARD		
1	C1,3	Capacitor	00 525.0023-0	B
2	C2,4	Capacitor	00 521.0138-0	B
3	C5,18	Capacitor	00 525.0085-0	B
4	C6,7,11,12	Capacitor, Fixed, Ceramic: 470 pf ±5%, 500V (Erie 831-000-X5R0-271J or equal)	00 515.0405-0	A
5	C5,18	Capacitor	00 524.0084-0	B
6	C8,14	Capacitor, Fixed, Electrolytic: 47 uf ±20%, 35V (Sprague 150D or equal)	00 517.1476-4 (00 516.0269-0)	A
6a	C10,19	Capacitor	00 524.0085-0	B
7	C13	Capacitor, Fixed, Ceramic: 47 nf ±20%, 25V (Sprague 3C15 or equal)	00 511.5473-4 (00 515.0234-0)	A
8	C15	Capacitor, Fixed, Ceramic: 330 pf ±10%, 600V (Cornell-Dubilier JBZ601YP331K or equal)	00 515.0074-0	A
9	C17	Capacitor, Fixed, Ceramic: 3.9 nf ±10%, 200V (Vitramon VK33BW392K or equal)	00 515.0238-0	A
10	CR1,2,5,6, 24,26	Rectifier (Solitron Devices, Inc. CER-68 or equal)	00 614.0110-0	A
11	CR3,4,7,8, 17,18,21,22	Diode	00 614.0007-0	B
12	CR9	Diode: Zener (Motorola 1/4M 6.2AZ10 or equal)	00 614.0214-0	A
13	CR10 thru 16,19,27, 28,29,30,31	Diode	00 614.0293-0	B
14	CR23,25	Stabistor	00 648.0004-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: DUAL INTEGRATOR TRAY

MODEL NO. 0.12.1611 Sh. 1 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
15	K1	Relay	00 618.0303-0	B
16	K2	Relay: 18 VDC, 520 ohms Coil, 4 Form C Contacts (Allied Control T-154-4C-520 or equal)	00 618.0171-0	A
17	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-43 or equal)	00 542.0488-0	A
18	Q1,5,11,12	Transistor	00 686.0258-0	B
19	Q2,6	Transistor	00 686.0270-0	B
20	Q3,4,7,8	Transistor	00 686.0245-0	B
21	Q9,10	Transistor: 2N3646	00 686.0230-0	A
22	Q13,16	Transistor: 2N3638A	00 686.0305-0	A
23	Q14,15	Transistor: 2N3638	00 686.0250-0	A
24	R1,2,7,8	Resistor, Precision (Matched Pair)	00 640.0109-0	B
25	R3,4,9,10	Resistor, Fixed, Composition: 2.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0272-0	A
26	R5,11	Resistor, Fixed, Composition: 1.1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0112-0	A
27	R6,12	Resistor, Fixed, Composition: 1 ohm ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0109-0	A
28	R13,14	Resistor, Fixed, Composition: 1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 626.0102-0	A
29	R15	Resistor, Fixed, Composition: 820 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0821-0	A
30	R16,17,18, 20	Resistor, Fixed, Composition: 1.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0122-0	A
31	R19,27	Resistor, Fixed, Composition: 2.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0222-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10 /11 /67

UNIT TITLE
DUAL INTEGRATOR TRAY

MODEL NO.
0.12.1611 Sh. 2 of 3 Sh.

1-3-12

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
32	R21	Resistor, Fixed, Composition: 1.8K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0182-0	A
33	R22	Resistor, Fixed, Composition: 15K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0153-0	A
34	R23,24,42	Resistor, Fixed, Composition: 10K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0103-0	A
35	R25	Resistor, Fixed, Composition: 18K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0183-0	A
36	R26	Resistor, Fixed, Composition: 1.5K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0152-0	A
37	R36,37	Resistor, Fixed, Composition: 10 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0100-0	A
38	R38	Resistor, Fixed, Composition: 390 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0391-0	A
39	R39	Resistor, Fixed, Composition: 10 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0100-0	A
40	R40,41	Resistor, Fixed, Composition: 3.3 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0339-0	A
41	R43,44	Resistor, Fixed, Composition: 100 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0101-0	A
42	XK2	Socket	00 650.0079-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/ 11 /67

UNIT TITLE

DUAL INTEGRATOR TRAY

MODEL NO.

0.12.1611 Sh. 3 of3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	P2	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-43 or equal)	00 542.0488-0	A
2	J1	Connector Block: (White)	00 542.1545-2	B
3		Connector, Plug: 22 Contacts; Male (Amphenol 133-022-21 or equal)	00 542.0569-0	A
4		Connector Block: Lettered (POT-INTEGRATOR 0.12.1675)	00 542.1547-9	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: INTEGRATOR POT TRAY

MODEL NO.: 0.12.1675-0 Sh. 1 of 1 Sh.

1

DATE 12/ 14 /67

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1	Capacitor: Matched Pair	00 525.0011-0	B
2	C2	Capacitor:	00 521.0138-0	B
3	C6,11	Capacitor, Fixed, Ceramic: 470 pf ±5%, 500V (Erie 831-000-X5R0-471J or equal)	00 515.0405-3	A
4	C8,14	Capacitor, Fixed, Electrolytic: 47 uf ±20%, 35V (Sprague type 150D or equal)	00 517.1476-4	A
5	C13	Capacitor, Fixed, Ceramic: 0.047 uf ±20%, 25V (Sprague type 3C15 or equal)	00 511.5473-4 (00 515.0234-0)	A
6	C15	Capacitor, Fixed, Ceramic: 330 pf ±10%, 600V (Cornell-Dubilier LA6T33C4 or equal)	00 515.0405-3	A
7	C17	Capacitor, Fixed, Ceramic: 3900 pf ±10%, 200V (Vitramon VK31CW392K or equal)	00 515.0237-0	A
8	C18	Capacitor:	00 524.0084-0	B
9	C19	Capacitor:	00 524.0085-0	B
10	CR1,2,24	Diode: 1N4002	00 614.0110-0	A
11	CR3,4,17, 18,21	Diode:	00 614.0007-0	B
12	CR9	Diode: Zener, 6.2V (Motorola type 1/4M6.2AZ10 or equal)	00 614.0214-0	A
13	CR10 thru 16, 19, 27 thru 31	Diode	00 614.0293-0	B
14	CR23	Stabistor	00 648.0004-0	B
15	K1	Relay:	00 618.0303-0	B
16	K2	Relay, Armature; 4 Form C, Coil 520 ohms, 18V (Allied Control T154-4C-520 or equal)	00 618.0171-0	A
17	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-43 or equal)	00 542.0419-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
SINGLE INTEGRATOR CARD

MODEL NO.
00.012.1684 Sh.1 of 3 Sh.

3

DATE 12 / 14 / 67

M446

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	Q1,11,12	Transistor: 2N3640	00 686.0258-0	A
19	Q2	Transistor	00 686.0270-0	B
20	Q3,4	Transistor	00 686.0245-0	B
21	Q9,10	Transistor: 2N3646	00 686.0230-0	A
22	Q13,16	Transistor: 2N3638A	00 686.0305-0	A
23	Q14,15	Transistor: 2N3638	00 686.0250-0	A
24	R1,2	Resistor, Precision: Matched Pair	00 640.0109-0	B
25	R3,4	Resistor, Fixed, Composition: 2.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0272-0	A
26	R5	Resistor, Fixed, Composition: 1.1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0112-0	A
27	R6	Resistor, Fixed, Composition: 1 ohm ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0109-0	A
28	R13,14	Resistor, Fixed, Composition: 1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0102-0	A
29	R15	Resistor, Fixed, Composition: 820 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0821-0	A
30	R16,17,18, 20	Resistor, Fixed, Composition: 1.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0122-0	A
31	R19,27	Resistor, Fixed, Composition: 2.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0222-0	A
32	R21	Resistor, Fixed, Composition: 1.8K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0182-0	A
33	R22	Resistor, Fixed, Composition: 15K ohms, ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0153-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 12/14/67

UNIT TITLE
SINGLE INTEGRATOR CARD

MODEL NO.
00.012.1684 Sh. 2 of 3 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
34	R23,24,42	Resistor, Fixed, Composition: 10K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0103-0	A
35	R25	Resistor, Fixed, Composition: 18K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0183-0	A
36	R26	Resistor, Fixed, Composition: 1.5K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0152-0	A
37	R36	Resistor, Fixed, Composition: 10 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0100-0	A
38	R38	Resistor, Fixed, Composition: 390 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0391-0	A
39	R39	Resistor, Fixed, Composition: 10 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0100-0	A
40	R40	Resistor, Fixed, Composition: 3.3 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0339-0	A
41	R43,44	Resistor, Fixed, Composition: 100 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0101-0	A
42	XK2	Socket Relay:	00 650.0079-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 12 / 14 / 67

UNIT TITLE
SINGLE INTEGRATOR CARD

MODEL NO.
00.012.1684 Sh.3 of 3 Sh.

APPENDIX 2

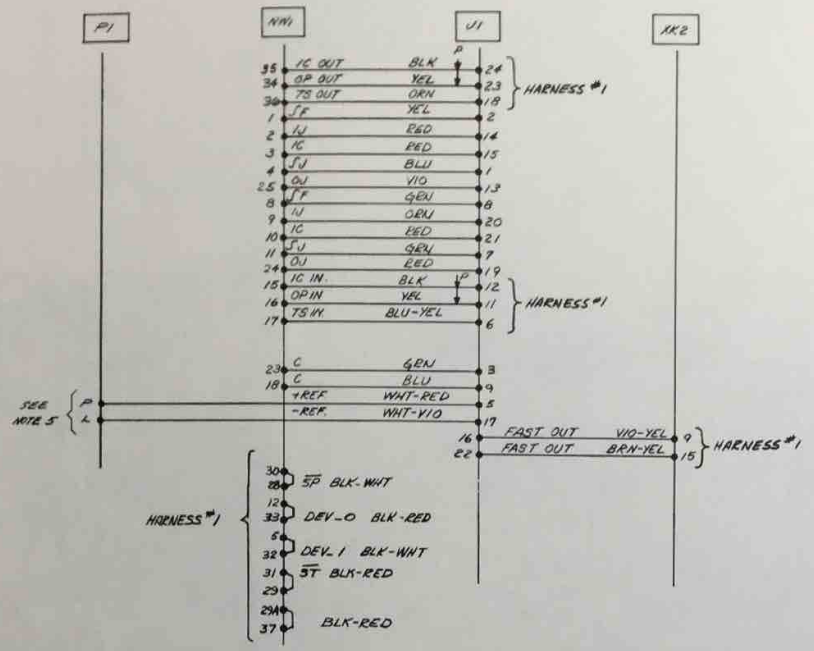
DRAWINGS

This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

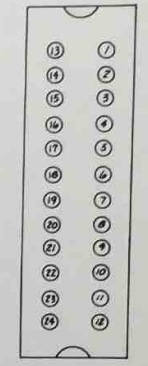
EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

INDEX

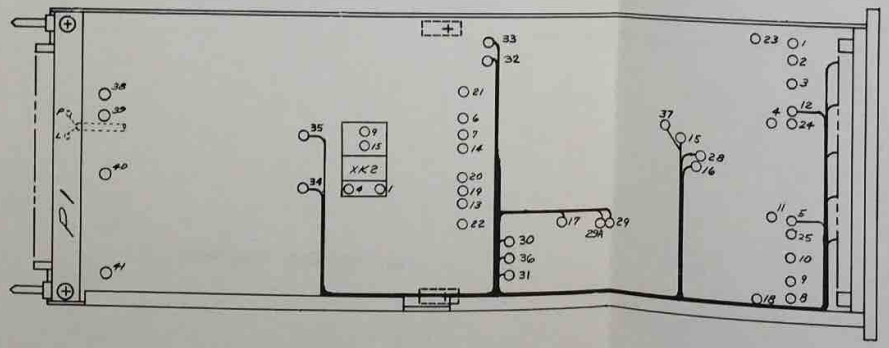
Unit or Component	Type of Drawing	Drawing Number
0.12.1611 Dual Integrator	Assembly W/ Wiring	D00 012 1611 0A
	Schematic	D00 012 1612 0S
0.12.1675 Pot-Integrator Tray	Assembly W/ Wiring	D00 012 1675 0A
	Schematic	D00 012 1684 0S

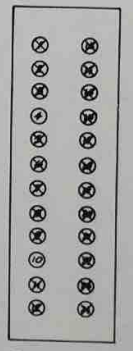


NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) WIRES TO BE #22 P.H.U.
   b) COAX PER B00 916 0001 0.
2. ⊗ DENOTES LOCATION OF CONTACTS (ITEM #11) PER DETAIL "A".
3. SEE (A00 018 1800 OP) FOR HARNESS #1 & JUMPERS.
4. WIRING INFO NOTE:
   a. SOLDER JUMPERS ON PC BOARD THEN TO J1
   b. INSTALL HARNESS
5. THESE WIRES TO BE RUN UNDER P.C. BOARD IN GRAY VINYL SLEEVING & INDEPENDENT OF ANY HARNESSING.
6. AFTER V & M INSPECTION, THE COMPLETED ASS'YS ARE TO BE SENT TO THE PRECISION COMPONENTS GROUP BY SERVICE REQUEST, FOR CAPACITOR ACCURACY CHECKS.



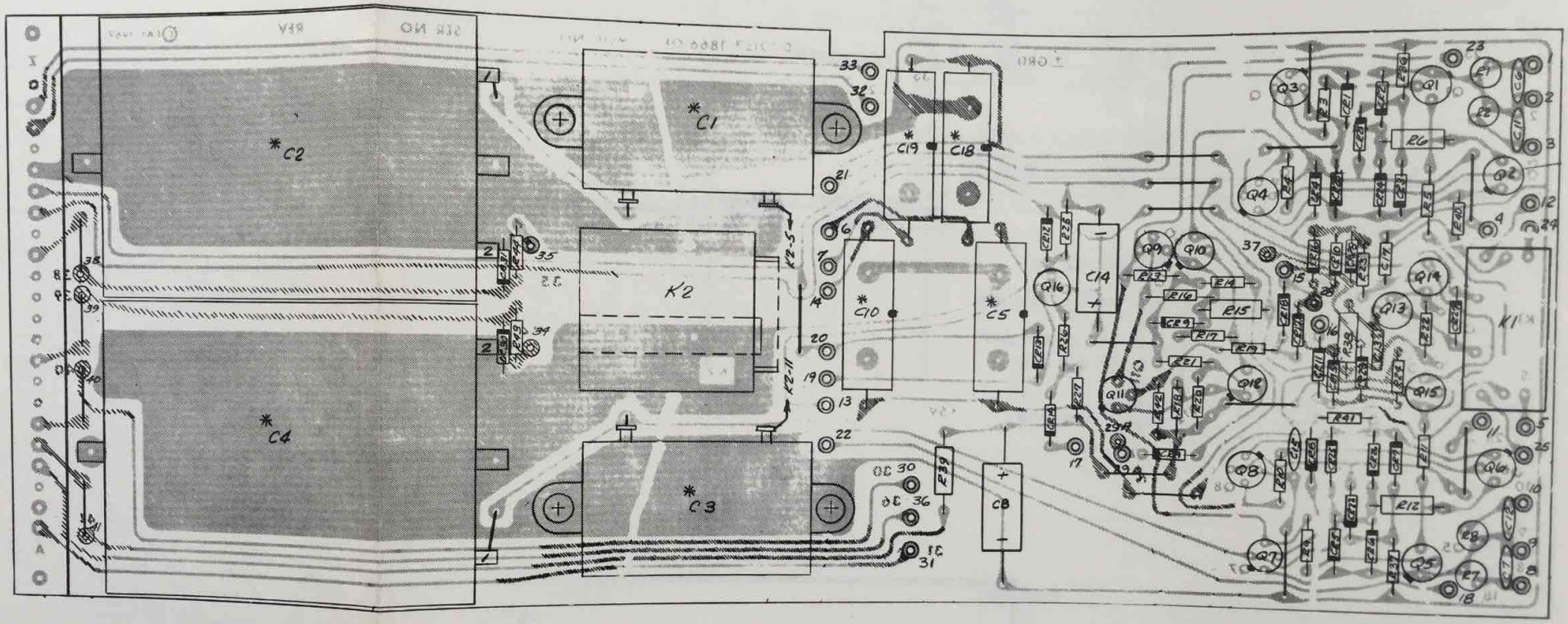
CONN. BLOCK REAR VIEW



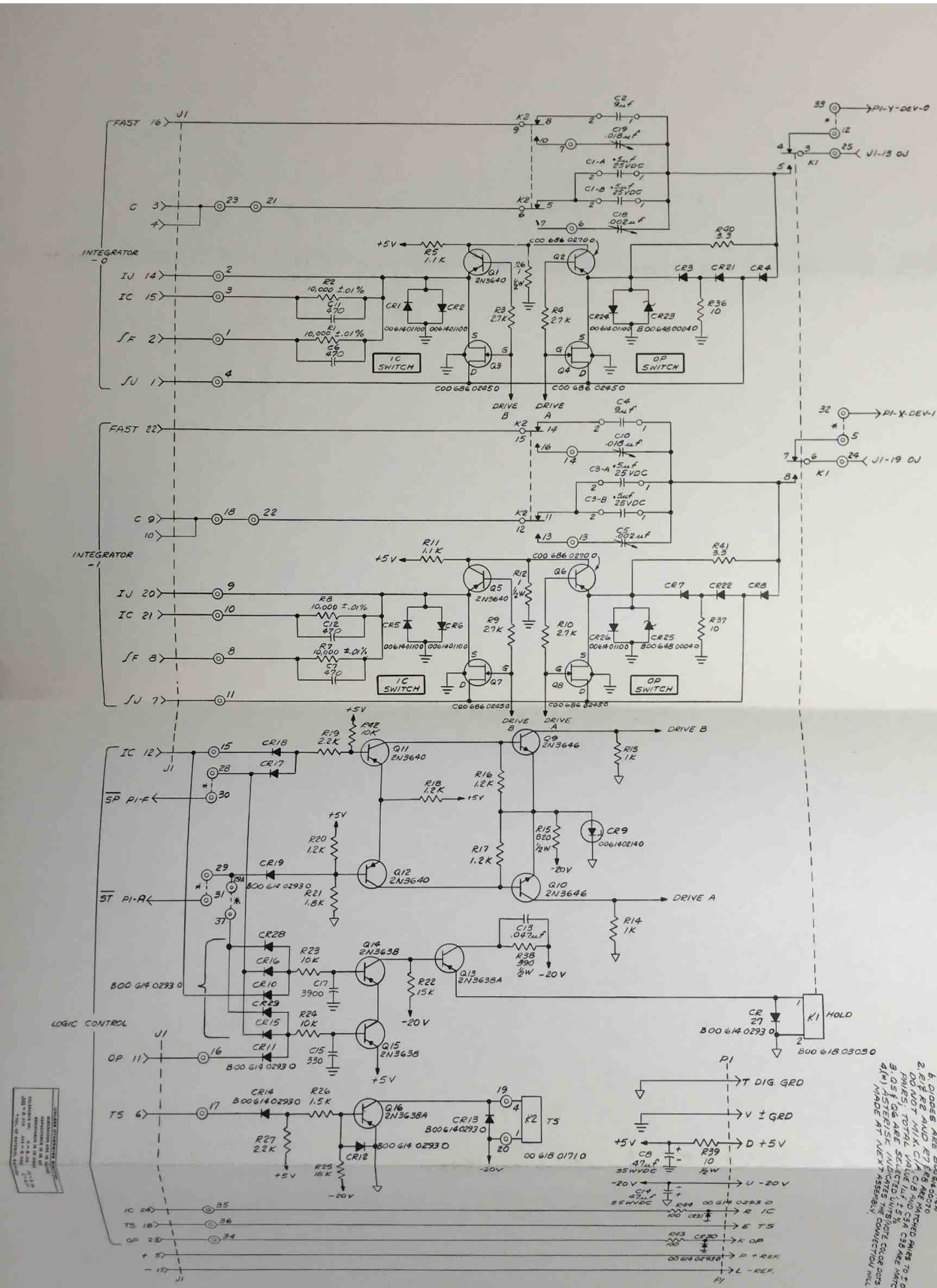


CONN. BLOCK FRONT VIEW

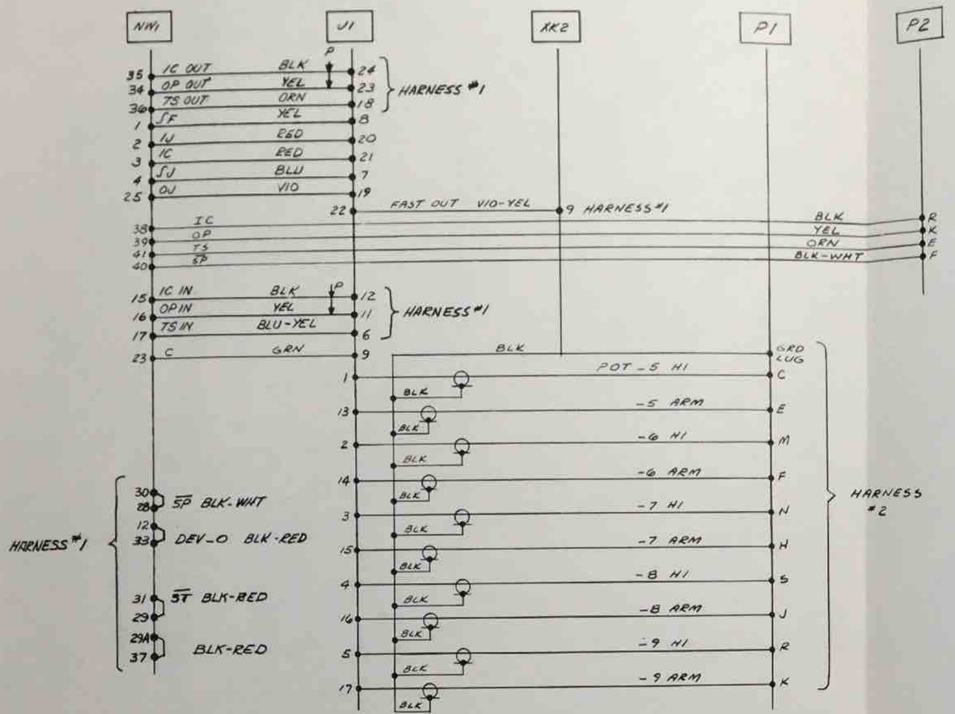
EAI
ASSEMBLY & WIRING DUAL INTEGRATOR TRAY
DWG. NO.
SIZE
REV. NO.
PROJECT 19316
D00 010 1401 0A
SHEET 2 OF 2 SHEETS

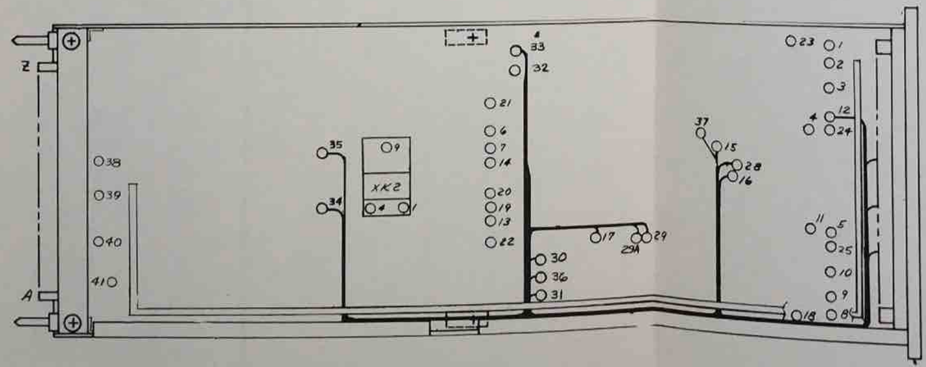


12.1612 Dual Integrator

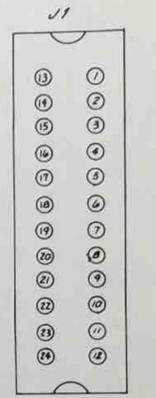


NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a. RESISTORS ARE ±5% ¼W
   b. DIODES ARE B00 640 0070
2. R1 & R2 AND C1 & C6 ARE MATCHED PAIRS; C12 & C7 ARE MATCHED PAIRS; TOTAL SCALE ACCURACY ±1%. C3A & C3B TO ±0.1%. DO NOT MIX. C1A & C1B AND C18 & C19 ARE SELECTED WITH ±1%
3. Q5 & Q6 ARE SELECTED WITH ±1%
4. (*) ASTERISK INDICATES THAT SOLDER COLOR DOTS (WHERE MADE AT NEXT ASSEMBLY.

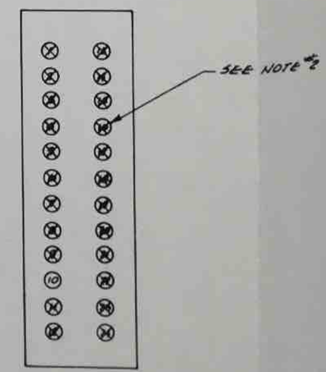




NOTES:
1. UNLESS OTHERWISE SPECIFIED:
 a) WIRES TO BE #22 P.H.U.
 b) COAX PER B00 916 0001 0.
2. ⊗ DENOTES LOCATION OF CONTACTS (ITEM #18) PER DETAIL "A".

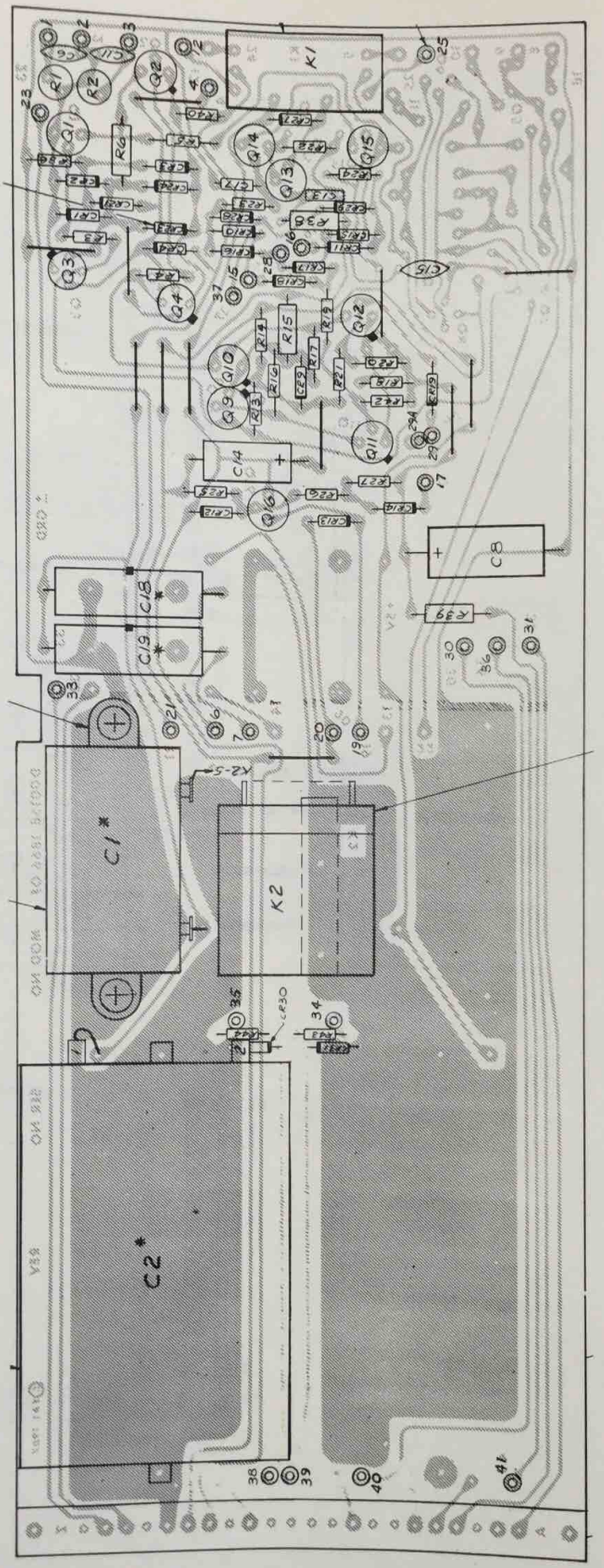


CONN. BLOCK REAR VIEW

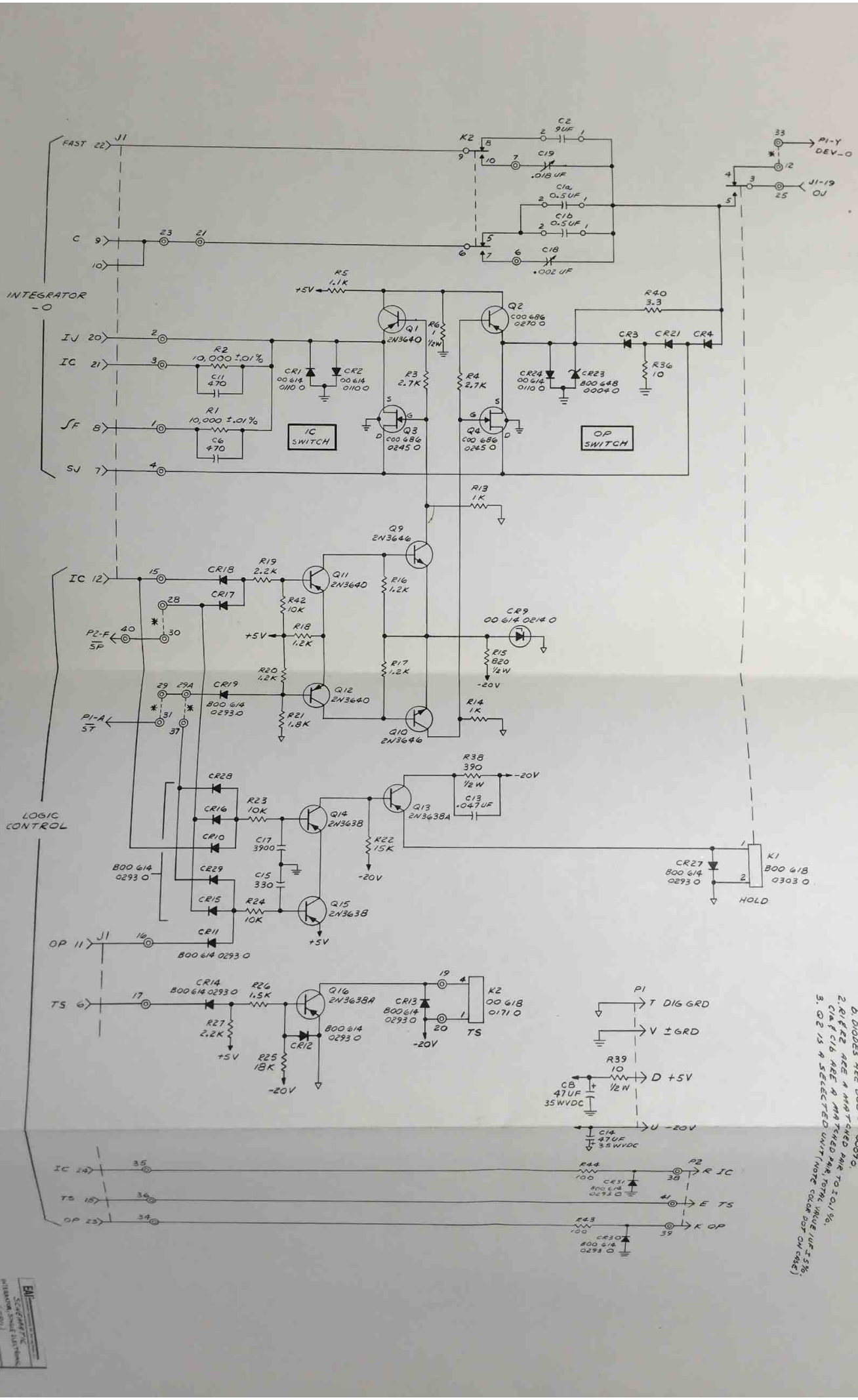


CONN. BLOCK FRONT VIEW

EAI	
ASSEMBLY & WIRING POT-INTEGRATOR TRAY (580)	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 10/71	D00 012 475 0A



0.12.1684 Integrator, Single Electronic



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   A. RESISTORS ARE ±5% ¼W
   B. DIODES ARE 800 614 0010.
2. R1 R2 ARE A MATCHED PAIR TO ±0.1%.
   C1a & C1b ARE A MATCHED PAIR TOTAL VALUE 1UF ±5%.
3. Q2 IS A SELECTED UNIT (NOTE COLOR DOT ON CASE).

SECTION 2

NON-LINEAR COMPONENTS

CHAPTER 1

HIGH ACCURACY QUARTER-SQUARE MULTIPLIERS, MODELS 0.7.0146 and 0.7.0150

1.1 INTRODUCTION

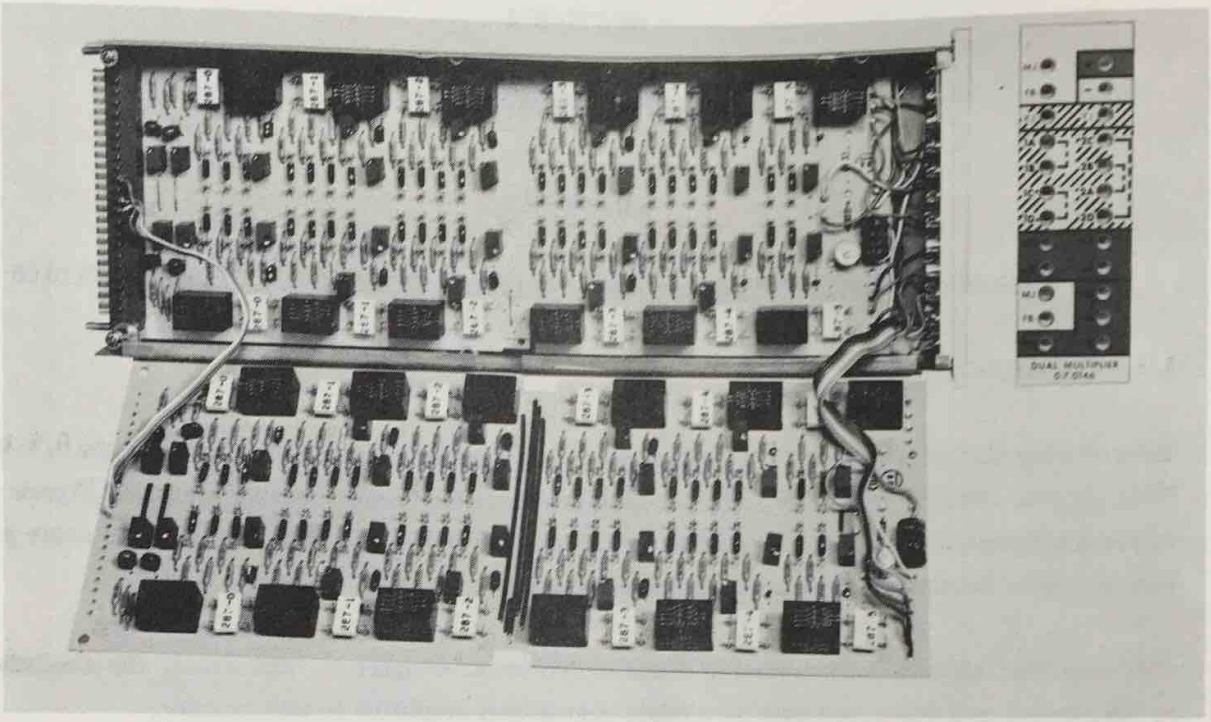
This chapter describes the 0.7.0146 High Accuracy Quarter-Square Multiplier and the 0.7.0150 Dual Quarter-Square Multiplier. These units are installed in the positions shown in Figure 1.1 in standard computers. The trays (Figure 1.2) are similar in that each contains the same printed circuit cards but are dissimilar in the patching areas.

The amplifier circuit is described in detail in Section 1, Chapter 1. Therefore, the amplifier is illustrated and described only as a basic operational amplifier in this chapter.

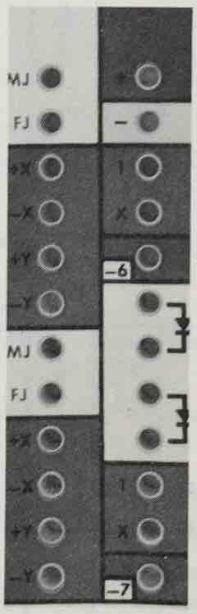
* QUARTER-SQUARE MULTIPLIER MODEL 0.7.0150

A00		ATTEN P00-P04	A02 A03		A08	ATTEN P05-P09		A10		ATTEN P10-P14	A12 A13		A18	ATTEN P15-P19
AMPL	INT	----	AMPL	MULT	AMPL	----	CONTROL TRAY	AMPL	INT	----	AMPL	MULT	AMPL	----
		COMP.	A04			T/S				COMP.	A14			T/S
A01		F/R	A05		A09	D/A		A11		F/R	A15		A19	D/A
A20		ATTEN P20-P24	A22 A23		A28	ATTEN P25-P29		A30		ATTEN P30-P34	A32 A33		A38	ATTEN P35-P39
AMPL	INT	----	AMPL	MULT	AMPL	----	TRUNKS	AMPL	INT	----	AMPL	MULT	AMPL	----
		COMP	A24			T/S				COMP.	A34			T/S
A21		F/R	A25		A29	D/A		A31		F/R	A35		A39	D/A
A40		ATTEN P40-P44	A42 A43	QUAD LOG * DFG MDFG	A48	ATTEN P45-P49		A50		ATTEN P50-P54	A52 A53	QUAD LOG * DFG MDFG	A58	ATTEN P55 P59
AMPL	INT	----	AMPL	A46	AMPL	----	TRUNKS	AMPL	INT	----	AMPL	A56	AMPL	----
		COMP	A44			T/S				COMP.	A54			T/S
A41		F/R	A45	A47	A49	D/A		A51		F/R	A55	A57	A59	D/A
A60		ATTEN P60-P64	A62 A63	SINE/COSINE * MDFG	A68	ATTEN P65-P69		A70		ATTEN P70-P74	A72 A73	SINE/COSINE * MDFG	A78	ATTEN P75 P79
AMPL	INT	----	AMPL	A66	AMPL	----	TRUNKS	AMPL	INT	----	AMPL	A76	AMPL	----
		COMP	A64			LIMITER				COMP.	A74			LIMITER
A61		F/R	A65	A67	A69			A71		F/R	A75	A77	A79	

Figure 1.1. Patch Panel Layout Showing 0.7.0146 and 0.7.0150 Quarter-Square Multiplier Locations



(a) Multiplier Tray, 0.7.0146



(b) Multiplier Tray, 0.7.0150

Figure 1.2. Multiplier Trays

The multiplier circuit uses the quarter-square principle, illustrated by the following identity:

$$XY = \left| \frac{X + Y}{2} \right|^2 - \left| \frac{X - Y}{2} \right|^2$$

The use of this identity reduces multiplication to the operations of squaring and summation. The squaring operations are performed by two function generating networks on the multiplier card, and the summation is performed by the output amplifier.

Each multiplier is capable of multiplying two variables and division. In addition to these functions, the 0.7.0146 is capable of squaring two variables independently, or extracting the square roots of two variables independently.

1.2 TECHNICAL DATA

The following specifications refer to the multiplier circuit when patched for multiplication, and include the output amplifier measured at 75°F room ambient.

Static Error

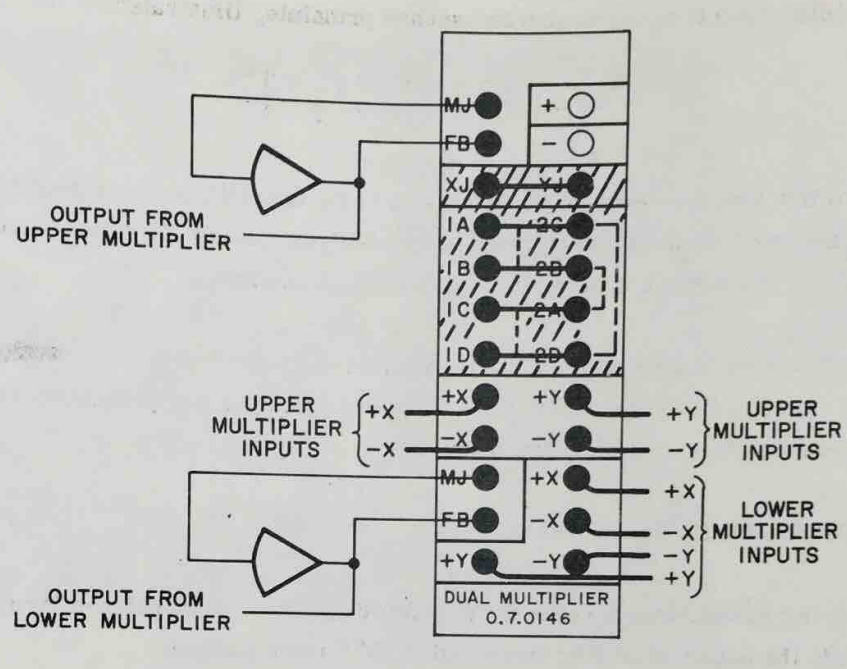
$\lvert X \rvert + \lvert Y \rvert = 20V$	±0.015% of Full Scale, Typical ±0.025% of Full Scale, Maximum
X and Y = 0V	±0.0025% of Full Scale, Maximum

Input Impedance

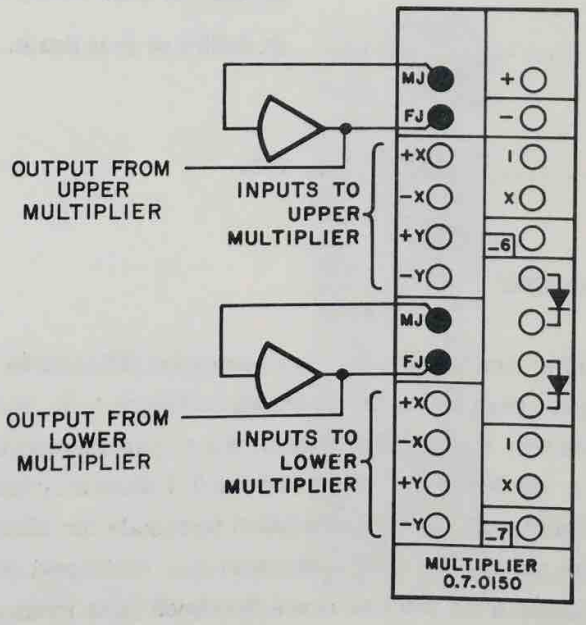
Each Input 1.6k

1.3 OPERATING CONSIDERATIONS

These multiplier, while containing similar circuits, are somewhat different in operation. Typical multiplication patching for each multiplier is shown in Figure 1.3. Note that the upper multiplier in the 0.7.0146 tray contains patch terminals to permit patching inputs to both sections of the multiplier. The lower multiplier and the 0.7.0150 multiplier do not contain this feature. The 0.7.0150 tray also contains patch terminals for MDFG readout. (See Chapter 5, Section 2 of this manual for MDFG information.) Additional multiplier operational information is contained in the 580 Reference Handbook (EAI Publication Number 00 800.2055-0).



(a) 0.7.0146 Multiplier



(b) 0.7.0150 Multiplier

Figure 1.3. Multipliers Patched for Multiplication

1.4 THEORY OF OPERATION

As previously stated, the operation of the quarter-square multiplier is based on the identity:

$$XY = 1/4 \left[(X + Y)^2 - (X - Y)^2 \right]$$

This identity is readily implemented by analog computer circuits. Figure 1.4 shows a basic multiplier circuit employing this technique. Referring to this circuit, note that +X and +Y are summed through resistor R1 and R2, and +X and -Y are summed through R3 and R4. Diodes CR1, CR2 and CR3 are each reverse biased at different potentials by individual bias resistors connected to a negative potential. The value of the input resistor to each diode (represented by R_i), and the potential at which each diode begins to conduct, is carefully selected

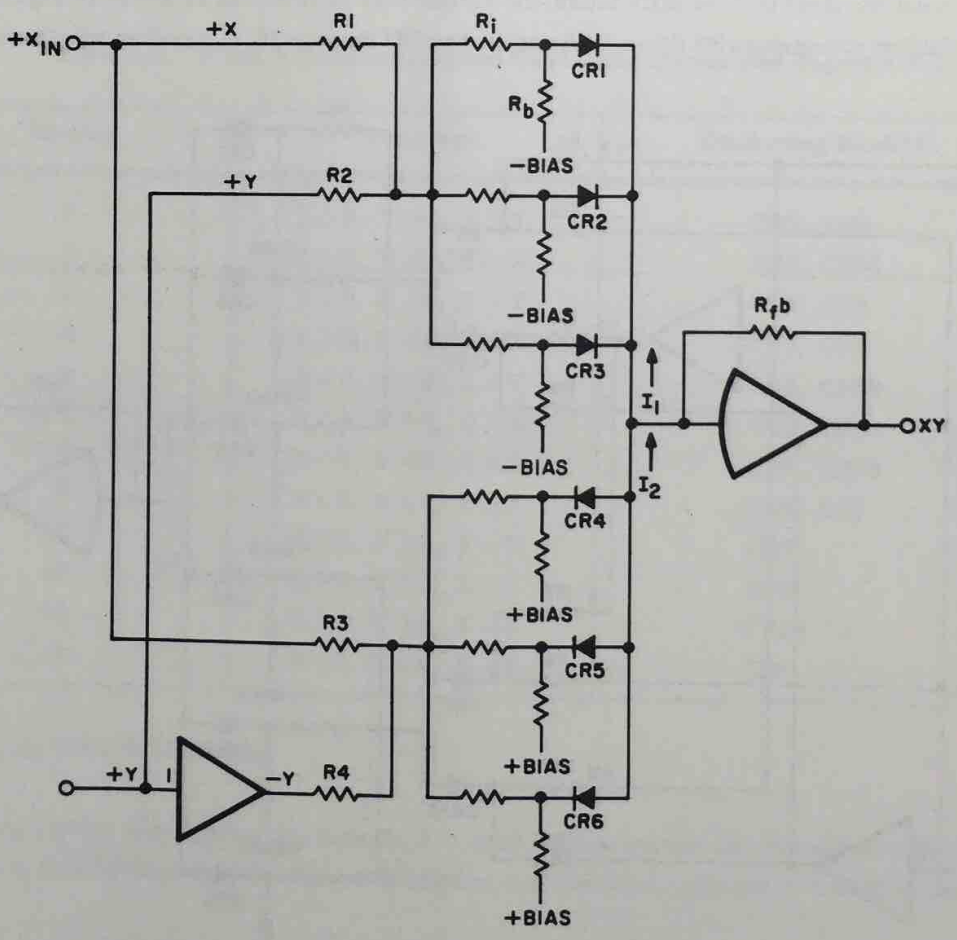


Figure 1.4. Simple Quarter-Square Multiplier

so that the output current from the CR1-CR2-CR3 network represents an approximation to $\left[\frac{X+Y}{2}\right]^2$. Similarly, the CR4-CR5-CR6 network produces an output current which approximates $-\left[\frac{X-Y}{2}\right]^2$. The minus sign within the parenthesis indicates that the resultant current represents the *difference* between X and Y, accomplished by providing the network with an inverted value of Y. The minus sign before the parenthesis results from the reversed polarity of CR4-CR6 compared with CR1-CR3.

This simple circuit could be used to multiply, but it suffers from several drawbacks:

1. The value of X and Y must be = zero.
2. Since only three diodes are used in each squaring circuit, the approximation must necessarily be coarse, and substantial errors result.

To correct the first of these difficulties, the circuit may be modified as shown in Figure 1.5. The addition of resistors R5 through R8 and diodes CR7 through CR10, together with the addition

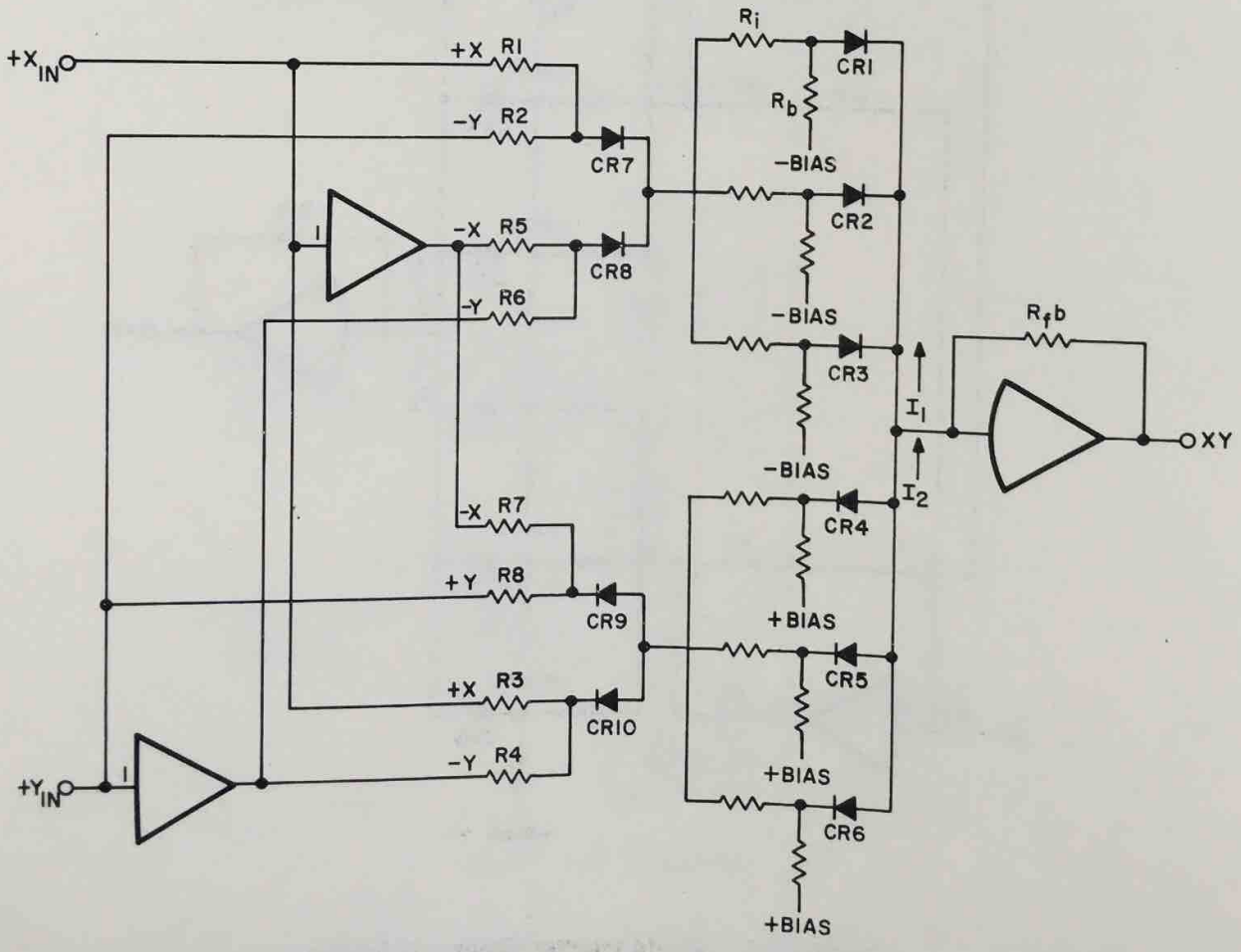


Figure 1.5. Simple Four Quadrant Quarter-Square Multiplier

of an inverted value of X, permits either or both inputs to be negative in polarity. This circuit thus provides full four-quadrant multiplication. Diodes CR7 through CR10 may be thought of as input selecting diodes, since they determine which input summing networks (resistors R1-R8) are connected to the squaring circuits for any combination of input amplitudes and polarities. The following table (Table 1.1) indicates the conducting diode or diodes for all input combinations.

The four-quadrant multiplier of Figure 1.5 still suffers from the inaccuracy imposed by the small number of diode networks. The accuracy may be improved to any degree required by adding more diode networks in parallel with CR1-CR3 and CR4-CR6.

Table 1.1. X and Y Combinations and Conducting Diodes (See Figure 1.4.)

Number	Condition	Conducting Diode(s)
1	$X>0$, $Y>0$, $X>Y$	CR7, CR9
2	$X>0$, $Y>0$, $Y>X$	CR7, CR10
3	$X>0$, $Y<0$, $X>Y$	CR7, CR9
4	$X>0$, $Y<0$, $Y>X$	CR8, CR9
5	$X<0$, $Y>0$, $X>Y$	CR8, CR10
6	$X<0$, $Y>0$, $Y>X$	CR7, CR10
7	$X<0$, $Y<0$, $X>Y$	CR8, CR10
8	$X<0$, $Y<0$, $Y>X$	CR8, CR9
9	$X>0$, $Y>0$, $X=Y$	CR7
10	$X>0$, $Y<0$, $X=Y$	CR9
11	$X<0$, $Y>0$, $X=Y$	CR10
12	$X<0$, $Y<0$, $X=Y$	CR8

1.5 CIRCUIT DESCRIPTION

Since the circuit descriptions for both the 0.7.0146 High Accuracy Quarter-Square Multiplier and the 0.7.0150 Dual Quarter-Square Multiplier are identical, only the 0.7.0146 is described below.

Refer to Schematic D00 007 0146 0S for the following description. The card consists of two 21-segment function generator networks, and the precision 10k amplifier feedback resistor.

The two function generator networks are identical except that the diode and reference voltage polarities for the second network are the reverse of those shown along the upper part of the schematic. Therefore, only a partial schematic of DFG2 is provided, to illustrate the polarity reversal, and only DFG1 is described in this section.

The function generator circuit consists of six groups of diode networks. The first network consists of diodes CR1-CR4 and the associated bias and input resistors. The $+X_1$ and $+Y_1$ inputs are summed by R1a and R1b, while the $-X_1$ and $-Y_1$ inputs are summed by R1c and R1d. The four R1 resistors are precisely matched, and encapsulated in an epoxy compound. The encapsulation assures protection and assists in maintaining a common temperature for the resistors, as well as preventing any mixing of the resistors in a matched set. The summing junction of R1a and R1b is connected to the anode of CR1a, while the summing junction of R1c and R1d is connected to the anode of CR1b. The CR1 diodes perform the input selection function corresponding to diodes CR7 and CR8 of Figure 1.4; they are very carefully matched at a selected current level, and placed in an epoxy case. The epoxy case is coded with the last three digits of the EAI part number to indicate the current level at which the diodes are matched.

The CR1-CR4 network produces the first three segments of the squaring curve as the summation of $+X_1$ and $+Y_1$ or $-X_1$ and $-Y_1$ increases in a positive direction from zero. Since all diodes have a finite forward voltage drop, the first segment could not be produced until the input sum reaches this finite value to cause diodes CR1 and CR2 to conduct. This would reduce the accuracy of the square curve produced by the function generator for low input values. To eliminate this error, positive bias voltages are applied to the anodes of CR1a and CR1b by temperature compensated networks R2-R4 and R13-R15. The bias voltage is adjusted so that CR1a and CR1b are just at the threshold of conduction with no input signals. This forward biasing is necessary only for the networks producing the first positive and negative-going segments.

Diodes CR2, CR3 and CR4 produce the first three segments of the squaring curve. Diode CR2 is normally reverse-biased by the voltage divider between the input +10 volts and -10 volts. When the input goes sufficiently positive to overcome the reverse bias, a current flows through R5 and CR2 to the common cathode junction of all segment diodes. As the input continues to increase, the reverse bias for CR3 is overcome, and a current flows through R7 and CR3. Note that resistor R6 acts as a biasing resistor for CR2 and as part of the input resistance for CR3 and CR4. This dual use of resistors reduces the number of precision components required, and results in a more stable circuit than that represented by Figure 1.4, where each diode has a separate input and bias resistor. Resistor R12 adjusts the bias for diodes CR2 through CR4, so that the breakpoints occur at the proper input levels to generate an

accurate squaring curve. Thermistor RT3, shunted by R11 and in series with R10, provides temperature compensation for the bias potential. The shunt and series resistance trim the compensating curve of the thermistor to the exact characteristics required by the fixed resistors and the diodes in the circuit.

The five remaining segment-generating networks are identical in theory and operation. Diodes CR6 through CR9 in the second network generate segments 4 through 7; diodes CR11 through CR14 form the third network and generate segments 8 through 11. Diodes CR16 through CR19, CR21 through CR24, and CR26 and CR27 form the fourth, fifth, and sixth networks respectively, and generate the remaining ten segments, so that the complete squaring curve is produced by a total of 21 straight line segments.

The negative DFG (DFG2) is identical with the circuit just described, except that the diodes are reversed and bias potentials of the opposite polarity are used. The negative circuit sums the $+X_2$ and $-Y_2$ signals and the $-X_2$ and $+Y_2$ signals to provide its inputs. The output of the negative circuit thus provides output current representing the $-\left[\frac{X - Y}{2}\right]^2$ term in the multiplier identity.

1.6 MULTIPLIER ADJUSTMENT PROCEDURE

The adjustment procedures for both the 0.7.0146 and 0.7.0150 multipliers are identical except for the patch panel positions. Figures 1.5 and 1.7 indicate the differences in patching.

1.6.1 Required Equipment

1. Null Voltage Test Set or Equivalent
2. Test Patch Cords - As required

1.6.2 Preliminary Steps

1. *Temperature.* To calibrate the multiplier within specifications, the ambient temperature should be 85°F (29.5°C) within ±2°F (±1°C). During the time when adjustments are being performed, the ambient temperature should not vary by more than ±0.3°F (±0.16°C). Since the multiplier must be operated in the service position while adjustments are performed, these temperature requirements are imposed on the computer surroundings for the period of adjustment.

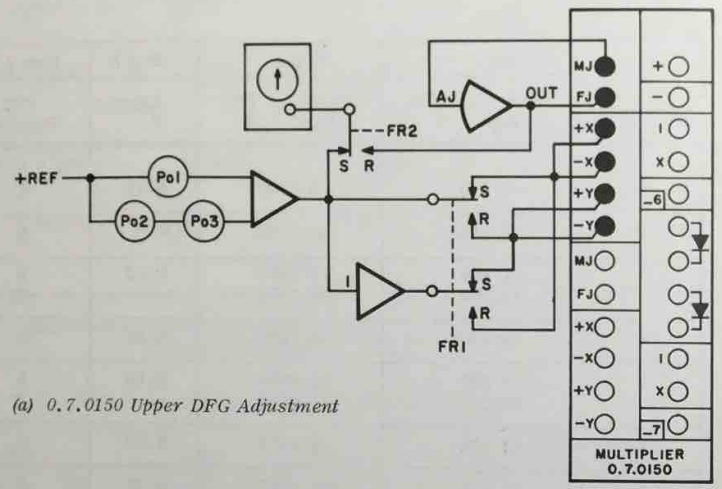
NOTE

For maximum accuracy, the specified ambient temperature range must be maintained when making multiplier adjustments. Failure to observe this precaution may result in excessive error. If the ambient temperature specifications cannot be met, it is suggested that the unit be returned to EAI for re-calibration.

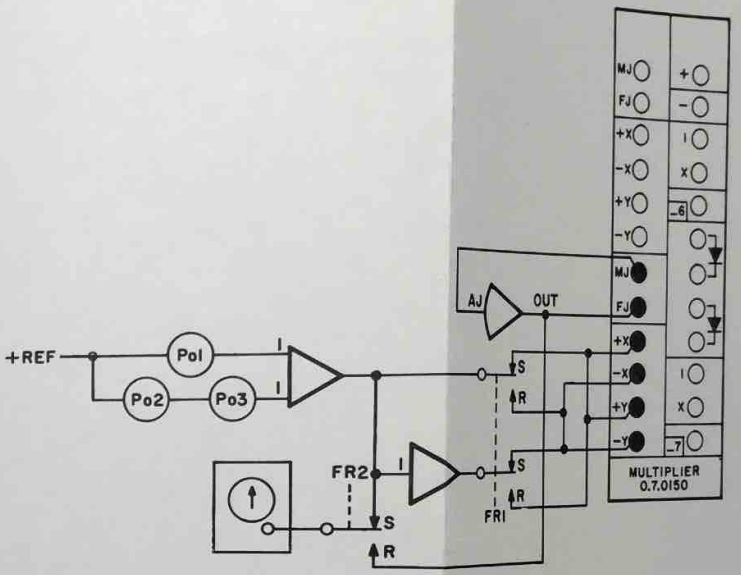
2. *Equipment Warm-Up.* Prior to performing any adjustments, the equipment should be allowed to stabilize at operating temperature. This requires a minimum of one-half hour with power on for the computer. Follow the manufacturer's instructions concerning warm-up and calibration of the null voltage test set (or equivalent).

1.6.3 Adjustment Steps

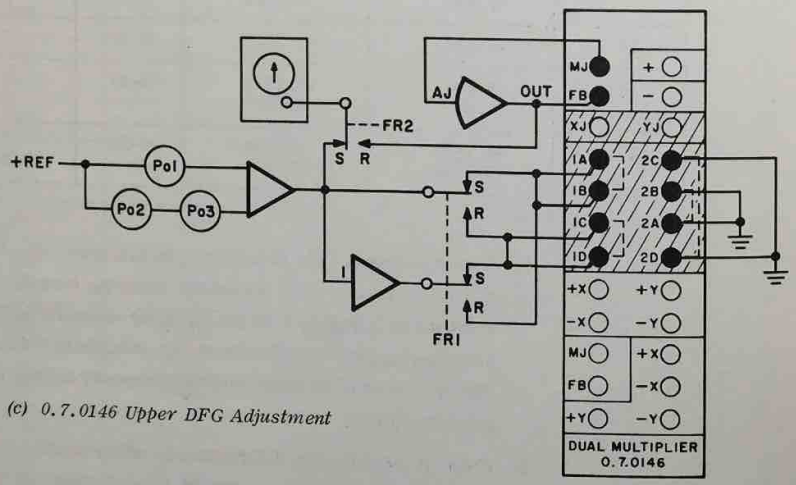
1. Remove the multiplier tray to be adjusted, and place it on a service shelf.
2. Patch the circuit of Figures 1.6a and 1.6c for the upper multipliers. Patching for the lower multipliers is shown in Figures 1.6b and 1.6d.
3. The adjustment procedure consists of providing precisely measured inputs to each squaring circuit, and adjusting the breakpoint potentiometers on the card to produce the required output (see Figure 1.7). The null voltage test set must be capable of measuring the input and output voltage to within ±0.05 millivolt. Note that the outputs specified are not the precise square of the inputs, but differ by an amount necessary for proper "fitting" of the segmented approximation to a true square curve. Table 1.2 lists the inputs applied, the outputs required, and the controls for the +squaring adjustment for both the upper and lower multipliers. Perform the adjustments carefully and in the order listed.
4. If difficulty is encountered while attempting to perform any adjustment, a component in the associated segment group is probably at fault. If the switching error in procedural Step 5 (Table 1.2) exceeds ±1 millivolt, the matched diode set or the matched resistor set for the segment group must be replaced.



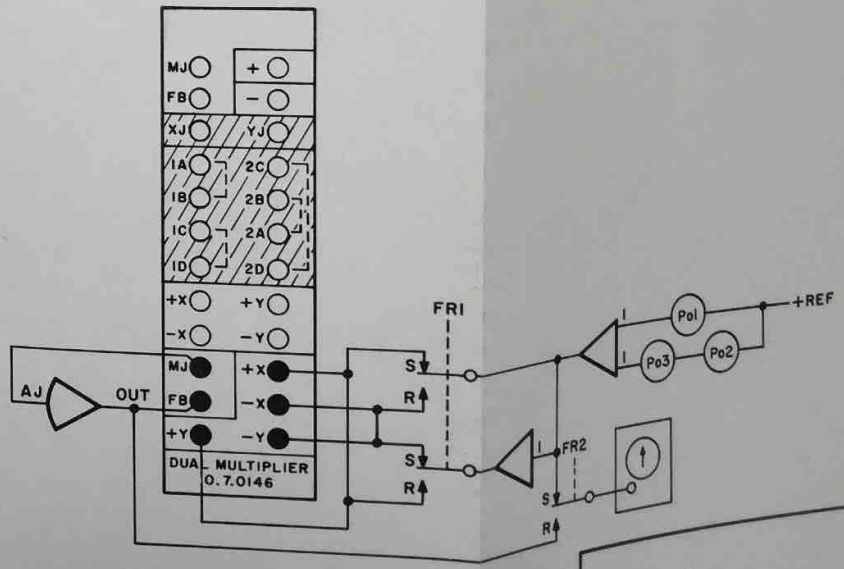
(a) 0.7.0150 Upper DFG Adjustment



(b) 0.7.0150 Lower DFG Adjustment



(c) 0.7.0146 Upper DFG Adjustment



(d) 0.7.0146 Lower DFG Adjustment

Figure 1.6
DFG Positive Squaring Adjustment Circuit

Table 1.2. +Squaring Card Adjustments

Adjustment	Step 1 Input Voltage \ FR2 S	Step 2 Output Voltage \ FR2 R	Step 3 Adjust R-	Step 4 FR1 Position	Step 5 Input Switching Error
1	+0.370	+0.0143	R-15	S	-----
2	+0.0143	+0.0143	R-4	R	-----
3	+1.360 +1.360	+0.1854 +0.1854	R-12 ----	S R	----- ±1 MV
4	+2.520	+0.6343	R-27	S	-----
5	+3.260 +3.260	+1.0634 +1.0634	R-24 ----	S R	----- ±1 MV
6	+4.470	+1.9974	R-39	S	-----
7	+5.230 +5.230	+2.7359 +2.7359	R-36 ----	S R	----- ±1 MV
8	+6.420	+4.1210	R-51	S	-----
9	+7.260 +7.260	+5.2712 +5.2712	R-48 ----	S R	----- ±1 MV
10	+8.530	+7.2755	R-63	S	-----
11	+9.350 +9.350	+8.7425 +8.7425	R-60 ----	S R	----- ±1 MV
12	+9.9999 +9.9999	+9.9999 +9.9999	R-70 ----	S R	----- ±1 MV

5. When all steps for the 12 adjustments have been completed, the +squaring circuit is properly set. To set the -squaring circuits, patch the configuration shown in Figure 1.8a for the upper multiplier and Figure 1.8b for the lower multiplier, and perform the steps in Table 1.3 for each adjustment. The procedure is identical with the procedure outlined above; only the signal polarities differ.

6. When all steps for the 12 adjustments on the negative squaring circuit are complete, the multiplier should be carefully removed from the service shelf and returned to its operating position. Avoid physical shocks which may tend to disturb the adjustments.

