Service Data

Vickers®

Servo Valves

Single Ended Linear DC Servo Amplifier

EM-A-10

Revised 09/01/87

General

This manual is written primarily to establish a logical trouble-shooting procedure for the solid state EM (electronic modular) amplifier. Complete systems are beyond the scope of this manual and will not be covered. Adequate information is presented for an Electrical Technician to repair the EM-A-10 amplifier.

EM-A-10 (308118) Linear Servo Amplifier

A. Description

The EM-A-10 is a special purpose DC servo amplifier designed specifically for a Vickers SE3 or SF4 flapper type servo valve. The EM-A-10 consists of a high gain summing amplifier, a low gain DC amplifier and a power output stage.

The amplifier module also contains a ±10 volt regulated power supply which may be used for development of input signals through an external 5000 ohm potentiometer.

The complete amplifier and power supply are contained on a plug-in module whose approximate dimensions are 3-1/2 x 5 inches. Refer to table 1 for electrical and mechanical specifications.

B. Specifications

Input Impedance	Min.	Typ.	Max.	Units
4	4.95	5	5.05	KΩ
5	49.5	50	50.5	KΩ
Input Signal Level	–100	0	+100	V-peak
Gain: Continuously				
Adjustable: Input 5	2		20	Amps/volt
Input 4	0.20		2	Amps/volt
Output	Single ended with respect to common			
Output Current				
20 Ω load	20	200	400	MA
Output current limits	–20		500	MA
Dither current adjustable	3		100	MAp-p
Output drift at max. gain				
During warm-up (30 min.)			±30	MA
vs. temperature			±1	MA/°F
vs. time (after 30 min.)			±10	MA/24 hrs.
vs. supply voltage			±1	MA
Frequency Response DC - 300 Hz max. gain full load			–3	DB
Regulated Output Supply into 500 Ohm load				
Pin 7 to common	+9	+10	+11	Vdc
Pin 8 to common	–9	–10	–11	Vdc
Temperature Range				
Operating	–29		+71	°C
Storage	–40		+85	°C
Power Supply Req'mnt Voltage Range	+14	+19	+20	Vdc
	–14	–19	–20	Vdc
Mechanical Specs				
Module	Special printed circuit card			
Module Size	5.0" x 3.5" x 1.0"			
Module Weight	8 ox.			
Controls	Screwdriver adjusted Dither Gain			

Table 1. Electrical and Mechanical Specifications for the EM-A-10.

C. Installation

The EM-A-10 servo amplifier is designed for mounting on a power supply plate such as the EMP-A-11. Input and output connections to the amplifier circuitry are provided by printed circuit pin connections on the module. These pin connections, when installed into a plug-in receptacle, must be connected as shown in Table 2. TB2 wiring interconnections, located on the EMP-A-11 power supply plate, are shown for convenience.

Portions of the EM–A-10 servo amplifier are of the incapsulated construction and must be replaced as complete assemblies. Amplifier A1 and A2 shown on the schematic diagram Figure 1 are examples of this type of construction. Replacement of A1 and A2 require factory adjustments to be performed to the resistance values designated by an asterisk (*). Therefore, should replacement of either amplifier be required, it is recommended that the installation be accomplished by Vickers. Replacement EM-A-10 amplifiers are available.

EMP-A-11 TB2 (J)A (J)B (J)C	Plug-in receptacle pin conn'tions	Plug-in module pin conn'tions	Signal
–	a	1	Dither (13 Vac)
–	b	2	N.C
–	c	3	–19 Vdc input
4	d	4	Input #1
5	e	5	Input #2
6	f	6	Summing Junction
7	h	7	Regulated +DC output
8	j	8	Regulated –DC output
–	k	9	N.C.
–	l	10	N.C.
1	m	11	Negative output to coil
2	n	12	Positive output to coil
–	p	13	+19 Vdc input
–	r	14	Slotted for polarizing key
3	s	15	Common

Table 2. The EM-A-10 Plug-in Receptacle and Terminal Board Interconnecting Wiring

D. Circuit Description

Amplifier Section - The EM-A-10 is a DC amplifier, consisting of a high gain summing pre-amplifier feeding a unity gain buffer amplifier which drives a power output stage.

The output stage is statically adjusted to produce 200 Milliamperes (MA) of current through the 20Ω servo valve coil. (Vickers type SE3/SF4 servo valve) and varies from this 200 MA value with variations in input signal.

