PRC-BC4-MS

TRANS WORLD COMMUNICATIONS TECHNICAL MANUAL

Operator's and Technical Manual

PRC-BC4
MULTIPLE BATTERY CHARGER

TRANSWORLD™

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TRANS WORLD COMMUNICATIONS

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MULTIPLE BATTERY CHARGER

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WARRANTY

Trans World Communications, Inc. (TWC) warrants that new TWC equipment has been manufactured free of defects in design, material and workmanship. If the equipment does not give satisfactory service due to defects covered by this warranty, TWC will, at its option, replace or repair the equipment free of charge.

The warranty is for a period of 90 days from the date of installation. In the event that the equipment is not installed within 90 days of factory shipment, satisfactory evidence of the installation date must be submitted.

LIMITATIONS:

This warranty does not cover physical damage caused by impact, liquids or gases. Defects caused by lightning, static discharge, voltage transients, or application of incorrect supply voltages are specifically excluded from this warranty.

RETURN OF EQUIPMENT - USA:

The equipment shall be returned freight prepaid to the Service Department, Trans World Communications, Inc., 240 Pauma Place, Escondido, California 92025. The equipment should be packed securely, as TWC will not be responsible for damage incurred in transit. Please include a letter containing the following information:

1. Model, serial number, and date of installation.
2. Name of dealer or supplier of equipment.
3. Detailed explanation of problem.
4. Return shipping instructions.

TWC will return the equipment prepaid by United Parcel Service, Parcel Post or truck. If alternate shipping is specified, freight charges will be made collect.

RETURN OF EQUIPMENT - FOREIGN:

Write for specific instructions. Do not return equipment without authorization. It is usually not possible to clear equipment through U.S. Customs without the correct documentation. If equipment is returned without authorization, the sender is responsible for all taxes, customs duties and clearance charges.

LIMITED PARTS WARRANTY:

This warranty shall cover all parts in the equipment for a period of 12 months from the date of installation, subject to the previous conditions and limitations. The parts will be replaced free of cost. The labor charges will be made at the current TWC hourly service rate.

PARTS REPLACEMENT:

If it is not practical, or the purchaser does not want to return the equipment to the factory, this warranty is limited to the supply of replacement parts for a period of 12 months from the date of equipment installation. The following instructions for the supply of replacement parts should be followed:

1. Return defective parts prepaid to: Parts Replacement, Trans World Communications, Inc., 240 Pauma Place, Escondido, California 92025.

2. Include a letter with the following information:
   a) Part number(s).
   b) Serial number and model of equipment.
   c) Date of installation.

Parts returned without this information will not be replaced. In the event of a dispute over the age of the replacement part, components date coded over 24 months prior will be considered out of warranty.

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CHAPTER 1
DESCRIPTION AND TECHNICAL SPECIFICATIONS

1.1 GENERAL

This manual describes the PRC-BC4 battery charger, its installation, operation and maintenance. Also described is the BB-LA6 lead-calcium battery, for which the PRC-BC4 is designed.

1.2 DESCRIPTIONS

1.2.1 PRC-BC4

The PRC-BC4 is a state-of-the-art gang charger designed for use with the BB-LA6 lead-calcium batteries. The charger utilizes a three-level charging circuit to ensure full charging and maximum battery life. Up to four batteries may be charged at one time.

The batteries are charged at a high rate until they reach a preset terminal voltage. Then the charge current is tapered off gradually while the battery is held at the terminal voltage until the charge current decreases to one-tenth (10 %) of the bulk charge rate. This second "overcharge" level brings the battery back to full capacity. The charger then maintains the battery at the recommended "float" level indefinitely. Battery current will revert to the bulk charge rate if for some reason the battery voltage drops significantly.

The units may be configured to operate from either 110 or 220 Vac, and from either 50 or 60 Hz. It may also be operated from an external 20 to 30 Vdc. See Chapter 2 for instructions on how to configure the ac input voltage.

1.2.2 BB-LA6

The BB-LA6 is a sealed, 6 ampere-hour, 12 Vdc lead-calcium battery for use with manpack radio sets. It is fitted with an internal 7-A fuse to prevent hazard produced by shorting the battery output terminals. Its connector mates directly with the power terminals on the manpack, and the battery is also charged through this connector.