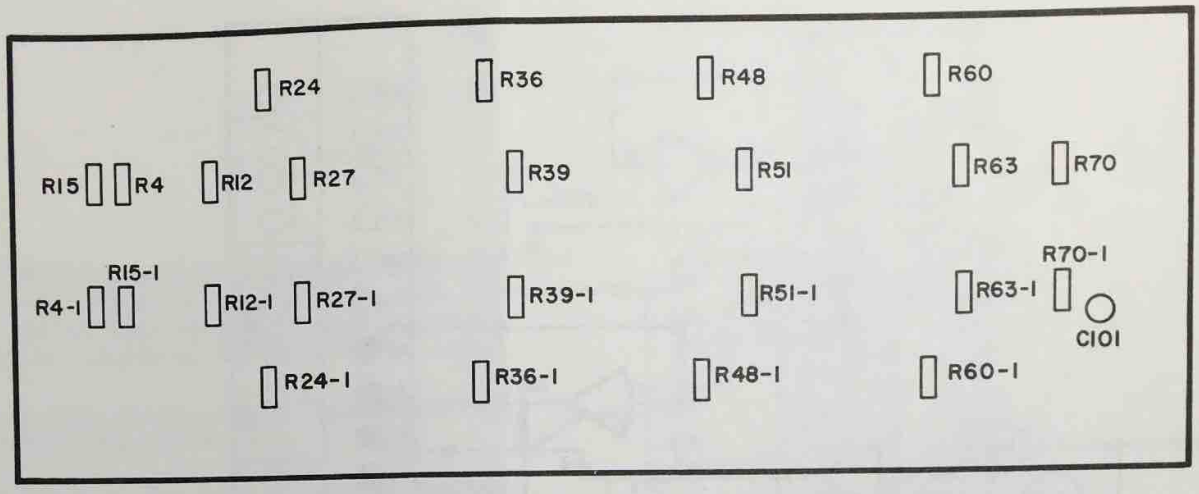
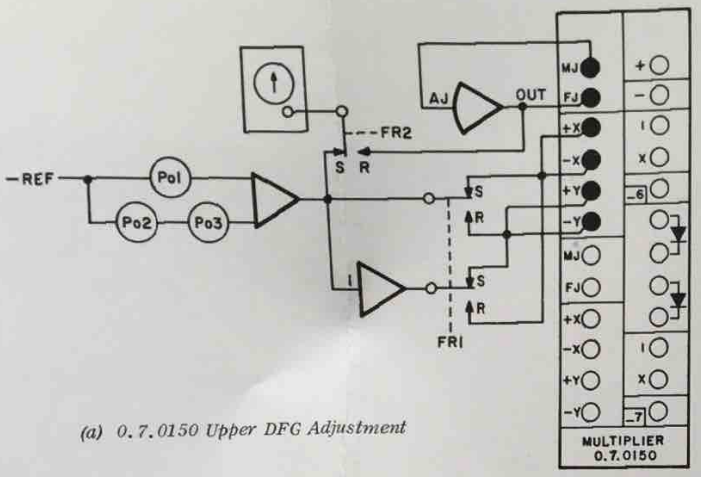


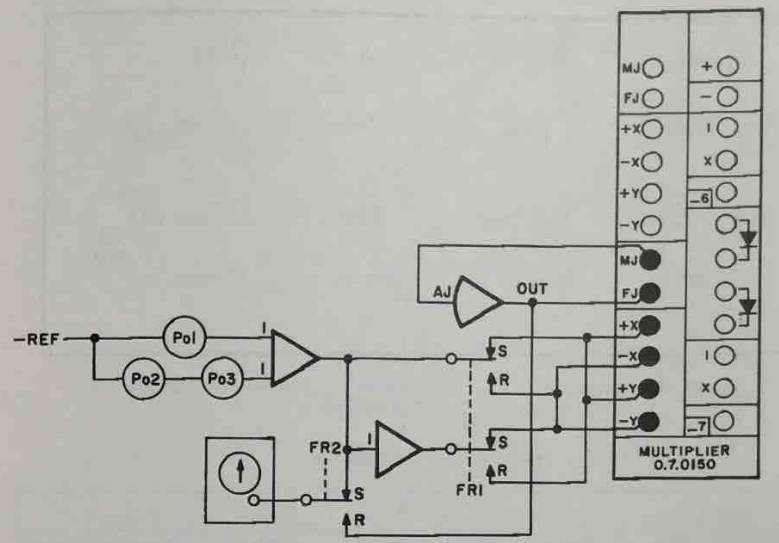
Figure 1.7. Quarter-Square Multiplier Tray (Models 0.7.0146 and 0.7.0150) Showing Adjustment Locations

Table 1.3. -Squaring Card Adjustments

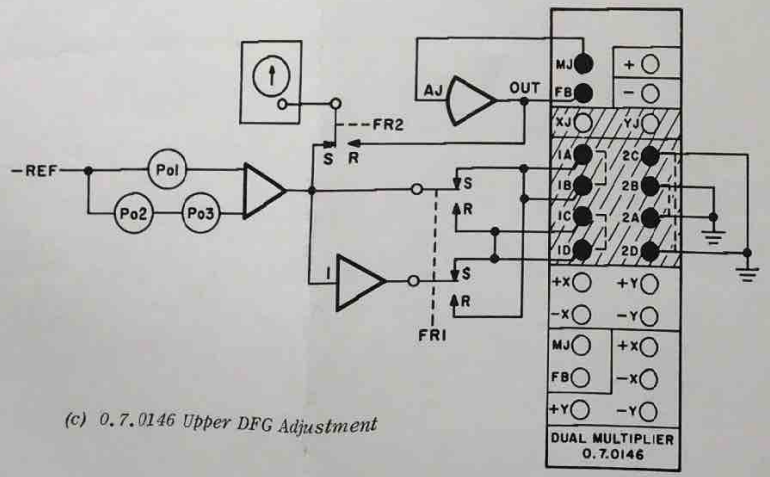
Adjustment	Step 1	Step 2	Step 3	Step 4	Step 5
	Input Voltage \ FR2 S	Output Voltage \ FR2 R	Adjust R-	FR1 Position	Input Switching Error
1	-0.370	-0.0143	R-15-1	S	-----
2	-0.370	-0.0143	R-4-1	R	-----
3	-1.360 -1.360	-0.1854 -0.1854	R-12-1 ----	S R	----- ±1 MV
4	-2.520	-0.6343	R-27-1	S	-----
5	-3.260 -3.260	-1.0634 -1.0634	R-24-1 ----	S R	----- ±1 MV
6	-4.470	-1.9974	R-39-1	S	-----
7	-5.230 -5.230	-2.7359 -2.7359	R-36-1 ----	S R	----- ±1 MV
8	-6.420	-4.1210	R-51-1	S	-----
9	-7.260 -7.260	-5.2712 -5.2712	R-48-1 ----	S R	----- ±1 MV
10	-8.530	-7.2755	R-63-1	S	-----
11	-9.350 -9.350	-8.7425 -8.7425	R-60-1 ----	S R	----- ±1 MV
12	-9.9999 -9.9999	-9.9999 -9.9999	R-70-1 ----	S R	----- ±1 MV



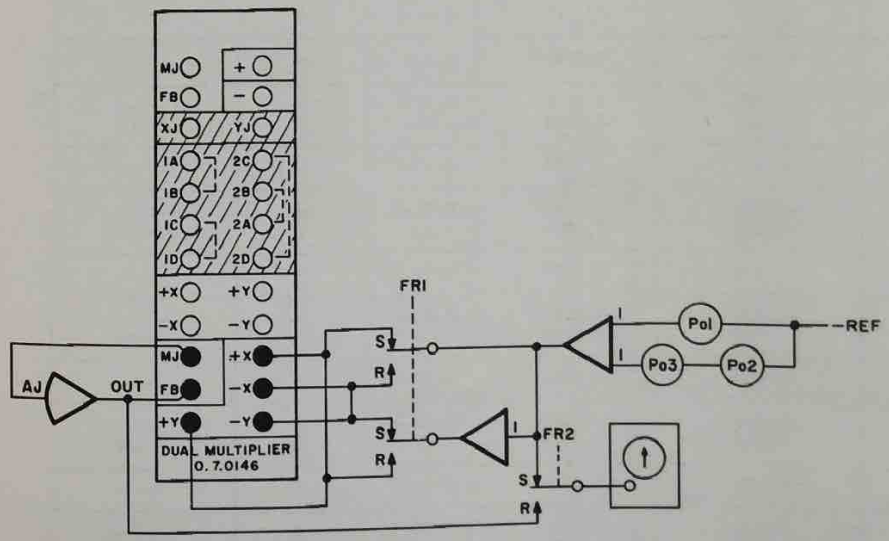
(a) 0.7.0150 Upper DFG Adjustment



(b) 0.7.0150 Lower DFG Adjustment



(c) 0.7.0146 Upper DFG Adjustment



(d) 0.7.0146 Lower DFG Adjustment

Figure 1.8
DFG Negative Squaring Adjustment Circuit

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LISTS INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	J1	Connector Block: White	00 542.1545-2	B
		0.7.0145-1 MULTIPLIER CARD		
1	C101	Capacitor, Variable: 15-60 pf, 500V (Erie 538-011-F or equal)	00 524.0076-0	A
2	CR1	Diode (Matched Pair)	00 614.0287-0	B
3	CR2-() thru CR4-(),CR6-() thru CR9-(),CR11-() thru CR14-(), CR16-() thru CR19-(),CR21-() thru CR24-(),CR26-(), CR27-()	Diode	00 614.0199-1	B
4	CR5-()	Diode (Matched Pair)	00 614.0287-1	B
5	CR10-()	Diode (Matched Pair)	00 614.0287-2	B
6	CR15-()	Diode (Matched Pair)	00 614.0287-3	B
7	CR20-()	Diode (Matched Pair)	00 614.0287-4	B
8	CR25-()	Diode (Matched Pair)	00 614.0287-5	B
9	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-23 or equal)	00 542.0419-0	A
10	R1-(),16-(), 28-(),40-(), 52-(),64-()	Resistor, Precision	00 640.0110-0	B
11	R2-(),13-()	Resistor, Fixed, Film: 55.26K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-0	A
12	R3-(),14-(), 45-()	Resistor, Fixed, Film: 429 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: DUAL $1/4^2$ MULTIPLIER

MODEL NO. 0.7.0146 Sh. 1 of 6 Sh.

DATE 10/ 11 /67

17

1-1-3
2-1-17

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
13	R4-(),15-()	Potentiometer	00 642.0696-0	B
14	R5-()	Resistor, Fixed, Film: 85.52K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-2	A
15	R6-()	Resistor, Fixed, Film: 14.93K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-3	A
16	R7-()	Resistor, Fixed, Film: 55.41K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-4	A
17	R8-()	Resistor, Fixed, Film: 11.54K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-5	A
18	R9-()	Resistor, Fixed, Film: 10.6K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.06363-6	A
19	R10-()	Resistor, Fixed, Film: 386.3K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-7	A
20	R11-()	Resistor, Fixed, Film: 38.9K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-8	A
21	R12-()	Potentiometer	00 642.0696-5	B
22	R17-()	Resistor, Fixed, Film: 104K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0636-9	A
23	R18-()	Resistor, Fixed, Film: 4,001 ohms ±0.5%, 1/8W (Int. Resistance CEA-T0 or equal)	00 634.0637-0	A
24	R19-()	Resistor, Fixed, Film: 75.81K ohms ±0.5%, 1/8W (Int. Resistance CEA-T0 or equal)	00 634.0637-1	A
25	R20-()	Resistor, Fixed, Film: 3,487 ohms ±0.5%, 1/8W (Int. Resistance CEA-T0 or equal)	00 634.0637-2	A
26	R21-()	Resistor, Fixed, Film: 48.89K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0637-3	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: DUAL $1/4^2$ MULTIPLIER

DATE 10/ 12 / 67

MODEL NO. 0.7.0146

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
27	R22-()	Resistor, Fixed, Film: 2.32K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 632.2321-2	A
28	R23-()	Resistor, Fixed, Film: 27.96K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0637-4	A
29	R24-(), 36-(),51-() 63-()	Potentiometer	00 642.0696-2	B
30	R25-()	Resistor, Fixed, Cilm: 77.39K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0637-6	A
31	R26-()	Resistor, Fixed, Film: 37K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0637-7	A
32	R27-()	Potentiometer	00 642.0696-3	B
33	R29-()	Resistor, Fixed, Film: 85.04K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0637-8	A
34	R30-()	Resistor, Fixed, Film: 965.5 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0637-9	A
35	R31-()	Resistor, Fixed, Film: 63.44K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-0	A
36	R32-()	Resistor, Fixed, Film: 847.5 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-1	A
37	R33-()	Resistor, Fixed, Film: 48.64K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-2	A
38	R34-()	Resistor, Fixed, Film: 531 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-3	A
39	R35-()	Resistor, Fixed, Film: 33.58K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-4	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/ 12 / 67

UNIT TITLE
DUAL $1/4^2$ MULTIPLIER

MODEL NO.
0.7.0146 Sh. 3 of 5 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
40	R37-()	Resistor, Fixed, Film: 24.11K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-5	A
41	R38-()	Resistor, Fixed, Film: 3.34K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-6	A
42	R39-()	Potentiometer	00 642.0696-0	B
43	R41-()	Resistor, Fixed, Film: 71.18K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-7	A
44	R42-()	Resistor, Fixed, Film: 500 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-8	A
45	R43-()	Resistor, Fixed, Film: 53.84K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0638-9	A
46	R44-()	Resistor, Fixed, Film: 429 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-0	A
47	R46-()	Resistor, Fixed, Film: 270 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-2	A
48	R47-()	Resistor, Fixed, Film: 29.83K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-3	A
49	R48-(), 70-()	Potentiometer	00 642.0696-0	B
50	R49-()	Resistor, Fixed, Film: 13.85K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-4	A
51	R50-()	Resistor, Fixed, Film: 2.48K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0637-4	A
52	R53-()	Resistor, Fixed, Film: 64.3 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-6	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: DUAL 1/4^2 MULTIPLIER

MODEL NO. 0.7.0146

DATE 10 / 12 / 67

2-1-20

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
53	R54-()	Resistor, Fixed, Film: 312 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-7	A
54	R55-()	Resistor, Fixed, Film: 43.78K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-8	A
55	R56-()	Resistor, Fixed, Film: 279.8 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0639-9	A
56	R57-()	Resistor, Fixed, Film: 34.62K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-0	A
57	R58-()	Resistor, Fixed, Film: 203 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-1	A
58	R59-()	Resistor, Fixed, Film: 25.87K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-2	A
59	R60-()	Potentiometer	00 642.0696-6	B
60	R61-()	Resistor, Fixed, Film: 9.8K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-3	A
61	R62-()	Resistor, Fixed,Film: 687 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-4	A
62	R65-()	Resistor, Fixed, Film: 59.08K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-5	A
63	R66-()	Resistor, Fixed, Film: 173.5 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-6	A
64	R67-()	Resistor, Fixed, Film: 47.93K ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-7	A
65	R68-()	Resistor, Fixed, Film: 8.013 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-T0 or equal)	00 634.0640-8	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10 / 11 /67

UNIT TITLE

DUAL 1/4^2 MULTIPLIER

MODEL NO.

0.7.0146 Sh. 5 of 6 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
66	R69-()	Resistor, Fixed, Film: 413 ohms ±0.5%, 1/8W (Int. Resistance Co. CEA-TO or equal)	00 634.0640-9	A
67	R100	Resistor, Precision	00 638.1048-0	B
68	R101	Resistor, Fixed, Composition: 39K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0393-0	A
69	RT1-(), 2-()	Thermistor	00 646.0098-0	B
70	RT3-()	Thermistor	00 646.0099-0	B
71	RT4-()	Thermistor	00 646.0100-0	B
72	RT5-()	Thermistor	00 646.0101-0	B
73	RT6-()	Thermistor	00 646.0102-0	B
74	RT7-()	Thermistor	00 646.0103-0	B
75	RT8-()	Thermistor	00 646.0104-0	B
		0.7.0145-2 MULTIPLIER CARD Identical with 0.7.0145-1 except Item 9 is deleted.		

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
DUAL $1/4^2$ MULTIPLIER

MODEL NO.
0.7.0146

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1,2	Diode	00 614.0007-0	B
2	J1	Connector Block: Yellow	00 542.1545-1	B
3		Connector Block: Lettered (MULTIPLIER 0.7.0150)	00 542.1552-5	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 12/ 14 / 67

UNIT TITLE
DUAL $(1/4)^2$ MULTIPLIER

MODEL NO.
0.07.0150 Sh. 1 of 1 Sh.

APPENDIX 2

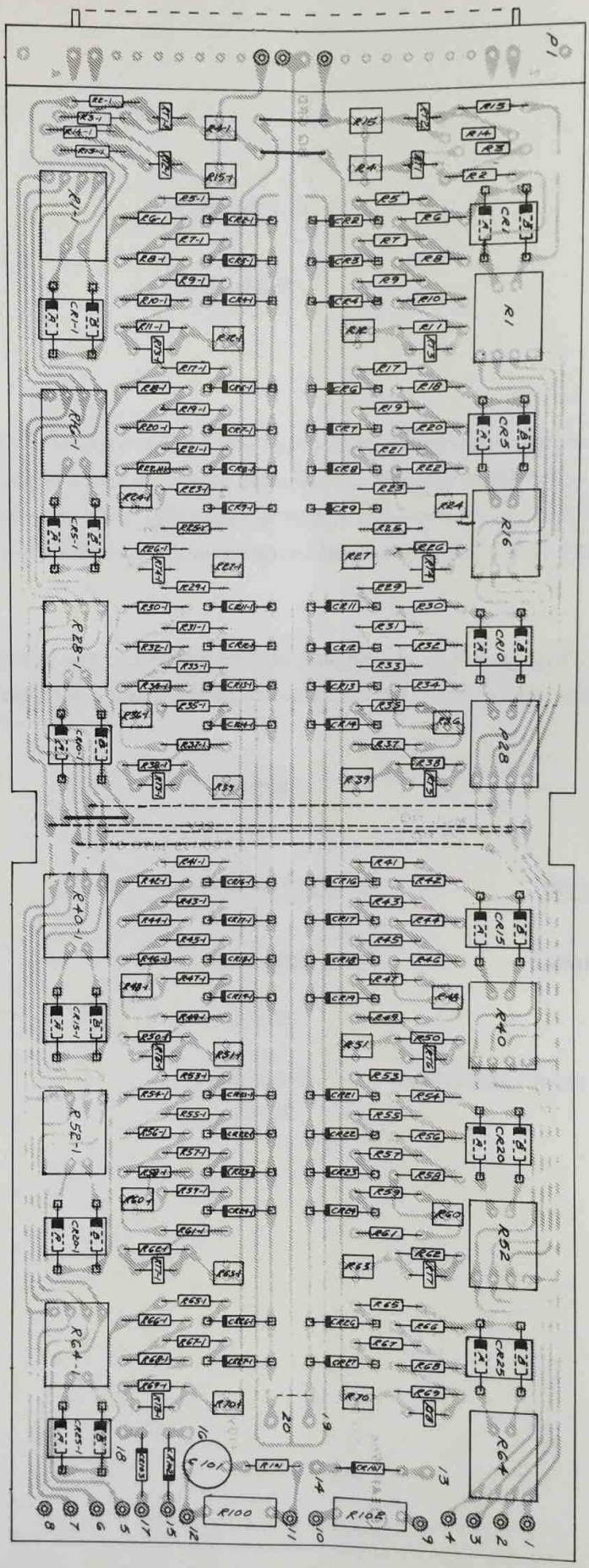
DRAWINGS

This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

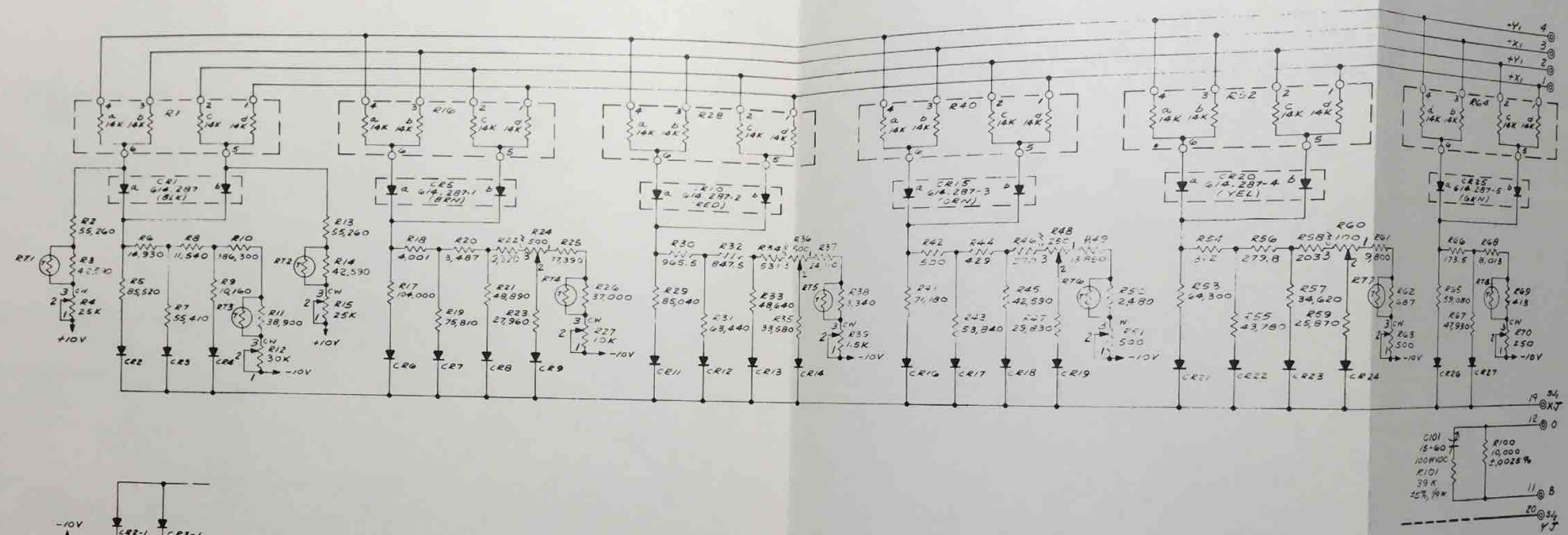
INDEX

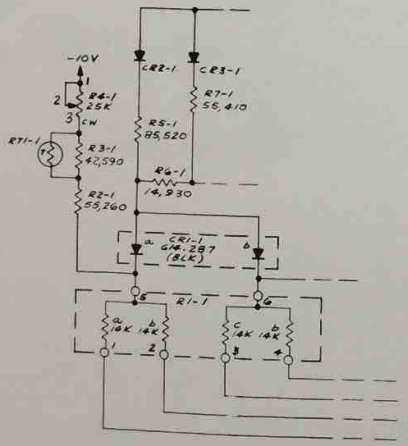
Unit or Component	Type of Drawing	Drawing Number
0.7.0146 Multiplier	Schematic	D00 007 0146 0S (Sheets 1 and 2)
	Wiring	C00 007 0146 0W
0.7.0150 Dual $(1/4)^2$ Multiplier	Schematic	C00 007 0150 0S
	Wiring	C00 007 0150 0W



7.0145 Multiplier

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) DIODES ARE CG14.1931
   b) RESISTORS ARE ±0.5%, 1/8 W.





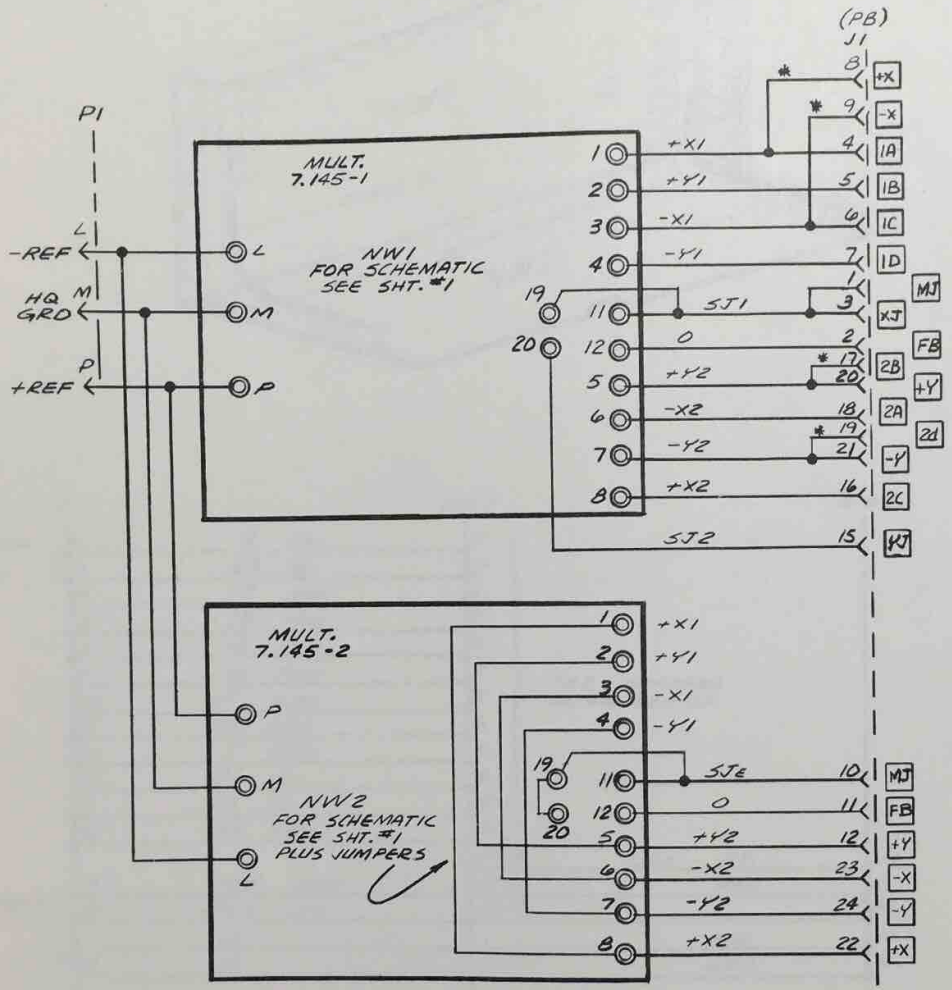
(SAME AS DETAILED SCHEMATIC ABOVE EXCEPT DIODES & BIAS POLARITIES REVERSED)

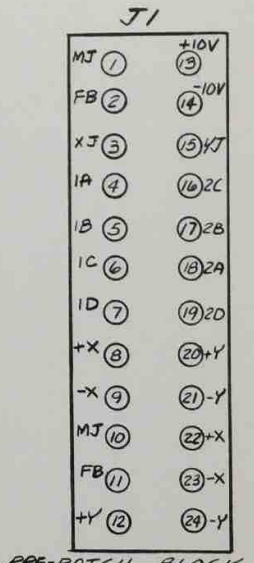
P1
P ← +REF (+10V)
M,N ← HD GRD
L ← -REF (-10V)

+Y2
-X2
-Y2
+X2

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
SCHEMATIC MULTIPLIER
SIZE C
REV. NO. D
D 00 007 0146 05

NOTE
* DENOTES JUMPERS ON PRE-PATCH BLOCK.

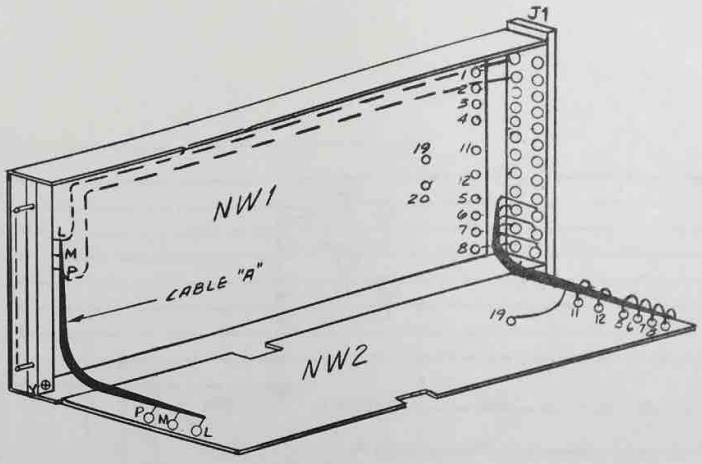


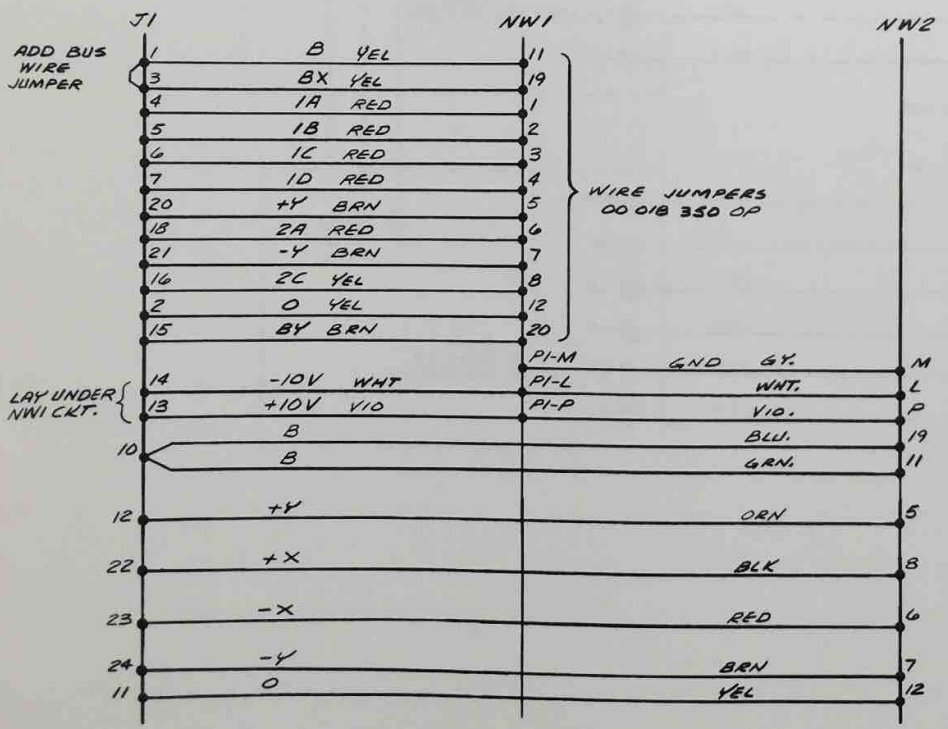


PRE-PATCH BLOCK (FRONT VIEW) REF. ONLY

EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.	
SCHEMATIC DUAL $(1/4)^2$ MULT	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19284	C 00007 01460 5
SHEET 2 OF SHEETS	

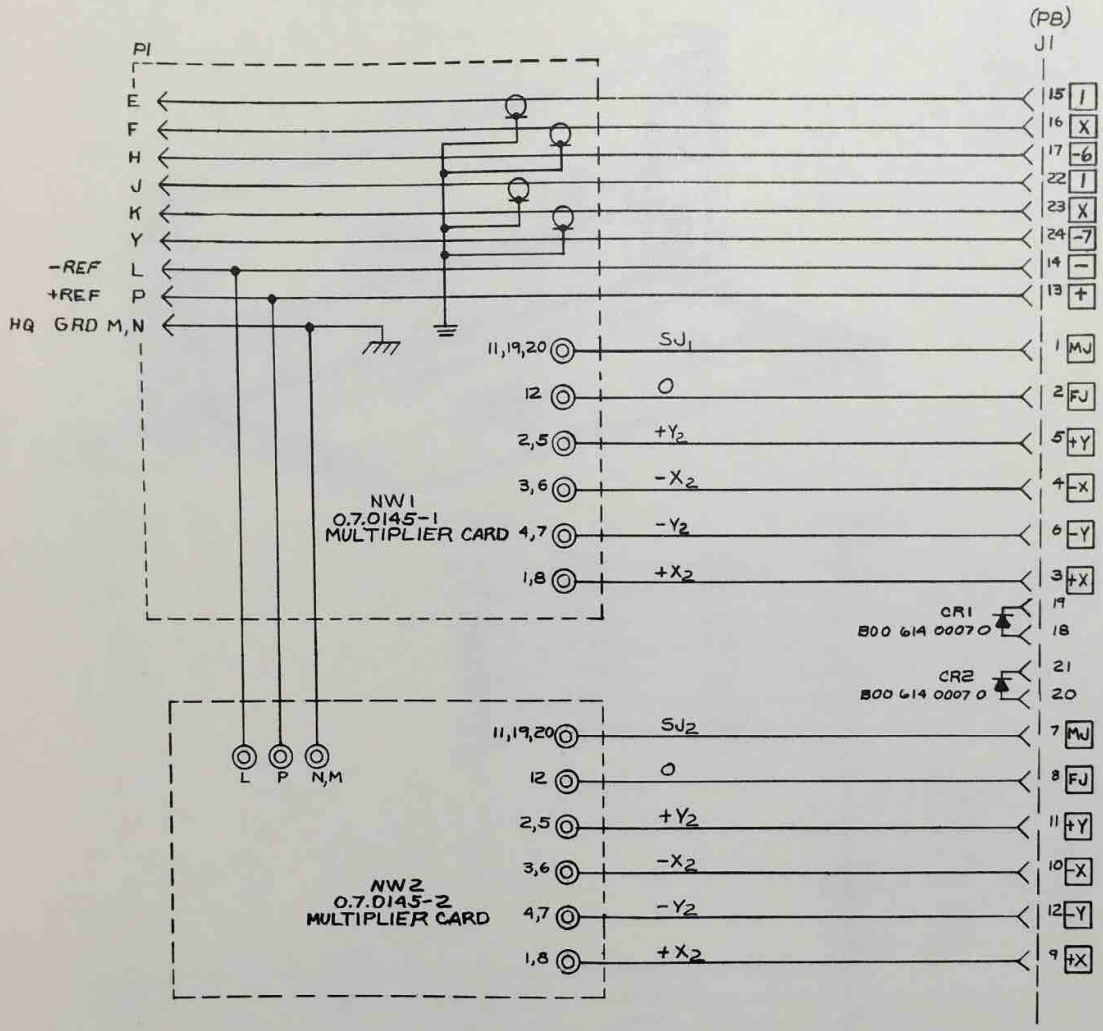
NOTES:
1. CABLES MUST BE OF SUFFICIENT LENGTH SO THAT UNIT MAY BE EASILY SERVICED.





EAI: ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.	
WIRING DUAL (1/4)² MULT.	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19284	C 00007 0146 0W
SHEET / OF / SHEETS	

NOTE :
1. FOR MULTIPLIER CARD SCHEMATIC SEE D00 007 0146 0S SH. 1.



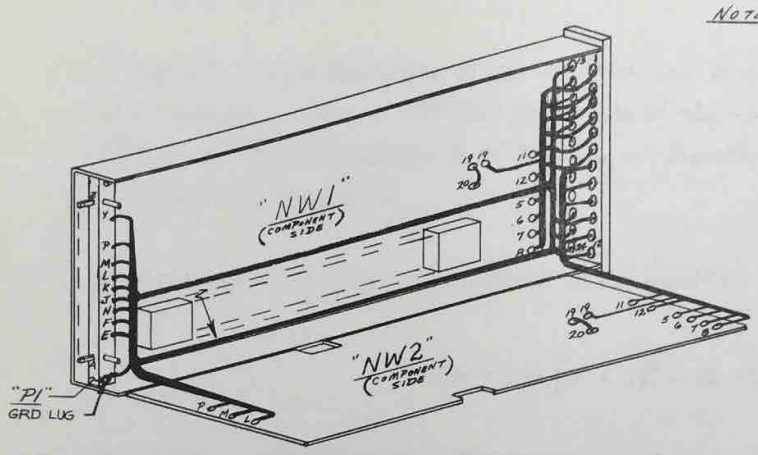
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN pF
RESISTANCE IS IN OHMS.
TOLERANCE ON: X = ± .03 .XX = ± .02
.XXX = ± .010 .XXX = ± .005 ∠ = ± 1°
# TOL. OF MATERIAL SUPPLIED

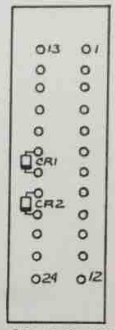
EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.

SCHEMATIC
DUAL (1/4)^2 MULT.
(580)

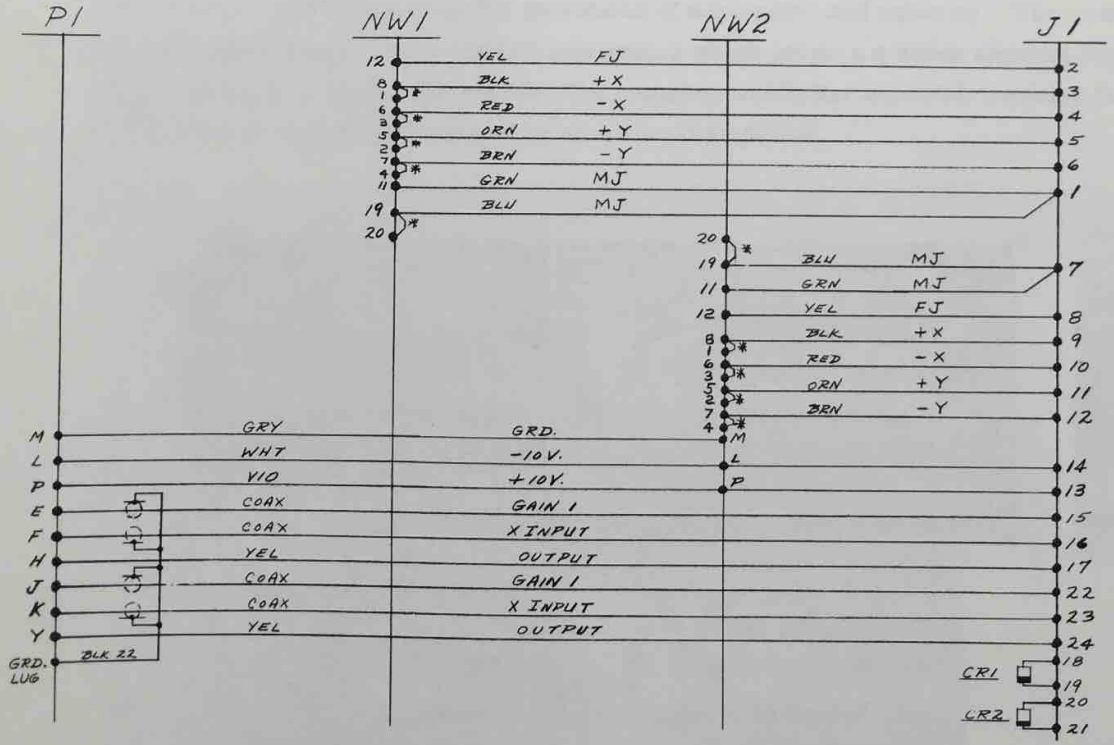
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 310191	C00 007 0150 0S
SHEET / OF / SHEETS	

NOTES:
1. CABLES MUST BE OF SUFFICIENT LENGTH SO THAT UNIT MAY BE EASILY SERVICED.
2. ASTERISK (*) INDICATES JUMPERS THAT ARE TO BE INSTALLED ON NW1 & NW2. THESE JUMPERS ARE #22SD-BUS4 COVERED WITH EXTR. PLSTC. TUBING
3. HARNESS "A, B, & C ARE PART OF 18.1482
4. COAX TO BE TYPE (B009160001 0)
5. PHH WIRE TO BE #22 AWG.





CONN. BLOCK REAR VIEW



EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.

WIRING
DUAL (1/4)² MULT. (580)

SHT. NO.	
SIZE	
REV. NO.	
PROJECT	310191

C00 007 0150 0W

SHEET 1 OF 1 SHEETS

CHAPTER 2

MULTIPLIER, MODEL 0.7.0148

2.1 GENERAL DESCRIPTION

The Model 0.7.0148 Multiplier (Figure 2.1) is used in conjunction with a dc amplifier to produce a four quadrant product of -XY/10 from inputs of +X, -X, +Y, -Y. In addition to multiplication, the Model 0.7.0148 is capable of performing the mathematical operations of division, squaring, and square root extraction.

The operation of the multiplier is based on the identity:

$$XY = 1/4 \left[(X + Y)^2 - (X - Y)^2\right]$$

which reduces multiplication to the operations of summation and squaring. The squaring operations are performed by diode function generators which produce a seven segment straight line approximation to a square law curve. The complete multiplier assembly contains four squaring circuits whose outputs are summed by an external amplifier.

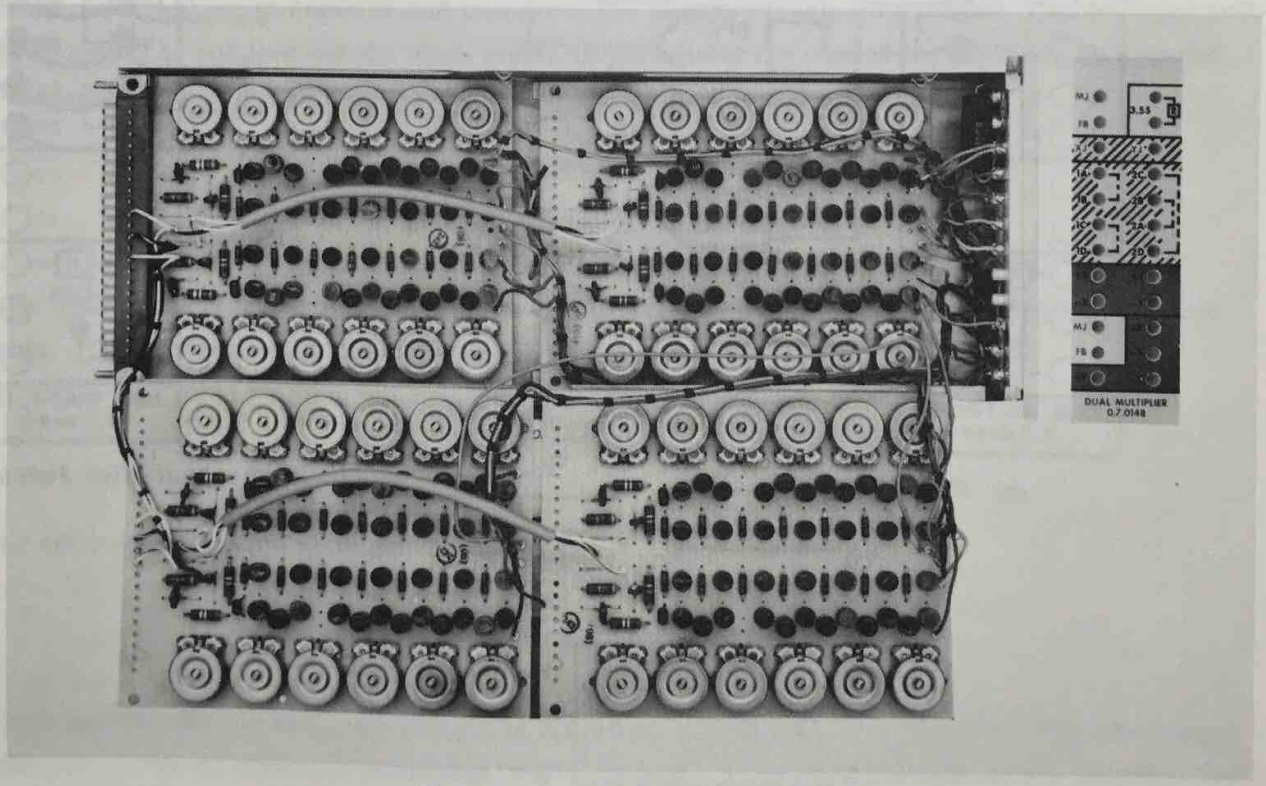


Figure 2.1. 0.7.0148 Multiplier

2.2 TECHNICAL DATA

Static Error - (X + Y) - 20 Volts	±40 Millivolts, Typical ±80 Millivolts, Maximum
Phase Shift (Multiplying ±10 Vdc by 20 Volts, Peak-to-Peak) at 1.0 kHz	0.26°, Maximum

2.3 OPERATING CONSIDERATIONS

The patching for the multiplier is shown in Figure 2.2. The input voltages +X, -X, +Y, and -Y are connected to proper patching terminals as shown in Figure 2.2b. The MJ and FB terminals are connected to the AJ and O patching terminations of a dc amplifier. All four inputs (±X, ±Y) must be patched. The output can be changed to +XY/10 by interchanging the +X and -X input *or* the +Y and -Y inputs. Note that the multiplier does not have any feedback resistor except the one (R1) in the multiplier. An appropriate symbol for the multiplier is also shown.

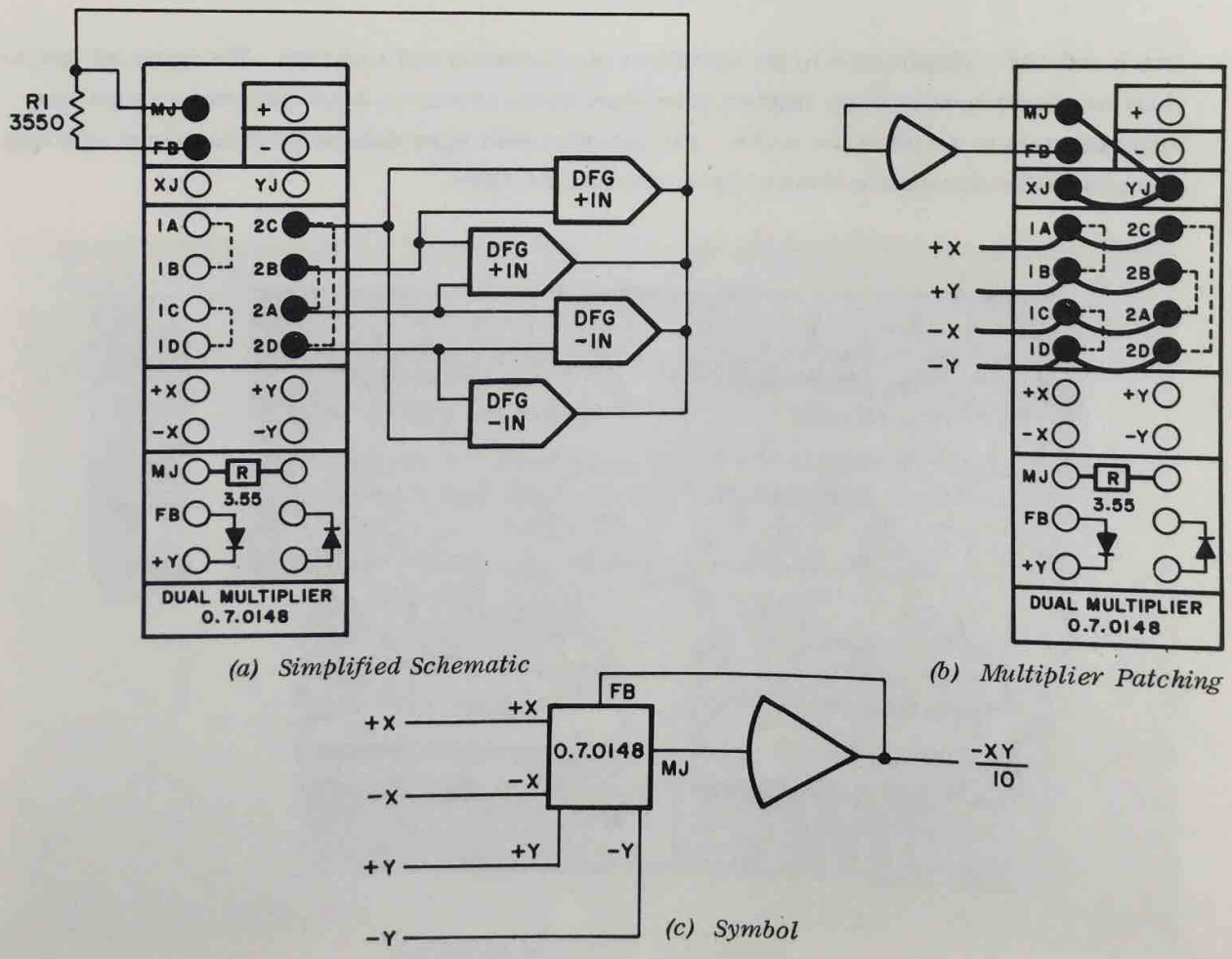


Figure 2.2. Multiplier Patching

2.4 CIRCUIT DESCRIPTION

A simplified schematic of the Model 0.7.0148 Multiplier is shown in Figure 2.3. For simplicity, only one segment in each diode function generator is shown. The inputs to the multiplier are applied to the terminals designation 1A, 1B, 1C, and 1D. The output of the squaring cards (S1 to S4) are connected to the summing junction of an external amplifier. The feedback resistor (R1) for the amplifier is located on the multiplier chassis. The upper two X^2 DFG's accept net positive inputs and produce a current at S1 or S2 that is proportional to $1/10 \left[\frac{X+Y}{2}\right]^2$. The scale factor of 1/10 is obtained by the choice of circuit resistance values; this scaling is introduced so that the output voltage from the amplifier does not exceed 10 volts. The two lower DFG's accept net negative input and produce an output current at S3 or S4 that is proportional to $-1/10 \left[\frac{X-Y}{2}\right]^2$. The total summing junction current is proportional to

$$\frac{1}{10}\left[\frac{X+Y}{2}\right]^2 - \frac{1}{10}\left[\frac{X-Y}{2}\right]^2$$

and produces an amplifier output voltage of -XY/10. Assume that +5 volts is applied to the 1A terminal and -8 volts is applied to the 1B terminal. (Then -5 volts is at 1C and +8 volts is at 1D.) With these inputs applied to the DFG's as shown in Figure 2.3, DFG 1 is not conducting because the net input voltage is negative and increases the negative bias on the diode. The net input voltage to DFG 2 is positive and the diode conducts permitting the sum of the inputs to be squared. The contribution of the DFG to the output voltage of the amplifier is

$$\frac{1}{10}\left[\frac{X+Y}{2}\right]^2 = -\frac{1}{10}\left[\frac{5-8}{2}\right]^2 = -\frac{9}{40}$$

(The minus sign is due to inversion in the amplifier.) The third DFG is cut off; the fourth conducts. The contribution of this DFG to the output voltage of the amplifier is

$$+\frac{1}{10}\left[\frac{X-Y}{2}\right]^2 = \frac{1}{10}\left[\frac{5+8}{2}\right]^2 = +\frac{169}{40}$$

The net output from the amplifier is

$$+\frac{169}{40} - \frac{9}{40} = \frac{160}{40} = +4 \text{ Volts}$$

which agrees with the designated output of XY/10 or = -(+5) (-8)/10 = +4 volts. For other input voltages, different combinations of the DFG's conduct. Thus input voltages of any polarity combination result in a product.

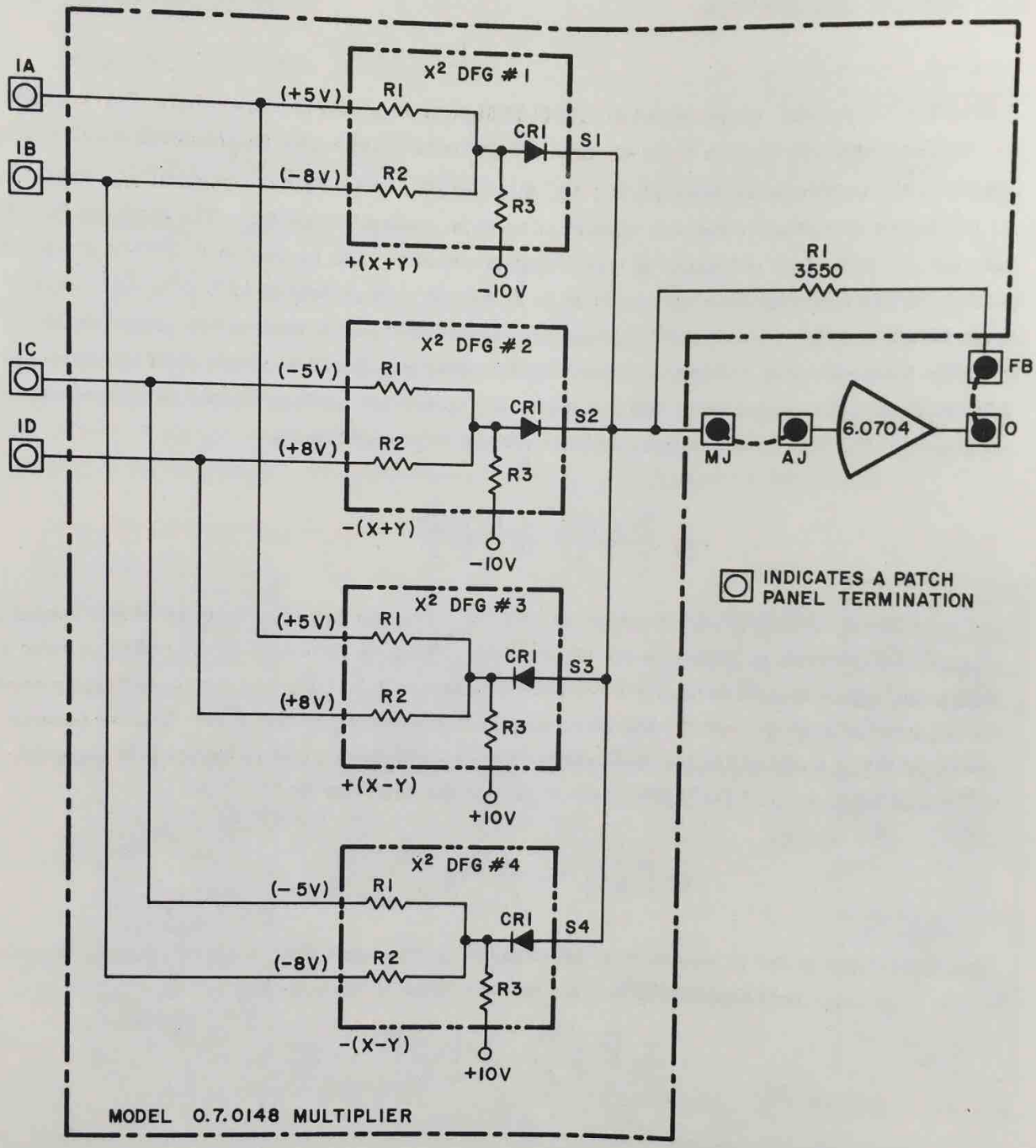


Figure 2.3. Multiplier, Simplified Schematic

The multiplier contains four etched-circuit cards, Model 0.7.0044, each of which contains two biased-diode squaring circuits. The DFG on the left side of Drawing C007 0044 0S accepts net positive inputs; the DFG on the right side accepts net negative inputs. The diode function generators produce a seven segment straight-line approximation to an X^2 function. Since both circuits are similar, the circuit description is confined to the positive input DFG.

Diodes CR1 to CR7 are biased to conduct at progressively increasing voltage magnitudes. As each diode conducts, the equivalent input impedance of the external amplifier is decreased, the gain of the amplifier is increased. Thermistors R14, R16, and R24 are used in the bias circuits to compensate for the effects of temperature variations. Variable padders are included in the bias networks so that the breakpoints of the segments can be adjusted. Inputs to the function generator (INPUT 1 and INPUT 2) are applied at circuit board terminals 5 and 6.

The four 0.7.0044 cards are connected as shown in Drawing D00 007 0148 0A to form a Model 0.7.0148 Multiplier. Resistor R1 is the feedback resistor for the external amplifier.

2.5 MAINTENANCE

The Model 0.7.0148 Multiplier requires very little maintenance. The adjustments are very stable and normally the unit is tested only to ensure the operator's faith in its performance.

2.5.1 Error Test

The following test provides a convenient means of checking the operation of the multiplier.

1. Connect the circuit shown in Figure 2.4a. Balance the amplifiers. Be sure that computer reference voltages are within specifications. The input and feedback resistors for amplifier number two and the input resistors for amplifier number four should be matched resistors. If desired, the oscilloscope may be replaced by an XY recorder.
2. Adjust the oscillator controls to that it is operating at 5 cycles per second, 20 volts peak-to-peak. Set the oscilloscope Y sensitivity to 10 millivolts/centimeter dc with a zero volt reference in the center of the screen; set the X sensitivity to 2 volts/centimeter.
3. An oscilloscope pattern similar to Figure 2.4b should be observed. A tilted waveform is caused by misalignment or reference unbalance. Specifications call for an error not to exceed ±80 millivolts; however, it is relatively simple to hold the maximum error to ±50 millivolts. The error voltage is measured from the zero line to the largest peaks as shown.
4. If the above test indicates that the multiplier is not operating within specifications, the diode function generator probably requires adjustment.

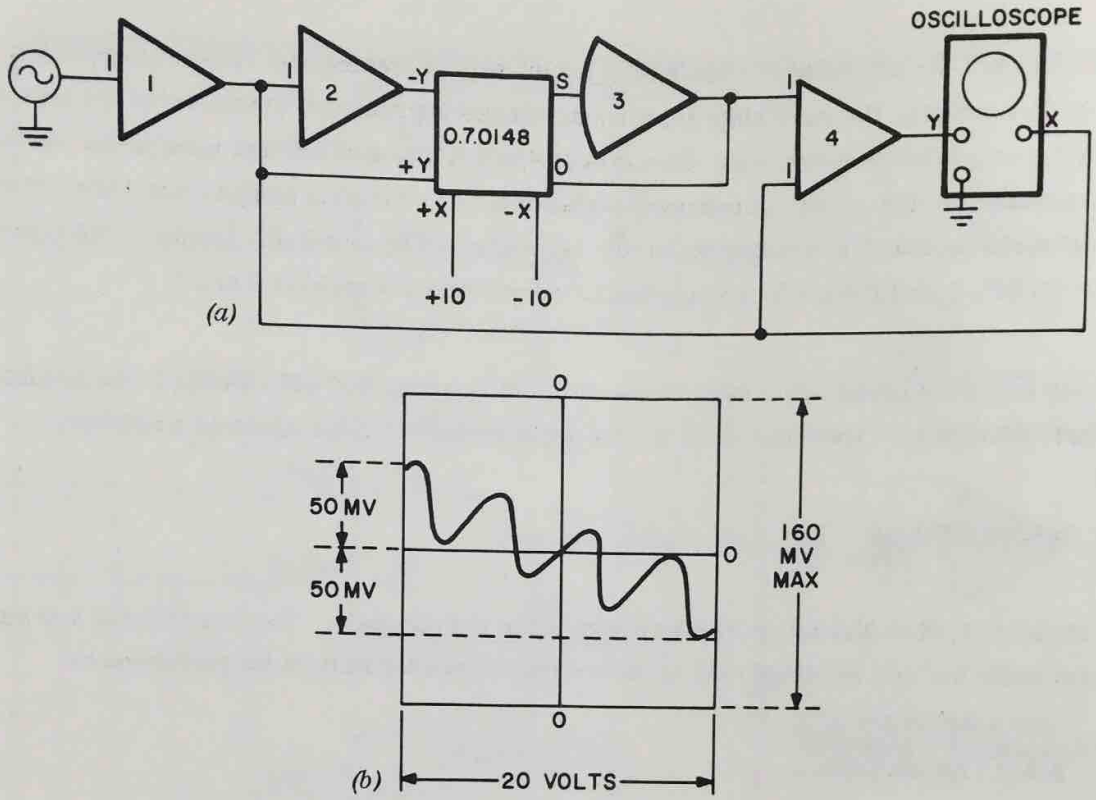
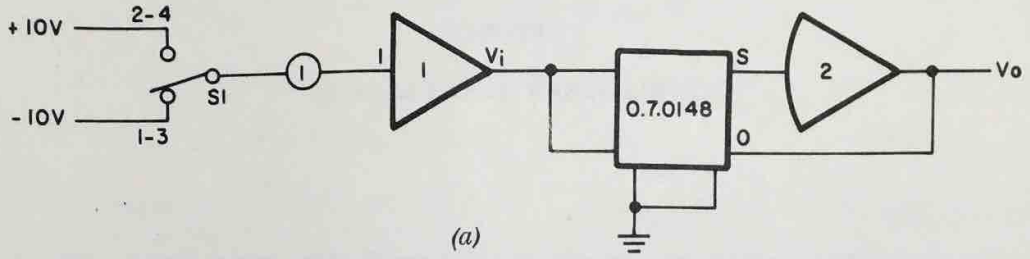


Figure 2.4. Error Test

2.5.2 Adjustment Procedure

Each of the four diode function generators is checked by applying selected input voltages and observing the output voltage. Proceed as follows:

1. Place the multiplier on a service shelf and connect the circuit shown in Figure 2.5a. The inputs to the multiplier are applied according to the schedule in Figure 2.5b. Balance the amplifiers and be sure that the computer reference/voltages are within specifications.
2. Figure 2.5c lists the input and output check point voltages for the DFG cards. Use coefficient potentiometer number one to set the output voltage of amplifier number one to the values listed in the V_i column. Always begin with the lowest voltage and continue in order to the highest voltage.
3. The output voltage of amplifier number two should correspond to the values listed in the V_o column. (The V_o column includes an allowable tolerance for each output voltage. The output voltage should be within the allowable tolerance when checking the DFG; when adjusting the DFG, set the output voltage to the given value.)



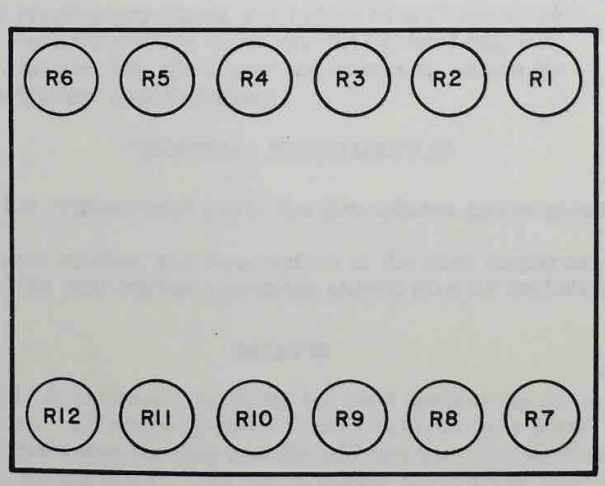
(a)

Card Number	Polarity of V_i	Apply V_i to	Ground Inputs
1	Plus	+X, +Y	-X, -Y
2	Minus	-X, +Y	+X, -Y
3	Minus	+X, -Y	-X, +Y
4	Plus	-X -Y	+X +Y

(b)

V_i (Volts)	Adjust		V_o (Volts)
	Cards 1 & 4	Cards 2 & 3	
2.50	R1	R7	0.64 ± .02
3.90	R2	R8	1.54 ± .02
5.30	R3	R9	2.82 ± .02
6.70	R4	R10	4.50 ± .02
8.10	R5	R11	6.58 ± .02
9.50	R6	R12	9.04 ± .02

(c)



(d)

Figure 2.5. Multiplier Adjustment

4. If the output voltage is out of tolerance, adjust the appropriate potentiometer listed in the ADJUST column. Be sure to adjust the potentiometers in order, R1 to R6, R7 to R12. The location of the adjustments is shown in Figure 2.5d.

2.5.3 Troubleshooting

Malfunction in the Model 0.7.0148 Multiplier can be localized by means of the adjustment procedure described above. The first segment that cannot be adjusted properly is probably at fault. Check the components in the suspected DFG with measurements made in a DFG that is known to be good. Test the unit after replacing any components.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,2,3	Capacitor, Fixed, Ceramic: 120 pf ±10%, 100V (Sprague 252C064121X9101B or equal)	00 515.0241-0	A
2	J1	Connector Block: White	00 542.1545-2	B
3	R1,2,3	Resistor, Precision	00 638.0764-0	B
4		Connector Block: Lettered (MULTIPLIER 0.7.0148)	00 542.1580-0	B
		0.7.0044-2 1/4^2 MULTIPLIER CARD		
1	CR1 thru 14	Diode	00 614.0042-0	B
2	R1,7	Potentiometer	00 642.0457-0	B
3	R2,3,8,9	Potentiometer	00 642.0445-0	B
4	R4,5,6,10, 11,12	Potentiometer	00 642.0444-0	B
5	R13,39	Resistor, Fixed, Composition: 300 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0301-0	A
6	R14,40	Thermistor	00 646.0004-0	B
7	R15,41	Resistor, Fixed, Composition: 12K ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0123-0	A
8	R16,42	Thermistor	00 646.0004-0	B
9	R17,43	Resistor, Fixed, Composition: 820K ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0824-0	A
10	R18,44	Resistor, Precision	00 638.0282-0	B
11	R19,45	Resistor, Precision	00 638.0283-0	B
12	R20,46	Resistor, Precision	00 638.0284-0	B
13	R21,47	Resistor, Precision	00 638.0285-0	B
14	R22,48	Resistor, Precision	Order by Description	B
15	R23,49	Resistor, Precision	00 638.0541-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: MULTIPLIER

MODEL NO. 0.7.0148 Sh. 1 of 2 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
16	R24,50	Thermistor	00 646.0002-0	B
17	R25 thru 36 51 thru 62	Resistor, Precision (Matched Pair) To be matched in pairs as indicated below: R25 and R26 — R51 and R52 R27 and R28 — R53 and R54 R29 and R30 — R55 and R56 R31 and R32 — R57 and R58 R33 and R34 — R59 and R60 R35 and R36 — R61 and R62	00 640.0048-0	B
18	R38,64,37, 63	Resistor, Precision (Matched Pair) To be matched in pairs as indicated below: R37 and R38 R63 and R64	00 640.0049-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 4 / 29 / 68

UNIT TITLE
MULTIPLIER

MODEL NO.
0.7.0148 Sh.2 of 2 Sh.

