TM 11-6130-413-40

TECHNICAL MANUAL

GENERAL SUPPORT
MAINTENANCE MANUAL

BATTERY CHARGER-ANALYZER AN/USM-432
(NSN 6130-01-055-1574)

HEADQUARTERS, DEPARTMENT OF THE ARMY
1 DECEMBER 1980

Battery Charger-Analyzer AN/USM-432 is HEAVY. Use two-man lift whenever unpacking or moving the unit.

WARNING

High voltage is used in this equipment. DEATH ON CONTACT may result if safety precautions are not observed. Be careful not to come in contact with high voltage connections or any power connections when repairing or adjusting this equipment. Turn off the power and discharge all capacitors before making any connections or doing any work inside the equipment.

DO NOT TAKE CHANCES

Battery Charger-Analyzer AN/USM-432 should be used only with a properly grounded ac power source.

CAUTION

ACID CONTAMINATES NICKEL-CADMIUM BATTERIES

Every effort must be made to keep nickel-cadmium batteries as far away as possible from lead-acid batteries because lead-acid batteries contain sulphuric acid. Do not use the same tools and materials, such as screwdrivers, wrenches, syringes, hydrometers, and gloves for both types of batteries. Any trace of acid or acid fumes will permanently damage nickel-cadmium batteries on contact.

WARNING

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided, The solvent should not be used near heat or open flame; the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided, When necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.

WARNING

COMPRESSED AIR

Compressed air is dangerous and can cause serious bodily harm. It can also cause mechanical damage to the equipment. Do not use compressed air to dry parts where cleaning compound has been used.

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WASHINGTON, DC, *1 December 1980*

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REPORTING OF ERRORS AND RECOMMENDED IMPROVEMENTS

You can improve this manual by recommending improvement using DA Form 2028-2 (Test) located in the back of this manual. Simply tear out the self-addressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

If there are no blank DA Forms 2028-2 (Test) in the back of your manual, use the standard DA Forms 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Communications and Electronic 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

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope.

This manual provides General Support (GS) maintenance instructions for Battery Charger-Analyzer AN/USM-432.

1-2. Maintenance Forms and Records.

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750.

1-3. Destruction of Army Materiel to Prevent Enemy Use.

Refer to TM 750-244-2, Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

1-4. Administrative Storage.

Administrative storage of equipment issued to and used by Army activities shall be in accordance with TM 740-90-1.

Section II. DESCRIPTION AND DATA

1-5. Description.

Refer to Technical Manual, Operator's and Organizational Maintenance, Battery Charger/Analyzer AN/USM-432, TM 11-6130-413-12 for general description and illustration of the equipment.

1-6. Tabulated Data.

Tabulated data for the equipment is provided in TM 11-6130-413-12.

CHAPTER 2

FUNCTIONING OF EQUIPMENT

2-1. General.

This chapter describes the functioning of Battery Charger-Analyzer AN/USM-432.

2-2. Functional Description

(fig. 2-1)

Figure 2-1 is a functional block diagram of the charg er-analyzer, showing input and output power and battery connections, general circuit board logic and related switching. Figure 2-2 is a simplified logic diagram showing the timing and control functions, Figure FO-1 is a schematic diagram of the charger-analyzer. Basic functions, charge, discharge, timing and control, are as follows:

a. Battery Charge. As shown in figure 2-1, the battery charger circuits include power transformer T1 and power switching and output voltage control SCR's, Q7 and Q8. This is a pulse-type charger with both SCR's connected in a full-wave circuit with zero-crossover gating. Current pulses from the shunt, R17, are integrated and compared with the average rate set by the front panel CHARGE AMP HR control. When pukes equal or exceed the average charging rate desired, the SCR gates are held off until the next period begins. There are 120 counts in each cycle and each gate is ½ of a 60 Hz period (120/120=1 second per period). During this initial step of charging, the battery is below the critical voltage and it can accept very high charging currents without heating appreciably. This characteristic is useful because the critical voltage is reached earlier in the cycle as a battery ages. Once the critical voltage is reached, the charging rate is reduced to about one fifth of the initial rate, and it might require completion of only about 15% of the charge with fresh cells; or 25% or more of the charge with older cells to reach critical voltage. For this reason batteries are charged at a rate well above the “straight line” one hour rate until the critical voltage is detected, then dropped to the lower rate for the remaining time.

b. Battery Dischurge. Battery discharge is accomplished at a constant current rate by power transistors Q3 through Q6 in a control loop with the current-sensing shunt. Fixed high-wattage power resistors are switched in parallel with the pass transistors Q3-Q6 to accomplish the higher discharge ratings. Two power transistors, Q1 and Q2, in series with the discharge circuit, provide isolation during charge pulses; during the charge cycle, these transistors are biased off to protect the discharge circuit.

c. Timing and Control. Three synchronous timers are included: two are used for the two charge functions; and one timer is used for discharge. Each timer is basically an electric clock with cam-operated switches. Operation of the switches occurs at 60 minutes for the charge timer, and at 60 and 120 minutes for the discharge timer (2 switches). Because the charger/ analyzer can operate on either 50 Hz or 60 Hz, a reversible panel overlay is used for timer control markings. One side of the panel is graduated for unit operation on 50 Hz supply, the other side is graduated for operation on 60 Hz supply. (Panel is factory-installed with 60 Hz graduations exposed.) To operate the timers, the operator sets the knob to the position marked START. The timer remains at this position until the logic starts the timer, which then runs until it reaches the 60 minute mark (CHARGE) and trips the switch. The discharge timer, in AUTO, runs until End of Discharge (EOD) takes place, or for 120 minutes. In manual, the discharge timer runs for 120 minutes. Control circuits and include the current amplifier, the integrator and charge comparator, the voltage comparator, and the sequence logic as well as the power op-amp that drives the discharge transistor.

