TM 11-6125-240-34

TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL FOR

MOTOR-GENERATOR PU-545/A (NSN 6125-00-958-6915)

HEADQUARTERS, DEPARTMENT OF THE ARMY

NOVEMBER 1978

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

High voltages and current exist in this equipment. Serious injury or DEATH may result from contact with the input or output connections. Reenergize the equipment before connecting or disconnecting the load to be powered. All maintenance and maintenance facilities must conform to TB 385-4, Safety Precautions for Maintenance of Electrical/Electronic Equipment. The fumes of TRICHLOROETHANE are toxic. Provide thorough ventilation whenever it is used; avoid prolonged or repeated breathing of vapor. Do not use near an open flame or hot surface; trichloroethane is nonflammable but heat converts the fumes to a highly toxic phosgene gas, the inhalation of which could result in serious injury or death. Prolonged or repeated skin contact with trichloroethane can cause skin inflammation. When necessary, use gloves, sleeves, and aprons which the solvent cannot penetrate.

DON'T TAKE CHANCES!

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, *DC 28 November 1978*

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REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028-2 located in the back of the manual Simply tear out the self-addressed form, fill it out as shown on the sampie, fold it where shown, and drop it in the mail. If there are no blank DA Forms 2028-2 in the back of your manual, use the standard DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703.

In either case a reply will be furnished direct to you.

LIST OF ILLUSTRATIONS

***This manual supersedes TM 11-6125-240-34,5 August 1976.**

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope

a. This manual describes Motor-Generater PU-545/A (inverter) and covers its functioning, and direct support and general support maintenance (AVIM).

b. Maintenance of Army aircraft is transitioning to three categories of maintenance. These maintenance catogories are aviation unit maintenance (AVIM); aviation intermediate maintenance (AVIM); and depot maintenance. AVIM and AVIM will replace organizational, direct support, and general support maintenance. In the interim, as maintenance units are reoganized into three categories of maintenance activities, this publication will be used by AVIM direct and general support personnel for the maintenance of Motor-Generator PU-545/A. The maintenance allocation chart (TM 11-6125-240-12) is configured to the five-category maintenance concept; however it can be used under the three-category maintenance concept where the code ( ) represents AVUM; the codes F and H represent AVIM; and D represents depot maintenance. Those organizations not yet assigned complete AVIM responsibilities should be cautious when using this publication. Whatever maintenance is performed must consider available skills, tools, test equipment, and time required to perform the maintenance.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications perrtaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO'S) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment Maintenance forms, records, and reports. which arte to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DSAR 4145.8.

c. *Discrepuncy in Shipment Report (DISREP) (SF 361).* Fill out and forward Discrepancy in Shipment Report. DISREP (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-l8/MCO P4610.19 and DLAR 4500.15.

1-4. Administrative Storage

Administrative storage of equipment issued to and used by Army activities shall be in accordance with best storage practices.

1-5. Destruction of Army Electronics Materiel

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

1-6. Reporting Equipment Improvement Recommendations (EIR)

EIR's will be prepared using Standard Form (SF) 368 (Quality Deficiency Report). Instructions for preparing EIR's are provided in TM 38-750, The Army Maintenance Management System. EIR's should be mailed direct to Commander, US Army Communications and Electronics Material Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. A reply will be furnished direct to you.

Section II. DESCRIPTION AND DATA

1-7. Description

A description of the capabilities, purpose, and use of the inverter may be found in TM 11-6125-240-12.

1-8. Tabulated Data

The technical specifications for the inverter may be found in TM 11-6125-240-12.

CHAPTER 2
FUNCTIONING OF EQUIPMENT

Section I. BLOCK DIAGRAM ANALYSIS

2-1. General

a. The inverter is divided into two sections: an electromecanical section, consisting of motor B1 and generator G1, and an electronic section, consisting of one of several types of voltage and frequency regulators.

(1) Electronic Regulator CSV1186-1, installed in earlier units, consists of three circuit boards designated Al, A2, and A3.

(2) The CSV2215-2 regulator, installed in later production units identified by Manufacturer Part No. 07639-MGE23-400A and marked with serial number suffix C, consists of a single circuit assembly mounted on a base. The CSV2215-3 regulator, installed in late'r production units identified by Manufacture'r Part No. 07639-MGEZ3-500A and marked with serial number suffix D, consists of a single circuit assembly but is furnished separately from the base. Both these regulators provide, on one card, all the functions provided by several cards on the earlier regulator.

(3) The 4B93-1 -A regulator, installed in the latest production units consists of a single circuit board assembly.

b. The purpose, operation, and inter-operation of the two sections (electronic and electromechanica]) of the inverter are explained in this chapter. Familiarity with the equipment and its functioning is a valuable tool in troubleshooting rapidly and effectively.

2-2. Block Diagram

(fig. 2-1)

a. Electromechanical Section.

(1) The 28 vdc input is applied to the electromechanical section of the inverter through terminal board TB1 to motor B1 and the exciter of generator G1, causing current to flow in each of the components.

(2) The reaction of the magnetic field established by the current flowing through motor B1 causes the armature to rotate. The exciter of G1 is mechanically coupled to the armature of motor B1 by a common shaft; therefore, the exciter also rotates.

(3) An ac voltage is induced in the ac field coils of G1 by the sweep of the exciter. The induced voltage is applied through filter FL1 to ac power connector J3. In addition, a sample of the ac output is applied to the voltage and frequency regulator.

b. Electronic Section. The regulator controls the inverter frequency output by controlling the strength of the motor field and thus governing the speed of the rotating section. The voltage output is regulated through control of the current in the ac generator exciter.

(1) As the mechanical speed of the inverter increases, the output frequency also increases. To control the frequency, the regulator controls the amount of current flow through the motor shunt coils. The speed of the motor may be reduced by increasing the strength of the motor shunt field.

(2) The current level in the generator exciter determine the magnitude of output voltage. Reducing the exciter current causes a reduction of ac output voltage. Output voltage is controlled by regulating the average current in the exciter.

(3) The regulator performs the function of a rapidly operating switch which interrupts the current flow in both motor and generator field windings at a rate of 800 Hertz (Hz). Control is accomplished with voltage- and frequency-sensing circuits in the voltage and frequency regulator that establish the magnitude of current required to produce the desired output.

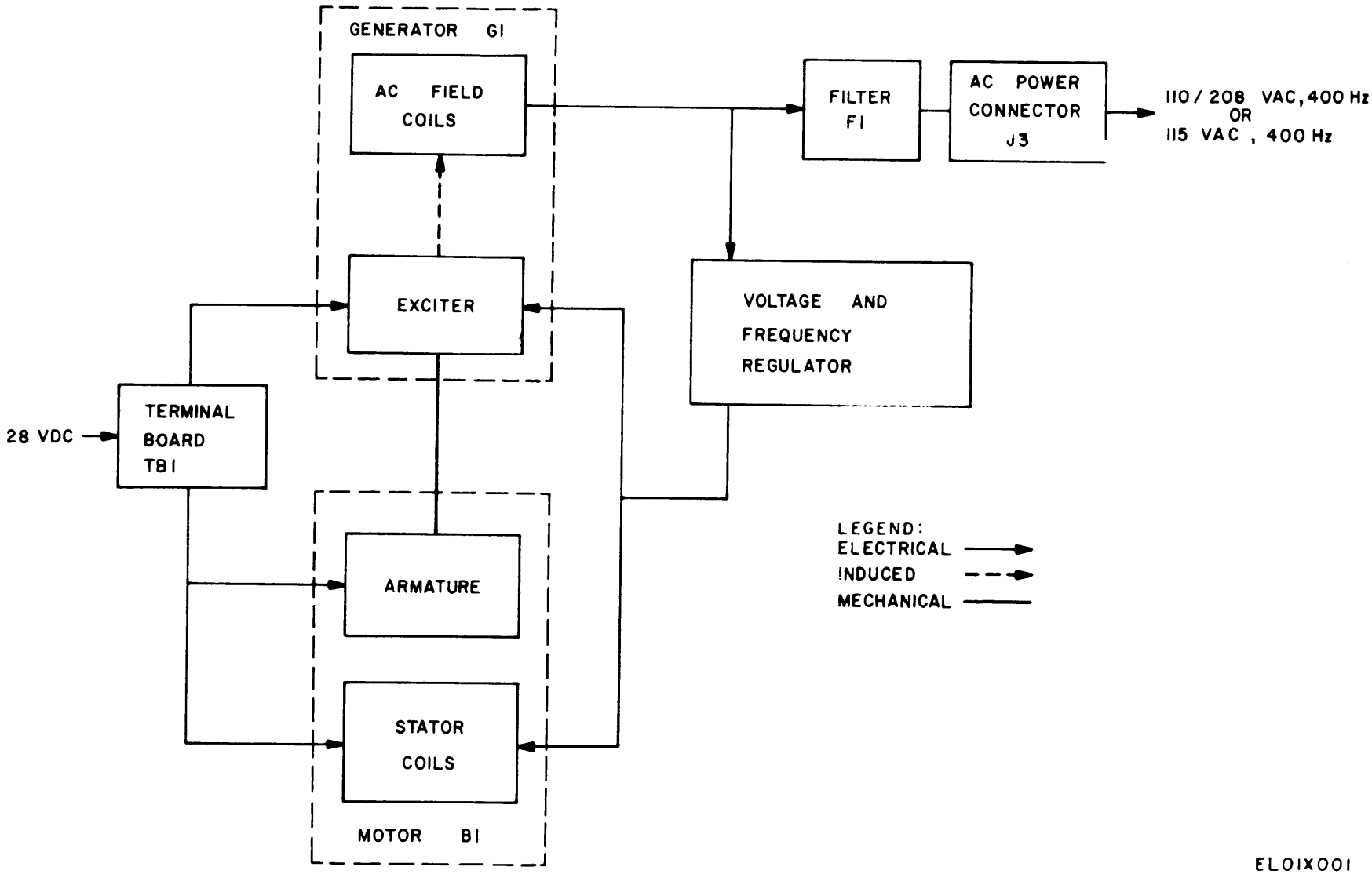


Figure 2-1. Inverter Block Diagram

Section II. OVERALL CIRCUIT ANALYSIS

2-3. Electromechanical Section

(fig. 2-2,2-3, and FO-1)

The electromechanical section of the inverter consists of motor B1 and generator G1. Both units share the same housing, with separate stationary windings. The armature of the motor and the exciter of the generator share a common shaft. .

a. Motor B1. Motor B1 is a, four-pole, series-shunt motor with windings wound in magnetic opposition to each other. It operates on 28 vdc input power drawn from the aircraft electrical system.

(1) Power for operation of the motor is applied through a set of series coils (Ll through L4) and a shunt coil (L5). The series coils and the shunt coil are connected so that they are always magnetically opposed to each other. Four dc brushes are located at the neutral point between the four coils (poles); therefore, adjacent commutator bars on the armature reach a dc brush when no voltage is between brushes.

(2) When 28 vdc is impressed upon series coils L1 through L4, current will flow from the negative terminal of TB1 through the armature and brushes of motor Bl, the series coils, and choke L10 to the positive terminal of TB1. Current also flows from ground through shunt coil L5, and choke L10 to the positive terminal of TB1. The magnetic field resulting from the current flow through coils L1 through L5 reacts with the magnetic field set up by current flow through the armature of motor B1, causing the armature to rotate.

(3) By rotating through a magnetic field, the armature causes a counter electromotive force (cemf) to be induced in the armature winding. The speed of armature rotation continues to increase until the cemf is almost equal to the dc input. The small difference between the cemf and the dc input permits the flow of enough current to keep the armature rotating.

b. Generator G1. The ac generator is a rotating-field type generator. Direct current from the external source is fed to the rotor through the sliprings and the four ac contact brushes.

(1) When motor B1 starts, it turns the exciter of generator G1. As the exciter rotates, magnetic fields set up by the current through the exciter windings pass conductors in the ac field coils (IA, L?, and L8) and induce an alternating current.

(2) Alternating current is then passed through filter FL1 and made available at ac power connector J3.

2-4. Electronic Section

a. CSV1186-1 Regulator (fig. 2-2).

(1) Control of the voltage and frequency of the inverter output is accomplished in the voltage and frequency regulator by establishing the exact moment to turn on conduction through motor B1 and generator G1 exciter fields,

(2) The ac sample from the generator field coils is applied to circuit board Al, where it is converted into voltage and frequency error signals.

(3) Circuit board A2 contains shunt field power transistor Q3 which pulses 28 vdc power to the shunt field of motor B1 for frequency control.

(4) Circuit board A3 is identical with board A2 and functions in the same manner, except that it pulses 28V dc power through the exciter field of generator G1 for voltage control.

(5) Circuit board Al contains the circuit components for sensing and controlling the operation of the power transistors on circuit boards A2 and A3,

b. CSV2215-2 and CSV2215-3 Regulator *(fig.* 2-3).

(1) The regulator senses one phase of the motor-generator's ac output; separate parts of the regulator compare magnitudes of the sensed ac voltage and frequency to their respective preset values. If an error exists between either of the motor-generator's controlled entities and it preset comparator, the regulator will function to minimize that error, maintaining ac output voltage and frequency within the desired tolerance.

(2) The regulator controls the field currents by alternately switching the field transistor into saturated on and off states. This switching rate is proportional to the ac frequency, due to the method of sensing used. The proportionality of on-time and off-time, which determines the average field voltage (and so field current) is a function of the respxtive error signal.

(3) To provide continuous field current, essential for satisfactory motor-generator performance, each field is connected across a diode in the regulator, commonly called a free-wheeling or commutating diode. During the time that the controlling transistor is in the off state, the field current flows through this diode, decaying only slightly until the next on state occurs.

c. 4B93-1-A Regulator (FO-1). All components of the 4B93-1-A regulator are located on a single circuit board assembly. This regulator functions as described in paragraphs 2-9 and 2-10.

Section III. CIRCUIT ANALYSIS, CSV1186-1

2-5. Voltage Regulation (CSV1186-1)

(fig. 2-2)

a. One side of the generator exciter field is connetted to positive dc and the other side is connected to the collector of power transistor Q6. When the power transistor is on, total dc voltage appears across the

field. When transistor Q6 is off, total dc voltage appears across the transistor Q6.

b. The sensing voltage is taken from the output terminal of the generator and applied to the primary of the sensing transformer. The stepped-down ac voltage across the secondary is rectified by the full-wave, center-tap arrangement of the transformer, and filtered to a dc level of approximately 15 volts. The differential or de sensing voltage and a 12-volt Zener voltage from the voltage sensing circuit is fed to the base of a driver transistor on the amplifier circuit which determines the length of on-or-off-time of power transistor Q6. Any increase in differential voltage will cause a decrease in on-time of the power transistor which will result in a lower field current and a re-resultant decrease in output voltage. Any decrease in differential voltage will increase the on-time with a corresponding increase in output voltage.

c. The regulator reacts instantaneously to any change in output voltage and maintains it constantly at a preset value. Free-wheeling diode CR8 is used to provide a path for the field current during the off-time of power transistor Q6.

2-6. Frequency Regulation (CSV1186-1)

(fig. 2-2)

a. One side of the motor shunt field is connected to negative dc and the other side is connected to the collector of power transistor Q3. When the power transistor is on, practically total dc voltage appears across the field. When the power transistor is off, total dc voltage appears across transistor Q3.

b. Frequency regulation is accomplished by sensing the ac potential developed across a reactance transformer of a series LC circuit, tuned to approximately 570 Hz. The LC circuit operates at 400 Hz on the low side of the resonance curve. The value of the ac potential developed is proportional to the frequency and will continue to be constant for any one frequency so long as the values of L and C remain constant. This potential is then stepped down, rectified, and compared with another potential obtained by rectification of the ac sensing voltage. The two are approximately 180° out of phase and are rectified, one positive and one negative. Thus, the difference between these potentials becomes a representation of the frequency the level of which is independent of any change in ac voltage level; frequency control is independent of voltage control.

c. The signal obtained by comparison of the two above mentioned potentials is fed to the base of a driver transistor which is part of the amplifier circuit. The amount of the differential voltage fed to the base of the drive transistor (located in the amplifier circuit) establishes the length of on-time or off-time of power transistor Q3. Any increase in frequency will cause a decrease in the differential voltage that will increase the on-time of power transistor Q3, resulting in a higher field current and a consequent reduction in frequency.

d. The regulator reacts instantaneously to any change in output frequency and maintains it constantly at a preset value.

e. Free-wheeling diode CR9 is used to provide a path for the field current during the off-time of power transistor Q3. Anticipation to changes in input voltage and electric load are coupled into the speed control amplifier circuit with an ac network.

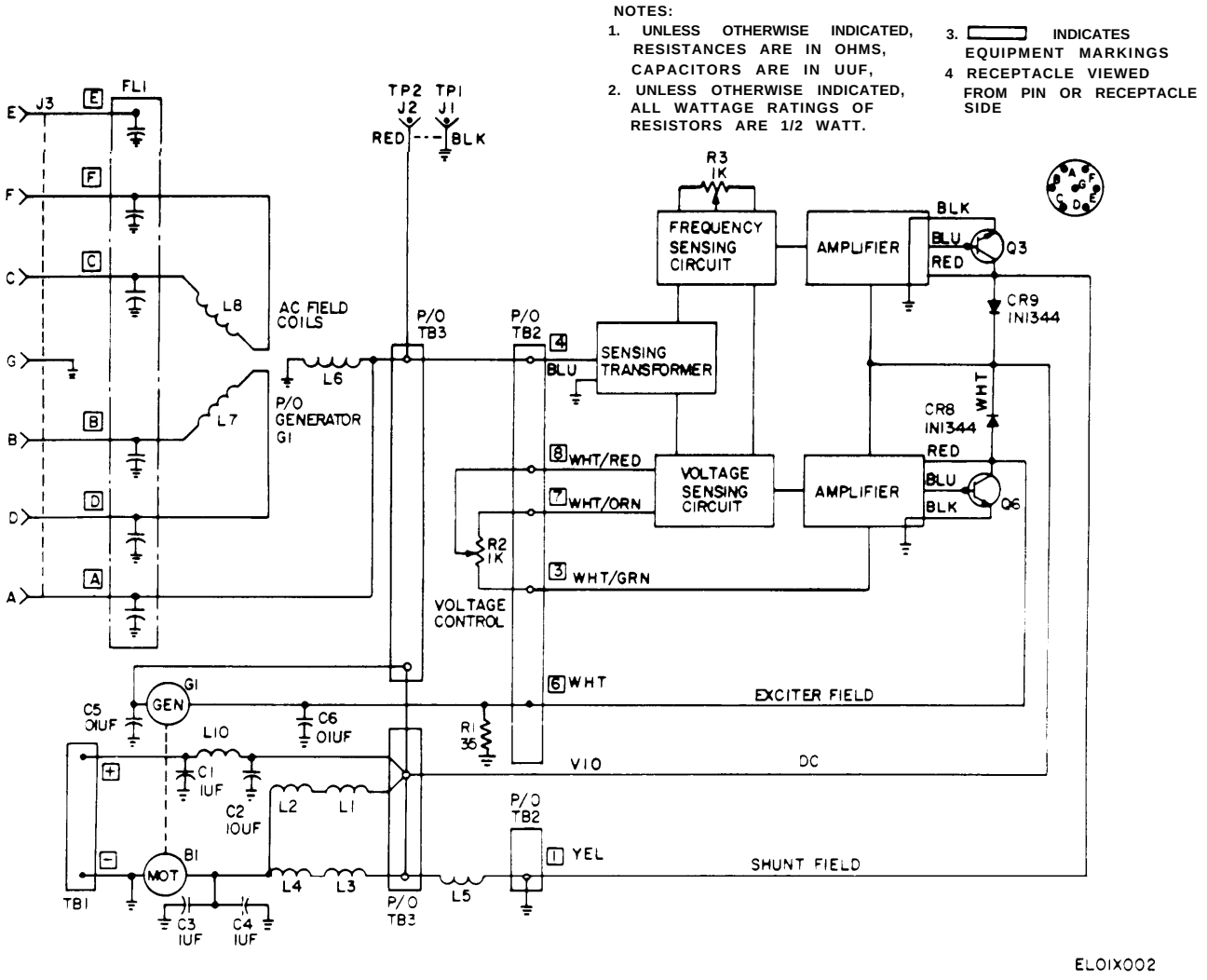


Figure 2-2. Motor-Generator PU-545/A with CSV1186-1 Regulator, Simplified Schematic Diagram

Section IV. CIRCUIT ANALYSIS, CSV2215-2 AND CSV2215-3

2-7. Voltage Regulation (CSV2215-2 and CSV2215-3)

(fig. 2-3)

a. One side of the generator exciter field is connected to positive dc and the other side is connected to the collector of power transistor Q7. When power transister Q7 is on, total dc voltage appears across the field. When transistor Q7 is off, total dc voltage appears across the transistor.

b. The sensing voltage is taken from the output terminal of the generator and applied to the sensing circuit, where it is compared with the voltage in the breakdown Zener diode (CR7) circuit. The differential of these voltages is fed to the base of driver transistor Q5, which determines the length of on- or off-time of the power transistor Q7. Any increase in differential voltage will cause a decrease in on-time of power transistor Q7, resulting in a lower field current in the generator, and a corresponding drop in output voltage. Any decrease in differential voltage will increase the on-time of Q7, with a corresponding increase in output voltage.

c. The regulator reacts instantaneously to any change in output voltage and maintains it constantly at a preset value. Free-wheeling or commutating diode CR8 is used to provide a path for the field current during the off-time of power transistor Q8.