1.3 TECHNICAL SPECIFICATIONS

Technical specifications for the PRC-BC4 battery charger, the BB-LA6 lead-calcium battery and the CY-2562 battery box are listed in Table 1-1.

TABLE 1-1.
Technical Specifications.

PRC-BC4	
Size:	4.0" x 9.5" x 11.0" (10 cm x 24 cm x 28 cm).
Weight:	9.5 lbs (4.3 kg).
Input Voltage:	110/220 Vac or 20-30 Vdc.
Input Current:	1 A max. @ 110 Vac, 1/2 A max. @ 220 Vac, 5 A max. @ 20-30 Vdc.
Reverse Polarity Protection:	Fully protected on dc input and battery outputs.
Operating Temperature Range:	0-60° C ambient.
Operating Controls:	POWER on/off switch, RESET button for each charger circuit.
Panel Indicators:	POWER ON and FAULT, CHARGING, READY for each charger circuit.
Bulk Charging Rate:	1.1 A (C/5).
Bulk to Overcharge Transition Voltage:	14.0 Vdc.
Overcharge Terminate Current:	110 mA (C/50).
Float Charge Voltage:	13.3 Vdc.

TABLE 1-1.
Technical Specifications, Continued.

Float to Bulk Transition Voltage:	12.0 Vdc.
Temperature Coefficient on Voltage Levels:	-12 mV/degree C.
Current Drain on Battery with Power Off:	5 μA max.
Nominal Charge Time with 80% Discharged Battery:	6 hours.

BB-LA6

Size:	9.5" x 3.7" x 2.3" (24.2 cm x 9.4 cm x 5.8 cm).
Weight:	5.5 lb (2.5 kg).
Nominal Capacity:	6 Ah.
Nominal Voltage:	12 Vdc.
Maximum Instantaneous Output Current:	30 A @ 20 degrees C.
Maximum Continuous Output Current:	7 A @ 20 degrees C.
Internal Resistance:	0.02 ohms max. fully charged.
Percent of Original Capacity versus Storage Time:	after 3 months: 90%. after 6 months: 80 %. after 12 months: 60 %.

CY-2562 BATTERY BOX

Size:	3.0" x 4.0" x 11.0" (7.5 cm x 10 cm x 28 cm).
Weight:	0.5 lb (0.23 kg).

CHAPTER 2
INSTALLATION

2.1 UNPACKING

The equipment is packed in heavy-duty corrugated cardboard cartons. The cartons and packing materials should be retained in case the equipment is reshipped.

2.2 CHECKING UNPACKED EQUIPMENT

Inspect the equipment for possible damage during shipment. Check all accessories against the packing list. Normally the PRC-BC4 is shipped with one CY-2562 battery box, three battery charging cables, one ac power cord, and one dc power cord.

2.3 AC INPUT POWER CONFIGURATION

The ac power connection is made through the preassembled power cable fitted with a three-pin female connector that plugs into the connector on the front panel of the unit. The other end of the cable is fitted with a three-pin male connector which plugs into a standard U.S. wall socket. If it is necessary to rewire this cable, note that one of the following color codes will be used:

PHASE:	BLACK	BROWN
NEUTRAL:	WHITE	BLUE
GROUND:	GREEN	GREEN/YELLOW STRIPE

On the outside case of the unit there is a voltage indicator label showing the ac voltage setting. Check this to make sure the correct voltage is selected for the particular installation. If the voltage is not correct, the connections for the power transformer must be changed in accordance with the instructions in Figure 2-1 below. The ac fuse must also be changed.

CAUTION!

REMOVE THE POWER CORD BEFORE OPENING THE CASE OF THE UNIT. DANGEROUS VOLTAGES ARE EXPOSED INSIDE THE CASE AND RISK OF ELECTRIC SHOCK IS GREAT WITH THE CASE OPEN AND THE POWER APPLIED.

2.4 DC INPUT POWER CONNECTION

A two-pin connector and a length of 14 AWG cable are provided. One end of this cable is not assembled to facilitate connection to the dc power source. Connections should be made according to Figure 2-2. The external power source should apply between 20 and 30 Vdc and be capable of supplying at least 5 A. The unit may be operated from the ac supply while the dc supply is still connected; but if the dc supply voltage is 20 V or greater, all the current will be taken from the dc supply. This operation, therefore, is not recommended.