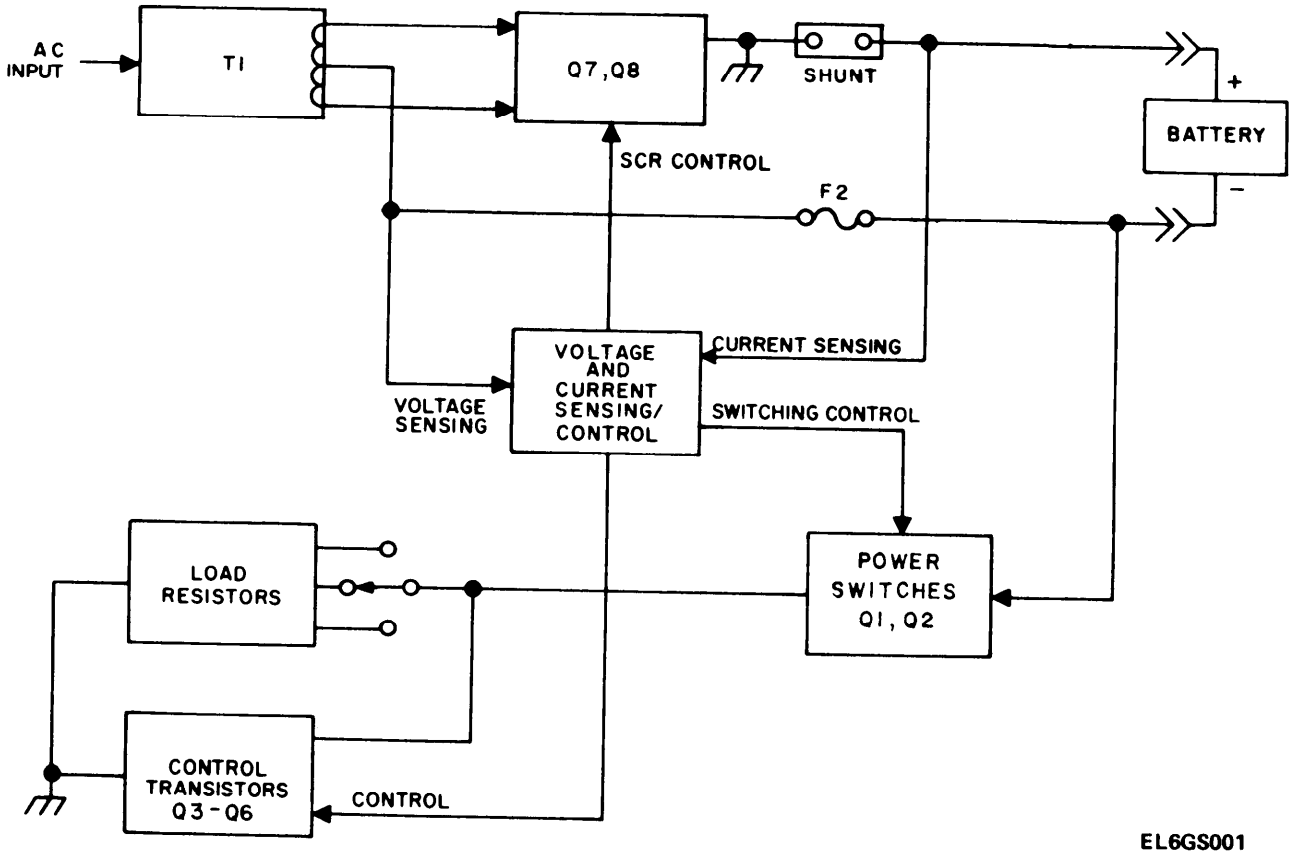

Figure 2-1. *Charger-Analyzer, Functional Block Diagram.*

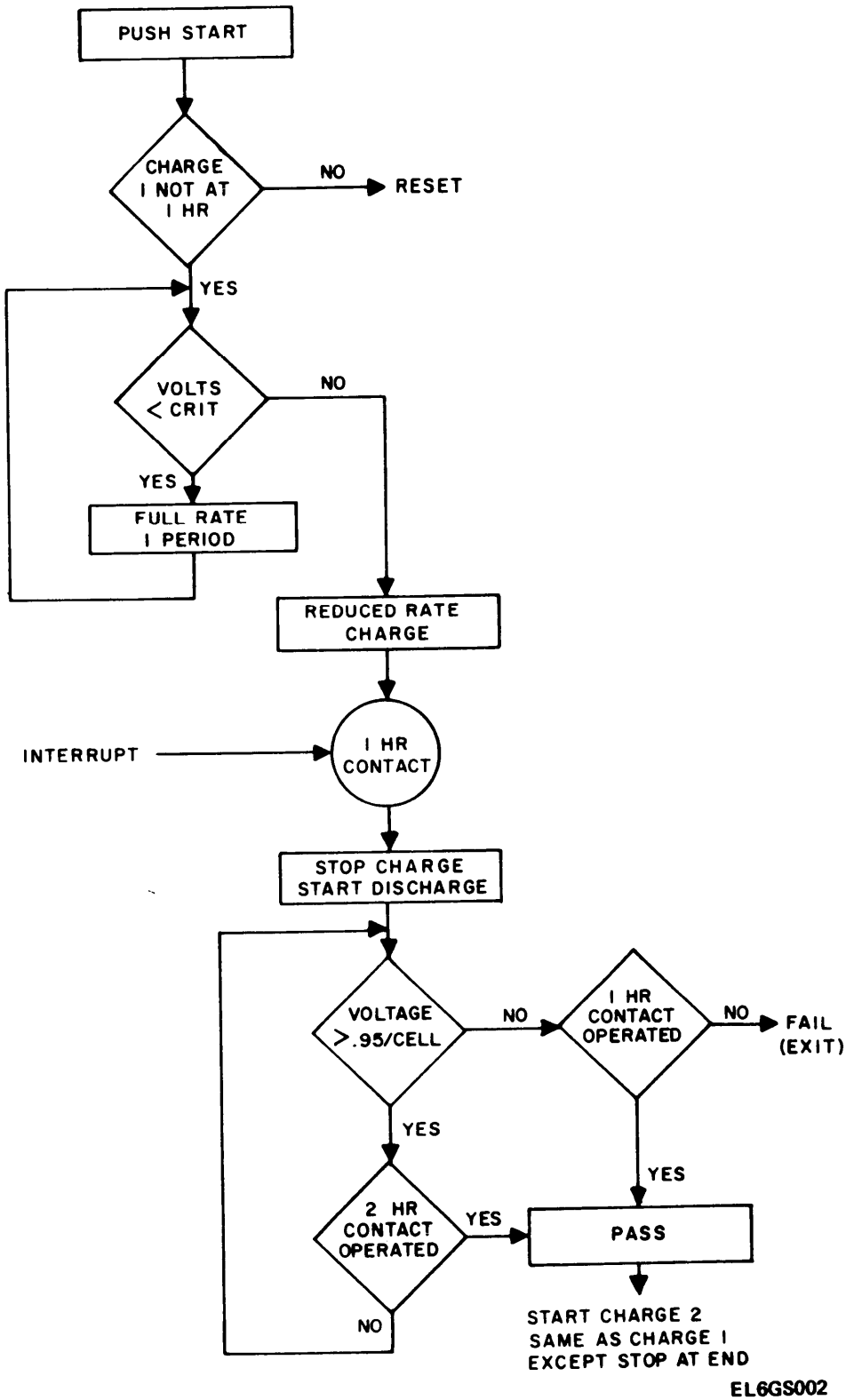

Figure 2-2. Timing and Control Functions, Logic Diagram.

CHAPTER 3

GENERAL SUPPORT MAINTENANCE

WARNING

When servicing equipment, be extremely careful to avoid contact with ac power line voltage terminals. Serious injury or death may result from contact with supply voltages (208-230 volts ac) present at these points.

Section I. GENERAL

3-1. Scope of GS Maintenance

a. All maintenance procedures for the equipment covered within this manual are within the scope of general support maintenance and are covered in this chapter. Maintenance duties assigned to general support are listed below, together with references to paragraphs covering specific maintenance functions. No tools or materials other than those listed in paragraph 3-2 are required.

(1) Performance test (paras 3-4, 3-5).
(2) Physical tests and inspections (para *3-3b).*
(3) Troubleshooting (paras 3-6 through 3-8).
(4) Replacement of component (paras 3-9 through 3-12).
(5) Equipment adjustments (para 3-13).

b. Testing procedures are prepared for use by general support personnel responsible for maintenance of electronic equipment to determine the acceptability of repaired equipment. These procedures set forth the specific requirements that repaired equipment must meet before it is returned to the using organization.

c. Comply with the instructions for each check, performing each check in sequence to insure desired test results. Do not vary the sequence.

3-2. Test Equipment, Tools, and Materials Required

All test equipment, tools and materials required to perform the testing procedures for general support are listed below:

a. Test Equipment.

Test Equipment	Technical Manual	National Stock Number	Common Name
Multimeter AN/USM-223	TM 11-6625-654-14	6625-00-999-7465	Multimeter
Multimeter, TS-352B/U	TM 1l-6625-366-15		Multimeter
Oscilloscope, AN/USM-281	TM 11-6625-1703-15	6625-00-228-2201	**Oscilloscope**
Test Set, Capacitor, ZM-3/U		6625-00-299-1060	**Capacitor Test** Set
Transformer, Variable, TF-171A	None		Variac
or			
Transformer, Variable Power, CN-16B/U			Variac
Stopwatch/Timer		6645-00-903-1696	Timer

b. Tools and Materials.

Tools and Materials	Technical Manual	National Stink Number	Common Name
Tool Kit, Electronic Equipment TK-105/G	SC 5180-91-CL-R07	5180-00-610-8177	Tool Kit
Teat Leads			Teat Leads
Thermometer			Thermometer

Section II. TROUBLESHOOTING

3-3. Maintenance Procedures

a. General. The first step in servicing is to observe the operation of the equipment and note what operations can and cannot be accomplished. This will help to localize the trouble to a particular component or group of components. The second step is to isolate the fault, which means tracing the fault to a defective part responsible for the abnormal operation. Some faults, such as broken circuit board wiring, or wires that connect between controls, switches, or cable assemblies can often be located by sight. The majority of the faults, however, must be isolated by continuity checks and component substitution.

b. Visual Inspection. The purpose of visual inspection is to locate faults without testing or measuring circuits. All visual signs should be observed and an attempt made to localize the fault to a particular area or isolate it to a particular component. Visual inspection of the equipment often points out areas of trouble. If any of the conditions listed below appear, effort should be directed to make the necessary repairs. The following are some suggested general items:

(1) Check that all internal wiring connections are properly secured and insulated.

(2) Check that all grounding connections are properly and securely made.

(3) Inspect connectors, receptacles, jacks, and plugs for broken, worn, or warped contact surfaces.

(4) Check for proper termination of all external cables.

(5) Inspect all parts for evidence of overheating caused by short circuits or leakage paths. Discoloration and sometimes accompanying odors of burning components and wiring insulation indicate excessive heat has been generated. Damage from overheating is usually a symptom of less obvious trouble; and unless the cause is determined before parts are replaced, the damage may be repeated.

c. Testing Procedures. After any repair of the equipment always test it for satisfactory performance before returning the equipment to the user or placing it in repair stock. Refer to paragraphs 3-4 and 3-5 for operational checkout and testing procedures, respectively, Note that these procedures are also useful for checking equipment performance prior to troubleshooting as an aid to general location.

CAUTION

Portions of this equipment are transistorized; make voltage measurements only as specified in the voltage and resistance chart (para 3-8).

d. Checking Voltages and Resistances. When measuring voltages, use tape or sleeving to insulate the entire test prod, except for the extreme tip. A momentary short circuit can damage a transistor. (For example, if the bias resistor of a transistor is shorted out, excessive current between the emitter and the base could damage the transistor.)

e. Troubleshooting Procedures. The troubleshooting procedures (para 3-6) are based on symptoms of trouble and recommended procedures that will aid in localizing and finally isolating the trouble. Maintenance of the equipment is limited to replacement of assemblies and components based on observation of abnormal operating conditions, or inability of the unit to comply with the performance standards.

f. Intermittent Troubles. In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble maybe made to reappear by tapping or jarring the equipment. Check the internal wiring and connections for looseness.

g. Use of Multimeter. The multimeter can be used for simple electrical measurements. When using the ohmmeter portion of the multimeter (or any ohmmeter), disconnect power and observe the following caution.

CAUTION

As a general rule, it is not recommended that the RX1 range of any ohmmeter be used when testing transistors. The RXl range on most ohmmeters normally connects an internal 1.5 volt battery directly across the test leads, causing comparatively high current (50 milliamperes or more) to flow which may damage the transistor under test. Before using any ohmmeter to test transistor circuits, check the open-circuit voltage across the ohmmeter test leads for each meter range.

3-4. Operational Checkout Procedures

These procedures may also be used to check out unit operation after installation, servicing, or as a periodic operational check of the equipment. If a known good battery is used for test, the operational steps and panel indications should follow this procedure. Connect dc output connector J5 to the known good battery, connect ac connector P3 to the local ac power source, then perform the following procedures:

CAUTION

Do not block or restrict air flow through case screens.

a. Phase 1—Capacity Test (Initial Discharge)- Proceed as follows:

(1) Set ON-OFF switch (CB1) to OFF position.

(2) Set CELL SELECT switch (S6) to correspond with number of cells in battery connected to unit.

(3) Rotate AUTO-CHARGE NO. 1 timer (M3)

counter-clockwise to stop and return to 1 HR position.

(4) Set AUTO/MANUAL DISCHARGE timer (M2) to START position.

(5) Rotate AUTO/MAN CHARGE NO. 2 timer (Ml) counter-clockwise to stop and return to 1 HR position.

(6) Set ON-OFF switch (CB1) to ON position.

(7) Press POWER RESET switch (S5) momentarily.

(8) Set FUNCTION SELECT switch (S4) to AUTO position.

(9) Set 30V-3V switch (S3) to 30V position.

(10) Set DISCHARGE AMP-HR switch (S7) to appropriate position for one-hour rate (example: set to 17-31 for a BB-433A/A battery, 0-17 for a BB-432 A/A battery).