2-A1-4
2-2-12

APPENDIX 2

DRAWINGS

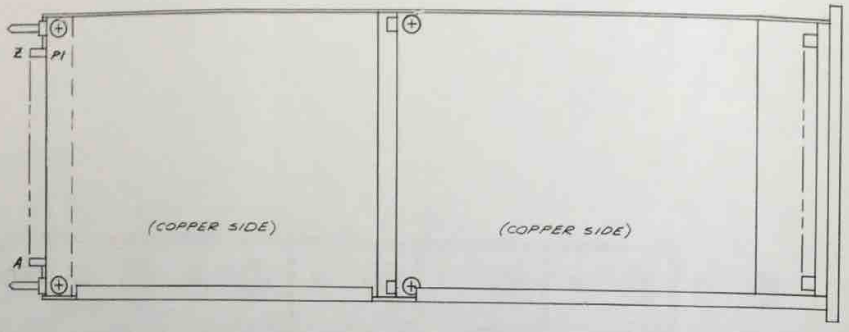
This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

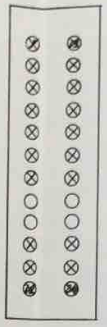
EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

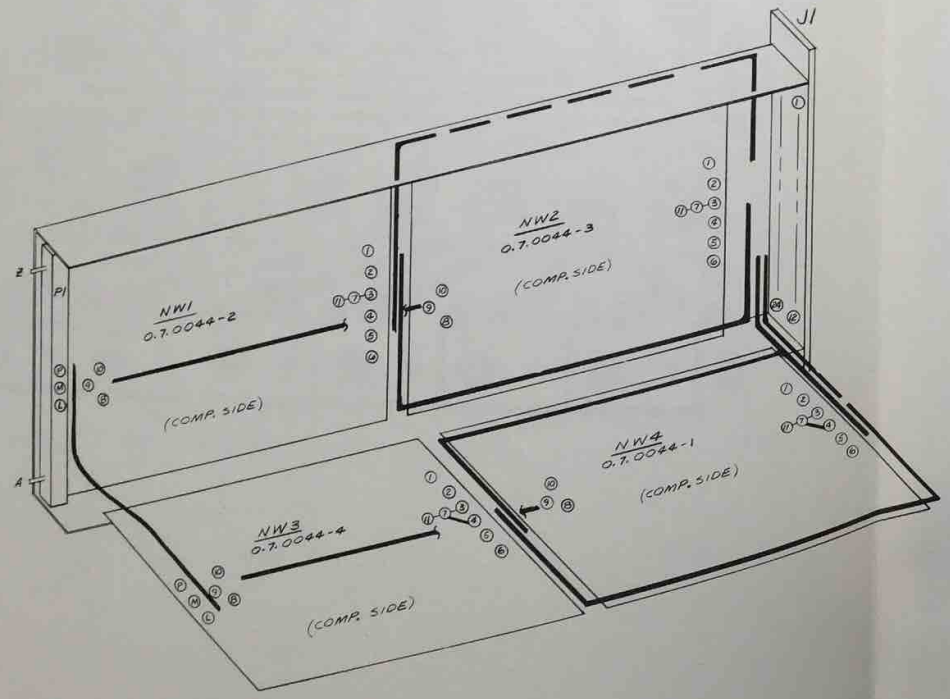
INDEX

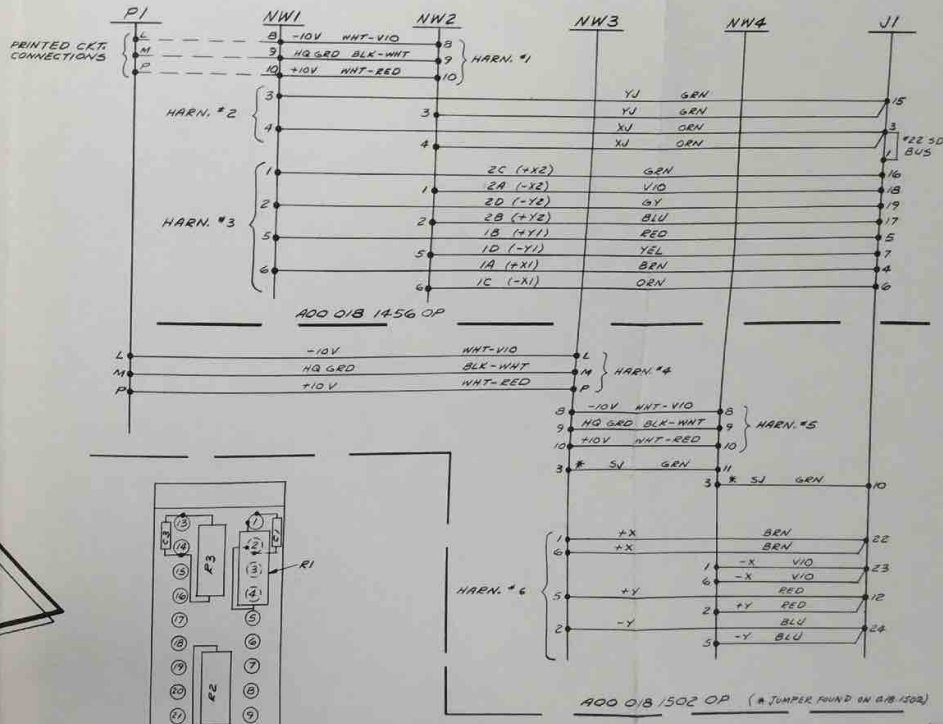
Unit or Component	Type of Drawing	Drawing Number
0.7.0148 Multiplier	Assembly W/ Wiring	D00 007 0148 0A
7.044 $1/4^2$ Multiplier	Schematic	C007 044 0S (Sheets 1 and 2)

NOTES:
1. UNLESS OTHERWISE SPEC., WIRES TO BE #22 PHU.
2. ⊗ DENOTES LOCATION OF ITEM #20. INSTALL PER DETAIL A.



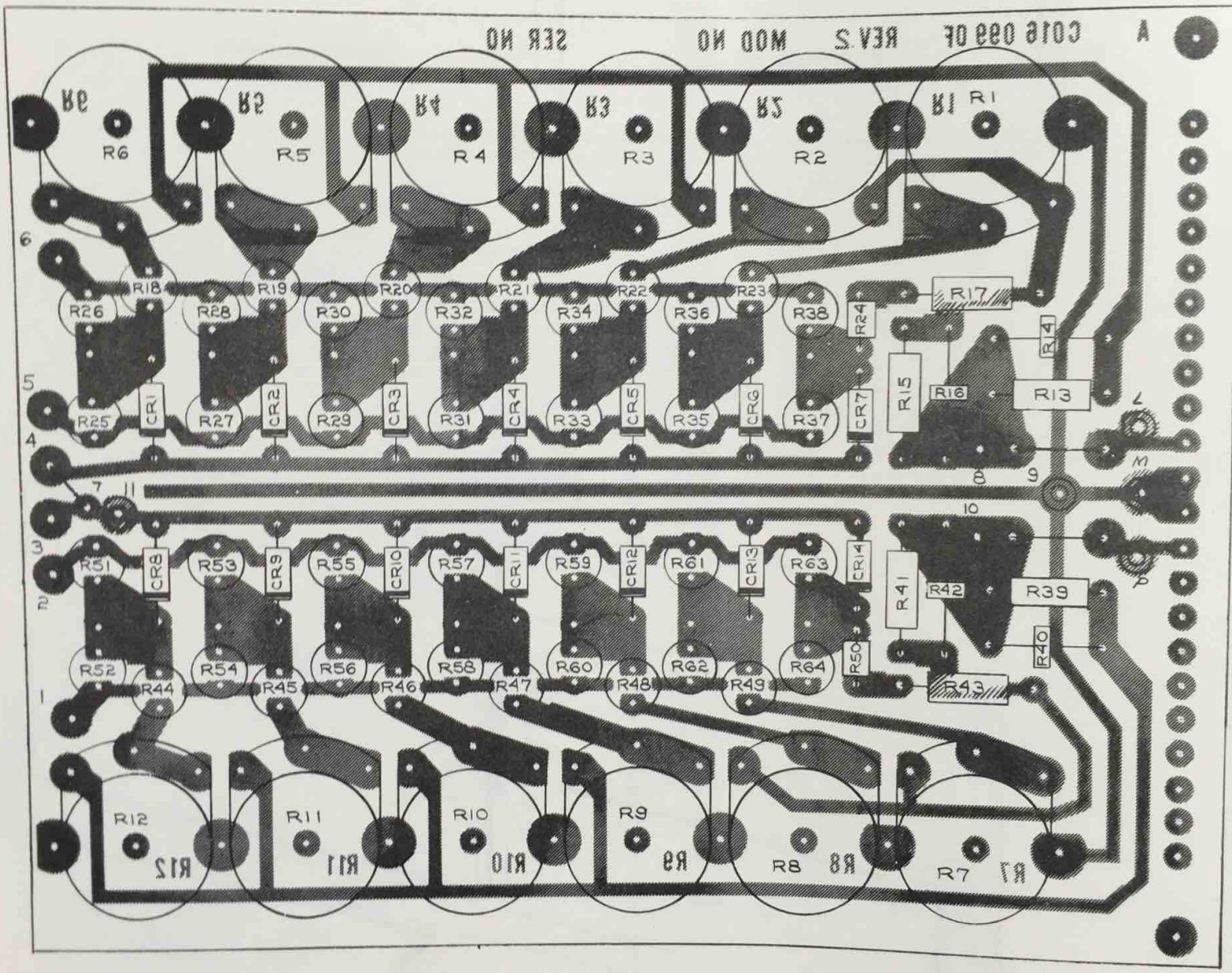






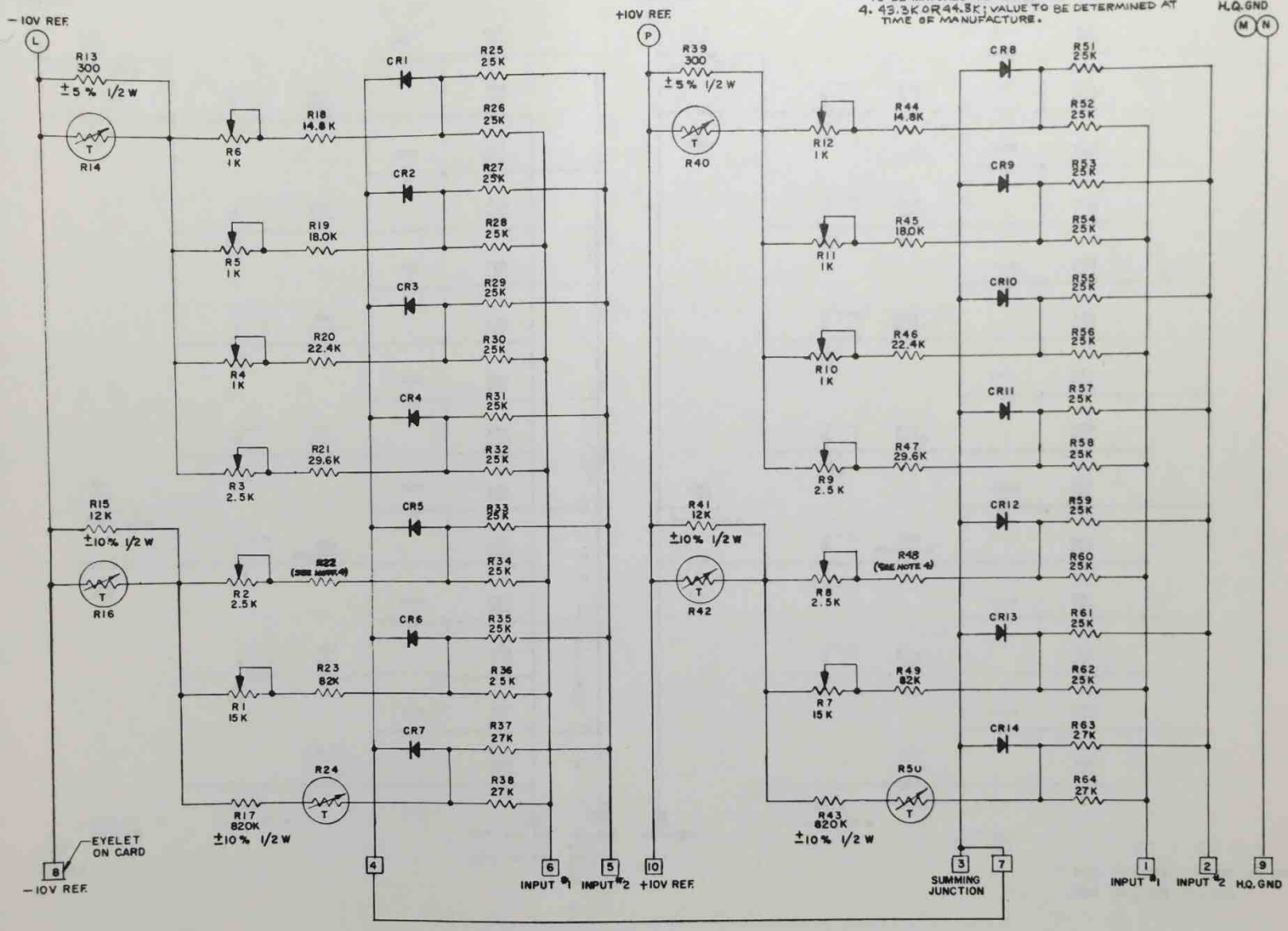
J1 – REAR VIEW
COVER COMPONENT LEADS WITH TEFLON TUBING WHERE NECESSARY

EAI	ASSEMBLY, W/WIRING DUAL MULTIPLIER (S80)
SKT. NO.	
SIZE	
REV. NO.	
PROJECT 19332	D00007014B 0A
SHEET 1 OF 1 SHEETS	



7.044 $(1/4)^2$ Multiplier

NOTE:
1. ALL RECTIFIERS TO BE RADIO RECEPTOR #DR-837.
2. ALL FIXED RESISTORS TO BE ±1%, 0.1 W UNLESS OTHERWISE SPECIFIED.
3. RESISTORS IN PAIRS R25 & 26, 27 & 28, 29 & 30, 31 & 32, 33 & 34, 35 & 36, 37 & 38, 51 & 52, 53 & 54, 55 & 56, 57 & 58, 59 & 60, 61 & 62, 63 & 64 TO BE MATCHED TO 0.1% RES. TOL.
4. 43.3K OR 44.3K; VALUE TO BE DETERMINED AT TIME OF MANUFACTURE.



UNIT NUMBER	NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
0-7.0044 3	00 007 0044 3S	00 007 0044 3P	AS SHOWN PER SHT. 2	A00 007 0148 0P	ERN 11158
0-7.0044 2	00 007 0044 2S	00 007 0044 2P	AS SHOWN PER SHT. 2	A00 007 0148 0P	ERN 11158
0-7.0044 1	00 007 0044 1S	00 007 0044 1P	AS SHOWN PER SHT. 1	A00 007 0045 0P	1830
0-7.0044	C00 007 0044 0S	A00 007 0044 0P	AS SHOWN PER SHT. 1	A00 007 0045 0P	1830

TABLE OF UNIT NUMBERS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN MMFD
RESISTANCE IS IN OHMS
TOLERANCE ON
FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±
& TOL. OF MATERIAL SUPPLIED

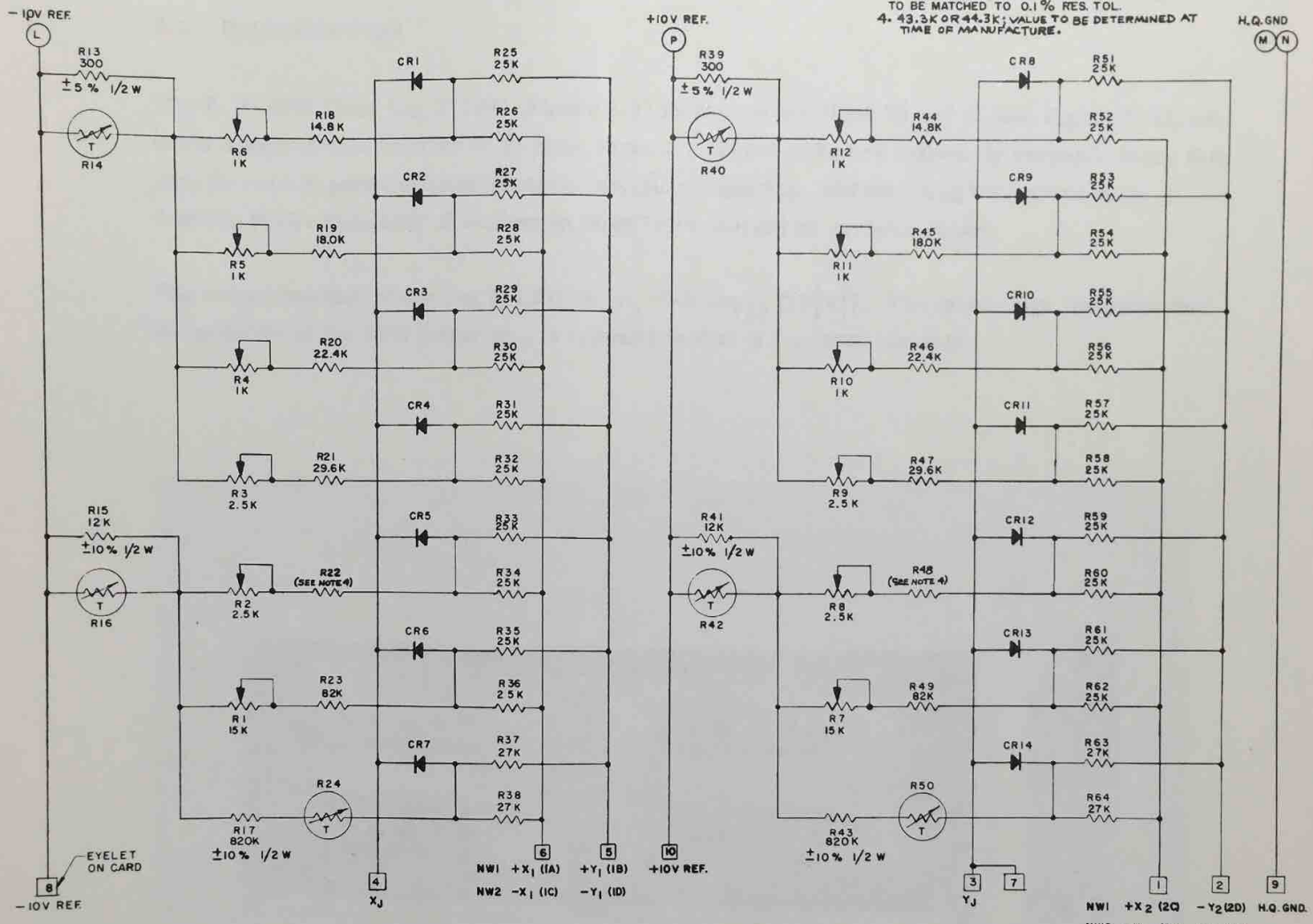
ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY

SCHEMATIC DIAGRAM (1/4)² MULTIPLIER

SHT. NO.	2
SIZE	C
REV. NO.	0
PROJECT	1830 C 007 044 0S

SHEET 1 OF 2 SHEETS

NOTE:
1. ALL RECTIFIERS TO BE RADIO RECEPTOR #DR-837.
2. ALL FIXED RESISTORS TO BE ±1%, 0.1 W UNLESS OTHERWISE SPECIFIED.
3. RESISTORS IN PAIRS R25 & 26, 27 & 28, 29 & 30, 31 & 32, 33 & 34, 35 & 36, 37 & 38, 51 & 52, 53 & 54, 55 & 56, 57 & 58, 59 & 60, 61 & 62, 63 & 64 TO BE MATCHED TO 0.1% RES. TOL.
4. 43.3K OR 44.3K; VALUE TO BE DETERMINED AT TIME OF MANUFACTURE.



0.7.0044 2S & 3S

UNLESS OTHERWISE SPECIFIED		
DIMENSIONS ARE IN INCHES		
CAPACITANCE IS IN MMFD		
RESISTANCE IS IN OHMS		
TOLERANCE ON		
FRACTIONS	DECIMALS	ANGLES
±1/64	±.005	±
% TOL. OF MATERIAL SUPPLIED		

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC DIAGRAM $(1/4)^2$ MULTIPLIER	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1830	C 007 044 0S
SHEET 2 OF SHEETS	

CHAPTER 3

QUAD LOG X DFG, MODEL 0.16.0355

3.1 INTRODUCTION

The 0.16.0355 Quad Log X DFG (Figure 3.1) located in positions 35 and 41 (see Figure 3.2), generate a logarithmic function of an input variable. These units are extremely versatile since they may be used to perform multiplication, division, squaring, and obtaining the square root, in addition to the capability of raising an input to an unusual or variable power.

The output function of the Log X DFG is: $e_o = -5 \text{ Log}_{10} (10|X|)$. The minus sign indicates that the polarity of the DFG output (e_o) is opposite to that of the input variable.

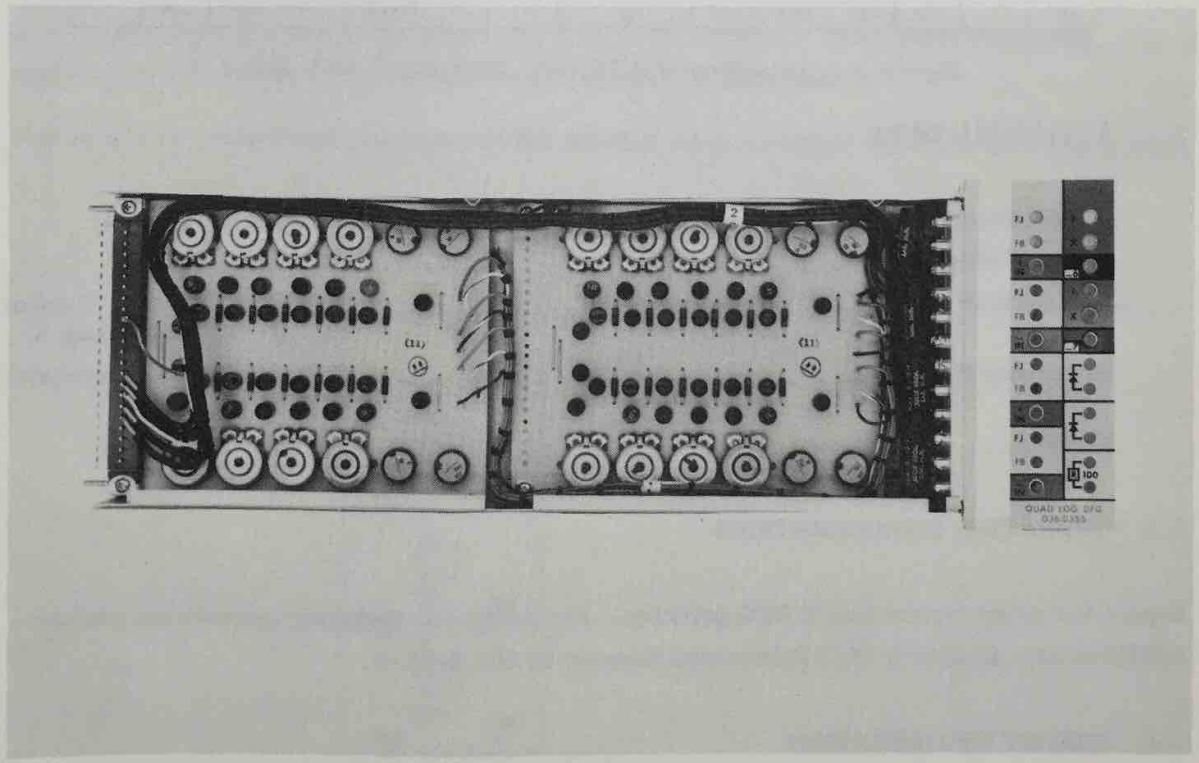


Figure 3.1. Quad Log X DFG, Model 0.16.0355

A00 AMPL A01	INT	ATTEN P00-P04 COMP. F/R	A02 A03 AMPL A04 A05	MULT	A08 AMPL A09	ATTEN P05-P09 T/S D/A	CONTROL TRAY	A10 AMPL A11	INT	ATTEN P10-P14 COMP. F/R	A12 A13 AMPL A14 A15	MULT	A18 AMPL A19	ATTEN P15-P19 T/S D/A
A20 AMPL A21	INT	ATTEN P20-P24 COMP F/R	A22 A23 AMPL A24 A25	MULT	A28 AMPL A29	ATTEN P25-P29 T/S D/A	TRUNKS	A30 AMPL A31	INT	ATTEN P30-P34 COMP. F/R	A32 A33 AMPL A34 A35	MULT	A38 AMPL A39	ATTEN P35-P39 T/S D/A
A40 AMPL A41	INT	ATTEN P40-P44 COMP F/R	A42 A43 AMPL A44 A45	QUAD LOG DFG MDFG A46 A47	A48 AMPL A49	ATTEN P45-P49 T/S D/A	TRUNKS	A50 AMPL A51	INT	ATTEN P50-P54 COMP. F/R	A52 A53 AMPL A54 A55	QUAD LOG DFG MDFG A56 A57	A58 AMPL A59	ATTEN P55 P59 T/S D/A
A60 AMPL A61	INT	ATTEN P60-P64 COMP F/R	A62 A63 AMPL A64 A65	SINE/COSINE MDFG A66 A67	A68 AMPL A69	ATTEN P65-P69 LIMITER	TRUNKS	A70 AMPL A71	INT	ATTEN P70-P74 COMP. F/R	A72 A73 AMPL A74 A75	SINE/COSINE MDFG A76 A77	A78 AMPL A79	ATTEN P75 P79 LIMITER

Figure 3.2. Location of 0.16.0355 Quad Log X DFG Trays

3.2 TECHNICAL DATA

Input Voltage Range	0.1 Volt to 10 Volts
Output Voltage Range	0 Volts to 10 Volts
Static Error	±0.5% (±0.05 Volt), Typical ±1.0% (±0.1 Volt), Log X
Frequency Response	Compatible With Associated Amplifier
Noise	<3 Millivolts (RMS)

3.3 OPERATING CONSIDERATIONS

Figure 3.3 gives typical Log X DFG patching. For additional operating instructions see the 580 Reference Handbook (EAI Publication Number 00 800.2055-0).

3.4 THEORY OF OPERATION

Drawing C016 126 0S is the schematic diagram of the Log X DFG printed circuit card. Note on this schematic that there are two separate but similar circuits. The circuit on the left-hand side responds only to negative input signals; the circuit on the right-hand side responds only to

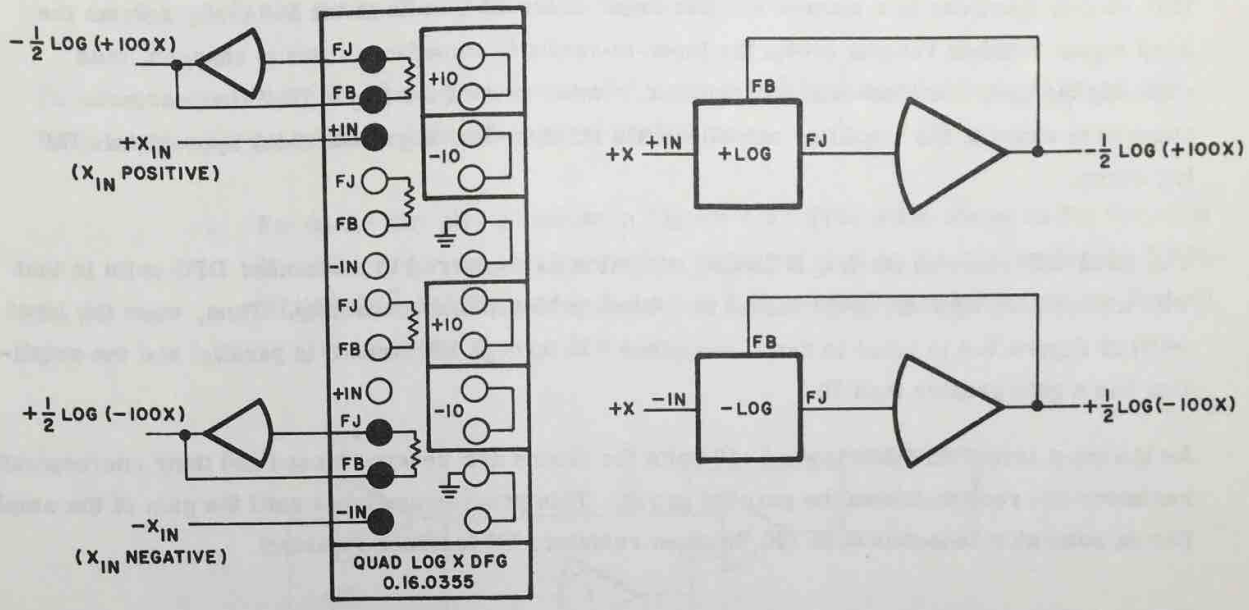


Figure 3.3. Log X DFG Patching

positive input signals. These two circuits differ only in the orientation of the diodes with respect to the bias voltages and also the polarities of the bias voltages. Due to this similarity, only the right-hand circuit (sensitive to positive input signals) is described.

Figure 3.4 is a simplified schematic of the positive input circuit of the 0.16.0355 Log X DFG.

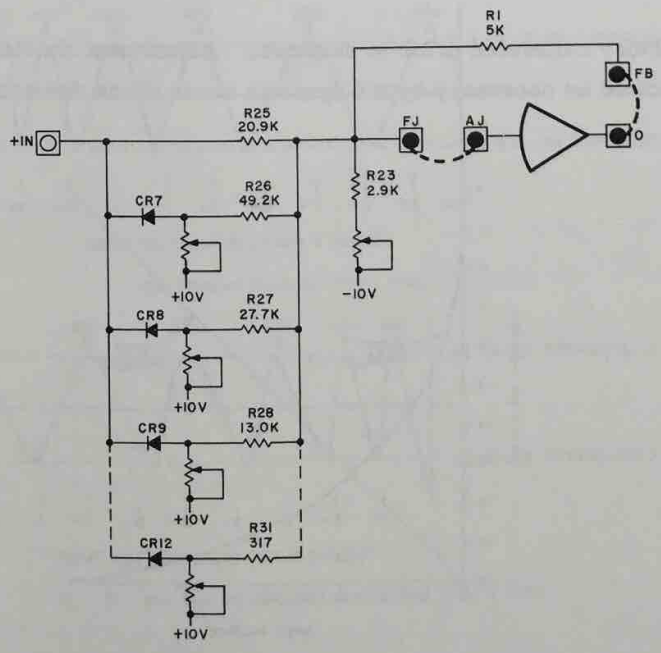


Figure 3.4. Positive Input Log X DFG Circuit, Simplified Schematic

This circuit functions in a manner similar to all of the DFG units of the 580 Computer; as the input signal reaches various levels the input-to-feedback impedance ratio is changed, thus changing the gain of the associated amplifier. In the case of the Log X DFG there are six changes in slope of the amplifier output, or six straight-line segments which approximate the log curve.

The main difference in the Log X circuit operation as compared to most other DFG units is that with a near zero input all of the diodes are *forward biased* and conducting. Thus, when the input (+IN) of Figure 3.4 is close to zero, resistors R25 through R31 are all in parallel and the amplifier has a gain greater than 10.

As the input level increases toward +10 volts the diodes are reverse biased and their corresponding resistors are removed from the parallel group. This process continues until the gain of the amplifier is somewhat less than 0.25 (20.9K input resistor, 5K feedback resistor).

Figure 3.5 compares graphically the input-to-output voltages of the Log X positive input circuit. Note that due to the inversion of the amplifier, the output signal is negative, or as previously indicated, $-5 \text{ Log}_{10} 10 X$. This curve illustrates the initial steep slope of the output curve (requiring a high amplifier gain) and the decrease in slope as X approaches 10 volts (requiring very small amplifier gain).

3.5 MAINTENANCE AND TEST PROCEDURES

The Log X DFG is factory calibrated prior to shipment. Adjustment should not be attempted unless definitely indicated as necessary by the dynamic error check described in the following sub-paragraph.

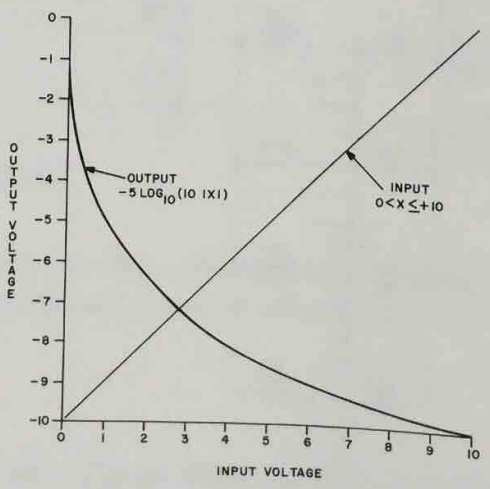
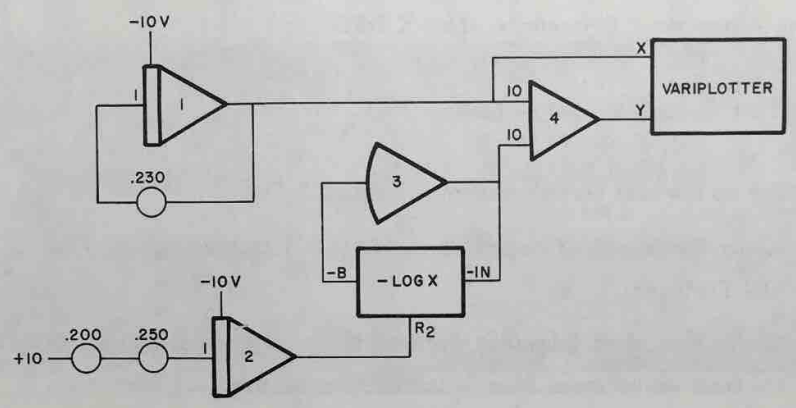


Figure 3.5. Graphical Input-to-Output Comparison of Positive Input Log X DFG

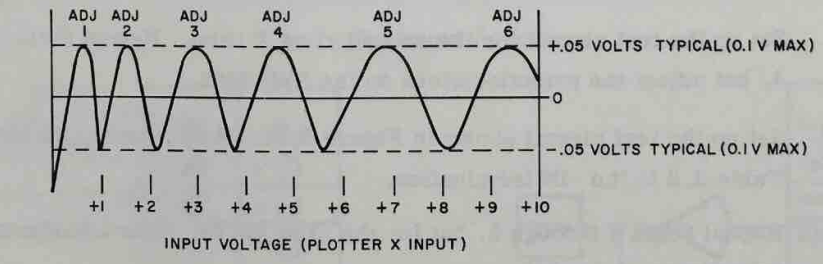
3.5.1 Dynamic Error Test Procedure Log X DFG

This test can be used to indicate if adjustment of the Log DFG's is required and to check the DFG output after completion of the adjustment procedure.

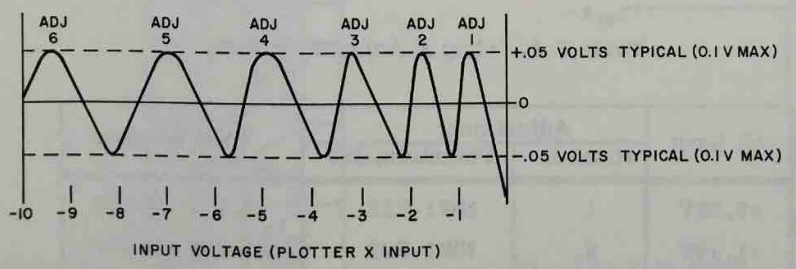
1. Set up the test circuit shown in Figure 3.6. (The setup shown is for the -Log X cards only.) An oscilloscope or voltmeter may be substituted for the VARI-PLOTTER.® Set the plotter Y input to 1.0 volt/inch sensitivity and the X input to 1.0 volt/inch.



(a) Test Circuit



(b) Typical Dynamic Error Plot; -Log X DFG



(c) Typical Dynamic Error Plot; +Log X DFG

Figure 3.6. Log X DFG Dynamic Error Test Circuit

2. Figure 3.6b shows a typical error plot. Note that when checking a -Log X card the resultant plot starts at the *right* and runs to the *left* side of the plotter.
3. If the error plot does not remain within the ±0.1 volt limits (0.1% error) refer to the static adjustment procedure.
4. To check a +Log X card, substitute the plus for the minus card of Figure 3.6 and change the IC inputs to the two integrators to +10 volts. Change the +10 input to integrator 2 to -10 volts. The resultant error curve should be similar to Figure 3.5c. Note in this case the plot will run *left to right*.

3.5.2 Static Adjustment Procedure +Log X DFG

The setup temperature should be approximately 75°F.

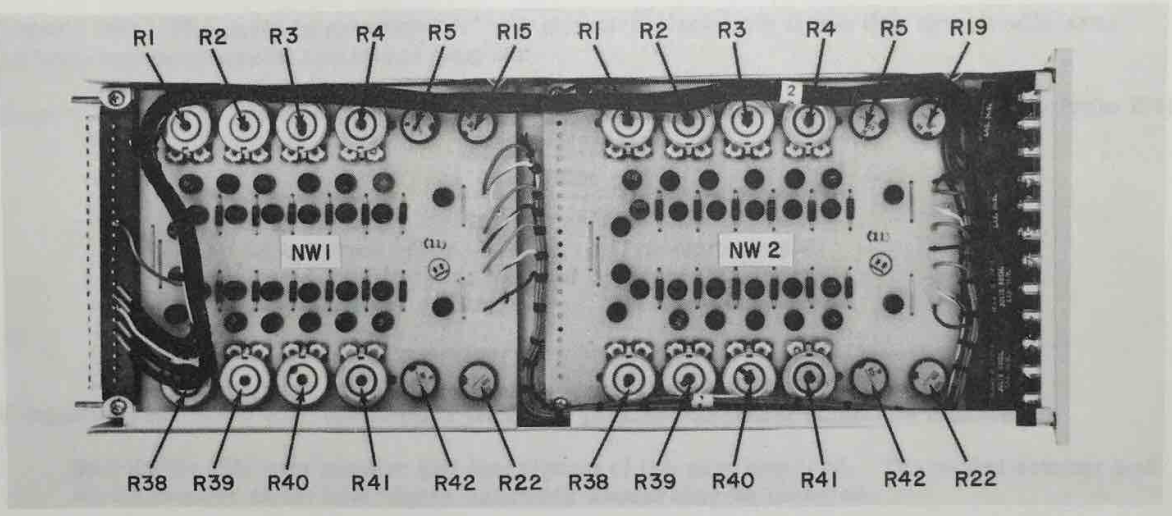
1. Set up the test circuit shown in Figure 3.7b.
2. Apply the inputs as indicated in Table 3.1 in the sequence listed, to the +IN Terminal.
3. If an adjustment is made, recheck the previous setting before proceeding to the next adjustment (due to interaction between adjustments).
4. Repeat Steps 2 and 3 as necessary.
5. Set up the test circuit for the second +Log X card. Repeat Steps 2 through 4, but adjust the potentiometers on the NW1 Unit.
6. Set up the test circuit shown in Figure 3.7c. Apply the inputs listed in Table 3.2 to the -IN termination.
7. Repeat Steps 3 through 5, but for the -Log cards. (See adjustment notations indicated in Table 3.2.)

Table 3.1. +Log X Adjustment Data

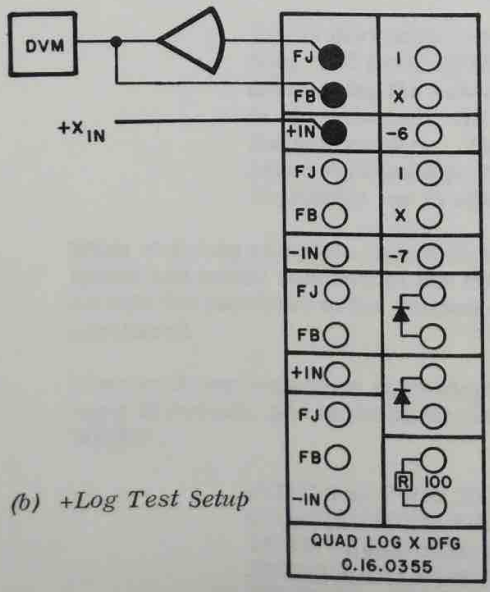
+X Input	Adjustment		DVM Readout
	Number	Potentiometer	
+0.32V	1	NW1-R22	-2.15V ±0.05V
+1.16V	2	NW1-R42	-5.23V ±0.05V
+2.47V	3	NW1-R41	-6.92V ±0.05V
+4.28V	4	NW1-R40	-8.13V ±0.05V
+6.51V	5	NW1-R39	-9.05V ±0.05V
+9.13V	6	NW1-R38	-9.79V ±0.05V

Table 3.2. -Log X Adjustment Data

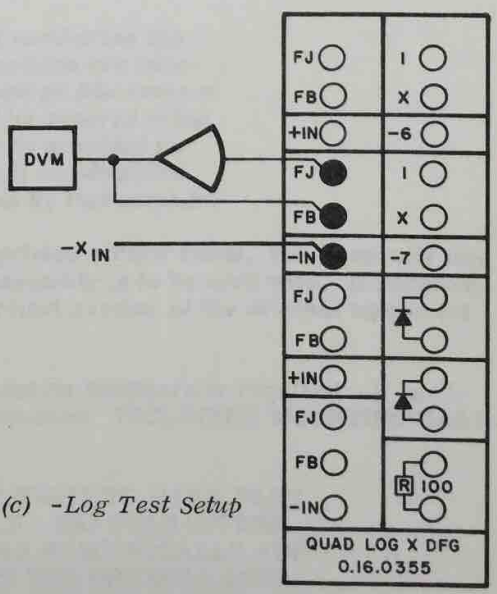
-X Input	Adjustment		DVM Readout
	Number	Potentiometer	
-0.32V	1	NW1-R19	+2.15V ±0.05V
-0.16V	2	NW1-R5	+5.23V ±0.05V
-2.47V	3	NW1-R4	+6.92V ±0.05V
-4.28V	4	NW1-R3	+8.13V ±0.05V
-6.51V	5	NW1-R2	+9.05V ±0.05V
-9.13V	6	NW1-R1	+9.79V ±0.05V



(a) Adjustment Locations



(b) +Log Test Setup



(c) -Log Test Setup

Figure 3.7. Log X Adjustment Location and Test Setup Patching

3.6 TROUBLE ANALYSIS

Malfunction in the Log X DFG can be localized by means of the adjustment procedure described in Sub-Paragraph 3.5.2 above. The first segment which cannot be adjusted properly is probably at fault. Refer to Schematic C016 0126 0S for component values and location. Check the components in the suspected segment with an ohmmeter, by comparing resistance measurements between the cards or with other units. Recalibrate the unit after replacing any components.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	CR1,2	Diode	00 614.0199-0	B
2	J1	Connector Block: White	00 542.1545-2	B
3	R1,2,3,4	Resistor, Precision	00 638.0765-0	B
4	R5	Resistor, Precision	00 638.1050-0	B
5		Connector Block: Lettered (LOG DFG 0.16.0355)	00 542.1551-8	B
		0.16.0127-1 LOG X DFG CARD		
1	CR1 thru 12	Rectifier	00 614.0042-0	B
2	R1,2,3,38, 39,40	Potentiometer	00 642.0448-0	B
3	R4,41	Potentiometer	00 642.0444-0	B
4	R5,42	Resistor, Variable, Wirewound: 1K ohms ±5%, 1W (Bourns 3365 or equal)	00 642.0654-0	A
5	R6,32	Resistor, Precision	00 638.0609-0	B
6	R7,33	Resistor, Precision	00 638.0611-0	B
7	R8,34	Resistor, Precision	00 638.0470-0	B
8	R9,35	Resistor, Precision	00 638.0610-0	B
9	R10,36	Resistor, Precision	00 638.0608-0	B
10	R11,37	Resistor, Precision	00 638.0440-0	B
11	R12,25	Resistor, Precision	00 638.0447-0	B
12	R13,26	Resistor, Precision	00 638.0450-0	B
13	R14,27	Resistor, Precision	00 638.0449-0	B
14	R15,28	Resistor, Precision	00 638.0444-0	B
15	R16,29	Resistor, Precision	00 638.0441-0	B
16	R17,30	Resistor, Precision	00 638.0438-0	B
17	R18,31	Resistor, Precision	00 638.0437-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE

QUAD LOG X DFG

MODEL NO.

0.16.0355 Sh. 1 of 2 Sh.

DATE 10 / 12 / 67

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	R19,22	Resistor, Variable, Wirewound: 100 ohms ±5%, 1W (Bourns 3365P-1 or equal)	00 642.0571-0	A
19	R20,23	Resistor, Precision	00 642.0439-0	B
		0.16.0127-3 LOG X DFG CARD Identical with 0.16.0127-1 except for the addition of Item 20.		
20		Connector, Plug: 22 Contacts; Male (Amphenol 133-022-23 or equal)	00 542.0419-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/ 12 / 67

UNIT TITLE
QUAD LOG X DFG

MODEL NO.
0.16.0355 Sh.2 of 2 Sh.

M446

APPENDIX 2

DRAWINGS

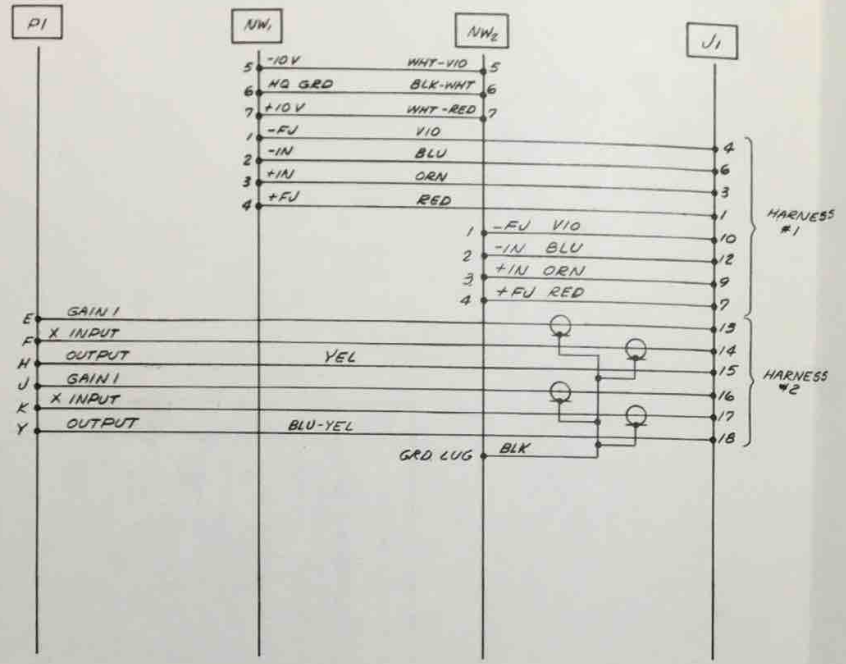
This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

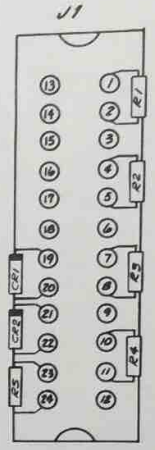
EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

INDEX

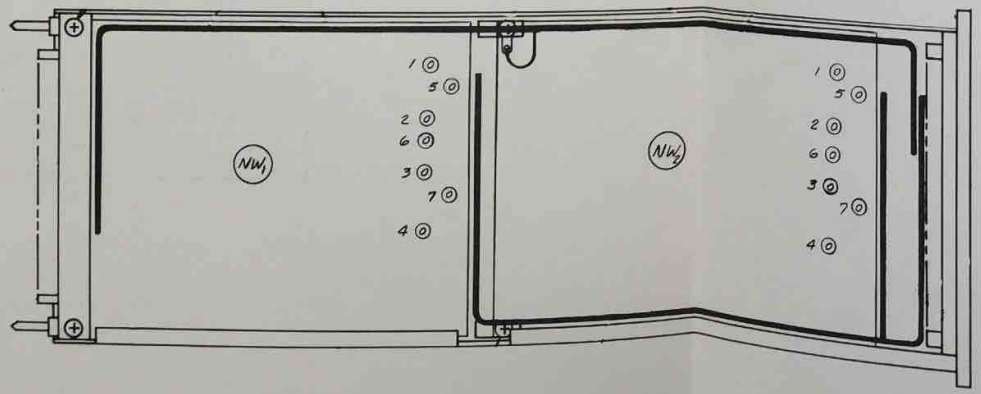
Unit or Component	Type of Drawing	Drawing Number
0.16.0355 Quad Log X DFG	Assembly W/ Wiring	D00 016 0355 0A
16.126 Log X DFG	Schematic	C016 126 0S

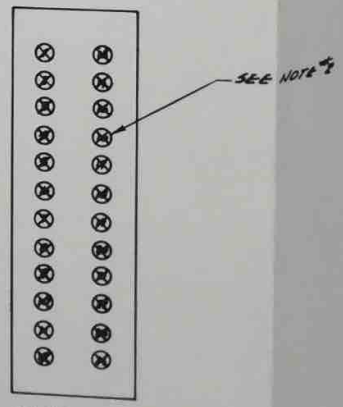
NOTES:
1. UNLESS OTHERWISE SPECIFIED
   a) WIRES TO BE #22 P.H.U.
   b) COAX PER B00 916 0001 0.
2. ⊗ DENOTES LOCATION OF CONTACTS (ITEM #12) PER DETAIL "A".
3. SEE A00 018 1352 OP FOR HARNESS 1&2





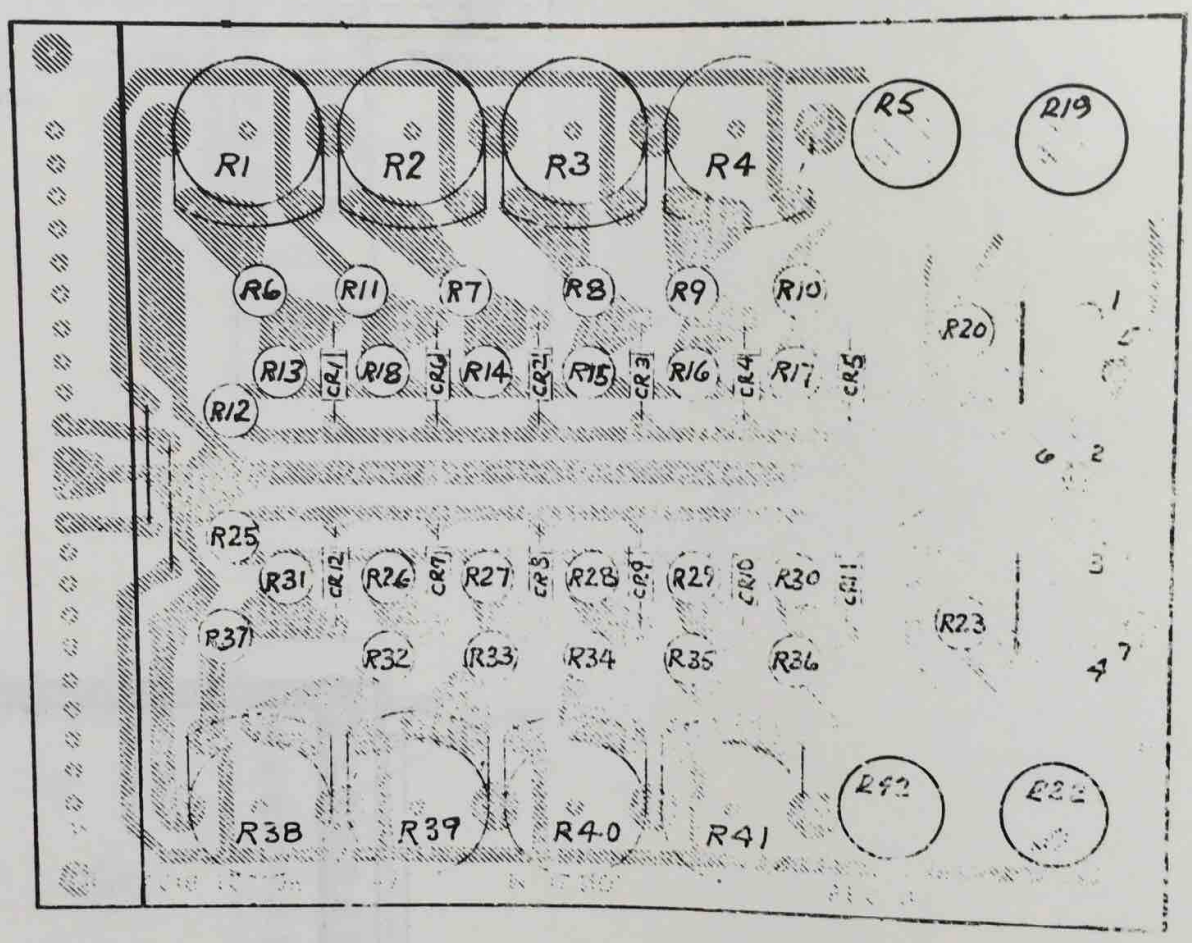
CONN. BLOCK REAR VIEW





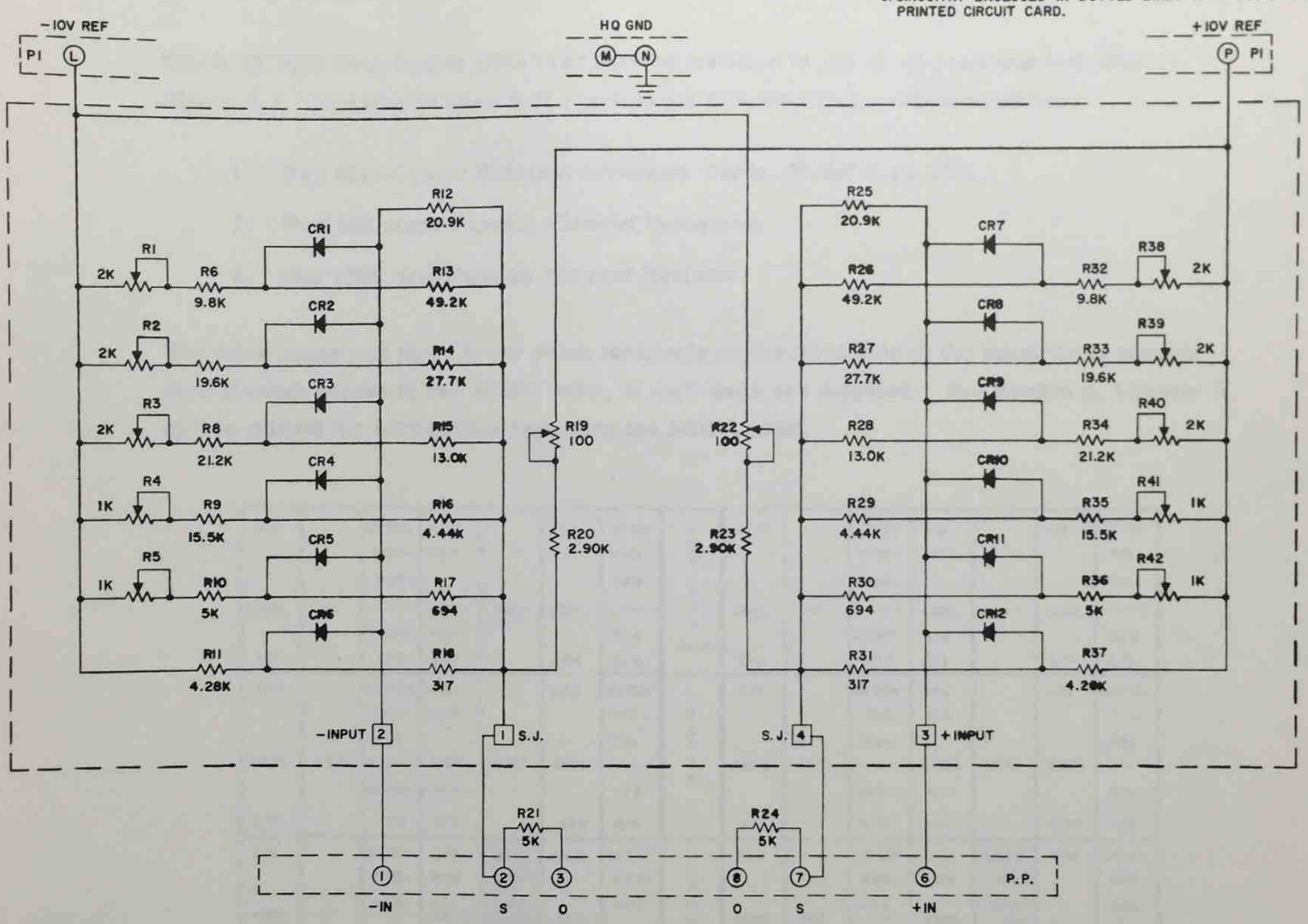
CONN. BLOCK FRONT VIEW

EAI
ASSEMBLY W/WIRING LIST QUAD LOG X DFG



16.127 Log X DFG

NOTE:
1. ALL RECTIFIERS ARE SILICON DIODES PER DWG. A614 042 0.
2. ALL FIXED RESISTORS, EXCEPT R21 & 24 ARE ±1%, .25W. R21 & R24 ARE ±0.1%, .15W.
3. CIRCUITRY ENCLOSED IN DOTTED LINES IS LOCATED ON 16.127-2 PRINTED CIRCUIT CARD.



UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN MMFD
RESISTANCE IS IN OHMS
TOLERANCE ON
FRACTIONS ± 1/64 · DECIMALS ± .005 · ANGLES ±
TOL. OF MATERIAL SUPPLIED

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC LOG X DFG	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1849	C 016 126 OS
SHEET / OF / SHEETS	

CHAPTER 4

SINE-COSINE DFG TRAY, MODEL 0.16.0360

4.1 INTRODUCTION

The 0.16.0360 Sine-Cosine DFG Tray may be installed in any of the positions indicated in Figure 4.1. The tray (Figure 4.2) contains the following major sub-assemblies:

1. Two Sine-Cosine Function Generator Cards, Model 0.16.0361.
2. Two 10K ohms Passive Element Resistors.
3. One 100K ohm Passive Element Resistor.

The three upper and three lower patch terminals on the right side of the patch block provide feed-through access to two MDFG units, if such units are supplied. See Section 2, Chapter 5 of this manual for information regarding the MDFG units.

A00 AMPL A01	INT	ATTEN P00-P04 COMP. F/R	A02 A03 AMPL A04 A05	MULT	A08 AMPL A09	ATTEN P05-P09 T/S D/A	CONTROL TRAY	A10 AMPL A11	INT	ATTEN P10-P14 COMP. F/R	A12 A13 AMPL A14 A15	MULT	A18 AMPL A19	ATTEN P15-P19 T/S D/A
A20 AMPL A21	INT	ATTEN P20-P24 COMP F/R	A22 A23 AMPL A24 A25	MULT	A28 AMPL A29	ATTEN P25-P29 T/S D/A	TRUNKS	A30 AMPL A31	INT	ATTEN P30-P34 COMP. F/R	A32 A33 AMPL A34 A35	MULT	A38 AMPL A39	ATTEN P35-P39 T/S D/A
A40 AMPL A41	INT	ATTEN P40-P44 COMP F/R	A42 A43 AMPL A44 A45	QUAD LOG DFG MDFG A46 A47	A48 AMPL A49	ATTEN P45-P49 T/S D/A	TRUNKS	A50 AMPL A51	INT	ATTEN P50-P54 COMP. F/R	A52 A53 AMPL A54 A55	QUAD LOG DFG MDFG A56 A57	A58 AMPL A59	ATTEN P55 P59 T/S D/A
A60 AMPL A61	INT	ATTEN P60-P64 COMP F/R	A62 A63 AMPL A64 A65	SINE/COSINE MDFG A66 A67	A68 AMPL A69	ATTEN P65-P69 LIMITER	TRUNKS	A70 AMPL A71	INT	ATTEN P70-P74 COMP. F/R	A72 A73 AMPL A74 A75	SINE/COSINE MDFG A76 A77	A78 AMPL A79	ATTEN P75 P79 LIMITER

Figure 4.1. Location of the Sine-Cosine Tray, Model 0.16.0360

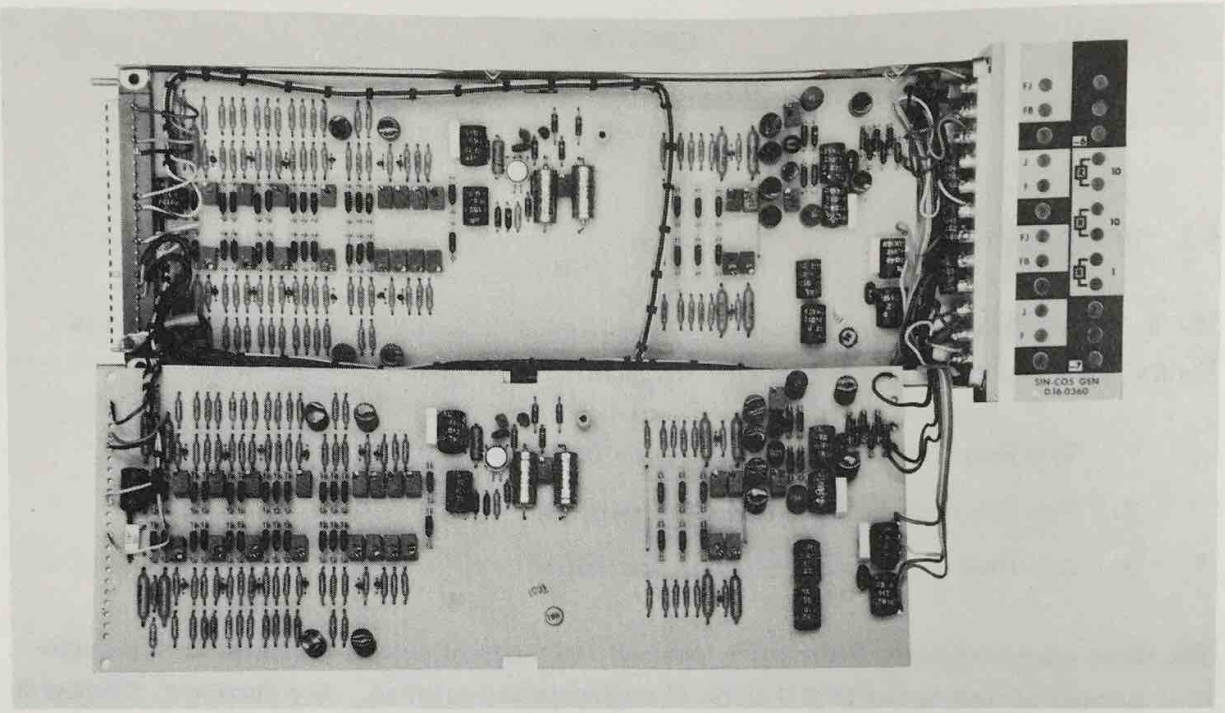


Figure 4.2. Sine-Cosine Tray, Model 0.16.0360

The sine-cosine (sin-cos) generator is designed for use with the 0.6.0614-1 Dual DC Amplifier and provides -Sin θ, -Cos θ, and +Cos θ modes of operation. One amplifier section of the dual dc amplifier is required for -Sin operation from -90° to +90°. Expansion of the -Sin operation to -180° to +180° and ±Cos operation from -180° to +180° requires the use of both amplifier sections of the dc amplifier.

The passive element resistors may be used, as required, for any computing functions.

4.2 TECHNICAL DATA

The following specifications refer to the 0.16.0360 Tray operated in the computer.

Static Error: For the θ Input Internal of -180° to +180°.

-5.0 Volts $\leqq E_o \leqq$ +5.0 Volts	±4 Millivolts, Maximum
-5.0 Volts $\leqq E_o \leqq$ +10.0 Volts	±6 Millivolts, Maximum
+5.0 Volts $\leqq E_o \leqq$ -10.0 Volts	±6 Millivolts, Maximum
Output	±2 Millivolts, Maximum
Temperature Drift	0.8 Millivolts/°F, Maximum

4.3 OPERATING CONSIDERATIONS

Complete application and patching information is included in the 580 Reference Handbook (EAI Publication Number 00 800.2055-0). Figures 4.3 through 4.6 illustrate the patching and computer diagrams for the various operating modes of the sine-cosine generator.

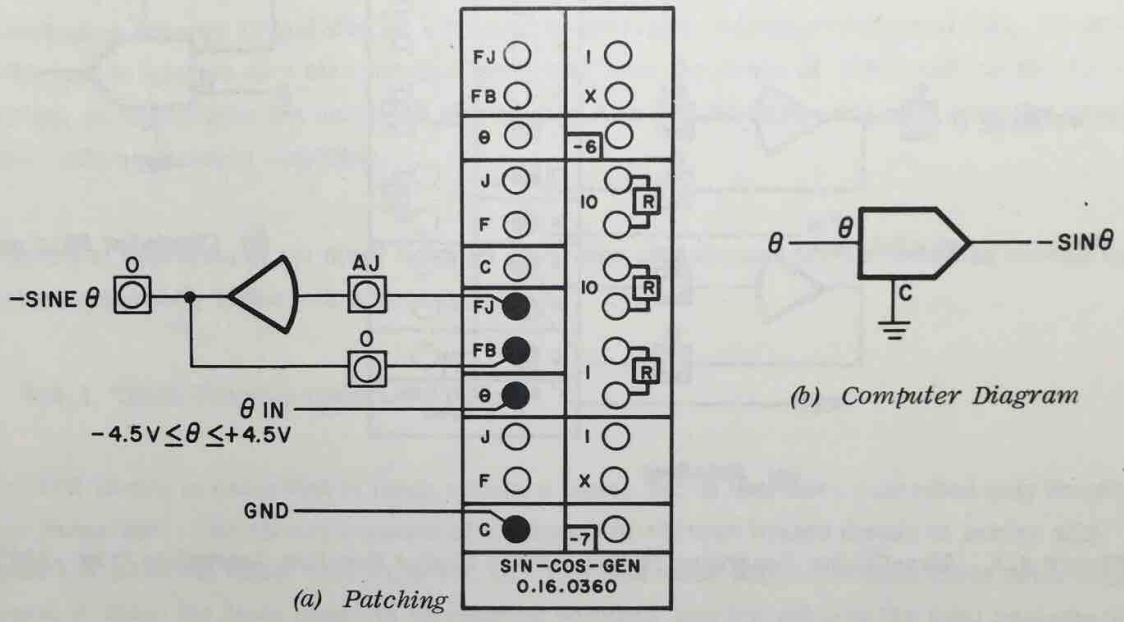


Figure 4.3. Sine-Cosine Generator Patching for Sine Function Generation from -90° to +90°

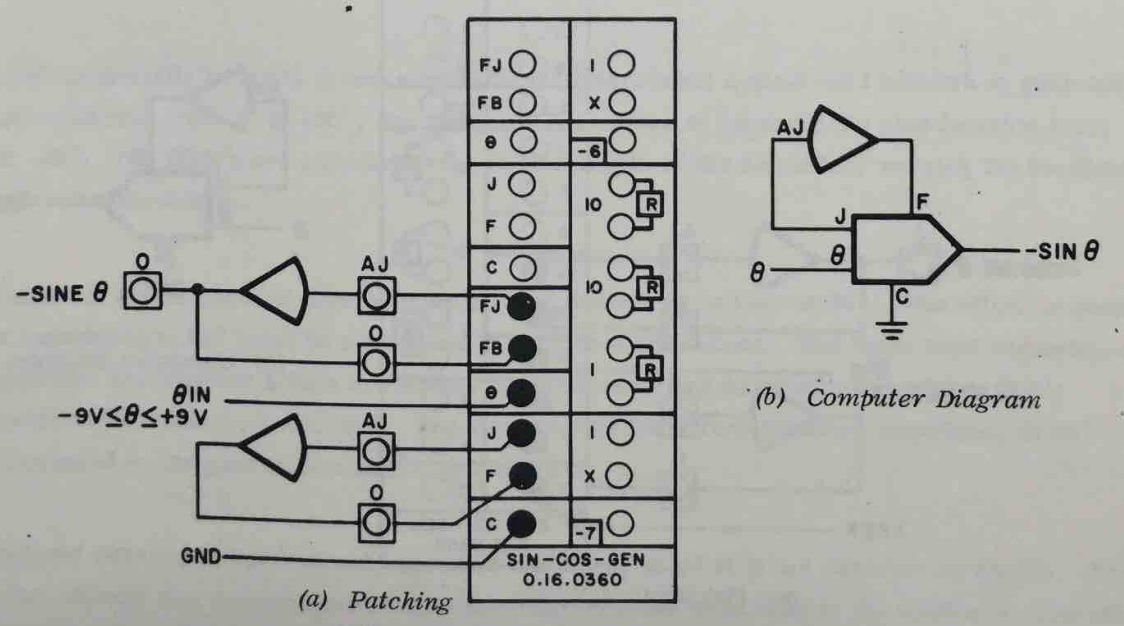
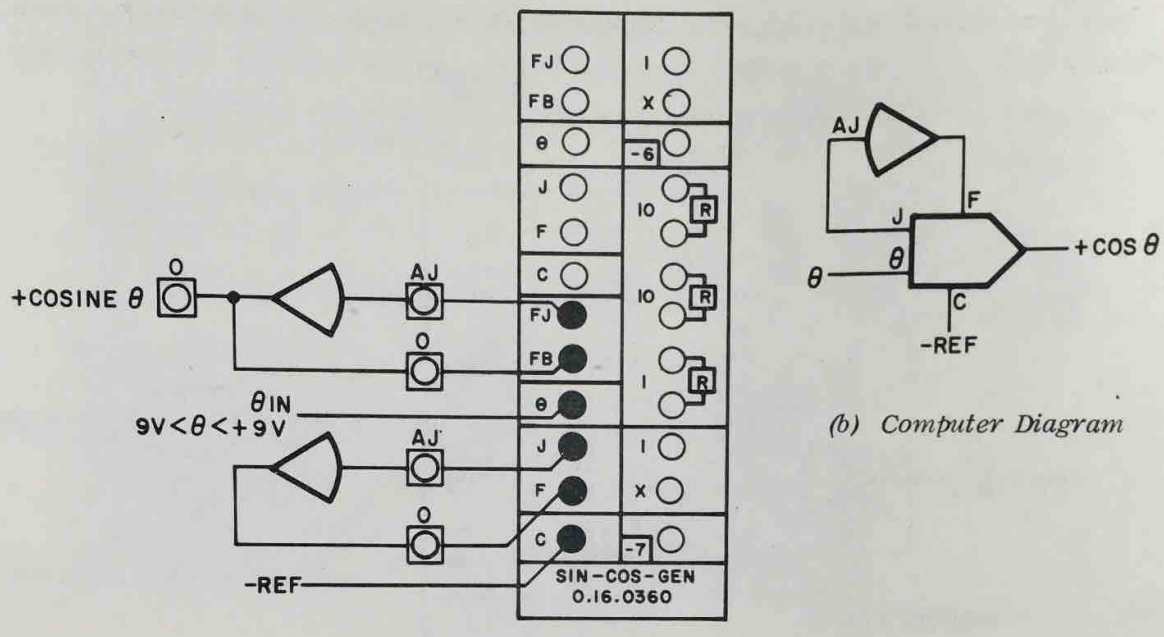


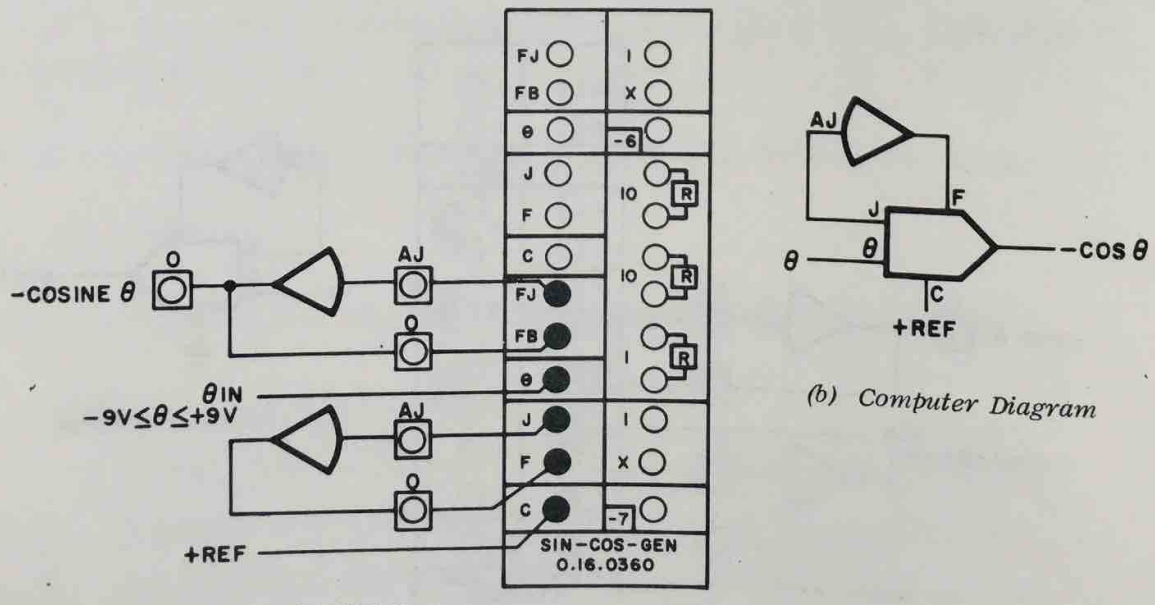
Figure 4.4. Sine-Cosine Generator Patching for Sine Function Generation from -180° to +180°



(a) *Patching*

(b) *Computer Diagram*

Figure 4.5. Sine-Cosine Generator Patching for + Cosine Function Generation from -180° to +180°



(a) *Patching*

(b) *Computer Diagram*

Figure 4.6. Sine-Cosine Generator Patching for - Cosine Function Generation from -180° to +180°

4.4 THEORY OF OPERATION

The sine-cosine generator consists of a diode generator (DFG) circuit (with internal amplification) that produces a sinusoidal feedback impedance for the associated operational amplifier. A waveshaping network is included on the function generator etched-circuit card that, (a) permits the unit to operate as a sine function generator over the range of ±180° with an external amplifier, or (b) permits the unit to be operated as a cosine function generator over the range of ±180° with an external amplifier.