2.5 ADJUSTMENTS

No adjustments or alignment are required during normal operation.

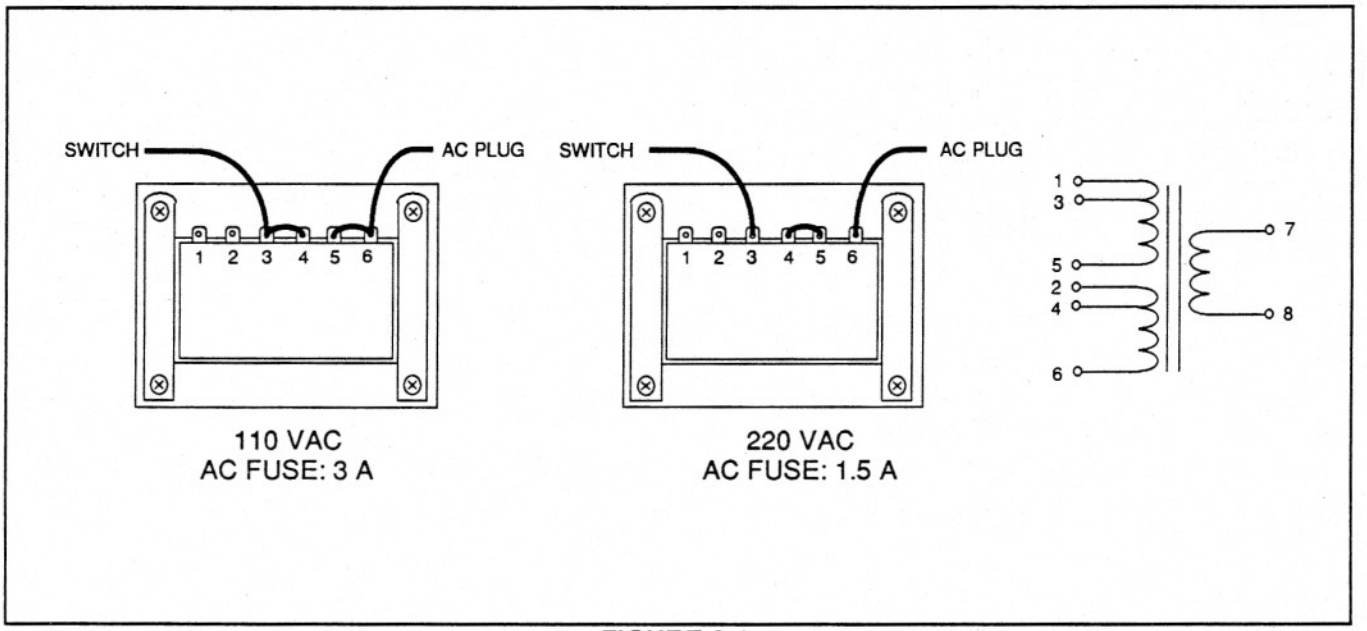

FIGURE 2-1.
Power Transformer Connections.

