E03 VOLTAGE CONTROLLER
For Use in S-56

I. INTRODUCTION

The voltage controller card (E03) is one of four, printed circuit cards comprising basic armature regulators for S-56 systems. Other standard cards, explained in separate instruction leaflets, are: E01, gate pulse generator; E02, current controller and gate pulse suppression; and E04, speed controller and ramp-function generator.

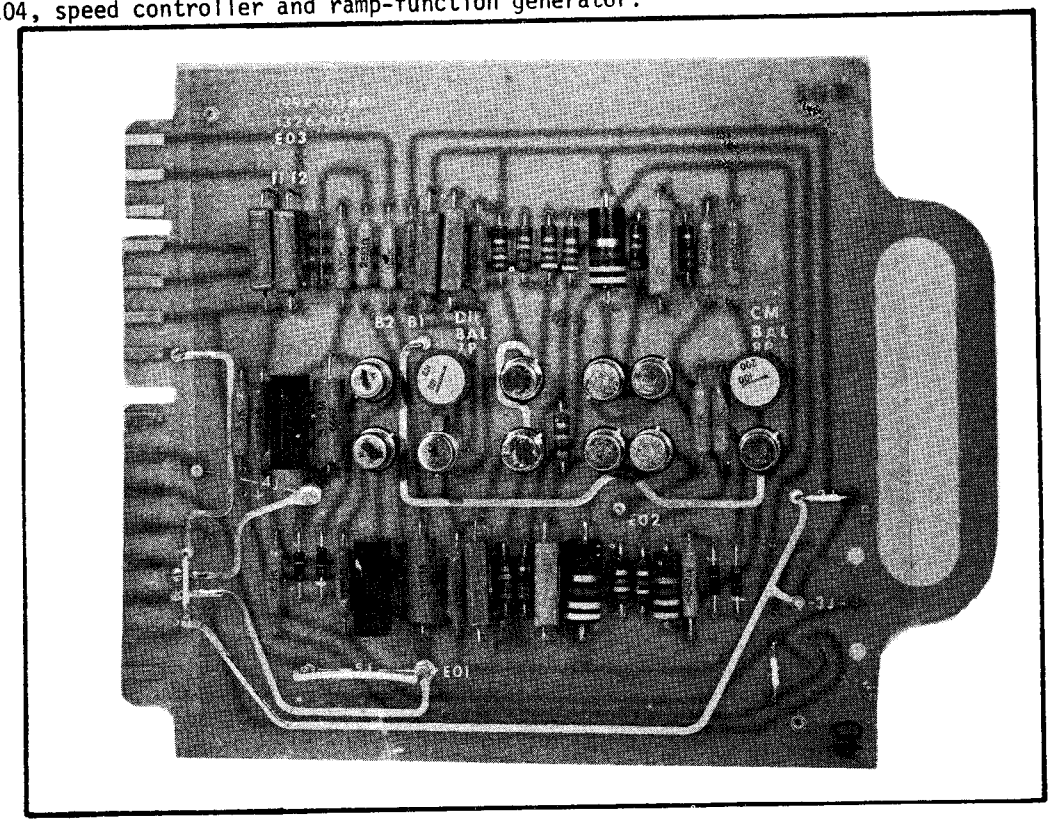

FIGURE 1 - E03 PC CARD

Figure 1 is a picture of the E03 pc card as used in speed regulators. By adding or eliminating components, and changing jumper positions, the same board is used in all S-56 basic armature regulators.

Printed circuit cards designed for S-56 systems are plug-in cards for insertion into AMP, connector type, number 67131-1 or equivalent. Each card type (designated by "E" number) is uniquely keyed to prevent insertion in improper regulator positions. Overall board dimensions are 6" X 7.6". A handle is machined in the card which facilitates insertion or removal, and prevents inadvertant component breakage or board contamination. All electrical inputs and outputs are taken through the 15 terminals located at the rear edge of the card. Reading from the top of the pc card to the bottom, terminals will always be identified on schematics by numbers 31, 33, 35, 37, ... 59. Potentiometers required for system adjustments are right-angle pots located along the front edge of the pc card.

II. DESCRIPTION

The two functions provided by the E03 pc card will be explained with reference to the schematic diagram, Figure 2.