2-8. Frequency Regulation (CSV2215-2, CSV2215-3)

(fig. 2-3)

a. One side of the motor shunt field is connected to negative dc and the other side is connected to the collector of power transistor Q3. When power transistor Q3 is on, practically total dc voltage appears across the field. When transistor Q3 is off, total dc voltage appears across the transistor.

b. Frequency regulation is accomplished by sensing an ac potential developed in the frequency sensing circuit. The value of this ac potential is proportional to the frequency and is constant for any one frequency. This potential is compared with another potential obtained by rectification of the ac sensing voltage. The two are approximately 180° out-of-phase one positive, and one negative. Thus, the difference between these potentials becomes a representation of the frequency, independent of any change in ac voltage level; frequency control is independent of voltage control.

c. The signal obtained by comparison of the two above mentioned potentials is fed to the base of a driver transistor which is part of the amplifier circuit. The amount of the differential voltage fed to the base of the driver transistor establishes the length of on-time or off -time of power transistor Q3. Any increase in frequency will cause a decrease in the differential voltage that will increase the on-time of power transistor Q3, resulting in a higher field current and a corresponding reduction in frequency.

d. The regulator reacts instantaneously to any change in output frequency and maintains it constantly at a preset level. Free-wheeling diode CR3 is used to provide a path for the field current during the off-time of transistor Q4.

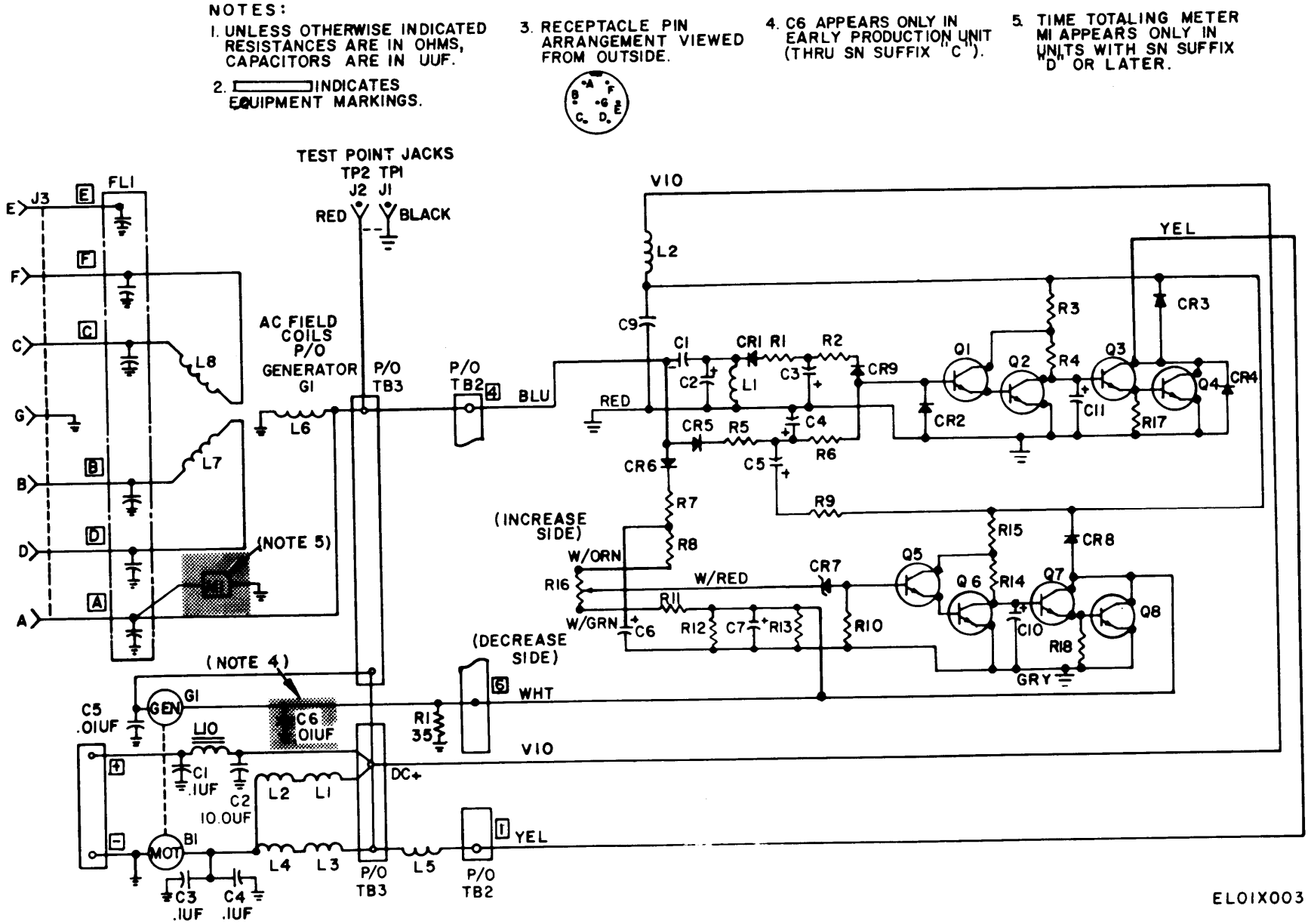


Figure 2-3. Motor-Generator PU-545/A with CSV2215-2 or CSV2215-3 Regulator, Schematic Diagram.

Section V. CIRCUIT ANALYSIS, REGULATOR 4B93-1-A.

2-9. Voltage Regulation (4B93-1-A)

(fig. FO-1)

a. Ac generator single-phase output voltage is sensed, half-wave rectified, reduced by a voltage divider and changed to a pulsating dc voltage with a ripple, through CR11, R24, R25 and C5. The superimposed ripple is further filtered into a sawtooth waveshape. This dc voltage with the superimposed sawtooth ripple varies directly with the ac voltage output of the ac generator and is compared with a Zener reference composed of CR2, CR3, CR4, CR5, R7 and R17.

b. Since the top of the resultant applied dc voltage signal is a constantly varying sawtooth wave, it will automatically straddle the Zener voltage reference line such that the width of the pulse formed will, just sustain it in a steady state, closed loop condition. Maximum excitation will be amplified to the generator when the pulse is maximum width or full-on and minimum excitation occurs at zero width or when full-off occurs. The average regulated voltage will then depend on the time ratio of the on and off condition or pulse width.

c. When the ac generator output voltage increases, a larger negative voltage is seen at the wiper arm of R2 causing Q9 to turn off (decrease pulse width). With Q9 off, current amplifier transistors Q7, Q8 and Q11 turn off, causing less current to flow through the alternating field winding, thus decreasing the ac voltage to nominal value.

d. When the ac generator output voltage decreases, the less negative voltage is seen at wiper arm of R2 causing Q9 to turn on (increase pulse width). With Q9 on, Q7, Q8 and Q11 turn on allowing more current to flow through the alternating field winding, thus increasing the ac voltage to nominal value. Variable resistor R2 is used to set the ac generator output voltage.

2-10. Frequency Regulation (4B93-1-A)

(fig. FO-l)

a. Ac generator output voltage is connected to the base of transistor Q1 through resistors R2 and R27. This signal overrides Q1 so that the negative half-cycle will bias Q1 into saturation and the positive half-cycle will bias Q1 off. During the positive half-cycle when Q1 is off, capacitor C1 is permitted to charge through R4 from the reference voltage created by Zener diodes CR2 and CR5. When Q1 turns on, during the negative half-cycles, Cl is discharged and will not start charging again until the beginning of the next negative half-cycle. Diode CR1 protects the base-emitter junction of Q1 during the positive half-cycles.

b. During the low frequency conditions, the time that Cl is allowed to discharge is longer than the time allowed during higher frequency operation. This means that for each half-cycle that Q1 is on, at low frequency conditions, Cl will discharge to a lower potential. Transistor Q10 is an emitter-follower whose base voltage is adjust by R5. The voltage across R5 is held constant by the reference voltage. The adjustment of R5 determines the voltage which Q10 applies across R6 and C7. The emitter of Q2 is also connected to R6 and C7.

c. The voltage across Cl is connected to the base of Q2, thus the voltage level to which Cl must charge to bias Q2 off is adjusted by R5. When the voltage across Cl reaches the level required to bias Q2 off, collect current decreases through R8, R9 and the base-emitter junction of Q3. When Q3 turns off, a path is provided for Q4 base current to flow through R11 and result in Q4 being on. With Q4 on, current amplifier transistors Q5 and Q6 turn on allowing more current to flow through the shunt field to the dc motor, decreasing its speed, thus lowering the frequency of the ac generator to nominal value.

d. During the high frequency conditions, the time that Cl is allowed to discharge is faster than the time allowed at low frequency operation. This means that for each half-cycle that Q1 is off, Cl will charge to a higher potential, biasing Q2 on. With Q2 on, base current is provided through R8 to turn Q3 on. As Q3 turns on, the base of Q4 is reversed biased and Q4 turns off, and in turn current amplifier transistors Q5 and Q6 turn off. With Q5 and Q6 off, less current flows through the shunt field of the dc motor increasing the frequency of the ac generator to a nominal value, Variable resistor R5 is used to set the ac generator output frequency.

CHAPTER 3
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

3-1. Introduction

The maintenance instructions in this and the following chapter supplement the organizational maintenance procedures in TM 11-6125-240-12. The troubleshooting which begins at the organizational level is carried to a higher level in these chapters.

3-2. Direct Support Maintenance Guidance

The maintenance and overhaul schedule outlined below should be followed. Implementation of this schedule will insure a high degree of reliability and an increase in effective inverter life.

a. Inverters that fail before 600 hours of service (recorded aircraft flight hours) should be sent to general support maintenance if the failure is caused by bad bearings, or if a replacement regulator card assembly is not available and the defective regulator card assembly is repairable.

NOTE

Repairable card assemblies are those coated with clear polyurethane and numbered either CSV2215-2, CSV2215-3, or 4B93-1-A. Nonrepairable card assemblies are coated with blue epoxy and numbered CSV1186-1.

If the inverter has not been modified (para 3-12) to handle all models of the universal regulator card assembly, a direct replacement card must be used or return the inverter to depot for modification.

b. Inverters that fail at any time because of one of the following, should be forwarded direct to depot maintenance.

(1) Defect in armature assembly.
(2) Defect in status coils.
(3) Worn bearing liner in endbell.
(4) Fragmented housing.

c. Turn in for depot overhaul, any inverter that vibrates excessively, overheats, is unusually noisy, or has a brush contact area on the commutator and/or slip rings that exhibit serious grooving or pitting.

d. In aircraft where the main and spare inverters are the same type, install the spare in the main position when the main inverter is turned in for depot overhaul. Operational hours of the spare inverter, if only occasional, should be disregarded. However, inspection, testing, and routine maintenance of the spare inverter will be performed periodically. For main inverters presently in operation, but for which no service time records are available, the accumulated operational hours should be a multiple of the average weekly or monthly aircraft hours and the number of weeks or months the inverter has been installed.

3-3. Direct Support Tools and Equipment

Tools and test equipment required for direct support maintenance of the inverter are listed in table 1 of appendix C (maintenance allocation) in TM 11-6125-240-12.

Section II. DIRECT SUPPORT TROUBLESHOOTING

3-4. Organization of Procedures

a. General. The first step in servicing a defective inverter is to sectionalize the fault. The second step is to trace the fault to a specific defective part. Some faults, such as burned-out resistors, arcing brushes, burned electrical leads, and shorted stator windings can often be located by sight, smell, or hearing. Other faults must be located as described below.

b. Sectionalization. The inverter consists of two major sections: the electromechanical motor-generator section and the electronic regulator section. The operational check in paragraph 3-5, used in conjunction with the organizational troubleshooting table in TM 11-6125-240-12, will be helpful in sectionalizing the fault.

c. ***Localization*** Repair and replacement of parts at direct support is limited to those functions and procedures specifically described in this chapter. Use troubleshooting table 3-1 for fault localization. If this fails to correct the problem, or if symptoms not mentioned in the troubleshooting table are noted, higher category maintenance is required.

d. Intermittent Trouble. When making any test, do not overlook the possibility of intermittent troubles. If present, this type of trouble may often be made to appear by tapping or jarring the equipment. In addition, check the external and internal wiring connections.

3-5. Operational Test

a. General. The operational test may be performed while the inverter is part of an aircraft installation. (Refer to the applicable aircraft manual.) If the inverter is determined to be the faulty unit, localize the trouble as outlined *in* troubleshooting table 3-1.

b. Power Requirements. Connect an external power supply to the external power connector on the aircraft while making the operational test. (Refer to the applicable aircraft technical manual.) The power supply must be capable of delivering 200 amperes at 27.5 volts dc.

c. Procedure.

(1) Turn the main power switch in the aircraft to ON. Check to see that the inverter starts and the aircraft dc voltmeter indicates 28 volts.

(2) Plug the prods of a power test set into the inverter test point jacks (fig. 3-1).

(3) Set the power test range selector to 150.

(4) Operate the inverter at no load (no ac components of the aircraft operating). Loosen the voltage potentiometer's locknut (fig. 3-1) and turn through its full range. Voltage indicated on the voltmeter of the power test set must not be lower than 109 or more than 121.

(5) Apply a full load to the inverter by turning on all the aircraft equipment that operates from the ac supplied by the inverter. (Refer to the applicable aircraft technical manual.) Repeat the procedure given in (4) above. No variation should recur in the adjustment range specified. Turn off the aircraft ac components and set the voltage adjustment potentiometer so that a 115-volt output is indicated on the voltmeter of the power test set. Tighten the locknut.

(6) Remove the regulator cover. Operate the inverter at no load and turn the frequency adjustment (fig. 3-1) through its full range. The limits of frequency regulation, as indicated on the frequency meter of the power test set, must be 390 Hz to 410 Hz.

NOTE

To reach the frequency adjustment on the 4B93-1-A, the regulator must be removed from the spacers (8, fig. 4-5) and flipped over. The frequency adjustment is located on the underside of the board.

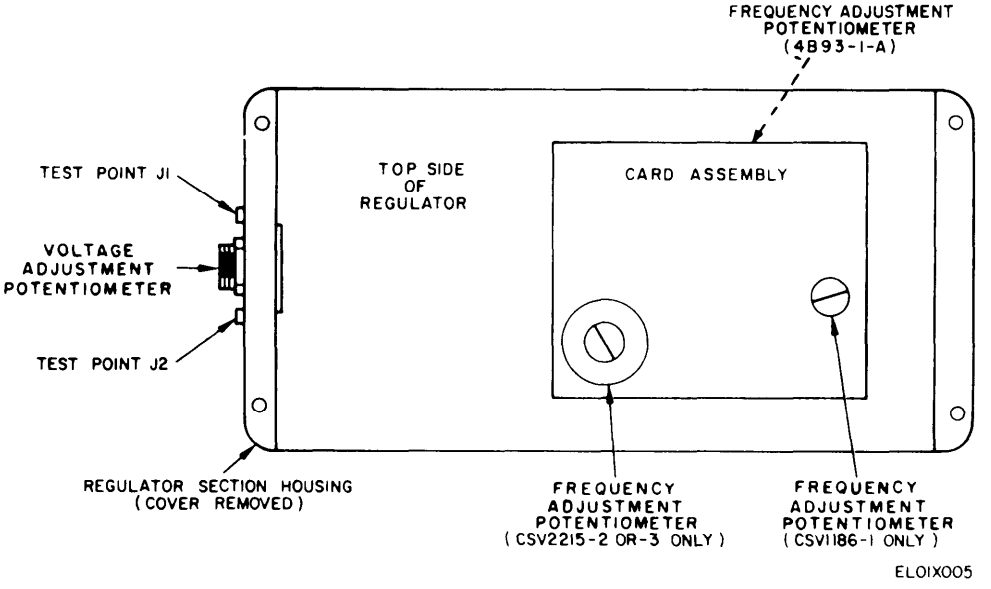


Figure 3-1. Voltage and Frequency Adjustments

(7) Apply a full load and turn the frequency adjustment through its full range. No variation should occur in the range specified in (6) above. Turn off the aircraft components and reset the inverter frequency adjustment to provide a 400-Hz output. Replace the regulator cover.

(8) Turn on the aircraft ac components one at a time until the inverter is fully loaded. Voltage variation between no load and full had must be less than 3 volts. The frequency variation must be less than 8 Hz.

(9) Upon completion of the operational test, remove the power test set prods from the inverter test point jacks. Turn off the aircraft master switch and disconnect the external power source from the aircraft.

3-6. Troubleshooting Table

If the operational test in paragraph 3-5 indicates a malfunction, localize it using troubleshooting table 3-1. If the procedures in the table fail to correct the fault, or if a malfunction not mentioned in the table is noted, refer the inverter to higher category maintenance.

Table 3-1. Direct Support Troubleshooting

NOTE

All checks are to be conducted with the inverter connected for normal use,

Malfunction	Probable cause	Corrective action
Inverter fails to start	*a.* Blown fuse or circuit breaker in dc line.	a. Check dc fuse or circuit breaker. (1) Clean and tighten fuse contacts. Replace Mown fuse. (2) Reset circuit breaker.
	b. Short circuit in dc line.	*b.* If circuit breakers or fuses are blown, inspect wiring between fuses or circuit. breakers and the inverter. Repair or replace as necessary.
	c. Open circuit in dc line.	*c.* Check wiring and input cconnection for open circuit. Repair or replace as necessary.
	d. Dc brushes not making contact with commutator.	*d.* Check for weak or broken brush holders, springs, and for sticking, worn or broken brushes. Replace as in paragraph 3-8.
	e. Armature jammed.	*e.* Remove fan cover and try to turn armature assembly by hand. Check for obstructions in airgap. If jammed, refer inverter to higher category maintenance.
Inverter starts, but delivers no output voltage,	*a.* Ac circuit open.	*a.* Check exterior wiring and connections for open circuit. Repair or replace as necessary.
	b. Ac contact brushes not making contact with sliprings.	*b.* Check for weak or broken brush holders, springs, and for sticking, worn, or broken brushes. Clean, or replace as in paragraph 3-8.
	c. Short or open circuit in generator G1 exciter winding.	*c.* Remove ac end cover and air duct plate (46, fig. 4-7) and use multimetcr to check resistance between the Sliprings. Resistance must be 2.99 ohms ± 10 percent. If the multi meter indicates much higher or zero resistance, refer inverter to higher category maintenance.
	d. Regulator failure.	*d.* Replace regulator card assembly as in paragraph 3-9; refer defective card assembly to higher category maintenance.
Output voltage is low.	*a.* Dc input voltage low.	*a.* Check dc voltage at power supply and correct.
	b. Voltage potentiometer out of adjustment.	*b.* Readjust voltage potentiometer as in TM 11-6125-240-12.
	c. Regulator failure.	*c.* Replace regulator card assembly as in paragraph 3-9; refer defective card assembly to higher category maintenance.
Output voltage is high.	*a.* Input voltage higher than 30V.	a Check dc voltage at power supply and correct.
	b. Voltage potentiometer out of adjustment.	*b.* Readjust voltage potentiometer as in in TM 11-6125-240-12.
	c. Regulator failure.	*c.* Replace regulator card as in paragraph 3-9; refer defective card assembly to higher category maintenance.
	d. Shorted coil in dc armature windings.	*d.* Check armature for shorted coils. A thin strip of stell held over the armature core will vibrate if a short exists. Refer inverter to higher category maintenance.
Output voltage unstable.	*a.* Loose connections.	*a.* Check for loose connections in the inverter, tighten as necessary
	b. Poor commutation or poor brush contact at sliprings.	*b.* Remove fan cover, ac end cover and air duct plate (46, fig. 4-7) and check condition of commutator and sliprings. Check brushes, brush holder and brush springs. Replace if defective. Clean commutator and sliprings with 000 paper.