The theory of operation of the diode function generator circuits and the waveshaping circuit are described separately in the following paragraphs.

4.4.1 Diode Function Generator Theory

Basic DFG theory is described in many standard texts, and is therefore described only briefly in this paragraph. The circuit consists of a network of reverse biased diodes in series with resistors of different values (see Figure 4.7). The bias value applied to each diode determines the point at which the diode conducts (breakpoint voltage), and the value of the total resistance in series with each diode determines the amount of current each diode segment contributes to the resultant function.

The circuit actually consists of two sinusoidal DFG networks; a quadrant I network to generate the sine function from 0° to +90°, and quadrant IV network to generate the sine function from 0° to -90°. The DFG's are included in the feedback path of the amplifier, varying the feedback impedance sinusoidally.

The slope of a sine curve is maximum at 0°, and decreases to zero at 90°. The effective feedback impedance at 90° must be zero ohms to provide a zero slope. The three final segments of the positive and negative DFG's are driven by a non-inverting differential amplifier (AR1) mounted on the etched-circuit card. The requirement for a zero feedback impedance at 90° is eliminated by the gain of this amplifier module.

A resistor (R1a) is in the feedback circuit at all times, since it is not switched by diodes. The current through this resistor determines the function slope when none of the diodes is conducting, thus establishing the slope as the function passes through 0°.

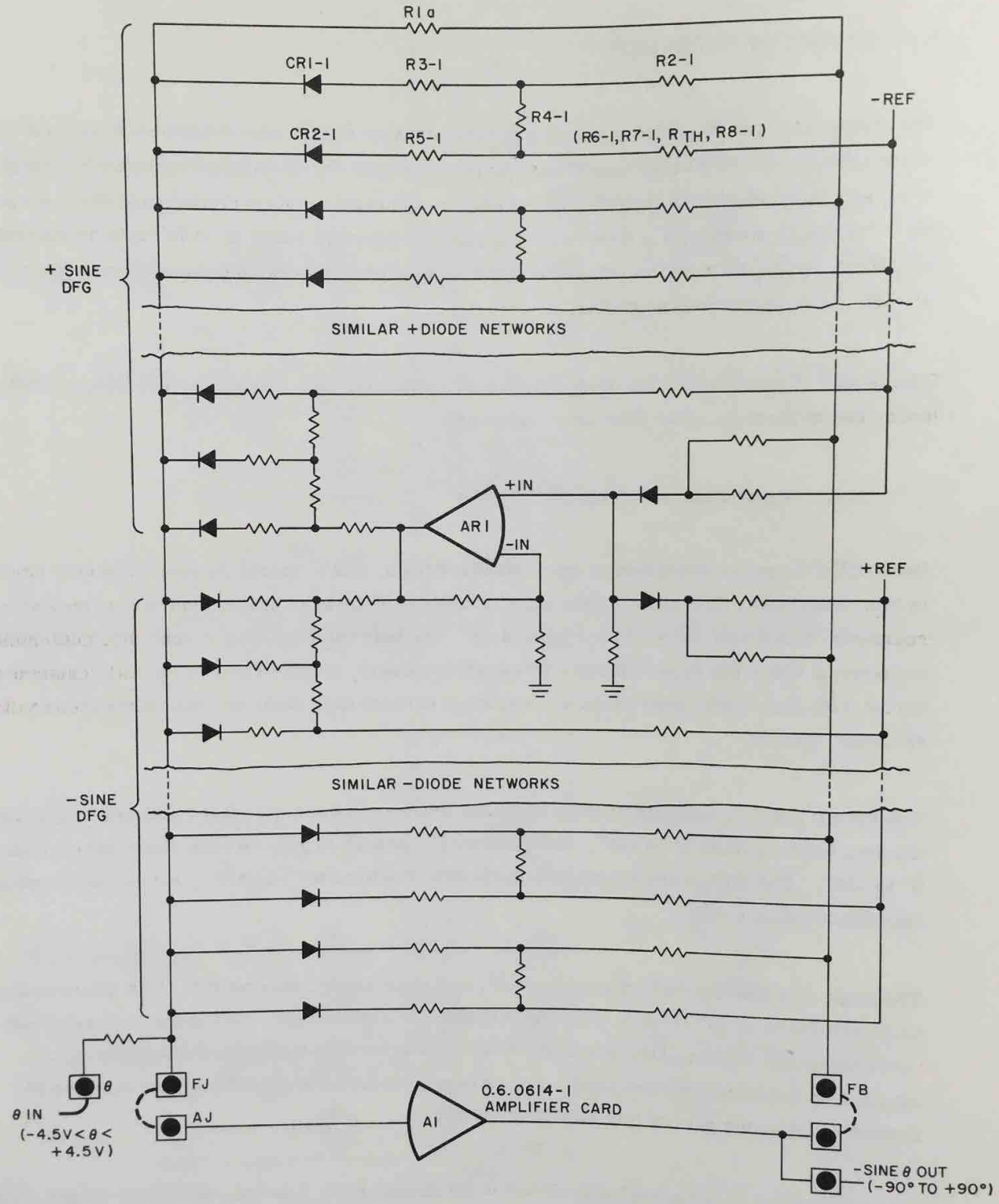


Figure 4.7. Sinusoidal DFG Circuit, Simplified Schematic

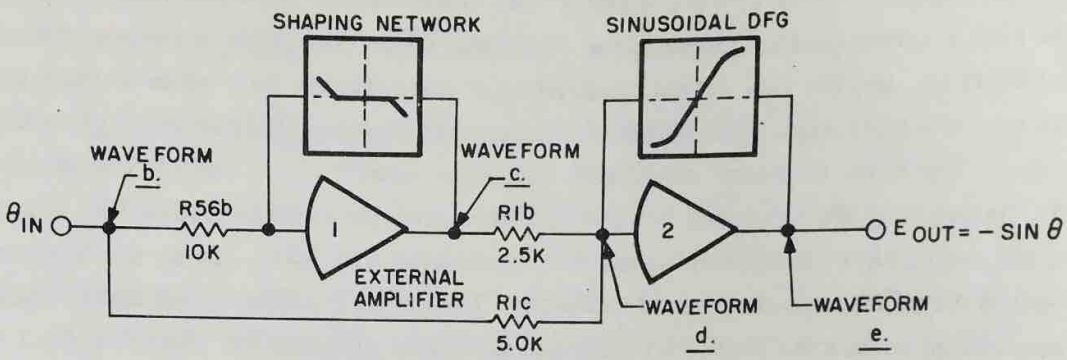
The components forming the first positive segment group in the DFG are identified on the figure for description. Diode CR1-1, together with slope resistor R3-1 and input resistor R2-1, forms the first positive diode segment of the sinusoidal DFG. The diode is reverse biased by resistors R2-1, R4-1, and the bias network consisting of R6-1 through R8-1 when no input signal is present. As the DFG input signal (the output of A1) becomes positive, the reverse bias on CR1-1 is overcome. The diode conducts, effectively switching resistors R3-1 and R2-1 in parallel with R1a. As the output of A1 increases in a positive direction, the reverse bias on CR2-1 is also overcome, and CR2-1 switches R4-1 and R5-1 in parallel with R3-1. Thus, the feedback resistance decreases as the amplifier output increases. The series resistor values and the diode bias voltage are chosen so that the feedback resistance decreases sinusoidally. Note that R4-1 forms part of the bias network for CR1-1, and forms part of the input and bias network for CR2-1. This dual use of resistors within a segment group reduces the number of precision resistors required for the DFG increasing the reliability and stability of the circuit.

4.4.2 Waveshaping Circuit Theory

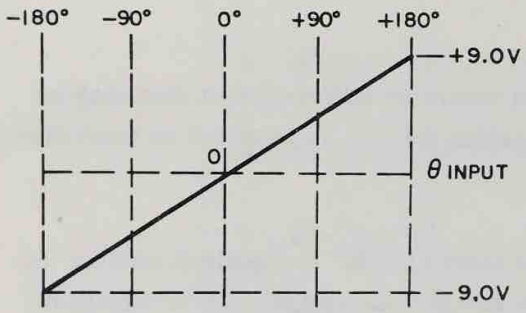
A waveshaping network incorporated on the sine-cosine generated etched-circuit card may be patched in conjunction with an external amplifier to generate the sine or cosine of an input signal over the range of ±180°.

The circuit for generating the sine of an angle over the range of ±180° is explained with the use of Figure 4.8. As shown on this illustration, the input signal is coupled through an amplifier-waveshaping circuit that produces the waveform shown in Figure 4.8c. The signal is summed with the original input signal at the input junction of amplifier 2. Since the input resistors to amplifier 2 have a 2:1 ratio, the effective input signal is as shown on Figure 4.8d. The sinusoidal DFG circuit is connected as the feedback element for amplifier 2, producing the output shown in Figure 4.8e.

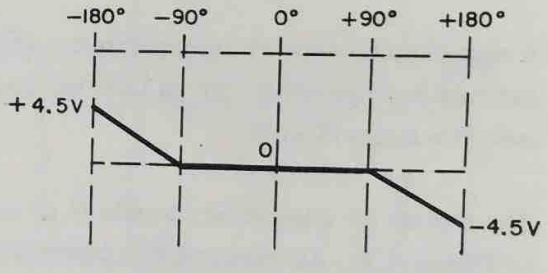
The basic theory of the cosine function generator is described with the aid of Figure 4.9. Depending on the patching of the control terminal (C), the circuit produces an output of +cos θ or -cos θ, over the range of ±180°. The arrangement shown on Figure 4.9a produces an output of -cos θ; if the C terminal is patched to -REF, the resultant output is +cos θ. For the arrangement shown, amplifier 1 produces no output for any negative input within the required range (0 to -9 volts), but acts as a normal gain-of-one inverter for positive inputs. The resultant output from amplifier 1 is shown in Figure 4.9c. This output is summed with the original input signal at the input junction to amplifier 2. A bias current, through R1d, shifts the zero level of the effective input to amplifier 2. The 2:1 ratio between resistors R1c and R1b, together with the bias current, makes the effective input to amplifier 2 appear as shown in Figure 4.9d. The sinusoidal DFG circuit in the feedback path of amplifier 2 produces the output shown in Figure 4.9e.



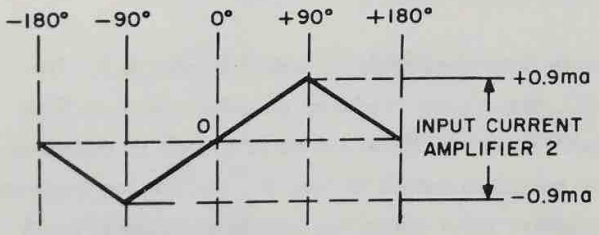
(a) Block Diagram



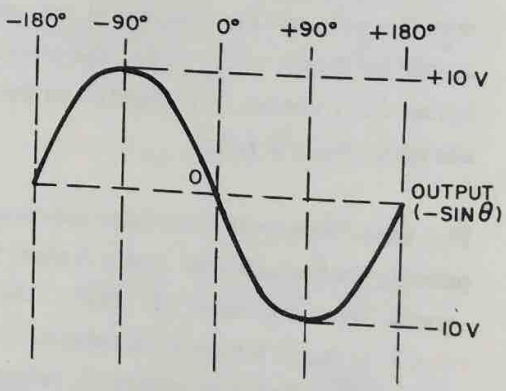
(b) Input



(c) Output of Shaping Network

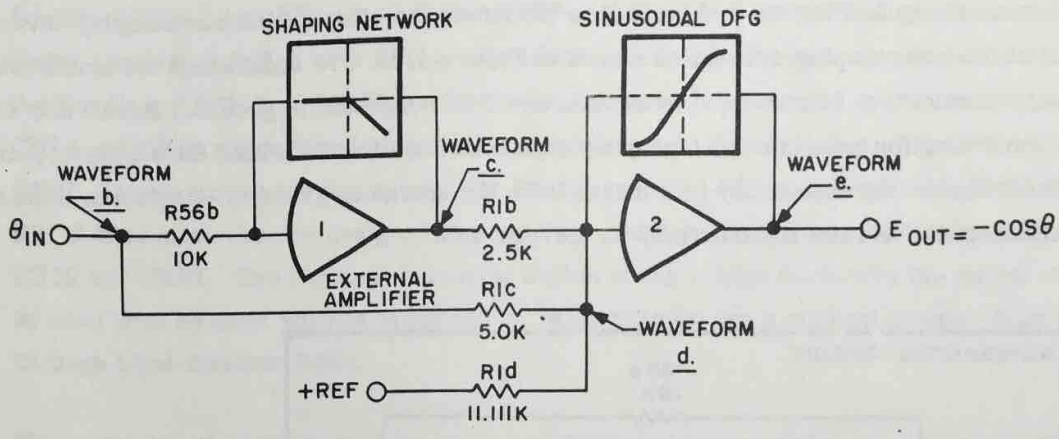


(d) Summation of Currents into SDFG Summing Junction Due to Voltage Inputs b. and c.

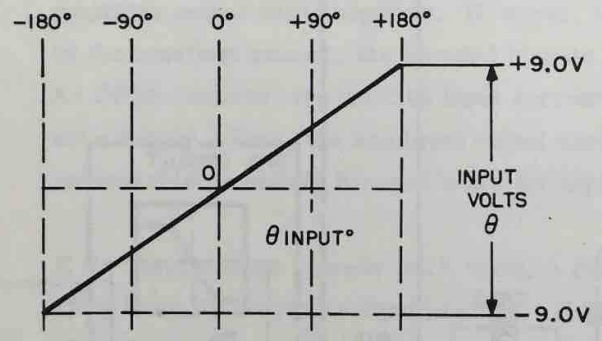


(e) Output Sine Function

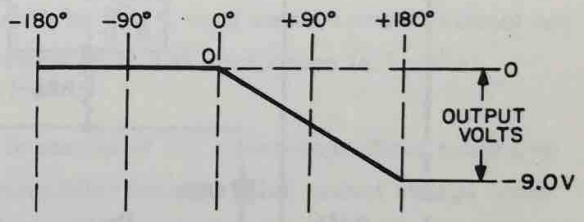
Figure 4.8. Sine Generator Waveforms



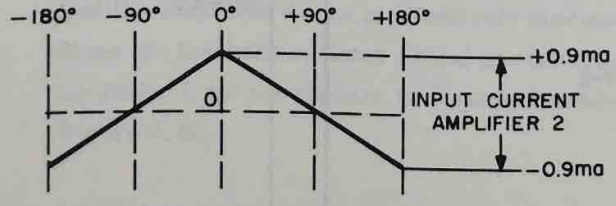
(a) Block Diagram



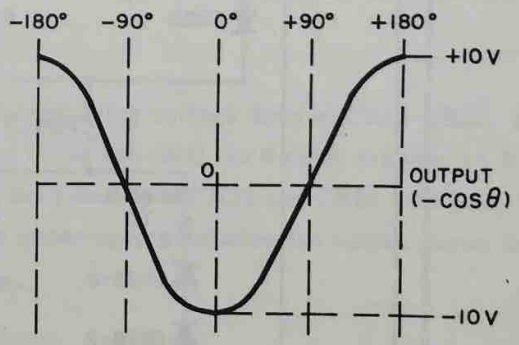
(b) Input



(c) Output of Shaping Network



(d) Summation of Currents into SDFG Summing Junction Due to Voltage Inputs b. and c. Plus REF Current Due to R1d



(e) Output Cosine Function

Figure 4.9. Cosine Generator Waveforms

The waveforms shown in Figures 4.8c and 4.9c illustrate the effect of the waveshaping network; the circuit of the waveshaping network is shown in Figure 4.10. To understand the operation of the circuit, assume first that no input is applied and C is connected to ground. Recall that the amplifier input junction is held at virtual ground potential by circuits within the amplifier, and that the amplifier draws essentially no current from the summing junction. Resistors R65c and R1d are connected to ground and thus may be disregarded.

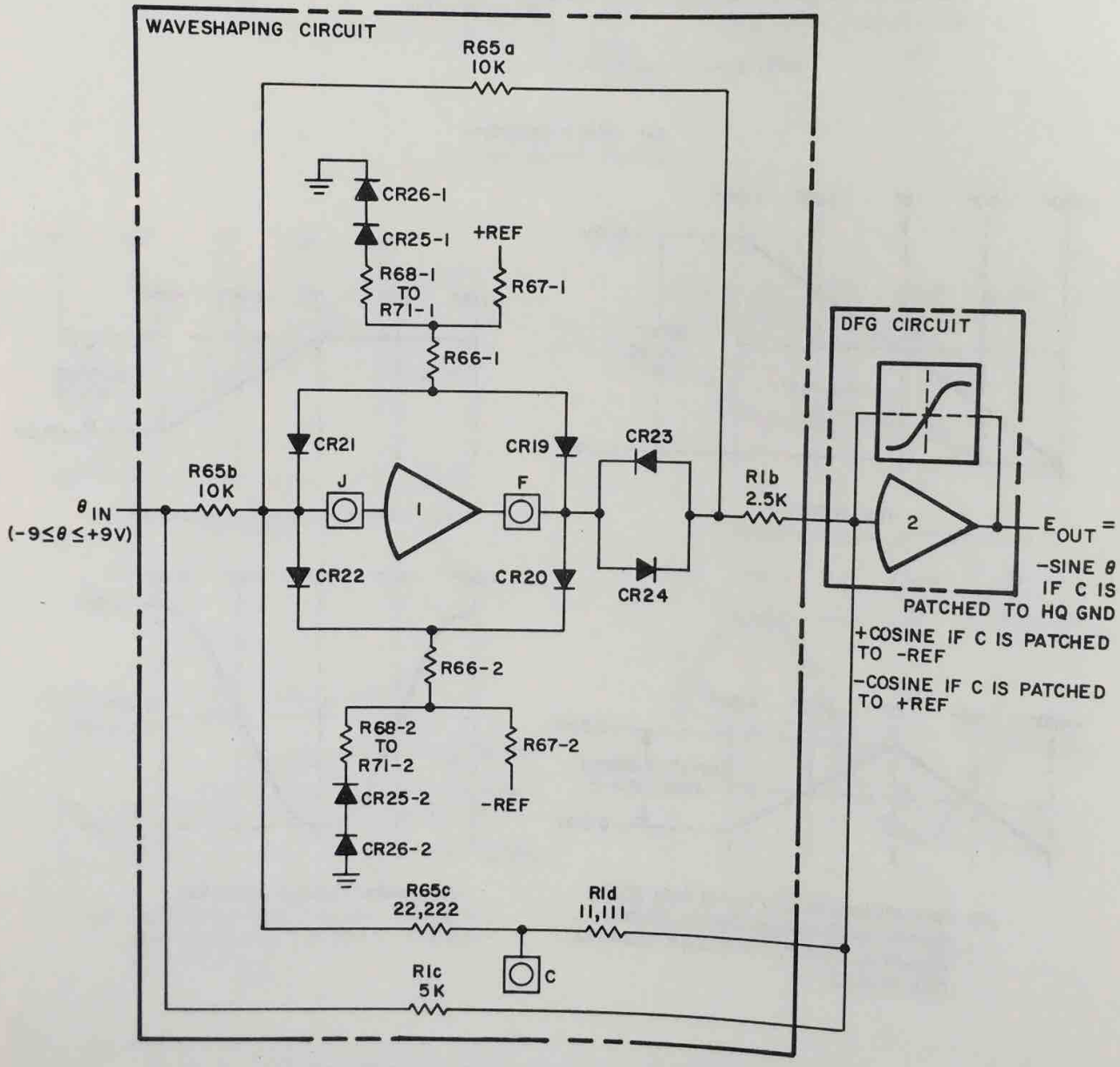


Figure 4.10. Sine-Cosine Generator Waveshaping Circuit

Resistors R67-1 and R71-1 and diodes CR25-1 and CR26-1 establish a positive bias potential at the junction of R66-1 with R67-1. An identical circuit establishes a negative bias potential at the junction of R66-2 with R67-2. These bias potentials are equal in absolute value. Diodes CR19 and CR20 are forward biased by these voltages. These diodes, together with CR21 and CR22, form a bridge circuit around the amplifier. The R66-1 through R71-1 and R66-2 through R71-2 bias networks are designed to provide a static current flow of 450 microamps through CR19 and CR20. The constant balancing action of the bridge maintains the output of the amplifier at zero until an input voltage in excess of $|4.5|$ volts forces a current greater than 450 microamps through input resistor R65b.

For example, if an input of +2.5 volts is applied, a current of 250 microamperes flows through R65b toward the junction of CR21 with CR22. This input current unbalances the circuit, and the amplifier output shifts negative. However, as soon as the amplifier output shifts away from zero by the smallest amount, the forward bias on CR20 is reduced, and CR22 is permitted to conduct. As CR22 conducts, the positive input current is diverted through this diode to the negative reference supply. Thus, the amplifier output needs to shift by only a very small amount (almost not measurable) to satisfy Kirchoff's law for input currents up to 450 microamps (4.5 volts).

If the input voltage exceeds ±4.5 volts, a current in excess of 450 microamps flows toward or away from the amplifier input junction. Since the amplifier input junction cannot change from virtual ground potential, and since the CR21-CR22 circuit cannot absorb or provide a current in excess of 450 microamps, the output of the amplifier must shift in such a way that the excess current can flow through feedback resistors R65a. The amplifier thus acts as a normal gain-of-one circuit for inputs in excess of ±4.5 volts.

Diodes CR23 and CR24 compensate for the normal conducting voltage drop of CR19-CR22, so that the amplifier output is effectively disconnected from R1b until the θ input exceeds ±4.5 volts. Since the feedback resistor (R65a) is connected to the junction of CR23 and CR24 with R1b, the amplifier 1 circuit appears as a perfect dead-zone generator, producing the output shown in Figure 4.8c.

The C terminal must be patched to ±REF for cosine operation. Assume for this description that the C terminal is patched to +REF, preparing the circuit to generate -cos θ. The circuit operates in the same way, except that an additional current of 450 microamps flows through R65c to the summing junction. If no input is applied, this current flows through CR22, R66-2 and R67-2 to -REF, and no current flows through CR20 or CR21, while 450 microamps flow through CR19. If a negative input is applied, the automatic balancing action of the amplifier and the CR19-CR22 circuit maintains the amplifier output at zero.

If a positive input is applied, the current flow toward the input junction exceeds the amount that can be shunted through CR22, and the current must flow through the Feedback resistor. Thus, the current through R65c, in effect, shifts the operating point of the waveshaping network by +90°. If the C terminal is patched to -REF, the operating point of the waveshaping network is shifted by -90°, and the complete circuit produces an output of +cosine θ.

The current through R1d is summed with the shaped signal through R1b and the θ signal through R1c at the input to amplifier 2. The resulting signal is as shown in Figure 4.9d (for -cosine θ operation).

4.5 CIRCUIT DESCRIPTION

Refer to Schematic D00 016 0361 0S for the following description.

The DFG circuit is shown at the top of the drawing. The positive DFG consists of diodes CR1-1 through CR12-1 and CR16-1, CR17-1 and CR18-1, together with the associated resistor networks. The negative DFG is identical, except for the diode and bias polarities, and consists of diodes CR1-2 through CR12-2, CR16-2, CR17-2, and CR18-2, and the associated resistor networks. The diodes of each polarity are arranged in six groups, and each group is equipped with one or two rheostats for setting the bias level required by the group. A thermistor (for example, RT1-1) is provided in each biasing network for temperature compensation. The thermistors are in series with, and shunted by, fixed resistors that alter the tracking characteristics of the thermistor to match those of the diodes in the group.

The circuit consisting of CR13-1 and its associated bias network (R42-1 through R46-1 and RT6-1) switches the input signal to amplifier AR1 when the required positive input level is reached. Diode CR13-2 and its biasing network perform the same function for negative inputs.

The waveshaping circuit is shown at the lower left of the drawing. The amplifier shown between the J and F terminals is the external high-gain amplifier that must be patched when ±180° sine operation or cosine operation is required.

The operation of the waveshaping circuit has been explained in Paragraph 4.4.2 of this chapter. Diodes CR25-1, CR26-1, CR25-3 and CR26-2 provide temperature compensation for the biasing network, allowing the bias potential to track any temperature-caused variations in diodes CR19 through CR22.

The circuit consisting of resistors R72-1 and R72-2 and capacitor C8-1 and C8-2, shown at the lower right of the schematic, decouples the ±15 volt input power to the AR1 amplifier module.

4.6 SINE-COSINE DFG ADJUSTMENT PROCEDURE

The sine-cosine DFG card is provided with a total of 23 (including amplifier balance resistor) adjustable resistors. These controls permit the sinusoidal curve produced by the function generator to be adjusted in the field if long-term component aging causes minor deviations from the required curve. No adjustments should be attempted without sufficiently accurate test equipment.

4.6.1 Required Equipment

1. Service Shelf, Model 0.51.0382
2. Null Voltage Test Set or Equivalent
3. Test Patch Cords as Required

4.6.2 Preliminary Steps

1. *Temperature.* To calibrate the sine-cosine DFG within specifications, the ambient temperature should be 77°F within ±1°F. During the time when adjustments are being performed, the ambient temperature should not vary by more than ±0.3°F. Since the tray must be operated on a service shelf while adjustments are performed, these temperature requirements are imposed on the computer surroundings for the period of adjustment.

NOTE

For maximum accuracy, the specified ambient temperature range must be maintained when making generator adjustments. Failure to observe this precaution may result in excessive error. If the ambient temperature specifications cannot be met, it is suggested that the unit be returned to EAI for re-calibration.

2. *Equipment Warm-Up.* Prior to performing any adjustments, the equipment should be allowed to stabilize at operating temperature. This requires a minimum of one-half hour with power applied to the computer. Follow the manufacturer's instructions concerning warm-up and calibration of the test equipment.

4.6.3 Adjustment Steps

1. Place the tray to be adjusted on the service shelf (EAI 0.51.0382). Allow the unit to warm up for one-half hour, unless the unit has been operating in the computer.
2. Assure that computer reference is adjusted to 10 volts ±0.005 volt, and that +REF and -REF levels are precisely balanced to within ±1.0 ma.
3. Patch the unit as shown in Figure 4.11. Carefully balance amplifiers A1, A2 and A3.

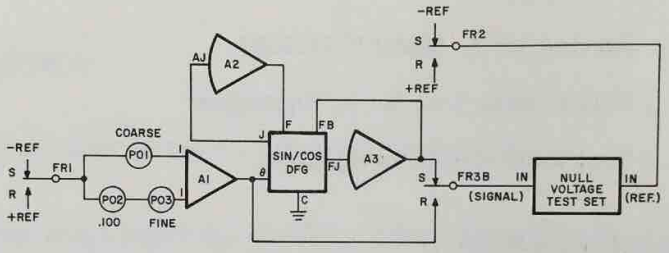


Figure 4.11. Sine-Cosine DFG Adjustment Circuit

4. Connect a test probe from the null voltage test set to TP1. Set the test set to 0.0000 volt, and adjust R47 until the voltage indicated by the test set is equal to 0.0000 volt ±0.2 millivolt. Amplifier AR1 is now accurately balanced.
5. Remove the test lead connected to TP1. Connect the null voltage test set input terminal to the arm of FR3.
6. Place function relay 1 in the S position.
7. Set the controls on the test set to the first input voltage listed in Table 4.1, and place FR2 and FR3 in the S positions. Adjust P01 and P03 until the test set indicates a null within ±0.05 millivolt.
8. Set the controls on the test set to the first output voltage listed in the table. Place FR2 and FR3 in their alternate R (+REF) positions, and adjust the appropriate potentiometer on the DFG until the test set indicates a null within 0.05 millivolt.
9. Repeat Steps 7 and 8 for adjustments 2 through 5. To perform adjustment 6, remove the lead from the arm of FR3 after setting the input level with P01 and P03, and connect the input of the test set to TP1. Set the test set to the indicated output voltage, and set the potentiometer listed for adjustment 6 until the test set indicates a null.

Table 4.1. -DFG Adjustments

Adjustment	Input Voltage (FR2 R)	Output Voltage (FR2 S)	Potentiometer
1	+0.800	-2.7557	R8-2
2	+1.270	-4.2887	R15-2
3	+1.790	-5.8481	R22-2
4	+2.670	-8.0268	R31-2
5	+3.690 +3.690	-9.600 -9.600	Coarse: R40-2 Fine: R41-2
6*	+3.800 +3.800	-1.500 -1.500 ±0.1 MV	Coarse: R45-2 Fine: R46-2
7	+9.000	0.0000	R70-2
8	+4.410 +4.410	-9.9935 -9.9935	Coarse: R63-2 Fine: R64-2

**See Text, Step 9.*

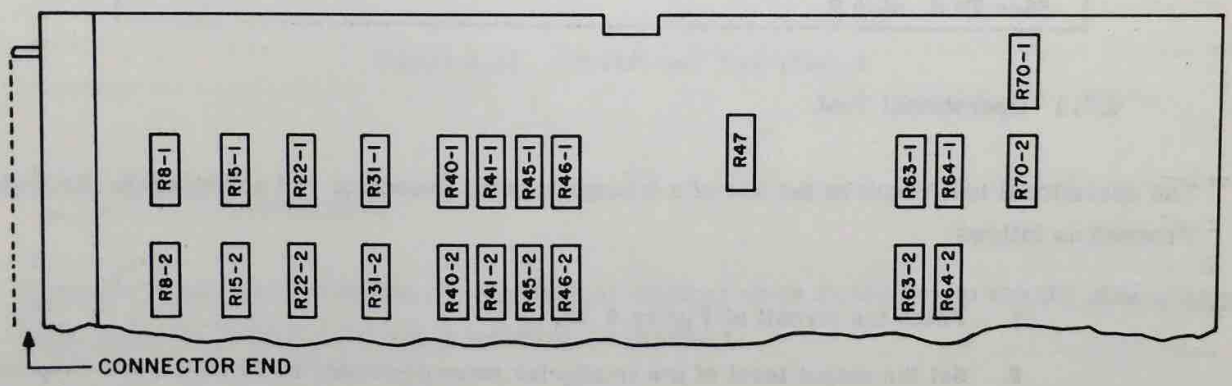


Figure 4.12. Adjustment Locations

10. Remove the load from TP1, and reconnect the test set input to the arm of FR3. Perform adjustments 7 and 8, using the procedures given in Steps 7 and 8.

11. This completes the adjustment of the -DFG circuit.

12. Interchange the connections to the S and R terminals of FR2. Place FR1 in the S position. Repeat Steps 7 through 10, using the data listed in Table 4.2.

13. This completes the sine-cosine DFG adjustment procedure. When replacing the unit in the patch bay, use care to assure that the tray is not subject to mechanical shock, since the control setting may be disturbed.

4.7 TESTING AND TROUBLESHOOTING

This paragraph provides a procedure for testing the sine/cosine DFG trays for proper operation, and includes a table of selected input/output voltages to verify the calibration accuracy.

Table 4.2. +DFG Adjustments

Adjustment	Input Voltage	Output Voltage	Potentiometer
1	-0.800	+2.7557	R8-1
2	-1.270	+4.2887	R15-1
3	-1.790	+5.8481	R22-1
4	-2.670	+8.0268	R31-1
5	-3.690 -3.690	+9.600 +9.600	Coarse: R40-1 Fine: R41-1
6*	-3.800 -3.800	+1.500 +1.500 ±0.1 MV	Coarse: R45-1 Fine: R46-1
7	-9.000	0.0000	R70-1
8	-4.410	+9.9935	Coarse: R63-1
-4.410	+9.9935	+9.9935	Fine: R64-1

**See Test, Step 9.*

4.7.1 Operational Test

The operational test requires the use of a triangular wave generator and a dual-beam oscilloscope. Proceed as follows:

1. Patch the circuit of Figure 4.13.
2. Set the output level of the triangular wave generator to 18 volts peak-to-peak, with a frequency of 500 cps.
3. Adjust the vertical positioning controls of the oscilloscope so that the channel A and channel B origins are on the center horizontal axis of the screen. Set the triggering controls of the oscilloscope for a positive external trigger, and adjust the trigger level control so that the sweep begins when the triangular waveform crosses the zero horizontal axis.
4. Observe the display. If the unit is operating correctly, the display should resemble Figure 4.14a.
5. Patch the C terminal to + Reference. A -cosine waveform resembling Figure 4.14b appears if the unit is operating properly.
6. Patch the C terminal to - Reference, and a +cosine waveform similar to Figure 4.14c appears on the oscilloscope if the unit is operating correctly.

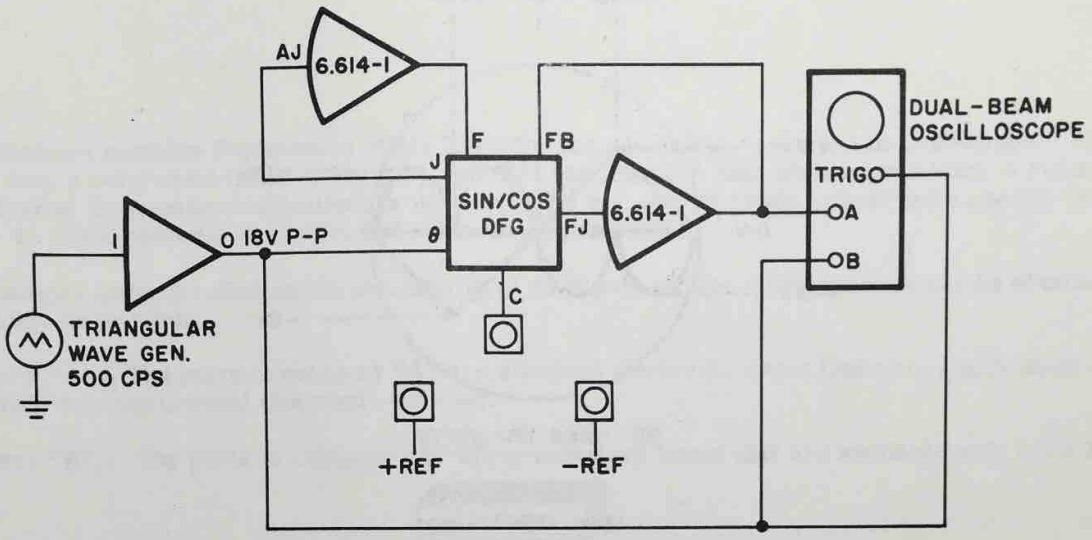


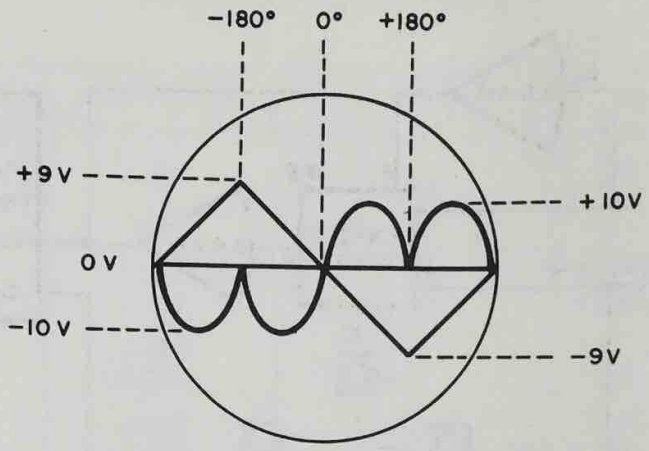
Figure 4.13. Operational Test Circuit

4.7.2 Troubleshooting

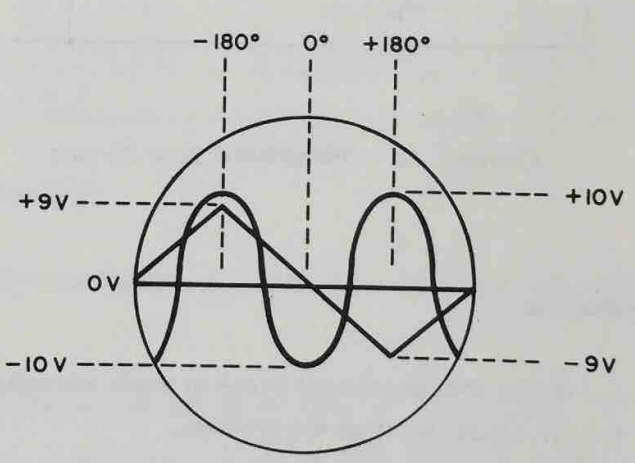
If trouble is encountered during the operational check or when attempting to use the sine-cosine DFG, refer to Table 4.3 for aid in isolating the problem.

Table 4.3. Troubleshooting

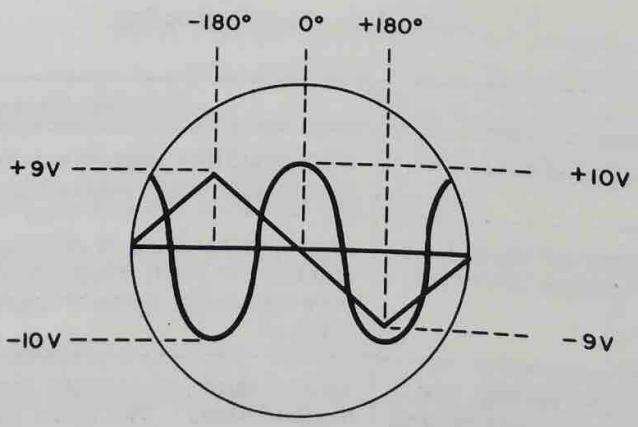
Symptom	Probable Cause
Sine function distorted near ±90°.	AR1 amplifier module unbalanced or defective; adjustment required (see Paragraph 4.6).
Sine function distorted beyond 90° ; -cosine function distorted from 0° to -180°.	Improper patching of external waveshaping amplifiers; faulty adjustment of waveshaping network; faulty diode or resistor in waveshaping network.
Error in sinusoidal function that cannot be corrected by performing adjustment procedure.	Leaky, open, or shorted segment or waveshaping diode. The faulty diode can be localized by noting the input voltage where the error begins, then referring to the schematic and setup tables (Tables 4.1 and 4.2).



(a) -Sine Waveform



(b) -Cosine Waveform



(c) +Cosine Waveform

Figure 4.14. Operational Test Waveforms

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	J1	Connector Block: (Yellow)	00 542.1545-1	B
2	R1,2	Resistor, Precision	00 638.1050-1	B
3	R3	Resistor, Precision	00 638.1050-2	B
4		Connector Block: Lettered (SIN-COS-GEN 0.16.0360)	00 542.1552-4	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
SIN-COS GENERATOR

MODEL NO.
0.16.0360-0 Sh. 1 of 1 Sh.

1

DATE 12/ 14 /67

2-4-

2-43-21

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	AR1	Integrated Circuitry: Operational Amplifier	00 592.0133-0	B
2	C1	Capacitor, Fixed, Ceramic: 180 pf ±5%, 100V (Vitramon VY10C181JE or equal)	00 515.0420-2	A
3	C2	Capacitor, Fixed, Ceramic: 820 pf ±5%, 50V (Vitramon VY15C821JE or equal)	00 515.0446-0	A
4	C3	Capacitor, Fixed, Ceramic: 200 pf ±5%, 200V (Erie 835 or equal)	00 511.1201-2	A
5	C4	Capacitor, Fixed, Film: 5100 pf ±5%, 200V (Sprague 192P or equal)	00 522.1512-0	A
6	C5,6	Capacitor, Fixed, Mica: 330 pf ±1%, 100V (Elmenco 4CRDM10F-331-GO-100V or equal)	00 519.0091-0	A
7	C7	Capacitor, Fixed, Ceramic: 750 pf ±5%, 100V (Vitramon VY15C751JE or equal)	00 515.0445-0	A
8	C8	Capacitor, Fixed, Electrolytic: 100 uf ±20%, 20V (Sprague 150D or equal)	00 517.1107-3	A
9	C9	Capacitor, Fixed, Ceramic: 1200 pf ±5%, 50V (Vitramon VY15C122JE or equal)	00 515.0447-0	A
10	CR1 thru 26	Diode	00 614.0199-1	B
11	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-23 or equal)	0 0 542.0419-0	A
12	Q1	Transistor	00 686.0330-0	B
13	Q2	Transistor	00 686.0331-0	B
14	R1-a,b,c,d	Resistor, Precision: Matched Set of 4	00 640.0134-0	B
14a	R2,9,16	Resistor, Fixed, Film: 25K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-1	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
SIN-COS GENERATOR

MODEL NO.
0.16.0361 Sh. 1 of 6 Sh.

DATE 4 / 29 / 68

Z-4-22

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
15	R3	Resistor, Fixed, Film: 869.1K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0782-5	A
16	R4	Resistor, Fixed, Film: 20.48K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-0	A
17	R5	Resistor, Fixed, Film: 518.3K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0782-4	A
18	R6	Resistor, Fixed, Film: 207K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0781-1	A
19	R7	Resistor, Fixed, Film: 30.8K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-4	A
20	R8,47	Resistor, Variable, Wirewound 20K ohms (Bourns 3500-S or equal)	00 643.3203-4	A
21	R10	Resistor, Fixed, Film: 413.5K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0781-4	A
22	R11	Resistor, Fixed, Film: 4.671K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-4	A
23	R12	Resistor, Fixed, Film: 268K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0781-3	A
24	R13	Resistor, Fixed, Film: 80.42K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-8	A
25	R14	Resistor, Fixed, Film: 6.95K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-5	A
26	R15	Potentiometer	00 642.0731-3	B
27	R17	Resistor, Fixed, Film: 219.9K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0781-2	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 12/ 16 / 67

UNIT TITLE
SIN-COS GENERATOR

MODEL NO.
0.16.0361 Sh. 2 of 6 Sh.

4-A1-5
2-4-23

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
28	R18	Resistor, Fixed, Film: 2.571K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-1	A
29	R19	Resistor, Fixed, Film: 108.3K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0781-0	A
30	R20	Resistor, Fixed, Film: 54.35K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-5	A
31	R21	Resistor, Fixed, Film: 3.66K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-3	A
32	R22	Potentiometer	00 642.0696-2	B
33	R23,42,50	Resistor, Fixed, Film: 10K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 632.1002-2	A
34	R24	Resistor, Fixed, Film: 94.93K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 632.0780-9	A
35	R25	Resistor, Fixed, Film: 71.07K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-9	A
36	R26	Resistor, Fixed, Film: 55.19K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-6	A
37	R27	Resistor, Fixed, Film: 560.3 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-7	A
38	R28	Resistor, Fixed, Film: 26.59K ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-2	A
39	R29	Resistor, Fixed, Film: 15.66K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-8	A
40	R30	Resistor, Fixed, Film: 910 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: SIN-COS GENERATOR

DATE 12 / 16 / 67

MODEL NO. 0.16.0361

2-4-24

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
41	R31	Resistor, Variable, Wirewound 500 ohms (Bourns 3500-S or equal)	00 643.3501-4	A
42	R32	Resistor, Fixed, Wirewound, Precision	00 638.1193-0	B
43	R33	Resistor, Fixed, Film: 2.863K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-3	A
44	R34	Resistor, Fixed, Film: 90.4 ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-1	A
45	R35	Resistor, Fixed, Film: 12.84K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-7	A
46	R36	Resistor, Fixed, Film: 66.8 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-0	A
47	R37	Resistor, Fixed, Film: 2.863K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-2	A
48	R38	Resistor, Precision:	00 638.1193-1	B
49	R39	Resistor, Fixed, Film: 193 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-3	B
50	R40	Resistor, Variable, Wirewound 100 ohms ±5%, 0.6W @70°C T.C. ±70 ppm/°C (Bourns 3500-S or equal)	00 643.3101-4	A
51	R41,46,64, 70	Potentiometer	00 642.0731-0	B
52	R43	Resistor, Fixed, Film: 11.29K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-6	A
53	R44	Resistor, Fixed, Film: 624 ohms ±0.5%, 1/8W (Int. Resistance CEA-TO or equal)	00 634.0778-8	A
54	R45	Potentiometer	00 642.0696-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 12/ 16 / 67

UNIT TITLE
SIN-COS GENERATOR

MODEL NO.
0.16.0361 Sh. 4 of 6 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
55	R48	Resistor, Fixed, Composition: 7.5 meg ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0755-0	A
56	R49	Resistor, Fixed, Composition: 15 megohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0156-0	A
57	R51a,R51b	Resistor, Precision: Matched Pair	00 640.0133-0	B
58	R52	Resistor, Fixed, Composition: 1.5K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0152-0	A
59	R53,54	Resistor, Fixed, Composition: 100 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0101-0	A
60	R55	Resistor, Fixed, Film: 414.5 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-6	A
61	R56	Resistor, Fixed, Film: 199.2 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-4	A
62	R57	Resistor, Fixed, Film: 56.53K ohms ±5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-7	A
63	R58	Resistor, Fixed, Film: 117.7 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-2	A
64	R59	Resistor, Fixed, Film: 150.2 ohms ±0.5%, 1/2W (Int. Resistance Corp. CEA-TO or equal)	00 634.0782-0	A
65	R60	Resistor, Fixed, Film: 17.84K ohms ±5%, 1/2W (Int. Resistance Corp. CEA-TO or equal)	00 634.0779-9	A
66	R61	Resistor, Fixed, Film: 1.717 ohms ±0.5%, 1/2W (Int. Resistance Corp. CEA-TO or equal)	00 634.0780-1	A
67	R62	Resistor, Fixed, Film: 338 ohms ±0.5%, 1/8W (Int. Resistance Corp. CEA-TO or equal)	00 634.0778-5	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 12/ 16 / 67

UNIT TITLE
SIN-COS GENERATOR

MODEL NO.
0.16.0361 Sh. 5 of 6 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
68	R63	Resistor, Variable, Wirewound 2K ohms ±5%, 0.6W @70°C T.C. ±70 ppm/°C (Bourns 3500-S or equal)	00 643.3202-4	A
69	R65a,R65b, R65c	Resistor, Precision: Matched Set of 3	00 640.0132-0	B
70	R67	Resistor, Precision	00 638.1193-2	B
71	R6,7	Resistor, Precision	00 638.1193-3	B
72	R68	Resistor, Precision	00 638.1193-4	B
73	R69	Resistor, Precision (Padder): Value to be determined at the time of manufacture.	Order by Description	B
74	R71	Resistor, Precision:	00 638.0588-0	B
75	R72	Resistor, Fixed, Composition: 10 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0100-0	A
76	RT1	Thermistor:	00 646.0110-0	B
77	RT2	Thermistor:	00 646.0111-0	B
78	RT3	Thermistor:	00 646.0112-0	B
79	RT4	Thermistor:	00 646.0113-0	B
80	RT5,7	Thermistor:	00 646.0114-0	B
81	RT6	Thermistor:	00 646.0115-0	B
		0.16.0361-1 The 0.16.0361-1 is identical to the 0.16.0361-0 less item 10.		

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
SIN-COS GENERATOR

MODEL NO.
0.16.0361 Sh. 6 of 6 Sh.

1

DATE 12 / 16 / 67

M446

APPENDIX 2

DRAWINGS

This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

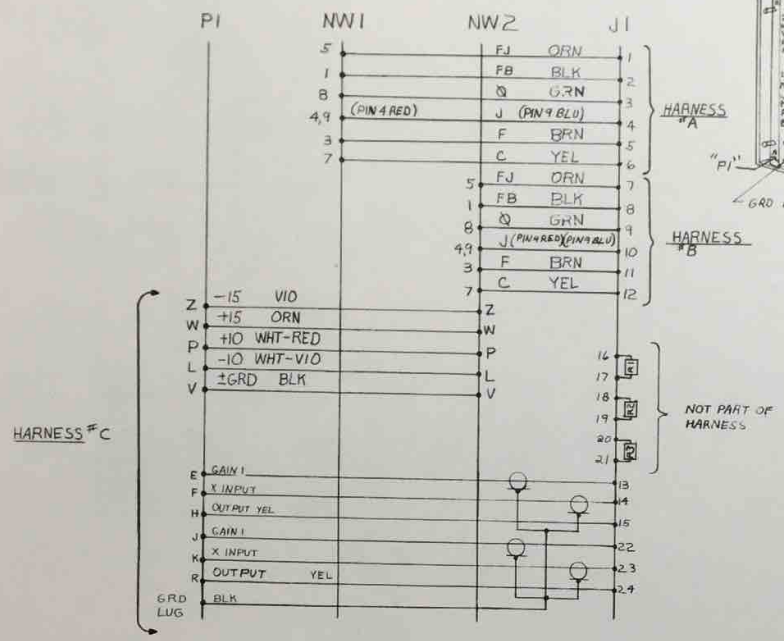
EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

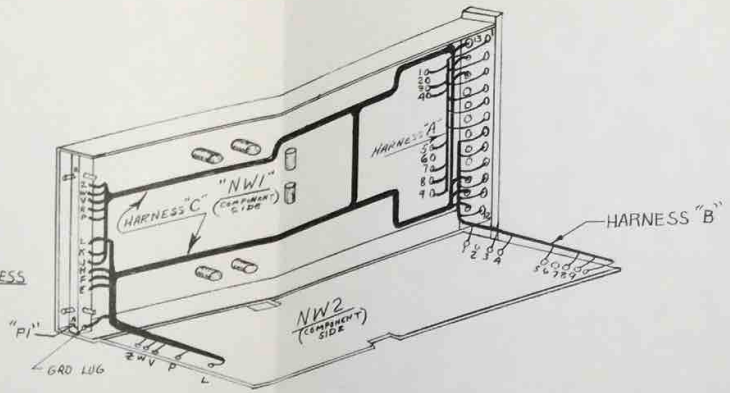
INDEX

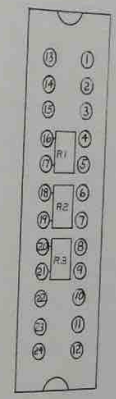
Unit or Component	Type of Drawing	Drawing Number
0.16.0360 Sine-Cosine Generator	Assembly W/ Wiring	D00 016 0360 0A
0.16.0361 Sine-Cosine Generator	Schematic	D00 016 0361 0S

NOTES

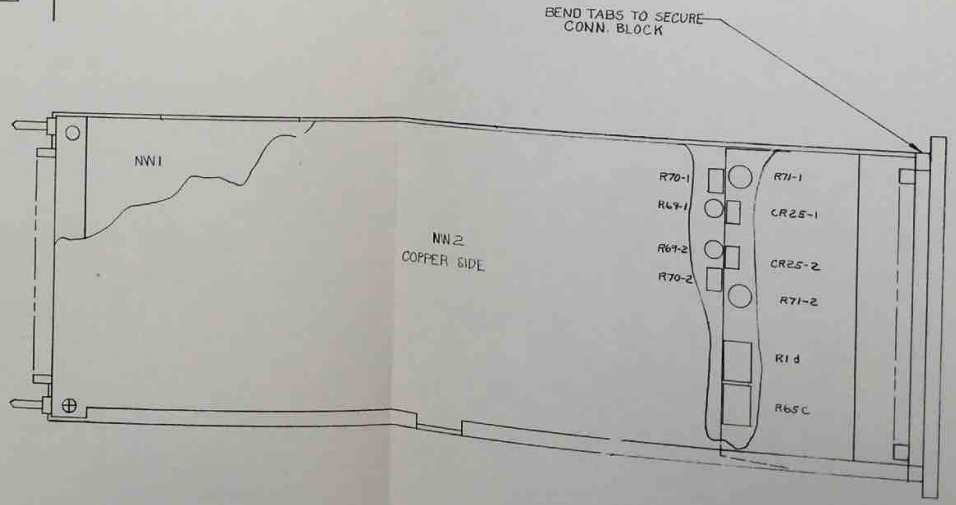
1. CABLES MUST BE OF SUFFICIENT LENGTH SO THAT UNIT MAY BE EASYLY SERVICED.
2. ⊗ DENOTES LOCATION OF CONTACTS (ITEM 7) PER DETAIL 'A'.
3. COAX TO BE TYPE 180 M16000 10.
   PHV WIRE TO BE #22 AWG.





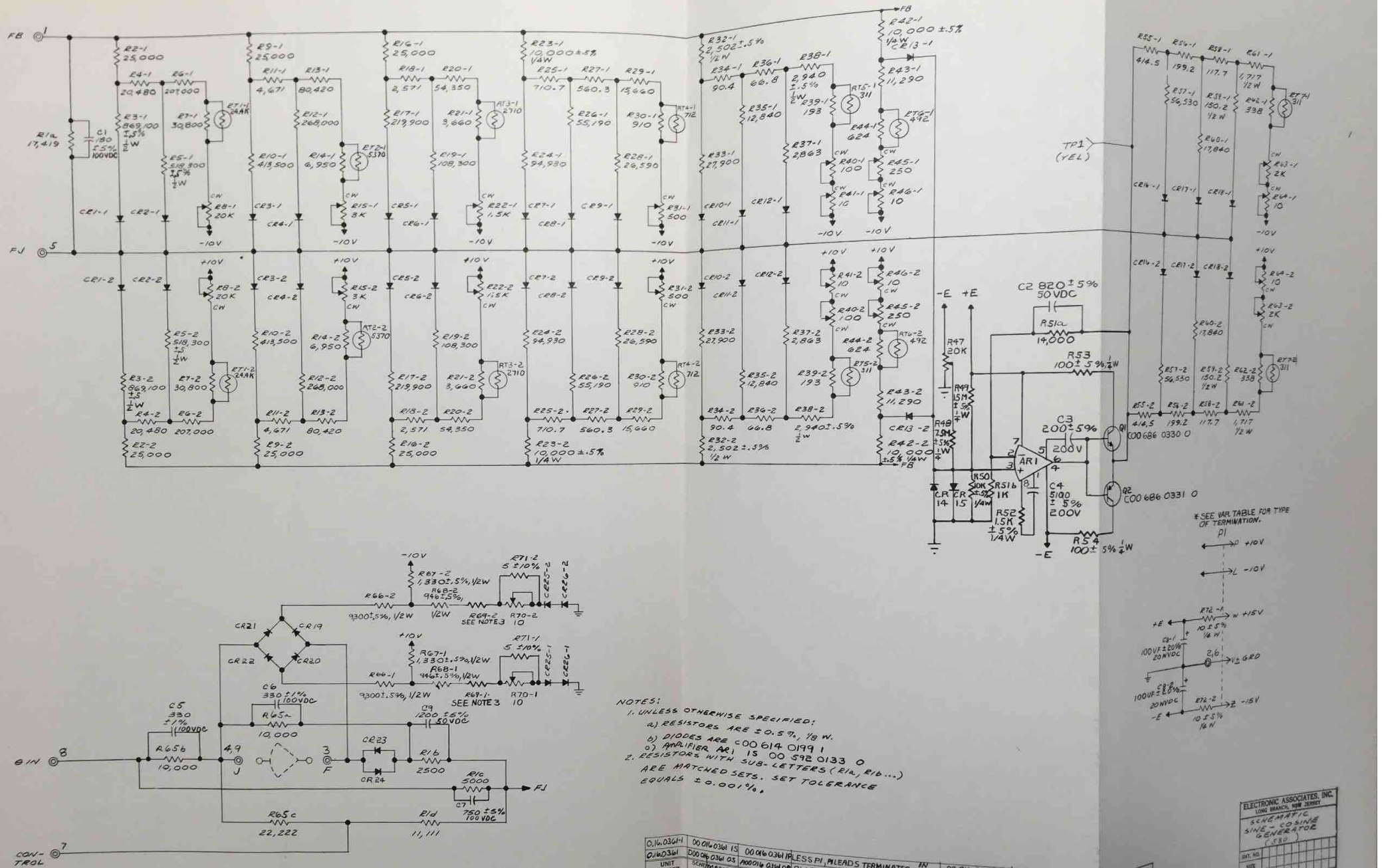


CONN. BLOCK REAR VIEW



CONN. BLOCK FRONT VIEW

EAI
ASSEMBLY W/WIRING INFO GENERATOR, SIN-COS (R-V)
DWG. NO. D0018039-04
SIZE
REV. NO.



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTORS ARE ±0.5%, 1/8 W.
   b) DIODES ARE CO0 614 0199 1
   c) AMPLIFIER AR1 IS 00 592 0133 0
2. RESISTORS WITH SUB-LETTERS (R1a, R1b...) ARE MATCHED SETS. SET TOLERANCE EQUALS ±0.001%.

0,16,0361-1	00 016 0361 1S	00 016 0361 1P	LESS P1, P LEADS TERMINATED AT VELETS	00 016 0360 0P	477508
0,16,0361	D00 016 0361 0S	A00 016 0361 0P	P1 LEADS TERMINATED AT CONN.	A00 016 0360 0P	477508
UNIT NUMBER	SCHEMATIC NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON	PROJECT NUMBER

TABLE OF UNIT NUMBERS

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY
SCHEMATIC SINE-COSINE GENERATOR (580)
DWG. NO. D00 016 0361 0S
SIZE
REV. NO.
PROJECT NO. 477508
SHEET 1 OF SHEETS

CHAPTER 5

THE MANUAL DIODE FUNCTION GENERATOR GROUP

5.1 INTRODUCTION

This chapter describes the components which comprise the manual diode function generator (MDFG) group. A flexible series of expansions permits the addition of from 1 to 8-10-segment MDFG circuits, together with setup facilities and amplifiers. The MDFG components are housed in drawers at the right side of the computer (Figure 5.1) with up to four MDFG circuits in each drawer. A setup circuit is included in the lower drawer.

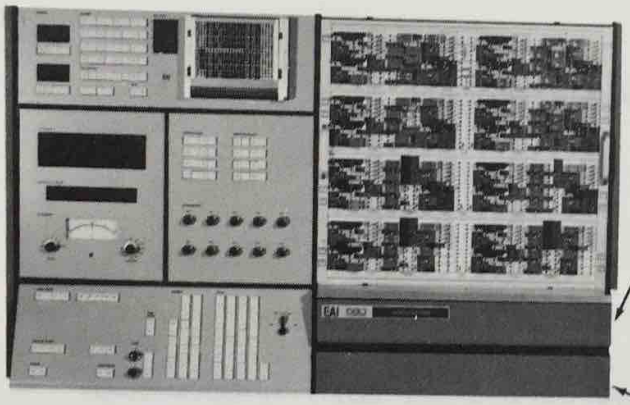
Patch panel access to the MDFG circuits is provided by wired-through trays (0.16.0358) or by wiring in the 0.7.0148 and 0.7.0150 Multipliers, 0.16.0355 Quad Log DFG tray or the 0.16.0360 Sin/Cos tray (Figure 5.2). These trays mount in position 5 of fields 4 through 7 (Figure 5.3).

The following major components comprise the MDFG group:

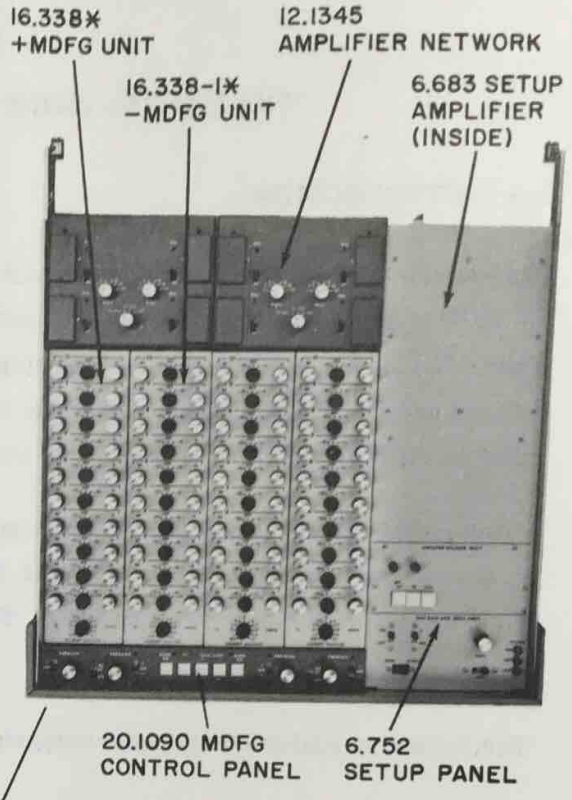
1. MDFG Networks 0.16.0338 (+) and 0.16.0338-1 (-)
2. Dual Amplifier Network 0.12.1345
3. MDFG Control Panel 0.20.1090
4. MDFG Setup Amplifier Network 0.6.0815

Each drawer contains a 0.20.1090 Control Panel and up to four MDFG expansion groups (0.2.0961 and 0.2.0961-1). The lower drawer also includes the 0.6.0815 Setup Amplifier Network. If less than 4-10-segments are required, the upper drawer will be empty and can be used for storing patching components. Expansion group 0.2.0961 adds a 0.16.0338 +MDFG Unit, two encapsulated differential amplifiers (0.6.0681-1), and 0.16.0358 Readout Tray (if required). Expansion group 0.2.0961-1 adds the same components, except that a 0.16.0338-1 MDFG Unit is substituted for the 0.16.0338 +MDFG Unit. Figure 5.4 is a layout drawing indicating the component supplied with each expansion group and the additional components required. The expansion flexibility of separate units is combined with the reliability and production economy of multiple purpose units by these groups. A 0.12.1345 Dual Amplifier Network mounts in the back of the drawer, and provides interconnections for the 0.6.0681-1 Amplifier Modules supplied with two MDFG expansion groups.

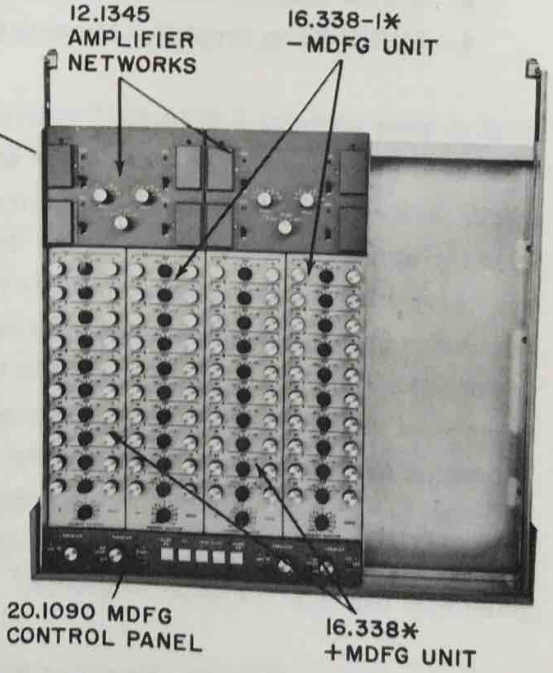
The 0.6.0815 MDFG Setup Amplifier Network includes a 0.6.0615-1 Amplifier Card. This card is described in detail in Section 1, Chapter 1. Therefore, the amplifier card is illustrated and described only in terms of its input and output connections in this chapter.