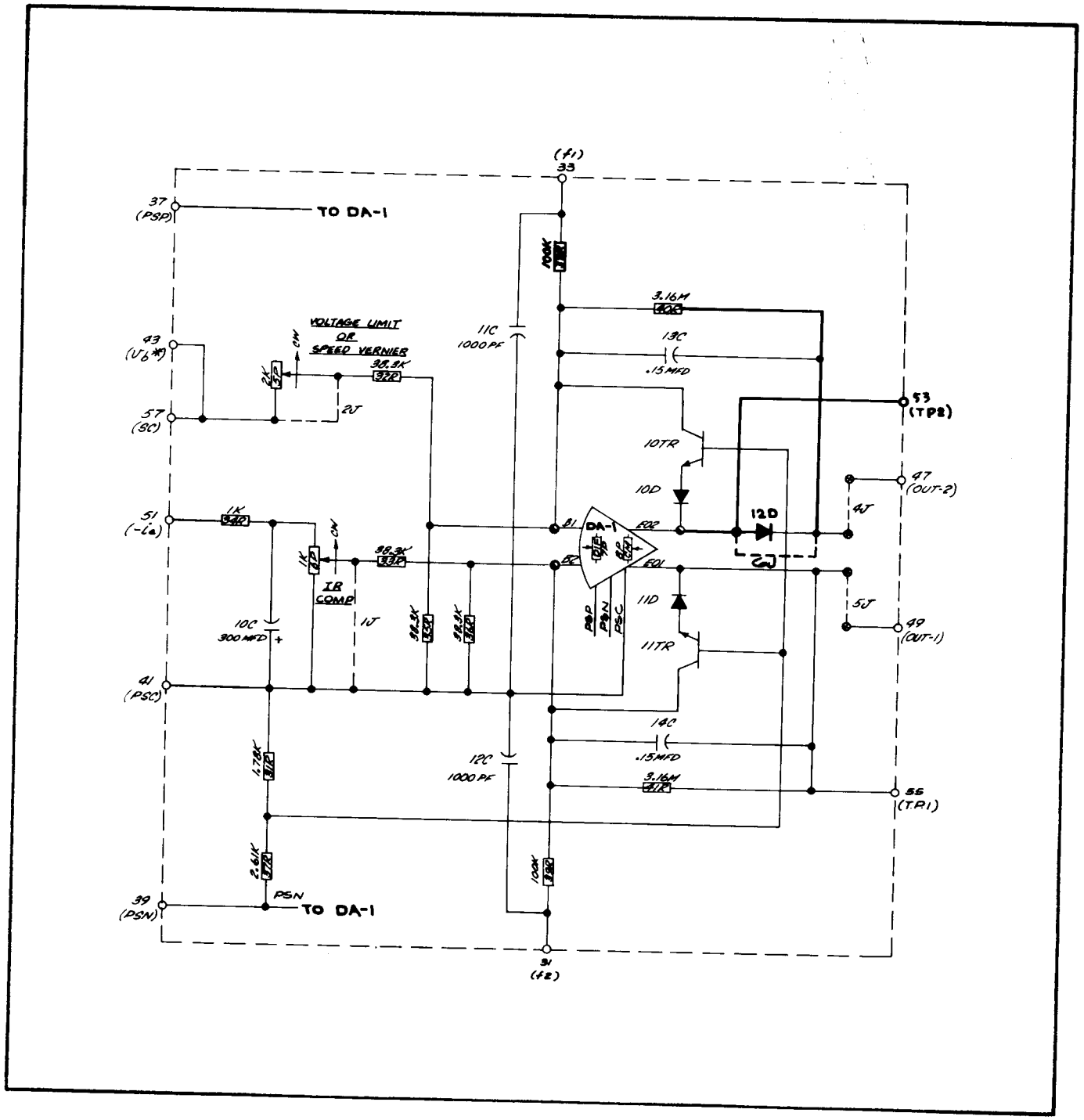

FIGURE 2 - E03 SCHEMATIC DIAGRAM

A. Voltage Controller

Differential amplifier (C-105C) and associated feedback components comprise the voltage controller used in S-56 parallel regulators. A general discussion of differential input-output operational amplifiers is contained in I.L. 16-800-125.

1. C-105C

Figure 3 is the schematic diagram of the operational amplifier C-105C.