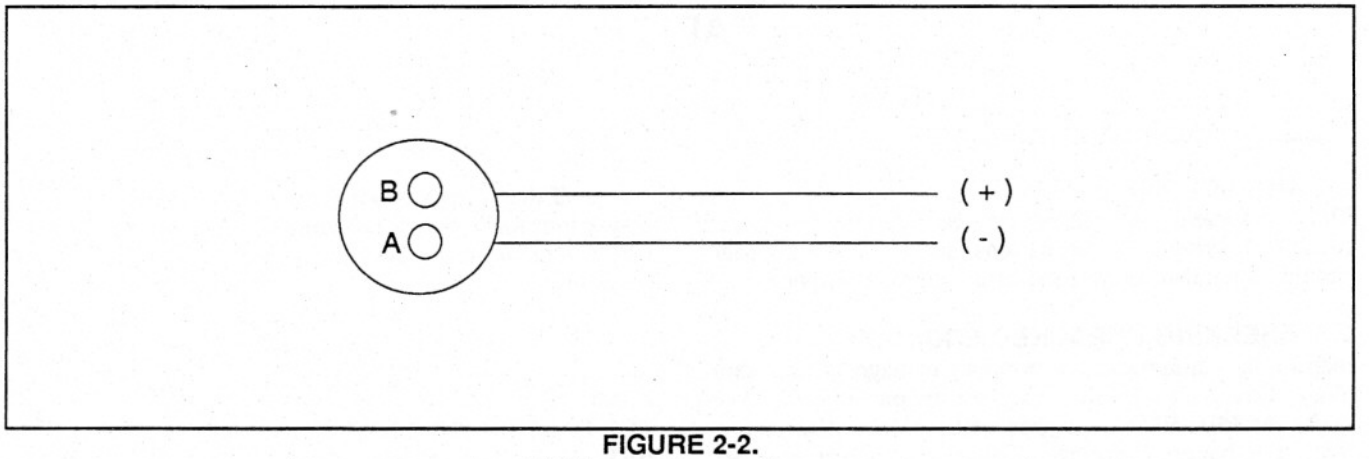

FIGURE 2-2.
DC Power Connections.

TABLE 2-1.
PRC-BC4 (J1-J3) Connector Pin-outs and Accessory Equipment Connections.

Pins on PRC-BC4 (J1-J3)	Description	Pins on BB-LA6
A	Ground	A
B	+12 Vdc	B

TABLE 2-2.
PRC-BC4 (J5) Connector Pin-outs and Accessory Equipment Connections.

Pins on PRC-BC4 (J5)	Description	Pins on Dc Power Source
A	Ground	A
B	+24 Vdc	B

2.6 DC OUTPUT POWER CONNECTIONS

J1-J3 are the accessory connectors used to provide 12-V dc input power to the BB-LA6. Table 2-1 shows the pin-outs for J1-J3.

2.7 DC INPUT POWER CONNECTION

J5 is the accessory connector used to provide dc input from either a 24-V dc supply or a vehicular battery. Table 2-2 shows the pin-outs for J5.

CHAPTER 3
OPERATION

3.1 FEATURES

The PRC-BC4 is designed to charge as many as four BB-LA6 batteries at one time. One of these fits in the battery box under the unit. Others are charged through the battery cables.

Each charging circuit has a set of indicator lights to show the status of any battery connected there, and a RESET button which is used to initiate the charge cycle. Each charger output is fully protected against short circuits and reverse polarity, and is current limited to the normal bulk charge rate of 1.1 A when in operation.

CAUTION!

DO NOT USE THIS CHARGER WITH ANY BATTERY OTHER THAN THE BB-LA6. CONNECTION OF LITHIUM, MAGNESIUM OR OTHER BATTERIES MAY RESULT IN EXPLOSION OR RELEASE OF TOXIC MATERIALS AND CONSEQUENT HAZARD TO PERSONNEL.

3.2 CHARGING THE BATTERIES

A. Connect the input power source and turn the unit on.

B. Connect a battery to be charged to the charger using a battery cable.

C. Press the RESET button associated with the particular battery.

D. Connect other batteries the same way. A fourth battery may be connected under the unit and mates with the four-pin connector there. The battery box may be used to secure this battery as the charger is moved.

E. Observe the indicator lights on each circuit to determine the status of each battery. The table below explains the meaning of each indicator.

TABLE 3-1.
Battery Charger Indicator Lights.

CONDITIONS	MEANING	ACTION
CHARGING light on.	Battery charging normally.	None.
READY light on.	Battery is fully charged.	Battery may be left connected to charger in this condition indefinitely.
FAULT light on with battery connected.	Either battery fuse is blown, or battery voltage is below 4 Vdc.	Check battery fuse. If OK, battery is probably faulty and may have to be discarded.
FAULT or READY light on with no battery connected.	This is normal.	Pressing RESET button with no battery attached should light FAULT light.