An explanation of the circuitry follows: Refer to the pictorial diagram, Figure 1, the simplified schematic diagram Figure 2, and the complete schematic diagram schematic diagram Figure 3.

Command and feedback signals are connected through R1 and R2 to the input of amplifier A1. Resistors R1, R2, and amplifier A1's input resistance form a summing network which permits a difference potential to be developed across amplifier A1's input resistance. The amplitude of this potential is determined by the polarity and amplitude of the input signals, the input coupling resistance R1 and R2, and the input resistance of amplifier A1. Under normal operating conditions, the junction of R1 and R2 is maintained at "virtual ground" within a few millivolts by A1. Diodes D8 and D9 limit amplitude extremes at the input of A1 to approximately $\pm$.5 volt minimum, if the amplifier output saturates. Amplifier A1 inverts the output signal with respect to the input signal, permitting gain adjustment to be obtained by a negative feedback arrangement through resistors R3 and R4. A portion of the inverted output is allowed to develop across the input resistance of amplifier A1. This negative feedback subtracts from the input signal subsequently reducing the gain of the amplifier.

The output of A1 is used to drive amplifier A2 which in turn provides the current necessary to drive power transistor Q5 and Q6. (Shown on the complete schematic diagram Figure 1).

Amplifiers A1 and A2 are of the same type. But amplifier A1's gain differs from that of amplifier A2, due to wiring arrangement. Amplifier A1's gain is essentially the ratio of feedback to input resistance or:

A1 Gain - Input 1 (Approx. gain of 2)

$$= \frac{R3 + \frac{R4 \bullet R4a}{R4 + R4a}}{R1}$$

A1 Gain - Input 2 (Approx. gain of 20)

$$= \frac{R3 + \frac{R4 \bullet R4a}{R4 + R4a}}{R2}$$

Amplifier A2 is connected to provide a non-inverting, unity gain amplifier characteristic. Unity gain amplifiers (gain of 1) provide isolation between circuits (buffer action) and will permit a source with low current capacity (A1) to drive a heavy load (Q5 and Q6).

Transistor Q5 and Q6 develop the necessary output current for the servo coil. Resistors R20 and R20a bias amplifier A2 and establish the 200 MA null current through Q6, D6, the servo coil, and resistor R26 (the current sensing resistor).

A voltage is developed across R26 directly proportional to the current through it. The voltage is reduced through voltage divider action by R23 and R21, and is fed to pin two (2) of the unity gain amplifier A2 reducing its gain. This gain reduction (negative feedback) improves the linearity of the driver stage A2 and the output transistor circuit Q5 and Q6. R25a and R25b are adjusted to limit the maximum current. When the voltage across R25a and R25b exceeds the threshold voltage of D4 and D5, the diodes conduct limiting a further current rise in the output circuit.

Dither - The dither signal (60 to 400 Hertz) is connected to pin 1 of the plug-in module. A variable resistive divider network R16 and R18 provide adjustment of the value of the dither. The dither is applied to pin two (2) of amplifier A2 through resistor R17. Dither signal is used to keep the servo flapper in constant motion, thus preventing the flapper from magnetizing in a locked condition against the orifice. Constant motion of the flapper will also reduce the effect of silting (the particle build-up around the orifice).

Power Supplies - Four regulated power supplies are provided on the plug-in module. Refer to the schematic diagram figure 1. The amplifier section utilizes both a positive ten (+10) and a negative ten (–10) volt supply for operation. A positive ten (+10) and a negative ten (–10) volt supply is also available for external use.

The externally connected supplies may be used for amplifier control circuitry if desired, thus providing the control voltage and amplifiers necessary for a complete system in one plug-in module.

All the regulated supplies operate in a similar manner, therefore, explanation of only one will be presented.

Upon application of negative nineteen (–19) volts DC to pin 3 of the plug-in module, Zener Diode Z2 conducts through R7 establishing a regulated source voltage for the base of Q2. A portion of this regulated voltage is applied to Q2 through the voltage divider network of R9, D2, and R11. Diode D2 and resistor R11 shunt the base resistance of Q2 and reduce the base drive as the temperature rises. This reduction in drive prevents thermal runaway of transistor Q2. Emitter resistor R13 swamps the emitter base junction resistance and prevents a large increase in emitter current, particularly at low temperatures. Q2 and R13 act as a variable voltage dropping resistor for Zener Diode Z4, and maintain a constant current through Z4 with varying input voltages. The combined action of Q2 and Z4 provide a regulated -10 volt source at pin 8 of the plug-in module.