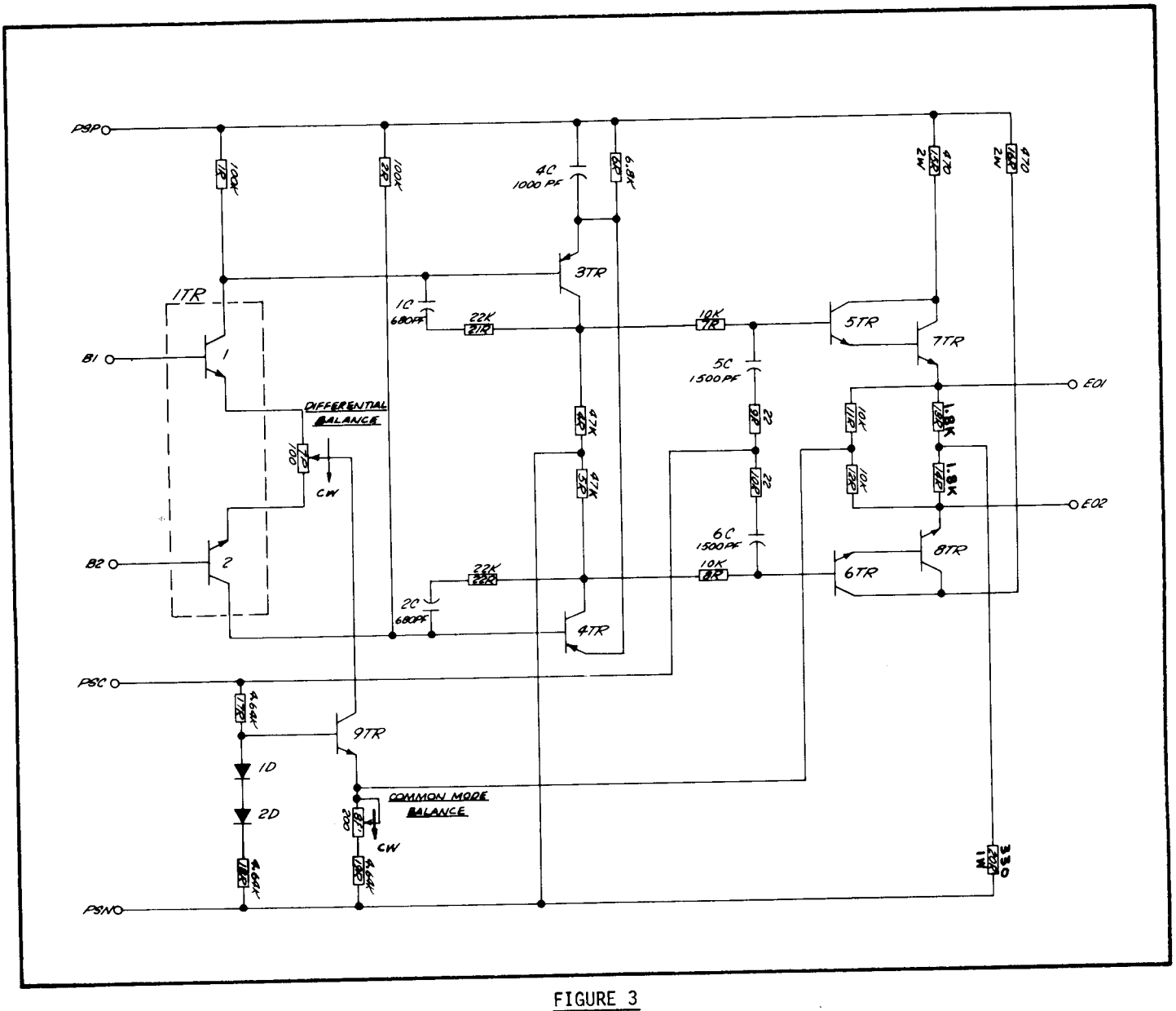

FIGURE 3

A small difference voltage applied between B1 and B2 is amplified through two differential stages. The first stage includes transistor 1TR, which has a matched pair of high-gain silicon transistors in a single TO-5 can, and the second stage includes transistors 3TR and 4TR. These two stages provide a dc differential voltage gain of approximately 4000.

A darlington connection of transistors (5TR-7TR and 6TR-8TR) is used as the output stage to achieve the required current gain and minimize loading of the second differential stage.

It should be noted that a positive differential error signal (B1 + with respect to B2) will yield a + output from E01 and an equal and opposite - output from E02.