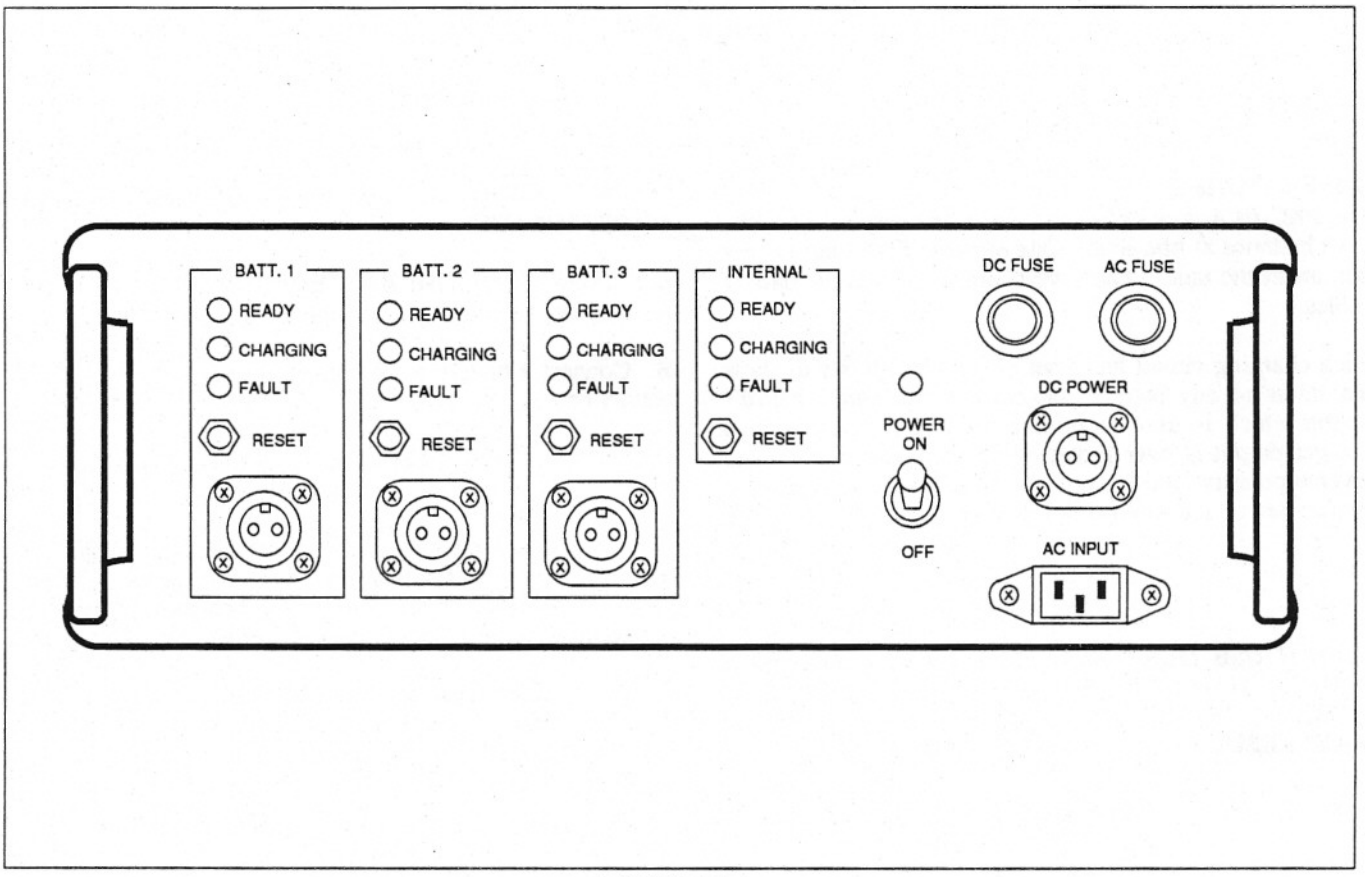

FIGURE 3-1.
PRC-BC4 Front Panel.

CHAPTER 4
TESTING AND TROUBLESHOOTING

4.1 TEST PROCEDURE

4.1.1 REQUIRED MATERIALS

Materials required to test and troubleshoot the PRC-BC4 are as follows:

(1) dc power supply, 6- to 20-Vdc output @ 5 A min.
(1) electrolytic capacitor, 30,000 to 150,000 uF, 25 Vdc
(1) resistor, 6.8 ohms, 10 W
(1) resistor, 2.2 ohms, 5 W
(1) resistor, 82 ohms, 3 W
(1) dc VOM, high input Z
(1) dc ammeter, 3 A scale min.
(4) clip jumpers
(1) heat gun or blow torch

If one of the steps in the test procedure is failed, refer immediately to section 4.2 for troubleshooting procedures.