(a) *MDFG Drawer Area of Computer Console*

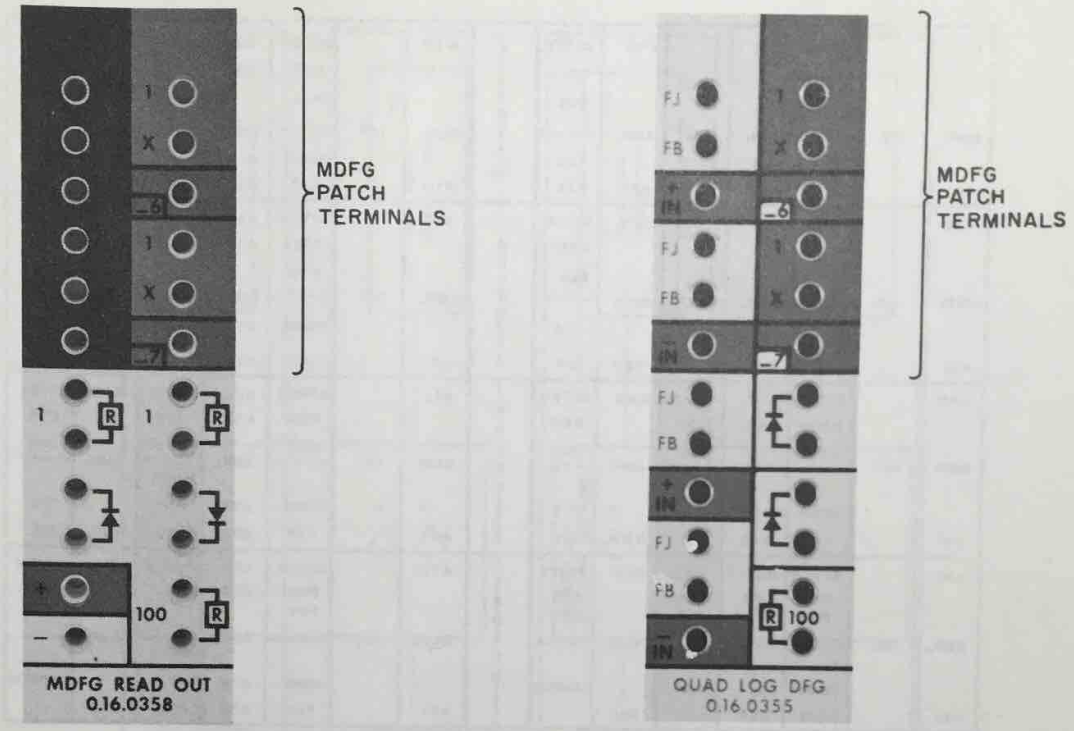


(b) *Lower Drawer*



(c) *Upper Drawer*

Figure 5.1. Major MDFG Components



(a) Separate Patch Block

(b) MDFG Patching Terminations on a Typical Multipurpose Tray

Figure 5.2. MDFG Patching Area

Each MDFG unit is capable of providing a 10-segment function of an input. The adjacent MDFG units that share a 0.12.1345 Network may be cascaded to provide a 20-segment function. The setup circuit contains an amplifier and additional circuits that permit the amplifier to perform as a track/store circuit for MDFG unit setup, or as a ramp-generating integrator for function checking. A plotter may be connected to terminals provided on the panel of the setup circuit for function checking.

5.2 OPERATION

Details of function setup are provided in the 580 Reference Handbook (EAI Publication Number 00 800.2055-0) and are not duplicated in this manual. A procedure for setting up a specific test function is included in Paragraph 5.6.2. The purpose of each of the controls is described in Paragraph 5.5, which also explains the associated circuitry.

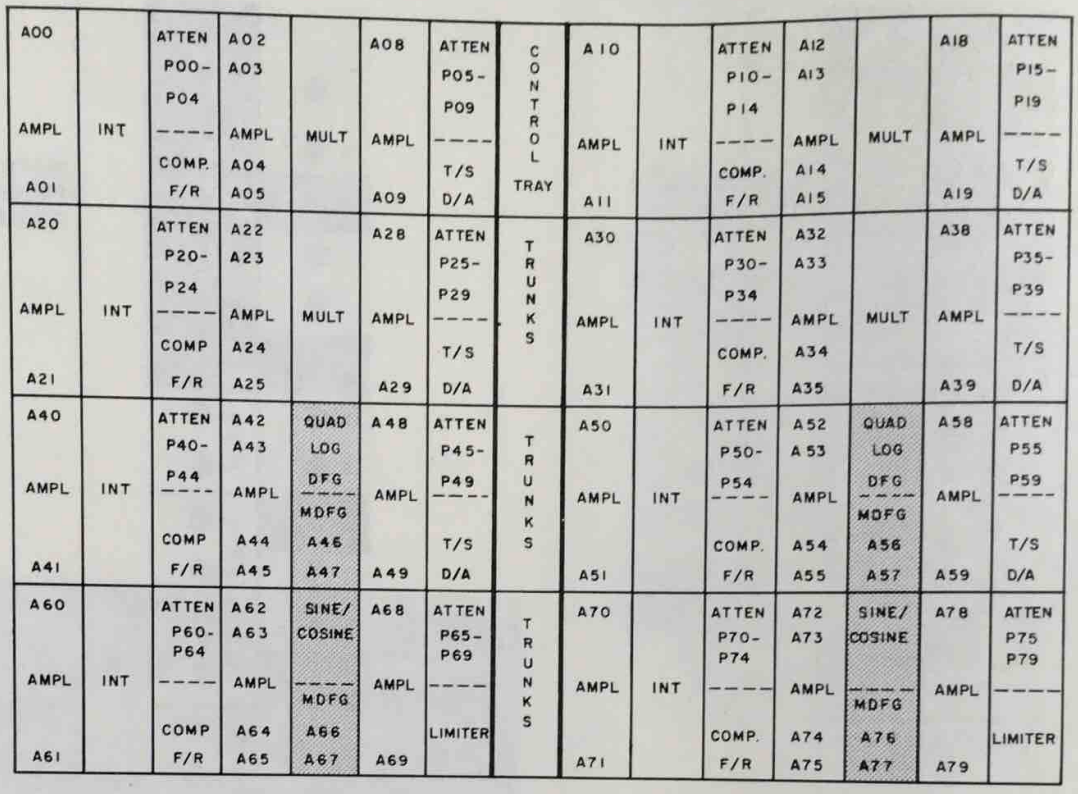


Figure 5.3. Patch Panel Layout Showing MDFG Patching Tray Locations

5.2.1 Patching

Patching for the three MDFG modes is illustrated in Figure 5.5. Figure 5.5a shows the patching for a pair of MDFG units operated in the *10-segment* mode; Figure 5.5b shows the patching for *20-segment* mode. When the MDFG units are not in use, one amplifier associated with each unit may be operated independently, as shown in Figure 5.5c.

NOTE

When using the MDFG amplifiers as independent inverters, assure that the MULT switch on the associated 0.12.1345 Network is placed in the 1 position. A gain error results if this switch is placed in any other position.

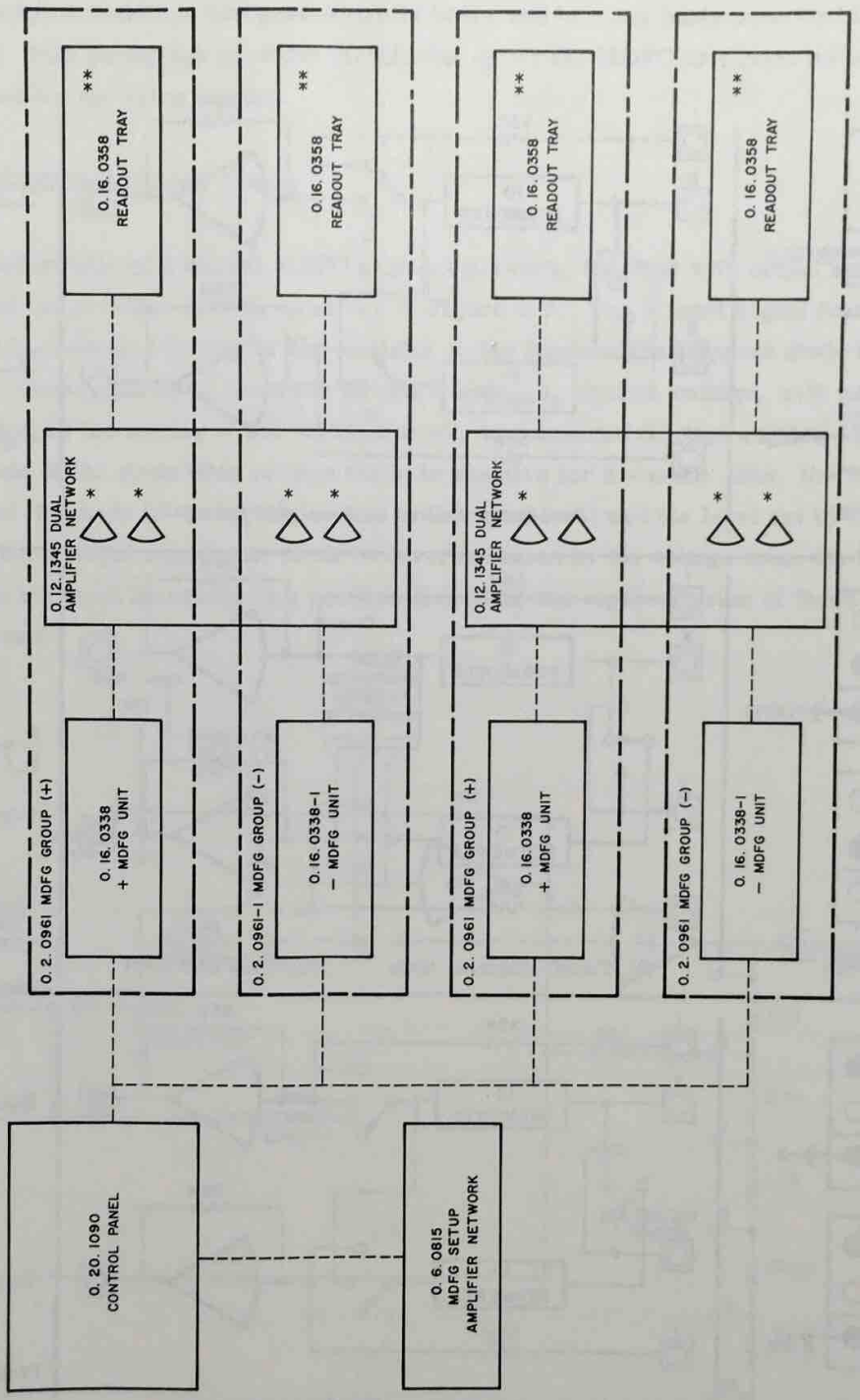


Figure 5.4. Typical MDFG Drawer Fully Expanded

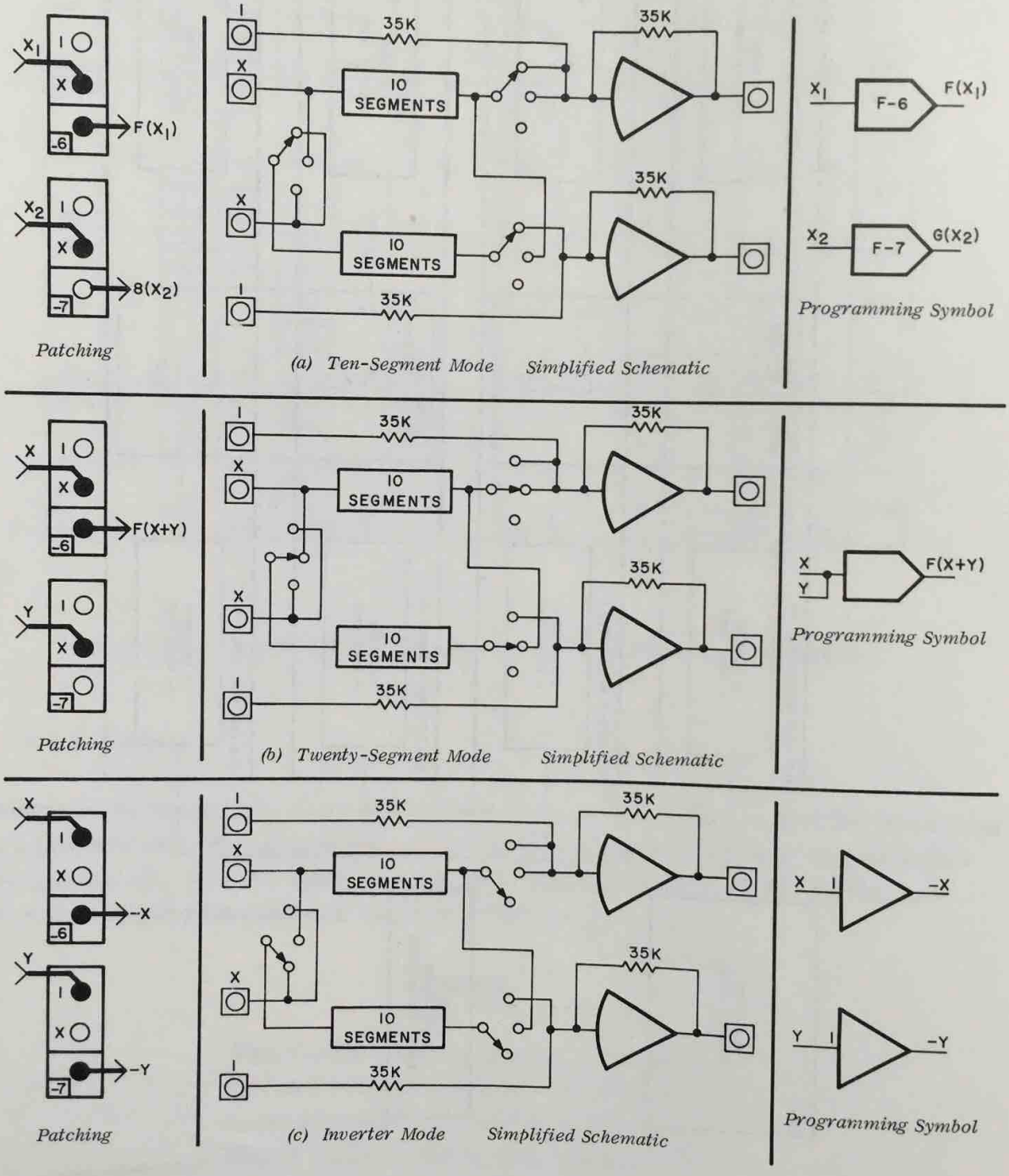


Figure 5.5. MDFG Patching and Programming Symbols

5.3 THEORY OF OPERATION

The basic theory of diode function generators is described in many basic texts and is not described here. This paragraph provides circuit theory for the MDFG unit (with its associated amplifiers) and for the setup circuit.

5.3.1 MDFG Unit Circuit Theory

A simplified schematic of a typical MDFG segment network, together with output summing amplifiers and the parallax circuit, is shown in Figure 5.6. The X input signal from the patching tray is connected through a 25k resistor to the anode of the segment diode (the + unit is shown; diode polarity is reversed for the - unit). A negative voltage, with an amplitude determined by the setting of the breakpoint pot, is connected through another 25k resistor to the anode of the diode (this voltage would be positive for a - unit): thus, the voltage at the anode of the diode is the algebraic sum of the input level and the level set by the breakpoint pot. With no input signal, the diode is reverse biased by the voltage from the breakpoint pot. As the input increases in a positive direction, the algebraic sum of these voltages approaches zero.

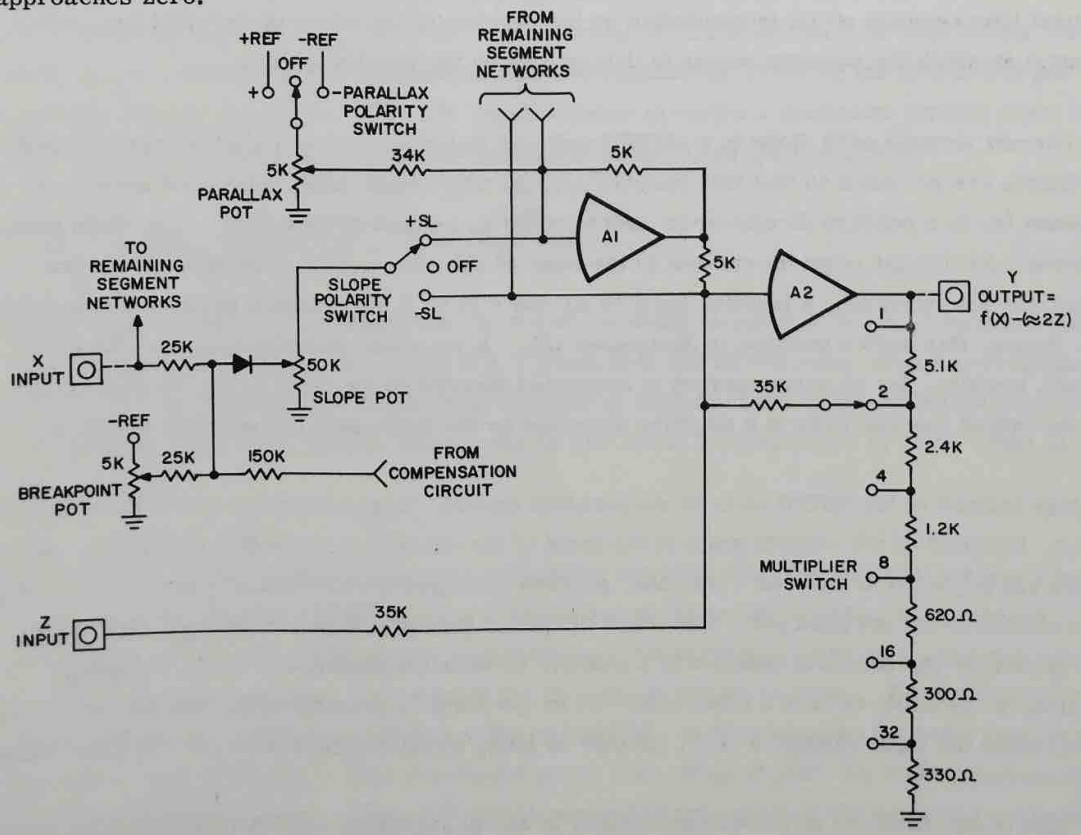


Figure 5.6. Segment Network and Output Amplifier, Simplified Schematic

If the diode were a perfect switch, it would begin to conduct as soon as the input sum went positive by the slightest amount. In practice, the diodes have a nearly constant voltage drop equal to approximately one-half volt, while conducting. This diode characteristic requires that the input signal exceed the desired breakpoint voltage by about one volt to cause the network to conduct. To compensate for this characteristic, a circuit is provided that adds a forward bias current to the junction of the input-breakpoint summing point. This current effectively shifts the summing point in a positive direction by the required amount. The circuit producing this compensating voltage performs the additional function of compensating the diodes against temperature variations. Since the characteristics of the diodes vary slightly with changes in temperature, the compensating bias is made to vary in the same proportion. Thus, when the MDFG is properly set up, the resultant output function remains accurate over the specified temperature range.

The current through the conducting diode flows through the wiper of the slope pot. The setting of this potentiometer determines the amount of current that flows to ground and the amount that flows toward the output amplifiers. Thus, the proportion of the function slope contributed by a segment (*the segment slope*) is controlled by the position of the wiper of the slope pot, while the point at which the segment begins is determined by the breakpoint pot.

The current through each diode in a +MDFG unit is a *positive* current. Two cascaded output amplifiers are provided so that this positive current may either cause the output function to increase (go in a positive direction) or decrease (go in a negative direction). The slope polarity switch directs the segment current to the input of the appropriate amplifier. Since the amplifiers are cascaded, a positive input to A1 (on Figure 5.6) causes a positive output from A2. Hence, this switch position is designated +SL. If the slope polarity switch is placed in the -SL position, the segment current is connected directly to the input of A2, by passing A1, and the output function goes in a negative direction as the input goes increasingly positive.

Another feature of the MDFG units is the parallax circuit. A potentiometer and a three position switch, mounted on the control panel at the front of the drawer, provide this capability. When the switch is placed in the + or - position, positive or negative reference voltage, respectively, is connected to the parallax pot. The wiper of the pot then provides a fixed input current to A1, offsetting the complete function in a positive or negative direction. Thus, the output function can be made to have a value from +10 to -10 volts (depending on the position of the pot wiper) when the input voltage is zero, as well as being offset by this amount for all input values.

The gain of amplifier A2 is selectable, from 1 to 32, in six steps. The selected gain (or multiplier) for the amplifier equals a maximum permissible segment slope, in volts per volt input.

For example, with the multiplier switch in the 2 position, as shown on Figure 5.6, the maximum segment slope that may be obtained is approximately 2 volts per volt input. The multiplier switch is normally set at the minimum value necessary to generate the required slope change, since the resolution of the slope pot is inversely proportional to the multiplication factor.

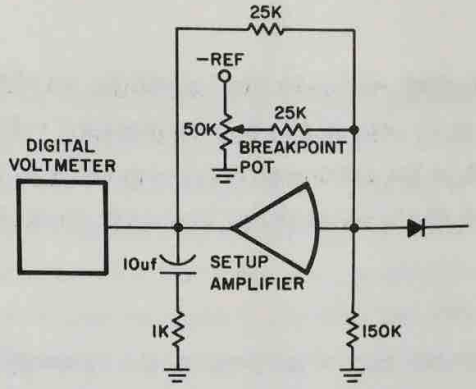
A 35k resistor connected to the input of A2 permits the subtraction of an input (designated Z on Figure 5.6) from the function. This resistor is matched with the 35K feedback resistor for A2 so that A2 acts as a unity gain inverter for the Z input, *if the multiplier switch is in the 1 position*. The multiplication factor applied to the Z signal results in a gain error unless the multiplier switch is in the 1 position, since the higher gain positions have a ±5% permissible gain error.

A central slope network is included in the MDFG as a part of the segment 1 circuit. If the slope polarity switch for segment 1 is placed in the +CS or -CS position, the segment 1 diode is switched out of the circuit and the input signal is connected through a 10k resistor directly to the wiper of the segment 1 slope pot. The setting of this slope pot thus determines the slope of the function when no segment diodes are conducting, allowing the function to pass smoothly through the origin. The 10k input resistor provides a maximum central slope of about 3.5 volts per volt input when the multiplier switch is in the 1 position.

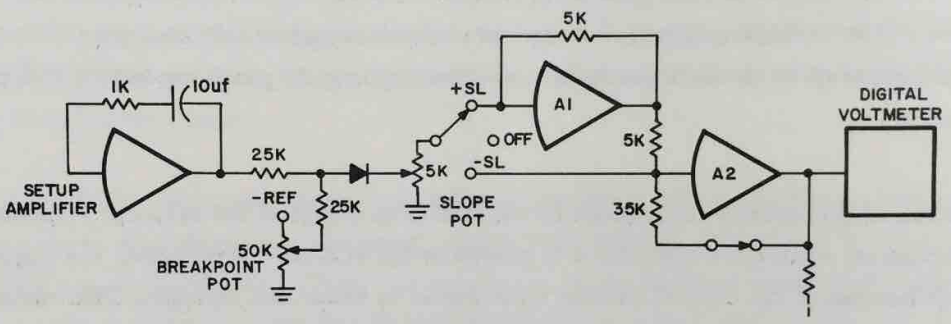
5.4.2 Control Panel and Setup Circuit Theory

Switches on the control panel provide control of the setup circuit and permit complex functions to be set up easily and rapidly. Figure 5.7 illustrates the MDFG setup circuit arrangements with simplified schematics. Many relay and switch contacts have been eliminated from the simplified drawings for clarity; these contacts are shown and explained in more detail in Paragraph 5.5.

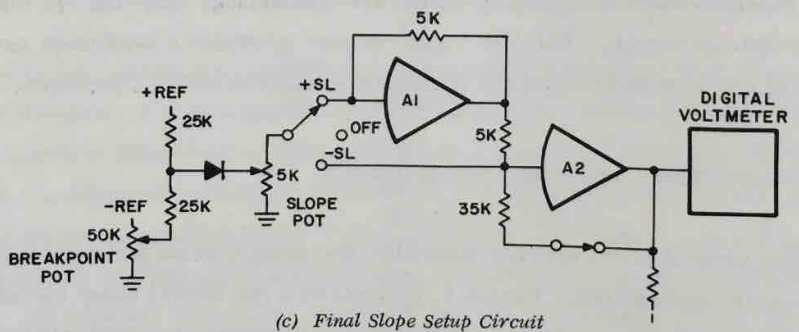
Figure 5.7a shows the equivalent breakpoint setup circuit. The X input from the patch panel is disconnected from the MDFG unit, and the output of the setup amplifier is connected as an input to the MDFG unit. The resulting circuit uses the setup amplifier as a unity gain amplifier, receiving the potential from the wiper of the breakpoint pot as an input. The output of the setup amplifier, connected to the digital voltmeter (DVM), is thus equal to the input required to cause the diode to conduct. The breakpoint pot is then adjusted until the DVM indicates the required breakpoint value. The capacitor connected to the output of the amplifier charges to this value through the 1k resistor.



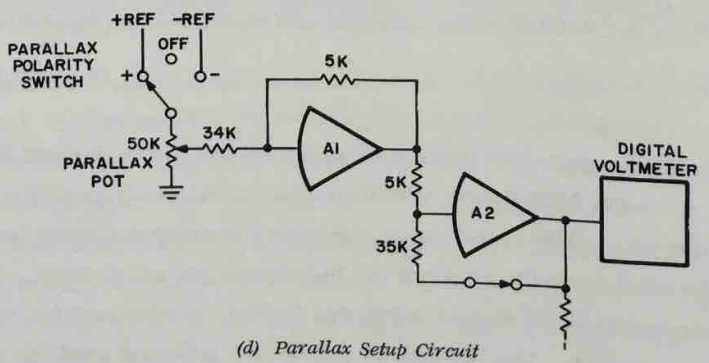
(a) Breakpoint Setup Circuit



(b) Slope Setup Circuit



(c) Final Slope Setup Circuit



(d) Parallax Setup Circuit

Figure 5.7. Setup Configurations, Simplified Schematic

If the SLOPE RO pushbutton on the control panel is now depressed, the configuration of Figure 5.7b results. The capacitor is now connected across the amplifier. The setup circuit thus forms a track/store circuit, tracking while a breakpoint is being set, or storing when slope adjustment is required. The stored voltage is applied as an input to all segments, and the DVM monitors the output of the function generator. The slope pot for the *previous* segment is adjusted until the DVM indicates the calculated function voltage at the breakpoint just set. The setup procedure can thus be a series of sequential steps: set all breakpoints, then set the slopes. An alternative procedure that is to set all breakpoints first, then set all slopes. The procedure used is determined by operator preference.

To set the final slope from the last breakpoint to the endpoint (when X = +10 volts or -10 volts, depending on the unit being set), depress the appropriate FINAL SLOPE pushbutton. The circuit arrangement of Figure 5.7c results. Adjust the slope pot for the last segment in the function until the DVM indicates the correct value for the endpoint.

Set the parallax voltage for the function after the polarity switch is placed in the + or - position, by depressing the PX pushbutton. The circuit arrangement of Figure 5.7d results, and the parallax pot is adjusted until the DVM indicates the correct function value with no input.

5.4 CIRCUIT DESCRIPTION

The circuits for each of the major components that comprise the MDFG group are most easily understood if their interconnections are explained. For this reason, a composite schematic diagram of a +MDFG unit, with its output amplifiers and control panel, is illustrated with connections to the setup group in Figure 5.8. This drawing has been simplified by the elimination of many power supply connections and frequency compensating networks, and by showing only part of the control panel and amplifier network.

The MDFG unit is shown at the upper left of Figure 5.8. The unit consists primarily of ten segment networks, nine of which are identical with that shown for segment 2. The segment 1 network differs slightly, due to the central slope provision incorporated in this network. As shown on the drawing, the slope polarity switch for this network has two poles and five positions. The lower arm (as shown on the drawing) selects the input source to the slope pot. When the switch is in the +SL or -SL positions, the input to the slope pot is provided by the diode network. When the switch is placed in the +CS or -CS position, the diode network is excluded from the circuit and the input signal is connected through R6 to the wiper of the slope

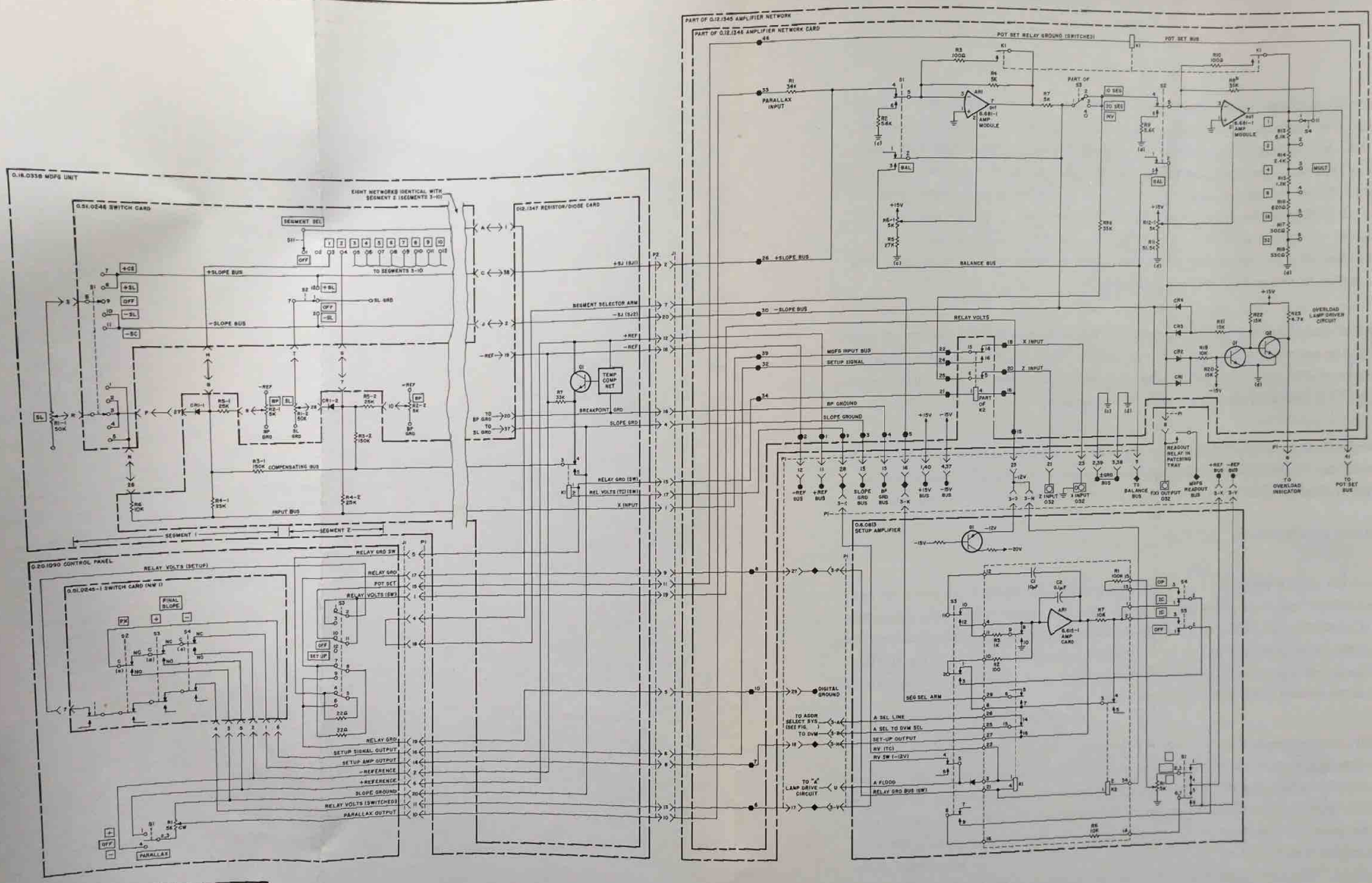


Figure 5.8.

Consolidated Schematic Diagram

The summing point of each segment network is connected to a contact of the SEGMENT SELECTOR switch. The position of the arm of this switch determines the network connected to the setup circuit for breakpoint setting. This switch should always be placed in the OFF position unless the unit is being set up, since the arm of the switch is connected to a bus common with the arms of the SEGMENT SELECTOR switches in all other MDFG units. Thus, should a switch inadvertantly be left in any position other than OFF, it would introduce an error when attempting to set up any other MDFG.

The network consisting of Q1 and Z1 provides a compensation voltage to all segments in the MDFG unit. This network performs the dual function of: (a) overcoming the normal forward voltage drop characteristics of the segment diodes, and (b) compensating for temperature variations that affect the diode characteristics slightly. Network Z1 is a combination of nonlinear and linear resistances, producing a temperature-dependent voltage. Transistor Q1 is an emitter-follower, coupling the voltage to all segments through contacts of K1. Relay K1 is energized when the breakpoints are being set, grounding the compensating bus.

The amplifier network is shown at the upper right of the figure. It consists primarily of two encapsulated differential amplifier modules (AR1-AR2), and input and feedback networks for the amplifiers. The + slope bus from the MDFG unit is connected to the input of AR1 through normally-closed contacts of the balance switch, S1. The - slope bus is connected through contacts of S3 and S2 to the input of AR2. Basic operating details of the amplifiers have been explained in Paragraph 5.4.1 and are not repeated here.

When a balance switch is depressed (S1, for example), the input of the associated amplifier is grounded through a 5.6k resistor by contacts 5 and 6 of the switch. The amplifier input is thus loaded with a resistance. Contacts 2 and 3 of the switch simultaneously connect the amplifier output to the balance bus, which is monitored (during balancing operations) by the DVM. The balance pot is then adjusted until the DVM indicates a minimum reading. Relay K1, the pot set relay, connects a low impedance feedback resistor across the amplifiers when the computer is in the *set pot* mode. One side of the coil of this relay is connected to the computer set pot bus, while the low side of the coil is connected to ground through contacts of the OFF-SET UP switch on the MDFG control panel. Thus, when an MDFG is being set up, the set pot relay associated with that unit cannot be energized.

Switch S3 determines the operating mode for the two MDFG units associated with each 0.12.1345 Amplifier Network. Only one pole of this three-pole switch is shown; the other poles, (a) connect the MDFG units in parallel when the switch is placed in the 20 SEG position, and (b) remove the MDFG inputs to the other AR2 amplifier when the unit is operated in the *20-segment* or *inverter* modes. The pole that is shown connects the MDFG signal as an input to AR2 when the switch is in either the 10 SEG position. When the switch is in the INV position, the only input connected to the AR2 amplifier is the 1 input from the patch panel, connected through R8a.

Relay K2 is the setup relay. It is energized when the OFF-SET UP switch on the control panel is placed in the SET UP position. The contacts of this relay remove the patched input signals to the MDFG circuit being set up, and connect the MDFG input bus to the setup signal.

The circuit consisting of transistors Q1 and Q2, together with diodes CR1-CR4, is an overload indicator driver. The values of R19-R20 and R21-R22 are selected so that an output voltage in excess of ±11.5 volts from AR1 to AR2 causes the associated overload indicator to light.

The control panel, shown at the lower left of Figure 5.8, operates together with the setup network shown at the lower right. All switches on the control panel, except for the PARALLAX switch, are concerned with MDFG setup operations. When the OFF-SET UP switch is placed in the SET UP position, relays K1 and K2 in the 0.6.0815 MDFG Setup Network are energized. Contacts 6 and 7 of K1 connect the setup amplifier input to the segment selector bus. When the SEGMENT SEL switch on the associated MDFG unit is placed in any position other than OFF, the setup amplifier receives the potential at the wiper of the selected breakpoint pot as an input. Contacts 15 and 16 of K1 connect the output of the setup amplifier to the DVM when the relay is energized, and contacts 9 and 10 of K1 connect capacitor C1 to ground through R3. Relay K2 removes the 10k feedback resistor from the setup amplifier when it is energized. Relay K1 in the MDFG unit is also energized at this time, grounding the MDFG compensating bus. The resulting circuit is as shown in Figure 5.7a.

If the SLOPE RO pushbutton is now depressed, the relay voltage for relays K1 and K2 in the setup network and K1 in the MDFG unit is interrupted, and the relays are de-engerized. The resulting circuit is as shown on Figure 5.7b.

The control panel pushbuttons designated PX, +FINAL SLOPE, and -FINAL SLOPE perform similar functions. When any of these pushbuttons are depressed, the lower contacts (as shown on Figure 5.8) interrupt the relay voltage for the K1 and K2 setup network relays and for the K1 MDFG relay. The upper contacts switch the appropriate signal to the setup signal bus (ground, when the PX pushbutton is depressed; + reference, when the +FINAL SLOPE pushbutton is depressed; and - reference, when the -FINAL SLOPE pushbutton is depressed).

The function of the PARALLAX switch and potentiometer have been explained in Paragraph 5.4.1.

The setup amplifier, in addition to its use as a track/store circuit for breakpoint and slope setting, is provided with components and switching for use as an integrator. When used in this mode, the setup amplifier provides a ramp signal to the arm of a plotter and to the input of an MDFG. The MDFG output function is connected to the plotter pen, and the resulting plot permits the operator to assure that the function has been accurately set.

This mode is enabled by placing the ON-OFF switch (S3) on the setup panel in the ON position. (The OFF-SET UP switch on the control panel for the MDFG being tested must be in the SET UP position.) When S3 is in the ON position, contacts 4 and 5 interrupt the relay voltage for relays K1 and K2 in the setup network, and K1 in the MDFG unit being tested. Contacts 11 and 12 of S3 connect capacitor C2 across the amplifier when the switch is in the ON position.

Contacts 2 and 3 of S4 connect the integrator input signal to contact 3 of the OFF-ON switch, S3.

The switch designated +OFF- on the setup panel (S1) determines the input polarity to the integrator, while the adjacent RATE potentiometer determines the input amplitude. Contacts 1 through 4 of S1 determine the input signal polarity, while contacts 5 through 8 determine the polarity of the initial condition voltage. The OFF-IC switch (S5) must be in the IC position if an initial condition is required. The polarity of the IC voltage is always the opposite of the signal voltage. If S1 is in the + position, a positive voltage is provided to S5 and a negative voltage is provided to the RATE pot. The setup amplifier then produces a ramp that begins at -10 volts and goes to +10 volts. However, if S5 is in the OFF position, the ramp begins at zero volt and goes to +10 volts.

When the OP-IC switch (S4) is in the OP position the signal at the wiper of the RATE pot is connected through 100k resistor R1 and 100 ohm resistor R2 to the input of the setup amplifier. Capacitors C1 and C2 constitute the amplifier feedback impedance, and the circuit produces an output voltage ramp. When S4 is placed in the IC position, the initial condition signal is connected to the amplifier, with R2 as a feedback impedance.

The amplifier select balance switch is used to select either the setup amplifier, time base amplifier or the servo amplifier for balancing. Depressing one of these switches connects its input to the S SEL line which in turn is connected to switch S2 located at the lower right of the voltmeter. When S2 is in the S BAL position the stabilizer output of the setup and time base amplifiers and the output of the servo amplifier can be read out on the voltmeter.

5.5 MAINTENANCE

No periodic maintenance is required for any components of the MDFG group, except for amplifier balancing. Procedures are included in this paragraph for setting up a test function to evaluate the performance of an MDFG unit if trouble is suspected.

5.5.1 Amplifier Balancing

5.5.1.1 *MDFG Amplifier Balance Procedure.* To balance the encapsulated amplifier associated with the MDFG units, proceed as follows:

1. Address the function generator bus with the signal selector system by depressing the F pushbutton.
2. Pull out the drawer containing the setup amplifier.
3. If balancing is attempted when the computer is in the *set pot* mode, the OFF-SET UP switch on the associated MDFG control panel must be placed in the SET UP position to de-energize the MDFG set pot relay. This step is unnecessary if the computer is in any other than *set pot*.
4. Place the spring-loaded balance switch for an amplifier in the BAL position and observe the DVM. The DVM should indicate ±0.0000 for a properly balanced amplifier. If the DVM indicates any other reading, adjust the balance pot for the amplifier with a small screwdriver until a ±0.0000 display is observed.
5. Balance the remaining amplifiers in the MDFG drawer in the same way. When these amplifiers have been balanced, place the OFF-SET UP switch in the OFF position (if it was necessary to place the switch in the SET UP position in Step 3), and close the drawer.
6. Pull the lower drawer out, and using the procedure in Steps 4 and 5, balance the amplifiers within the drawer. Proceed in this way until all MDFG amplifiers have been balanced.

5.5.1.2 *Setup Amplifier Balance Procedure.* The setup amplifier is balanced by using the balance meter and controls provided on the main amplifier balance panel at the left side of the computer. Proceed as follows:

1. Pull out the drawer containing the setup amplifier to be balanced.
2. Depress the SET UP pushbutton on the amplifier balance select panel.
3. Place the METER SELECT switch in the S BAL position. The balance meter now indicates the amplitude of the setup amplifier stabilizer output signal.
4. Adjust the SET UP BALANCE potentiometer (located above the SET UP pushbutton) until the meter indicates a reading of zero. This completes the setup amplifier balance procedure.

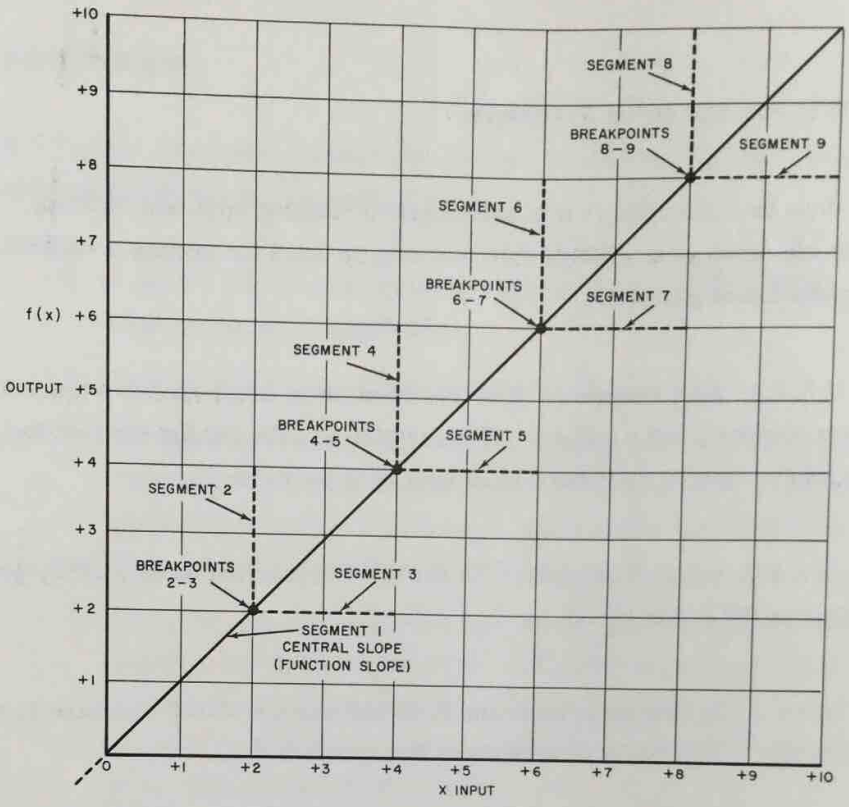
5.5.2 Test Function Setup Procedure

Procedural steps are provided in this paragraph for setting up a test function. The steps listed are for the setup of a +MDFG unit, but may be used for setting a -MDFG unit as well, by reversing the listed polarities.

5.5.2.1 *Test Function.* The test function is illustrated in Figure 5.9, along with a tabulation of required setup values. This function is selected for the test because it may be easily evaluated to determine if the unit is operating correctly.

5.5.2.2 *Setup Procedure.* To set the test function on an MDFG, perform the following steps in the order listed.

1. Balance the setup amplifier and the MDFG amplifiers, using the procedure described in Paragraph 5.6.1.
2. Place the MULT switch on the MDFG amplifier panel in the 1 position. Place the 10 SEG-20 SEG-INV switch in the 10 SEG position.
3. Place the PARALLAX switch in the OFF position and place the OFF-SET UP switch in the SET UP position.
4. Address the MDFG unit with the signal selector system.
5. Refer to the setup table (Figure 5.9b) and perform Steps 1 through 9. At the conclusion of Step 9, all breakpoints for the test function are properly positioned.
6. Perform Steps 10 through 15, depressing the SLOPE RO pushbutton to read the value while setting each SL potentiometer.
7. Perform Steps 16 and 17 of the setup table, depressing the FINAL SLOPE + pushbutton (rather than the SLOPE RO pushbutton) to read the values while setting SL pots 8 and 9.
8. Perform Step 18, adjusting SL potentiometer 1 until the output of the function generator equals +10.00 volts (+1.0000 DVM reading) when the input equals +10.000 volts. This step completes the function set-up procedure.



(a) Test Function (+ Unit)

Step	Segment Selector Switch Position	Segment Slope Switch		Adjust			
				BP Pot		SL Pot	
		Number	Position	Number	Value	Number	Value
1		All	OFF				
2	2			2	+0.2000		
3	3			3	+0.2000		
4	4			4	+0.4000		
5	5			5	+0.4000		
6	6			6	+0.6000		
7	7			7	+0.6000		
8	8			8	+0.8000		
9	9			9	+0.8000		
10*	4	2	+			2	+0.2000
11*	5	3	-			3	0.0000
12*	6	4	+			4	+0.2000
13*	7	5	-			5	0.0000
14*	8	6	+			6	+0.2000
15*	9	7	-			7	0.0000
16**	OFF	8	+			8	+0.2000
17**	OFF	9	-			9	0.0000
18**	OFF	1	+CS			1	+1.0000

(b) Table of Function Values

**Depress SLOPE RO pushbutton to read values for these steps.*

***Depress FINAL SLOPE + pushbutton to read values for these steps.*

Figure 5.9. +MDFG Test Function and Setup Table

5.5.2.3 *Test Function Plotting.* The test function may now be plotted. The facilities incorporated in the setup network are used to provide the required inputs to the MDFG and the plotter. Proceed as follows:

1. Connect the PEN, ARM, and GRD terminals on the setup panel to the appropriate terminals of an X-Y plotter.
2. The OFF-SET UP switch on the MDFG control panel should be left in the SET UP position, and the MDFG unit must be addressed by the signal selector system.
3. Place the OFF-ON switch on the setup panel in the ON position. The setup amplifier now operates as an integrator. Place the OP-IC switch in the IC position.
4. Place the +OFF- switch adjacent to the RATE pot on the setup panel in the + position (to plot the output of a -MDFG unit, this switch would be placed in the - position). Set the RATE pot to a point approximately one turn from its counter-clockwise limit.
5. The OFF-IC switch on the setup panel may be placed in either position. If this switch is in the OFF position, the ramp begins at zero and goes to +10 volts. If the switch is placed in the IC position, the ramp begins at -10 volts and proceeds to +10 volts.
6. The setting of the pen and arm sensitivity controls on the plotter must be determined by the position of the OFF-IC switch on the setup panel. If this switch is placed in the OFF position, the ramp amplitude is about 10 volts. The arm sensitivity control (for an 11×20 plotter) may then be placed in the 0.5 volt/inch position, while the pen sensitivity must be set to 1 volt/inch. However, if the OFF-IC switch is in the IC position, the ramp is 20 volts in amplitude and the total output function (including the extended central slope segment) has an amplitude of 20 volts. The plotter pen and arm sensitivity controls must then be set accordingly, to avoid overloading the plotter.

   After setting the sensitivity controls, adjust the plotter parallax or zero controls to position the plotter pen at the lower left corner of the plotting paper (for a +MDFG unit). Place the pen in the down of operate position.
7. Depress the OP side of the OP-IC switch on the setup panel. The resultant plot should resemble Figure 5.9a. When the plot is complete, place the pen in the up position and depress the IC side of the OP-IC switch. If any significant differences are noted between the plot and Figure 5.9a, refer to Paragraph 5.7 and correct the difficulty.

5.5.3 Peaking Adjustment

Peaking within the bandpass of the MDFG units is adjusted using trimming capacitors accessible from the rear of the MDFG drawers (Figure 5.10). The procedure used is straight-forward: Set up the test function of Figure 5.9, patch the circuit of Figure 5.11, apply a variable frequency sine wave input, and monitor the MDFG output with an ac voltmeter. The sine wave generator frequency, is swept over the range from 80 kc to 100 kc (the range where peaking occurs) to locate the frequency providing the peak amplitude. When this frequency is located (assure that the signal generator output level is constant), the appropriate trimming capacitor (C6-1 or C6-2) is adjusted until the peak amplitude exceeds the reference amplitude by 1 db.

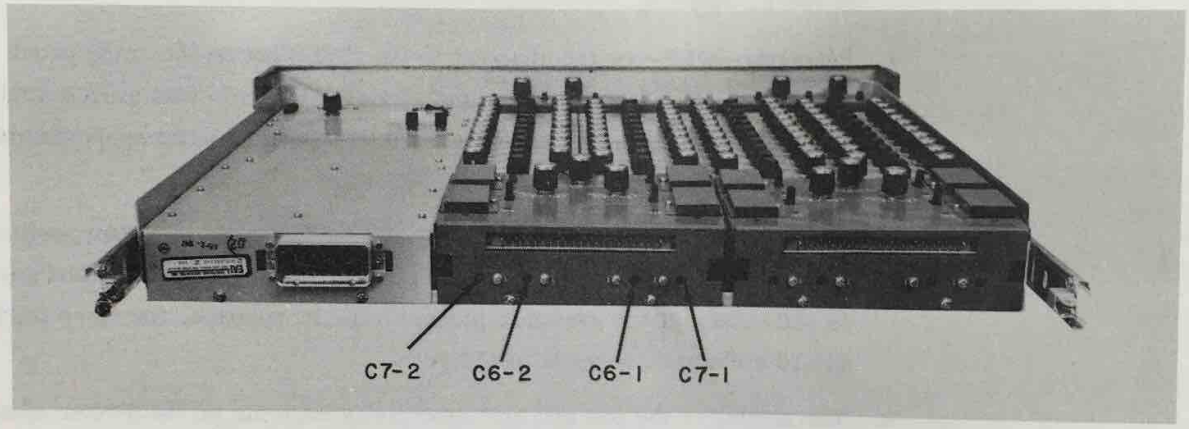


Figure 5.10. MDFG Drawer, Rear View

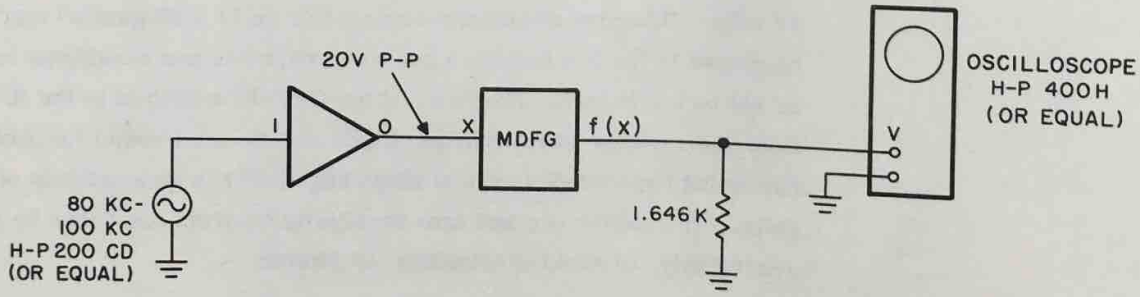


Figure 5.11. Peaking Adjustment Tests

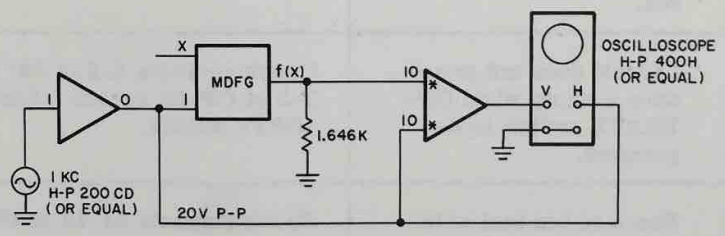
NOTE

The MDFG unit under test should not be selected for readout by the computer signal selector system when performing dynamic tests or adjustments, since the stray capacitance of the selector system affects the MDFG frequency response.

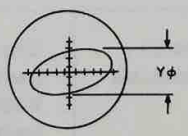
5.5.4 Phase Shift Adjustment

A trimming capacitor in parallel with the 1 input resistor permits adjustment of the phase shift of the unit when used in the *inverter* mode. Adjustment of this capacitor should not be attempted until the peaking adjustment for the unit (Paragraph 5.5.3) has been performed. To perform the adjustment, proceed as follows:

1. Place the 10 SEG-20 SEG-INV switch on the MDFG amplifier panel in the INV position.
2. Patch the circuit of Figure 5.12a.
3. Observe the waveform on the oscilloscope. The Y-axis intercept in volts (designated Y_0 on Figure 5.12b), multiplied by 0.286 equals the phase shift in degrees.
4. To perform the adjustment, back the capacitor adjustment screws out as far as possible, then turn the screw in slowly until Y_0 equals 0.105 volt. This is equal to a lagging shift of 0.03°.



(a) Test Circuit **Matched Input Resistors*



(b) Typical Waveform

Figure 5.12. Phase Shift Adjustment Circuit and Waveform

5.6 TROUBLESHOOTING

Before attempting to troubleshoot an MDFG unit, set up the test function described in Paragraph 5.6.2. If trouble is encountered while attempting to set the unit up, the trouble may be due to a problem in the setup circuit. Try to set up another MDFG unit to isolate the malfunction. If the problem is isolated to the setup circuit, refer to Table 5.1 and locate the symptoms.

If the trouble appears to be in an MDFG unit, remove the unit. Then refer to Table 5.2 and check the indicated components.

Table 5.1. Setup Circuit Trouble Symptoms and Probable Causes

Mode	Symptoms	Possible Causes (In Order of Probability)
Breakpoint Setup	DVM does not respond to adjustment of the BP pot being set.	MDFG SEGMENT SEL switch in wrong position; check.
	DVM responds to BP. pot adjustment but indicates incorrect value.	Assure that all other SEGMENT SEL switches are in OFF position; check K2 and ON-OFF switch in setup network.
Slope Setup	Slope value drifts while SLOPE RO pushbutton is depressed.	Check contacts 11-12 of S3 and contacts 9-8 of K1 in setup circuits; check C2 in setup network; check setup amplifier balance.
	Slope value remains stable but is incorrect when test curve is plotted.	Check K1 in MDFG unit; check transistor Q1 in MDFG unit.
Integrator (Ramp Generator)	Circuit does not produce a ramp when OPERATE switch is depressed.	Check contacts 3-2 of S3; check contacts 2-3 of OP-IC switch. Check contacts of +OFF- switch.
	Ramp is too fast with low settings of RATE pot.	Check contacts 11-12 of S3; check C2.
	Integrator does not respond to an IC potential.	Check contacts 5, 6, 7, and 8 of +OFF- switch; check contacts 8-9 of OFF-ON switch; check contacts 2-3 of OFF-IC switch; check contacts 3-4 of K2.
	Amplifier overloads at end of ramp - i.e., it takes an excessive amount of time to respond to an IC input.	Check amplifier balance; check limiter diodes CR6 and CR7.
ANY	No output from setup amplifier, or constant ±11 volt output.	Check amplifier card (0.6.0615-1 by substitution.

Table 5.2. MDFG Circuit Trouble Symptoms and Probable Causes

Symptoms	Possible Causes (In Order of Probability)
Error begins at some point on test curve and increases as input approaches ±10 volts.	Fault most probably exists in segment network where error begins. Check to assure that the slope polarity switch for the segment is properly set, then check the segment diode.
Breakpoints appear to shift with changes in temperature.	Check Q1 in MDFG unit; check compensating network Z1 by substitution, if possible.
Slope values required for test function cannot be achieved with MULT switch in 1 position.	Check output amplifiers by substitution.
Miscellaneous intermittent conditions.	Check connectors.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	R1	Potentiometer	00 642.0723-0	B
2	R2,3	Resistor, Variable, Composition: 50K ohms ±30% (Chicago Telephone Supply Series 70 #HH1860 or equal)	00 642.0351-0	A
3	S1	Switch, Slide: DPTT (Muter 5608 or equal)	00 664.0046-0	A
4	S3	Switch, Slide: 4 PDT (Muter 9604 or equal)	00 664.0045-0	A
5	S4	Switch, Rocker: SPDT (Switchcraft 51203-L or equal)	00 664.0054-0	A
6	S5	Switch, Slide: DPDT (Muter 4603 or equal)	00 664.0042-0	A
		0.6.0813 MDFG SET-UP CARD		
1	C1	Capacitor	00 521.0077-0	B
2	C2	Capacitor, Fixed, Plastic: 0.1 uf ±5%, 200V (Gudeman 356 or equal)	00 522.2140-0 (00 521.0174-0)	A
3	C3	Capacitor, Fixed, Electrolytic: 100 uf ±20%, 20V (Sprague 150D or equal)	00 517.1107-3	A
4	C4	Capacitor	00 516.0387-0	B
5	CR1,2	Diode (ITT G-187 or equal)	00 614.0043-0	A
6	CR3,4	Diode	00 614.0238-0	B
7	CR5	Diode: 1N4002	00 614.0110-0	A
8	CR6	Diode	00 614.0293-0	B
8	K1	Relay: 12 VDC, 185 ohms Coil; 4 Form C Contacts (Allied Control T-154-4C-185 or equal)	00 618.0094-0	A
9	K2	Relay	00 618.0291-0	B
10	Q1	Transistor	00 686.0381-0	B
11	Q2	Transistor: 2N3638	00 686.0250-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: MDFG SET-UP AMPLIFIER

MODEL NO. 0.6.0815

DATE 4 / 30 / 68

Sh.1 of 5 Sh.

2-5-27

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
12	R1	Resistor, Fixed, Composition: 100K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0104-0	A
13	R2	Resistor, Fixed, Composition: 100 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0101-0	A
14	R3	Resistor, Fixed, Composition: 1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0102-0	A
15	R6,7	Resistor, Fixed, Film: 10K ohms ±0.5%, 1/4W (Int. Resistance Co. CEB-T0 or equal)	00 634.0666-0	A
16	R8	Resistor, Fixed, Wirewound: 10 ohms ±5%, 5W (Ward Leonard 5XM10 or equal)	00 636.0309-0	A
17	R9	Resistor, Fixed, Composition: 110 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0111-0	A
18	R10	Resistor, Fixed, Composition: 390 ohms ±5%, 1W (Allen-Bradley GB or equal)	00 627.0391-0	A
19	R11	Resistor, Fixed, Composition: 220 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0221-0	A
20	R12	Resistor, Fixed, Composition: 2K ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0202-0	A
21	XK1	Socket, Relay: 16 Contacts (Allied Control 30055-4 or equal)	00 650.0133-0	A
		0.6.0615-1 DUAL DC AMPLIFIER CARD Identical with 0.6.0615-0 Except Item 20 is deleted (see Appendix 1, Chapter 1.).		
		0.36.0192 REP-OP TIMER CARD		
1	1cP1	Integrated Circuitry: Quad 2-Input Gate	00 592.0096-0	B
2	AR1	Integrated Circuitry: Amplifier, Wide Panel	00 592.0059-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: MDFG SET-UP AMPLIFIER

MODEL NO.: 0.6.0815 Sh. 2 of Sh.

DATE 4 / 30 / 68

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
3	C1,2	Capacitor (Matched Pair)	00 525.0019-0	B
4	C3,4	Capacitor (Matched Pair)	00 525.0020-0	B
5	C5	Capacitor	00 521.0146-0	B
6	C6,7	Capacitor, Fixed, Ceramic: 100 pf ±10%, 1000V (Cornell-Dubilier JBZ601YP101K or equal)	00 515.0019-0	A
7	C8,10,11,14	Capacitor, Fixed, Ceramic: 10 nf +60% -40%, 150V (Centralab DDM-103 or equal)	00 515.0151-0	A
8	C9,12,13,15	Capacitor	00 516.0387-0	B
9	CR1,2	Diode	00 614.0238-0	B
10	CR3,4,5,6,7	Diode	00 614.0293-0	B
11	CR8 thru 12	Diode: 1N916	00 614.0148-0	A
12	CR13	Diode, Zener: 1N748A	00 614.0289-0	A
13	CR14	Diode, Zener (Motorola 1/4M6.2AZ10 or equal)	00 614.0214-0	A
14	CR15	Diode	00 614.0110-0	A
15	K1	Relay: 18 VDC, 520 ohms Coil; 4 Form C Contacts (Allied Control T-154-4C-520 or equal)	00 618.0171-0	A
16	Q1,5,6,7, 8,11,13	Transistor: 2N3640	00 686.0258-0	A
17	Q2,9,10	Transistor	00 686.0246-0	B
18	Q3,4,12,14	Transistor: 2N3646	00 686.0230-0	A
19	Q15	Transistor	00 686.0270-0	B
20	Q16	Transistor: 2N3638A	00 686.0305-0	A
21	R2,10	Resistor, Fixed, Wirewound: 15 ohms ±5%, 3W (Ward Leonard 3X15WL or equal)	00 636.0264-0	A
22	R3,11	Potentiometer	00 642.0731-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 4 / 30 / 68

UNIT TITLE

MDFG SET-UP AMPLIFIER

MODEL NO.

0.6.0815 Sh. 3 of Sh.

M446

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
23	R4,12,22, 23,25	Resistor, Fixed, Film: 10K ohms ±0.1%, 50-ppm/°C,1/4W (Int. Resistance Co. CEA or equal)	00 632.1002-8	A
24	R5,13,26	Resistor, Fixed, Film: 4640 ohms ±0.1%, 50ppm/°C, 1/4W (Int. Resistance Co. CEA or equal)	00 632.4641-8	A
25	R6,14	Potentiometer	00 642.0696-0	B
26	R7,15	Resistor, Fixed, Composition: 110 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0111-0	A
27	R8,16,21, 30,35,49	Resistor, Fixed, Composition: 2.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0272-0	A
28	R17	Resistor, Fixed, Composition: 1.5K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0152-0	A
29	R18,33,36, 37,43,53	Resistor, Fixed, Composition: 2.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0222-0	A
30	R19	Resistor, Fixed, Composition: 18K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0183-0	A
31	R20,40,41, 42,46,50,51	Resistor, Fixed, Composition: 1.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0122-0	A
32	R24	Resistor, Fixed, Composition: 15 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0150-0	A
33	R27	Resistor, Fixed, Film: 5630 ohms ±0.1%, 50 ppm/°C, 1/4W (Int. Resistance Co. CEA or equal)	00 632.5361-8	A
34	R28	Resistor, Fixed, Composition: 1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0102-0	A
35	R29	Resistor, Fixed, Composition: 1 ohm ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0109-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: MDFG SET-UP AMPLIFIER

DATE 4 / 30 / 68

MODEL NO. 0.6.0815 Sh.4 of Sh.

2-5-30

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
36	R31	Resistor, Fixed, Composition: 3K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0302-0	A
37	R32	Resistor, Fixed, Composition: 1 megohm ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0105-0	A
38	R34	Resistor, Fixed, Composition: 560 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0561-0	A
39	R38,48	Resistor, Fixed, Composition: 470 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0471-0	A
40	R39,47	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0472-0	A
41	R44,45	Resistor, Fixed, Composition: 3.3K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0332-0	A
42	R52	Resistor, Fixed, Composition: 470 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0471-0	A
43	RT1,2	Thermistor	00 646.0116-0	B
44	XK1	Socket, Relay: 16 Contacts (Allied Control 300554 or equal)	00 650.0133-0	A
		0.51.0366 SELECT CARD		
1	R1	Resistor, Fixed, Composition: 8.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0822-0	A
2	R2	Resistor, Fixed, Composition: 15K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0153-0	A
3		Switch	00 656.0177-1	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: MDFG SET-UP AMPLIFIER

MODEL NO.: 0.6.0815 Sh. 5 of 5 Sh.

0 DATE 4/30/68

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1-(),2-()	Capacitor, Fixed, Electrolytic: 100 uf ±20%, 20V (Sprague 150D107X0020-S2 or equal)	00 517.1107-3 (00 516.0270-0)	A
2	C3-()	Capacitor, Fixed, Ceramic: 82 pf ±10%, 100V (Sprague 252C016-820X9101B or equal)	00 515.0327-0	A
3	C4-()	Capacitor, Fixed, Ceramic: 22 pf ±5%, 1000V (Sprague 19C411(10TCC-Q22) or equal)	00 515.0096-0	A
4	C5-()	Capacitor, Fixed, Ceramic: 12 pf ±5%, 1000V (Sprague 40C502(10TCC-Q12) or equal)	00 511.1120-2 (00 515.0091-0)	A
5	C6-()	Capacitor, Fixed, Ceramic: 33 pf ±10%, 100V (Sprague 252C028330X9101B or equal)	00 515.0423-0	A
6	C7-()	Capacitor, Fixed, Ceramic: 100 pf ±10%, 100V (Sprague 252C016101X9101B or equal)	00 515.0266-0	A
7	C8-()	Capacitor, Fixed, Ceramic: 22 nf ±20%, 25V (Sprague 3C9 or equal)	00 511.5223-4 (00 515.0236-0)	A
8	C9-(),10-()	Capacitor, Variable: 0.9 to 7.0 pf (Elmenco Type 40, #400 or equal)	00 524.0070-0	A
9	CR1-() thru 4-()	Diode	00 614.0007-0	B
10	CR5-(),6-()	Diode (ITT G-187 or equal)	00 614.0043-0	A
11	K1-()	Relay	00 618.0299-0	B
12	K2	Relay: 12 VDC Coil, 4 Form C Contacts (Allied Control T-154-4C-185 or equal)	00 618.0094-0	A
13	P1	Connector, Plug: 41 Contacts; Male (Amp 3-582152-5 or equal)	00 542.1422-0	A
14	Q1-(),2-()	Transistor	00 686.0229-0	B
15	R1-()	Resistor, Fixed, Film: 34K ohms ±0.1%, 1/4W (Int. Resistance Co. CEB-T0 or equal)	00 634.0811-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: AMPLIFIER NETWORK CARD

MODEL NO. 0.12.1345

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
16	R2-(),9-(), 26-()	Resistor, Fixed, Composition: 5.6K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0562-0	A
17	R3-(), 10-(),25-()	Resistor, Fixed, Composition: 100 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0101-0	A
18	R4-(),7-()	Resistor, Fixed, Film: 5K ohms ±0.1%, 1/2W (Int. Resistance Co. MEB-T0 or equal)	00 634.0643-0	A
19	R5-(),11-()	Resistor, Fixed, Film: 51.5K ohms ±0.5%, 1/4W (Int. Resitance Co. CEA-T0 or equal)	00 634.0575-2	A
20	R6-(),12-()	Potentiometer	00 642.0719-0	B
21	R8-()	Resistor, Precision (Matched Pair)	00 640.0136-0	B
22	R13-()	Resistor, Fixed, Composition: 5.1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0512-0	A
23	R14-()	Resistor, Fixed, Composition: 2.4K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0242-0	A
24	R15-()	Resistor, Fixed, Composition: 1.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0122-0	A
25	R16-()	Resistor, Fixed, Composition: 620 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0621-0	A
26	R17-()	Resistor, Fixed, Composition: 300 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0301-0	A
27	R18-()	Resistor, Fixed, Composition: 330 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0331-0	A
28	R19-()	Resistor, Fixed, Composition: 10K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0103-0	A
29	R20-(),22-()	Resistor, Fixed, Composition: 15K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0153-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10 / 17 / 67

UNIT TITLE

AMPLIFIER NETWORK CARD

MODEL NO.

0.12.1345 Sh. 2 of 3 Sh.

2-5-33

M465

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
30	R21-()	Resistor, Fixed, Composition: 13K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0133-0	A
31	R23-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0472-0	A
32	R24-()	Resistor, Fixed, Composition: 10 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0100-0	A
33	R27-()	Resistor, Fixed, Composition: 220 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0221-0	A
34	XK2	Socket	00 650.0079-0	B
35	S1-(),2-()	Switch, Slide: DPDT; 2 Form C, 0.5A, 125V (Muter Co. 4603-S-B1-A2 or equal)	00 664.0043-0	A
36	S3	Switch	00 658.0279-0	B
37	S4-()	Switch	00 658.0280-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 4 / 29 /68

UNIT TITLE
AMPLIFIER NETWORK CARD

MODEL NO.
0.12.1345 Sh. 3 of 3 Sh.