Table 3-1. Direct Support Troubleshooting — continued

Malfunction	Probable cause	Corrective action
	c. Open or shorted windings in ac stator coils.	*c.* Refer inverter to higher category maintenance.
Output frequency incorrect.	*a.* Frequency potentiometer out of adjustment.	*a.* Readjust frequency potentiometer as in paragraph 3-10.
	b. Open or short in dc stator coil.	*b.* Refer inverter to higher category maintenance.
Excessive sparking at brushes.	*a.* Brushes stuck in holder.	*a.* Check brushes, brush springs and holders. Replace if defective. Clean brush holders.
	b. Commutator or sliprings dirty or pitted.	*b.* Remove fan cover, ac end cover, and air duct plate (46, fig. 4-7) and check condition of commutator or sliprings. If dirty or pitted, refer inverter to higher category maintenance.
	c. Grounded circuit in armature coils.	*c.* Check input current; if it is more than 190 amperes, a short cicuit is present. Refer inverter to higher category maintenance.
Inverter overbeats.	a Poor external ventilation.	*a.* Check for adequate air circulation around unit. Correct as necessary.
	b. Poor internal ventilation,	*b.* Check to see that air louvers are free of obstructions. Correct as necessary.
	c. Faulty bearings.	*c.* Feel bearing housings in ac and dc endbell assemblies. If hot to the touch, refer inverter to higher category maintenance.
	d. Excessive load.	*d.* Check and comet as necessary.
	e. Defective fan.	*e.* Remove fan cover and inspect fan for broken or bent blades. Refer inverter ‘o higher category maintenance, if defective.
Excessive noise.	*a.* Inverter or associated hardware not firmly mounted.	*a.* Check mounting bolts and other bolts and screws; tighten as necessary.
	b. Worn bearings.	*b.* Remove fan cover and rotate armature counterclockwise by hand; feed and listen for roughness in bearings. If any is detected refer inverter to higher category maintenance.
	c. Armature dragging or striking on polepiece.	*c.* Remove fan cover and rotate armature counterclockwise by hand; feel and listen for indications of interference. If interference is evident, refer inverter to higher category maintenance.
	d. Shorted armature coil.	d. Refer inverter to higher category maintenance.
Interference in aircraft’s radio system.	Defective radio interference filter FL1.	Refer inverter to higher category maintenance.
Output voltage and frequency cannot be measured at test point jacks.	Test point jacks or wiring defective.	Check conditons of test point jacks and internal wiring for open or shorted circuits. Refer inverter to higher category maintenance.

Section III. DIRECT SUPPORT MAINTENANCE OF PU-545/A

3-7. Cleaning

Cleaning of the exterior of the inverter is carried out primarily at the organizational category. If such cleaning is necessary, the procedures in TM 11-6125-240-12 should be applied. In addition, clean the interior of the generator section as follows

a. Remove four screws from ac end cover (6, fig. 4-7) and two screws and regulator housing bracket from fan cover and remove cover.

b. Remove loose carbon dust and dirt from the interior with a stream of dry, low-pressure compressed air.

c. Replace ac end cover and fan cover.

3-8. Replacement of Brushes

(fig. 3-2)

Both ac and dc contact brushes are replaced at direct support as described below. The inverter must be removed from the aircraft for brush replacement.

a. Ac Contact Brushes.

(1) Remove the four electrical caps and withdraw the brush holders, springs, and brushes. Note that two are straight and two angled. Use like types for replacement.

(2) Slide the new brushes into their respective positions in the ac endbell. Be sure the curve of the brush matches that of the sliprings.

(3) Secure each brush with an electrical cap.

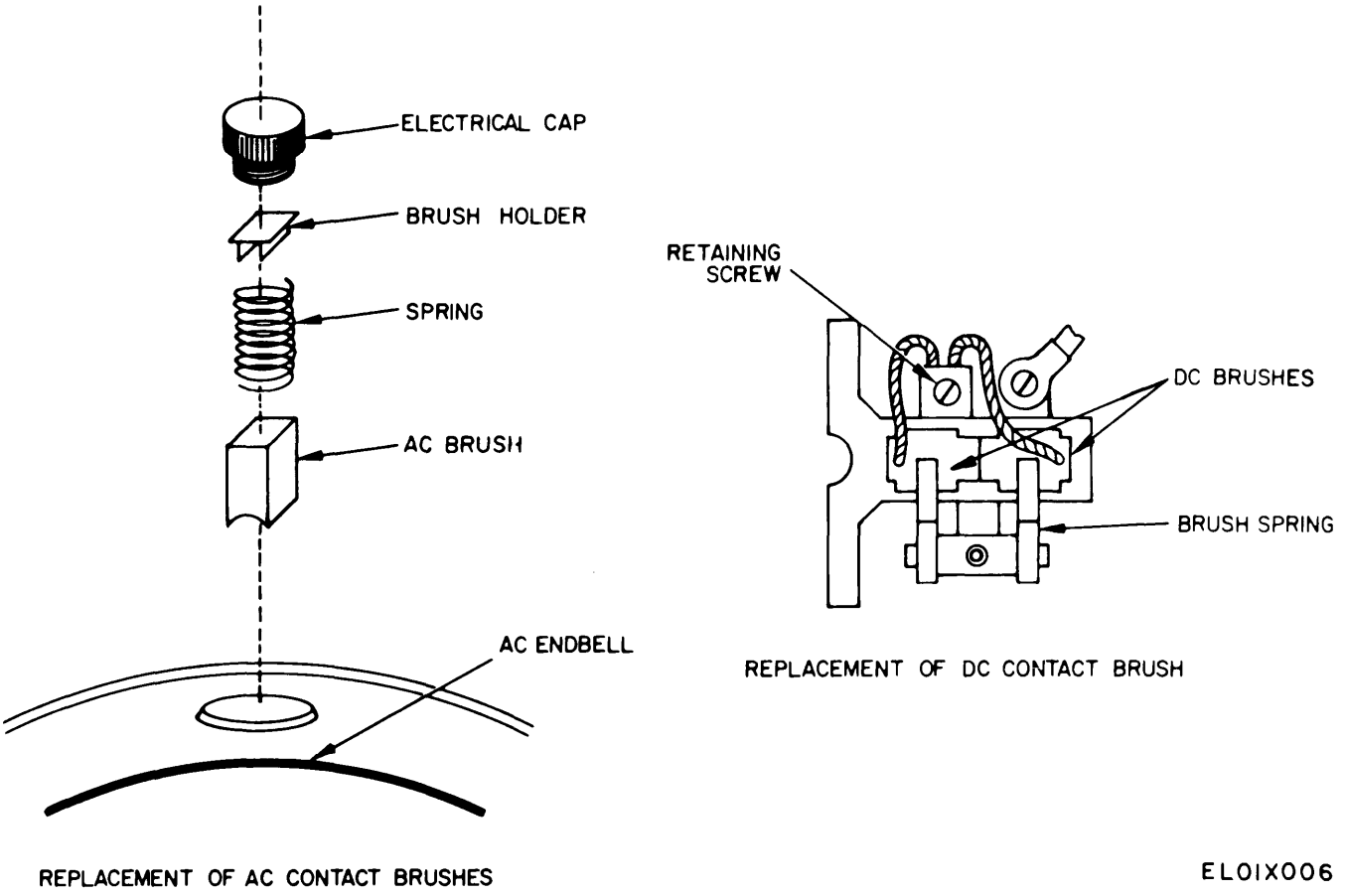


Figure 3-2. Replacement of Brushes.

b. Dc Contact Brushes.

(1) Remove the fan cover.

CAUTION

Dc brushes are critical items. Use only brushes specified for use on this equipment.

(2) Remove the retaining screws from the leads of each of four dc contact brushes.

(3) Lift up the brush springs and pull the brushes clear of their holders.

(4) Install new brushes by lifting the brush springs and sliding the new brushes into the holders. The curved face of the brush must fit the curve of the commutator. Make certain that they slide easily, without binding, and that the springs engage the center point of the brushes without interference from the leads.

(5) Secure the brush leads to the dc endbell with the screws removed in (2) above,

(6) Replace and secure fan cover.

c. Brush Run-In and Preseating. Preheating and final brush seating must be accomplished after the brushes have been installed. Connect the inverter as shown in figure 3-3 and operate it at 625VA (one-quarter rated output) for approximately two hours. Then check the brush contact area for shading and apply 2500VA (full load) until the requirements in (1) and (2) below are met. Minor variations in shading may appear occasionally, and should be disregarded.

(1) Ac contact brushes: 50 percent of brush contact area.

(2) Dc contact brushes: 100 percent in the direction of armature rotation, 75 percent of brush thickness.

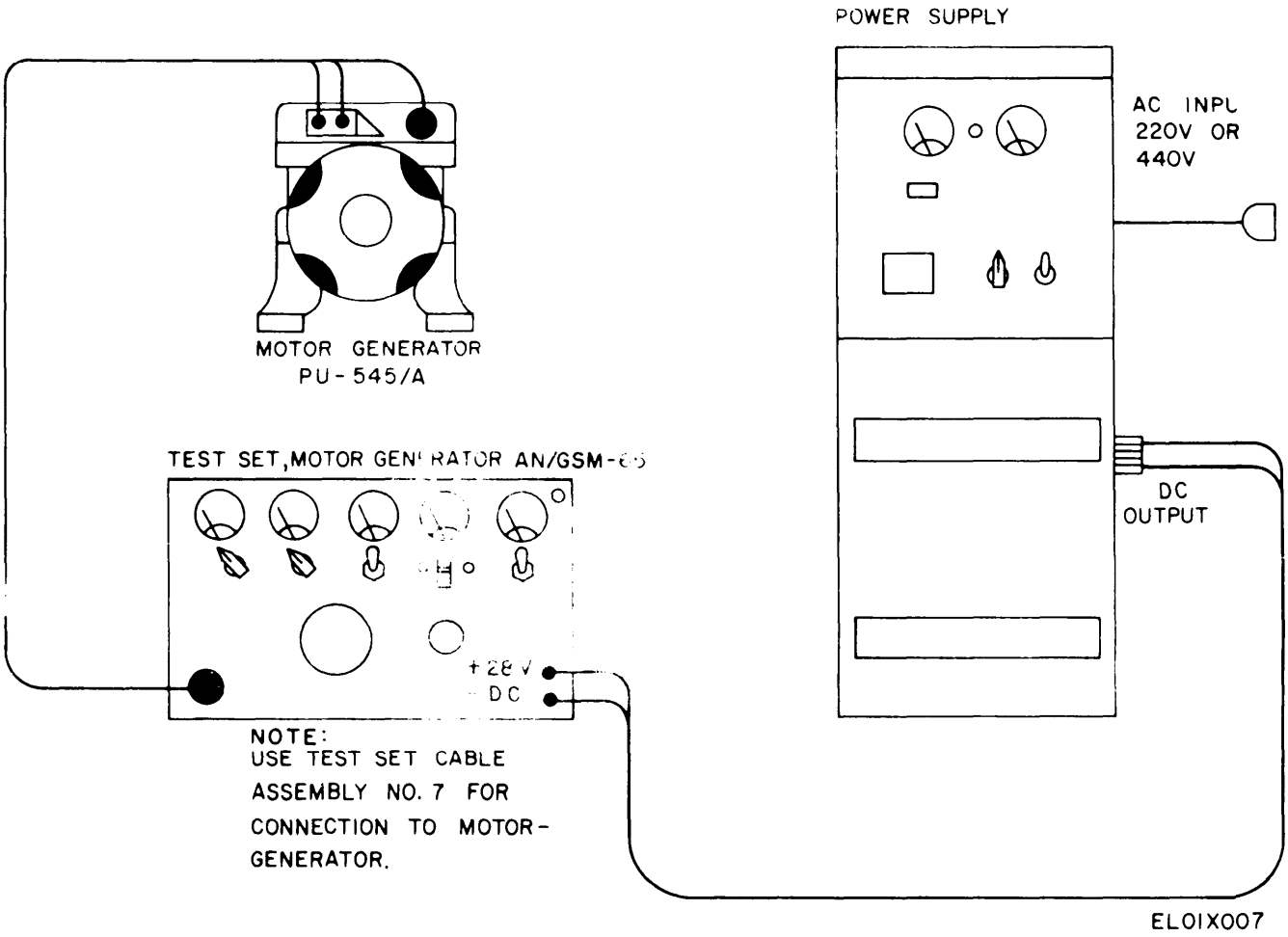


Figure 3-3. Connections for Brush Run-In and Performance Test

3-9. Replacement of Regulator Circuit Card Assembly

NOTE

The 4B93-1-A cannot be installed without modification (para 3-12) to the regulator section. This modification can only be performed at depot level.

a. Use the procedure in ***b*** below when replacement of the regulator card assembly is necessary. Note that regulator card assembly CSV1186-1 (3 piece, sealed with blue epoxy) is no longer maintained. If the inverter is equipped with this card assembly, universal type CSV2215-2, CSV2215-3, or 4B93-1-A (1 piece, sealed with clear polyurethane) should be used as a replacement. Forward card assembly CSV1 186-1 to depot maintenance for salvage of usable components.

b. On regulators with the CSV1186-1 or 4B93-1-A, the voltage adjustment potentiometer (fig. 3-1) is a separate unit attached to the regulator housing and fastened to terminals 3,7 and 8 of terminal board TB2 On the CSV2215-2 and CSV2215-3, the voltage adjustment potentiometer is connected directly to the card assembly. If a change of the CSV2215-2 or CSV2215-3 is made, remove the potentiometer from the housing along with its associated wiring and utilize the one supplied with the replacement card assembly,

(1) Remove the regulator cover.

(2) Make a small sketch, showing the color coding of each lead and where it is connected to the other wiring of the regulator.

(3) Disconnect the electrical leads of the card assembly.

(4) Remove the four bolts and washers that secure the card assembly base to the regulator housing, and remove it.

(5) Position the replacement card assembly card assembly in the regulator housing, and secure with the bolts and washers removed in (4) above.

(6) Change over the voltage potentiometer as described above, if necessary.

(7) Attach the leads as indicated in the sketch prepared in (2) above.

(8) Replace the regulator cover.

3-10. Adjustment of Output Frequency

Output frequency potentiometer L1 on CSV2215-3 (R3 on CSV1186-1), and R5 on 4B93-1-A is used to establish the 400 Hz ac output current. Follow the procedure below for adjustment.

NOTE

This procedure can be carried out in the aircraft if the inverter can be reached easily.

a. Remove the regulator cover.

b. Plug the power test set prods into the inverter test point jacks, and apply power to the inverter.

c. Refer to figure 3-1 and adjust L1 (or R3) for an indication of 400 Hz.

d. Check for variation in frequency between no load and full load conditions. A variation of less than 8 Hz is acceptable.

e. Disconnect power test set prods, and replace regulator cover.

Section IV. DIRECT SUPPORT TESTING PROCEDURES

3-11. General

These testing procedures have been prepared for use by direct support maintenance shops to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired equipment must meet before being returned to the using organization.

3-12. Modification Work Orders (MWO's)

At the time of this publication, there were no printed MWO's pertaining to this equipment. However, inverters, as they are received, are being modified at depot level to accept the 4B93-1-A regulator. These units can be identified by the letter "M" stamped on the data plate. For a listing of recent MWO's refer to DA Pam 310-7.

3-13. Tests and Procedures

Equipment which meets the performance standards in tables 3-2 and 3-3 may be considered acceptable for service. Perform each step in sequence. For each step, perform all the actions in the ***Control settings*** column, then perform the specific procedure and verify it against its performance standard.

Table 3-2. Physical Tests and Inspections

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	N/A	Inspect exterior and interior for overall cleanliness.	No dust, grease, dirt or carbon particles on surfaces.
2	N/A	N/A	a. Inspect mechanical assemblies for loose or missing screws, bolts, or nuts.	*a.* Screws, bolts, and nuts will be tight; none missing.
			b. Inspect ac connector and test points for looseness and damage.	*b.* No looseness or damage evident.
3	N/A	N/A	*a.* Inspect all components for cracked, burned, or damaged insulation.	a. None evident.
			b. Check regulator for security of mounting.	*b. No* looseness evident.
			c. Check all leads inside unit for security.	*c.* No looseness evident.
4	N/A	N/A	Check each ac contact brush in turn for proper condition and seating. Refer to paragraph 3-8.	Brushes are in good condition and seating is satisfactory. Refer to paragraph 3-8.

Table 3-3. *Voltage and Frequency Test*

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test Procedure	Performance standard
1	N/A	N/A	Be sure that all toggle switches on the motor generator test set are in the OFF position and connect equipment as shown in figure 3-3.	N/A
2	Adjust power supply to 27.5 vdc on test set dc VOLTS meter.	N/A	Zero all teat set meters, if necessary.	N/A

Table 3-3. Voltage and Frequency Test - Continued

Step No.	Control settings: Test equipment	Equipment under test	Test procedure	Performance standard
3	Set test set controls as follows: D.C. AMMETER RANGE to START. A.C. AMMETER RANGE to 50. LOAD CONTROL to 0. D.C. POWER to ON.	N/A	Adjust LOAD CONTROL for an indication of 90A on dc AMP meter of test set.	Indication on ac VOLTS meter must be 115 ±6 vac.
4	Adjust power supply to 29 vdc on test set dc VOLTS meter.	N/A	Return LOAD CONTROL to 0, and note indications on ac VOLTS and FREQUENCY meters.	Indications on ac VOLTS and FREQUENCY meters must be 115±6 vac and 400 ±10 Hz respectively.
5	Adjust power supply to 26 vdc on test set dc VOLTS meter.	N/A	Adjust LOAD CONTROL for an indication of 170A on D.C. AMP meter of test set. NOTE Be sure reading does not exceed the rating on the data plate.	Same as above.

CHAPTER 4
GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

4-1. Introduction

The maintenance instructions in this chapter supplement the direct support maintenance procedures outlined in chapter 3, and the organizational maintenance procedures in TM 11-6125-240-12. The troubleshooting which begins at these categories is expanded here to include actual repair of the inverter, by replacement of defective parts. Except for the armature, all repair parts are available to general support.

4-2. General Support Maintenance Guidance

Refer to paragraph 3-2 for an outline of the maintenance schedule for the inverter.

4-3. General Support Tools and Equipment

Tools and test equipment needed for general support maintenance of the inverter are listed in table of appendix C (maintenance allocation) in TM 11-6125-240-12.

Section II. GENERAL SUPPORT TROUBLESHOOTING

4-4. General

a. Electrical troubleshooting of the inverter is confined to the circuitry of the regulator section. Abnormal conditions in the following table are those which might be observed under normal input/load conditions. Before attempting to locate a defective part, be sure that adjustments alone will not correct the problem.

b. Regulator card assemblies which have been removed at direct support and referred to general support for repair should be installed on a working PU-545/A for troubleshooting.

NOTE

Regulator card assembly CSV1186-1 is no longer maintained and should be replaced with universal type CSV2215-2, CSV2215-3, or 4B93-1-A at direct support. Should an inverter with defective CSV1186-1 reach general support , carry out this replacement and send the CSV1186-1 to Depot for salvage of non-defective parts. Refer to paragraph 3-9.

4-5. Troubleshooting Table for CSV2215-2 and CSV2215-3

a. Troubleshoot the CSV2215-2 and CSV2215-3 regulator card assembly in accordance with table 4-1. Inspect the circuit card assembly and connecting leads before troubleshooting. Unless a defective part can be located visually, the sequence of operations in the table should be followed, since they are listed in order of probability. Refer to figure 4-1 for location of parts.

b. A pointed probe will be required to puncture the protective coating when checking the circuitry of the regulator card assembly. After repairs are completed this coating must be restored in accordance with paragraph 4-17.