4.1.2 PRC-BC4 TEST

To test the PRC-BC4:

A. Use the dc power supply to charge the capacitor to some voltage between 6 and 13 Vdc.

B. Using one of the battery charging cables and the clip jumpers, attach the capacitor to one of the charger outputs as if it were a battery; i.e., pin "A" to minus, pin "B" to plus. See Figure 4-1.

C. The charger circuit under test should indicate READY after a few seconds. If it does not, measure the capacitor voltage to make sure it is more than 6 Vdc. If it is more than 6 Vdc, there is a fault in that charger circuit.

D. Connect the dc ammeter and the 6.8-ohm and 2.2-ohm resistors in series and connect across the capacitor. See Figure 4-2.

E. Measure the dc current. It should be 1.1 A ±0.1. The charger circuit under test should indicate CHARGING while ammeter and resistors are connected.

F. Disconnect the ammeter and resistor. The charger should indicate READY again after a few seconds.

G. Connect the dc voltmeter across the capacitor. Connect the 82-ohm resistor across the capacitor.

H. Measure the dc voltage. It should be 13.3 Vdc ±0.2 Vdc.

I. Press and hold the RESET button and observe the capacitor discharging.

J. Release the button when the capacitor voltage is between 6 and 10 Vdc.

K. Charger should indicate CHARGING. Measure the dc voltage. It should be 14.0 Vdc, ±0.2 Vdc.

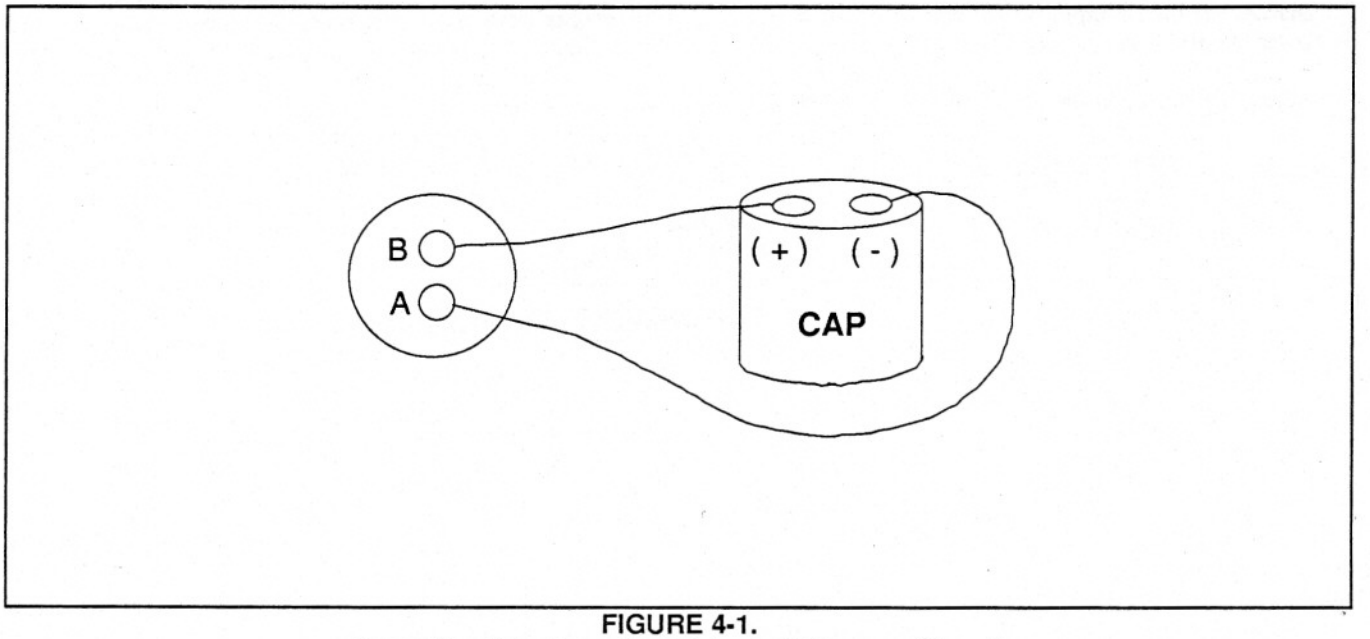

FIGURE 4-1.
Capacitor Attachment to Output of Charger Circuit.