E. Troubleshooting Procedure

Determine if the EM-A-10 module is functional. Refer to the schematic diagram figure 1 and the pictorial diagram Figure 2.

Note

The EMP-A-11 power supply or its equivalent must be used to perform the following test. Minor wiring changes may be required if an equivalent supply is used.

1. Remove electrical power from the system.

2. Remove the input signal connections 4, 5, 6, 7, and 8. Tape the wire ends and symbolize to prevent error.

3. Connect a linear taper, 5000 ohm test potentiometer as shown in figure 4.

4. Remove the EM-A-10 plug-in module. Use the ohmmeter on the low ohm scale to check the resistance of the load as follows:

   Connect the ohmmeter between J* - m & n. A reading of approximately 20 ohms is considered normal. If the reading is normal, reinsert the plug-in module and proceed with the test.

Note

The characteristics of this amplifier are such that once conduction starts, a very small change in input signal level will cause a very large change in output current. Therefore, the 5000 ohm command test potentiometer (shown in figure 4) will seem to have no effect on the measured output voltage level until the center of the control is reached, then the voltage level will change rapidly from 0 to –1.5 volts. To obtain –0.6 volts (200 MA) reading, the control must be varied very slowly when the center of the control is reached.

5. Connect a volt-ohmmeter between TB2*-2 and TB2*-3 (common ground reference). Apply power and measure for negative .6 volts (200 MA). The voltage should vary from approximately zero (0) volts at one end of the test potentiometer adjustment range to approximately 1.5 volts at the other. If the amplifier performs as indicated, it is operating normally.