(11) Set CHARGE AMP-HR control (R16) to appropriate position for one-hour rate (example: set to approximately 35 AH for a BB-433 A/A battery). Note that battery should trickle-charge during the final 5 to-10 minute of the charge cycle; adjust control accordingly.

(12) Set DISCHARGE AMP control (R15) to appropriate position (example: set to approximately 30 amperes for a BB-433A/A battery). Use ammeter (M5) for precise setting.

(13) If FAIL light illuminates, clean by moving AUTO CHARGE No. 1 timer (M3) clockwise, then back to 1 hour position.

(14) Press START switch (S2) momentarily to initiate operational cycle and observe that the following actions occur:

(a) RUN light (amber, DS6) illuminates.

(b) Discharge light (amber, DS3) illuminates.

(c) Battery VOLTAGE (M4) and CURRENT (M5) meters display battery condition.

(d) PASS (DS2) or FAIL (DS4) lights illuminate at EOD. PASS indicates that battery discharged for at least one hour before reaching EOD.

(15) Monitor individual cell voltage during last 15 minutes of discharge.

b. Phase 2–Equalization (Manual Discharge)- This is a continuation of Phase 1; proceed as follows:

(1) Set FUNCTION SELECT switch (S4) to MANUAL DISCHARGE position and set AUTO/MANUAL DISCHARGE timer (M2) to START position.

(2) Press START switch (S2) momentarily to initiate operational cycle. Unit will discharge battery continuously; cell voltage must be monitored by operator. If desired, set 30V-3V switch (S3) to 3V position, connect test leads to(+) and (-) 3V terminals (J4, J3) and monitor cell voltage on VOLTMETER (M4). Short individual cells when the monitored cell voltage drops to 0.5 volts, in accordance with procedures contained in applicable battery tech order. This will ensure that each cell is at zero volt-s.

(3) Proceed to next phase when cell voltages are at zero (deep discharge).

CAUTION

When a battery is taken from storage for charging monitor charger periodically during first 45 minutes to make sure that battery is receiving normal charge pulses. sometimes a battey will go into trickle prematurely because of internal conditions resuiting from storage, If this occurs, allow battery to charge for the full hour, discharge it, and charge it again. This will condition the battery f&nod charging.

c. Phase 3, 4, 5—Initial Charge, Capacity Test, Final Charge (Auto Cycle) This is a continuation of Phase 2; proceed as follows:

(1) Set 30V-3V switch (S3) to 30V position and disconnect any test leads used in Phase 2.

(2) Set AUTO CHARGE NO. 1 timer (M3) to START position.

(3) Set AUTO/MANUAL DISCHARGE timer (M2) to START position.

(4) Set AUTO/MAN CHARGE NO. 2 timer (Ml) to START position.

(5) Set FUNCTION SELECT switch (S4) to AUTO position.

(6) Set DISCHARGE AMP-HR (S7), CHARGE AMP-HR (R2), DISCHARGE AMP (R1) and CELL SELECT (S6) to appropriate positions, according to battery type.

(7) Press START switch (S2) momentarily to initiate automatic cycle and observe that the following actions occur:

(a) RUN light (DS6) illuminates.

(b) Automatic charge light (DS5) illuminates.

(c) CURRENT meter (M5) reads full scale for less than a second, falls back to zero, then rises again to full scale at next cycle.

(d) VOLTAGE meter (M4) reads 26-28 volts after 40 to 50 minutes and unit continues to charge battery, at a lower rate, for remainder of cycle. (CURRENT meter (M5) still pulses, but for a shorter time during each interval; VOLTAGE meter (M4) is read during non-active part of pulse cycle.)

(e) Monitor cell voltage during last 15 minutes of charge cycle.

(f) After a 60-minute period, AUTO CHARGE NO. 1 timer (M3) stops, the associated run indicator (DS5) extinguishes, AUTO/MANUAL DISCHARGE timer (M2) begins operation and the associated run indicator (DS3) illuminates.

(g) Battery discharge continues at a constant rate until EOD is reached (0.95 volts per cell).

(h) If EOD is reached after the 60-minute period, PASS light (DS2) illuminates, AUTO/MANUAL DISCHARGE timer (M2) stops (providing an indica-

tion of actual battery capacity), associated run indicator (DS3) extinguishes, AUTO/MAN CHARGE NO. 2 timer (M1) begins operation and the associated run indicator (DS1) illuminates.

(i) At the end of the cycle, all indicators extinguish except PASS (DS2) and unit enters a RESET mode.

d. Operational Errors- If the operator changes control function settings during mid-cycle, or uses the wrong control settings for the battery parameters, internal detection circuits operate quickly to shut down the unit. If this occurs, recheck for proper control settings and restart unit to complete interrupted cycle.

e. Charger/Ana/yzer Reset- During discharge cycle, if charger/analyzer seems to be reset, possibly due to selection of the wrong DISCHARGE rate (over-current condition), re-select proper range, set DISCHARGE AMP control (R1) down to 0, reinitiate START (S2) and slowly bring DISCHARGE AMP control (RI) up to appropriate CURRENT (M15) level for the selected range. Note that this procedure will not operate in automatic discharge if charger/analyzer had failed EOD before one hour (FAIL light on). If this condition occurs, reset AUTO CHARGE NO. 1 timer (M3) clockwise, then back to the time-out condition; or advance AUTO/MANUAL DISCHARGE timer (M2) past the one-hour marking. (Perform the former procedure if setting of AUTO/MANUAL DISCHARGE timer (M2) is not to be disturbed.)

f. Equipment Shut-Down- Equipment operation can be fully terminated at any time, in the event of failure or external conditions, by setting the ON-OFF circuit breaker (CB1) to OFF position. Disconnect unit from ac power source and from battery connection.

3-5. Testings Procedures

a. The equipment is specified and tested on a functional operating basis. Under the specified conditions of temperature and line voltage, it must charge and discharge batteries in the manner described in paragraph 3-4. Since individual batteries vary, it is easier, and more meaningful to check the unit on the basis of results than specific measurements.

b. Performance of these testing procedures requires two serviceable batteries, preferably in the range of 30-40 ampere-hour capacity, such as BB-433 A/A. One battery should be nearly discharged; the other fully charged. Refer to paragraph 3-4 for operating data.

CAUTION

Make sure that charger/analyzer is in RESET before disconnecting and reconnecting batteries. Do not connect a battery when the RUN light (DS6) is on.

c. Set up charger/analyzer for automatic operation, Phases 3,4 and 5, in accordance with procedures given in paragraph 3-4 *c.* Connect discharged battery and start unit. Observe the ammeter (M5) deflects to nearly full-scale for between .4 and .75 seconds, then returns to zero. This action will be repeated every second (slightly longer when supply voltage is 50 Hz). Turn the CHARGE AMP-HR control (R16) to higher and lower settings and observe that charging pulse interval is longer at higher settings, shorter at lower settings. Return control setting to proper position for battery used.

d. Allow unit to charge battery for a few minutes, then press RESET (S1) and disconnect discharged battery. Connect fully charged battery and press start switch (S2) Unit should charge, but as voltage rises to 28.5 volts dc (for 19 cell batteries) between pulses, charge current will drop to an indicated 50 to 70 amperes and time of charge pulse drops to a fraction of the previous time (approximately one tenth of a second). Note that the time required to go to a lower (topping) charge rate depends on battery state of charge. Turn AUTO CHARGE No. 1 timer (M3) counterclockwise to one-hour marking, observing that unit switches automatically to discharge mode, CHARGE 1 light (DS5) goes off, and discharge RUN light (DS3) goes on.

e. Observe that discharge current is constant. Move DISCHARGE AMP HR control (S7) to higher and lower settings to verify that current can be controlled. When discharge setting is too high, an internal sensor will trip out discharge circuit. To reset this circuit, turn DISCHARGE AMP HR control (S7) to zero, press START (S2) and then set the desired discharge current. Return control to original position. Since DISCHARGE AMP HR control (S7) will be in 17-31 position, range of adjustment will be approximately 17 to 31 amperes. Press RESET (S1) and disconnect charged battery. Connect discharged battery and turn AUTO CHARGE No. 1 timer (M3) clockwise until FAIL light (DS4) goes off, then turn timer back until timer switch clicks. Now press START (S7). Observe that current remains at set point and battery voltage drops below .95 volts per cell after a few minutes of discharge, time depending on remaining charge in battery. Since 1 hours has not passed, observe that FAIL light (DS4) comes on at this point and RUN light (DS6) goes off. Unit should stop operation, thereby verifying FAIL logic.

f. Press RESET (S1), disconnect dischargd battery and connect charged battery. Turn AUTO CHARGE No. 1 timer (M3) clockwise until FAIL light (DS4) goes off, then turn timer back until switch clicks. Unit will return to DISCHARGE. Slowly turn AUTO/MANUAL DISCHARGE timer (M2) counter-clockwise to 2 HR marking. When timer reaches 2 HR marking, observe that CHARGE 2 light (DS1) comes on and DISCHARGE light (DS3) goes off. The green PASS light (DS2) will also come on as the charging begins.

g. Turn AUTO/MAN CHARGE No. 2 timer (Ml)

slowly counterclockwise until switch clicks. Observe that CHARGE 2 (DS1) and RUN (DS6) lights go off, charging stops, and PASS light (DS2) remains on. This concludes the checkout of automatic modes of operation.

h. Disconnect charged battery and reconnect discharged battery. Set up charger/analyzer for manual discharge operation, in accordance with paragraph 3-4. Allow unit to run until battery voltage is below .95 volts per cell. This verifies correct operation of manual discharge circuits (EOD disabled in this mode of operation).

3-6. Troubleshooting Procedures

The following troubleshooting procedures will aid in localizing equipment failures to a component part or to an assembly. In the event that equipment failures are caused by a defective circuit board assembly, further repairs are to be accomplished at depot level. For internal access refer to paragraph 3-10.