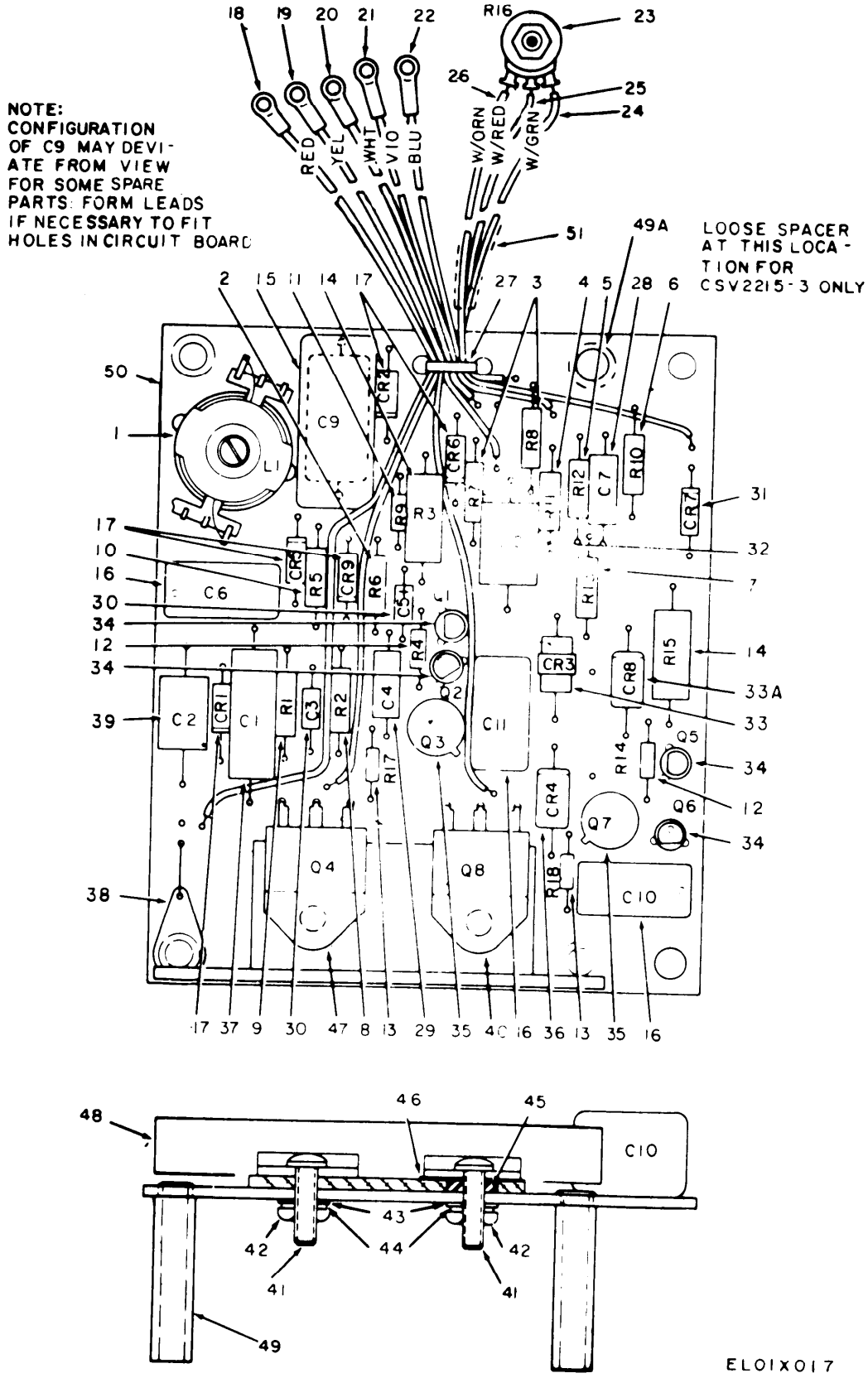


Figure 4-1. Regulator Card Assembly CSV2215-2 and CSV2215-3, Location of Parts.

Table 4-1. General Support Troubleshooting for CSV2215-2 and CSV2215-3

Malfunction	Probable cause	Corrective action
Low frequency	*a.* Q4 shorted or CR4 shorted.	*a.* Check Q4 collector to emitter and collector to base junctions with an ohmeter. If either junction checks shorted, remove the emitter lead and check to be sure that CR4 is not shorted. If Q4 and/or CR4 require placement, check Q3 per following procdure.
	b. Q3 Shorted	*b.* Check Q3 from collector to emitter with an ohmmeter If not shorted, check Q3 collector-base and emitter base for shorts. Replace Q3 if any junction checks shorted.
	c. Q1 or Q2 open.	*c.* Check Q1 and Q2 base-emitter and base collector junctions with an ohmmeter. If either junction is open, replace the defective transistor.
	d. CR3 shorted.	*d.* Check CR3 from anode to cathode with an ohmmeter. Replace if it is shorted.
	e. R1 shorted or low resistance.	e. Measure R1 resistance with an ohmmeter, reverse ohmmeter leads and measure again. One of these indications must be in excess of 6000 ohms; replace R1 if both indications are low.
	f. R2 low resistance.	*f.* Repeat previous procedure for R2. If both indications are less than 12K ohms, replace R2.
	g. R5 or R6 high resistance or open.	*g.* Measure R5 and R6 with an ohmmeter. This resistance should be 130K and 24K maximum, respectively. Replace as required.
	h. CR5 shorted or open.	*h.* Check CR5 from anode to cathode with an ohmmeter. Replace if it is shorted or open.
	i. CR4 shorted.	*i.* Check CR4 for a short with an ohmmeter. The meter indication should dip toward zero ohms, then as the capacitor changes, increase to at least 10K ohms. Replace if shorted.
	j. Cl or C2 defective.	*j.* Remove Cl and C2 from the circuit and measure the capacitance with available equipment. The value should be 0.013 to 0.017 microfarads, and 0.13 to 0.17 microfarads, respectively. Replace either capacitor that is out of tolerance.
High frequency.	*a.* Q4 open, CR3 open, CR4 open.	*a.* Check Q4 base-emitter and base-collector junctions with an ohmmeter. If either junction checks open, replace Q4. If Q4 is replaced, check CR3 and CR4 from anode to cathode for open junctions and check Q3 per fourth procedures listed for this trouble. Replace as required.
	b. Q1 or Q2 shorted.	*b.* Check Q1 and Q2 collector-emitter and collector-base junctions for shorts with an ohmmeter. Replace Q1 or Q2 if either junction checks shorted.
	c. L1 defective.	*c.* Connect an ohmmeter across the two lead terminals of L1 reactor. (Preferably the ohmmeter should be placed across the parallel capacitor, C2. Checking reactor in this manner will ensure a proper printed circuit connection and also eliminate the possibility of damaging the fine inductor wire with pointed probes.) The resistance should measure 200 to 300 ohms. Replace L1 if the resistance is outside these limits. **NOTE** If after completing all following procedures, the fault is not discovered, remove L1 and check the inductance on available equipment with the adjustable core removed Replace the core if the inductance is less than 0.4 henry.
	d. Q3 open, CR3 open.	*d.* Remove Q3 from the circuit board and check base-emitter and base-collector junctions with an ohmmeter. If either junction checks open,

Table 4-1. General Support Troubleshooting for CSV2215-2 and CSV2215-3— Continued

Malfunction	Probable cause	Corrective action
		replace Q3. If Q3 is replaced, check CR3 from anode to cathode for an open or shorted junction.
	e. R3 open or high resistance.	*e.* Measure R3 resistance with an ohmmeter reverse meter leads and measure again. If either of the indications are in excess of 1200 ohms, replace R3.
	f. R1, R2 or R4 open or high.	*f.* Repeat the preceding procedure for Rl, R2 and R4. The greater indication must be less than 8000 ohms for Rl, 15,000 ohms for R2 and 100 ohms for R4.
	g. CR1 open or shorted.	*g.* Check CR1 with an ohmmeter. Replace if it measures either shorted or open.
	h. CR9 open.	*h.* Check CR9 with an ohmmeter. Replace if it measures open.
	i. Cl or C2 defective.	*i.* Remove C1 and C2 from the circuit and measure the capacitance with available equipment. The value should be 0.013 to 0.017 microfarads, and 0.13 to 0.17 microfarads, respectively. Replace either capacitor that is out of tolerance.
No output voltage.	*a.* Q8 open.	*a.* Check Q8 base-emitter and base-collector junctions with an ohmmeter, If either junctions checks open, replace Q8. If Q8 is replaced, check Q7 and QA per fifth procedure listed for this trouble. Replace parts as required
	b. Q5 or Q6 shorted.	*b.* Check Q5 and Q6 collector-emitter and collector-base junctions with an ohmmeter. If either junction checks shorted, replace the defective transistor.
	c. CR7 shorted.	*c.* Check CR? for a short from anode to cathode with ohmmeter (use ohmmeter with less than 18 volt batteries). If junction checks short, replace CR7.
	d. R15 open or high resistance.	*d.* Measure R15 resistance with an ohmmeter. Reverse ohmmeter leads and measure again. If either indication is in excess of 1200 ohms, replace R15.
	e. Q7 open, CR8 open.	*e.* Remove Q7 from the circuit board and check base-emitter and base-collector junctions with an ohmmeter. If either junction checks open, replace Q5. If Q5 is replaced, also check CR8 from anode to cathode for open junction.
Low output voltage.	*a.* CR7 Zener voltage low.	*a.* Check CR7 Zener diode either on or off the circuit board suitable for measuring the Zener voltage. With reverse current of 50 microamps, remeasure the Zener voltage. Replace CR7 if the Zener voltage is less than 17 volts.
	b. R16 open (if connected to regulator).	*b.* Measure the resistance between the center tap (w/red lead) and the low potential (w/green lead) side of R16 variable resistor. This resistance must be less than 12K ohms; replace R16 if outside limit.
	c. R11 or R12 open or high resistance.	*c.* Measure R11 and R12 resistance with an ohmmeter. The resistance must be less than 17K and 4K ohms, respectively. Replace parts as required.
	d. R7 or R8 shorted or low resistance.	*d.* Measure R7 and R8 resistance with an ohmmeter. Each resistor must measure 30K ohms minimum. Replace either resistor that is outside limit.
High output voltage.	*a.* Q8 show CR8 open.	*a.* Check Q6 collector-emitter and collector-base junctions with an ohmmeter. If either junction is shorted, replace Q8 Also, if Q8 is replaced, check CR8 from anode to cathode for open circuit and check Q? per following procedure. Replace parts as required.
	b. Q7 shorted.	h. Check Q7 collector-emitter and collector-base junctions for short circuits. Replace Q7 if either junction is shorted.

Table 4-1. General Support Troubleshooting for CSV2215-2 and CSV2215-3 — Continued

Malfunction	Probable cause	Corrective action
	c. Q5 or Q6 open.	*c.* Check Q5 or Q6 base-emitter and base-collector junctions with an ohmmeter. Replace Q5 or Q6 if either junction is open.
	d. CR7 Zener open or high Zener voltage.	*d.* Check CR7 as a normal diode with an ohmmeter, from anode to cathode for an open circuit. If it checks good, measure the Zener Voltage, using any suitable device, either in or out of the circuit, with 50 microamps reverse current. Replace CR7 if the Zener voltage is greater than 19 volts or if it checks open as a normal diode.
	e. R16 open or high resistance (if connected to regulator).	*e.* Connect an ohmmeter to the centertap (w/red lead) terminal of variable resistor R16 and to the high potential (w/orange lead) terminal of same. Change setting to both ends of trawl. The resistance must read less than 10 ohms at one end and 10K to 12K at the other end of travel. If not, remove and replace R16.
	f. CR6 defective.	*f.* With an ohmmeter check CR6 from anode to cathode for a short or open. Replace as required.
	g. R7 or R8 open or high resistance.	*g.* Measure R7 and R8 resistance with an ohmmeter. Replace either resistor if it measures greater than 35K ohms.
	h. R11 shorted or low resistance.	*h.* Measure R11 resistance with an ohmmeter. If it measures less than 13K ohms, replace it.
	i. R12 shorted or low resistance (C12 defective).	*i.* Measure resistance of R12 with an ohmmeter. If it measures less than 2.5K ohms, remove and recheck it. If it checks greater than 2.5K out of the circuit, it is good. C7 then should be replaced since it will either be shorted or have excessive leakage.
Frequency unstable.	*a.* C5 defective.	*a.* Remove C5 from circuit and measure the capacitance by any convenient means. The value should be between 0.8 and 1.2 microfarads. Replace, if not within tolerance.
	b. C4 defective.	*b.* Remove C4 from circuit and measure the capacitance by any convenient means. The value should be between 18 and 26 microfarads. Replace, if not within tolerance.
	c. R9 defective.	*c.* Measure the resistance of R9 with an ohmmeter. The resistance should be between 1 K ohms and 2K ohms. Replace, if not within tolerances.
Voltage unstable.	C6 defective.	Remove C6 from circuit and measure the capacitance by any convenient means. Replace C6 if its value is not between 0.27 and 0.39 microfarads.

4-6. Troubleshooting Table for 4B93-1-A

a. Troubleshoot the 4B93-1-A regulator card assembly in accordance with table 4-2. Inspect the circuit card assembly and connecting leads before troubleshooting. Unless a defective part can be located visually, the sequence of operations in the table should be followed, since they are listed in order of probability. Refer to figure 4-2 for location of parts.

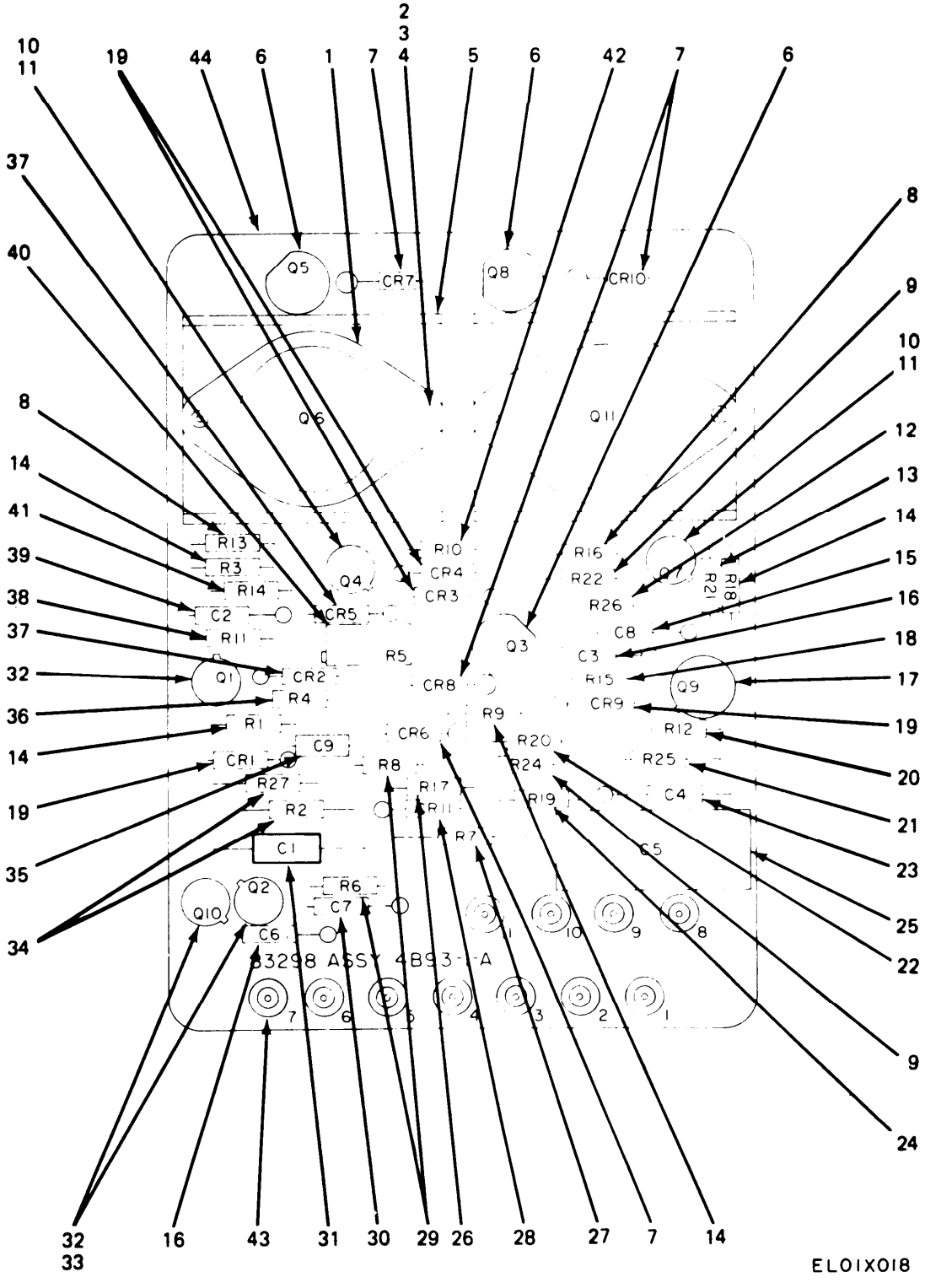
b. A pointed probe will be required to puncture the protective coating when checking the circuit of the regulator card assembly. After repairs are completed, this coating must be restored in accordance with paragraph 4-18.

Table 4-2. General Support Troubleshooting for 4B93-1-A

Step No.	Malfunction	Probable cause	Corrective action
1	Frequency out of tolerance.	a. Frequency adjustments resistor R5 incorrectly set.	a. Set variable resistor R5 for correct frequency.
		b. Zener reference changed	*b.* Check CR2, CR3, CR4 and CR5. Replace faulty components.
2	Poor frequency regulation.	*a.* Zener reference changed.	a. Check CR2, CR3, CR4 and CR5. Replace faulty component.
		b. Incorrect capacitor valves.	*b.* Check all capacitors in frequency sec-

Table 4-2. General Support Troubleshooting for 4B93-1-A — **continued**

Step No.	Malfunction	Probable cause	Corrective action
			tion. Replace faulty components.
3	Low frequency.	Shorted transistors	Check Q4, Q5, Q6 and associated components. Replace faulty components.
4	High frequency.	Open transistors	Check Q4, Q5, Q6 and associated components. Replace faulty components.
5	Ac output voltage out of tolerance.	*a.* Voltage adjustment resistor R2 incorrectly set. *b.* Zener reference changed.	*a.* Set variable resistor R2 for correct voltage. *b.* Check CR2, CR3, CR4 and CR5. Replace if faulty.
6	Excessive modulation of ac output voltage.	Faulty feedback capacitor C4.	Check C4, Replace faulty component.
7	Poor voltage regulation.	*a.* Faulty input capacitor C5. *b.* Faulty reference.	a Check C5, Replace faulty component. *b.* Check CR2, CR3, CR4 and CR5. Replace faulty components.
8	High output voltage.	Shorted transistor.	Check Q7, Q8, Q9,Q11 and associated components. Replace faulty components.
9	Low output voltage.	Open transistors.	Check Q7, Q8, Q9 and Q1l. Replace faulty components.



1 Transistor
2 Machine screw
3 Flatwasher
4 Nut and lockwasher
5 Heatsink
6 Transistor, silicon
7 Semiconductor, diode
8 Resistor, fixed
9 Resistor, fixed
10 Transistor, silicon
11 Adapter
12 Resistor, fixed
13 Resistor, fixed
14 Resistor, fixed
15 Capacitor, fixed
16 Capacitor, fixed
17 Transistor, silicon
18 Resistor, fixed
19 Semiconductor, diode
20 Resistor, fixed
21 Resistor, fixed
22 Resistor, fixed
23 Capacitor, fixed
24 Resistor, fixed
25 Capacitor, fixed
26 Resistor, fixed
27 Resistor, fixed
28 Semiconductor, diode
29 Resistor, fixed
30 Capacitor, fixed
31 Capacitor, fixed
32 Transistor, silicon
33 Adapter
34 Resistor, fixed
35 Capacitor, fixed
36 Resistor, fixed
37 Semiconductor, diode
38 Resistor, fixed
39 Capacitor, fixed
40 Resistor, variable
41 Resistor, fixed
42 Resistor, fixed
43 Nut, clinch
44 Printed wiring board

Figure 4-2. Regulator Card Assembly 4B93-1-A, Locution of Parts

Section III. GENERAL SUPPORT MAINTENANCE OF PU-545/A

4-7. Cleaning

a. Clean the inverter according to the instructions in TM 11-6125-240-12 and paragraph 3-6 of this manual.

WARNING

The fumes of TRICHLOROETHANE are toxic. Provide adequate ventilation whenever it is used; avoid prolonged or repeated breathing of vapor. Do not use near an open flame or hot surface; trichloroethane is nonflammable but heat converts the fumes into a highly toxic phosgene gas the inhalation of which could result in serious injury or death. Prolonged or repeated skin contact with trichloroethane can cause skin inflammation. When necessary, use gloves, sleeves, and aprons which the solvent cannot penetrate.

b. If the generator section is disassembled, wipe the armature and stator coils with a cloth dampened with trichloroethane, and clean thoroughly with a brush. Do not soak the assemblies in the trichloroethane. After cleaning, dry out the armature and stator assemblies by baking them for 2 to 4 hours at 200° F (93° C).

4-8. General Parts Replacement Techniques

a. *Regulator Section.* Most repair parts of the regulator section can be removed and replaced easily. Disassemble if necessary, according to instructions in paragraphs 4-9 through 4-12. Before beginning, check to see that replacement parts are available; observe the following precautions:

(1) Disconnect the inverter from the power source before beginning repair.

(2) Before a part is unsoldered, observe the position of all leads to that part, and identify each one that is to be removed with reference to its soldered terminal. Tag each lead, or draw a small sketch of the wiring to the component and note the color coding and lead designation.

(3) Use a pencil-type soldering iron and a heat-sink (such as long-nosed pliers) when soldering and unsoldering leads, to prevent damage to adjacent components.

(4) Where defective parts must be replaced, use identical replacement parts. The new part must be mounted in the same position as the one it replaces.

(5) Before soldering, carefully clean the terminals and lead connections. Use enough heat to make a well-soldered connection. A poor solder joint that causes faulty operation is difficult to locate,

b. Generator Section. Repair of the generator section is also a matter of replacement of defective parts. Procedures for disassembly, including exploded diagrams, are given in paragraph 4-13.