6. Remove AC power from the system.

7. Connect symbolized wiring removed in step E. 2.

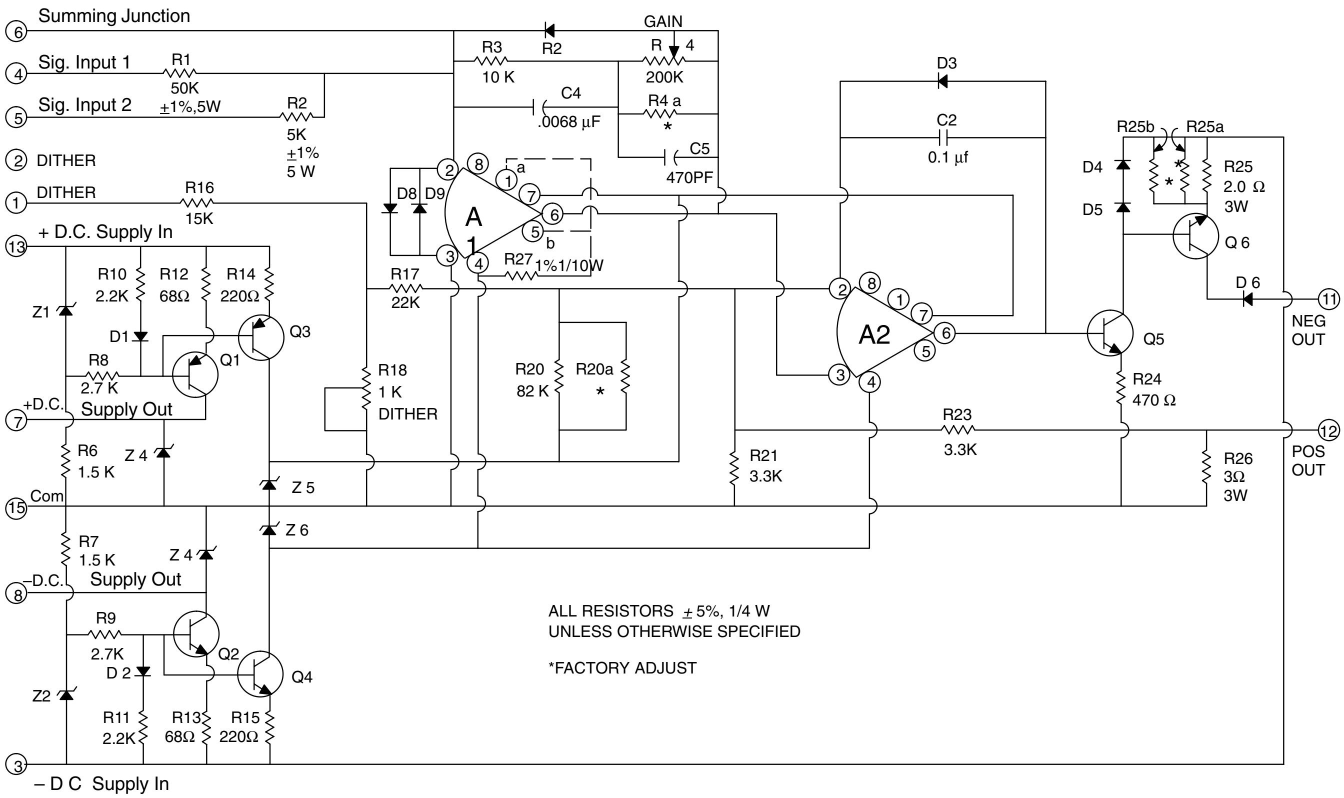


Figure 1. Complete Schematic Diagram for EM-A-10

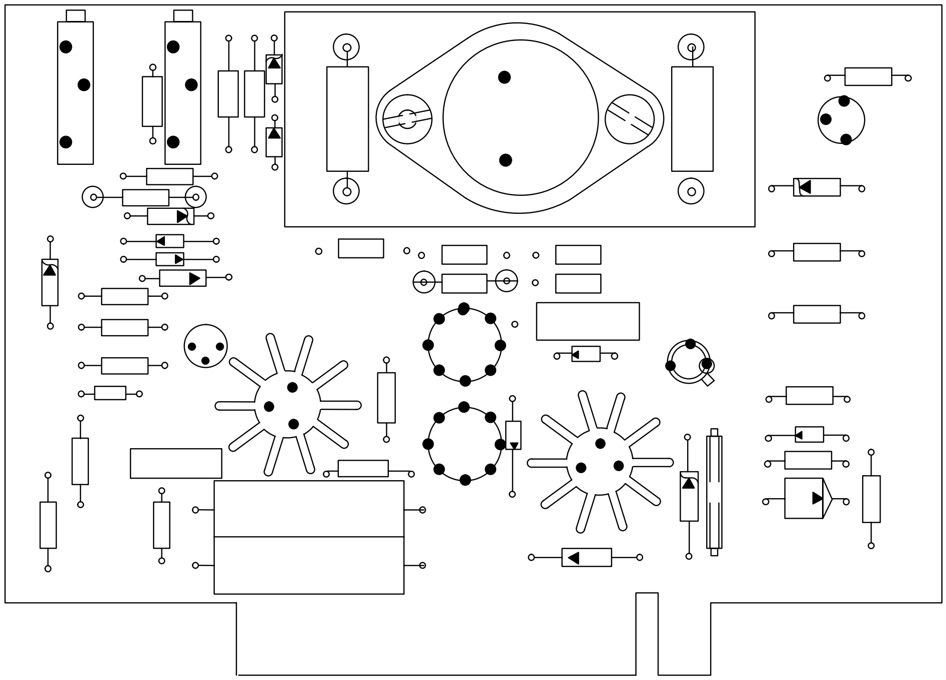


Figure 2. Pictorial Diagram of the EM-A-10