Item	Malfunction	Probable Cause	Corrective Action
1	Battery does not charge (no current)	Blown output fuse F2 (100A).	Check fuse F2. If good, voltmeter (M4) will read leas than 30 volts during charge; if open, make a thorough visual check of unit for damaged components. If so, repair and/or replace before proceeding. If F2 blows consistently (high ambient temperature) move primary tap "0" to "+5%" (10 AWG blk).
2	Battery does not get full charge (read battery voltage in RESET or OFF mode) Battery should trickle-charge during the final 5 to 10 minutes of the charge cycle. CHARGE AMP-HR setting should be close to the one-hour rate for a good battery under test. (Note that there are some 30 AH batteries that may have an actual 42 AH capacity.)	Defective battery under test, Check for shorted cells.	Check with good battery.
		High capacity battery with charge rate set to low.	Raise rate of charge by 10%.
		Operation at leas than 208v with T1 set at 230v.	Reset transformer taps to match line voltage.
		Current amplifier or integrator malfunctioning.	Connect ammeter (0-50 Adc) in series with the battery cable (disassemble connector) and compare current during discharge with the meter on the panel of the unit. If they agree ±2 amperes, the current amplifier is functioning. If the current amplifier is functioning properly, place a battery on charge and note voltage at which the unit goes to low charge rate. If it does so at leas than 28 volts, the voltage comparator circuit associated with U13 and U14 is malfunctioning and must be repaired. (Control voltage is 28v for 19 cell, 29.5v for 20 cell.
		Integrating capacitors C10 and Cll, or input resistor R48 have drifted to lower values, resulting in a shorter time constant.	Replace defective components.
		One of the SCRS (Q7, Q8) is open or not getting gate signal. In this instance, a low capacity battery would charge properly, but there would not be enough time in the period to get in the current needed for larger batteries.	Connect oscilloscope between T1 secondary terminal "o" and ground and observe that figure 3-1 waveform (A) appears. If waveform S(B) appears, replace associated SCR (Q7,Q8) and/or check gate generator circuits.
		Corroded or loose connection causing voltage drop, limiting output current.	Charge a battery for an hour with the charger cover off-then disconnect the unit. Touch current-carrying terminals and check for heating. If a connection is hot, disassemble it, check for burned or corroded surface, poor terminal crimps, etc. - then reconnect, tightening carefully.

Item	Malfunction	Probable Cause	Corrective Action
3	Unit skips from Charge 1 to Charge 2 without discharging; or does not move to next phase.	Defective timer switch contacts.	Check timer switching by starting with the suspected timer set about 10-15 minutes CW from the 1 hour mark. Then start the cycle. Turn the pointer manually very firmly and steadily to the one hour mark. If the transition is satisfactory, proceed to do the same thing but this time "tease" the contacts by hesitating and even reversing the motion slightly as the knob is moved to the end point. If the contact or the cam is worn out, the resulting contact bounce may cause the circuit to jump a phase or go into reset. **NOTE** In practice, the discharge timer does not transfer on timer operation -it either= EOD before or after the one hour contact. As a result, its contacts seldom operate at a time when transition is possible.
4	All batteries pass discharge test.	EOD circuits inoperative.	Check voltage on battery at end of Phase 1 (immediately after PASS light cornea on). If it is less than 18.05 ±5% (for 19 cells) or 19 ± 5% (20 cells) then EOD is switching in at too low a voltage.
5	Batteries do not discharge; or no control of output. (Refer to paragraph 3-4d.)	*a.* Blown output fuse F2 (not the problem if unit charges). *b.* Defective circuit board.	a. Replace F2. Replace PCB(A1) and forward to Depot for further repair.
6	Unit stops in middle of a phase	Operator error or electrical noise or bad connection activating error detection circuit.	Check procedures; check battery voltage and/or line voltage connections.

NOTE

If printed board is suspected refer to table 3-1 for normal voltage and readings on a functioning assembly.

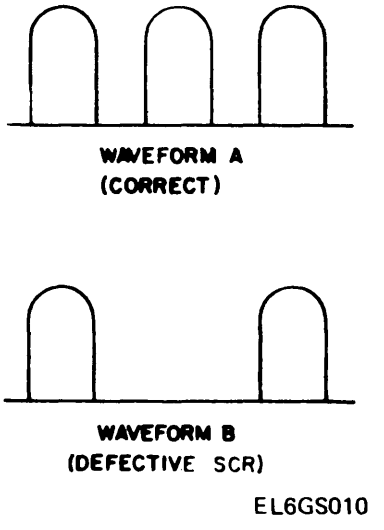

Figure 3-1. SCR Waveforms

Table 3. Connectors J1 and J2, Multimeter Test Readings

Pin No.	*Mode* Auto Charge	**Mode** Auto Discharge
	Connector J1	
A	- 5.lv dc	-5.lv dc
B	Ov dc for all&charge *timer positions,* except:	2 HR =-12v
C	Charge l Timer:START to l HR= -12v	l HR = Ov
**D	- 12v dc	-12v dc
E	- 12v dc	-l2v dc
F	Approximately 2v dc, pulsed	Ov
H	Approximately 2v dc, pulsed	Ov
J	0 to -7.5v dc, charging; 0 to - l.lv dc, trickle	O to - 7.5v dc
K	- 7.5v dc, charge -l.lvd c, trickle	-7.5v dc
L	0	0
M	0	0
N	- v dc (batt)	- v dc (batt)
*P	-12v dc to-5v dc	
R	Approximately - lv dc	- v dc (batt) to approximately -15 dc
S	+ 12v dc, pulsed	-0.lv dc/amp (discharge current)
T	-v dc(batt)	- V dc (batt)
U	Approximately 4.5v dc	- V dc (batt)
V	Approximately -60 mv dc, pulsed	+.5 mv dc/amp (discharge current)
W	0	0
X	22v ac	22v ac
Y	22v ac	22v ac
Z	0	0 (main ground)
	Connector J2	
A	Charge 2 timer motor; 115v ac when running	
B	115v ac (approximately)	
C	Charge 1 timer motor; 115v ac when running	
D	Not used	
E	- 12v for leas than 60 min.; OV for more than 60 min.	Discharge timer M2
F	Ov, not discharging; - 12v dc, discharging	
H		
J	Ov, PASS light off - 12v dc PASS light (DS3) on	
K	- 12v dc when charge 2 activated (DSl on) 0 vdc DSl off	
L	Not Used	
M	- 12v dc, run light (DS6)on; Ov, run light off	
N	- 12v dc, Fail light (DS4)on; Ov, Fail light off	
P	- 12v dc, charge light (DS5) on; Ov, charge light off	
R	- 12v dc	
S	Charge 2 timer:startto l HR; -12v dc at l HR	
T	Manual Charge Ov, idle and not selected; - 12v dc, when selected and started	
U	0	
V	Auto	
W	Manual Charge Ov, idle and not selected, - 12v dc, when selected and Started	
X	Charge l timer:Ov, start to l HR; -12v dc at l HR	
Y	Ov, idle - 12v dc, run	Discharge timer M2
Z	Ov for less than 60 min.; - 12v dc for more than 60 min.	

* Reading depends on setting of DISCHARGE AMP control (R15).
* * Except Ov when function select switch is off.

3-7. Resistance of Transformer, Inductors, and Relays

CAUTION

Make resistance measurements with input power off.

a. The resistance values are provided as an aid to troubleshooting. When using the data, observe the following instructions:

(1) Before making resistance measurements, determine whether faulty operation is due to one of these parts. To do this, follow the troubleshooting procedures (paragraph 3-6).

(2) Do not use resistance measurements as the sole basis for discarding any of these parts as defective. Because of broad winding tolerance during manufacture, resistances of identical coils may vary from the chart values, which are typical average values.

(3) The normal resistance of replacement parts may differ slightly from the values given in the chart.

b. The resistances of the transformer, relays and conductors aree listed below:

Part	Measured between terminals	Dc resistance (ohms ± l0%)
T1	O to 31 (either secondary terminal)	Less than l ohm
	0 to ll0(tertiary)	4 ohms
	0 to +5%(primary)	Less than l ohm
	0 to -5%(primary)	Less than l ohm
	0 to 208 (primary)	Less than l ohm
	0 to 230(priInary)	Less than l ohm
A1K1, A1K2	Across coil terminals	370 ohms
K1	Across coil terminals	225 ohms
K2	Across coil terminals	180 ohms
FL1, FL2	Across filter terminals	Less than l ohm

3-8. Semiconductor Resistance Measurements

The resistance measurements given in the following chart were made with the equipment disconnected from the power source and external battery.

a. Note that each semiconductor j unction resistance measurement has two values: the lower resistance value represents the forward bias resistance; while the higher resistance value represents the reverse bias resistance. Be sure to check the polarity of the multimeter leads before making measurements.

b. Transistor junction resistance measurements provide a quick check and will usually reveal open or shorted transistors. However, when a specific transistor is indicated as being associated with a circuit fault, it is advisable to check the transistor by substitution; alternatively, the transistor may be removed from circuit and tested with the aid of Transistor Test Set TS-1836/U. Also note that erroneous readings can indicate that an associated circuit component is defective such as a shorted diode, leaky capacitor, or off-value resistor. Check components before replacing transistors.

c. Transistor Junction Resistance Readings.

Transistor	Resistance Measurement between terminals (ohms)						Remarks
	E(+)	E(-)	B(+)	B(-)	C(+)	C(-)	
Q1	100K (minn)	8 to 20	8 to 20	lOOK (min)	100K (min)	100K (min)	See Note
Q2	100K (min)	8 to 20	8 to 20	100K (min)	100K (min)	100K (min)	See Note
Q3	100K (min)	8 to 20	8 to 20	100K (min)	100K (min)	100K (min)	See Note
Q4	100K (min)	8 to 20	8 to 20	100K (min)	lOOK (min)	100K (min)	See Note
Q5	lOOK (min)	8 to 20	8 to 20	100K (min)	100K (min)	lOOK (min)	See Note
Q6	100K (min)	8 to 20	8 to 20	100K (min)	100K (min	100K (min)	See Note

NOTE

Q1 through Q6 are parallel-connectd Readings given are for out-of-circuit measurements.