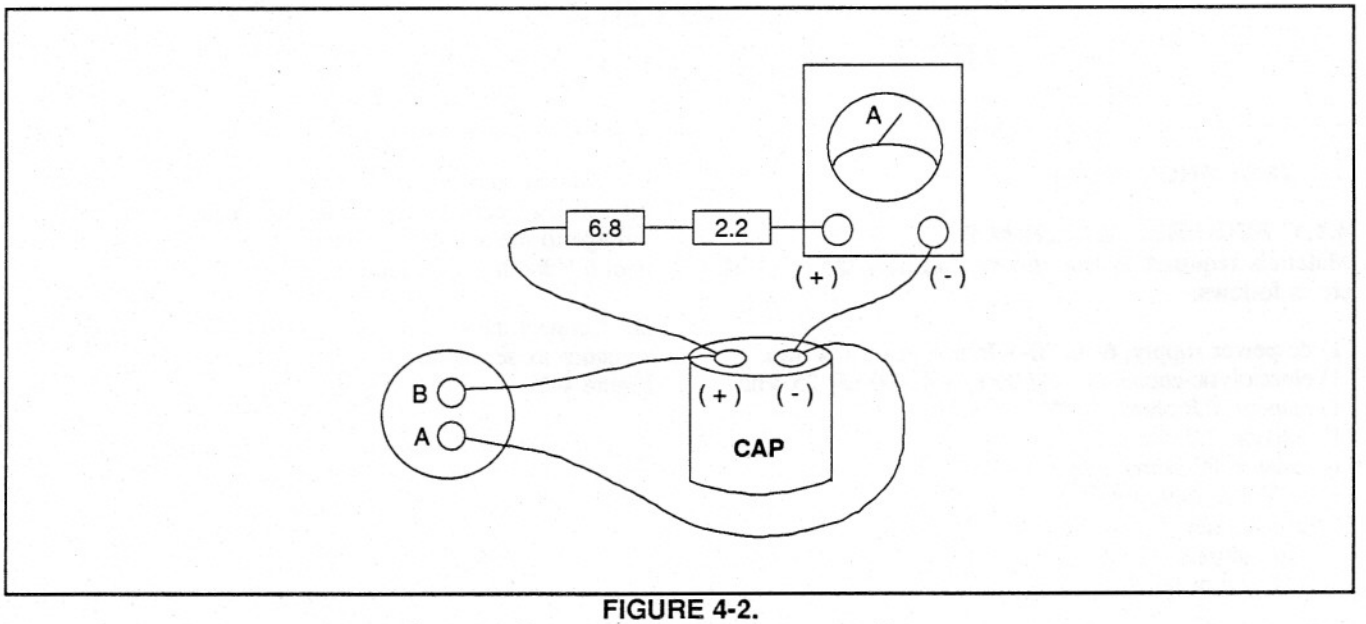

FIGURE 4-2.
Charger Current Limit Measurement Setup.

L. Connect the 2.2-ohm resistor across the capacitor. Observe that the charger indicates FAULT after a few seconds.

M. Repeat steps A through L for the other charger circuits.

N. Connect the 82-ohm resistor across the dc input of the charger on the front panel.

O. Measure the dc voltage across the resistor. Should be 0.0 Vdc +/- 0 Vdc.

P. Disconnect the ac input power source and connect the dc power supply to the dc input of the charger.

Q. Adjust the supply voltage to between 20 and 30 Vdc.

R. Verify the charger is working normally by performing steps A through E on one of the charger circuits.

S. Use the heat gun or blow torch to heat the thermostat until it trips. Check that the unit is then disabled until the thermostat trips back on.

T. End of test.

4.2 TROUBLESHOOTING

4.2.1 INDEX TO PROCEDURES

Table 4-1 is an index which will direct the technician to the proper troubleshooting procedure based on which step in the above test procedure was failed.

All the charger circuits are identical to one another. In the following procedures, the UC3906 charger IC is referred to as "IC" and the associated section of the LM324 opera-

TABLE 4-1.
Troubleshooting.

STEP FAILED	PERFORM TROUBLESHOOTING PROCEDURE
C	4.3.1
E	4.3.2
F	4.3.1
H	4.3.3
I	4.3.4
K	4.3.5
L	4.3.6
O	4.3.7
R	4.3.7

tional amplifier as "op amp." Perform the steps one by one, skipping to the next step as each is passed.