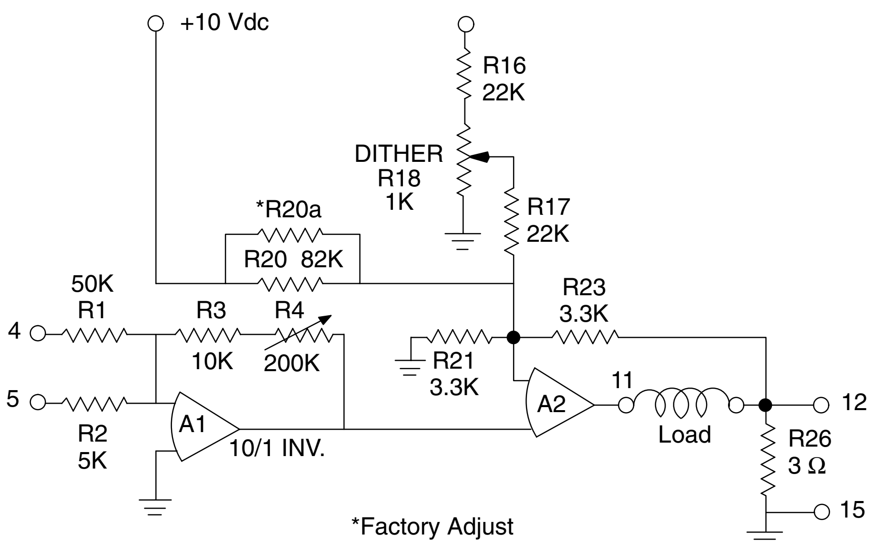
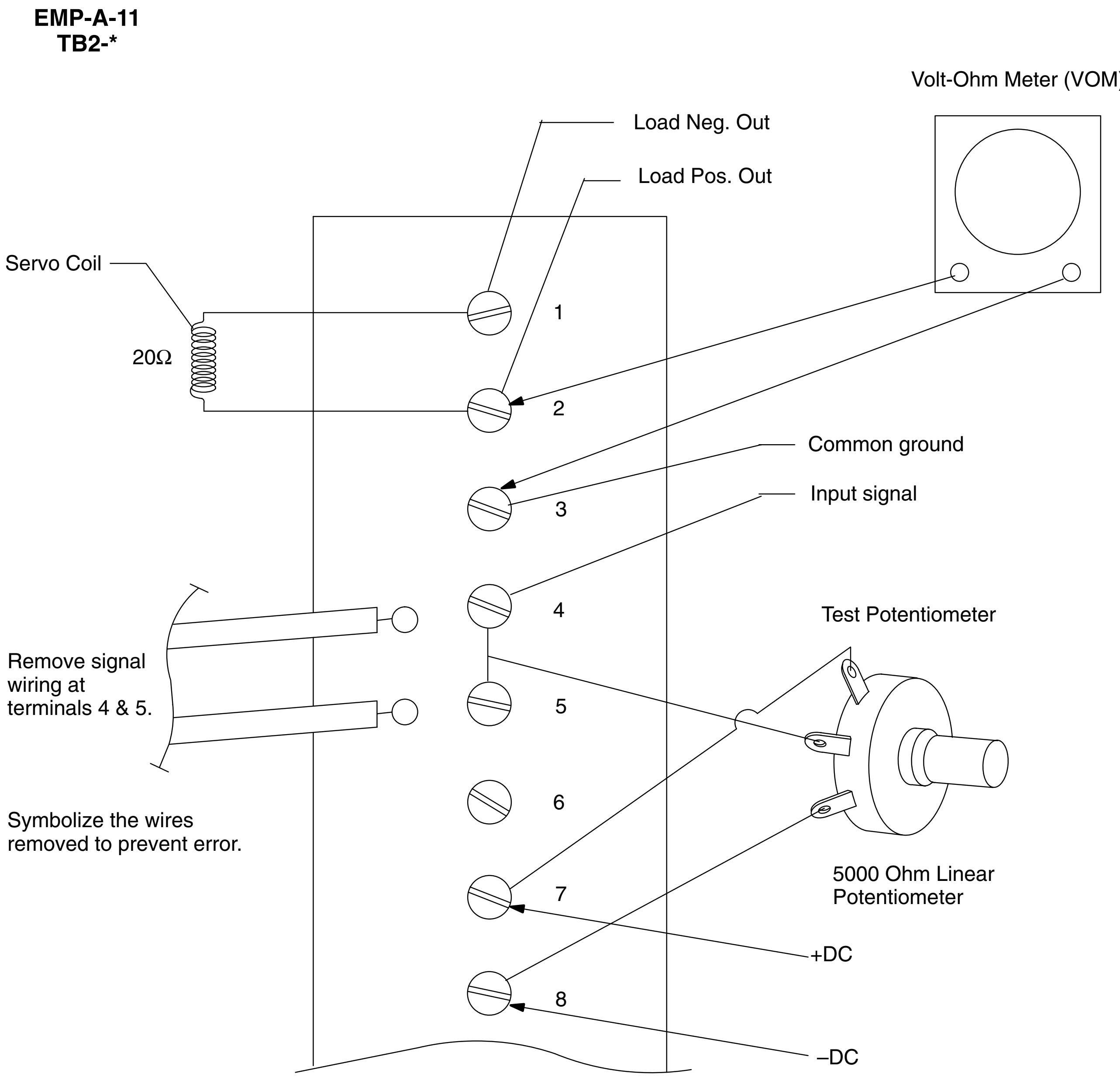


Figure 3. Simplified Schematic Diagram of the EM-A-10



Note

If the EMP-A-11 power supply is not used, connect the power source as shown to test the EM-A-11 amplifier.

Figure 4. Test Potentiometer Wiring Diagram