Section III. REMOVAL, REPLACEMENT AND ADJUSTMENTS

3-9. General Parts Replacement Techniques

The following general precautions should be observed when replacing parts in this equipment.

a. For parts removal and replacement, always work on a clean, flat work surface. When reassembling mechanical parts, make sure that mating surfaces are clean and free of nicks, burns, or surface irregularities. Blow out interior of cases with clean compressed air source.

b. Whenever an electrical part such as a transistor, diode, IC, resistor, capacitor, etc., is to be removed, note the exact position of the part before removing it. Replace the part in the same position.

c. Use a low-wattage soldering iron (25 watts maximum) when replacing components or repairing wiring on printed circuit boards. Excessive soldering heat can damage componenets or printed wiring.

d. When removing and replacing control knobs, preset the control to a readily identifiable position and install replacement control knobs to line up in exactly the same position.

CAUTION

Avoid using a soldering gun when repairing transistor or IC circuits; damaging voltage can be induced into components.

e. Use a cross tip screwdriver to loosen or tighten Phillips head screws. Use a hand screw starter to remove loosened Phillips head screws or to hold and start Phillips head screws.

f. Solder transistor leads quickly; whenever wiring permits, use a heat sink (such as long-nosed pliers) be-

tween the soldered joint and the transistor.
Use approximately the same length and dress of transistor leads as used originally.

3-10. Removal and Replacement

A formed, perforated sheet-metal removable cover, figure 3-2, completely encases all the internal components of the Charger/analyzer. This cover is removed to gain access to these components for maintenance. To remove cover, remove hardware securing cover to the main chassis and lift off and set aside cover. Also note that the front and rear panels can be detached from the main chassis and swung down for servicing once the attaching screws are removed. Place cushioning pads beneath panels to avoid damage to components. To replace cover or panels, reverse the removal procedure.

3-11. Disassembly and Reassembly

Once the top cover is removed, all components are accessible. The steps necessary to disassemble and reassemble are obvious, and no special instructions are *re*quired. However, certain procedures and precautions must be observed prior to, and during, reassembly.

a. Make sure that all mating machine surfaces are absolutely clean.

b. Use thermal compound between all semiconductor and mounting surfaces.

c. Make sure that no hardware, such as nuts, bolts, and washers, have fallen inside the equipment.

3-12. Parts Location

Figures 3-3 through 3-6 illustrate the location of replaceable partsi of the equipment.

3-13. Equipment Adjustments

The following adjustments may be required after replacing a defective part or as a result of troubleshooting. The cover of the unit must be removed to gain access to these adjustments located on circuit board Al.

a. Meter Zeroing Adjustments- Each of the front-panel meters, M4 and M5, figure 5-1, has a mechanical zero adjustment screw located in the front of the meter. With power off, adjust M4 for center-zero; adjust MS for left-side zero.

b. Current Limit Adjustment- Potentiometer R73 is adjusted to prevent the pass transistors from being damaged by excessive discharge currents, or by operator error. Refer to figure 3-6 for location of R73. Connect equipment to ac line and a known good battery (fully charged), then proceed as follows:

(1) Set ON-OFF switch (CB1) to OFF position.

(2) Set AUTO-CHARGE No. 1 timer (M3) to 1 HR position.

(3) Set AUTO/MANUAL DISCHARGE timer (M2) to START position.

(4) Set AUTO/MAN CHARGE No. 2 timer (M1) to 1 HR position.

(5) Set ON-OFF switch (CB1) to ON position.

(6) Press POWER RESET switch (S5) momentarily

(7) Set FUNCTION SELECT switch (S4) to MANUAL DISCHARGE position.

(8) Set 30V-3V switch (S3) to 30V position.

(9) Set DISCHARGE AMP-HR switch (S7) to 0-17 position.

(10) Set DISCHARGE AMP control (R15) initially to 0 position.

(11) Press START switch (S2) momentarily to initiate operational cycle.

(12) Slowly increase setting of DISCHARGE AMP control until unit goes into RESET. Note that trip-point current is 24 amperes. If not, reset unit and adjust R73 and DISCHARGE AMP control until correct trip-point is obtained. (Refer to paragraph 3-4 *e* for restart procedures.)

(13) Set ON-OFF switch to OFF position and disconnect equipment.

c. Opertaional Amplifier Null Adjustments— operational amplifier stage U2 requires two null adjustments, set as follow: (Allow a 10-minute warm-up period, then shut equipment off.)

(1) Turn on equipment as described in paragraph b, steps (1) through (9), except remove F2.

(2) Connect digital voltmeter between ground and U2 pin 10 and adjust R64 for zero volts.

(3) Connect a 470 ohm resistor between pins 1 and 12 of U2 (figures 3-6). (Attach resistor across DIP clip.)

(4) Reconnect digital voltmeter between ground and U2 pin 12 and adjust R47 for +100 millivolts.

(5) Shut down equipment by setting ON-OFF switch to OFF position.

(6) Disconnect resistor, digital voltmeter, ac and battery connections.

d. Comparator Adjustment- If it is necessary to replace voltage regulator U23 (- 12V), check the voltage at U13, pin 4 with no battery connected and the unit turned on (any mode). The voltage at this point measured to ground should be -6.0 ± .1 volt. If it is out of this range, the trickle point will be incorrect and batteries may be damaged. Change R2C to correct the voltage, by using the list below. Measure the - 12V bus with a digital voltmeter and select the appropriate resistor,

Voltage	*Calculated Value*	*Use*
-11.5	8,736 ohm	8,870 ohm
-11.75	9,133 ohm	9,300 ohm
-12.00	9,630 ohm	9,630 ohm
-12.25	9,927 ohmi	10,000 ohm
-12.5	10,320 ohm	l0,500 ohm

After changing the resistor, recheck the voltage at U13, pin 4 to be sure that it is correct.

3-14. Checkout After Repair

Perform the testing procedures given in paragraph 3-4 to verify that the equipment is functioning properly.