The various capacitors with their related resistors serve as shaping networks to optimize frequency and phase shift characteristics of the amplifier.

To balance the amplifier (refer to Figure 2), connect terminals 43, 51, 31, and 33 to PSC. Short out diode 12D.

a. Connect a multimeter from TP1 to TP2 and using the differential pot 7P, adjust for zero.

b. Connect the multimeter from either TP1 or TP2 to PSC and adjust the common mode pot 8P for zero output.

c. Recheck a. above and repeat steps a. and b. until both measurements read zero without adjustment.

2. Controller Function

Symmetrical feedback components associated with the C-105C (see Figure 2) commit its use as a time delay amplifier. The general form of the transfer equation is:

$$\frac{E01}{e_{(sc)}} = \frac{41R}{2 \times 32R} \times \frac{1}{(1 + 41R \times 14Cp)} \simeq \frac{40}{(1 + 0.47p)}$$

To prevent the amplifier from saturating the output voltage is limited by transistors 10TR, 11TR and diodes 10D and 11D to approximately ±10.5V as set by the voltage divider consisting of 31R and 37R.

With the minor changes shown in Figure 4, the E03 board is used in voltage, speed, and current regulators.

Style No.	Use for	Items Eliminated	Jumpers Used
1326A03G01	Single Drive Voltage Regulator	5P	2J, 4J
1326A03G02	Multi-Drive Voltage Regulator		4J
1326A03G03	Speed Regulator	12D, 34R, 10C, 5P, 6P	1J, 2J, 5J, 6J
1326A03G04	Current Regulator	34R, 10C, 6P, 5P	1J, 2J, 4J

FIGURE 4

In all S-56 armature regulators, the voltage controller is used as a time delay amplifier with differential and (unless one armature terminal is grounded) common mode inputs. The voltage loop is closed through dropping resistors mounted in the basic regulator cage assembly (I.L. 16-800-101), which connect the TPM output terminals to the inputs (terminals 31 and 33) of the E03 board. Impedance to ground from either armature terminal is a minimum of one megohm.

Control input signals (with the exception of I.R. compensation) are positive and always feed base 1.

The voltage loop is one of the parallel control loops in both current and voltage regulators. When used in either type of regulator, proper phasing requires the inverted output (OUT-2) of the voltage controller be used, and 12D is the switching diode for the voltage controller. (Required reverse biasing for 12D is supplied through 18R in the E02 pc card.)

As used in speed regulators, the voltage loop is an inner loop fed from the paralleled output of a speed controller E04 and current controller E02. Proper phasing requires the noninverted output (OUT-1) of the voltage controller card be used without the switching diode which, in this case, would serve only to create an undesired deadband.

Advantages to employing an inner voltage loop in speed regulators, general information on S-56 systems, and advantages derived from parallel-controlled regulators is discussed in I.L. 16-800-100.

3. Characteristics and Ratings

a. Allowable operating ambient range: 0 to 55°C.

b. Output: $V_{OUT\ (47-41)}$: ±10.5V ±0.7V
$V_{OUT\ (49-41)}$: ±10.5V ±0.7V
$I_{OUT\ max.}$: 3.5 ma

c. DC power requirements: +24V ±1.2V --- 40 ma max.
-24V ±1.2V --- 40 ma max.

d. Potentiometers:

5P --- (1) Sets the point of voltage limit in current regulators.
(2) Provides a vernier speed adjustment of approximately 5% for multi-drive voltage regulators.

6P --- I.R. compensation for voltage regulators may be used to produce either a rising or drooping characteristic by changing the polarity of feedback from the transductor. + feedback is connected when 1TB18 and 1TB15 are connected at the basic regulator cage assembly, and - feedback when 1TB18 and 1TB17 are connected.

7P --- Differential balance adjustment for the dc amplifier.

8P --- Common mode balance adjustment for the dc amplifier.

III. SERVICE

Personnel familiar with electrical equipment utilizing semiconductors can isolate most problems using an oscilloscope, multimeter, and information contained in relative instruction leaflets.

Semiautomatic equipment is available at the factory to test static and dynamic performance of all edge-connected printed circuit cards. Generally, repair of modules is facilitated by returning them to: Westinghouse Electric Corporation
Industrial Systems Division
P.O. Box 225
Buffalo, New York 14240.