2=5=34

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	R1,2-1 thru 2-10	Potentiometer	00 642.0723-0	B
2	R1-2 thru R1-10	Potentiometer	00 642.0723-1	B
		0.12.1347 RESISTOR DIODE NETWORK CARD		
1	C1	Capacitor, Fixed, Ceramic: 22 pf ±10%, 1000V (Cornell-Dubilier CZ601UJ220K or equal)	00 515.0014-0	A
2	C2	Capacitor, Fixed, Ceramic: 100 pf ±10%, 100V (Sprague 252C016101X9101B or equal)	00 515.0266-0	A
3	CR1	Diode	00 614.0199-0	B
4	CR2	Diode (ITT G-187 or equal)	00 614.0043-0	A
5	CR3	Rectifier (Solitron Devices Inc. CER-68 or equal)	00 614.0110-0	A
6	K1	Relay	00 618.0291-0	B
7	Q1	Transistor	00 686.0305-0	B
8	R3	Resistor, Fixed, Film: 25K ohms ±0.5%, 1/4W (Int. Resistance Co. CEB-T0 or equal)	00 634.0742-0	A
9	R4 ,5	Resistor, Fixed, Film: 150K ohms ±0.5%, 1/4W (Int. Resistance Co. CEB-T0 or equal)	00 634.0743-0	A
10	R6	Resistor, Fixed, Film: 10K ohms ±0.5%, 1/4W (Int. Resistance Co. CEB-T0 or equal)	00 634.0666-0	A
11	R7	Resistor, Fixed, Composition: 33K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0333-0	A
12	R8	Resistor, Fixed, Composition: 15K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0153-0	A

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
13	Z1	Network Temperature Compensator	00 646.0159-0	B
14		Socket, Transistor: 3 Contacts (Augat 8069-1G1 or equal)	00 650.0121-0	A
		0.51.0246 SWITCH CARD		
1	S1	Switch	00 658.0281-0	B
2	S2 thru 10	Switch	00 658.0277-0	B
3	S11	Switch	00 658.0278-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE: MDFG UNIT

MODEL NO. 0.16.0338

0

DATE 10/ 17 /67

2-5-36

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
		Identical with 0.12.1347 except for Item 7.		
7	Q1	Transistor	00 686.0305-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/ 17/ 67

UNIT TITLE
RESISTOR DIODE NETWORK CARD

MODEL NO.
0.12.1347-1 Sh. 1 of 1 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	C1,2	Capacitor, Fixed, Ceramic: 0.1 uf -40% +60%, 150V (Centralab DDM-103 or equal)	00 515.0151-0	A
2	J1,2,3,4	Connector, Housing: 10 Position (Amp 582583-1 or equal)	00 542.1437-0	A
3	R1,2,3,4	Potentiometer	00 642.0723-0	B
4	R5,6,7,8	Resistor, Fixed, Composition: 22 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0220-0	A
5	S1,2,3,4	Switch, Slide: SPTT (Muter 5604 or equal)	00 664.0044-0	A
6	S5,6	Switch, Slide: 4PDT (Muter 9604 or equal)	00 664.0045-0	A
		0.51.0245 SWITCH CARD		
1	C1 thru 8	Capacitor, Fixed, Ceramic: 0.1 uf -40% +60%, 150V (Centralab DDM-103 or equal)	00 515.0151-0	A
2		Switch, Sensitive: SPDT (Cherry E61-00A or equal)	00 662.0046-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE

CONTROL PANEL

MODEL NO.

0.20.1090 Sh. 1 of 1 Sh.

3

DATE 10 / 17 / 67

2-5-38

APPENDIX 2

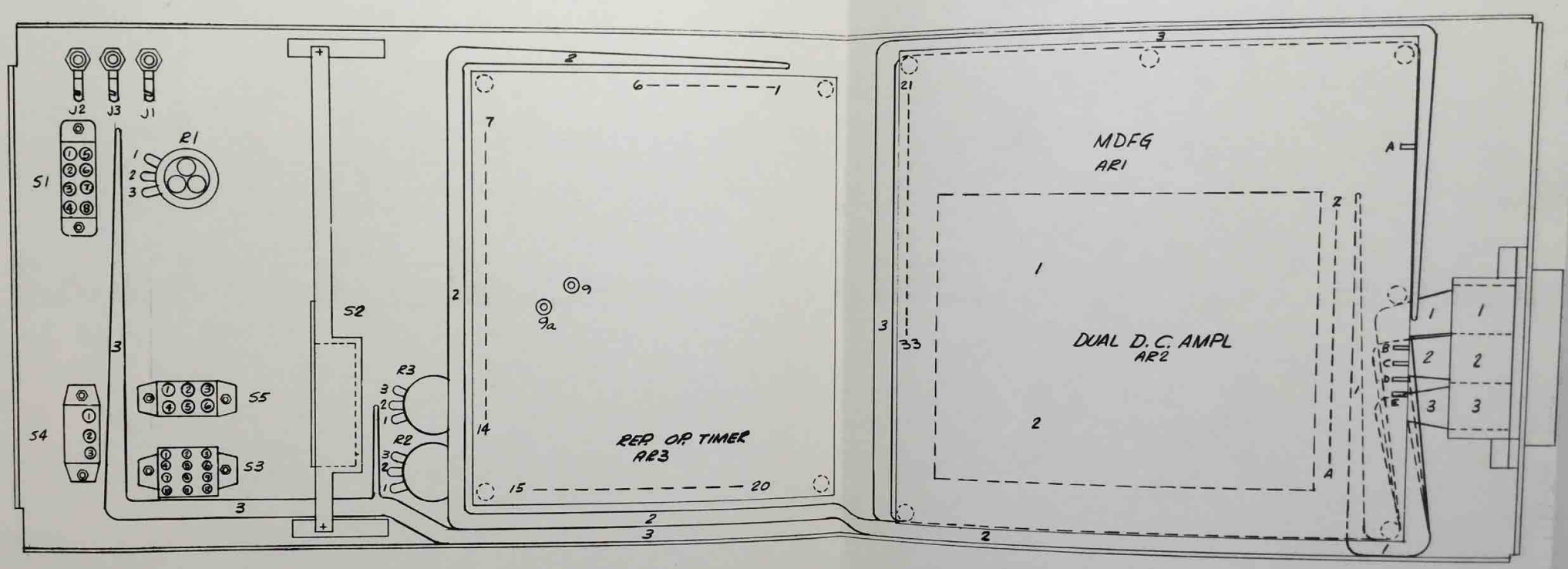
DRAWINGS

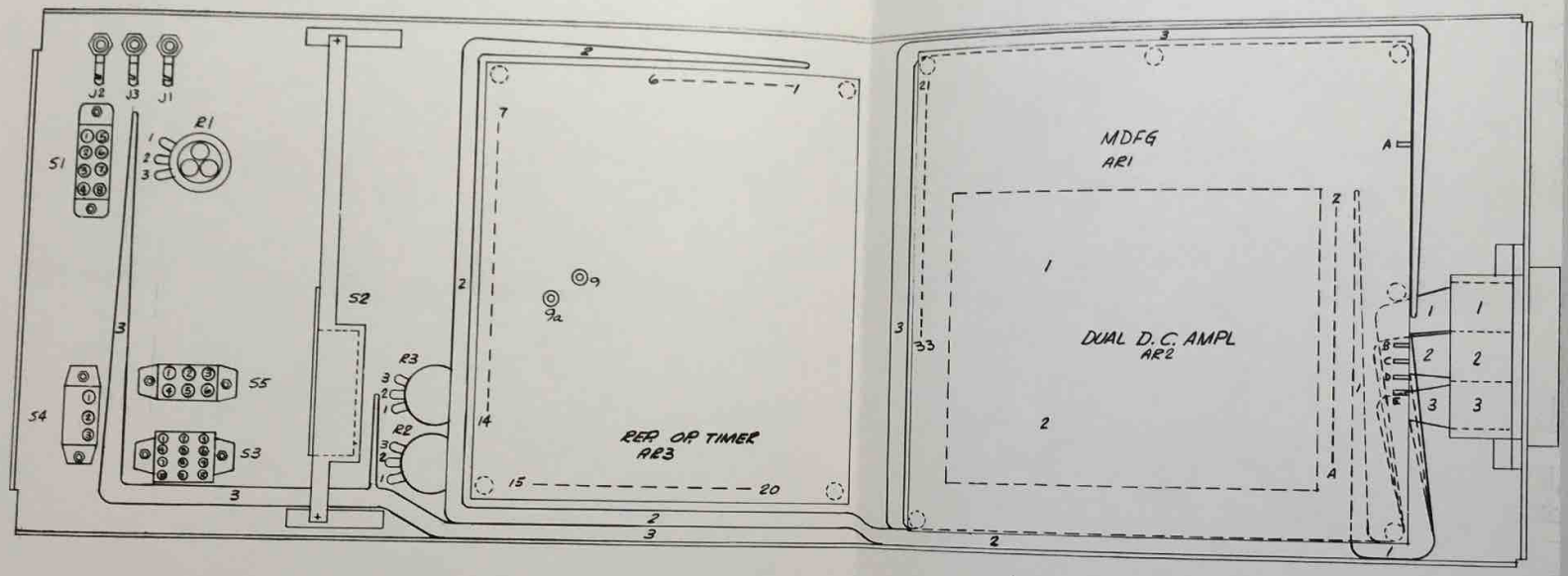
This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

INDEX

Unit or Component	Type of Drawing	Drawing Number
0.6.0815 MDFG Set-Up Amplifier	Wiring	D00 006 0815 0W (Sheets 1 and 2)
0.6.0813 MDFG Set-Up Card	Schematic	D00 006 0813 0S
12.1345 Amplifier Network	Schematic Wiring	D012 1345 0S D012 1345 0W
16.338 MDFG Unit	Schematic Wiring	D016 338 0S D016 338 0W
20.1090 Control Panel	Schematic Wiring	C020 1090 0S D020 1090 0W
0.51.0356 Readout Tray	Assembly W/ Wiring	D00 051 0356 0A
0.51.0366 S Select	Schematic	D00 051 0366 0S


J2
J3
J1
R1
S1
S2
S3
S4
S5
R3
R2
REF. OP. TIMER
AR3
MDFG
AR1
DUAL D.C. AMPL
AR2



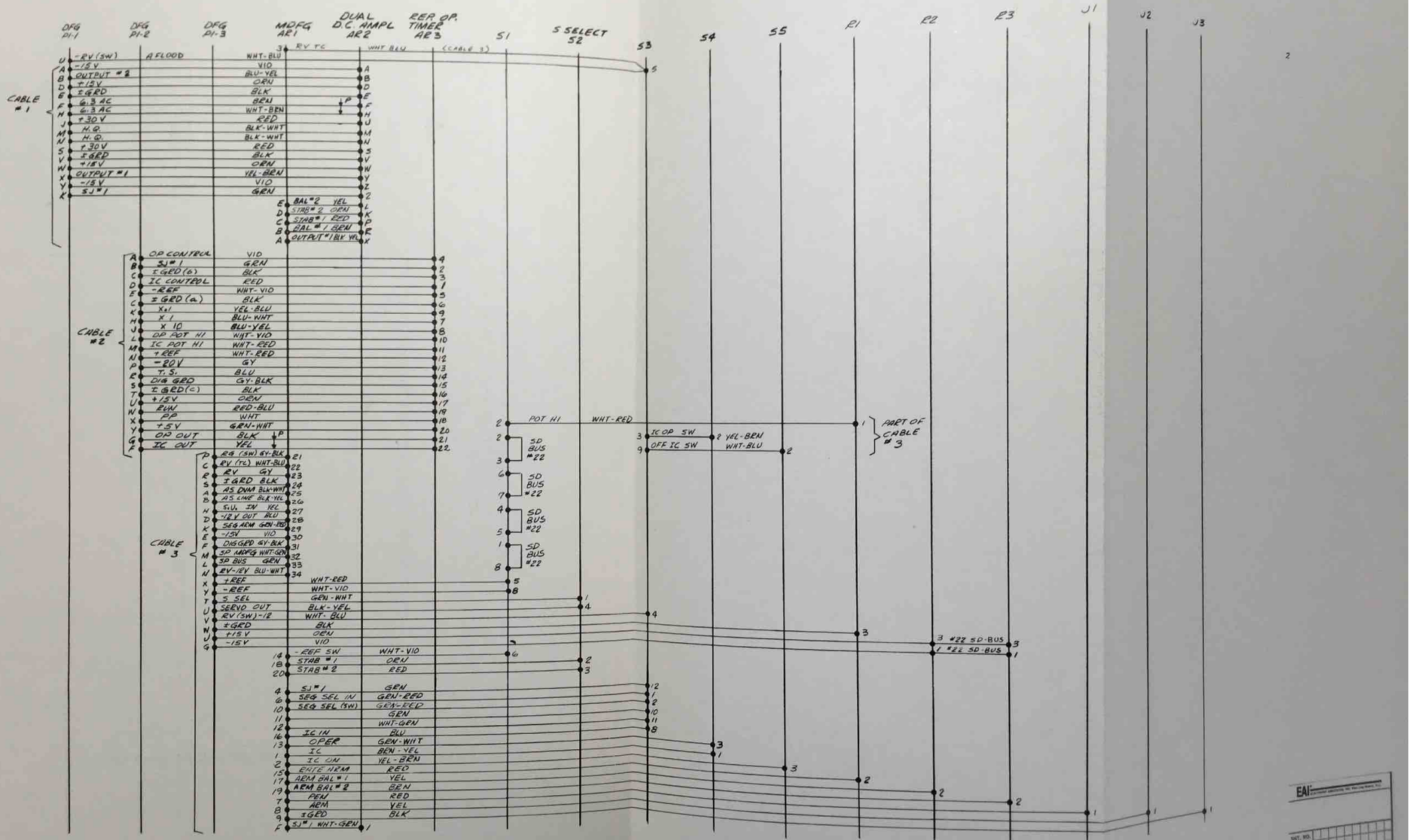
EAI

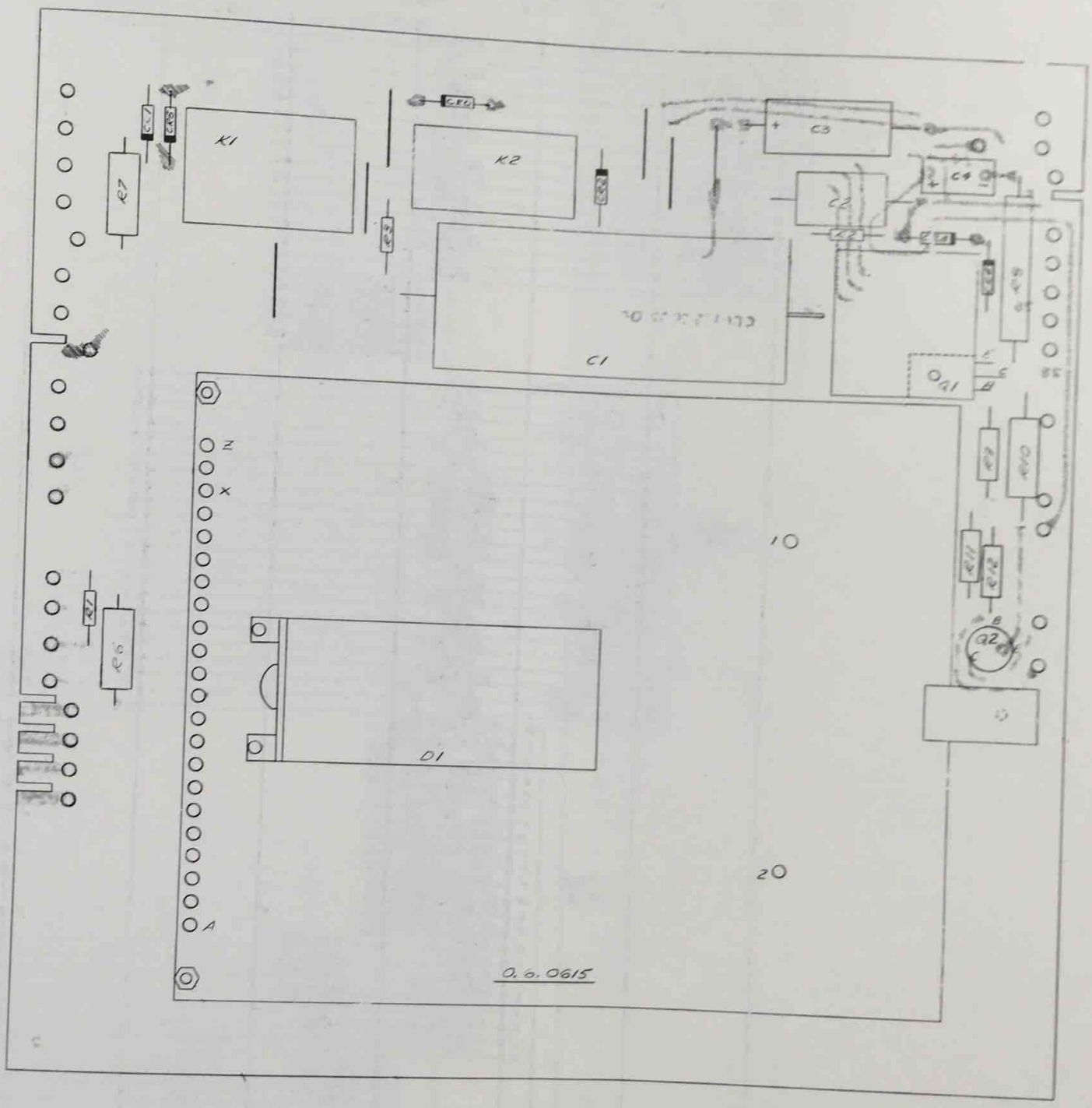
WIRING
MDFG SET-UP AMPL
W/HARNESS

DWT. NO.	2
SIZE	D
REV. NO.	2
PROJECT	19330

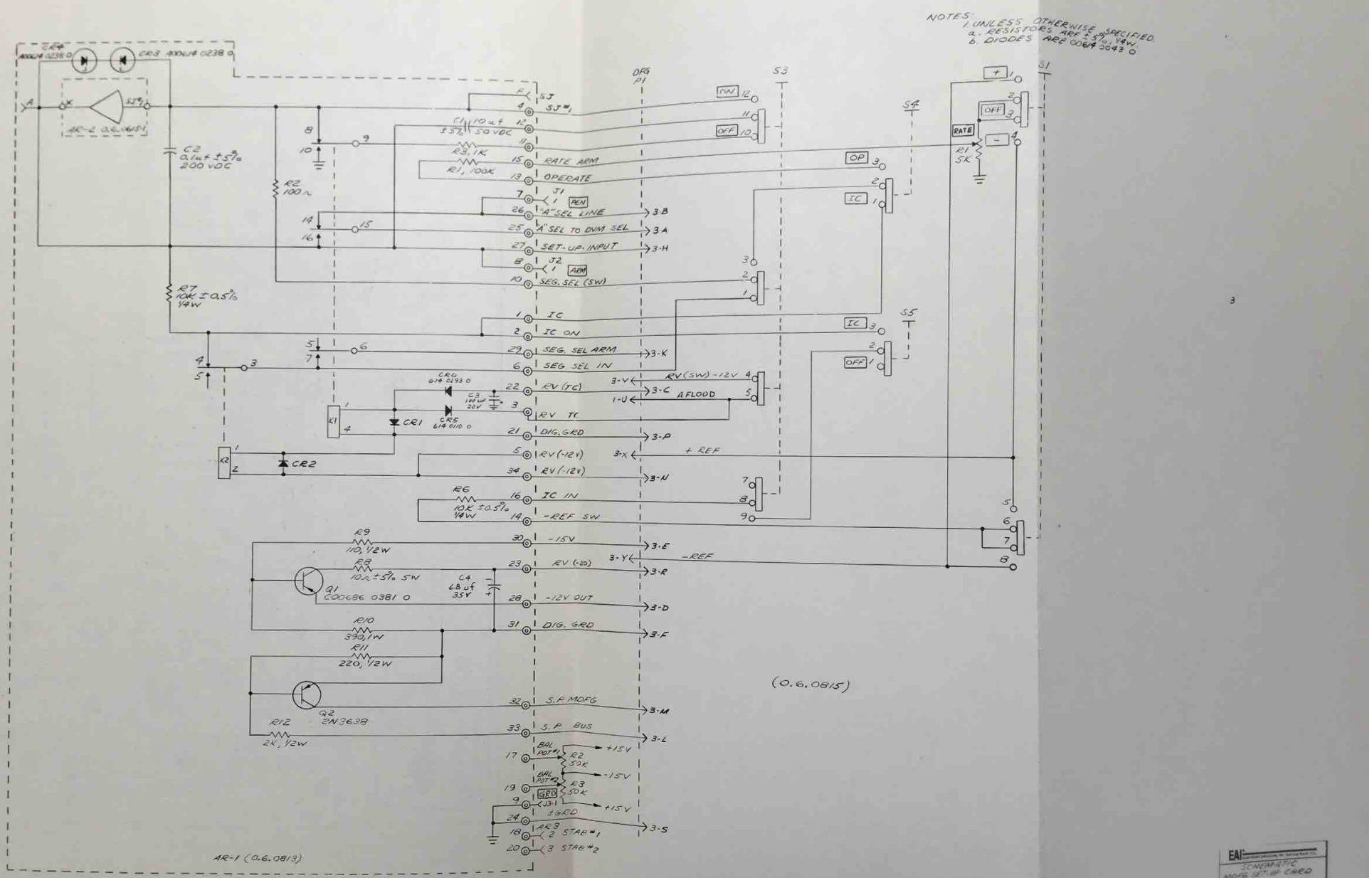
D00 006 0818 0W

SHEET 1 OF 4 SHEETS

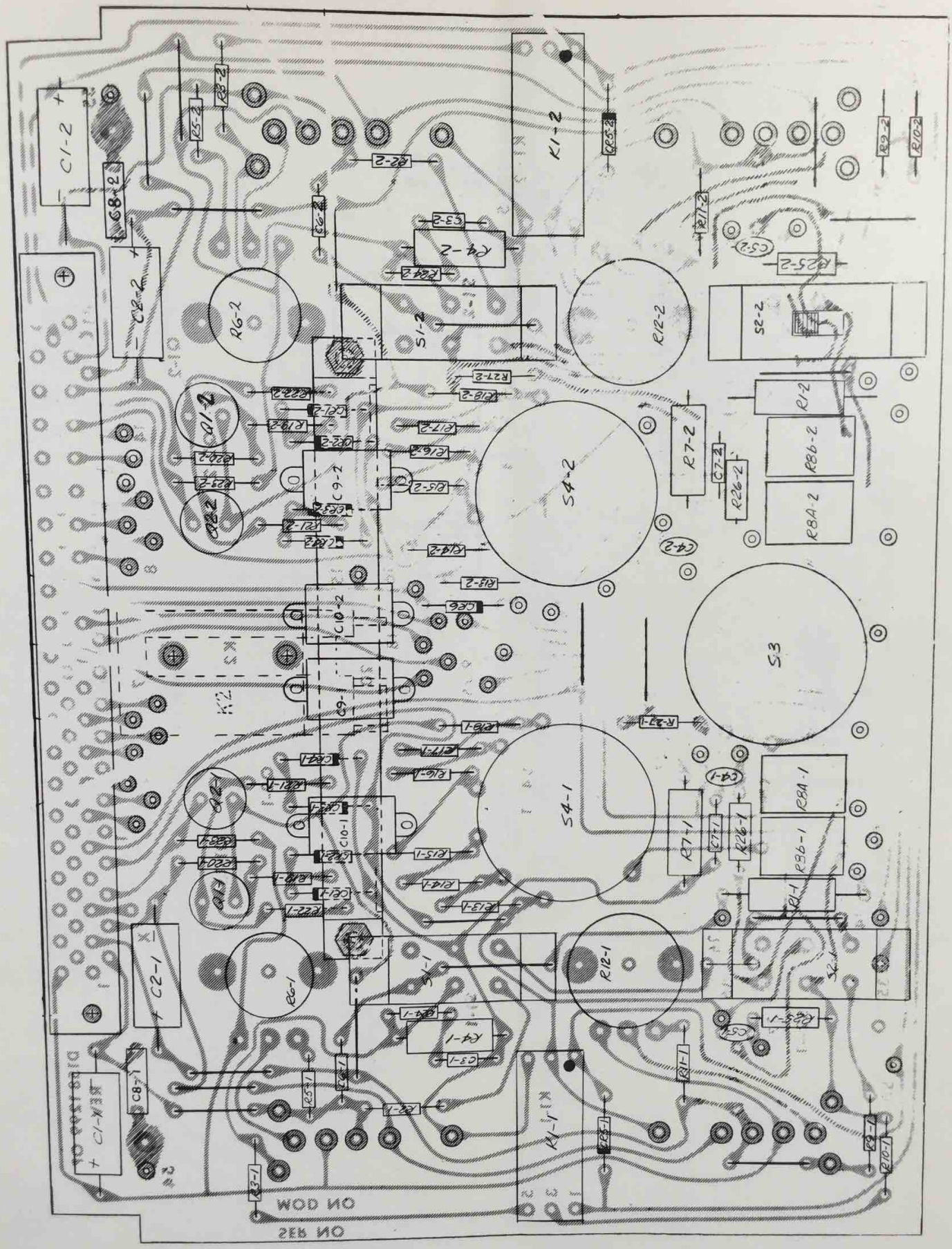

DFG P1-1
DFG P1-2
DFG P1-3
MDFG AR1
DUAL D.C. AMPL AR2
REF OP. TIMER AR3
S1
S SELECT S2
S3
S4
S5
R1
R2
R3
J1
J2
J3
CABLE #1
CABLE #2
CABLE #3
-RV (SW)
A FLOOD
-15 V
OUTPUT #2
+12 V
±GRD
6.3 AC
6.3 AC
+30 V
M.Q.
M.Q.
+30 V
±GRD
+15 V
OUTPUT #1
-15 V
SJ #1
RV TC
WHT-BLU
VIO
BLU-YEL
ORN
BLK
BRN
WHT-BRN
RED
BLK-WHT
BLK-WHT
RED
BLK
ORN
YEL-BRN
VIO
GRN
(CABLE 3)
BAL #2 YEL
STAB #2 ORN
STAB #1 RED
BAL #1 BRN
OUTPUT #1 BLK YEL
OP CONTROL
SJ #1
±GRD (b)
IC CONTROL
-REF
±GRD (a)
X 0.1
X 1
X 10
OP POT HI
IC POT HI
+REF
-20 V
T.S.
DIG GRD
±GRD (c)
+15 V
RUN
PP
+5 V
OP OUT
IC OUT
VIO
GRN
BLK
RED
WHT-VIO
BLK
YEL-BLU
BLU-WHT
BLU-YEL
WHT-VIO
WHT-RED
WHT-RED
GY
BLU
GY-BLK
BLK
ORN
RED-BLU
WHT
GRN-WHT
BLK
YEL
RG (SW) GY-BLK
RV (TC) WHT-BLU
RV GY
±GRD BLK
AS DVM BLK-WHT
AS LINE BLK-YEL
SJU IN YEL
-12 V OUT BLU
SEG ARM GRN-RED
-15V VIO
DIS GRD GY-BLK
SP MDFG WHT-GRN
SP BUS GRN
RV-12V BLU-WHT
±REF
-REF
S. SEL
SERVO OUT
RV (SW)-12
±GRD
+15 V
-15 V
-REF SW
STAB #1
STAB #2
SJ #1
SEG SEL IN
SEG SEL (SW)
IC IN
OPER
IC
IC OUT
ERR ARM
ARM BAL #1
ARM BAL #2
ARM
ARM
IGRD
SJ #1 WHT-GRN
WHT-BLU
WHT-VIO
GRN-WHT
BLK-YEL
WHT-BLU
BLK
ORN
VIO
WHT-VIO
ORN
RED
GRN
GRN-RED
GRN-RED
GRN
WHT-GRN
BLU
GRN-WHT
BRN-YEL
YEL-BRN
RED
YEL
BRN
RED
YEL
BLK
POT HI
WHT-RED
SD BUS #22
IC OP SW
OFF IC SW
2 YEL-BRN
WHT-BLU
PART OF CABLE #3
3 #22 SD-BUS
1 #22 SD-BUS



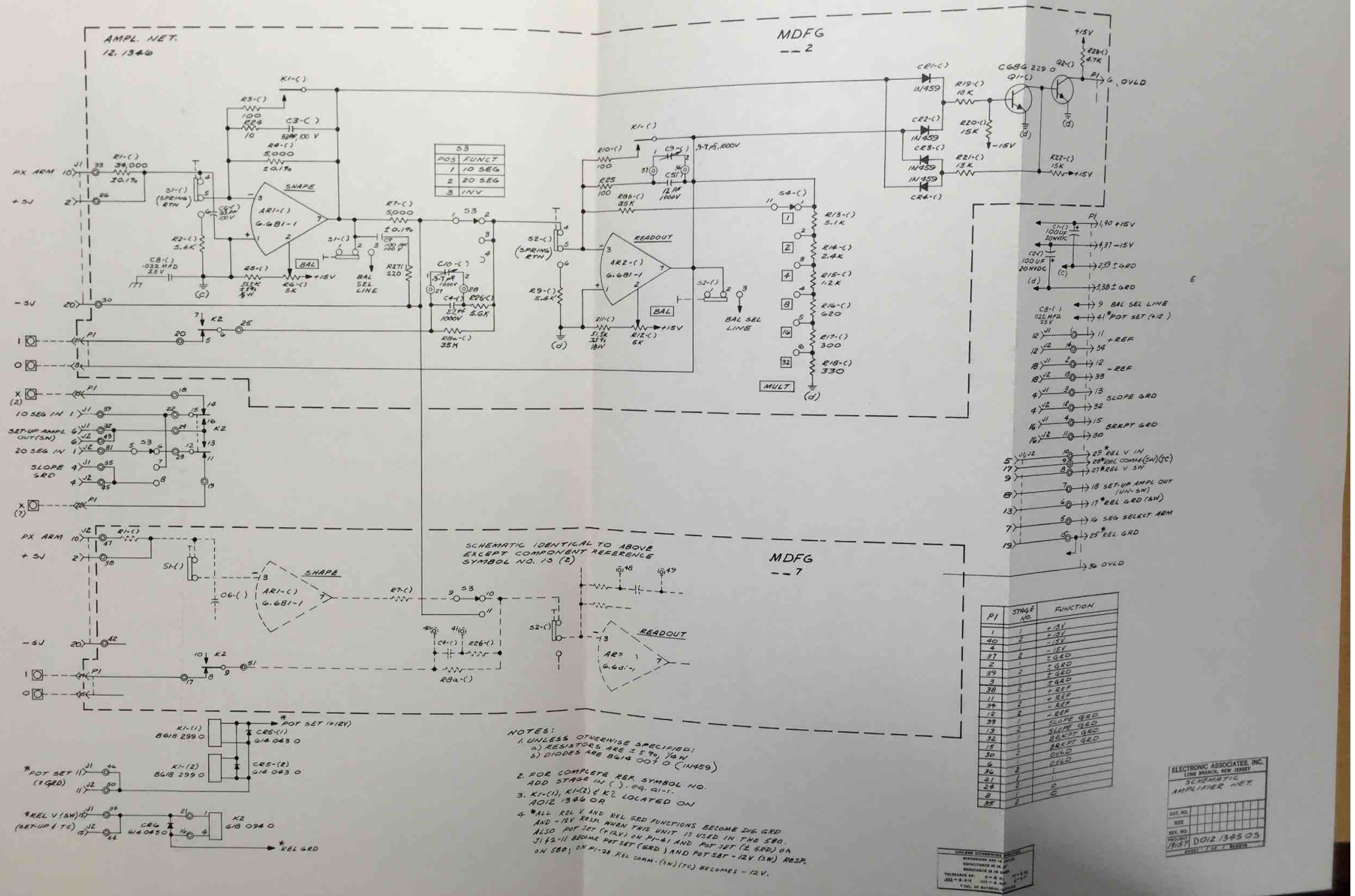
0.06.0813 MDFG Setup Card



EAI
SCHEMATIC
MDFG SET-UP CARD
DWG. NO. D00-006 0813 05



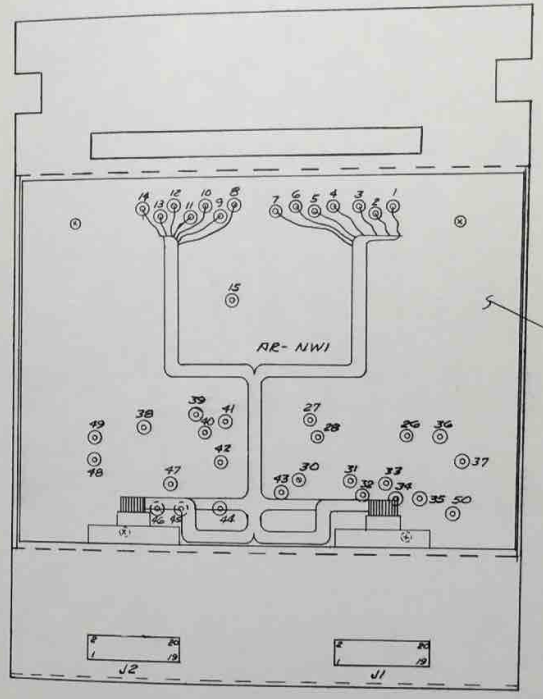
0.12.1346 Amplifier Network, MDFG



P1	STAGE NO.	FUNCTION
1	1	+15V
40	2	+15V
4	1	-15V
37	2	-15V
2	1	± GRD
39	2	± GRD
3	2	± GRD
38	2	+ REF
11	1	+ REF
34	2	+ REF
12	2	- REF
33	1	SLOPE GRD
13	2	SLOPE GRD
32	1	BRKPT GRD
15	2	BRKPT GRD
30	1	OVLD
6	2	OVLD
36	2	
21	1	
24	2	0
8	1	0
35	2	

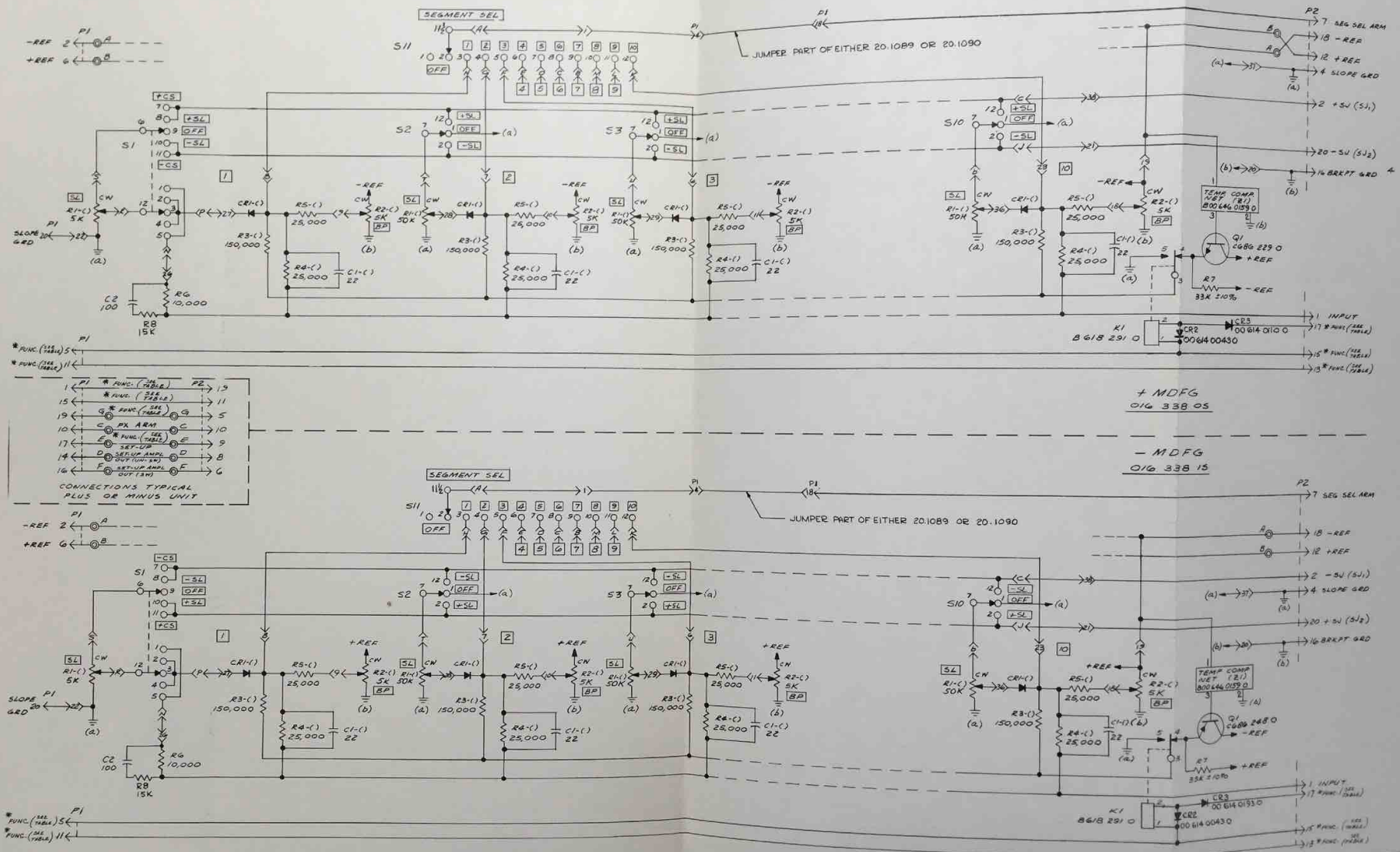
AR-NW1-		J1	J2
1	+ REF	WHT-RED	12
14	+ REF	WHT-RED	12
2	- REF	WHT-VIO	18
13	- REF	WHT-VIO	18
3	SLOPE GRD	BLK	4
12	SLOPE GRD	BLK	4
4	BKRPT GRD	BLK-WHT	16
11	BKRPT GRD	BLK-WHT	16
10	*REL V	BLU	5
9	*REL GRD SW (TC)	WHT-GRY	5 17
8	*REL V (SW)	BLU-WHT	17 9
7	SET-UP AMPL OUT (IN-SW)	BLU-YEL	9 8
6	*REL GRD (SW)	GRY	8 13
5	SEG. SEL ARM	GRN	13 7
15	*REL GRD	GRY	7 19
33	PX ARM	RED	19 10
47	PX ARM	RED	10
26	+ SJ	GRN	2
38	+ SJ	GRN	2
30	- SJ	GRN	20
42	- SJ	GRN	20
39	10 SEG IN	ORN	1
32	SET-UP AMPL OUT (SW)	YEL	6
43	SET-UP AMPL OUT (SW)	YEL	6
31	20 SEG IN	ORN	1
35	SLOPE GRD	BLK	4
45	SLOPE GRD	BLK	4
46	*POT SET (3GRD)	BLK-RED	11
50	*POT SET (3GRD)	BLK-RED	11
34	*REL V (SW) SET-UP & TC	WHT-BLU	15
44	*REL V (SW) SET-UP & TC	WHT-BLU	15

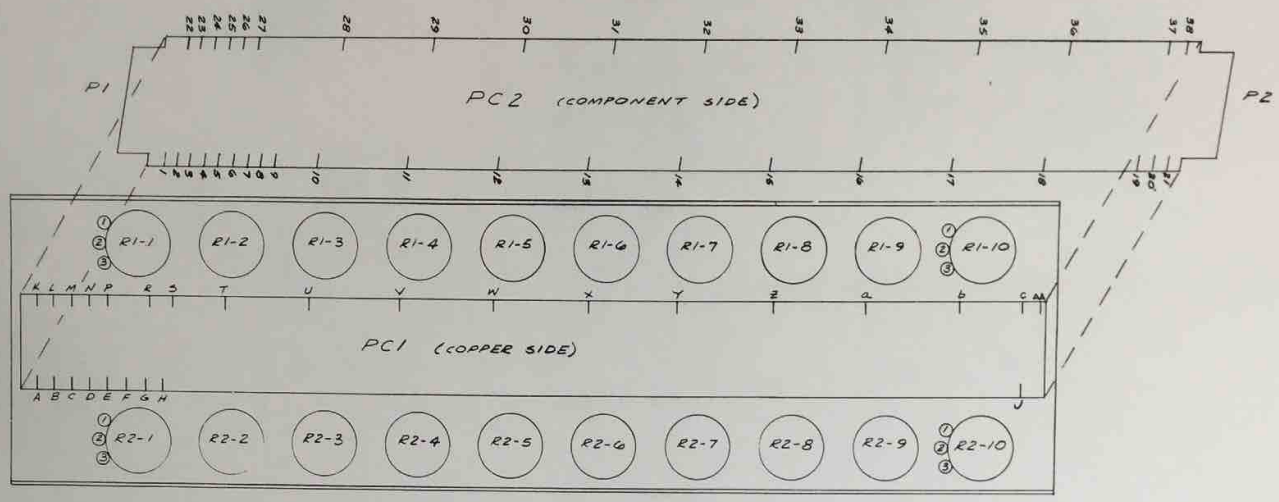
NOTE
1. UNLESS OTHERWISE SPECIFIED:
   a. WIRES TO BE "22 AWG".
2. ON AR-NW, WIRES #5, 26, 38, 30, & 42 ARE NOT TO BE INCLUDED IN HARNESS.
3. *ALL "REL V" AND "REL GRD" FUNCTIONS BECOME "DIG. GRD" AND "-12V" RESP. WHEN THIS UNIT IS USED IN THE 580. ALSO "POT SET (3GRD)" ON AR-NW1-46 & 50 BECOMES POT SET - 12 V (SW) IN THE 580.

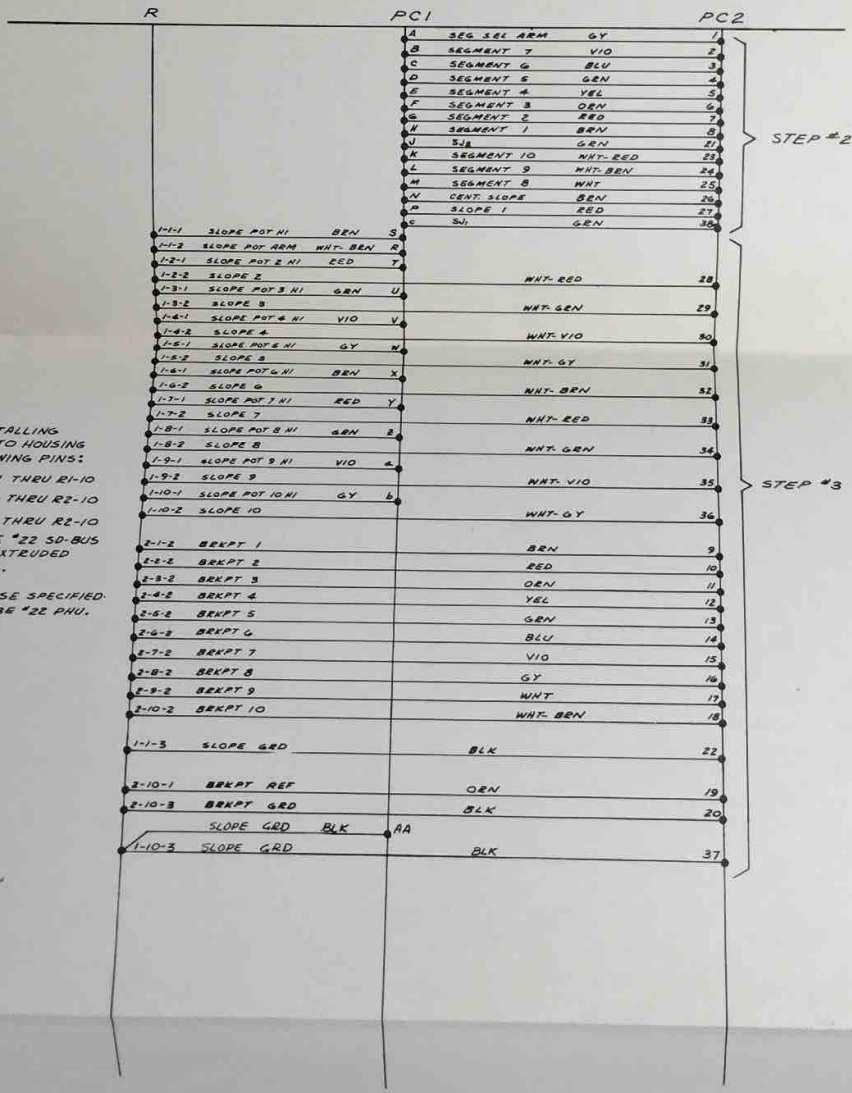


4

ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
WIRING
AMPLIFIER NETWORK
DWG. NO.
SIZE
REV. NO.
PROJECT
D012 1345 ON
SHEET OF SHEETS


SEGMENT SEL
S11
S1
S2
S3
S10
JUMPER PART OF EITHER 20.1089 OR 20.1090
+ MDFG
016 338 05
- MDFG
016 338 15
CONNECTIONS TYPICAL PLUS OR MINUS UNIT
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
a) DIODES ARE CG14 199 0
b) RESISTORS ARE ± 0.5%, 1/4W
2. SWITCHES S1-S11 ARE LOCATED ON A051 246 OP.
3. RESISTORS R3-R7, CR1, Q1, K1, Z1, C1 & C2 ARE LOCATED ON A012 1347 OP.
4. FOR COMPLETE REF. SYMBOL NUMBER ADD STAGE IN ( ), e.g. R1-(1)
ELECTRONIC ASSOCIATES, INC.
LONG BRANCH, NEW JERSEY
SCHEMATIC MDFG UNIT
SIZE D
DWG. NO. D016 338 05

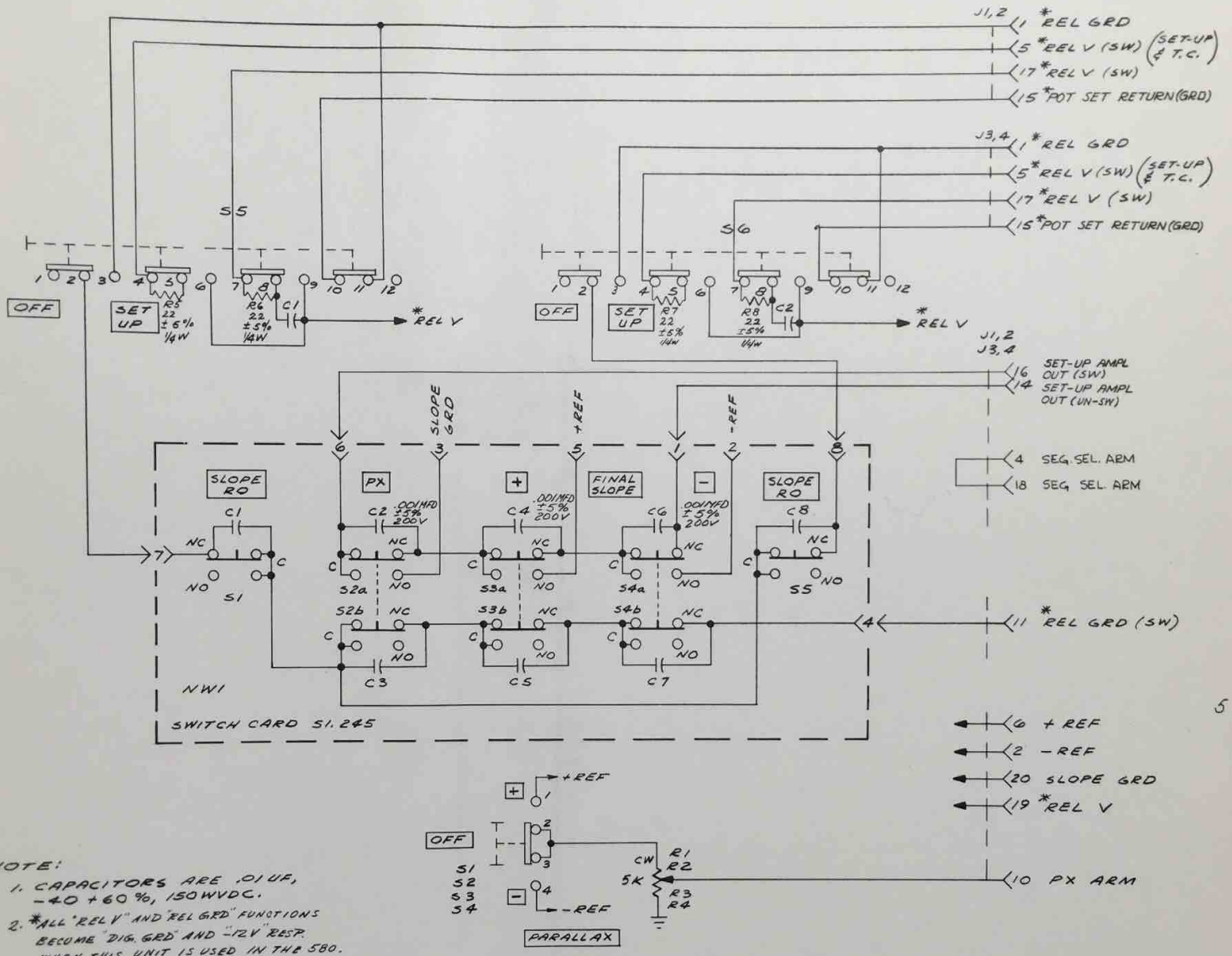




NOTES:

1. BEFORE INSTALLING PC1 & PC2 INTO HOUSING JUMPER FOLLOWING PINS:
   a) PIN 3 ON R1-1 THRU R1-10
   b) PIN 1 ON R2-1 THRU R2-10
   c) PIN 3 ON R2-1 THRU R2-10
   JUMPERS TO BE #22 SD-BUS COVERED WITH EXTRUDED PLASTIC TUBING.
2. UNLESS OTHERWISE SPECIFIED ALL WIRES TO BE #22 PHU.

ELECTRONIC ASSOCIATES, INC.
WIRING
MDFS UNIT
004 538 ON



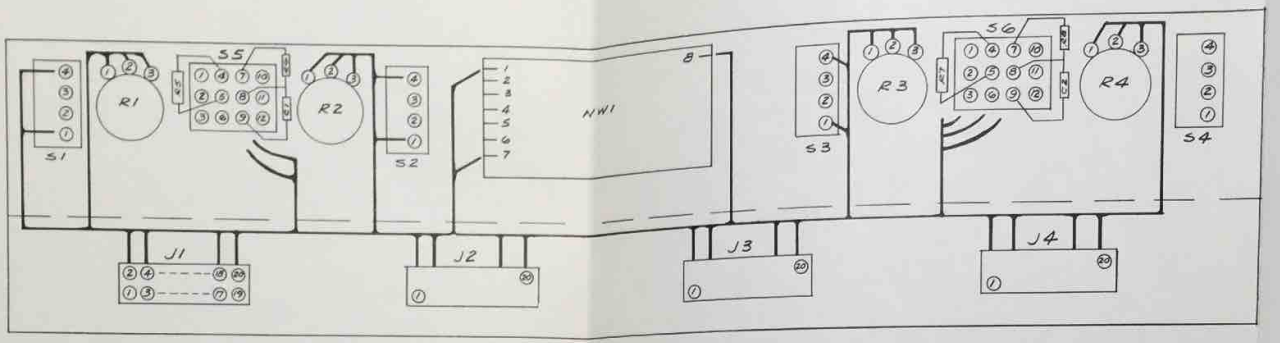
NOTE:

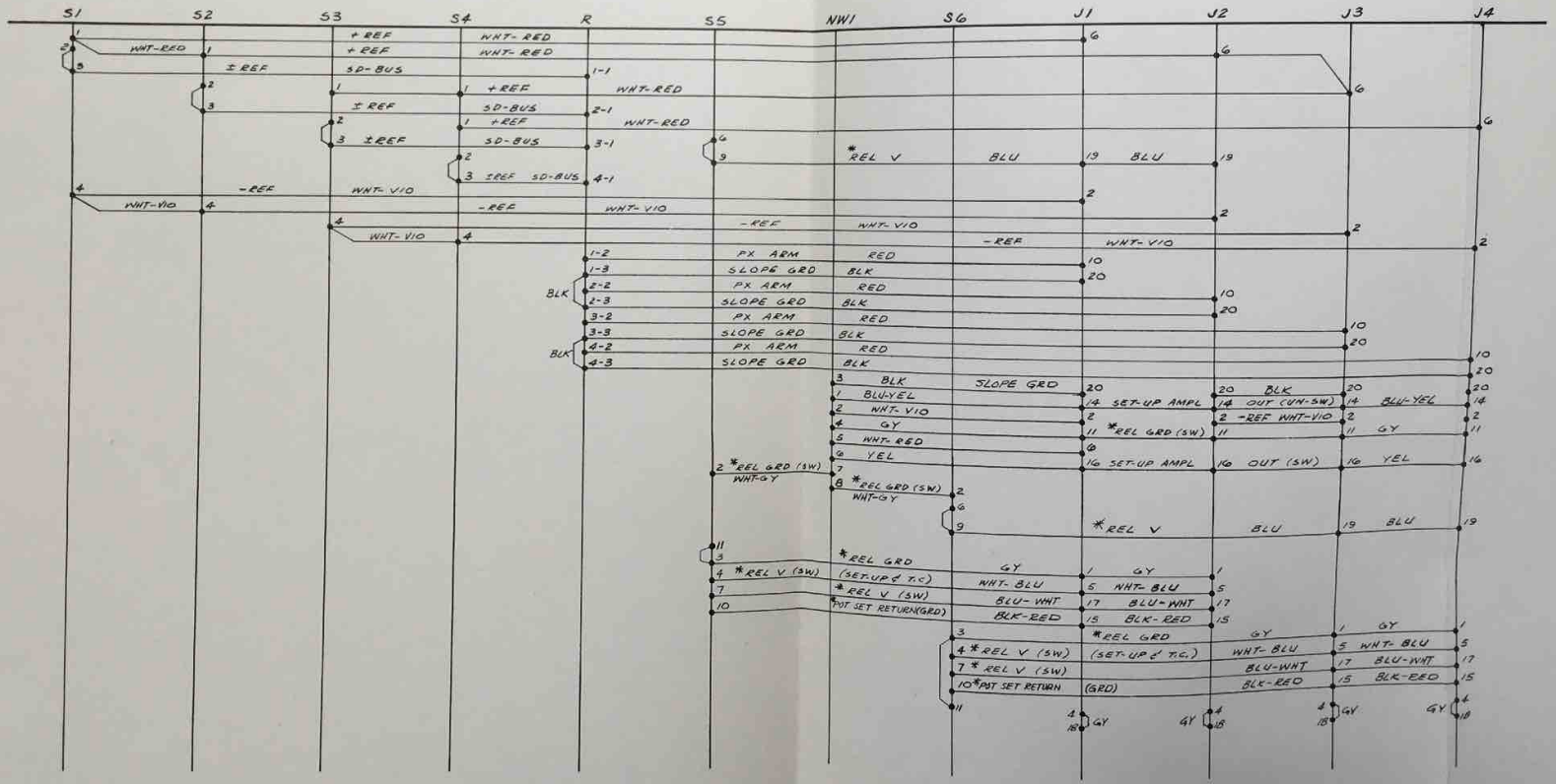
1. CAPACITORS ARE .01 UF, -40 +60 %, 150 WVDC.
2. *ALL "REL V" AND "REL GRD" FUNCTIONS BECOME "DIG. GRD" AND "-12 V" RESP. WHEN THIS UNIT IS USED IN THE 580. ALSO "POTSET RETURN (GRD)" BECOMES "POT SET -12 V (SW)" WHEN USED IN 580 J1, 2, 3 & 4 - 15 POSITIONS.

5

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN μF
RESISTANCE IS IN OHMS
TOLERANCE OF: X = ± .03 .XX = ± .02 .XXX = ± .015 .XXX = ± .005 ∠ = ± 1°
*TOL. OF MATERIAL SUPPLIED

ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
SCHEMATIC CONTROL PANEL	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 1957	C020 1090 05
SHEET 1 OF 1 SHEETS	

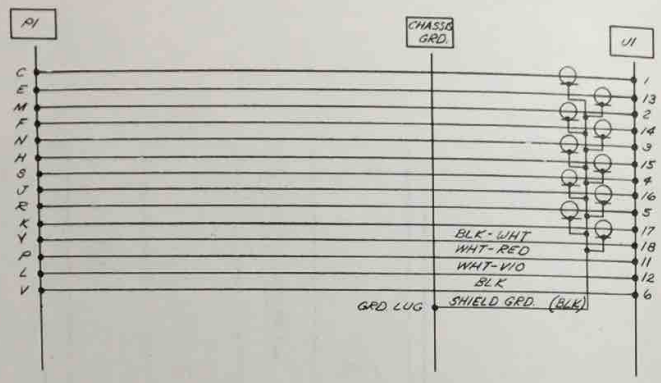




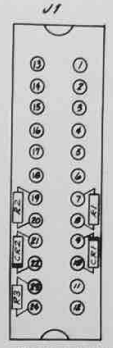
NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) WIRES ARE #22 PNU.
   b) JUMPERS ARE #22 SD-BUS COVERED WITH EXTRUDED PLASTIC TUBING WHERE NECESSARY.
2. * ALL REL V AND REL GRD FUNCTIONS BECOME DIG. GRD AND -12V RESP. WHEN THIS UNIT IS USED IN THE 580. ALSO "POT SET RETURN" POSITION 3, J1, 2, 3 & 4 - 15 BECOMES "POT SET - 12V (SW)" WHEN USED IN 580.

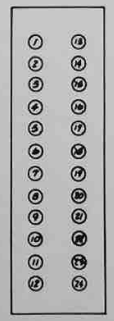
ELECTRONIC ASSOCIATES, INC. LONG BRANCH, NEW JERSEY	
WIRING CONTROL PANEL	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19/57	D020 1090 0W
SHEET 1 OF 1 SHEETS	



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) WIRES TO BE #22 P.H.V.
   b) COAX PER B00916 0001 0.



CONN. BLOCK
REAR VIEW

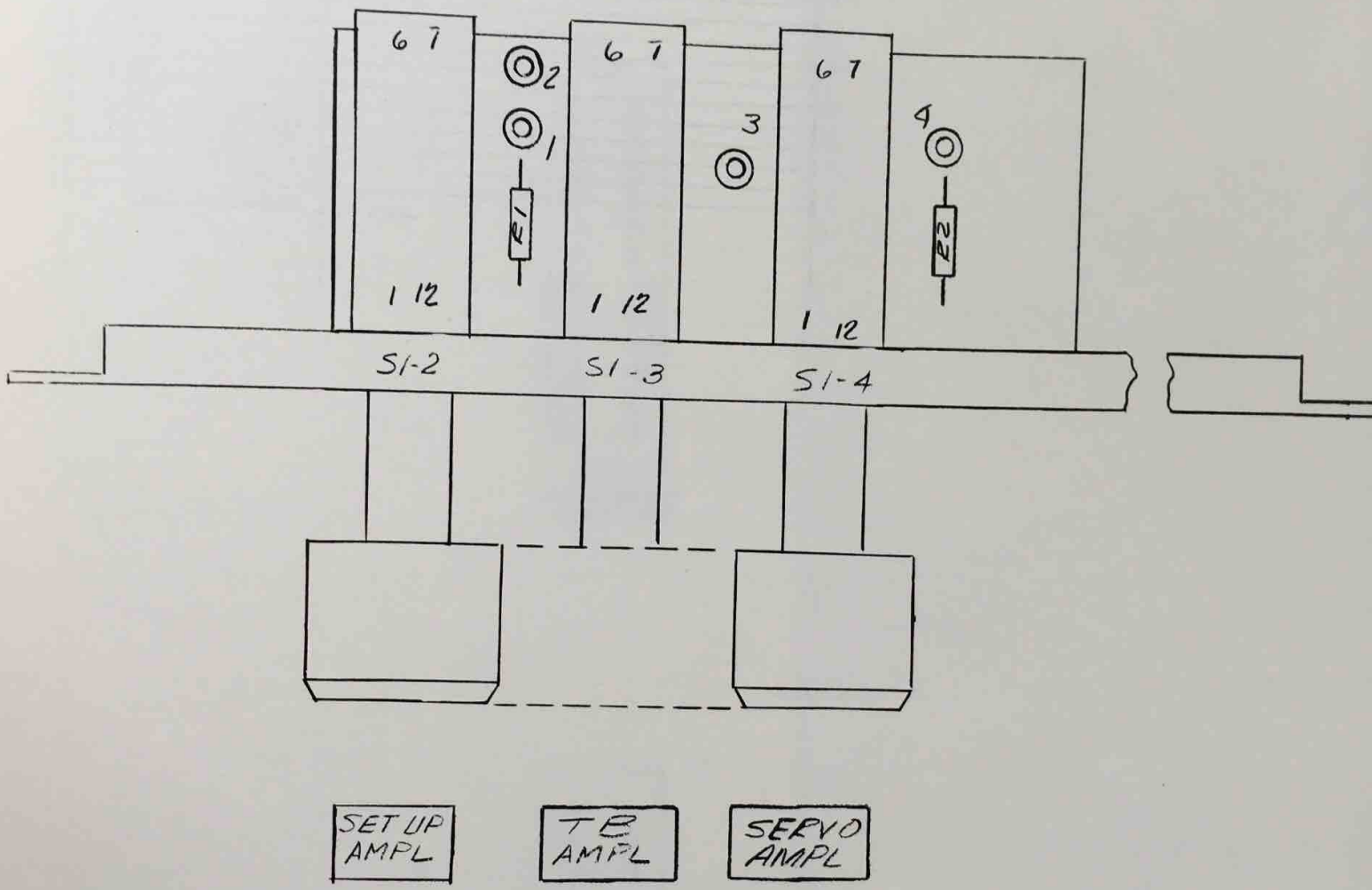


CONN. BLOCK
FRONT VIEW

EAI
ASSEMBLY WIRING INTO READOUT TRAY

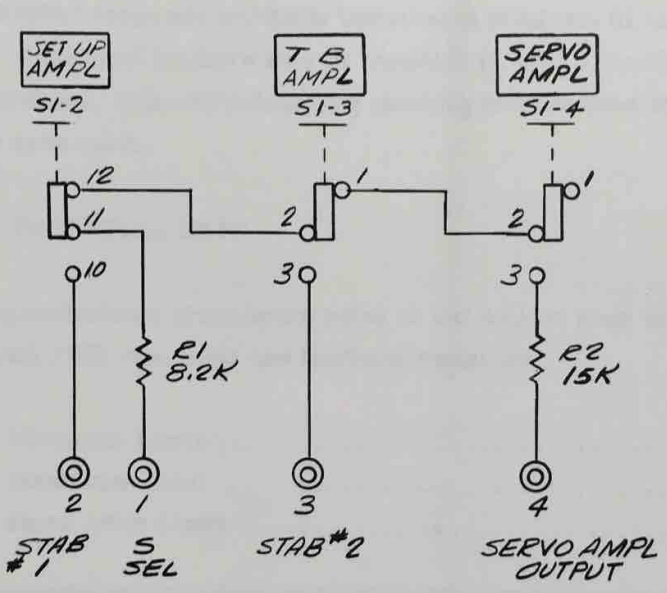
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19316	D00 051 0366 00

SHEET 2 OF 2 SHEETS



0.51.0366 S Select Card

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a. RESISTORS ARE ±5%, 1/4 W.
2. ALL SECTIONS ARE INTERLOCKING.



UNLESS OTHERWISE SPECIFIED	
DIMENSIONS ARE IN INCHES	
CAPACITANCE IS IN pf	
RESISTANCE IS IN OHMS	
TOLERANCE OF:	.X = ± .03 .XX = ± .02 .XXX = ± .015 .XXX = ± .005 ∠ = ± 1°
*TOL. OF MATERIAL SUPPLIED	
EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.	
SCHEMATIC S SELECT CARD	
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19330	B00 051 036605
SHEET 1 OF 1 SHEETS	

CHAPTER 6

POTENTIOMETER-LIMITER TRAY, MODEL 0.42.0342

6.1 INTRODUCTION

The 0.42.0342 Potentiometer-Limiter Tray (Figure 6.1) provides three variable, accurate feedback limiters capable of limiting either or both the positive and negative amplifier outputs.

Two limiter trays are normally installed in positions 51 and 60 in the patch bay. (See Figure 6.2.) Additional limiters may be installed in any _5 through _9 attenuator slot. Besides limiter terminations, this unit retains the patching terminations for the attenuators normally terminated in the area used.

6.2 TECHNICAL DATA

The specifications given below refer to the limiter when operating in conjunction with an amplifier with 100k ohm input and feedback resistors.

Minimum Limit	≦1 Volt
Maximum Limit	≧10 Volts
Slope After Limit	≦8 Millivolts

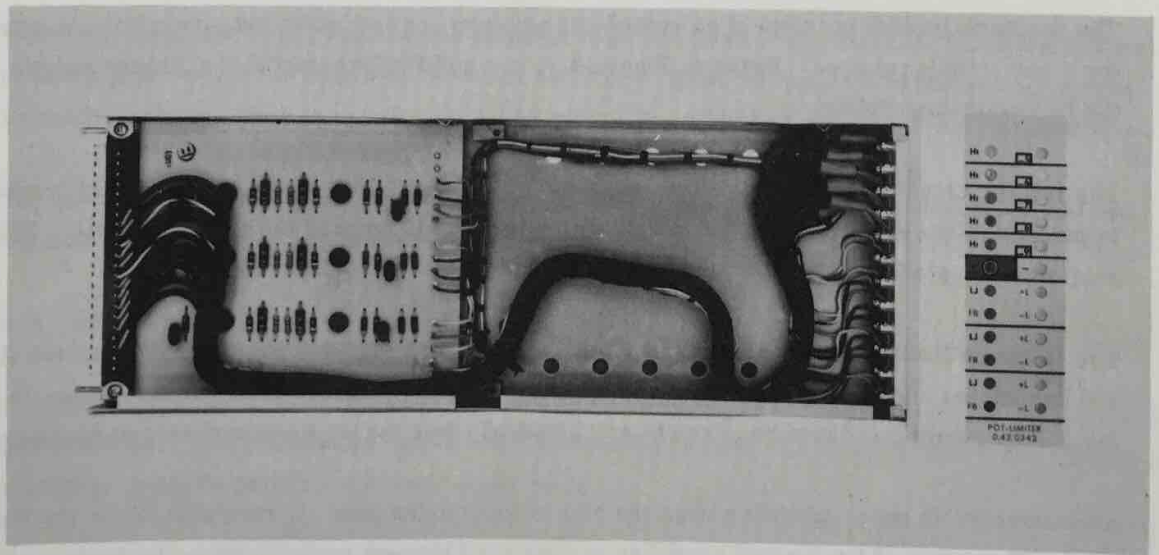


Figure 6.1. Potentiometer-Limiter Tray, Model 0.42.0342

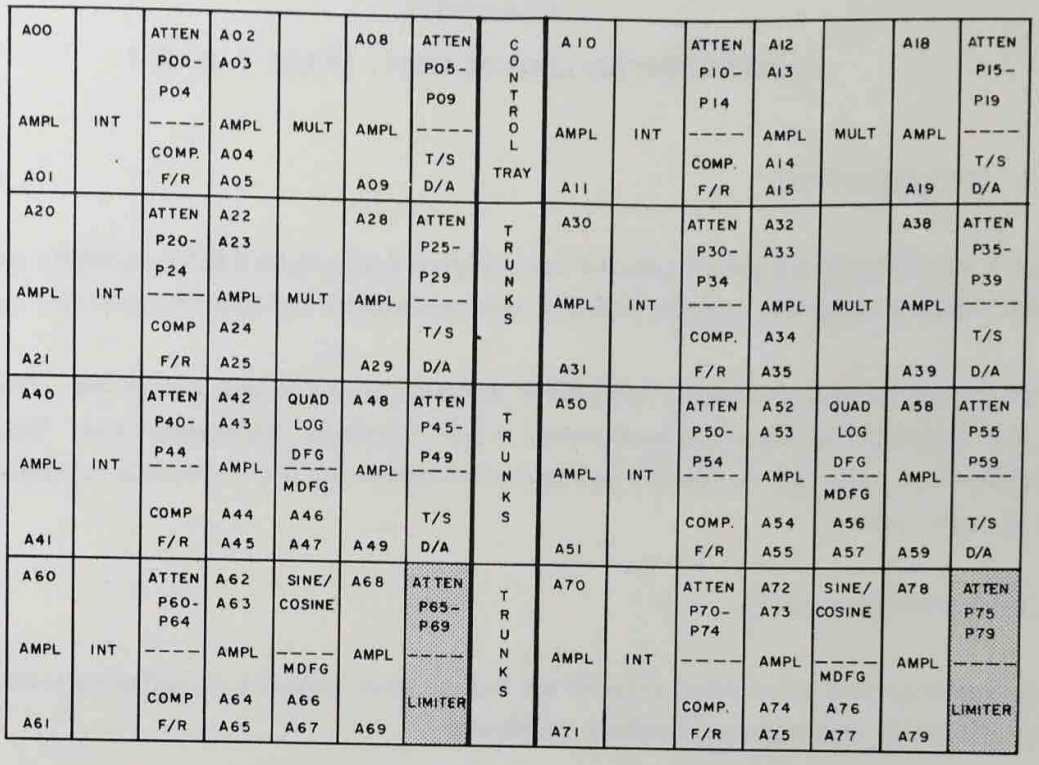


Figure 6.2. Location of Pot-Limiter Trays

6.3 THEORY OF OPERATION

The feedback limiter consists of an etched-circuit card and two servo set attenuators to establish the + and - limit voltages. Refer to Figure 6.3, a simplified schematic of a limiter circuit, for the following description.