4-9. Removal of Regulator Section

(fig. 4-3)

a. Turn fastener studs (2 and 3) one-quarter turn and lift regulator housing cover (4) from regulator housing (52). Remove grooved pins (1) from fastener stud only if replacement is required.

b. Remove two machine screws (5) and two lockwashers (6); remove terminal board cover (7), and ac plug cover (7A).

c. Remove two nuts (8 and 11), two lockwashers (9 and 12), and two flat washers (10 and 13) to disconnect electrical leads from terminal board TB3 (38). Remove one nut (14), lockwasher (15) and flat washer (16) to detach electrical lead (17) from terminal board TB3. Lift off terminal connecting links (18 and 19).

d. Remove two nuts (20), lockwashers (21), flat washers (22), and machine screws (23) to detach dc leads from terminal board TB1. Remove one nut (24), lockwasher (25), and flat washer (26) to free electrical lead (27) and other ground leads from shouldered stud. Remove insulation sleeving from shouldered stud (28A). Unscrew and remove stud, freeing lower washers (25 and 26).

e. Remove machine screw (29), lockwasher (30), flat washer (31), and loop clamp (32), from terminal board TB2 (2, fig. 4-6) freeing circuit card leads.

f. Remove four screws (33, fig. 4-3) and four flat washers (34), and lift out the regulator (38A or 38 B).

NOTES

Refer to paragraph 3-9 for specific instructions for removal of each of the various models of the regulator.

The regulator and base are removed as a unit and should be disassembled only if repair is necessary.

g. Remove four machine screws (37) and flat washers (37A) and lift out terminal board TB 3(38).

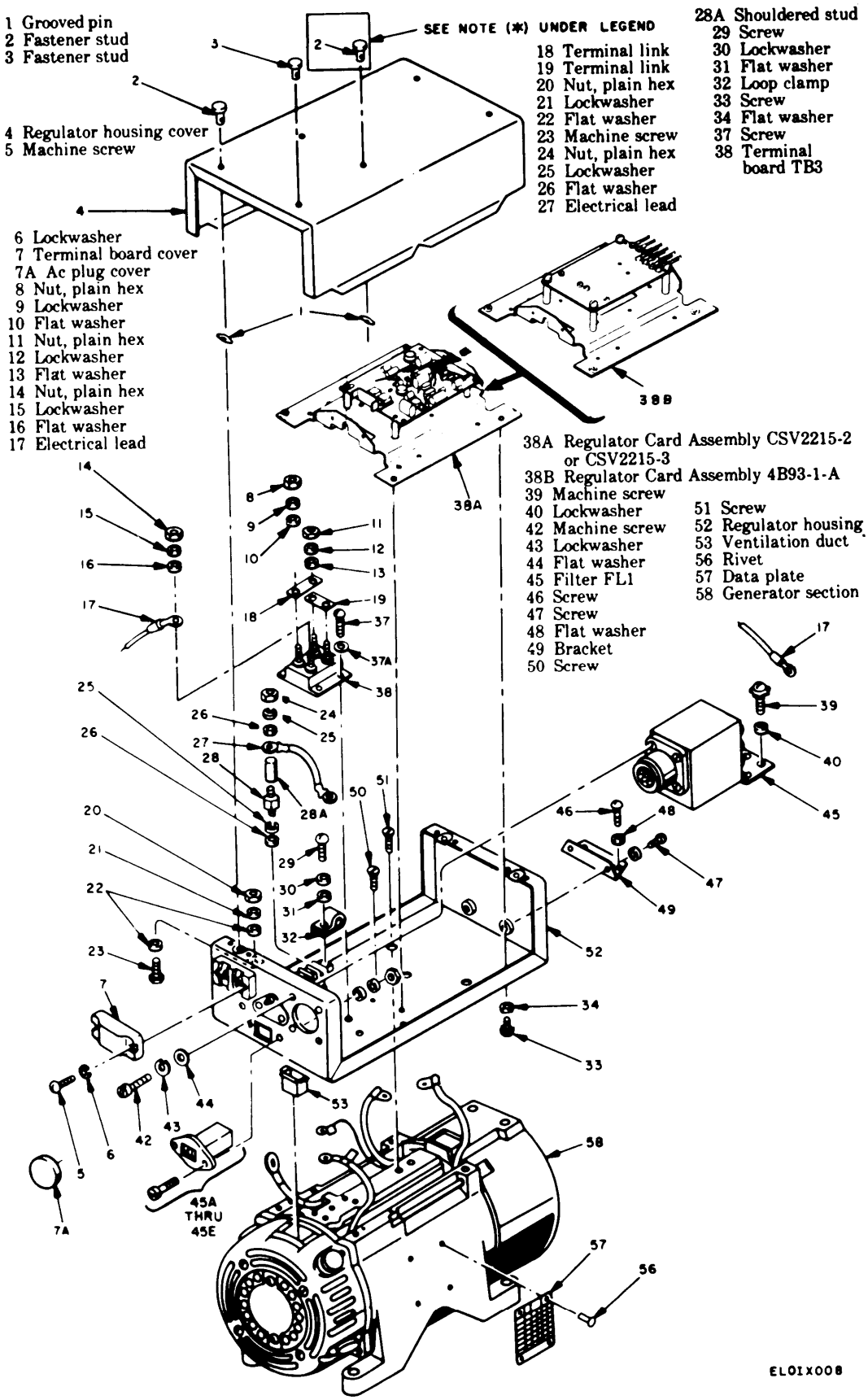


Figure 4-3. Regulator Section, Exploded View.

h. Remove six nuts at rear of radio interference filter FL1 (45) to disconnect ac stator leads. Remove three screws (39), three lockwashers (40), four screws (42), and four lockwashers and flat washers (43 and 44) and lift out radio interference filter FL1 (45).

i. Remove two screws (46), two flat washers (48) to free bracket (49), Remove two screws (50 and 51) and lift regulator housing (52) from the generator section (58). Ventilation duct (53) may also be removed at this time.

4-10. Disassembly of Regulator Card Assembly CSV2215-2 or CSV2215-3 (fig. 4-4)

Disassembly only to the extent necessary to effect repair. Proper troubleshooting procedures will isolate defective parts rapidly, and minimize the possibility of overlooking secondary malfunctions.

a. Remove nut (1), lockwasher (2), flat washers (3) and screw (4), to detach loop clamp (5) from base (6).

b. Remove nut (7), lockwasher (8), flat washers (9) and screw (10), to detach red electrical lead (11) from base.

c. Remove nuts (12), lockwasher (13), flat washers (14) and machine screws (15). Lift circuit card (16) from base.

NOTE

Separation of circuit card CSV2215-3 and base allows one sleeve spacer (17) to come loose. Preserve this spacer with other hardware for subsequent reassembly.

d. Before disconnecting regulator leads from their terminations on the board, make certain they are color-coded and attached as shown in figure 4-1.

CAUTION

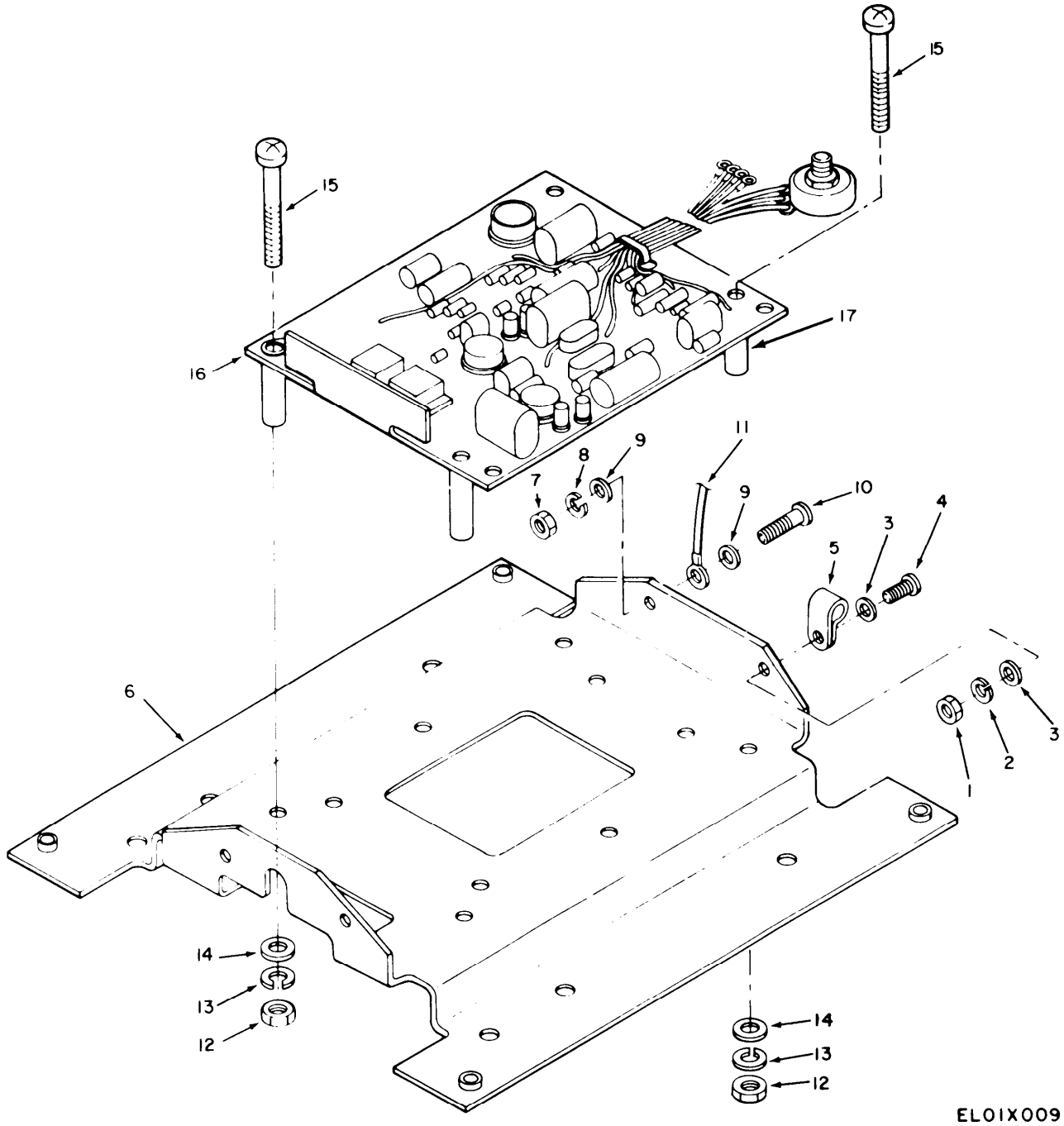
Use a 50-watt (or less) soldering iron with a grounded tip when unsoldering leads. Current leakage through some soldering irons is enough to damage semiconductors and transistors.

e. Use a sharp knife to trim protective coating from around defective parts. Turn the circuit card over and remove all coating from solder joints. Remove only the coating covering the defective parts; do not disturb coating on the surrounding area.

f. If any of the electrical leads are broken or damaged, the entire lead must be replaced. Do not attempt to splice the leads.

NOTE

Removal of spacers, and disassembly of L1 or L2 is not recommended.



1 Nut, plain hex
2 Lockwasher
3 Flat washer
4 Machine screw
5 Loop clamp
6 Base
7 Nut, plain hex
8 Lockwasher
9 Flat washer
10 Machine screw
11 Electrical lead
12 Nut, plain hex
13 Lockwasher
14 Flat washer
15 Machine screw
16 Circuit card
17 Sleeve spacer

Figure 4-4. Regulator Card Assembly CSV2215-2 and CSV2215-3, Exploded View.

4-11. Disassembly of Regulator Card Assembly 4B93-1-A

(fig. 4-5)

a. Disassemble or remove components only to the extent necessary to effect the repair. Proper troubleshooting procedures will isolate defective components rapidly and will minimize the possibility of overlooking damaged or malfunctioning components.

b. Before disconnecting regulator leads from their terminations, make certain that the leads are tagged or

marked and that the markings agree with those on the circuit board as shown in figure 4-2.

c. Disconnect the electrical leads from regulator assembly 4B93-1-A (1, fig. 4-5) by removing screws (2) and lockwashers (3) from lug terminals ***(4).***

NOTE

This step disconnects voltage adjust variable resistor R2 from the card assembly.

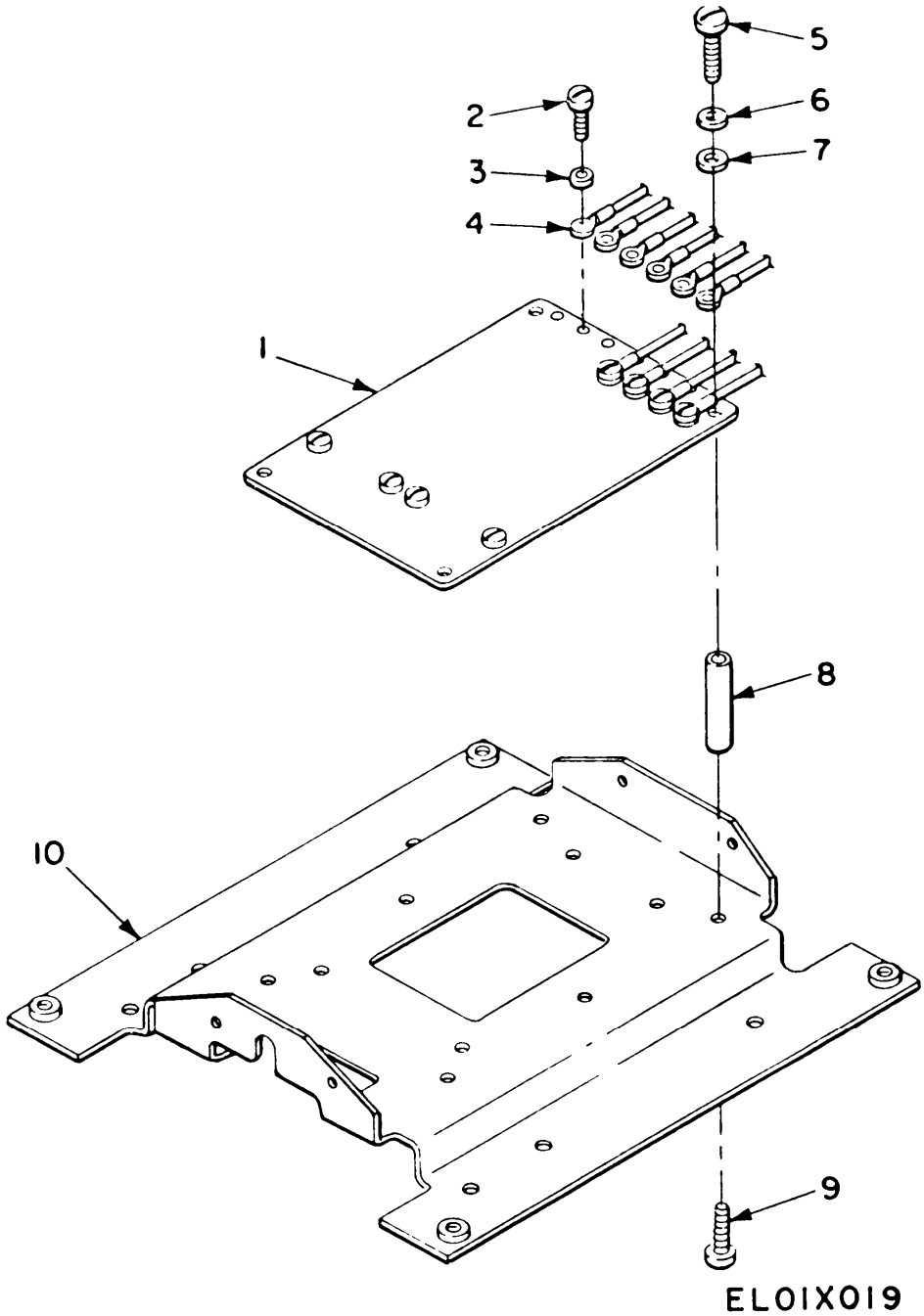
d. Remove screws (5), lockwashers (6), and flat washers (7). Lift regulator assembly 4B93-1-A (1) from base assembly (10).

e. If necessary, remove threaded spacer (8) by removing screws (9).

f. After determining defective components through troubleshooting (para 4-6), use a pen knife or exacto knife to trim away the protective coating around the defective component on the circuit card assembly. Turn the circuit card over and remove all coating from soldered connections of the defective component. Refer to figure 4-2 for locations of all components.

NOTE

Follow the outline of the components to be replaced when removing protective coating. Remove only protective coating that covers the part to be removed. Do not disturb or remove protective coating from other components, or remove excessive amounts of coating from the surrounding area.



1 Regulator Assembly 4B93-1-A
2 Machine Screw
3 Lockwasher
4 Lug terminal
5 Machine screw
6 Lockwasher
7 Flat washer
8 Threaded spacer
9 Machine screw
10 Base assembly

Figure 4-5. Regulator Card Assembly 4B93-1-A, Exploded View.

4-12. Disassembly of Regulator Housing

(fig. 4-6)

a. If electrical lead (1) is still connected to terminal board TB2 (2), note its position and back out attaching screw to disconnect.

b. Remove two screws (3) and flat washers (4) to detach terminal board and designation plate (5) from housing (32).

c. Remove three nuts (6), three lockwashers (7), three flat washers (8), and bolt (9). Remove strap as-

assembly (10) and angle bracket (11) from terminal board (TB1) (12).

d. Remove four screws (13) and four flat washers (14) to detach terminal board TB1 from housing. Remove capacitor (15) from spring clip inside housing. Only remove lug terminal (16) from capacitor if damaged.

e. Remove a nut from each test point jack (17) and withdraw jacks from housing. Data plate (18) will also come free. Only remove lug terminals (19) from test point jacks if damaged.

f. Remove screws (20) and retaining clamp (21) to free capacitor nut C2 (22) from housing. Only remove lug terminals (23) from capacitor leads if damaged.

g. Remove screw (24) and flat washer (25) to detach angle bracket (26) from housing.

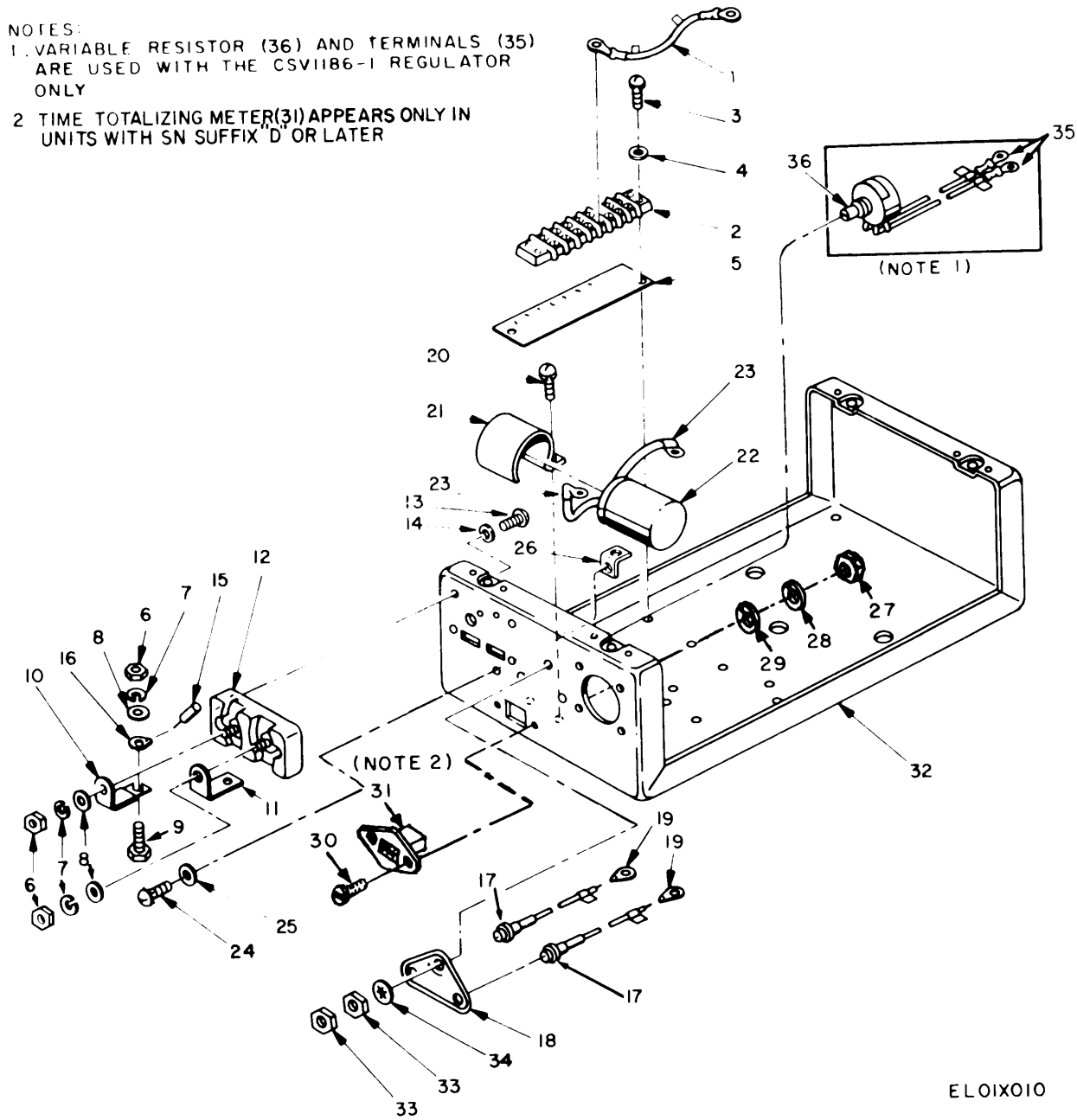
NOTE

If regulator contained a CSV1186-1 or 4B93-1-A card assembly, the variable resistor (36) will also be removed during this step.

h. Remove two nuts (27), lockwashers (28), flat washers (29) and screws (30) to detach time totalizing meter (31) from housing (32).