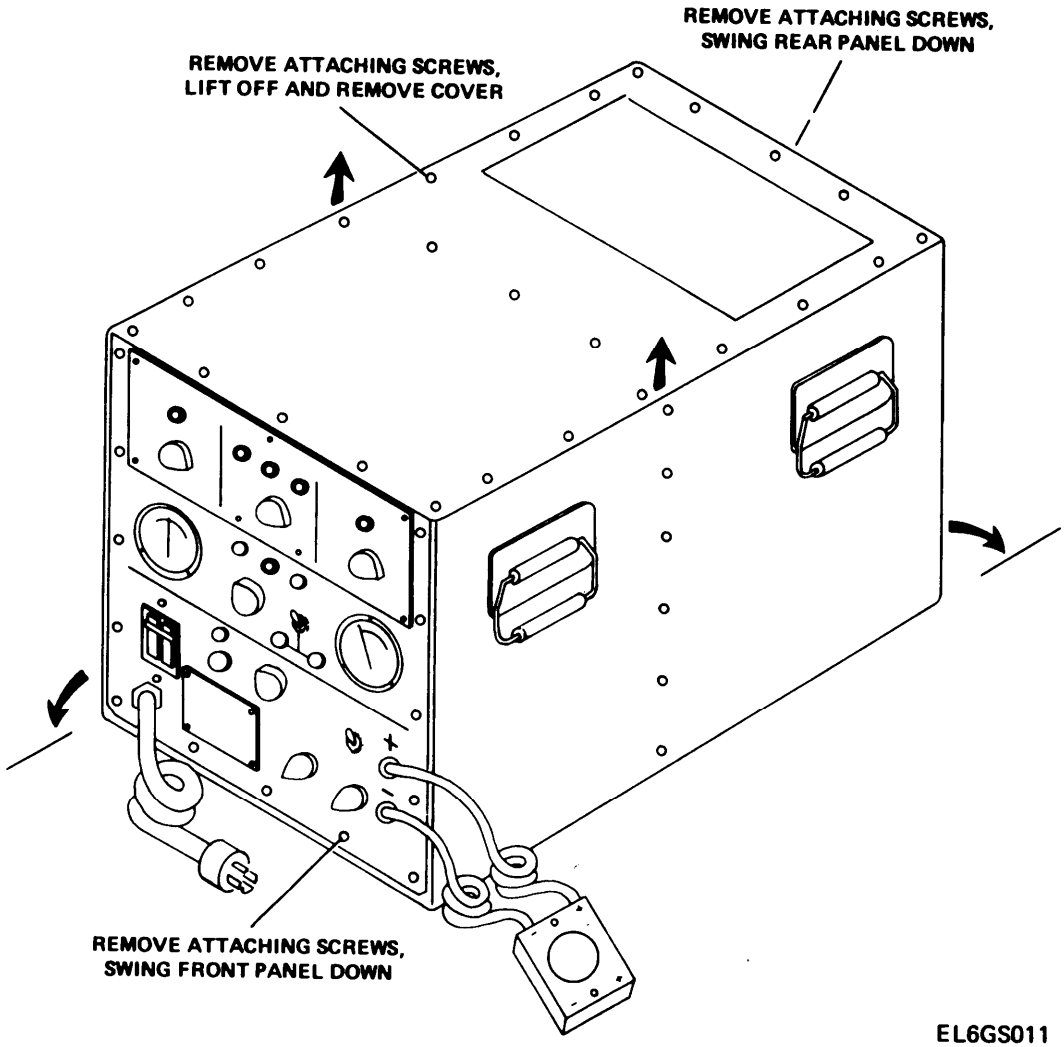

Figure 3-2. *Equipment Disassembly.*

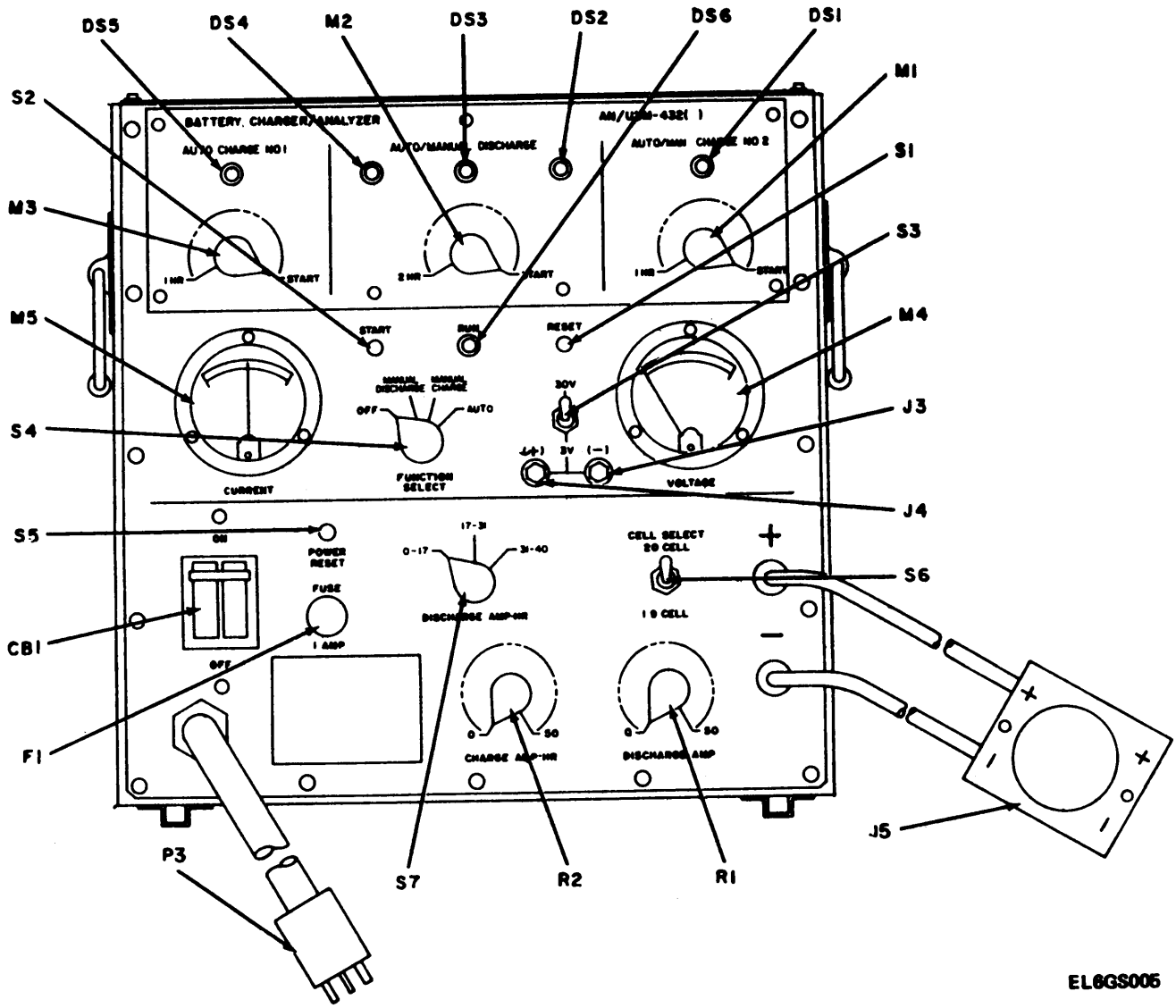

Figure 3-3. Front Panel, Component Location.