The limiter circuit must be patched to an amplifier for use. The output of the limited amplifier is patched to the FB terminal, and the amplifier junction is patched to the LJ terminal. This configuration places the limiter in parallel with the amplifier feedback resistor.

The feedback limiter consists of two identical circuits, one for each polarity. Transistor Q1 and associated components form the negative limiter circuit; Q2 and associated components form the positive limiter. Since the circuits are identical, only the Q1 (negative) circuit is described.

Attenuator R1 is set to provide a negative bias voltage to the base of transistor Q1 on the limiter card. The output of the limited amplifier is connected through resistor R5 to the emitter of Q1. When the output of the amplifier is positive the limiter is cut off. Resistor R4 provides a positive potential to the collector of Q1 under these conditions, and diode CR2 is reverse biased.

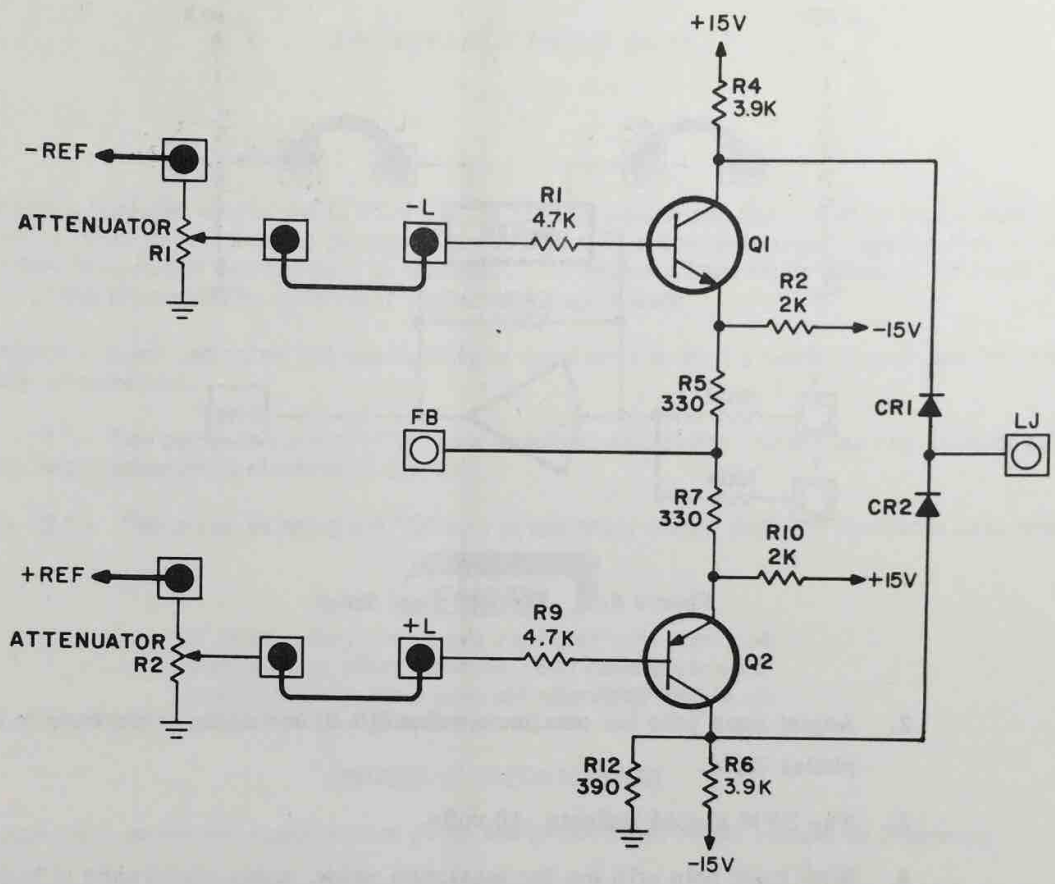


Figure 6.3. Feedback Limiter Circuit, Simplified Schematic

When the amplifier output reaches the selected bias, transistor Q1 conducts, placing a low impedance path across the amplifier feedback resistor. When the negative output voltage drops below the selected bias, transistor Q1 is cut off and the amplifier returns to normal operation.

The positive limiter circuit is identical, except for the use of a PNP transistor (Q2), and reversing diode CR2 and bias potentials.

6.4 MAINTENANCE

Troubleshooting the limiter is relatively easy since most of the components can be checked with an ohmmeter. The transistors can be checked by substitution. To check to see if the limiter is operating properly perform the tests given below.

6.4.1 Maximum Limit Check

1. Set up the test circuit shown in Figure 6.4.

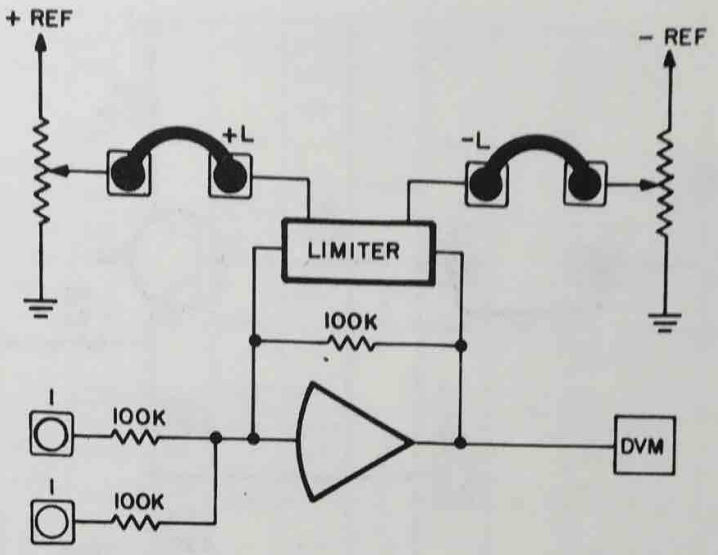


Figure 6.4. Limiter Test Setup

2. Adjust limit pots for maximum value (10.0) and apply +reference to one amplifier input.
3. The DVM should indicate -10 volts.
4. With limit pots still set for maximum value, apply +reference to both inputs.
5. The DVM reading should not exceed 11.999 volts.
6. Repeat Steps 3, 4, and 5 using -reference inputs. The DVM inputs should be the same but opposite in polarity.

6.4.2 Slope After Limit

1. Set up the test circuit shown in Figure 6.4.
2. Connect +reference to both amplifier inputs.
3. Adjust the -limiter pot for a reading of 1.0 volt on the DVM.
4. Remove reference from one of these amplifier inputs and observe the new DVM reading.
5. Using the formula Slope = $\frac{\Delta E}{10}$ calculate the amount of slope after limits. The slope should not exceed 8 millivolts/volt.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	J1	Connector Block: White	00 542.1545-2	B
2		Connector Block: Lettered (POT-LIMITER 0.42.0342)	00 542.1551-7	B
		0.16.0354 ±LIMITER CARD		
1	C1-(),2-()	Capacitor, Fixed, Mica: 330 pf ±2%, 100V (Elmenco 4CRDM10F-331-G0-100WV or equal)	00 519.0091-0	A
2	C3-(),4-()	Capacitor, Fixed, Ceramic: 33 pf ±10%, 200V (Vitramon VK23BW330JW or equal)	00 515.0288-0	A
3	CR1-(),2-()	Diode	00 614.0007-0	B
4	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-23 or equal)	00 542.0419-0	A
5	Q1-()	Transistor	00 686.0311-0	B
6	Q2-()	Transistor	00 686.0312-0	B
7	R1-(),4-(), 6-(),9-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0472-0	A
8	R2-(),10-()	Resistor, Fixed, Composition: 3.3K ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0332-0	A
9	R5-(),7-()	Resistor, Fixed, Film: 332 ohms ±1%, 1/4W (Int. Resistance Corp. Type CEA or equal)	00 632.3320-0	A
10	R11-(), 12-()	Resistor, Fixed, Composition: 390 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0390-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE

POT LIMITER TRAY

MODEL NO.

0.42.0342 Sh. 1 of 1 Sh.

DATE 4/ 26 / 68

APPENDIX 2

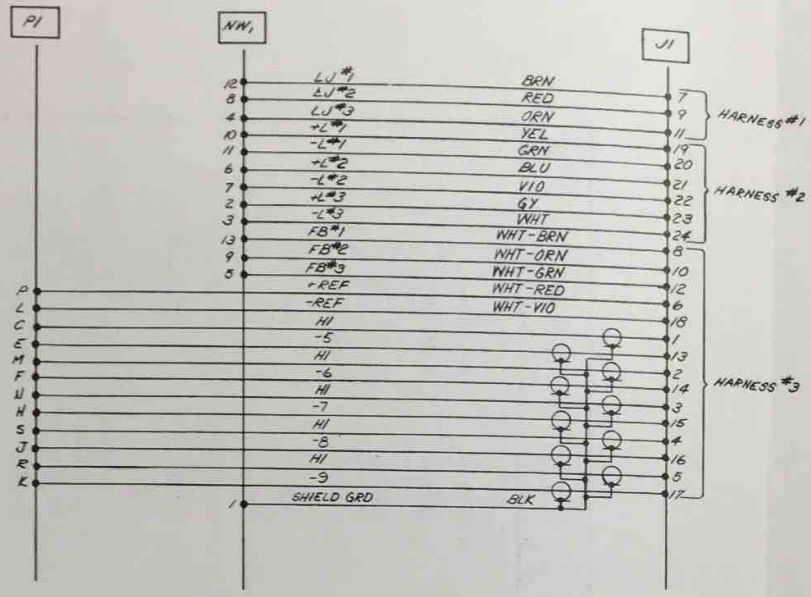
DRAWINGS

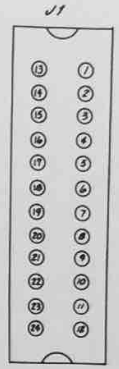
This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

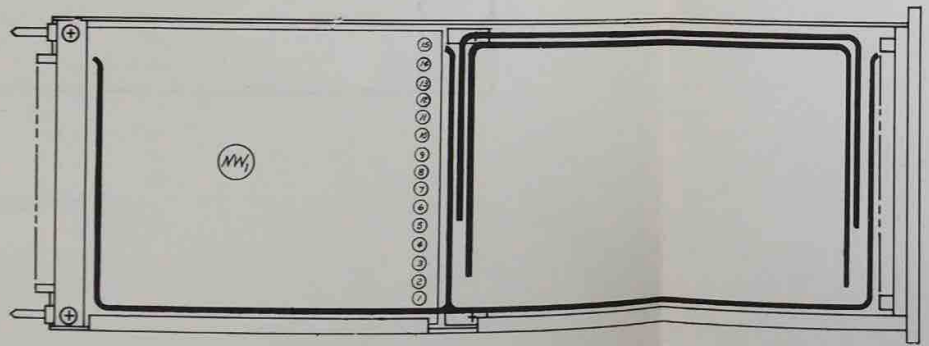
INDEX

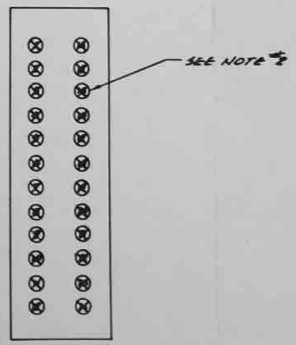
Unit or Component	Type of Drawing	Drawing Number
0.42.0342 Pot-Limiter Tray	Assembly W/ Wiring	D00 042 0342 0A
0.16.0354 ±Limiter Card	Schematic	B00 016 0354 0S





CONN. BLOCK
REAR VIEW



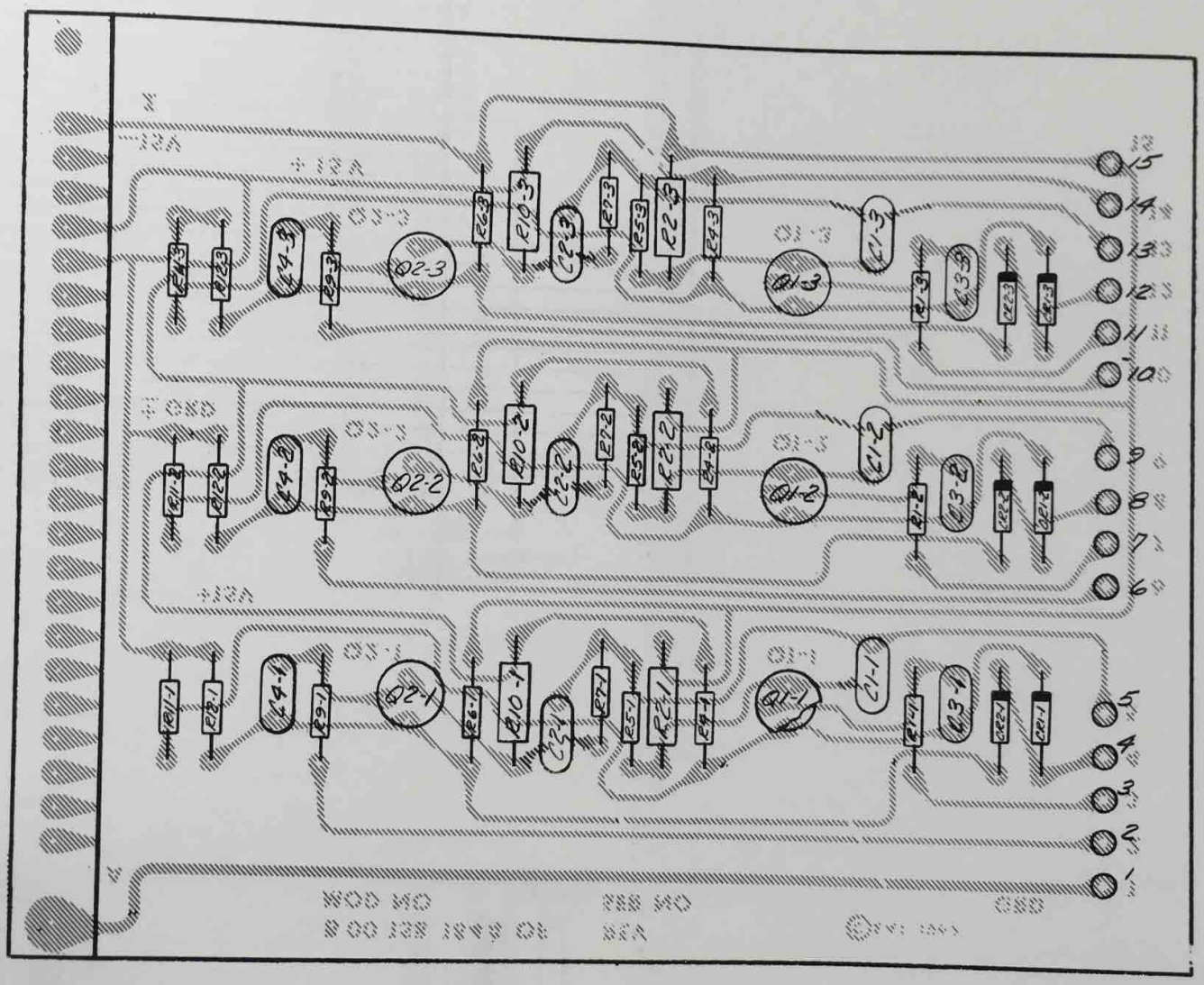


CONN. BLOCK
FRONT VIEW

EAI

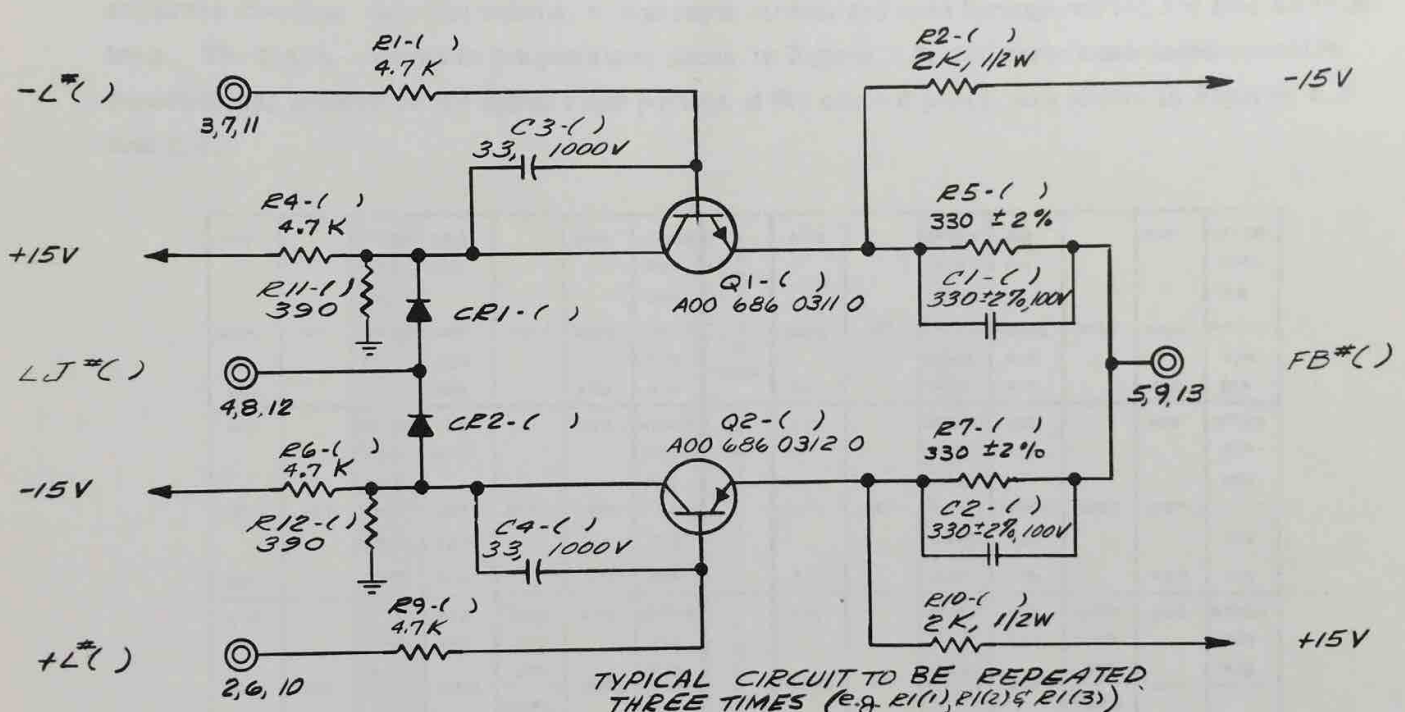
ASSEMBLY W/WIRING INFO
POT LIMITER TRAY

SHT. NO.
SIZE
REV. NO.
PROJECT 19316
D00 042 0342 0A

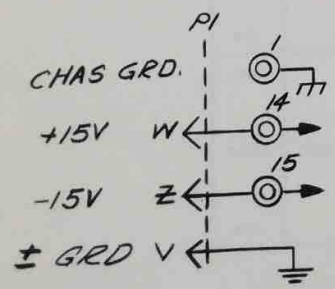


16.0354 ±Limiter Card

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a. RESISTORS ARE ±5%, 1/4W.
   b. DIODES ARE B00 614 0007 0.



TYPICAL CIRCUIT TO BE REPEATED THREE TIMES (e.g. R1(1), R1(2) & R1(3))



UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN pf
RESISTANCE IS IN OHMS
TOLERANCE OF: .X = ± .03 .XX = ± .02 .XXX = ± .015 .XXX = ± .005 ∠ = ± 1°
*TOL. OF MATERIAL SUPPLIED

EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.

SCHEMATIC
± LIMITER

SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19316	B00 016 0354 05

SHEET / OF / SHEETS

SECTION 3

LOGIC INTERFACE

CHAPTER 1

POTENTIOMETER-COMPARATOR-FUNCTION RELAY TRAY, MODEL 0.42.0340

1.1 INTRODUCTION

The 0.42.0340 Potentiometer-Comparator-Function Relay (Pot-Comp-F/R) trays contain three separate circuits: function relays, comparator circuit and feed through wiring for five attenuators. The trays, located in the positions shown in Figure 1.1, and their associated override pushbuttons, located on the upper right portion of the control panel, are shown in Figures 1.2 and 1.3.

A00 AMPL A01	INT	ATTEN P00-P04 COMP. F/R	A02 A03 AMPL A04 A05	MULT	A08 AMPL A09	ATTEN P05-P09 T/S D/A	CONTROL TRAY	A10 AMPL A11	INT	ATTEN P10-P14 COMP. F/R	A12 A13 AMPL A14 A15	MULT	A18 AMPL A19	ATTEN P15-P19 T/S D/A
A20 AMPL A21	INT	ATTEN P20-P24 COMP F/R	A22 A23 AMPL A24 A25	MULT	A28 AMPL A29	ATTEN P25-P29 T/S D/A	TRUNKS	A30 AMPL A31	INT	ATTEN P30-P34 COMP. F/R	A32 A33 AMPL A34 A35	MULT	A38 AMPL A39	ATTEN P35-P39 T/S D/A
A40 AMPL A41	INT	ATTEN P40-P44 COMP F/R	A42 A43 AMPL A44 A45	QUAD LOG DFG MDFG A46 A47	A48 AMPL A49	ATTEN P45-P49 T/S D/A	TRUNKS	A50 AMPL A51	INT	ATTEN P50-P54 COMP. F/R	A52 A53 AMPL A54 A55	QUAD LOG DFG MDFG A56 A57	A58 AMPL A59	ATTEN P55 P59 T/S D/A
A60 AMPL A61	INT	ATTEN P60-P64 COMP F/R	A62 A63 AMPL A64 A65	SINE/COSINE MDFG A66 A67	A68 AMPL A69	ATTEN P65-P69 LIMITER	TRUNKS	A70 AMPL A71	INT	ATTEN P70-P74 COMP. F/R	A72 A73 AMPL A74 A75	SINE/COSINE MDFG A76 A77	A78 AMPL A79	ATTEN P75 P79 LIMITER

Figure 1.1. Location of the Pot-Comp-F/R Tray, Model 0.42.0340

The function relays are used for any switching functions necessary for the solution of a problem. Control of these relays is accomplished using logic levels patched to the S and R terminals on the patch panel. Override logic levels are provided by the FUNCTION RELAY pushbuttons on the control panel.

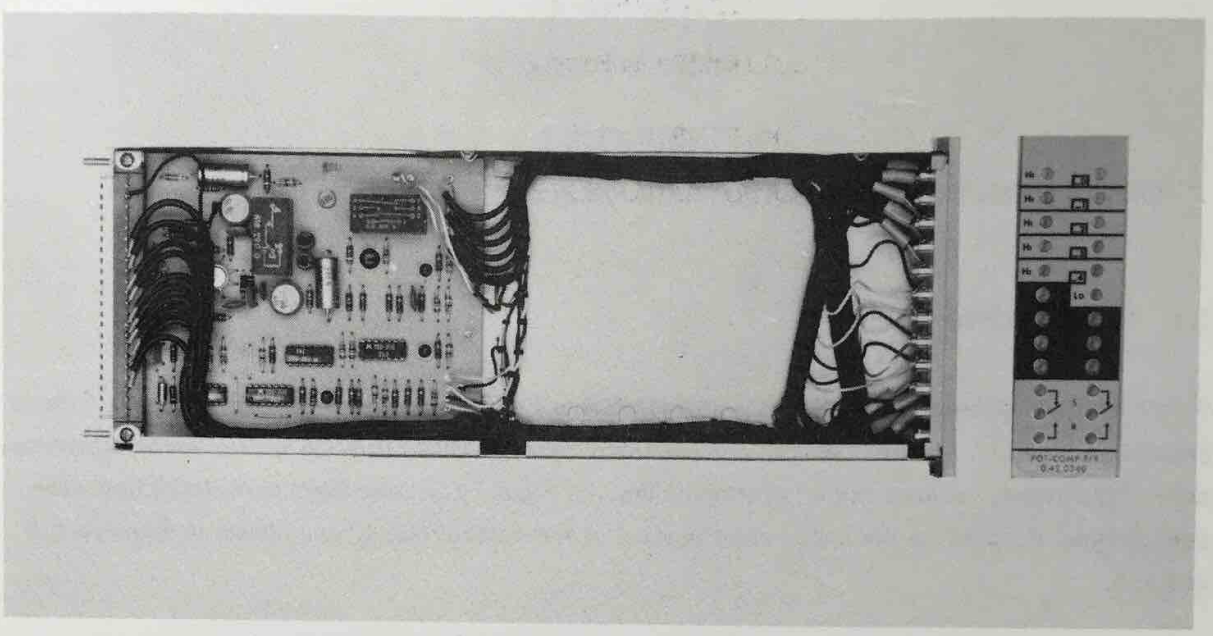


Figure 1.2. Pot-Comp-F/R Tray, Model 0.42.0340

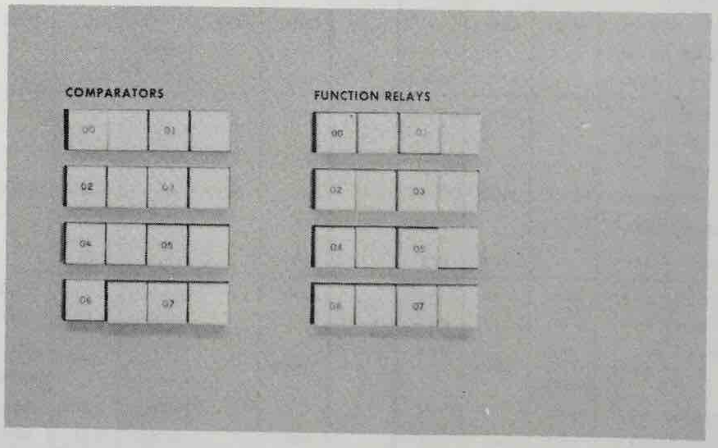


Figure 1.3. Comparator and Function Relay Pushbuttons

The comparator algebraically compares two analog input voltages and provides a logic signal and its complement as an output. If the algebraic sum of the input voltages is positive, the comparator output state is high and its complement is low. If the algebraic sum of the input voltages is negative the reverse is true. Comparator override logic levels are provided by the comparator pushbuttons located on the control panel.

The potentiometer feedthrough wiring on the tray provides patching to the high and wiper terminals of five potentiometers. A description of the computer attenuator system is given in Chapter 5 of the 580 Console Component Manual (Publication Number 00 800.2056-0).

1.2 SPECIFICATIONS

The following specifications refer to the 0.42.0340 Pot-Comp-F/R operating in the computer.

1.2.1 Comparator Circuit

Switching Voltage Center Value	±1 Millivolt
Hysteresis	±4 Millivolts
Switching Time	1 Microsecond

1.2.2 Function Relay

Contact Resistance	0.5 Ohm Maximum

1.3 OPERATING CONSIDERATIONS

Figure 1.4 gives typical patching for the comparator section of the tray. Note that the COMPARATOR pushbuttons, located on the auxiliary control panel (Figure 1.3), may be used to override the comparator input voltage.

Note that Figure 1.5 gives typical function relay patching. The function relay patch terminals are graphically marked with the relay contacts which are shown in the set position. Logic high signals patched to S (set) and R (reset) terminals causes the relay to respond to the like positions shown on the patch block. The FUNCTION RELAY pushbuttons on the auxiliary control panel (Figure 1.3) may be used to override the S and R inputs on the patch panel.

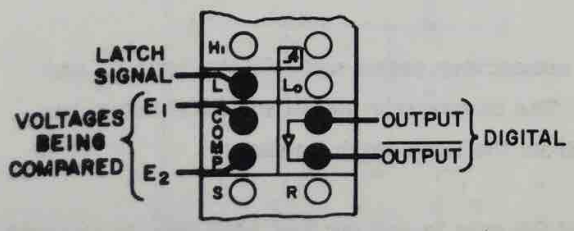


Figure 1.4. Typical Comparator Patching

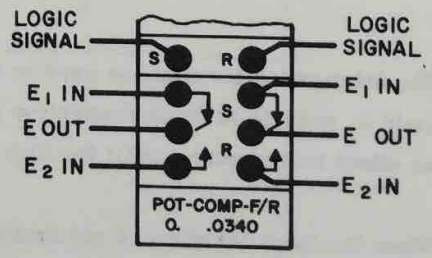


Figure 1.5. Typical Function Relay Patching

A complete description of comparator and function relay operation is given in the 580 Reference Handbook (EAI Publication Number 00 800.2055-0).

1.4 THEORY OF OPERATION

Since the 0.42.0340 Pot-Comp-F/R Tray consists of two separate circuits, each is described in a separate section. Section 1.4.1 concerns the comparator and Section 1.3.2 concerns the function relays.

1.4.1 Comparator

The comparator, shown in the simplified schematic, Figure 1.6, consists of an analog input, a digital output and an override pushbutton.

Analog voltages are applied to the comparator units. The algebraic sum of these voltages is derived at the junction of resistors R1 and R2, and compared by comparator amplifier AR1. The resultant output is opposite in polarity to the amplifier input. As an example, if the algebraic sum of the voltages is negative the output of AR1 is positive.

Assuming that the output of AR1 is positive (high), the input to OR gate 2a (pin 6) is high forcing the output low. The output of AR1 is also inverted by inverter 1a and its low output is fed to pin 1 of AND gate 2a. If the latch terminal is not patched, pin 7 of OR gate 2a and pin 2 of AND gate 2a are both low. The two low inputs to the AND gate force its output high. The low at the S terminal of FF2a and the high at the clear terminal force the 1 output to a high. This output is inverted (inverter 3b) and the logic 0_1, terminal is low. The second inverter makes the logic 0_2 terminal the complement of the logic 0_1 terminal or in this case high. If the comparator amplifier AR1 output is negative (low), the resultant outputs at the logic 0_1 and 0_2 terminals are high and low respectively.

The latch patch terminal is used to override the comparator output and hold the logic 0_1 and logic 0_2 outputs at their respective logic levels. The comparator amplifier (AR1) output has no effect on the output until the high is removed from the latch patch terminal.

When the latch terminal is patched high, pin 7a of OR gate 2a and pin 2 of AND gate 2a are both high. The high inputs to these two gates force their outputs low and the inputs to the S and R terminals on the flip-flops are both low. The lows on the S and C inputs inhibit the flip-flop, and the logic 0_1 and 0_2 terminals are held at their respective logic levels until the high is removed from the L terminal.

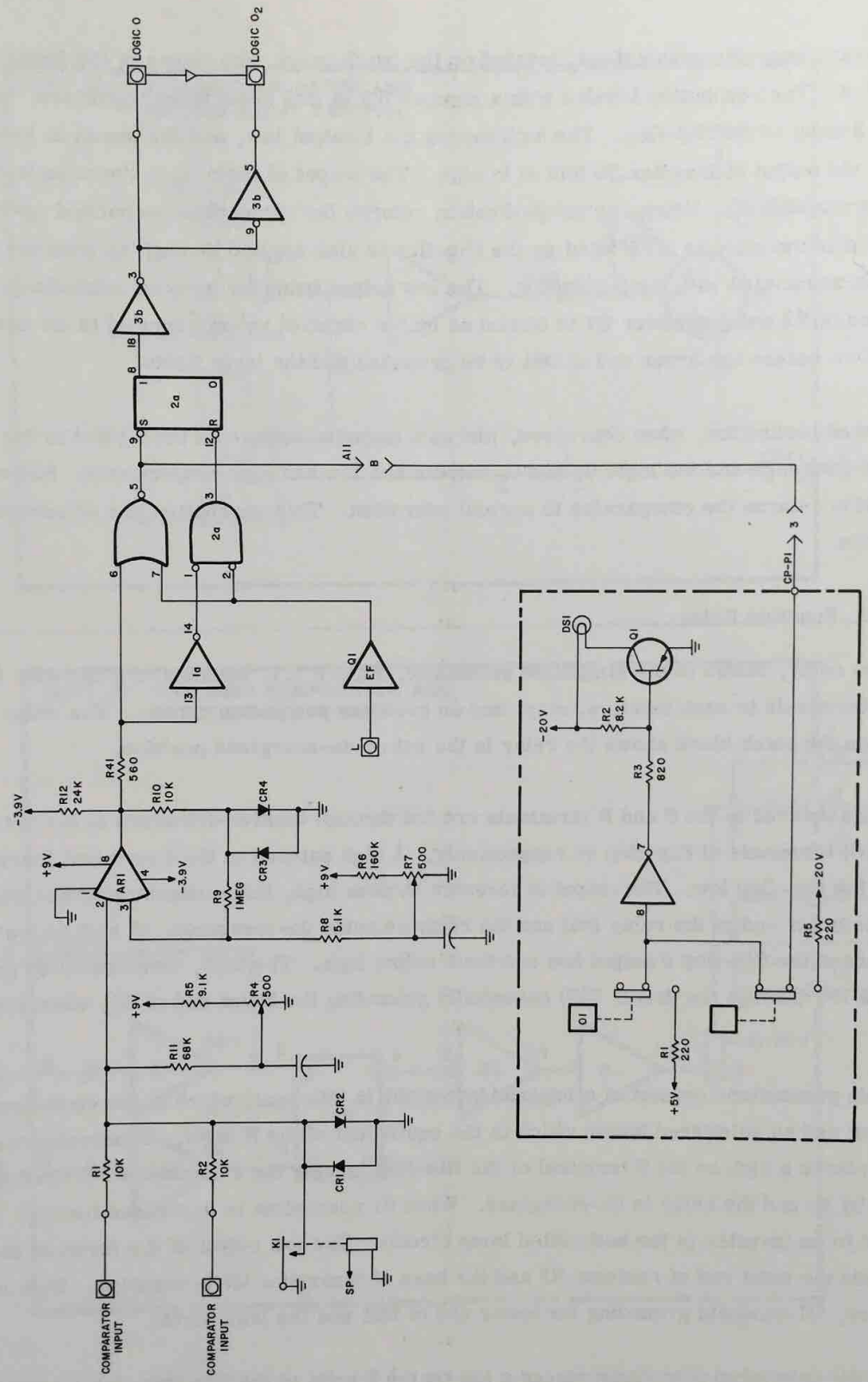


Figure 1.6. Comparator, Simplified Schematic

The momentary override pushbuttons, located on the patch panel, are shown at the lower left of Figure 1.6. The pushbutton labeled with a number (01 in this case) when depressed, feeds a high to the S input of the flip-flop. The high forces the 1 output low, and the signal at logic 0_1 taken from the output of inverter 3b (pin 3) is high. The output of logic 0_2 is the complement of the 0_1 terminal (low). Releasing the pushbutton returns the comparator to normal operation. The high that is switched to the S input on the flip-flop is also applied through an inverter on the lamp circuit associated with the pushbutton. The low output from the inverter essentially grounds the input end of R3 and transistor Q1 is turned on by the negative voltage applied to its base. Turning Q1 on causes the lower end of DS1 to be grounded and the lamp lights.

The unlettered pushbutton, when depressed, places a negative voltage on the S input to the flip-flop the 1 output goes high and the logic 0_1 and 0_2 outputs are low and high respectively. Releasing the pushbutton returns the comparator to normal operation. This pushbutton has no associated lamp circuits.

1.4.2 Function Relay

The function relay, shown in the simplified schematic, Figure 1.7, consists of a flip-flop (4b) with patch terminals to each input, a relay, and an override pushbutton circuit. The relay schematic on the patch block shows the relay in the set or de-energized position.

Logic signals patched to the S and R terminals are fed through emitter-followers to the set (S) and Clear (C) terminals of flip-flop 4b respectively. A high patched to the S terminal forces the 1 output of the flip-flop low. The output of inverter 4b goes high, the momentary driver places a high in the lower end of the relay coil and the relay remains de-energized. A high at the R terminal forces the flip-flop 0 output low and the 1 output high. The high, inverted by 4b is applied as a low through the driver (Q2) essentially grounding the lower end of K1, energizing the relay.

The override pushbuttons consist of a lettered button (01 in this case) which is the equivalent of the S input and an unlettered button which is the equivalent of the R input. Depressing the 01 pushbutton places a high on the S terminal of the flip-flop forcing the 1 output low. The signal is inverted by 4b and the relay is de-energized. When 01 pushbutton is depressed the high is also applied to an inverter in the associated lamp circuit. The low output of the inverter essentially grounds the input end of resistor R3 and the base of transistor Q1 is negative. With its base negative, Q1 conducts grounding the lower end of DS1 and the lamp lights.

Depressing the unlettered pushbutton places a low on the S input of the flip-flop, the 1 output goes high, the signal is inverted and the relay is energized. There is no associated lamp circuit for the unlettered pushbutton.

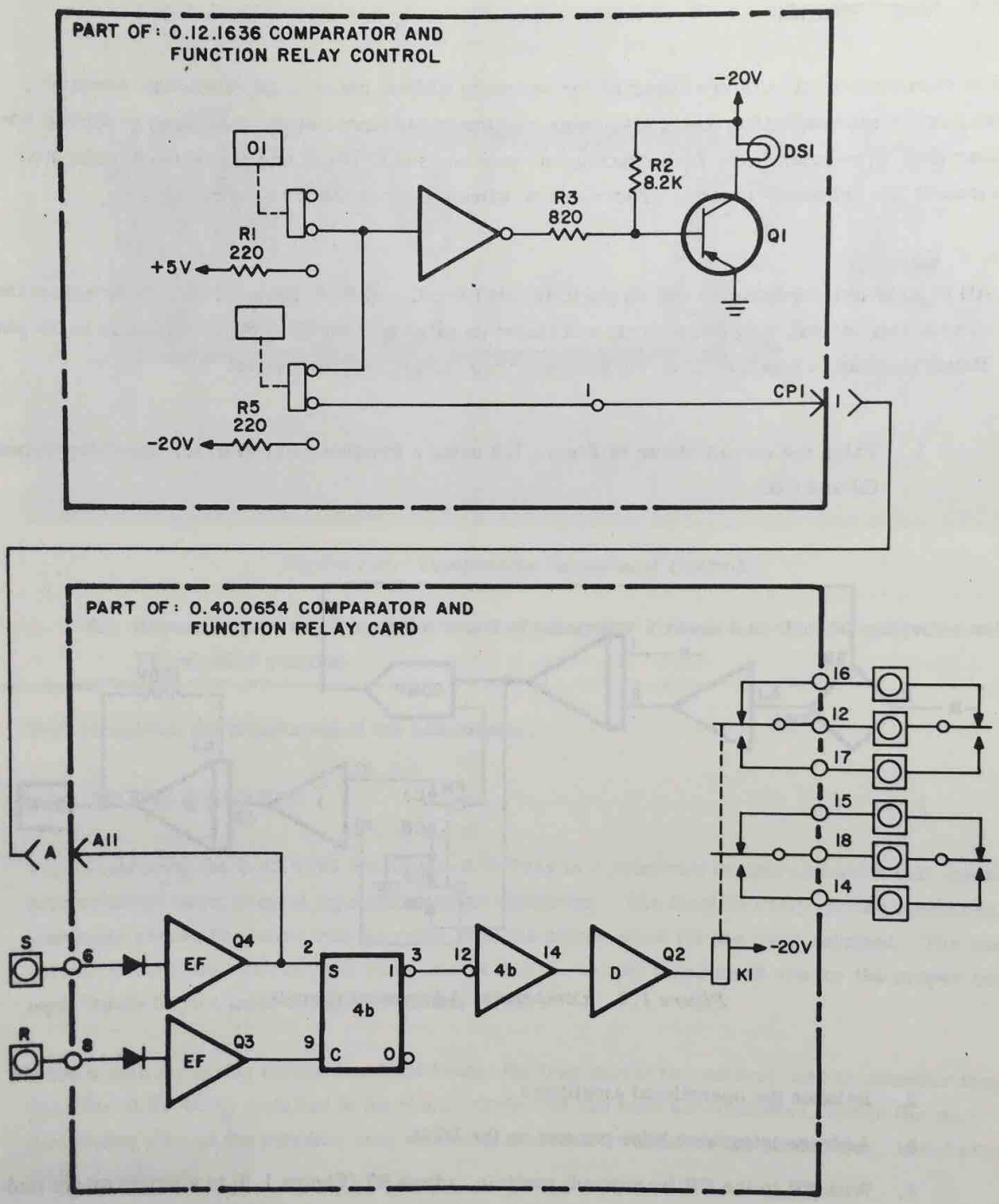


Figure 1.7. Function Relay, Simplified Schematic

1.5 MAINTENANCE

The comparator circuits are designed for accuracy without periodic adjustments. However, longterm component drift may cause some changes in characteristics, therefore requiring adjustment. The procedures in this paragraph may be used to check and adjust the comparator circuits in a minimum of time. There are no adjustments on the function relays.

All comparator adjustments are on the 0.42.0340 Pot-Comp-F/R Tray. To check or adjust the comparator circuit, remove the tray and insert an extender tray (EAI No. 0.52.0382) in its place. Mount the tray to be adjusted on the extender tray and proceed as follows:

1. Patch the circuit shown in Figure 1.8 using a function relay (FR) for switching between CJ and CB.

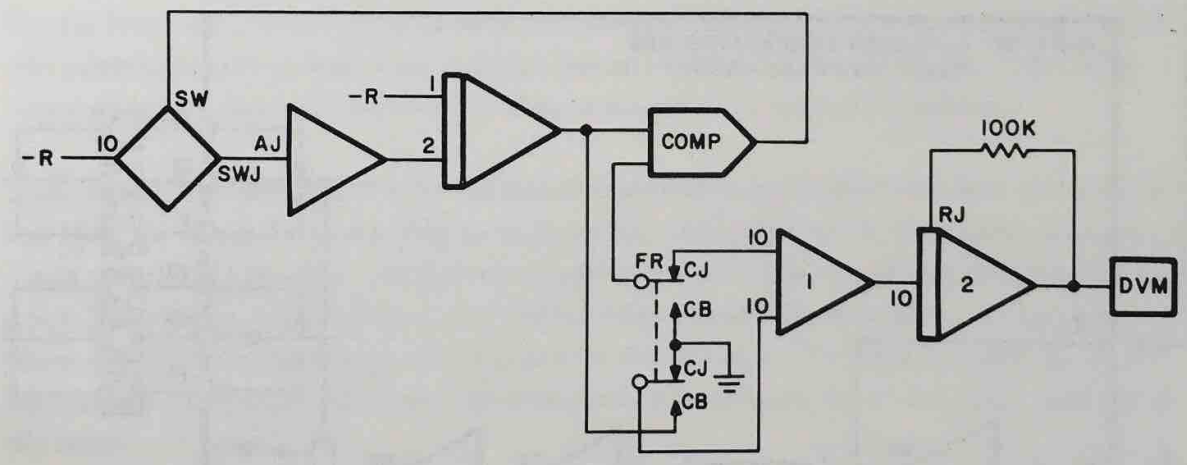


Figure 1.8. Comparator Adjustment Circuit

2. Balance the operational amplifiers.
3. Address integrator 2 for readout on the DVM.
4. With FR in the CB (energized) position, adjust R7 (Figure 1.9) to approximately mid-range, and adjust R4 until the output of integrator 2 nulls. (This reading is 100 times the switching center value.)
5. Switch FR to the CJ (de-energized) position and adjust R7 until the output of integrator 2 nulls.

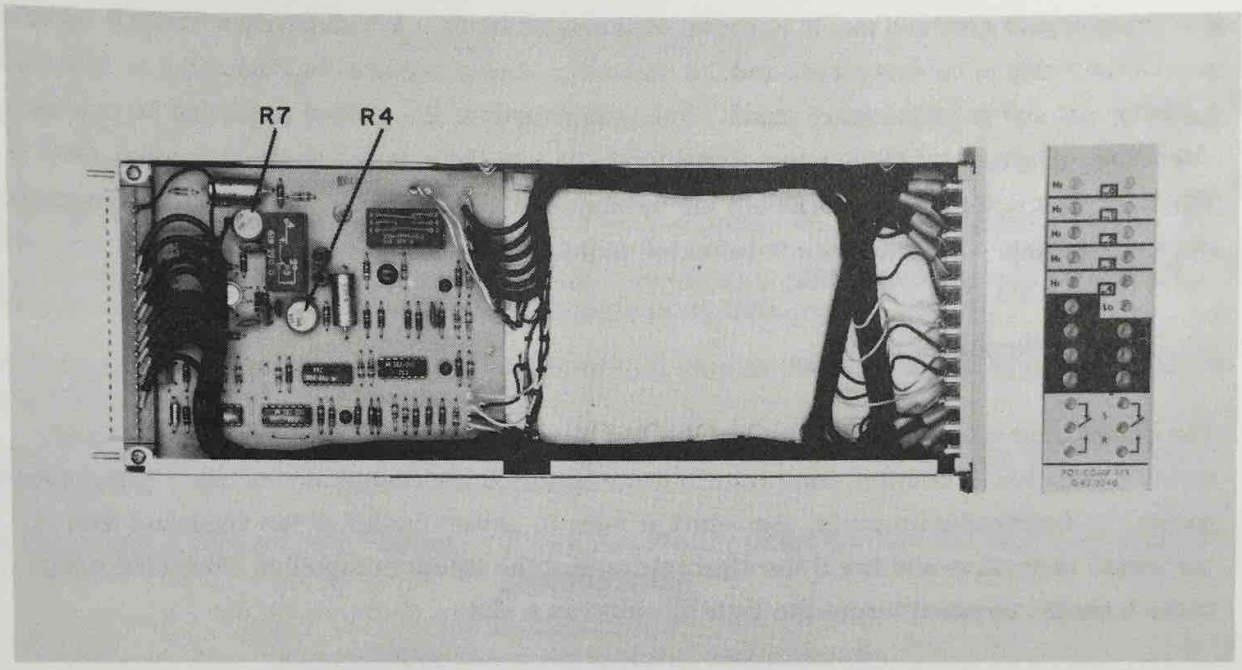


Figure 1.9. Comparator Adjustment Controls

6. Repeat Steps 4 and 5 until the output of integrator 2 reads less than 20 millivolts with FR in either position.

This completes the adjustment of the comparator.

1.6 TROUBLESHOOTING

Troubleshooting the 0.42.0340 Pot-Comp-F/R Tray is a relatively simple operation that can be accomplished using general type maintenance equipment. The function relay checks consist of continuity checks to ensure that the relay is in the proper state for the input supplied. The comparator checks are basically the same except that the checks being made are for the proper output logic levels for the input voltage conditions given.

When a malfunctioning circuit has been found, the tray should be removed, and an extender tray (EAI No. 0.51.0382) installed in its place. Once this has been accomplished, mount the malfunctioning tray on the extender tray and using standard troubleshooting procedures, isolate the faulty component.

1.6.1 Function Relays

The function relays can be checked by applying a logic signal to either the S or R patch terminals and making a continuity check of the relay contacts. With a high patched to the S terminal the

continuity should read the way it is shown on the patch block. A high patched to the R terminal causes the relay to be energized, and the continuity checks indicate that the relay is in a state opposite that shown on the patch panel. The pushbuttons on the control panel can be checked the same way. Depressing the numbered pushbutton causes the relay to de-energize and assume state shown on the patch panel. Depressing the unnumbered switch causes the relay to be energized and assume a state opposite to that indicated on the patch panel.

1.6.2 Comparator

The comparator can be checked by applying two input voltages that algebraically add up to either a negative or positive input voltage and monitoring the comparator output. If the comparator is functioning properly, the output at logic 0_1 should be high if the algebraic sum of the inputs is positive and low if the algebraic sum of the inputs is negative. Patching a high to the L (latch) terminal forces the logic 0_1 output to a high.

Depressing the numbered pushbutton (located on the control panel) associated with the comparator being checked causes the logic 0_1 output to go high. Depressing the adjacent unnumbered pushbutton causes the logic 0_1 output to go low. In all of the comparator tests given above, the complement output (logic 0_2) is in a state opposite to that of the logic 0_1 output.

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	J1	Connector Block: Yellow	00 542.1545-1	B
2		Connector Block: Lettered (POT-COMP-F/R 0.42.0340)	00 542.1551-9	B
		0.40.0654 COMPARATOR & FUNCTION RELAY CARD		
1	1a,2a,4b	Integrated Circuitry: Quad Two Input Gate	00 592.0096-0	B
2	3b	Integrated Circuitry: Dual Buffer	00 592.0090-0	B
3	AR1	Integrated Circuitry: Amplifier, DC Wide Band	00 592.0059-0	B
4	C1	Capacitor, Fixed, Ceramic: 100 pf ±10%, 1000V (Sprague 40C200A or equal)	00 515.0019-0	A
5	C2,3	Capacitor, Fixed, Electrolytic: 47 uf ±20%, 35V (Sprague 150D4760035-S2 or equal)	00 516.0269-0	A
6	C4,5,6,7,8, 9	Capacitor, Fixed, Ceramic: 10 nf +60% -40%, 150V (Sprague 19C385 or equal)	00 515.0151-0	A
7	C10	Capacitor, Fixed, Ceramic: 3.3 uf ±20%, 15V (Sprague 150D or equal)	00 516.0254-0	A
8	CR1 thru 5	Diode: 1N916	00 614.0148-0	A
9	CR6	Diode (Motorola 1/4M6.2AZ10 or equal)	00 614.0214-0	A
10	CR7	Diode, Zener: Ln748A	00 614.0289-0	A
11	CR8 thru 17, 19 thru 23	Diode	00 614.0293-0	B
12	K1	Relay	00 618.0303-0	B
13	K2	Relay	00 618.0290-0	B
14	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-23 or equal)	00 542.0419-0	B
15	Q1,3,4	Transistor: 2N3646	00 686.0230-0	A
16	Q2	Transistor: 2N3638A	00 686.0305-0	A
17	R1,2	Resistor, Precision	00 640.0109-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
POT COMPARATORS AND FUNCTION RELAY TRAY

MODEL NO.
0.42.0340 Sh. 1 of 3 Sh.

DATE 10 / 16 / 67

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
18	R4,7	Resistor, Variable, Wirewound: 500 ohms ±5%, 1W (Int. Resistance Co. CT-100 or equal)	00 642.0610-0	A
19	R5	Resistor, Fixed, Composition: 9.1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0912-0	A
20	R6	Resistor, Fixed, Composition: 160K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0164-0	A
21	R8	Resistor, Fixed, Composition: 5.1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0512-0	A
22	R9	Resistor, Fixed, Composition: 1 megohm ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0105-0	A
23	R10,36	Resistor, Fixed, Composition: 10K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0103-0	A
24	R11	Resistor, Fixed, Composition: 68K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0683-0	A
25	R12	Resistor, Fixed, Composition: 2.4K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0242-0	A
26	R15	Resistor, Fixed, Composition: 680 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0681-0	A
27	R17	Resistor, Fixed, Composition: 820 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0821-0	A
28	R19,20,21, 25,26,28, 30,31,32	Resistor, Fixed, Composition: 1.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0122-0	A
29	R22	Resistor, Fixed, Composition: 3.3K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0332-0	A
30	R23,24,29	Resistor, Fixed, Composition: 2.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0222-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/ 16 / 67

UNIT TITLE
POT COMPARATORS AND FUNCTION RELAY TRAY

MODEL NO.
0.42.0340 Sh. 2 of 3 Sh.

3-1-14

M446

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
31	R38	Resistor, Fixed, Composition: 390 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0391-0	A
32	R39,40	Resistor, Fixed, Composition: 100 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0101-0	A
33	R41	Resistor, Fixed, Composition: 560 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0561-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/ 17 / 67

UNIT TITLE
POT COMPARATORS AND
FUNCTION RELAY TRAY

MODEL NO.
0.42.0340 Sh. 3 of 3 Sh.

3-1-1

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1		Connector Block: 12 Contacts; Male (Amp 48008-1 or equal)	00 542.1059-0	A
		0.12.1636 COMPARATOR AND FUNCTION RELAY CONTROL CARD		
1	C1	Capacitor	00 516.0387-0	B
2	C2	Capacitor, Fixed, Electrolytic: 3.3 uf ±20%, 15V (Sprague 150D or equal)	00 516.0254-0	A
3	DS1-()	Lamp, Incandescent: 28V, 40 MA; Clear T1-3/4 Bulb (Hudson 369 or equal)	00 578.0089-0	A
4	INV-1	Integrated Circuitry: Hex Inverter	00 592.0100-0	B
5	Q1-()	Transistor: 2N3686	00 686.0250-0	A
6	R1-(),5-()	Resistor, Fixed, Composition: 220 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0221-0	A
7	R2-()	Resistor, Fixed, Composition: 8.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0822-0	A
8	R3-()	Resistor, Fixed, Composition: 820 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0821-0	A
9	R4-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0472-0	A
10		Switch, Pushbutton	00 656.0178-1	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
COMPARATOR AND FUNCTION RELAY CONTROL

MODEL NO.
0.51.0372 Sh. 1 of 1 Sh.

1-1

DATE 4 / 26 / 68

3-1-16

M446

APPENDIX 2

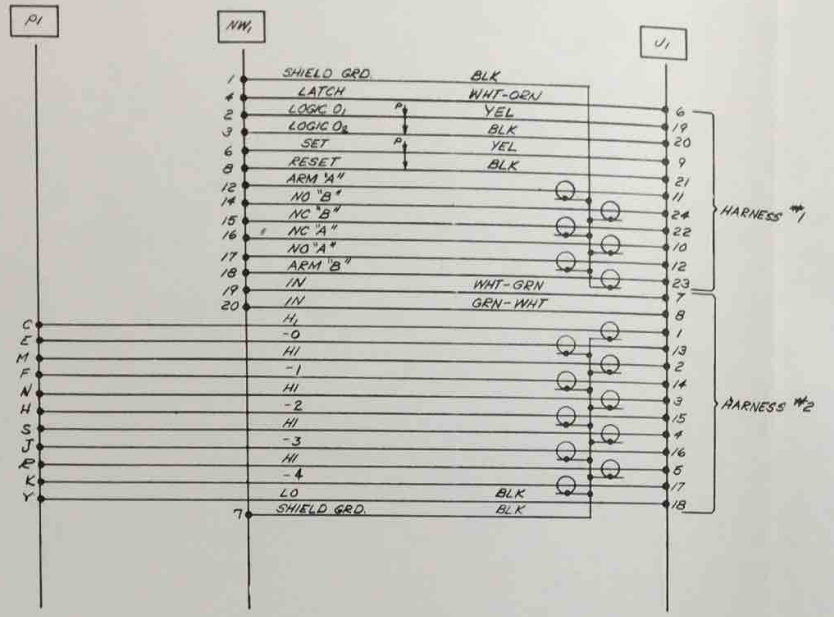
DRAWINGS

This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

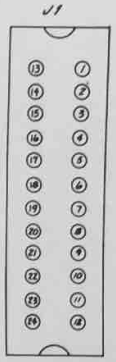
EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

INDEX

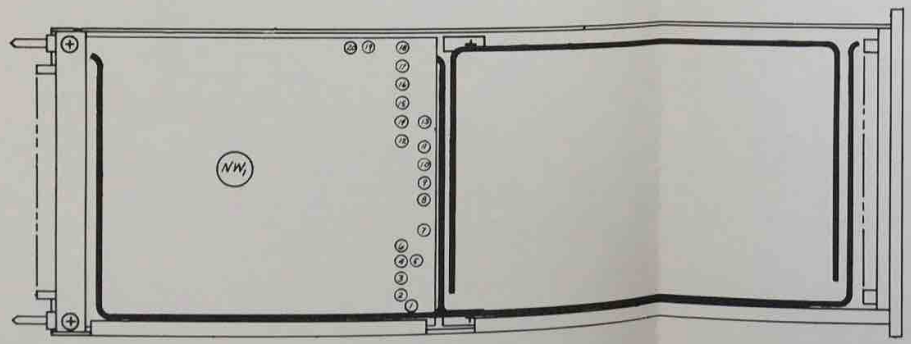
Unit or Component	Type of Drawing	Drawing Number
0.42.0340 Pot, Comparator and Function Relay	Assembly W/ Wiring	D00 042 0340 0A
0.12.1636 Comparator and Function Relay Control	Schematic	C00 012 1636 0S
0.40.0654 Comparator and Function Relay	Schematic	D00 040 0654 0S
0.51.0372 Comparator and Function Relay	Wiring	B00 051 0372 0W (Sheets 1 and 2)

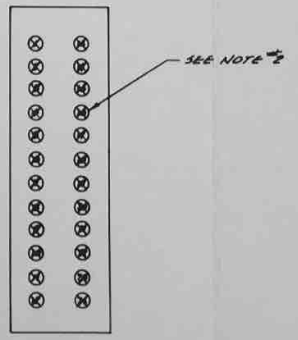


NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) WIRES TO BE #22 P.M.W.
   b) COAX PER B00 916 0001 0.
2. ⊗ DENOTES LOCATION OF CONTACTS (ITEM #12) PER DETAIL "A".
3. SEE (A00 018 1353 0P) FOR HARNESS 1, 2.



CONN. BLOCK REAR VIEW

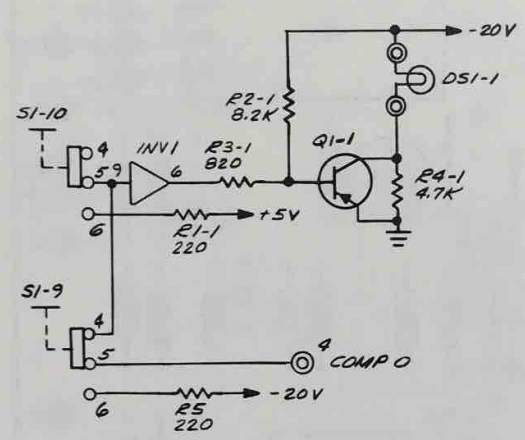


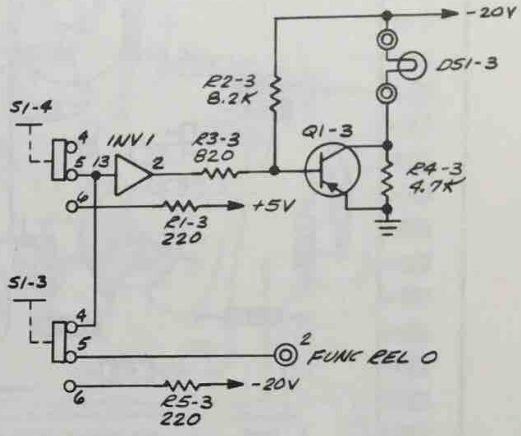


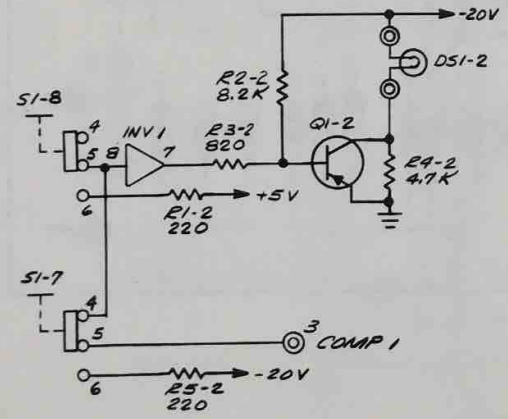
CONN. BLOCK FRONT VIEW

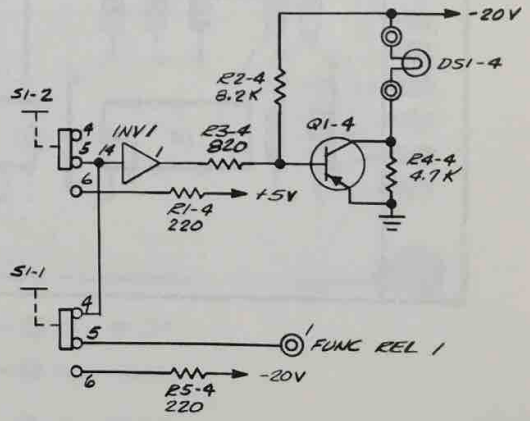
EAI
ASSEMBLY & WIRING DIF COMPARATOR & FUNCTION RELAY
SHT. NO.
SIZE
REV. NO.
PROJECT 19316
D00 042 0340 0A
SHEET 1 OF 1 SHEETS

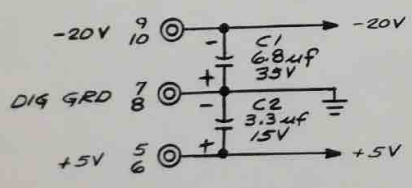
NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a. ALL RESISTORS ARE ±5%, 1/4W.
   b. ALL TRANSISTORS ARE 2N3638.
   c. ON ICP, PIN 4 GOES TO GRD, PIN 11 TO +5V.
   d. SWITCH SECTIONS ARE MOMENTARY.











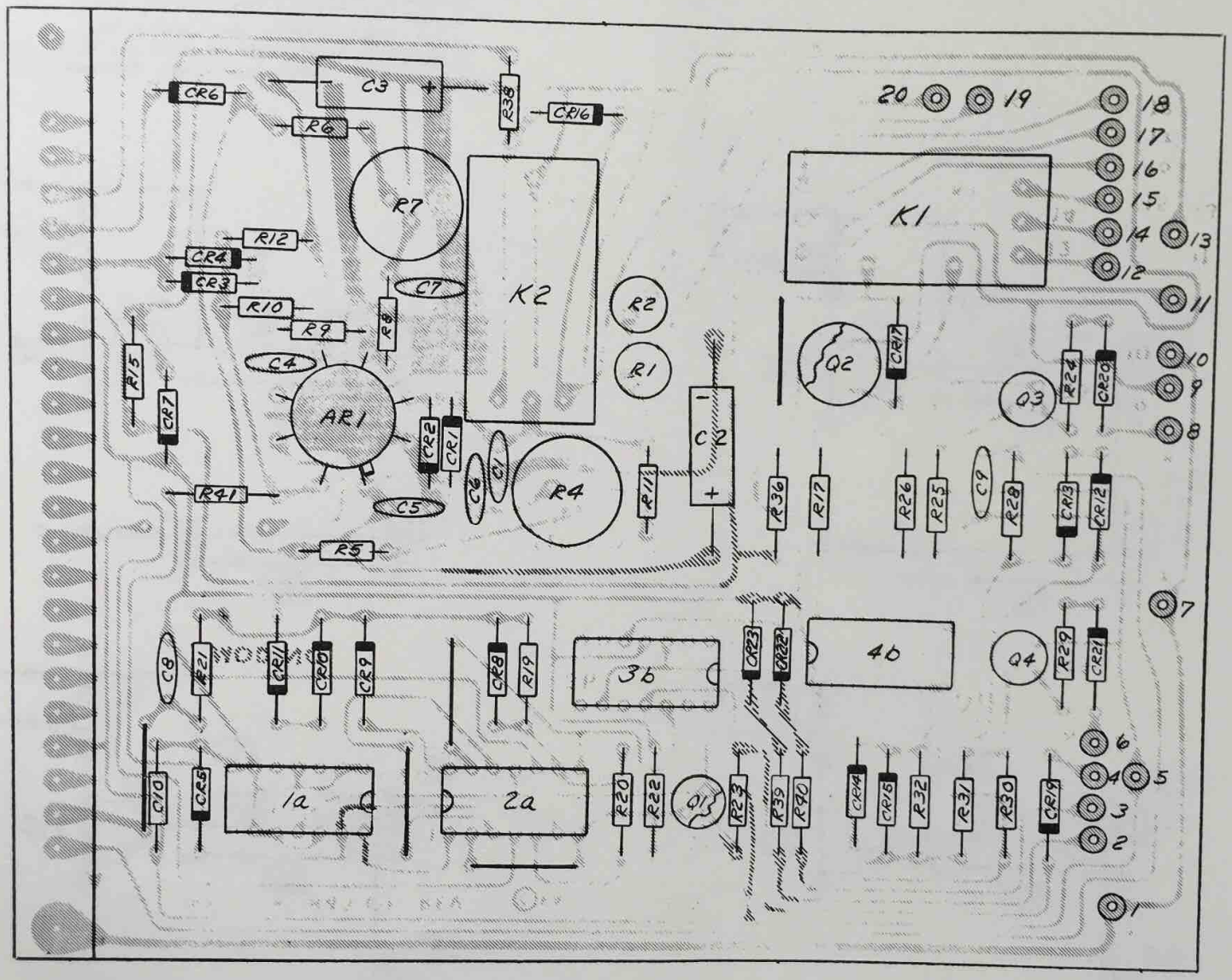
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN pf
RESISTANCE IS IN OHMS
TOLERANCE OF: .X = ± .03 .XX = ± .02
.XXX = ± .015 .XXX = ± .005 ∠ = ± 1°
* TOL. OF MATERIAL SUPPLIED

EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.