NOTE

Time totalizing meter appears only in CSV2215-2 or CSV2215-3 units with SN suffix D or later.



1 Electrical lead
2 Terminal board TB2
3 Machine screw
4 Flat washer
5 Designation plate
6 Nut, plain hex
7 Lockwasher
8 Flat washer
9 Bolt, machine hex
10 Strap assembly
11 Angle bracket
12 Terminal board TB1
13 Machine screw
14 Flat washer
15 Capacitor
16 Lug terminal
17 Test point jack
18 Data plate
19 Lug terminal
20 Machine screw
21 Retaining clam
22 Capacitor nut C2
23 Lug terminal
24 Machine screw
25 Flat washer
26 Angle bracket
27 Nut, plain hex
28 Lockwasher
29 Flat washer
30 Machine screw
31 Time totalizing meter
32 Housing
33 Nut, plain hex
34 Lockwasher
35 Terminal board pins
36 Variable resistor

Figure 4-6. Regulator Housing Exploded View.

4-13. Disassembly of Generator Section

(fig. 4-7)

a. Remove two screws (1) and lockwashers (2), and remove fan cover (3). Remove dc brushes as described **in paragraph** 3-8.

b. Remove four screws (4) and flat washers (5) and remove ac end cover (6). Remove ac brushes as described in paragraph 3-8.

c. Remove bearing locknut (7), key washer (8), fan (9), flat key (10), and fan spacer (11) **from dc end of armature** (12).

d. Remove four screws (13), lockwashers (14) and

flat washers (15), to detach external bearing plate (16).

e. Remove four nuts (17) from opposite end of stator housing (18). Remove four machine screws (19). Remove two screws (20) to detach dc stator (21) leads from insulated dc brush holders (22). Free stator leads from dc endbell (23) assembly and remove endbell assembly from stator housing. Tap with fiber ma] let to facilitate removal.

f. Remove two screws (24) to detach electrical lead (25) from dc brush holders (22). Remove two screw (26), retaining clamps (27) and capacitor units (28) eight screws (29 and 30), flat washers (31 and 32), and bushings (33) to detach brush holders (22) from dc endbell.

g. Remove two brush springs (34) from each of four brush spring pins (35). Back out each of four setscrews (36) to release the brush spring pins from the holders.

h. Remove two screws (37), flat washers (38), bearing plates (39 and 40), load spring (41), and shim washers (42) from ac endbell (43).

i. Remove four screws (44), flat washers (45), and cover plate (46) from ac endbell. Remove two screws (47), lockwashers (48), and flat washers (49), to disconnect ac stator electrical leads (50). Remove ac endbell assembly and armature (12) from housing (18) as an assembly. Work endbell off armature shaft.

j. Remove two screws (51), four flat washers (52), two capacitor units (53), and two loop clamps (54).

k. Remove screw (55), flat washer (56), and air duct (57) from ac endbell (58). Remove two screws (59), lockwashers (60), flat washers (61), to detach electrical leads (62).

NOTE

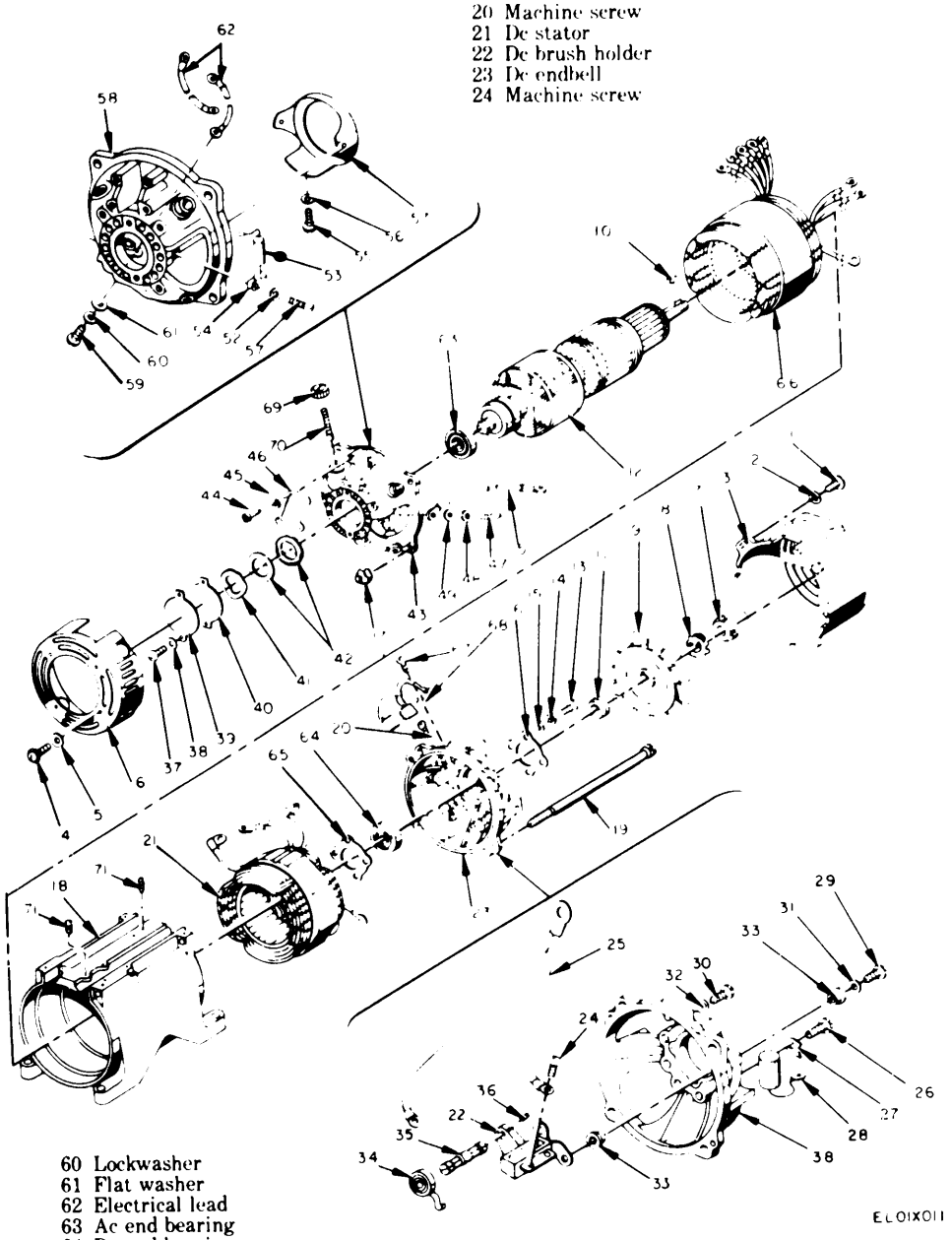
Capacitor C6, shown in figure 4-8, is not used with regulator card assemblies CSV2215-2 and CSV2215-3. If it is still installed in the ac endbell, remove at this time and discard, along with associated hardware.

l. Using a bearing puller, remove bearings (63 and 64) from ends of the armature shaft. Remove internal bearing plate (65) from shaft.

NOTE

Removal of the ac (66) and dc (21) stators from the stator housing (18) should only be attempted at depot maintenance, and then, only if necessary.

1 Machine screw
2 Lockwasher
3 Fan cover
4 Machine screw
5 Flat washer
6 Ac end cover
7 Bearing locknut
8 Key washer
9 Fan
10 Flat key
11 Fan spacer
12 Armature
13 Machine screw
14 Lockwasher
15 Flat washer
16 Bearing plate
17 Nut, self-locking
18 Stator housing
19 Machine screw
20 Machine screw
21 Dc stator
22 Dc brush holder
23 Dc endbell
24 Machine screw
25 Electrical lead
26 Machine screw
27 Retaining clamp
28 Capacitor unit
29 Machine screw
30 Machine screw
31 Flat washer
32 Flat washer
33 Bushing
34 Brush spring
35 Brush spring pin
36 Setscrew
37 Machine screw
38 Flat washer
39 Bearing plate
40 Bearing plate
41 Load spring
42 Shim washer
43 Ac endbell
44 Machine screw
45 Flat washer



46 Cover plate
47 Machine screw
48 Lockwasher
49 Flat washer
50 Electrical lead
51 Machine screw
52 Flat washer
53 Capacitor unit
54 Loop clamp
55 Machine screw
56 Flat washer
57 Air duct
58 Ac endbell
59 Machine screw
60 Lockwasher
61 Flat washer
62 Electrical lead
63 Ac end bearing
64 Dc end bearing
65 Bearing plate
66 Ac stator
67 Machine screw
68 Dc brush
69 Electrical cap
70 Brush spring
71 Setscrew

Figure 4-7. Generator Section Exploded View.

4-14. Replacement of Bearings

WARNING

Even if received under the proper NSN (3110-00-689-7392), do not install bearings if they are unsealed (unsealed bearings are those type where the ball bearing can be seen).

Before pressing new bearings into place on the armature shaft, read the following procedure thoroughly. Bearings are critical items. Failure to observe this procedure may result in premature bearing failure and damage to the motor-generator.

a. Use only bearing specified in parts list. DO NOT SUBSTITUTE.

b. Rotate bearing stock. Use oldest first. The life of bearing lubricant is 5-3/4 years from the date imprinted on the bearing package wrapper. Do not assemble equipment with bearings older than 3-3/4 years. Older bearings should be returned to the manufacturer for rehabilitation.

c. Each equipment having the bearings replaced shall be marked (date) AGE CONTROLLED ITEM, The date entered shall be the date code shown on the outside of the bearing container. New equipment will be designated AGE CONTROLLED, necessitating date change only.

NOTE

The marking of AGE CONTROLLED ITEM is recommended but not mandatory. If this procedure is not carried out, keep a record of bearings replacement with appropriate date reflected.

d. The work area must be neat and clean and free of lint and abrasive or other harmful particles.

e. The bearing must not be removed from the storage container until immediately before installation on the shaft. If necessary to set the bearing down temporarily y, place it on its own wrapper or on a piece of clean oilproof paper or plastic film.

f. Be sure the shaft journal surface, locating shoulder and undercut are free of dirt, roughness or burrs which might interfere with complete and proper seating of the bearing. Shaft shoulder shall not be nicked, rolled or damaged.

g. When pressing bearings onto shaft, position so that when practical the bearing markings are outward, away from the shaft shoulder. Use an arbor press (Greenard Model # 3) or other suitable tool for pressing bearings onto the shaft. Apply pressure uniformly to the inner race only. Avoid any pressure to the outer race and be extremely careful not to touch the shield or seal with the pressing tool. The bearing itself must not be touched, as damage may occur.

NOTE

If rotor cannot be installed into the unit in the same day, cover the bearings with plastic film or oil proof paper.

h. Before assembling rotor endbell, and housing with the bearings, apply a thin film of high-temperature molsulphide (surfcote 1000, or equivalent, manufactured by Hohman Plating, Dayton, Ohio, FSCM01094) to the bearing bore. Remove any excess lumps of compound.

i. Slide the endbell gently over the bearing. Do not hammer or otherwise force this operation.

NOTE

If a bearing must be removed from the shaft for any reason, replace it with a new bearing even though the bearing removed is new and unused. The act of removal has a damaging effect on bearings. When replacing a bearing which is secured with a locknut and key washer, always use a new key washer at reassembly.

4-15. Reassembly of Generator Section

(fig. 4-7)

Before beginning the following reassembly procedure, clean the parts of the generator section, if necessary, as described in paragraph 4-7.

a. Connect the two lead assemblies (62) to their respective brush holders inside the ac endbell (58), using a flat washer (61), lockwasher (60), and screw (59).

b. Slide each of two capacitor assemblies (53) into a loop clamp (54). Assemble a flat washer (52), capacitor, clamp, and a second washer and secure to ac endbell with a screw (51). Tighten clamp screws to a torque of 12 pound-inches. Capacitor terminals must be on top of all lead terminals. Refer to figure 4-8 and make terminals and lead connections as shown.

c. Attach the air duct (57) using a flat washer (56) and screw (55). Tighten air duct screw to a torque of 12 pound-inches.

d. Center a brush spring pin (35) in each brush holder (22). Install a setscrew (36), but do not tighten. Install two brush springs (34) on each brush spring pin. With a screwdriver, turn each brush spring pin clockwise, to produce 18 to 22 ounces of pressure; tighten setscrew.

e. Mount each of two capacitor units (28), using a retaining clamp (27) and screw (28).

CAUTION

Two brush holders are electrically insulated by bushings, and two are grounded to the dc endbell. Be sure to install as described below and illustrated in figure 4-7. If these parts are installed in the wrong location dc + will be applied directly to ground, the inverter will not run, and system damage will result.

f. Attach the insulated brush holders to the dc endbell using two bushings (33), flat washer (31) and screw (29). Note that brush holder mounting screw

must engage lead of capacitor unit (28). Refer to figure 4-9.

g. Attach the grounded brush holders to the dc endbell using a flat washer (32), and screw (30). Be sure that one jumper lead (fig. 4-9) is connected between the pair of grounded brush holders, and the other between the pair of insulated brush holders.

h. Connect lead assembly (25) to grounded brush holders with two screws (24).

CAUTION

Read paragraph 4-14 carefully before replacing bearings. Failure to observe the specifications, therein, may result in premature bearing failure. Bearings are critical items, use only the type specified for use on this inverter.

i. Push the internal bearing plate (65) into position on the dc end of the armature assembly (12). Apply a thin film of Loctite A (manufactured by Loctite Corporation, Newington, Conn., FSCM05972) to the bearings (63 and 64) into place on the armature shaft.

NOTE

Use minimum amount of Loctite to avoid getting any on the seal, or inside the bearing.

j. Work the ac endbell assembly (43) over the bearing (63). Slide the armature assembly, with bearings, and ac endbell attached, into the stator housing (18) from the ac end. Tap with a fiber mallet to seat firmly. Attach the load assembly (50) from the ac stator, using flat washer (49), lockwasher (48), and screw (47). Make sure that the lead assembly is in the notch in the stator housing.

k. Work the dc endbell assembly (23) into position over the hearing (CM) and onto the stator housing. Tap with a fiber mallet to seat firmly. Position the external bearing plate (16) over the armature shaft and align the external hearing plate screwholes with those of the internal hearing plate. Install four flat washers (16), lockwashers (15), and screw (14), as shown.

l. Insert four screws (19) through the dc endbell, stator housing, and ac endbell, and install four nuts (17). Do not tighten.

m. Be sure that outer and inner races of the bearing on the dc end are locked in place. Install the load spring and shim as follows. Refer to figure 4-10.

(1) Stand the inverter on the fan cover with the ac end upward.

(2) Check distance between spring and surface of endbell (A, fig. 4-10) with a dial indicator. Shim as necessary, so that A is between 0.015 and 0.033 inch.

NOTE

If 0.005-inch shims must be used, interleave them between 0.015-inch shims. Do not use more than two 0.005-inch shims, nor place them directly against either the bearing or the spring.

(3) Install bearing plates (39 and 40) and secure with two screws (37) and flat washers (38).

(4) Set the inverter back on its base and remove fan cover, pending further reassembly. Check to see that armature rotates freely.

n. Attach each of the short heavy brush leads from the dc stator (21) to the dc brush holders (22) with a screw (20).

o. Replace brushes as described in paragraph 3-8.

p. Assemble fan spacer (11), flat key (10), fan (9), *new* key washer (8) and a *new* locknut (7) on dc end of armature shaft. Tighten locknut to a torque of 150 to 180 inch-pounds. Bend one or more key washer tabs into locknut slots to lock the nut. Be sure that armature still rotates freely.

q. Install fan cover (3), securing with two washers (2) and screws (1).

r. Install ac endbell cover (6), securing with four flat washers (5) and screws (4).

s. Reset brush neutral as described in paragraph 4-20.

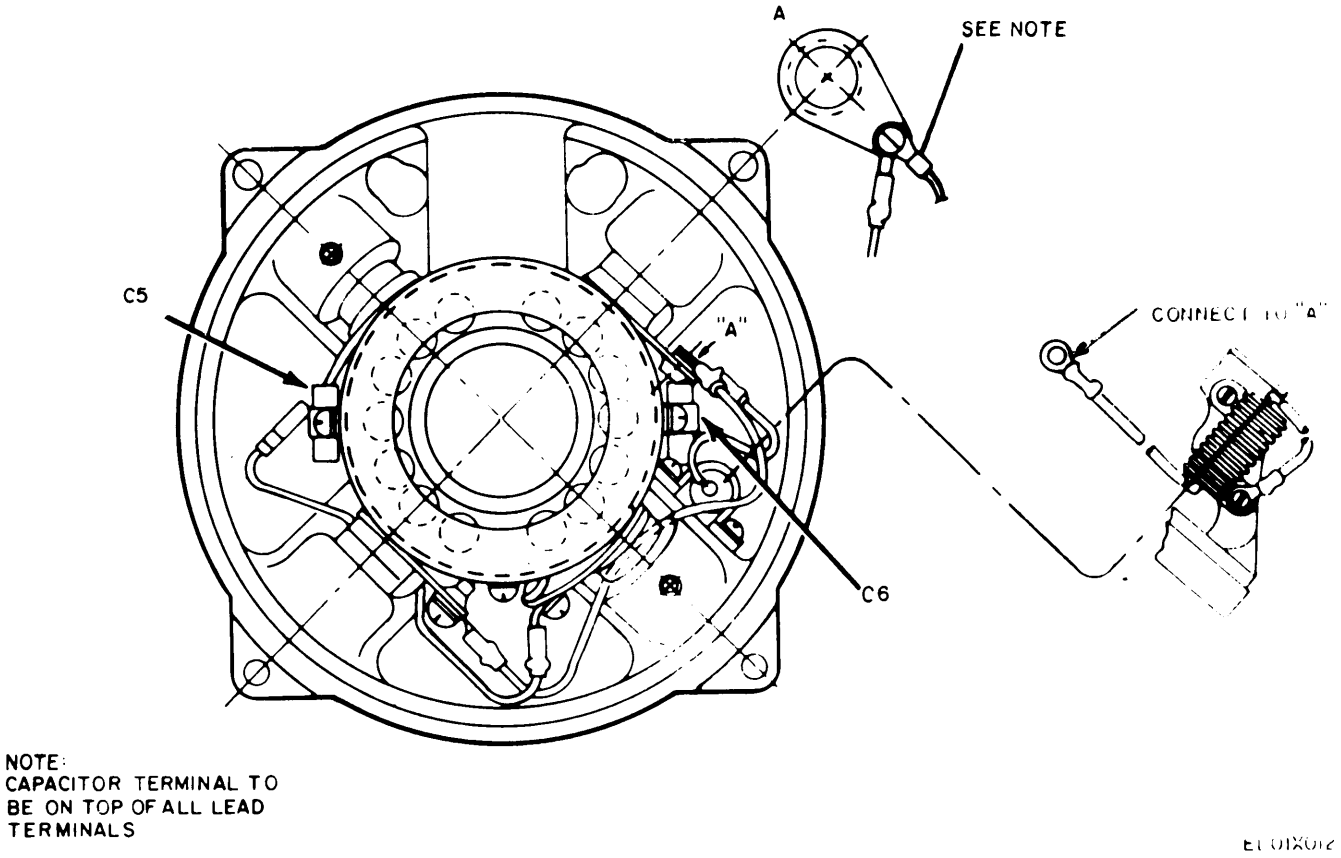


Figure 4-8. Ac Endbell Wiring.