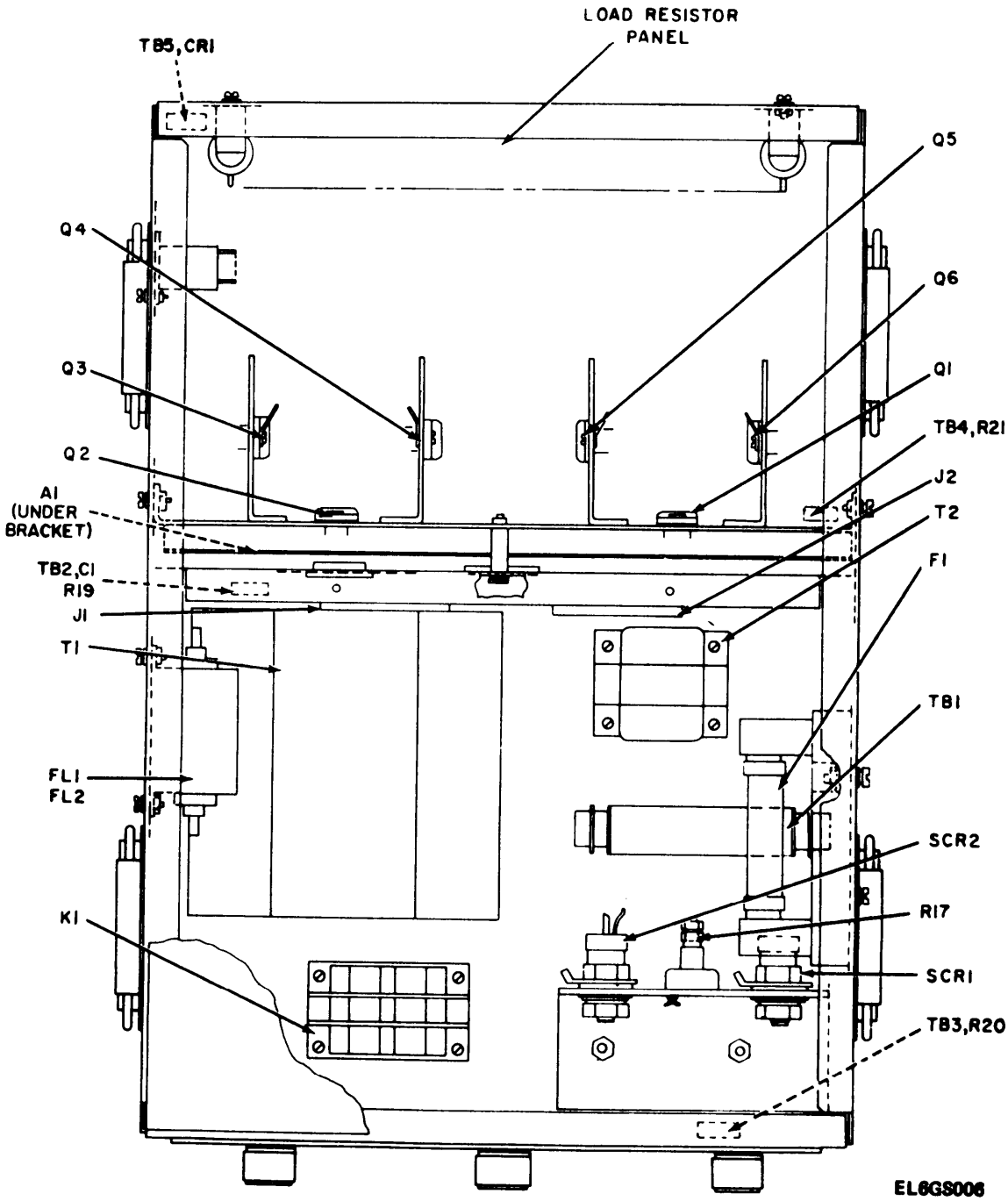

Figure 3-4. Chassis, ***Component Location.***

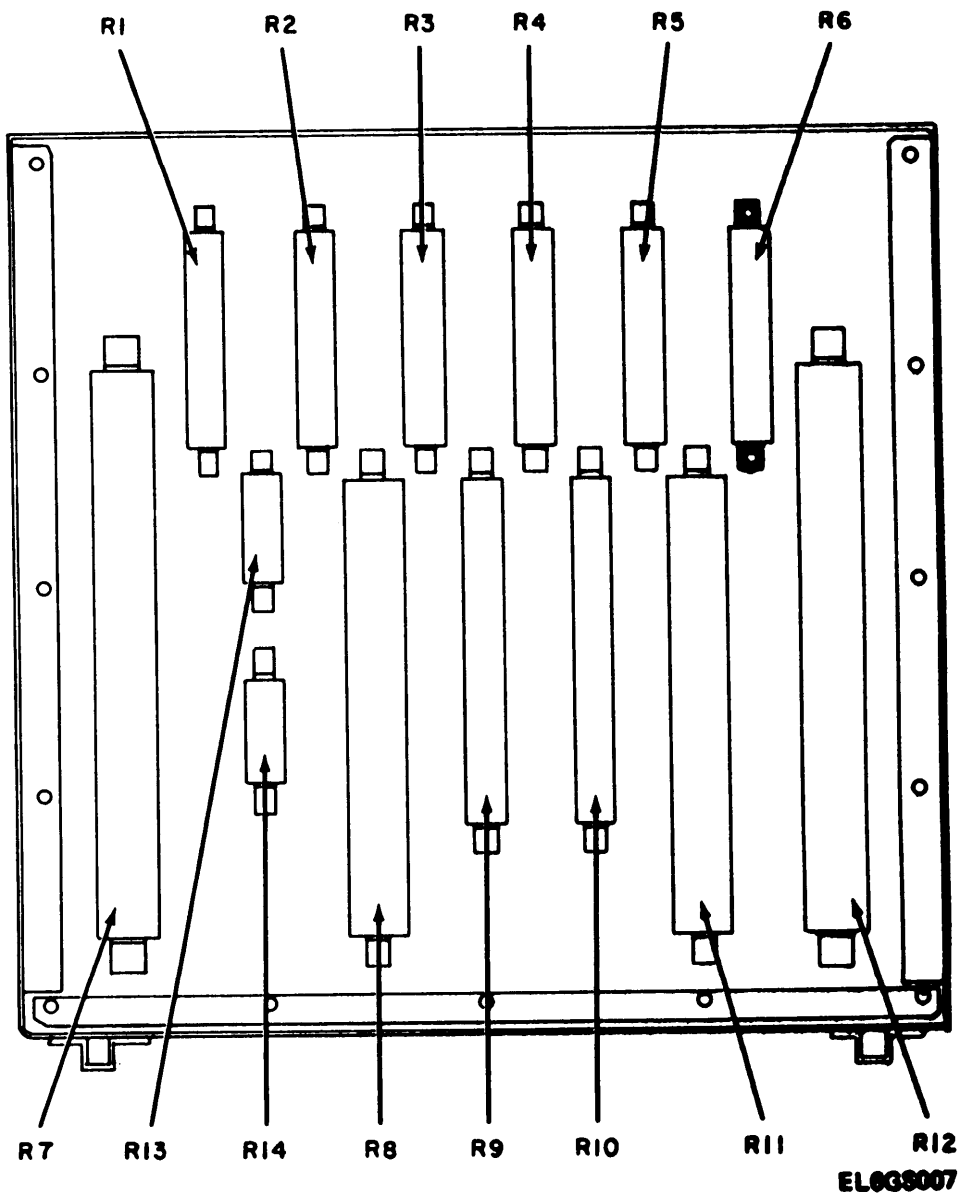

Figure 3-5. Load Resistor Panel, Component Lock

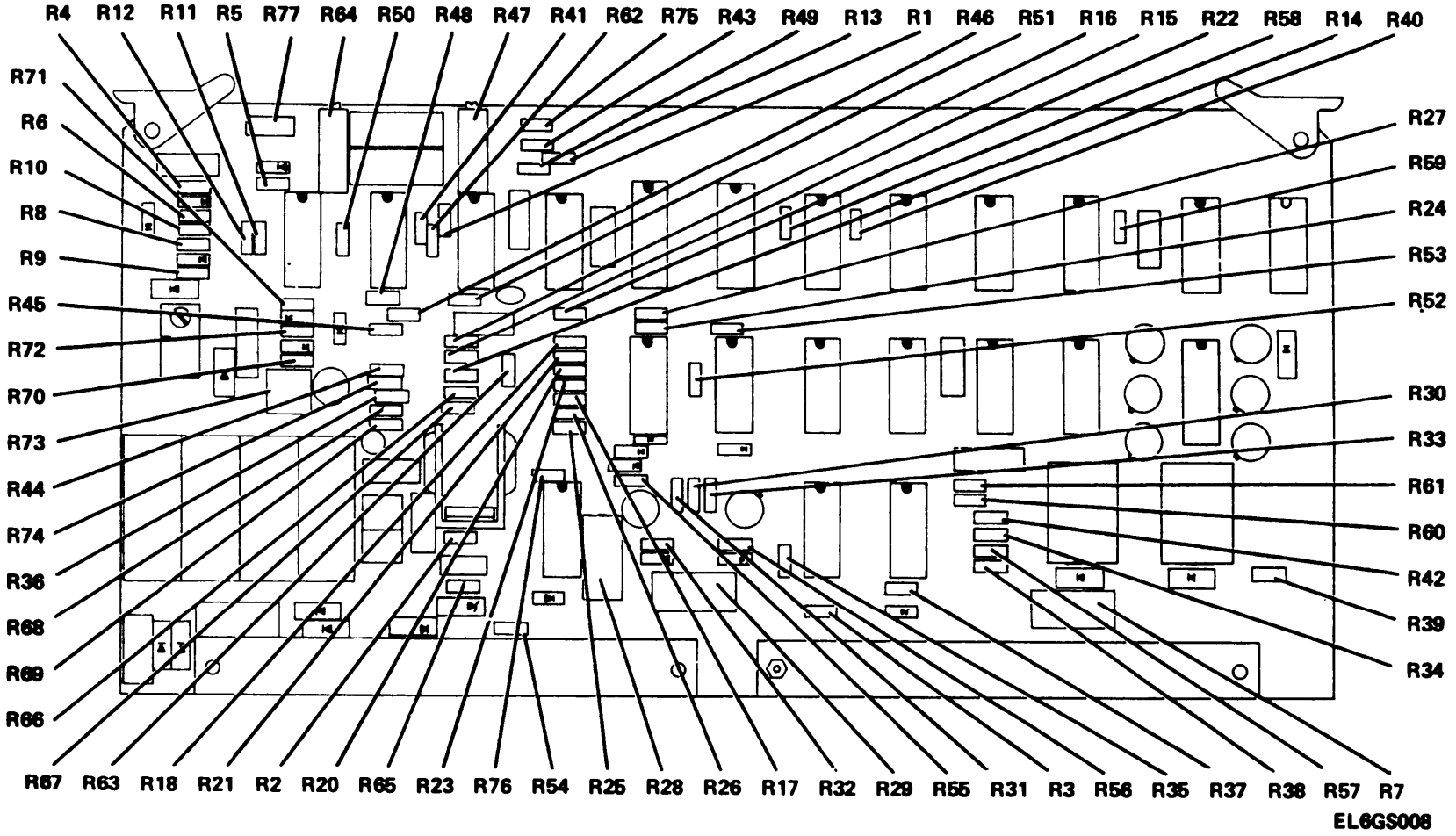

Figure 3-6 (1) *Circuit Board Assembly A1, Component Location(Sheet 1 of 2)*

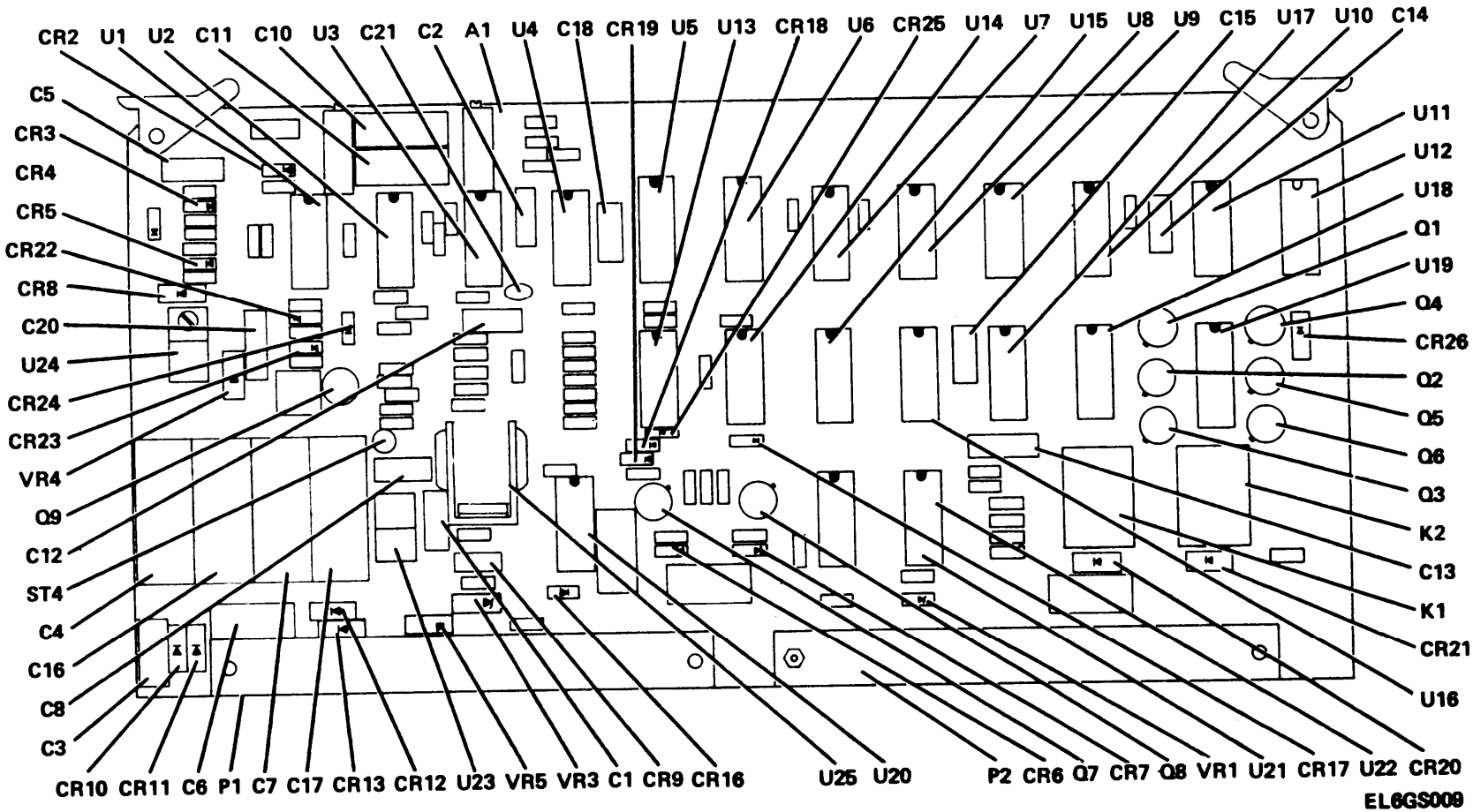

Figure 3-6 Circuit Board Assembly A1, Component Location (Sheet 2 of 2)

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	Index of Modification Work Orders.
SB 11-573	Painting and Preservation Supplies Available for Field Use for Electronics Command Equipment.
SB 38-100	Preservation, Packaging, and Packing Materials, Supplies, and Equipment Used by the Army.
SC 5180-91-CL-R07	Tool Kit, Electronic Equipment TK-105/G (NSN 5180-00-610-8177).
TB43-0118	Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TM 11-2019	Test Sets I-49, I-49A and 149-B and Resistance Bridges ZM-4A/U and ZM-4B/U.
TM11-6140-203-14-1	Operator's, Organizational, Direct Support, and, General Support Maintenance Manual for Aircraft and Non-aircraft nickel-cadium batteries (General).
TM1l-6140-203-14-2	Operator's, Organizational, Direct Support, and General Support Maintenance Manual for Aircraft Nickel-Cadmium Batteries.
TM1l-6140-203-14-3	Operator's, Organizational, Direct Support and General Support Maintenance Manual for Non-Aircraft Nickel-Cadmium Batteries.
TM1l-6625-203-12	Operator and Organizational Maintenance Manual: Multimeter AN/URM-105 and AN/URM-105C Including Multimeter ME-77/U and ME-77C/U.
TM1l-6625-539-14-4	Operator's, Organizational, Direct Support, and General Support Maintenance Manual: Test Set, Transistor TS-1836D/U (NSN 6625-00-138-7320).
TM1l-6625-654-14	Operator's, Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools List) for Multimeter AN/USM-223.
TM 38-750	The Army Maintenance Management Systems (TAMMS).
Tm 43-0139	Painting Instructions for Field Use.
Tm 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