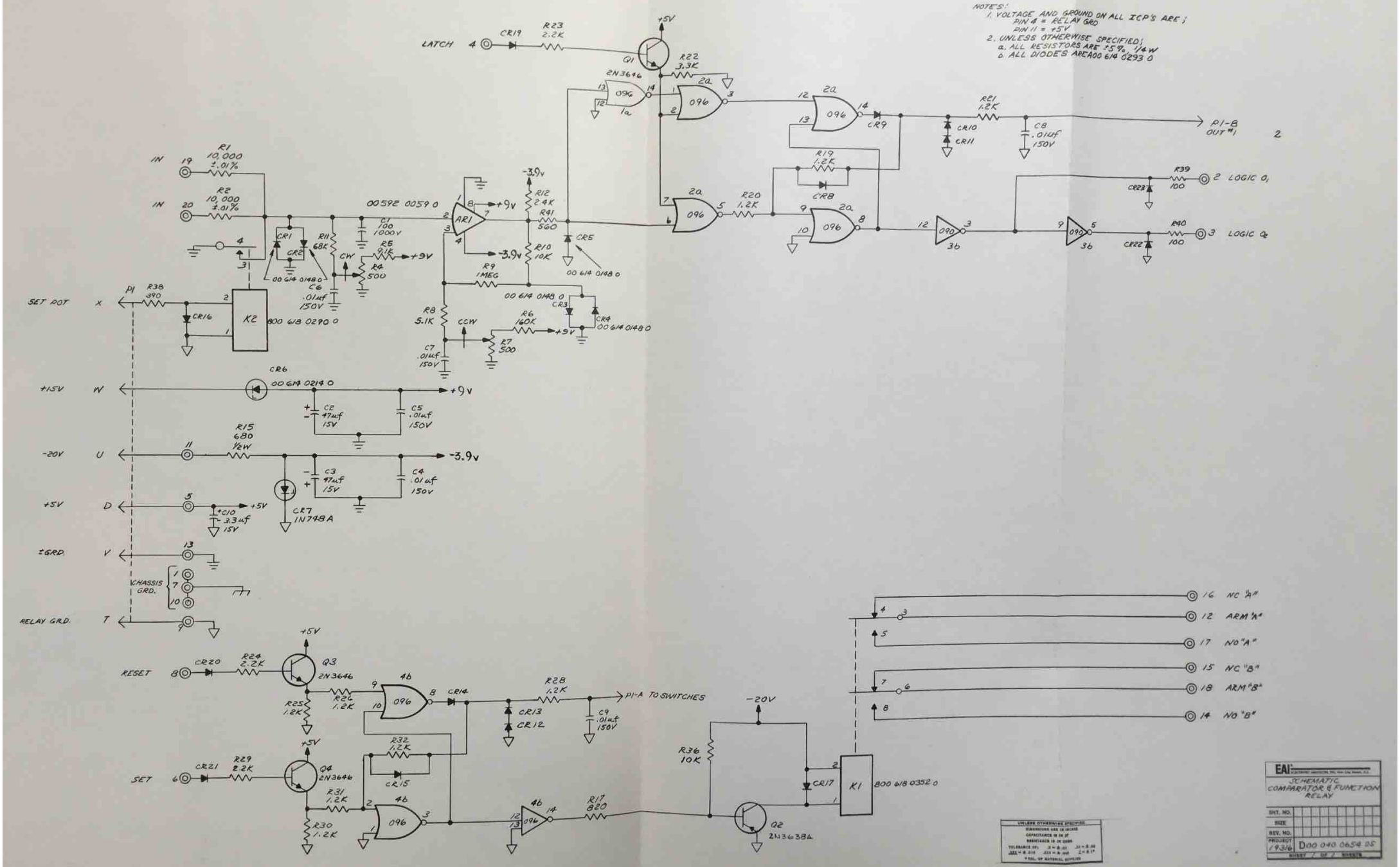
SCHEMATIC
COMP & FUNC REL CONTROL

SHT. NO.	
SIZE	
REV. NO.	
PROJECT	19330 C00 012 1636 05

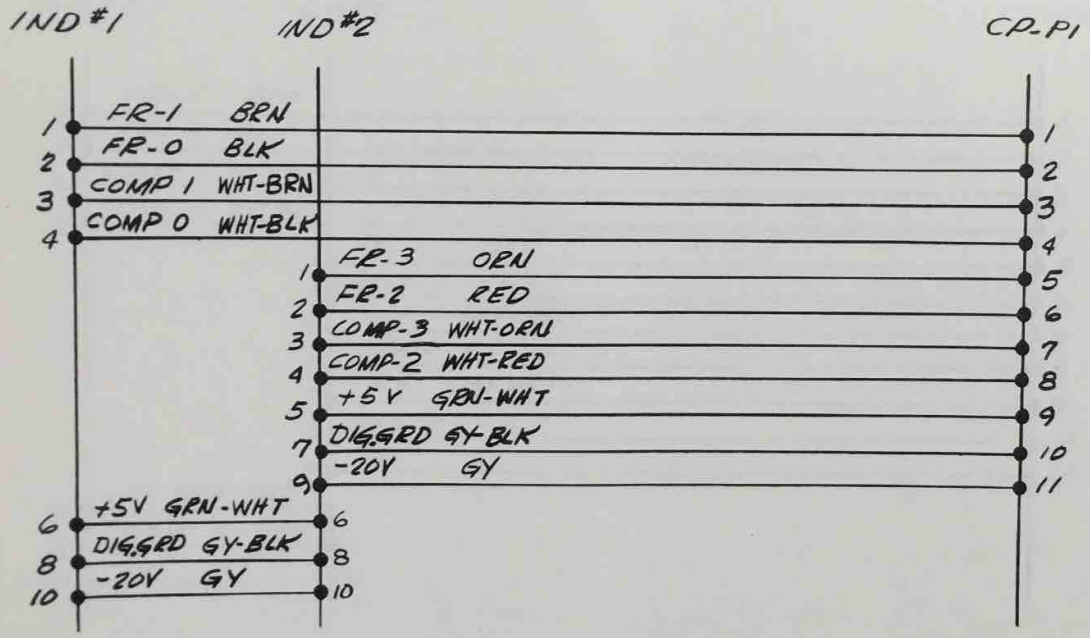
SHEET 1 OF 1 SHEETS



40.0654 Comparator and Function Relay


NOTES:
1. VOLTAGE AND GROUND ON ALL ICP'S ARE;
PIN 4 = RELAY GRD
PIN 11 = +5V
2. UNLESS OTHERWISE SPECIFIED;
a. ALL RESISTORS ARE ±5%, 1/4 W
b. ALL DIODES ARE A00 614 0293 0
LATCH
CR19
R23 2.2K
Q1 2N3646
R22 3.3K
IN
R1 10,000 ±1%
R2 10,000 ±1%
CR1
CR2
R11 68K
R5 91K
R4 500
CW
C6 .01uf 150V
00 614 0148 0
00592 0059 0
C1 100 1000V
AR1
+9v
-3.9v
R12 2.4K
R41 560
R10 10K
CR5
R9 1MEG
R8 5.1K
CCW
R6 160K
R7 500
C7 .01uf 150V
CR3
CR4
SET POT
P1
R38 390
CR16
K2
800 6/8 0290 0
+15V
CR6
C2 47uf 15V
C5 .01uf 150V
-20V
R15 680 ½W
C3 47uf 15V
C4 .01uf 150V
+5V
C10 .33uf 15V
CR7 1N748A
±GRD.
CHASSIS GRD.
RELAY GRD.
R21 1.2K
CR9
CR10
CR11
C8 .01uf 150V
P1-B OUT #1
R19 1.2K
CR8
R20 1.2K
R39 100
R40 100
CR22
2 LOGIC 0,
3 LOGIC 0
RESET
CR20
R24 2.2K
Q3 2N3646
R25 1.2K
R26 1.2K
R28 1.2K
CR13
CR12
C9 .01uf 150V
P1-A TO SWITCHES
SET
CR21
R29 2.2K
Q4 2N3646
R31 1.2K
R30 1.2K
R32 1.2K
CR15
R17 820
R36 10K
CR17
K1
800 6/8 0352 0
Q2 2N3638A
16 NC "A"
12 ARM "A"
17 NO "A"
15 NC "B"
18 ARM "B"
14 NO "B"
EAI
SCHEMATIC COMPARATOR & FUNCTION RELAY
SHT. NO.
SIZE
REV. NO.
PROJECT 19316
D00 040 0654 25
SHEET 1 OF 1 SHEETS

NOTES:
1. WIRES ARE #22 PHU AWG.
2. SEE C00 051 0372 0A FOR EYELET LOCATION ON CKT BOARDS.



UNIT NUMBER	NUMBER	PARTS LIST & NEXT ASSY.	DESCRIPTION	PARTS LIST USED ON:	PROJECT NUMBER
051.0372-1	00 051 0372 1W	00 051 0372 1P	AS SHOWN ON SHT 2	A00 020 1181 0P	19330
051.0372	B00 051 0372 0W	A00 051 0372 0P	AS SHOWN ON SHT 1	A00 020 1181 0P	19330

TABLE OF UNIT NUMBERS

EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.

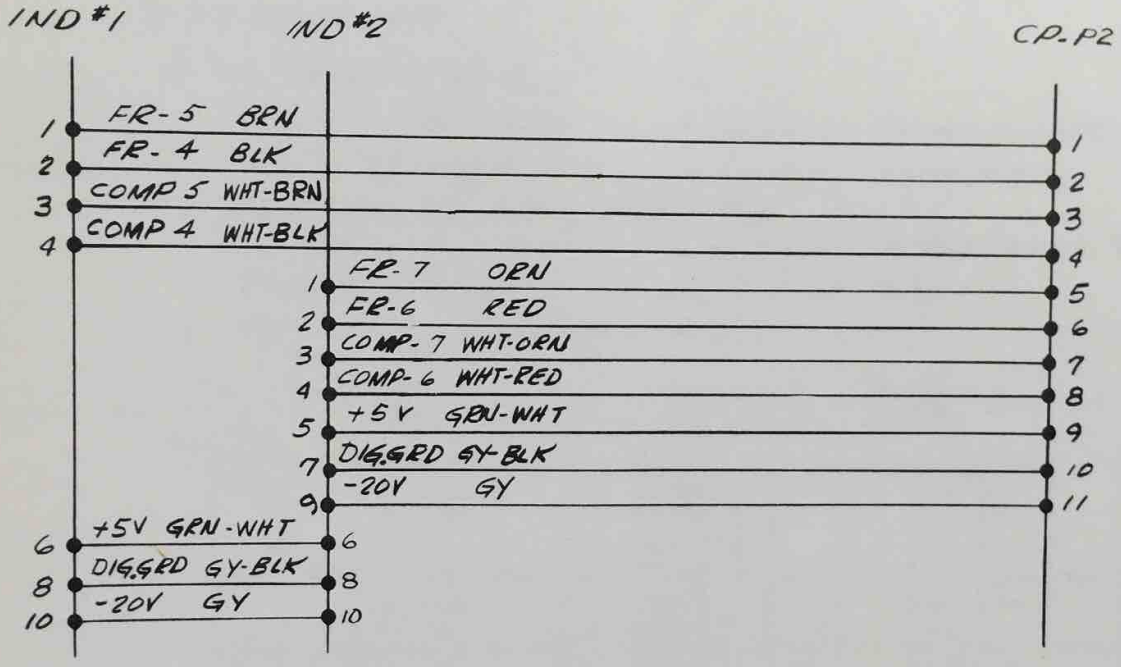
WIRING
COMP& FUNCT. REL. CONT.

SHT. NO.	2
SIZE	B
REV. NO.	0
PROJECT	19330

B00 051 0372 0W

SHEET 1 OF 2 SHEETS

NOTES:
1. WIRES ARE #22 PHU AWG.
2. SEE C00 051 0372 0A FOR EYELET LOCATION ON CKT BOARDS.



00 051 0372 1W

EAI	ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.
SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19330	B00 051 0372 0W
SHEET 2 OF SHEETS	

CHAPTER 2

POTENTIOMETER, TRACK/STORE AND D/A SWITCH TRAY, MODEL 0.42.0341

2.1 INTRODUCTION

This chapter describes the 0.42.0341 Pot, T/S, and D/A switch Tray which is installed in the positions shown in Figure 2.1. Two additional trays can be installed in positions 46 and 54. Circuits housed in this tray also permit control of the track/store and D/A switch modes and permit initializing the track/store unit. The tray also contains the patching for five attenuators, which are described in Chapter 5 of the 580 Console Components Manual (EAI Publication Number 00 800.2056-0). The tray and its patching area are shown in Figure 2.2.

2.2 TECHNICAL DATA

2.2.1 Track/Store Circuit

Drift in Long *Store* Mode	250 Microvolts/SEC, Maximum
Offset in *Track* Mode	±50 Microvolts
Reset Time, Full Scale to within 0.1% of Input	50 Microseconds, Maximum
Bandwidth in *Track* Mode	90 kc
Total Instantaneous Dynamic Error in *Track* Mode -	
200 Hz	0.15%
1 Hz	0.75%

A00		ATTEN P00-P04	A02 A03		A08	ATTEN P05-P09	CONTROL TRAY	A10		ATTEN P10-P14	A12 A13		A18	ATTEN P15-P19
AMPL	INT	----	AMPL	MULT	AMPL	----		AMPL	INT	----	AMPL	MULT	AMPL	----
		COMP.	A04			T/S				COMP.	A14			T/S
A01		F/R	A05		A09	D/A		A11		F/R	A15		A19	D/A
A20		ATTEN P20-P24	A22 A23		A28	ATTEN P25-P29	TRUNKS	A30		ATTEN P30-P34	A32 A33		A38	ATTEN P35-P39
AMPL	INT	----	AMPL	MULT	AMPL	----		AMPL	INT	----	AMPL	MULT	AMPL	----
		COMP	A24			T/S				COMP.	A34			T/S
A21		F/R	A25		A29	D/A		A31		F/R	A35		A39	D/A
A40		ATTEN P40-P44	A42 A43	QUAD LOG DFG MDFG	A48	ATTEN P45-P49	TRUNKS	A50		ATTEN P50-P54	A52 A53	QUAD LOG DFG MDFG	A58	ATTEN P55 P59
AMPL	INT	----	AMPL	----	AMPL	----		AMPL	INT	----	AMPL	----	AMPL	----
		COMP	A44	A46		T/S				COMP.	A54	A56		T/S
A41		F/R	A45	A47	A49	D/A		A51		F/R	A55	A57	A59	D/A
A60		ATTEN P60-P64	A62 A63	SINE/COSINE MDFG	A68	ATTEN P65-P69	TRUNKS	A70		ATTEN P70-P74	A72 A73	SINE/COSINE MDFG	A78	ATTEN P75 P79
AMPL	INT	----	AMPL	----	AMPL	----		AMPL	INT	----	AMPL	----	AMPL	----
		COMP	A64	A66		LIMITER				COMP.	A74	A76		LIMITER
A61		F/R	A65	A67	A69			A71		F/R	A75	A77	A79	

Figure 2.1. Patch Panel Layout Showing Track/Store - D/A Switch Tray Locations

2.2.2 D/A Switch Circuits

The following specifications refer to the switch connected as an input to a unity-gain inverter.

Operate Time	1 Microsecond
Static and Linearity Error (Outside Feedback Loop)	±0.015%
Bandwidth (20 Volts Peak-to-Peak)	100 kHz
Feedthrough at 1 kc (Switch Open)	≦60 db
Leakage Current (Switch Open)	≦50 PA, Maximum

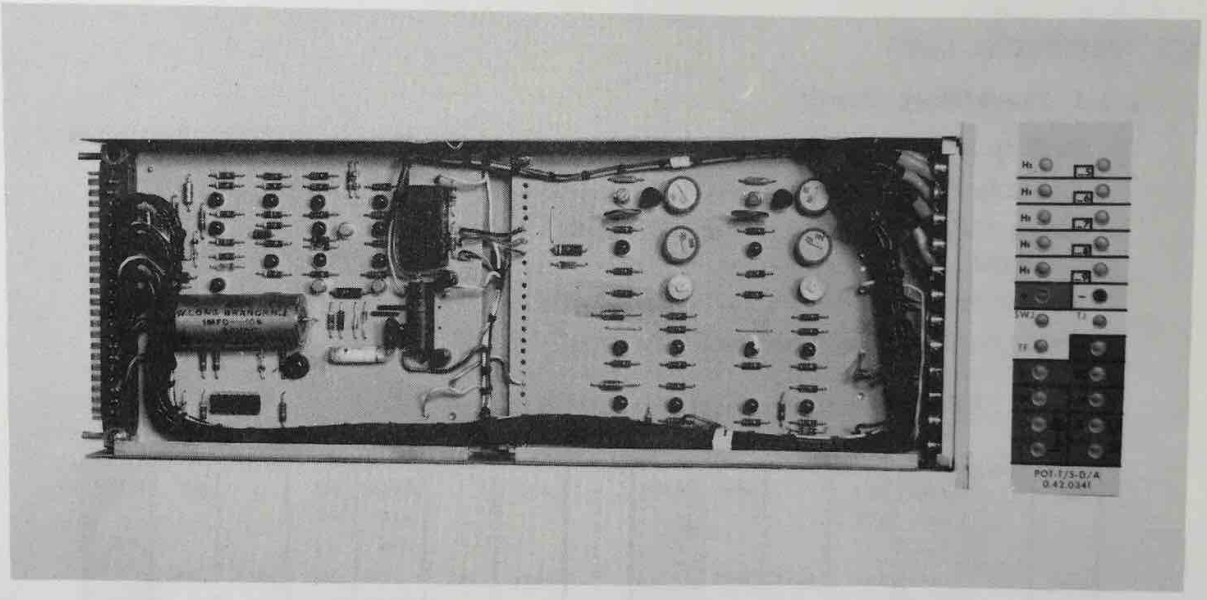


Figure 2.2. Model 0.42.0341 Track/Store - D/A Switch Tray and Patching Area

2.3 OPERATING CONSIDERATIONS

Figure 2.3 shows typical track/store patching. The T (Track) patch terminal controls the operation of the unit. A high at this point causes the unit to track. A low forces it to the store mode. The (T) IC (Track IC) patch terminal, when patched high, overrides the T input and energizes relay K1. When energized, a set of contacts on K1 connects the TJ input to the D/10 output which permits amplifier derivative readout. A second set of contacts connects the IC patch terminal through 10k resistors to the store capacitors which permits charging the capacitors to the IC level.

Figure 2.4 shows typical patching for the D/A switches. A high patched to the SW (Switch) patch terminal causes the electronic switch to conduct connecting the 10 input to the SWJ (Switch Junction) patch terminal.

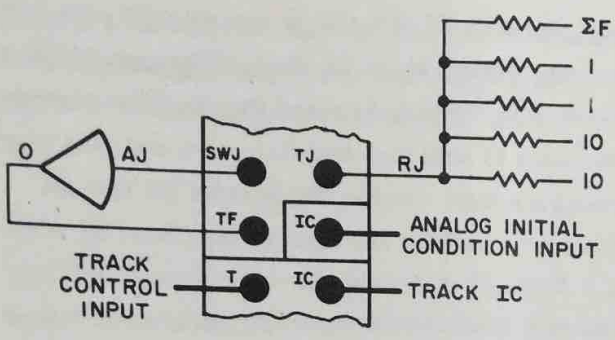


Figure 2.3. Track/Store Patching (Typical)

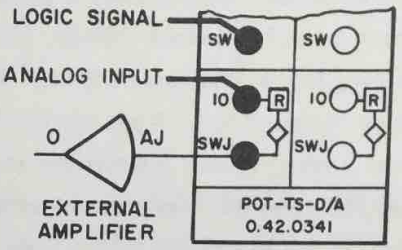


Figure 2.4. D/A Switch Patching (Typical)

Complete descriptions of the track/store and D/A switch operation is given in the 580 Reference Handbook (EAI Publication Number 00 800.2055-0).

2.4 THEORY OF OPERATION

Figures 2.5 and 2.6 are simplified schematics showing both the track/store and D/A switch portions of the tray. Since these units operate independently, each one is described separately.

2.4.1 Track/Store Switch Circuits

The track/store switch network is shown in Figure 2.5. The signal at the track input is high when track operation is selected. The high level causes the output of the Q3, Q4 level-shifter/driver to go low, and the short store and long store electronic switches are both inhibited. The high input causes the output of driver Q1, Q2 to go high, and the track electronic switch couples the signal at contact 7 of K1 to the amplifier (K1 is energized when the master mode control circuit selects the *SP* or *ST* mode, or when the track/store *IC* mode is selected by the master mode control circuit or by local patching). Thus, the signal patched to the TJ terminal is connected to the amplifier in the *track* mode.

When the track signal goes low, the track electronic switch is inhibited, removing both the input signal and the dc feedback resistor from the amplifier. Simultaneously, the short store electronic switch conducts, connecting a 0.005 microfarad capacitor (C2) around the amplifier. This capacitor is always connected to the output of the amplifier when the circuit is patched for track/store operation. The very short time constant of the R20-C2 network permits the capacitor to charge to the amplifier output voltage, even with rapid dynamic changes. The small value of the capacitor, however, would result in a high drift rate while the circuit was in the *store* mode. To allow the circuit to follow high rate dynamic signals while tracking, yet provide low drift storage, two values of storage capacitance are provided. When the unit is

switched from the *track* mode to the *store* mode, the R20-C2 network is immediately switched around the amplifier. After a 10 millisecond delay, during which C3 charges through R23 to the stored amplifier output voltage, the R23-C3 network is connected around the amplifier through the long store electronic switch. Thus, performance at both high tracking rates and long storage times is optimized. When the track signal again goes high, the low output from the Q3, Q4 level-shifter/driver inhibits the short store electronic switch, and through the CR1-CR8 AND gate, inhibits the long store electronic switch.

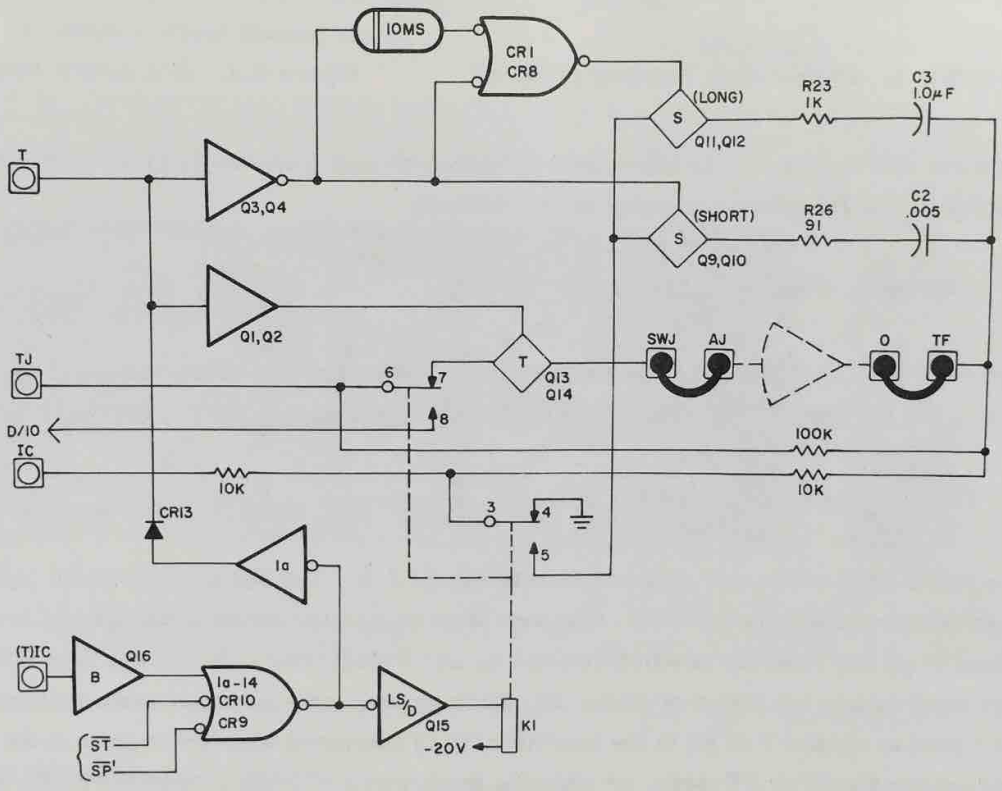


Figure 2.5. Track/Store Circuit, Simplified Schematic

To energize the *IC* mode control relay (K1), it is necessary for either the (T) IC input to be high or the $\overline{ST}$ and $\overline{SP}$ line to have a low input. The (T) IC input, buffered by emitter follower Q16, is connected to one input of an OR gate. The $\overline{ST}$ and $\overline{SP1}$ not lines are connected to the other two inputs. The gate is arranged so that its output goes low if the (T) IC input goes high or if either the $\overline{ST}$ or $\overline{SP}$ line goes low. The low at the OR gate output energizes relay K1 through the level shifter/driver Q15. The OR gate output is also inverted (1a) forcing the unit into the track mode. When K1 is energized, the input at TJ (Track Junction) is connected to the D/10 line permitting an amplifier derivative readout. The second set of relay contacts connects the SWJ (Switch Junction) terminal to the IC input through a 10k resistor.

The OR gate output is also used to force the unit into the track mode. This is accomplished by inverting the gate output (1a) and applying a high to the inputs of the store level-shifter/driver (Q3 and Q4) and the track driver (Q1, Q2).

2.4.2 D/A Switch Circuit

The D to A switch circuit, shown on Figure 2.6, is contained entirely on the 0.12.1614 D to A switch card in the pot-track/store and D/A switch tray. A logic signal patched to the SW terminal is connected directly to eyelet 3 of the D to A switch card. Level-shifter/driver circuit Q1, Q3 couples the signal to the Q5, Q6 switch circuit. When the logic signal is high, an analog signal is coupled through the switch to the input of an external amplifier. When the logic signal goes low, the signal path through the switch is opened.

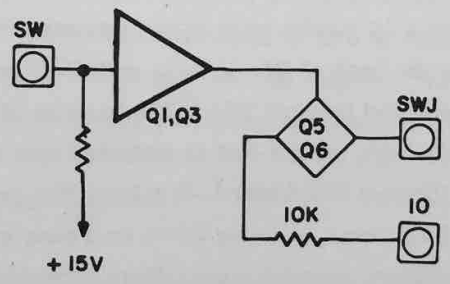


Figure 2.6. D/A Switch, Simplified Schematic

2.5 CIRCUIT DESCRIPTION

2.5.1 Track/Store Switch Card 0.12.1613

Refer to Schematic D00 012 1613 0S for the following description.

The track signal from the track/store control network is connected to the track input of the card, and coupled through R1 to the base of Q1. Transistor Q1 is connected as a phase inverter, developing complementary signals at its collector and emitter. The inverted signal at the collector of Q1 is connected to the base of inverter Q2. The signal at the collector of Q2 thus goes high when the track input signal goes high.

The non-inverted signal at the emitter of Q1 is connected to the emitter of common-base amplifier Q4. The signal at the collector of Q4 is coupled to the base of inverter Q3, and the signal at the collector of Q3 is thus high when the track input signal is low.

Three electronic switches are provided on the card; the short store electronic switch (Q9-Q10), the long store electronic switch (Q11-Q12), and the track electronic switch (Q13-Q14). The switches are all similar, so only the Q9-Q10 switch is described. This switch receives a drive signal from the collector of Q3, directly connected to the gate terminal of field-effect transistor (FET) Q9, and through R19 to the base of Q10. When the drive signal is low, Q9 is cut off and Q10 is saturated. The conduction of Q10 effectively grounds the junction of R20 and CR3 through R21. When the drive signal goes high, Q10 is cut off and Q9 conducts, connecting the R20-C2 network across the amplifier. Diode CR2 reduces the turn-off time of Q10 by providing a low-impedance path for the stored charge. If the amplifier output changes rapidly in a negative direction, when the circuit is in the *track* mode, the transient voltage would tend to reverse bias Q10; the shunting effect of CR3 provides a low impedance return path under these conditions. When the circuit is in the *store* mode, the voltage at the cathode of CR3 is not sufficient to allow the diode to conduct.

Transistors Q5 through Q8 form a 10 millisecond delay network. When the circuit is in the *track* mode, the drive signal to the base of Q5, is low, and Q5 is saturated. The ground level at the collector of Q5 is coupled through R11 to the base of Q6, causing Q6 to conduct. When the drive signal to Q5 goes high, as the unit is switched into the *store* mode, Q5 cuts off, and capacitor C1 charges through R10 toward -6 volts. The resultant waveform at the collector of Q5 is a negative-going ramp, causing Q6 to decrease in conduction. The signal at the collector of Q6 is an amplified, positive-going ramp, coupled through R13 to the base of Q7. Transistors Q7 and Q8 form a regeneratively-coupled amplifier. The initial part of the positive going waveform at the base of Q7 has no effect since this stage is heavily saturated. However, as the ramp increased in a positive direction, Q7 begins to decrease in conduction. The negative change at the collector of Q7 is coupled through R16 to the base of Q8. The amplified, positive change at the collector of Q8 is fed back to the base of Q7 through R17, and the regenerative action of the two stages causes Q8 to cut off almost instantly. Thus, after a delay determined by the time constant of R10 and C1, the collector of Q8 goes high, reverse-biasing CR8. Diode CR1 has been reverse-biased by the high drive signal from Q3, and the junction of CR1, CR8, and R18 goes to ground. This change from low to high causes FET Q11 to conduct and transistor Q12 to cut off, switching the R23-C3 network across the amplifier in parallel with the R20-C2 network. Thus C3 is permitted to charge through R23 for approximately 10 milliseconds after the unit is switched into the *store* mode.

When the unit is again switched into the *track* mode, the drive signal from Q3 goes low, cutting off FET Q9 and saturating Q10. The low also forward-biases diode CR1, causing FET Q11 to cut off, and saturating Q12. The low at the base of Q5 saturates this stage, and capacitor C1 discharges through the low impedance of Q5. Thus, the delay circuit resets rapidly, and can be placed in the *store* mode again after only a brief interval.

The track electronic switch (Q13-Q14) is identical in operation with the short-store and long electronic switches. Diodes CR5 and CR6 protect the switch from damage that might be caused by inadvertently patching a signal directly to the TJ terminal, instead of through an input resistor.

The IC relay (K1) is de-energized when the computer is in the *operate* or *hold* modes. The relay is energized when the computer is placed in the *set pot* or *static test* modes by the computer master mode control circuit or when a high logic signal is patched in the (T) IC terminal.

The circuit controlling the IC relay (K1) consists of an emitter-follower stage (Q16) for the input; two integrated circuit OR gates (1a) connected as inverters, two diodes, (CR9, 10) connected as an OR gate and Q15 used as a driver.

When a high appears at eyelet 3, diode CR12 is forward-biased, the base of Q16 goes high and the transistor conducts. The high at the emitter of Q16 is connected to pin 13 of inverter 1a. The output of the inverter goes low (0 volt) and the negative voltage through R37 to the base of Q15 causes the transistor to saturate, grounding the pin 2 of K1 energizing the relay.

2.5.2 D to A Switch Card 0.12.1614

Refer to Schematic C00 012 1614 0S for the following description.

The switch drive signal is connected to the base of phase inverter Q1. The inverted signal at the collector of Q1 is connected to the base of Q3, a common-emitter inverter stage. The non-inverted signal at the emitter of Q1 is connected to the emitter of common base amplifier Q2. The non-inverted signal at the collector of Q2 is connected to the base of inverter Q4. Thus, the signals at the collectors of Q3 and Q4 are complementary, the signal at the collector of Q3 having the same phase as the drive signal. The collector of Q3 is connected to the gate terminal of FET Q6, and through R9 to the base of transistor Q5. Transistor Q5 and the FET are complementary devices; when the drive signal goes high, the FET conducts and the transistor is cut off. When the drive signal goes low, the FET is cut off and Q5 is saturated.

An analog input signal is connected to precision resistor R13. The signal at the resistor junction is connected through potentiometer R11 and a temperature-compensating network consisting of R12 and thermistor RT-1. When the drive signal is low, the resistor junction is grounded by the low saturated impedance of Q5. When the drive signal is high, Q5 is cut off, and the low conducting impedance of the FET couples the analog signal to the summing junction of the associated amplifier.

Resistors R8, R10, and R14 improve the linearity of the switch by providing a small change in the bias voltage to the FET as the input signal changes.

The amplitude of switching transients is reduced by the Q2, Q4, R7, and C3 network. The inverted drive signal developed across R7 is differentiated by C3 and coupled to the summing junction of the associated amplifier. Proper adjustment of C3 minimizes the amplitude of transients that occur when the switch changes state.

Diode CR2, connected to the base of Q2, is used to force the FET into conduction when the computer is in the *pot set* mode.

2.6 MAINTENANCE AND ADJUSTMENTS

The adjustments given below are for the D/A switch circuits. No adjustments are required for the track/store circuit.

All D/A switch adjustments are on the 0.12.1614 D to A switch card. To check or adjust the D/A switch circuit, remove the tray and insert a service shelf (EAI Number 0.51.0382) in its place. Install the tray to be adjusted on the service shelf and proceed as follows:

1. Connect the circuit of Figure 2.7. Carefully balance the amplifiers. Address A01 for readout by the DVM.

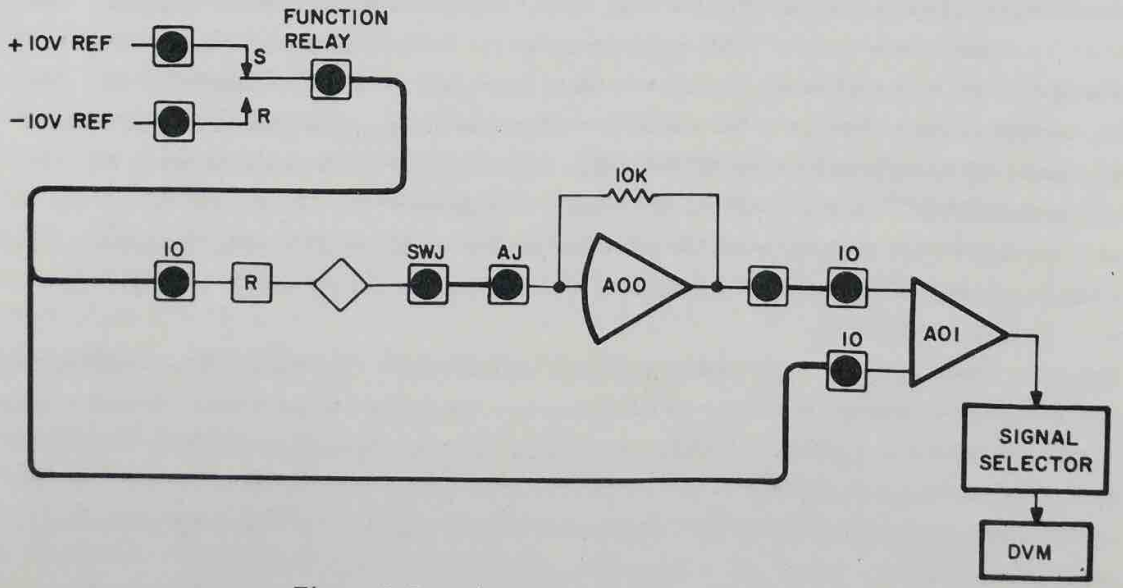


Figure 2.7. D/A Switch Adjustment Circuit

2. With the function relay control pushbuttons, place the function relay in the R-position so that -10 volts is applied to the "1" analog input of the switch.
3. Adjust R14 on the card (see Figure 2.8) until the DVM indicates an output of 0.0000.
4. Place the function relay in the S position, and adjust R11 on the card until the DVM indicates an output of 0.0000.
5. Repeat Steps 3 and 4 until the DVM indicates an output of 0.0000 ±10 millivolts with the function relay in either position.
6. Remove the output amplifier (A01), and connect an oscilloscope to the output of A00. Remove the patch cords to the digital pushbutton and the function relay.
7. Connect the output of a square wave generator with an amplitude of 5 volts peak-to-peak at a frequency of 1 kHz to the SW input.
8. Ground the "10" analog input to the D/A switch. Synchronize the oscilloscope externally with the output from the square wave generator, and set the vertical gain controls of the scope to provide a sensitivity of 5 millivolts per centimeter.
9. Observe the waveform on the scope, and carefully adjust capacitor C3 to minimize the switching transients.
10. This step completes the D/A switch adjustment procedure.

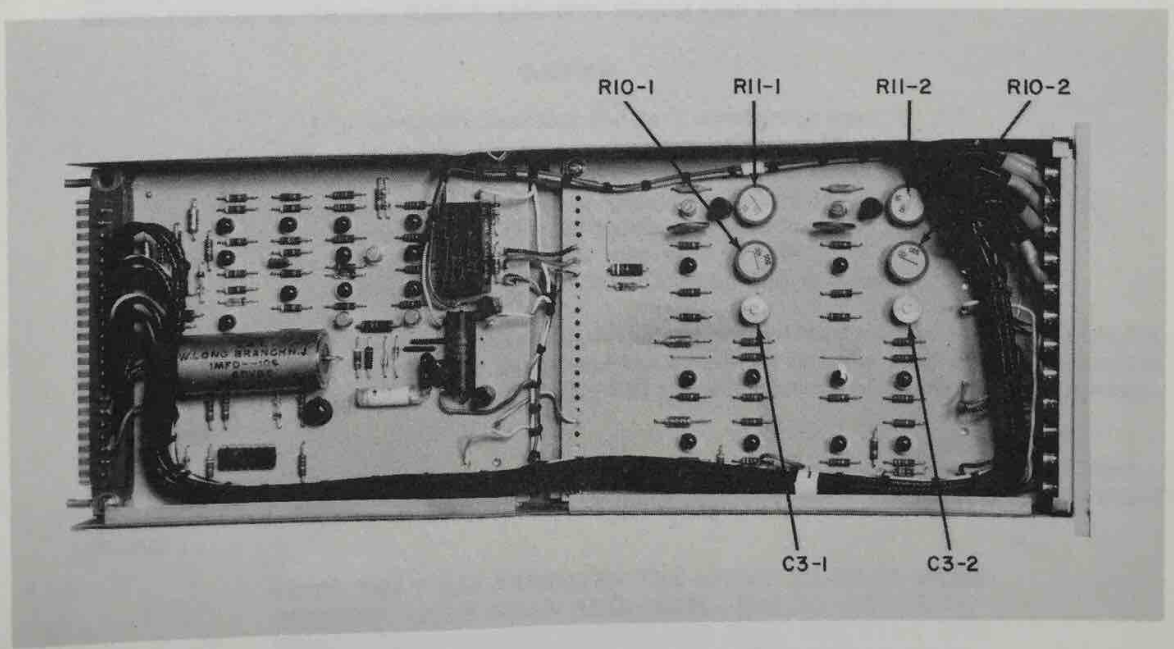


Figure 2.8. D/A Switch Card Showing Adjustments

APPENDIX 1

REPLACEABLE PARTS LISTS

This appendix contains Replaceable Parts Lists for the equipment described in this chapter. In each case, a brief description of the part, the EAI part number and, where applicable, a reference symbol (schematic designation) is included. To enable a particular sheet to be readily located, an index precedes the individual replaceable parts lists.

The category column indicates the availability of each part so that a replacement can be obtained as quickly as possible.

Category "A" - The parts in category "A" are standard electronic items that are usually available from any commercial electronic supplier.

Category "B" - The parts in category "B" are proprietary items that are available only from EAI.

CAUTION

If proprietary items are replaced with items obtained from other sources, EAI cannot assume responsibility for a unit not operating within its published specifications.

ORDERING INFORMATION

To expedite your order for replacement parts the procedures below should be followed:

1. Specify the EAI part number and description of the part required. The model number and serial number of the next higher assembly should also be included.

NOTE

EAI is currently revising the part numbering system. All parts effected by this revision are identified using the new and the old number (the number in parenthesis). All parts should be ordered using the new number. The old number is provided to cross reference parts that may still be identified physically, or in other publications by that number.

2. When ordering complete assemblies (networks, printed circuit cards, etc.), specify the model and serial numbers of the equipment the assembly is to be used with. If possible, include the purchase order number or the EAI project number of the original equipment purchased.

3. When ordering expansion components, note if mounting hardware is required. If hardware is needed, add to the purchase order the statement "INCLUDING MOUNTING HARDWARE".

NOTE THAT EAI RESERVES THE RIGHT TO MAKE PART SUBSTITUTIONS WHEN REQUIRED. EAI GUARANTEES THAT THESE SUBSTITUTIONS ARE ELECTRICALLY AND PHYSICALLY COMPATIBLE WITH THE ORIGINAL COMPONENT.

PARTS LIST INDEX

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
1	J1	Connector Block: Yellow	00 542.1545-1	B
2		Connector Block: Lettered (POT-T/S-D/A 0.42.0341)	00 542.1552-0	B
		0.12.1613 TRACK AND STORE CARD		
1	1a	Integrated Circuitry: Quad 2-Input Gate	00 592.0096-0	B
2	C1	Capacitor, Fixed, Ceramic: 47 nf ±20%, 25V (Sprague 3C15 or equal)	00 511.5473-4 (00 515.0234-0)	A
3	C2	Capacitor	00 521.1543-0	B
4	C3	Capacitor	00 521.0830-1	B
5	C5	Capacitor, Fixed, Mica: 47 pf ±2%, 100V (Cornell-Dubilier CD15C47PFG or equal)	00 519.0075-0	A
6	C6	Capacitor, Fixed, Mica: 33 pf ±2%, 500V (Elmenco 4CRDM10E-330-G0-500WV or equal)	00 519.0090-0	A
7	C8,11	Capacitor, Fixed, Electrolytic: 3.3 uf ±20%, 15V (Sprague 150D335X0015A2 or equal)	00 516.0254-0	A
8	C12	Capacitor, Fixed, Ceramic: 10 pf ±5%, 500V (Sola CD8C-100J500V or equal)	00 511.1100-2 (00 515.0203-0)	A
9	CR1,2,8,9, 10,12,13	Diode	00 614.0142-0	B
10	CR3,4	Diode	00 614.0007-0	B
11	CR5,6	Rectifier: 1N4002	00 614.0110-0	A
12	CR7	Diode (ITT G-187 or equal)	00 614.0043-0	A
13	CR11	Diode, Zener (Motorola 1/4M6.2AZ10 or equal)	00 614.0214-0	A
14	K1	Relay	00 618.0303-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

UNIT TITLE
POT TRACK AND STORE
D/A SWITCH TRAY

MODEL NO.
0.42.0341 Sh. 1 of 4 Sh.

DATE 10/ 18/ 67

M446

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
15	P1	Connector, Plug: 22 Contacts; Male (Amphenol 133-022-23 or equal)	00 542.0419-0	A
16	Q1,4,5,7, 10,12,14	Transistor: 2N3640	00 686.0258-0	A
17	Q2,3,8,16	Transistor: 2N3646	00 686.0230-0	A
18	Q6	Transistor	00 686.0257-0	B
19	Q9,11,13	Transistor	00 686.0245-0	B
20	Q15	Transistor	00 686.0248-0	B
21	R1,2,5,6, 8,27,32,35	Resistor, Fixed, Composition: 2.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0222-0	A
22	R3,4,23	Resistor, Fixed, Composition: 1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0102-0	A
23	R7	Resistor, Fixed, Composition: 3.3K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0332-0	A
24	R9,11,12,13, 15,16,18	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0472-0	A
25	R10	Resistor, Fixed, Composition: 75K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0753-0	A
26	R14	Resistor, Fixed, Composition: 220 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0221- 0	A
27	R17	Resistor, Fixed, Composition: 47K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0473-0	A
28	R19,24	Resistor, Fixed, Composition: 1.5K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0152-0	A
29	R20	Resistor, Fixed, Composition: 91 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0910-0	A

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/18/67

UNIT TITLE
POT TRACK AND STORE
D/A SWITCH TRAY

MODEL NO.
0.42.0341 Sh. 2 of 4 Sh.

3-2-14

M446

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
30	R21,25	Resistor, Fixed, Composition: 1 ohm ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0109-0	A
31	R22,26,33	Resistor, Fixed, Composition: 1.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0122-0	A
32	R29,30	Resistor, Precision	00 640.0109-0	B
33	R31	Resistor, Fixed, Composition: 12K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0123-0	A
34	R36,38	Resistor, Fixed, Composition: 390 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0391-0	A
35	R37	Resistor, Fixed, Composition: 22K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0223-0	A
36	R40	Resistor, Fixed, Composition: 820 ohms ±5%, 1/2W (Allen-Bradley EB or equal)	00 626.0821-0	A
37	R41	Resistor, Precision	00 638.0925-0	B
		0.12.1614-1 D/A SWITCH CARD		
1	C1,2	Capacitor, Fixed, Ceramic: 3.3 uf ±20%, 15V (Sprague 150D335X0015A2 or equal)	00 516.0254-0	A
2	C3-()	Capacitor, Variable: 2.5-11 pf (Erie 538-011-BZP0-90R or equal)	00 524.0068-0	A
3	CR1	Diode, Zener (Motorola 1/4M6.2AZ10 or equal)	00 614.0214-0	A
4	CR2-1,2-2	Diode (ITT G-187 or equal)	00 614.0043-0	A
5	Q1,2,5-()	Transistor: 2N3640	00 686.0258-0	A
6	Q3,4-()	Transistor: 2N3646	00 686.0230-0	A
7	Q6-()	Transistor	00 686.0246-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10 / 18 /67

UNIT TITLE
POT TRACK AND STORE
D/A SWITCH TRAY

MODEL NO.
0,42.0341 Sh.3 of 4 Sh.

ITEM	REF. DESIG.	DESCRIPTION	EAI NO.	*CAT.
8	R1,3 thru 7, 9-()	Resistor, Fixed, Composition: 2.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0222-0	A
9	R2-()	Resistor, Fixed, Composition: 1.2K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0122-0	A
10	R8-()	Resistor, Fixed, Composition: 1K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0102-0	A
11	R10-()	Resistor, Variable: 500 ohms ±5%, 1W (Int. Resistance Co. CT100 or equal)	00 642.0610-0	A
12	R11-()	Resistor, Variable: 50 ohms ±5%, 1W (Int. Resistance Co. CT100 or equal)	00 642.0725-1	A
13	R12-()	Resistor, Fixed, Composition: 110 ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0111-0	A
14	R13-()	Resistor, Precision (Matched Pair)	00 640.0125-0	B
15	R14-()	Resistor, Fixed, Film: 200K ohms ±1%, 1/4W (Int. Resistance Co. CEA-T0 or equal)	00 634.0718-0	A
16	R15-()	Resistor, Fixed, Composition: 390 ohms 5%, 1/2W (Allen-Bradley EB or equal)	00 626.0391-0	A
17	R16-()	Resistor, Fixed, Composition: 4.7K ohms ±5%, 1/4W (Allen-Bradley CB or equal)	00 625.0472-0	A
18	RT1-()	Thermistor	00 646.0116-0	B

*NOTE: THE CATEGORY COLUMN IS DESIGNED TO INDICATE AVAILABILITY OF PARTS.
A - INDICATES PARTS THAT SHOULD BE PURCHASED LOCALLY.
B - INDICATES PARTS THAT SHOULD BE PURCHASED FROM EAI.

DATE 10/ 18/ 67

UNIT TITLE
POT TRACK AND STORE
D/A SWITCH TRAY

MODEL NO.
0.42.0341 Sh. 4of 4Sh.

APPENDIX 2

DRAWINGS

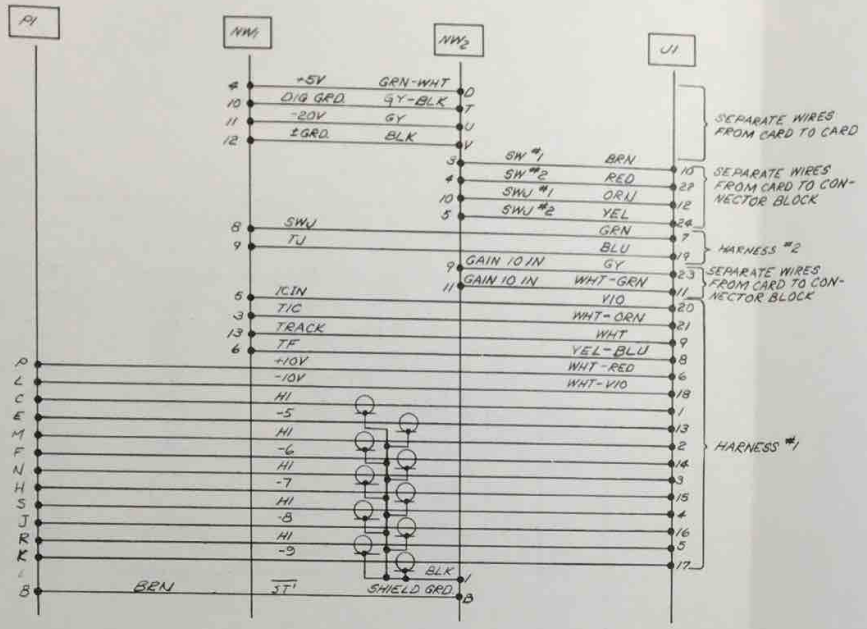
This appendix contains necessary schematics and wiring diagrams of equipment described in this chapter. To facilitate locating a particular sheet, an index is provided that lists the model number of each unit or component, the type of drawings, and the associated drawing number. The drawings are bound into the manual in the order listed under the index Drawing Number column.

EAI drawings are prepared in accordance with standard drafting practices for electro-mechanical and electronic equipment. All symbols are in accordance with current government standards.

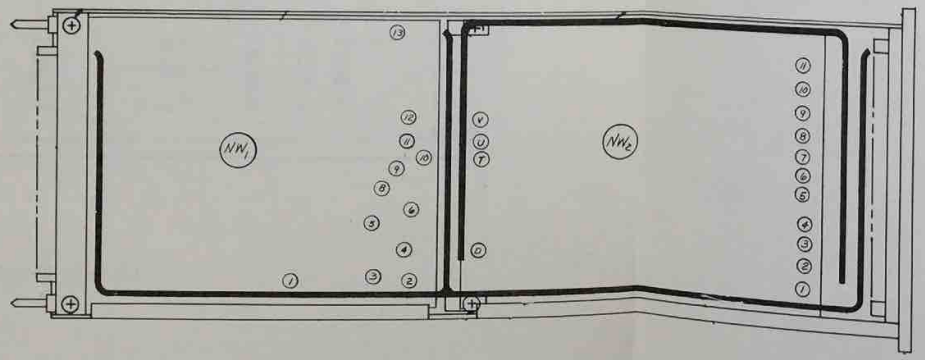
INDEX

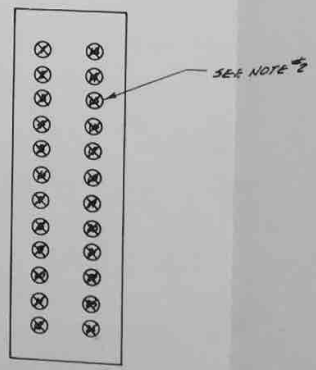
Unit or Component	Type of Drawing	Drawing Number
0.42.0341 Pot, Track/Store, D/A Switch Tray	Assembly W/ Wiring	D00 042 0341 0A
0.12.1613 Track and Store Card	Schematic	C00 012 1613 0S
0.12.1614 D/A Switch Card	Schematic	C00 012 1614 0S

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) WIRES TO BE #22 P.H.U.
   b) COAX PER B00916 0001 0.
2. ⊗ DENOTES LOCATION OF SPRINGS (ITEM #12) PER DETAIL "A".
3. SEE (A00018/402 0P) FOR HARNESS 1, #2



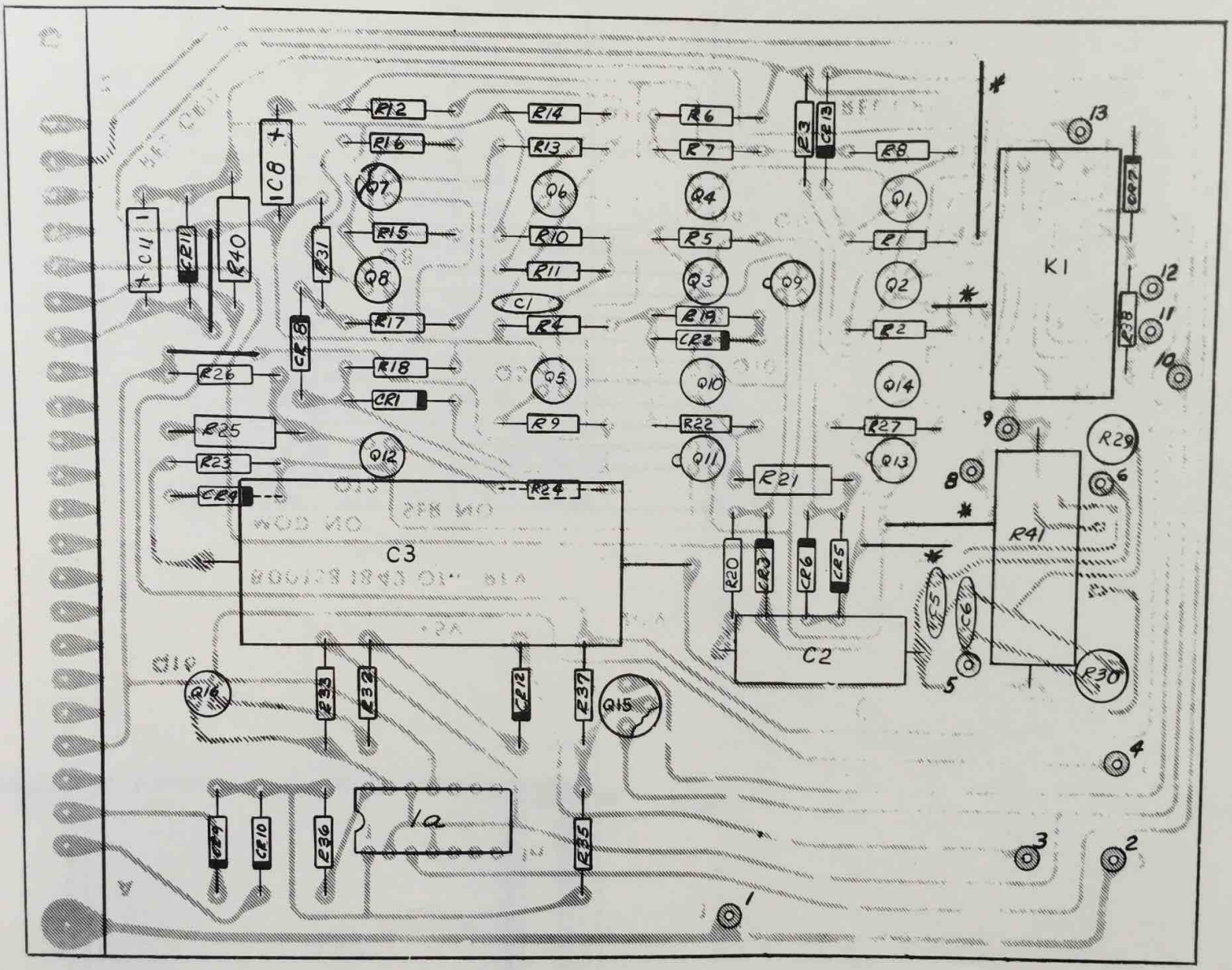
CONN. BLOCK REAR VIEW



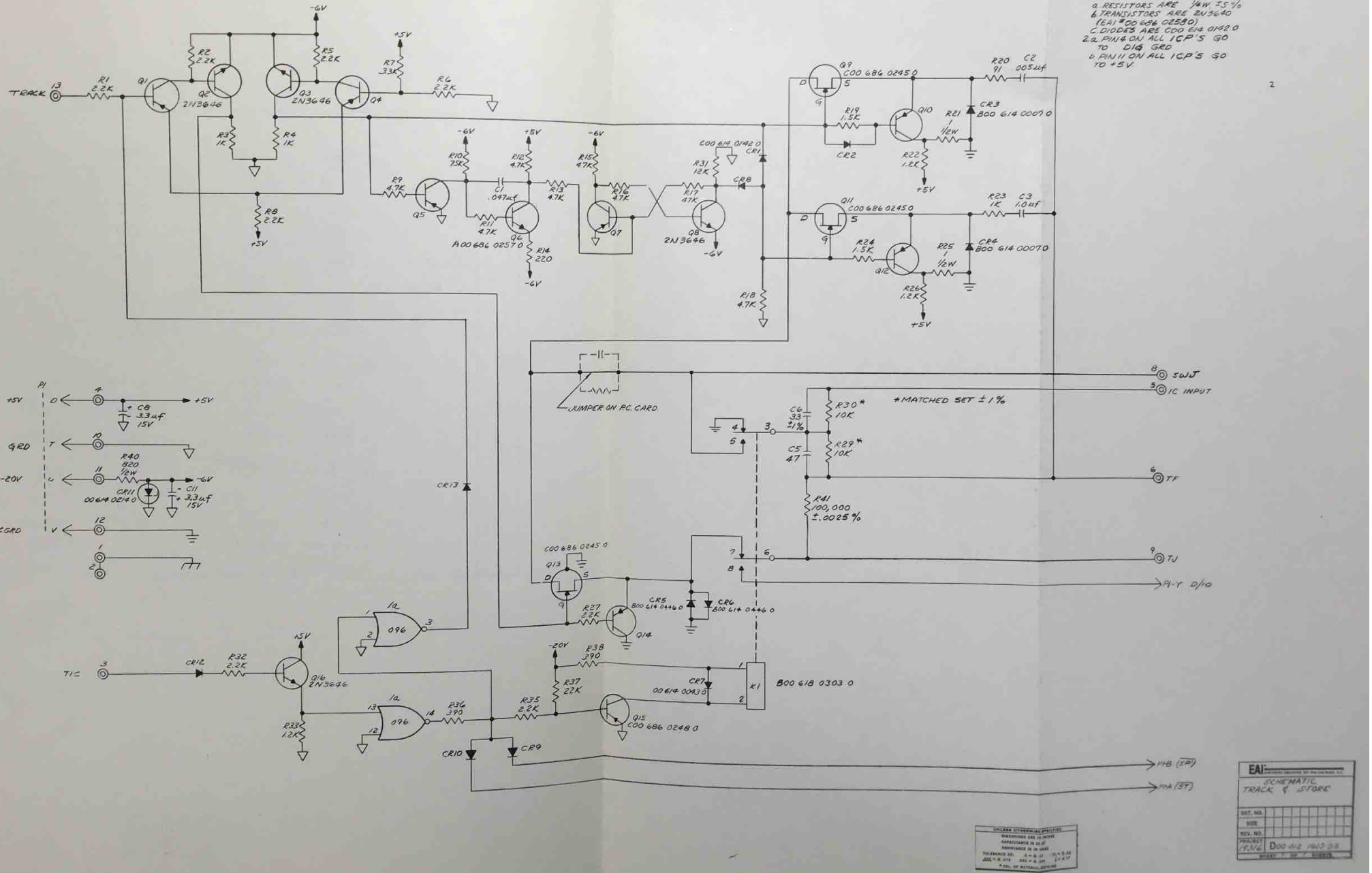


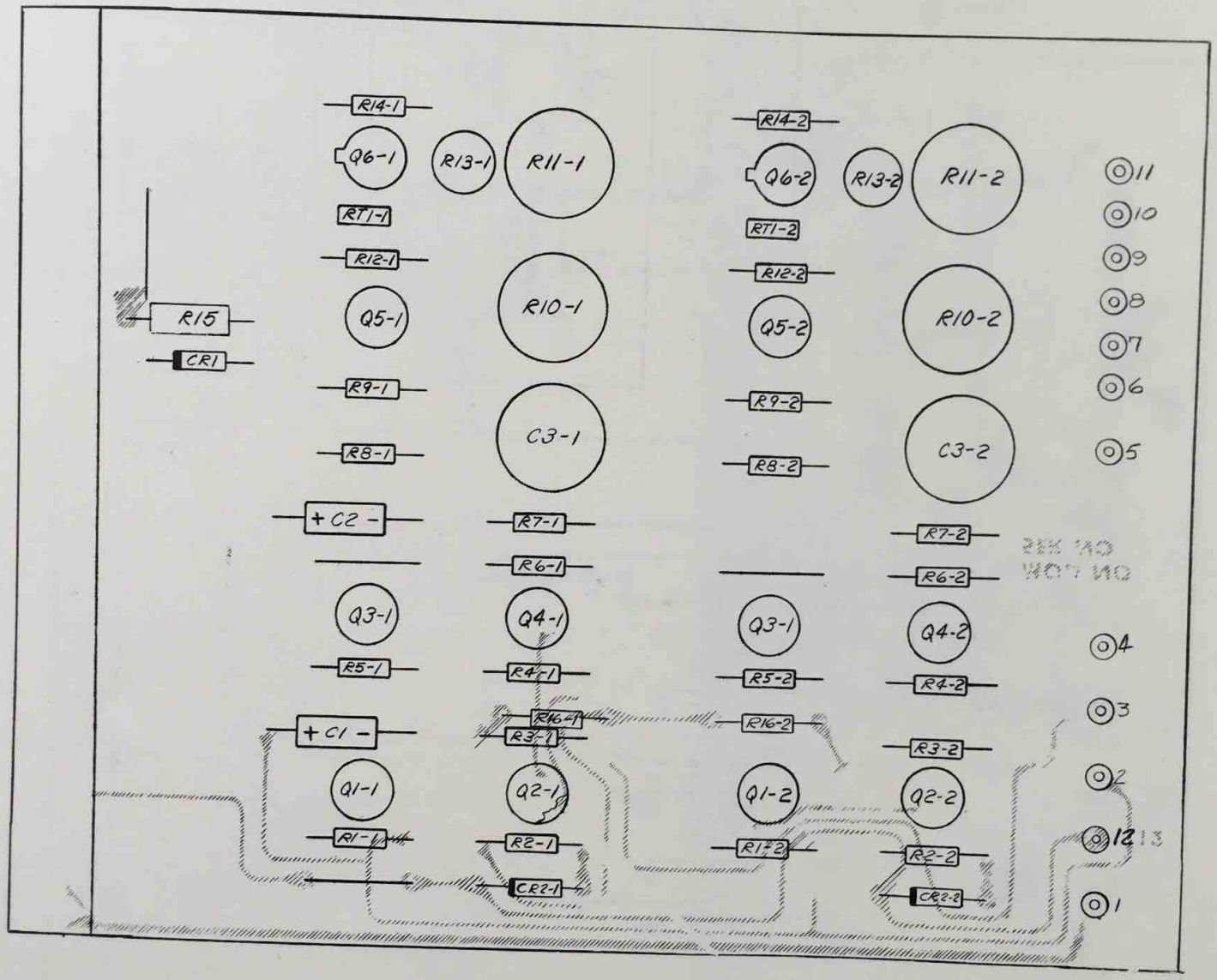
CONN. BLOCK FRONT VIEW

EAI
ASSEMBLY W/ WIRE WRAP POST TRACK / STORE 9A SWITCH TRAY
SHT. NO.
SIZE
REV. NO.
PROJECT 1984
D 00 0402 0341 0A



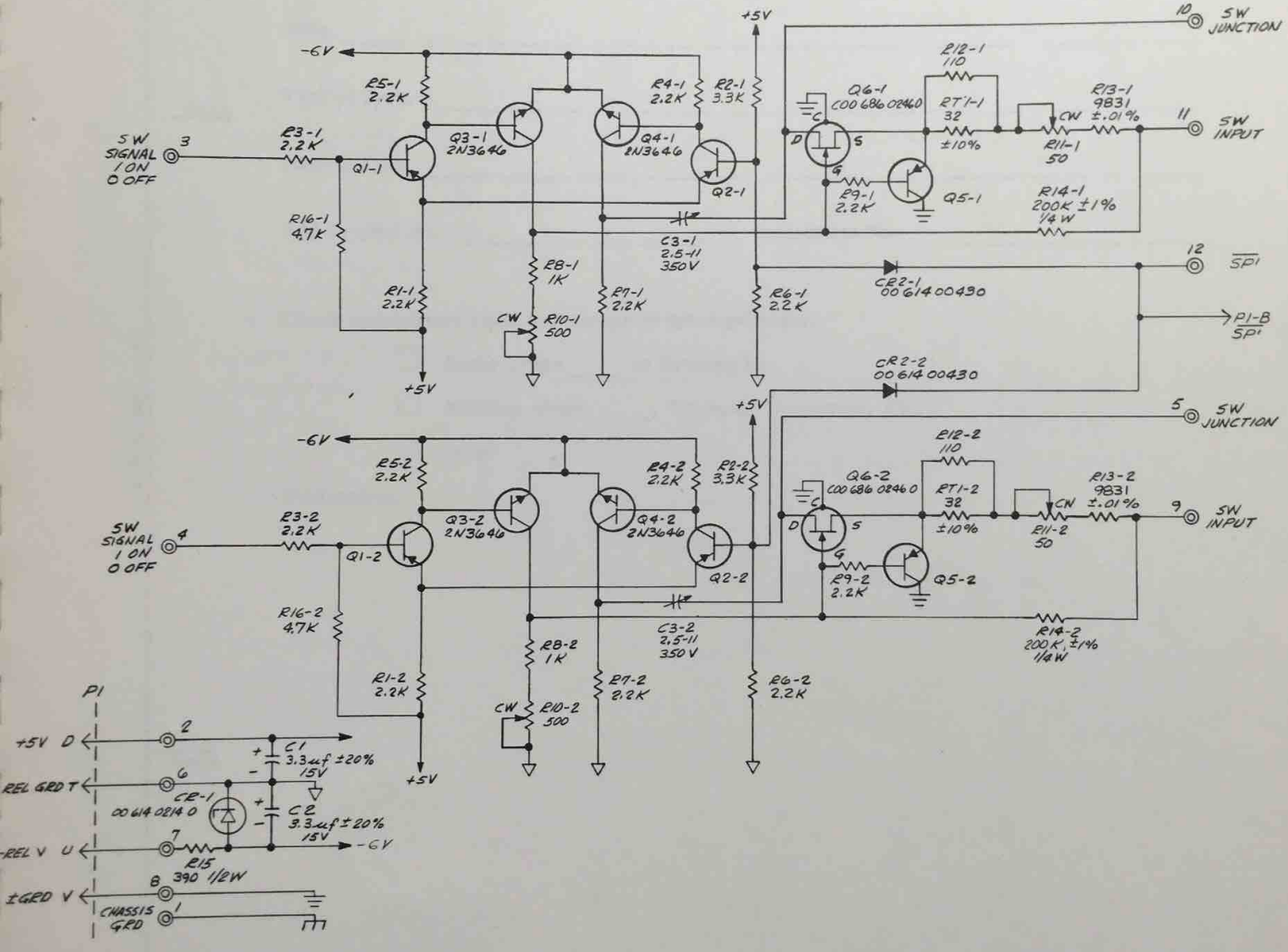
12.1613 Track and Store Card


NOTES;
1. UNLESS OTHERWISE SPECIFIED:
a. RESISTORS ARE ¼W, 5%
b. TRANSISTORS ARE 2N3640 (EAI #00 686 02580)
c. DIODES ARE C00 614 0142 0
2. a. PIN 6 ON ALL ICP'S GO TO DIG GRD
b. PIN 11 ON ALL ICP'S GO TO +5V
TRACK
TIC
DIG GRD
-20V
+5V
-6V
JUMPER ON P.C. CARD.
*MATCHED SET ±1%
SWJ
IC INPUT
TF
TJ
P1-Y D/10
HB (SP)
PA (ST)
K1
B00 618 0303 0
SCHEMATIC
TRACK & STORE



12.1614 D/A Switch Card

NOTES:
1. UNLESS OTHERWISE SPECIFIED;
   a. RESISTORS ARE ±5%, 1/4 W.
   b. TRANSISTORS ARE 2N3640



UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
CAPACITANCE IS IN pf
RESISTANCE IS IN OHMS
TOLERANCE OF: .X = ± .03 .XX = ± .02 .XXX = ± .015 .XXX = ± .005 ∠ = ± 1°
* TOL. OF MATERIAL SUPPLIED

EAI ELECTRONIC ASSOCIATES, INC. West Long Branch, N.J.

SCHEMATIC
D/A SWITCH CARD

SHT. NO.	
SIZE	
REV. NO.	
PROJECT 19316	C 00 012 1614 05

SHEET 1 OF 1 SHEETS