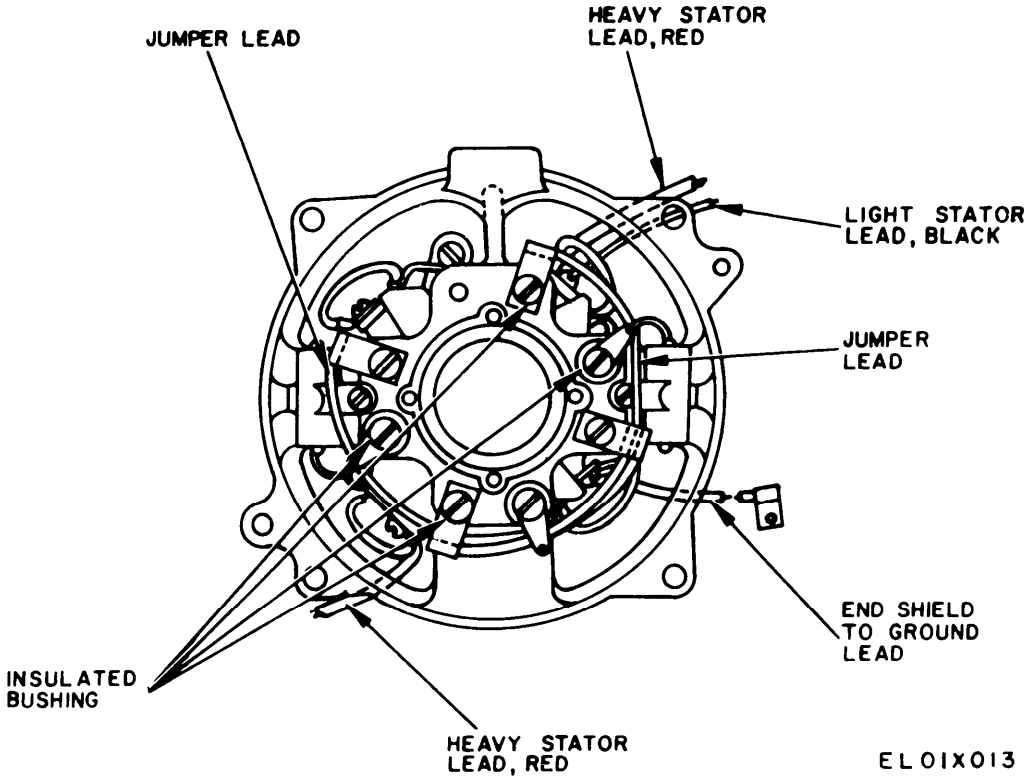


Figure 4-9. Dc Endbell Wiring.

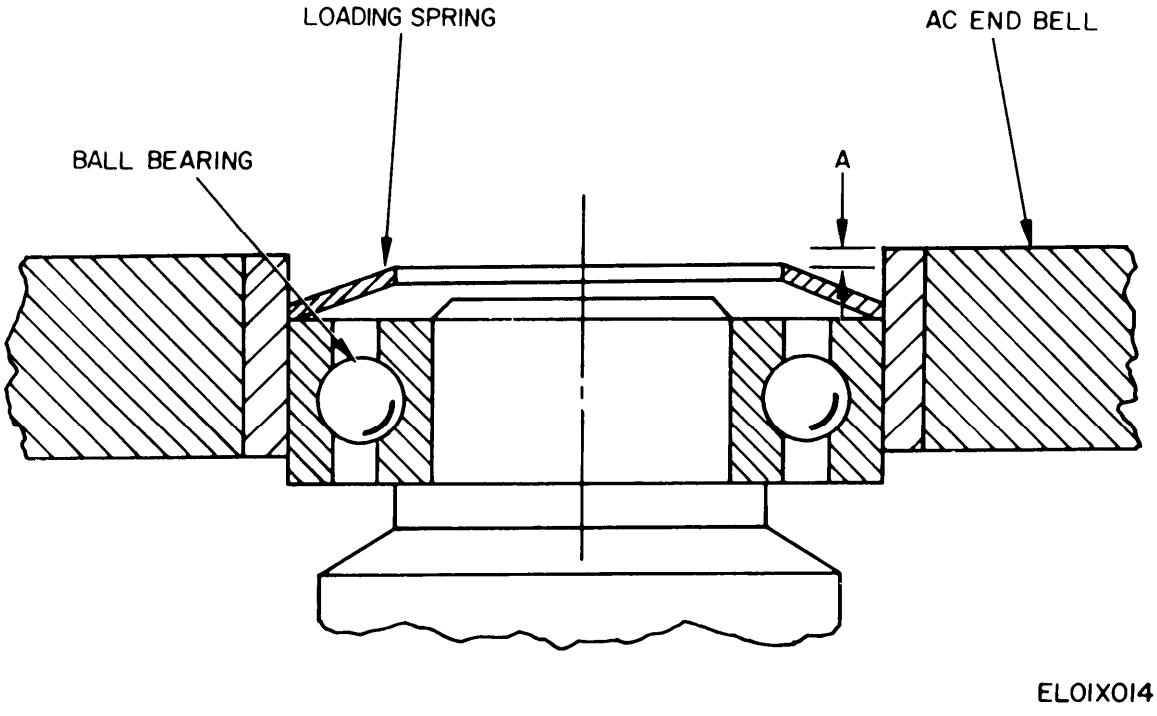


Figure 4-10. Load Spring Deflection

4-16. Reassembly of Regulator Housing

(fig. 4-6)

a. Insert the time totalizing meter (31) in the housing (32), and fasten in place with two screws (30), flat washers (29), lockwashers (28), and nuts (27).

NOTE

Time totalizing meter appears only in CSV2215-3 units with SN suffix D, or later.

b. Attach the angle bracket (26) inside the housing with a flat washer (25) and screw (24).

NOTE

If card assembly to be used is a 4B93-1-A or CSV1186-1, the voltage adjust variable resistor (36) must be installed during this step.

c. Position capacitor C2 in the housing and secure with a retaining clamp (21) and two screws (20).

d. Position the data plate (18) on the outside of the housing and assemble the two test point jacks (17), using the original hardware.

e. Place the capacitor (15) in the clip provided with the lug terminal end down.

f. Position terminal board assembly TB1 (12) on the end of the housing and secure at the outside with four screws (13) and four flat washers (14). Assemble the strap assembly (10) and angle bracket (11) in terminal board assembly TB1 over the studs; secure with the flat washers (8), lockwashers (7), and nuts (6). Be sure to engage lug terminal (16) of capacitor (15) with bolt (9) as shown.

g. Install the designation plate (5) and terminal board TB2 (2) inside the housing and secure with two screws (3) and flat washers (8). Connect the electrical leads (1) to the terminal board.

4-17. Reassembly of Regulator Card Assembly CSV2215-2 or CSV2215-3

a. Replace parts on the circuit card according to approved shop techniques, with the special provisions below (fig. 4-1 and 4-8).

CAUTION

Use a 50-watt (or less) soldering iron with a grounded tip, Current leakage through some soldering irons is sufficient to damage semiconductor and transistors.

(1) Assemble resistor, capacitors, semiconductors, transistors, and reactors as follows:

(a) For components with axial leads bend at right angles to fit into the assigned holes.

(b) Push the body of the component against the surface of the board.

(c) Using diagonal cutter pliers, bend leads down and snip off about 1/16 to 1/18 inch long. Lead must lie flush along the circuit track before soldering.

(2) Silicon transistors Q4 and Q8 are mounted to circuit card, using machine screws and hex nuts. Before mounting these components the leads must be bent at right angles, 0.72 inch from the center of the mounting hole. Exercise extreme care when bending these leads to avoid fracturing the case. Apply a light coating of Thermacote (manufactured by Thermally Co., Dallas, Texas, FSCM10103) to contact surfaces of parts just before assembling. Buildup of parts (40) through 48, fig. 4-1) must be as illustrated.

(3) Polarized capacitors C3, C4, C5, and C7 must be attached with the positive lead positioned as shown in figure 4-8.

(4) Semiconductor diodes CR1, CR2, CR3, CR5, CR6, CR7, CR8, and CR9 must be attached with the cathode lead positioned as shown in figure 4-8.

(5) Leads must follow the routing, termination, and color-coding shown in figure 4-1.

(6) Use solder conforming to Federal Specification QQ-S-571, SN63; use a heatsink in all soldering operations.

b. When all defective components have been replaced, repair protective coating as follows.

WARNING

Polyurethane is caustic and emits toxic fumes. Prolonged skin contact and breathing of fumes must be avoided. Provide forced ventilation when working in an enclosed area. Wear protective gloves, and throw them away after completion of this procedure.

NOTE

The coating used is polyurethane resin PC18 (manufactured by Hysol Div. of Dexter Corp., Olean, N. Y., FSCM 04347).

(1) Clean around components and new solder joints with isopropyl alcohol to remove dirt, film and solder flux. Use oil free compressed air to blow off excess, then remove all alcohol by heating the circuit assembly in a vented oven about 1/2 hour at 190° to 210° F. Allow circuit assembly to cool. The interval between cleaning and application must not exceed 4 hours.

(2) If reactor L1 required recoating, brush RTV732 or RTV893 (manufactured by Chemical Products Division of Dow Corning, Midland, Michigan, FSCM 71984) on the area around the adjusting screw Air dry 4 hours. Remove adjusting screw. Apply No. 122 mold release grease (manufactured by Emerson and Cuming, 50 Walpole, Canton, Mass., 02021, FSCM 04552) to the screw hole and to the adjusting screw. Replace screw. Apply Lecogel HR34C (manufactured by AMF Electrosystems Division, Vandalia, Ohio, FSCM 07639) to the area around the adjusting screw

CAUTION

Use metal, glass, or hard plastic container for polyurethane resin. Do not use paper.

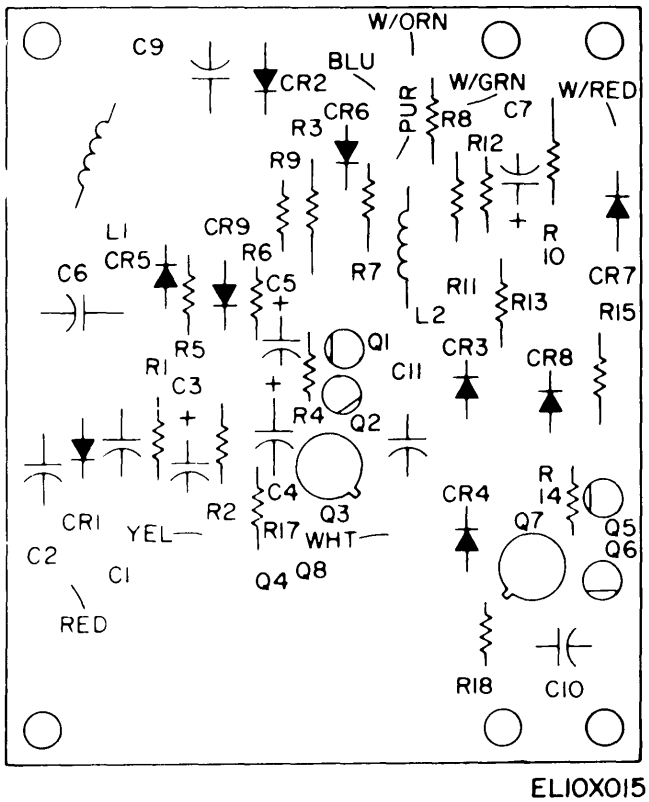


Figure 4-11. Component Location and Polarity, CSV2215-2 and CSV2215-3.

(3) If coating has been broken near one of the spacers, mask holes with Maskant No. 037 (Type 1) Clear Amber (manufactured by Seal-Peel Inc., *775* Stephenson Highway, Royal Oak, Michigan FSCM 91068). Wrap leads with aluminum foil and mask with No. 037 (Type 1).

(4) Stir resin thoroughly before using. Apply with a brush to both sides of the circuit assembly, working material over, around, and under the replaced part. Cure 4 hours in a circulating oven at 140° ± 5° F. Allow the circuit assembly to cool. Repeat coat and cure cycle an additional two times.

NOTE

Place a pan of water in the bottom of the oven to assure adequate humidity.

(5) Remove masking and any excess residue.

NOTE

If reactor L1 (1, fig. 4-1) has been replaced, remove the coating over the adjusting screw area until performance tests are completed. Recoat setscrew after frequency has been set.

c. Assemble circuit card to base (fig. 4-4) as follows:

(1) Position circuit card (16) onto base (6), with the heatsink end of the circuit card toward the open end of the base.

(2) Install two screws (15) through the heatsink end of the circuit card into the base assembly. Add flat washer **(14) and lockwasher (13). Apply Loctite to the screw threads and install nut (12). Tighten to 8-12 inch-pound torque.** If heatsink is scratched during assembly, touch up with Alodyne 1200 per MIL-C-5541.

(3) Insert two screws (15) through opposite end of the circuit card into the base assembly. Add flat washer (14), lockwasher (13), Loctite and nut (12). tighten to 8-12 inch-pound torque.

(4) Reattach red electrical lead (11) between circuit card and base, using screw (10), flat washer (9), lockwasher (8), and nut (7).

(5) Group remaining leads into loop clamp (5) and secure it with screw (4), two flat washers (3), lockwasher (2) and nut (l).

4-18. Reassembly of Regulator Card Assembly 4B93-1-A

(fig. 4-5 arid 4-12)

a. Procedure.

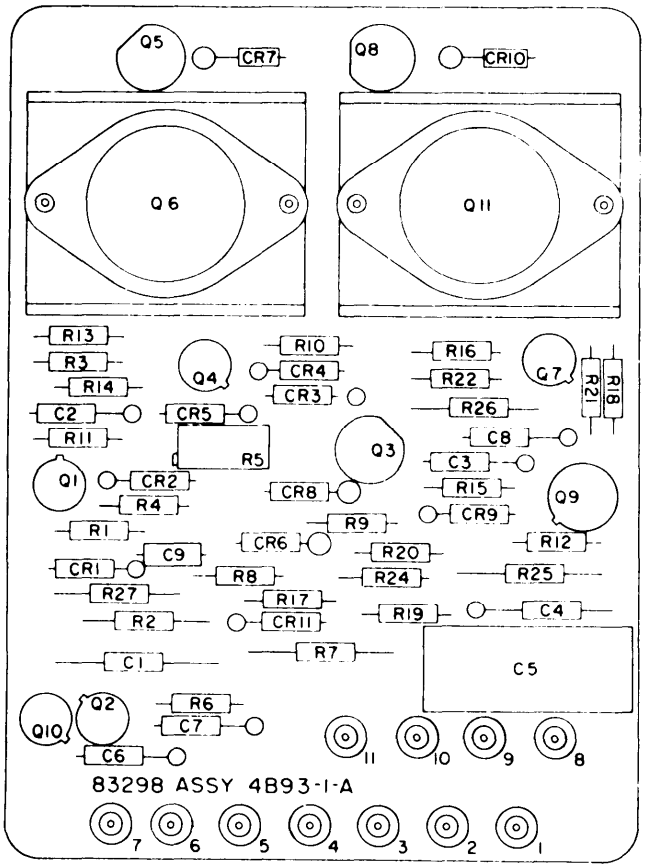
(1) All components on the printed wiring board are replaceable. Refer to figure 4-12, troubleshooting paragraphs 4-4,4-5, 4-6 and the following instructions for replacement of components.

NOTE

Use a pencil-type soldering iron 23 to 37.5 watts. Make certain that the soldering iron tip is clean and free of oxides. Coat tip with a film of solder.

(2) For all soldering operations use Kester (Kester Solder Co., Newark, N.J.) 60-40 or 63-37 solder, core size No. 66, with flux No. 44 or Ersin Multicore 60-40 solder No. 365 (manufactured by Multicore Sales Corp. Div. of BIC, Port Washington, N.Y.). This solder consists of 60 or 63 percent tin and 40 or 37 percent lead and has a melting temperature of 357° F (181° C) (no government equivalent specification is available). Use Kester Liquid Flux No. 1544. For cleaning flux from soldered connections, use Lonco Flux Remover HCR (clear) (manufactured by London Chemical Co., Melrose Park, Ill.) (no government equivalent specification is available).

(3) Tin leads by dipping in flux which has been diluted by adding one part ethylalcohol to three parts of flux, by volume, and apply 63-37 or 60-40 lead tin solder. Dip leads in undiluted flux and place part in a covered tray, so that flux will not be removed from leads, After flux has cured, store parts in a plastic bag until ready for installation.



REFERENCE DESIGNATION	NOMENCLATURE
C1	**Capacitor 0.047** uf, 100V
C2	capacitor 1.5 uf, 20V
C3	Capacitor 1 uf, 35V
C4	Capacitor 10 uf, 20V
C5	Capacitor 0.22 uf, 400V
C6	Capacitor 1 uf, 35V
C7	capacitor 4.7 uf, 10V
C8	Capacitor 0.22 uf, 35V
C9	Capacitor 0.01 uf, 200V
CR1	Semiconductor 819782-22 (mfd by 83288)
CR2	Semiconductor 1543026-2 (mfd by 83298)
CR3	Semiconductor 819782-22 (mfd by 83298)
CR4	Semiconductor 819782-22 (mfd by 83298)
CR5	Semiconductor 1543026-2 (mfd by 83298)
CR6	Semiconductor 1549913-2 (mfd by 83298)
CR7	Semiconductor 1549913-2 (mfd by 83298)
CR8	Semiconductor 1549913-2 (mfd by 83298)
CR9	Semiconductor 819782-22 (mfd by 83298)
CR10	Semiconductor 1549813-2 (mfd by 83298)
CR11	Semiconductor 819782-26 (mfd by 83298)
Q1	Transistor 2N3251
Q2	Transistor 2N3251
Q3	Transistor 1544412 (mfd by 83288)
Q4	Transistor 2N2907A
Q5	Transistor 1544542 (mfd by 63298)
Q6	Transistor 2N3772
Q7	Transistor 2N2907A
Q8	Transistor 1544542 (mfd by 83298)
Q9	Transistor 1545643-3 (mfd by 83288)
Q10	Transistor 2N3251
Q11	Transistor 2N3772
R1	Resistor 10 K ohm 1/8 W
R2	Resistor 37.4 K ohm 1/4 W
R3	Resistor 10 K ohm 1/8 W
R4	Resistor 24.9 K ohm 1/8 W
R5	Resistor 10 K ohm 1 W
R6	Resistor 1 K ohm 1/8 W
R7	Resistor 499 ohm 1/2 W
R8	Resistor 1 K ohm 1/8 W
R9	Resistor 10 K ohm 1/8 W
R10	Resistor 100 ohm 1/8 W
R11	Resistor 12.1 K ohm 1/8 W
R12	Resistor 15 K ohm 1/8 W
R13	Resistor 2 K ohm 1/8 W
R14	Resistor 2490 ohm 1/8 W
R15	Resistor 750 ohm 1/8 W
R16	Resistor 2 K ohm 1/8 W
R17	Resistor 6810 ohm 1/8 W
R18	Resistor 10 K ohm 1/8 W
R19	Resistor 26.1 K ohm 1/8 W
R20	Resistor 49.9 K ohm 1/8 W
R21	Resistor 4880 ohm 1/8 W
R22	Resistor 3010 ohm 1/8 W
R24	Resistor 3010 ohm 1/8 W
R25	Resistor 69.8 K ohm 1/8 W
R26	Resistor 2 K ohm 1/4 W
R27	Resistor 37.4 K ohm 1/4 W

ELOIX020

Figure 4-12. Component Location and Polarity, 4B93-1-A.

CAUTION

Do not touch leads with fingers or allow leads to become contaminated.

(4) Cut and form components leads (B, fig. 4-13) to the dimensions shown in chart below. After inserting lead wires through printed circuit board, cut wires, if necessary, and bend as shown in A, figure 4-13. Draw part firmly against circuit board and form wires for

maximum contact under circuit board. When soldering, make certain to completely cover wire lead with solder and with contour of lead visible.