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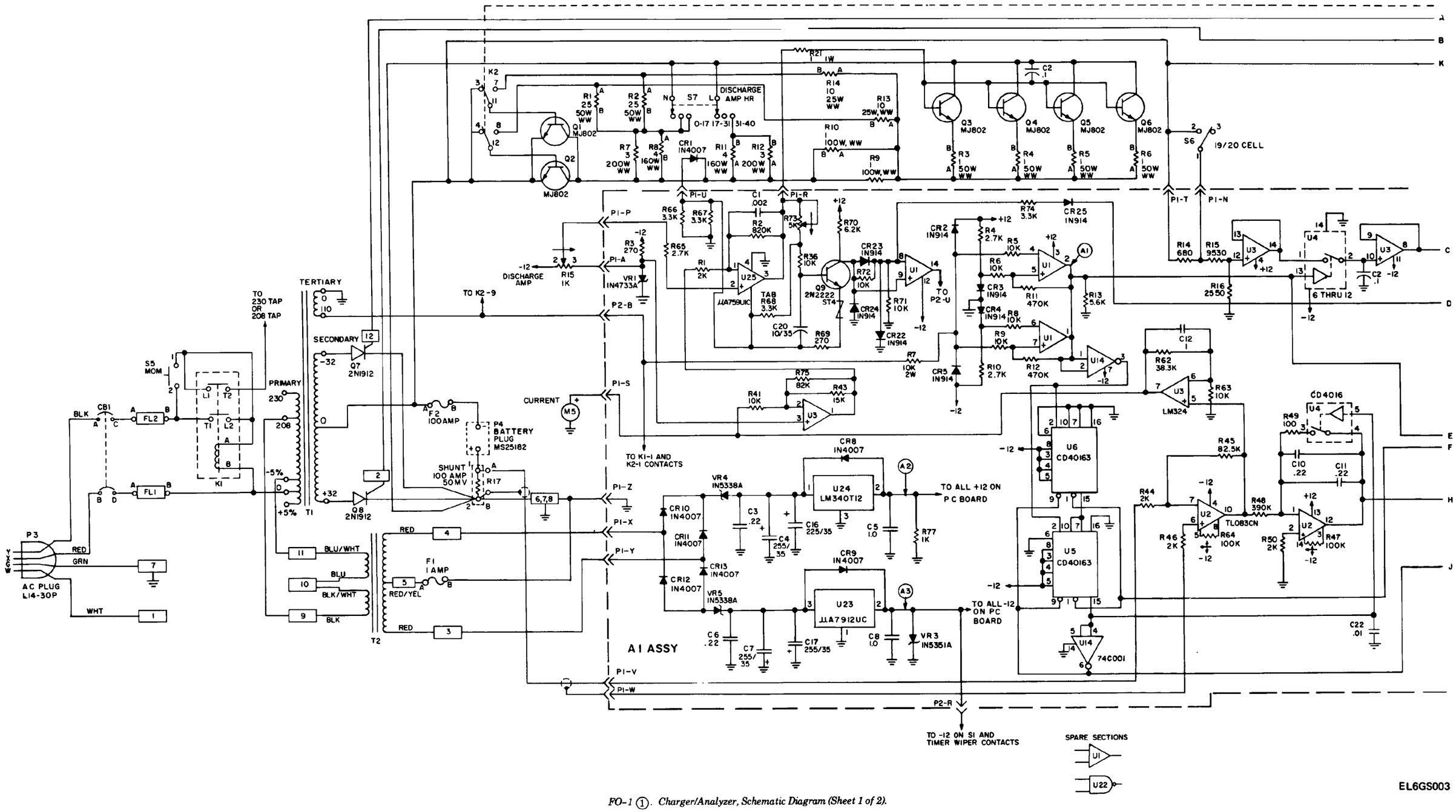
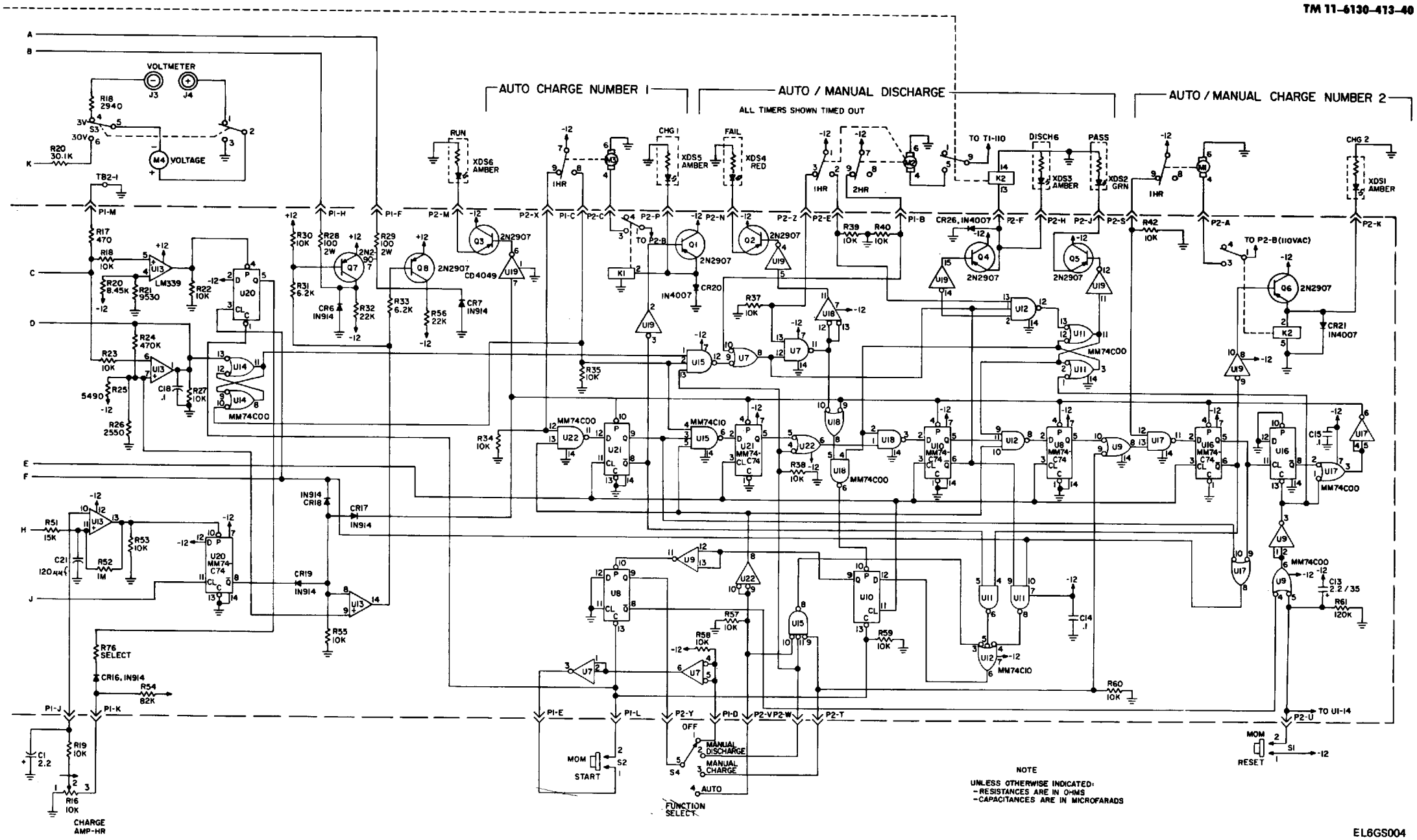


FO-1 (1). Charger/Analyzer, Schematic Diagram (Sheet 1 of 2).



FO-1 (2). Charger/Analyzer, Schematic Diagram (Sheet 2 of 2).

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PUBLICATION NUMBER	DATE	TITLE
TM 11-5840-340-12	23 Jan 74	Radar Set AN/PPC-76

BE EXACT...PIN-POINT WHERE IT IS				IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
PAGE NO.	PARAGRAPH	FIGURE NO.	TABLE NO.	
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.

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER
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THE METRIC SYSTEM AND EQUIVALENTS

NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

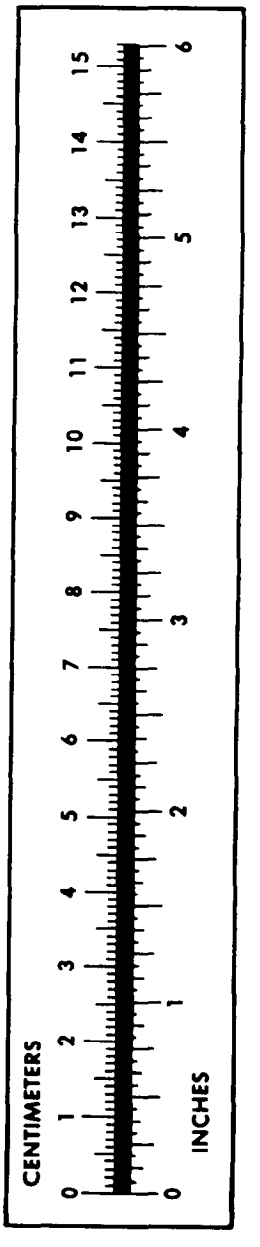
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
ers	Gallons	0.264
ms	Ounces	0.035
ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
lometers per Liter	Miles per Gallon	2.354
meters per Hour	Miles per Hour	0.621



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