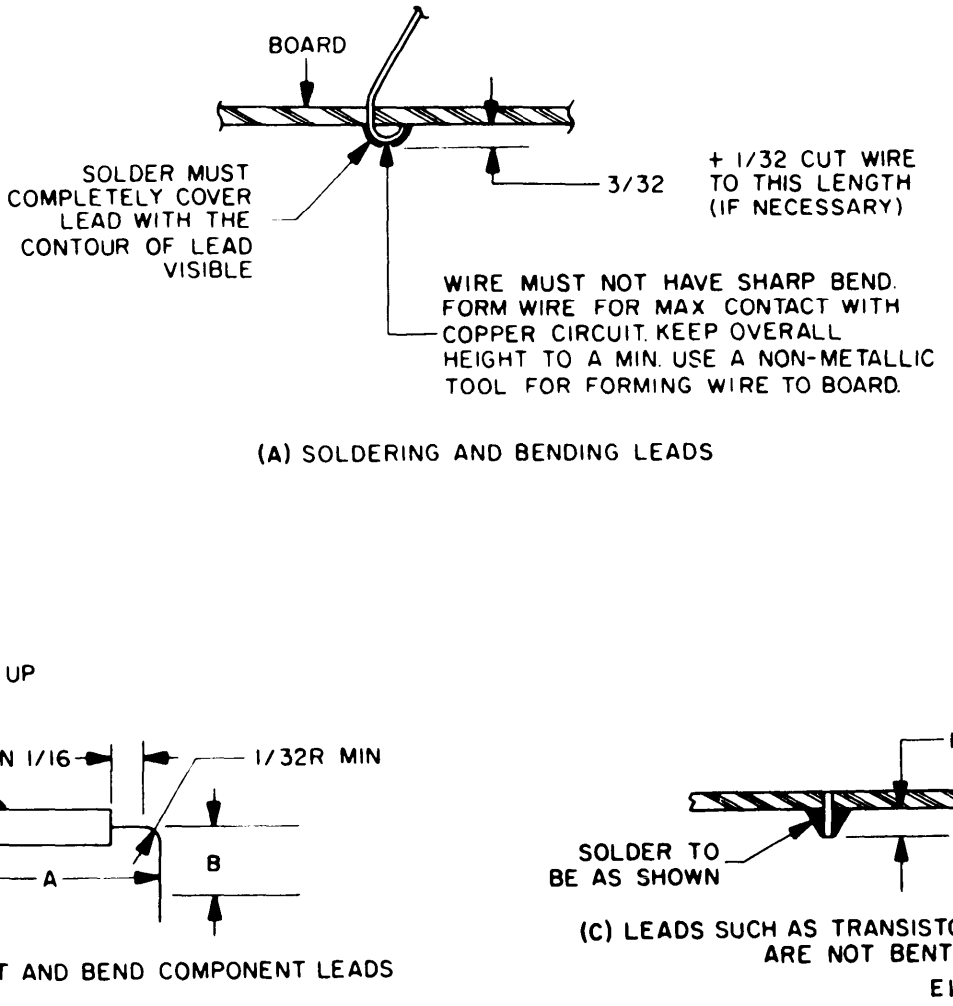


Figure 4-13. Forming Component Leads

Reference designation	Lead dimensions (B, fig. 4-13)	
	Dimension A	Dimension B
C1	1.0	0.343
C2	0.6	0.250
C3	0.6	0.250
C4	0.8	0.281
C6	0.6	0.250
C7	0.6	0.250
C8	0.6	0.250
CR1	0.5	0.250
CR2	0.5	0.234
C3	0.5	0.250
CR4	0.5	0.250
CR5	0.5	0.234
CR6	0.5	0.312
CR7	0.5	0.312
CR8	0.5	0.312
CR9	0.5	0.250
CR10	0.5	0.912
CR11	0.5	0250
R1	0.6	0.250
R2	0.8	0.265
R3	0.6	0.250
R4	0.6	0.250

Reference designation	Lead dimensions (B, fig. 4-13)	
	Dimension A	Dimension B
R6	0.6	0.250
R7	0.9	0.296
R8 thru R22	0.6	0.250
R24	0.6	0.250
R25	0.9	0.296
R26	0.8	0.265
R27	0.8	0.265

CAUTION

Place soldering iron in contact with lead wire or circuit board track. Solder must be melted by heat received from lead wire or circuit board track, not by direct contact with soldering iron. Do not overheat printed circuit board.

(5) Cut rigid vertical leads of parts, if necessary, under circuit board to 1/16 ± 1/32 inch, as shown in C, figure 4-13.

CAUTION

When removing or installing soldered leads of resistors, capacitors, transistors, and semiconductor devices, a vacuum soldering method must be used to prevent solder from entering part.

(6) Polarized capacitors C2 (fig. 4-2 and 4-12), C3 (16), C4 (23), C6 (16), C7 (30) and C8 (15) must be assembled to the printed wiring board (44) with the positive (+) lead of the capacitor located as shown in figure 4-12.

(7) All semiconductor diodes CR1, CR3, CR4, CR9 (fig. 4-2), CR2, CR5 (37), CR6, CR7, CR8, CR10 (7), and CR11 (28) must be assembled to the printed wiring board with the cathode lead located as shown in figure 4-2. The cathode (banded end) is identified in figure 4-12.

(8) After soldering, clean joints thoroughly with Lonco Flux Remover (HCR) within 4 hours after soldering operation.

(9) Install transistors Q6, Q11 (fig. 4-2) and transistor heatsinks (5) to printed wiring board (44) and secure with screws *(2),* flat washers (3) and nut and lockwashers (4). Tighten nut and lockwashers (4) to a torque of 5 to 6 pound-inches.

(10) After assembling all components to the printed wiring board, apply conformal coating of polyurethane EN-4 as described in *b* below. Apply coating to both sides with the exception of those areas surrounding the mounting holes.

b. Protective Polyurethane Coating of Voltage and Frequency Regulator 4B93-1-A.

(1) Clean the component mounting area of the printed circuit board with denatured alcohol to be sure of satisfactory adhesion of the coating to the board.

(2) Clean the component soldered joints of the printed circuit board with Lonco Flux Remove HCR (clear), London Chemical Co., Melrose Park, Ill., or equivalent.

CAUTION

Restrict application of the flux remover only to areas necessary to remove flux, because this cleaning agent deteriorates the polyurethane coating.

(3) Thoroughly mix polyurethane EN-4 Part A (straw) and Part B (amber) with a metal mixing paddle (100 parts A-17.5 parts B by weight). Dilute with a 50/50 blend of methyl ketone and toluene.

(4) Brush a thin coating on the component and cure for 8 hours at 82° C (180° F).

4-19. Replacement of Regulator Section

(fig. 4-3)

a. Work the leads from the generator section (55) up through the holes in the regulator housing (54) as shown in figure 4-14. Be sure ventilation duct (56) is in place.

b. Secure the regulator housing with four screws (52 and 53). Attach bracket (51), using two screws (49), two screws (48), and four flat washers (50).

c. Replace radio interference filter FL1 (42), and secure to housing with three screws (43) and flat washers (44); secure to front of regulator housing with four screws (45), lockwashers (46), and flat washers (47). Connect the A, B, C, D, and F leads from the generator section to their respective terminals on the back of the filter FL1. Also reconnect loose electrical lead to terminal A.

d. Replace terminal board TB3 (41) and secure with four screws (39) and flat washers (40). Replace terminal links (18 and 19) in position shown in figure 4-14.

e. Replace shouldered stud (29), using lockwasher (30), and flat washer (31). Slip insulated sleeving (28) over stud, and wrap the long lead of capacitor C2 (22, fig. 4-4) over the sleeving from bottom to top. (This forms choke L10.) Attach the leads to the terminals of TB1 (12, fig. 4-6) using two bolts (23) four flat washers (22), one above and one below on each bolt, two lockwashers (21) and two nuts (20). Be sure to engage lug terminal of capacitor Cl (15, fig. 4-6).

f. Refer to paragraph 3-9 for a review of regulator card assembly replacement, and then position circuit card assembly (38) in regulator housing and secure with four bolts (36), and flat washers (37). Reattach

leads to proper terminals on terminal board TB2.

g. Gather leads from regulator card assembly into loop clamp (35) and secure to end of terminal board TB2 with screw (32), lockwasher (33), and flat washer (34).

h. Complete reattachment of wiring, as follows.

NOTE

There are no markings on terminal board TB3. Numbers below refer to figure 4-14.

(1) Secure to terminal 1 of TB3 with one nut (11), Iockwasher (12) and flat washers (13).

(a) Loose lead from terminal A at rear of radio interference filter FL1.

(b) Lead from test point J2.

(c) Loose lead from terminal 4 of TB2.

(2) Secure to terminal 2 of TB3 with one nut (11), lockwasher (12), and flat washer (13), light lead B2 from shunt coil L5.

(3) Secure to terminal 4 of TB3 with one nut (8), lockwasher (9), and flat washer (10), heavy lead. From dc series coils L3 and L4 (from hole on right side of TB3).

(4) Secure to terminal 3 of TB3 with one nut (8), lockwasher (9), and flat washer (10):

(a) Heavy lead from dc series coils L1 and L2 (from hole on left side of TB3).

(b) People lead from circuit card assembly.

(c) Short lead of capacitor C2 (22, fig. 4-6)

(5) Secure to top of shouldered stud (29) with nut (24), lockwasher (25) and flat washer (26):

(a) Electrical lead (27).

(b) GR lead from generator section.

(c) Lead from test point J1.

(6) Secure light lead (fig. 4-14) from shunt coil L5 to terminal 1 of TB2.

(7) Secure generator lead 6 to terminal 6 of TB2.

i. Replace cover (6) of terminal board TB1 with two screws (4) and lockwashers (5). Replace as plug cover (7).

j. Replace regulator access cover (2) and secure with fastener studs (l).

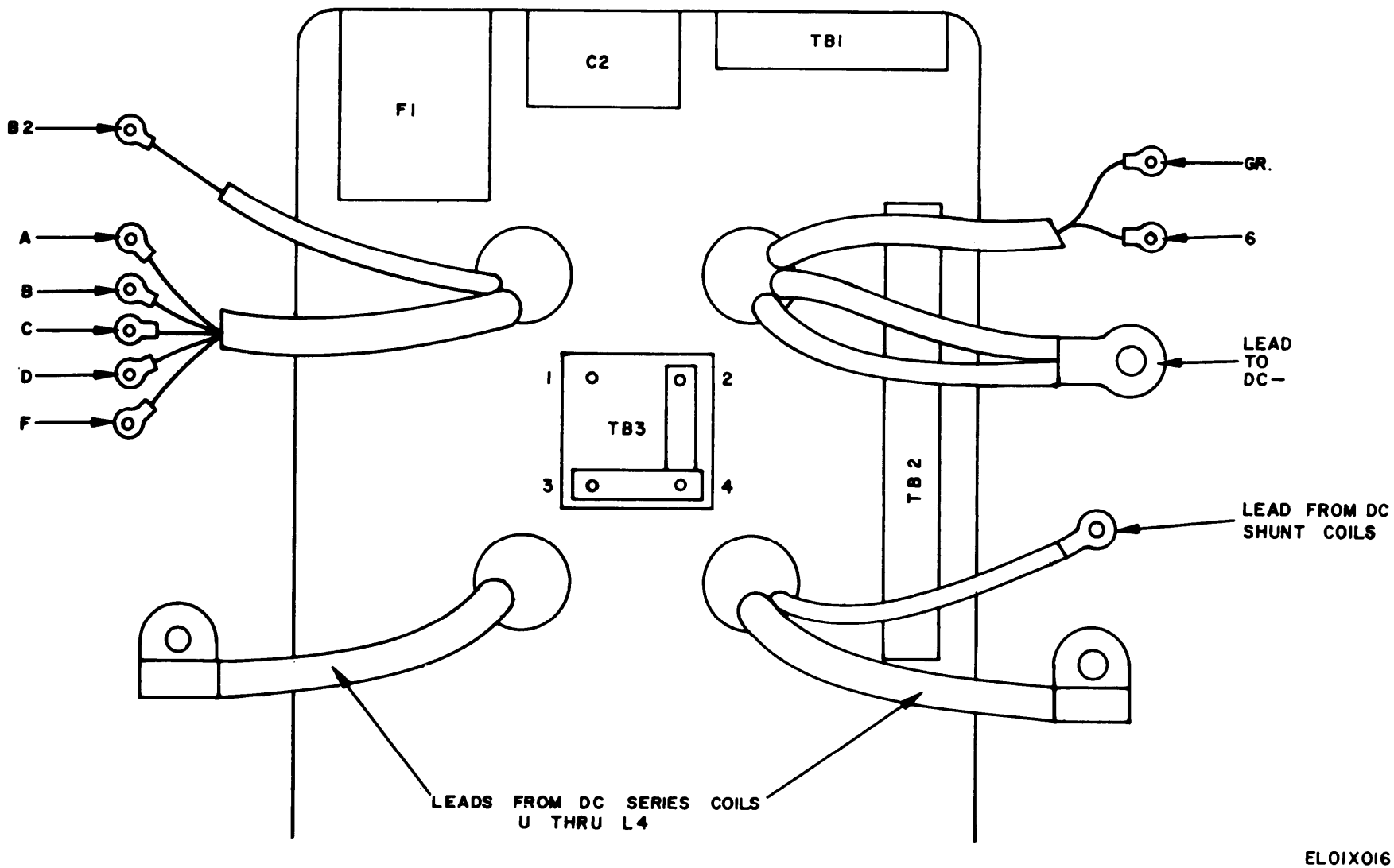


Figure 4-14. Position of Leads in Regulator Section Replacement

4-20. Setting Brush Neutral

Any time the dc endbell is separated from the stator housing, the dc brush neutral position must be reset. Proceed as follows:

a. Loosen the through-bolts that secure the endbells to the stator housing just enough to allow some play in he dc endbell.

b. Be sure that all toggle switches on the motor-generator test set are in the OFF position, and connect equipment as shown in figure 3-3.

c. Adjust power supply to 28 vdc.

d. Zero all test set meters, if necessary.

e. Set the test controls as follows:

(1) DC AMMETER RANGE to START.
(2) AC AMMETER RANGE to 50.
(3) LOAD CONTROL to 0.
(4) DC POWER to ON.
(5) LIVE CIRCUITS switch to ON.

f. After a 10-minute warmup period, rotate dc endbell while observing indication on de AMPS meter of test set. A minimum deflection indicates correct position.

g. Secure the dc endbell by tightening the through-bolts. Check to see that meter deflection is still at minimum.

h. Shut off power, and disconnect equipment.

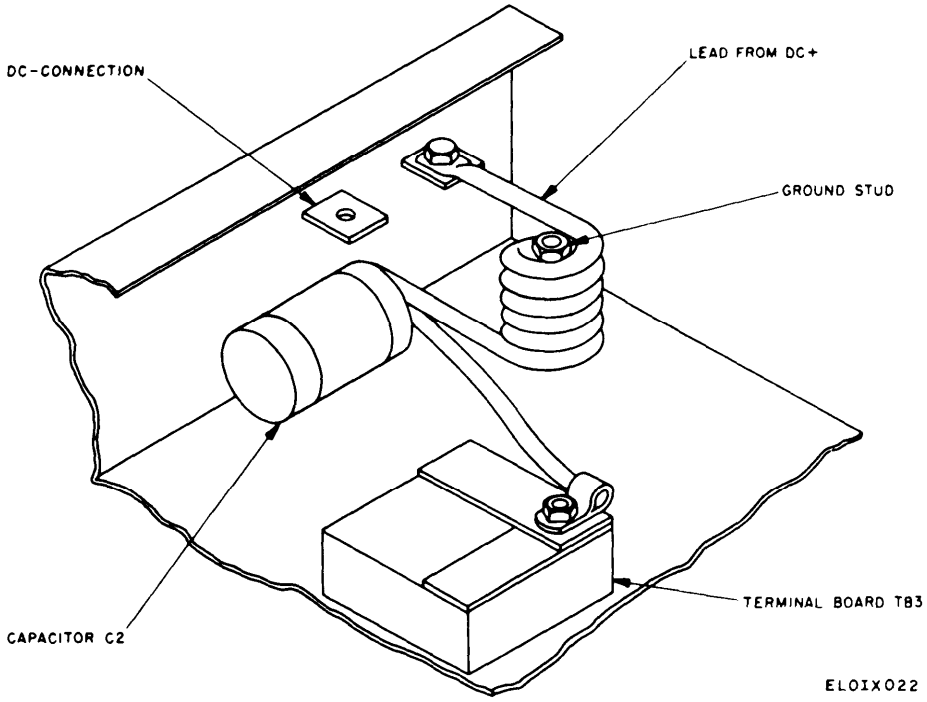


Figure 4-15. Choke Coil Construction.

Section IV. GENERAL SUPPORT TESTING PROCEDURES

4-21. General

The direct support testing procedures outlined in tables 3-2 and 3-3 are also applicable at general support. Inverters which meet the performance standards specified in these tables may be considered acceptable for return to service.

4-22. Modification Work Orders (MWO's)

At the time of this publication, there were no MWO's pertaining to this equipment. However, inverters, as they are received, are being modified at depot level to accept the 4B93-1-A regulator. These units can be identified by the letter "M" stamped on the data plate. For a listing of recent MWO's, refer to DA Pam 310-7.

APPENDIX A
REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7,8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
SB 11-573	Painting and Preservation Supplies Available for Field Use for Electronics Command Equipment.
TB 43-0118	Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TB 385-4	Safety Precautions for Maintenance of Electrical/Electronic Equipment.
TM 11-6125-240-12	Operator's and Organizational Maintenance Manual: Motor-Generator PU-545/A.
TM 11-6625-203-12	Operator and Organizational Maintenance: Multimeter AN/URM-105 and AN/URM-105C Including Multimeter ME-77/U and ME-77C/U.
TM 11-6625-680-15	Organizational, Direct Support, General Support and Depot Maintenance Manual, Test Set Motor-Generator AN/GSM-65.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

INDEX

INDEX (Continued)

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TM 11-5840-340-12	23 Jan 74	Radar Set AN/MPQ-76

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PAGE NO.	PARAGRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
2-25	2-28			Recommend that the installation antenna alignment procedure be changed throughout to specify a 2° IFF antenna lag rather than 1°. REASON: Experience has shown that with only a 1° lag, the antenna servo system is too sensitive to wind gusting in excess of 25 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2° without degradation of operation.
3-10	3-3		3-1	Item 5, Function column. Change "2 db" to "3db." REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.
5-6	5-8			Add new step f.1 to read, "Replace cover plate removed in step e.1, above." REASON: To replace the cover plate.
		F03		Zone C 3. On J1-2, change "+24 VDC to "+5 VDC." REASON: This is the output line of the 5 VDC power supply. + 24 VDC is the input voltage.

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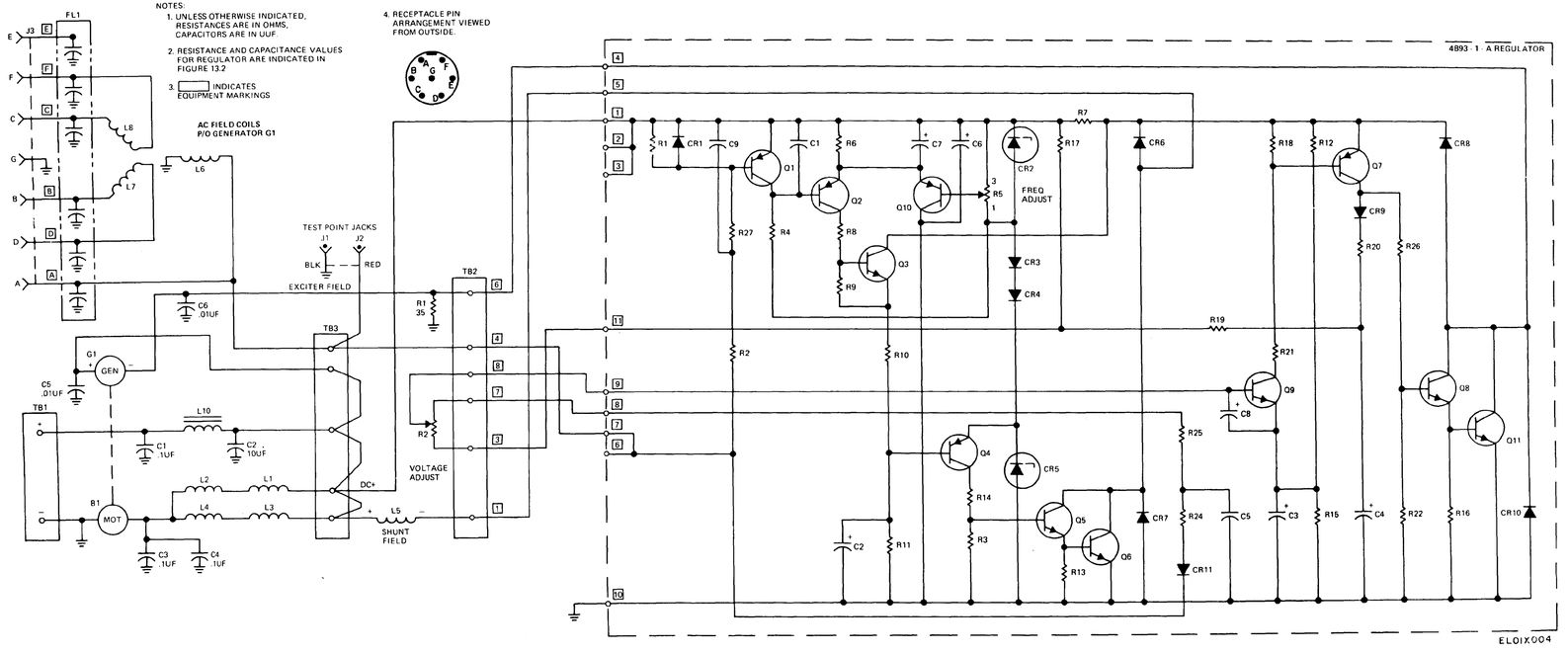

Figure FO-1. Motor-Generator PU-545/A with 4B93-1-A Regulator, Schematic Diagram

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