4.3 TROUBLESHOOTING PROCEDURES

4.3.1 CURRENT SOURCE

A. Measure the dc voltage at "+" terminal of rectifier bridge BR1. It should be 20 Vdc ±3 Vdc for ac operation, and about 1 Vdc less than the dc supply voltage for dc operation. If not, refer to procedure 4.3.8 for ac operation, procedure 4.3.7 for dc operation.

B. Check the indicator lights. If none is lit, refer to procedure 4.3.9.

C. If the CHARGING light is lit, skip to H.

D. At this point, the FAULT light is lit and there is more than 6 Vdc on the capacitor. Measure the dc voltage at pin 7 of the IC. If more than 100 mV, the IC should be replaced.

E. Measure the dc voltage at pin 12 of the IC. If less than 3 Vdc, check the resistive divider at pin 12.

F. Check for shorts to pin 11 of the IC. This pin drives the FAULT light through a resistor on the display board. If none, replace the IC.

G. Refer to procedure 4.3.9.

H. At this point the CHARGING light remains lit. If more than one indicator lamp is lit, refer to procedure 4.3.9.

I. Measure voltage from emitter to base of the MJE2955 pass transistor. If between 0.6 and 1.0 Vdc, skip to L.

J. If emitter-to-base voltage is less than 0.6 Vdc, replace IC.

K. If emitter-to-base voltage is more than 1.0 Vdc, replace pass transistor.

L. Check 1N5400 series diode using ohmmeter. If OK, replace pass transistor.

M. Replace 1N5400 diode.

4.3.2 BULK CHARGE CURRENT REGULATION

A. If dc current is OK, but CHARGING light is not lit, refer to procedure 4.3.9.

B. Measure dc voltage across 0.2-ohm current sense resistor. It should be 0.25 Vdc ±0.02 Vdc. If not, refer to procedure 4.3.1.

C. Turn off power and measure 0.2-ohm resistor. It should be within 5 %. If not, replace resistor.

D. Refer to procedure 4.3.1.

4.3.3 FLOAT CHARGE VOLTAGE

A. Measure the 100-kΩ and 20-kΩ 1-% resistors. The float voltage is set by the ratio of these resistors.

B. If the float voltage is radically wrong, refer to procedure 4.3.1 step I.

4.3.4 RESET FUNCTION

A. Measure the dc voltage on pin 3 of the IC. Press and hold the RESET button and observe the voltage drop to 0 Vdc.

B. Check the RESET switch and associated wiring.

4.3.5 OVERCHARGE VOLTAGE

A. Measure the 100-kΩ, 20-kΩ, and 330-kΩ 1-% resistors. The ratios of these resistors sets the overcharge voltage.

B. If the overcharge voltage is radically wrong, refer to procedure 4.3.1 step I.

4.3.6 UNDERVOLTAGE PROTECTION

A. If no indicator lights are lit, refer to procedure 4.3.9.

B. Refer to procedure 4.3.1 step E.

4.3.7 EXTERNAL DC SUPPLY INPUT

A. Measure D5, the MBR1635 diode with an ohmmeter. Replace if bad.

B. Measure from J5 pin B to PL7 pin 1 with an ohmmeter. It should measure short circuit. If not, check S6 and wiring.

C. Refer to procedure 4.3.8.

4.3.8 AC POWER SUPPLY

A. Check ac and dc fuses. If either fuse is blown, skip to D.

B. Measure across S5, the thermostat. The thermostat is closed until the chassis temperature reaches 75 degrees C. Replace if bad.

C. If problem is with operation from an external dc source, check all dc wiring at this point, both internal and external.

D. Remove the input power from the unit. Check BR1 rectifier bridge by measuring each of the four internal diodes using an ohmmeter. Replace if bad.

E. Measure from the "+" terminal of the bridge to the "-" terminal with the ohmmeter. If shorted, lift all the connections to the bridge and measure again. If still shorted, replace the bridge.

F. If there is no short, skip to I.

G. Remove the dc fuse. If there is still a short, check the power supply filter capacitor(s) one at a time for shorts. Replace if bad.

H. If there is still a short after the dc fuse has been removed, the short is on the inboard side of the fuse. The short can be isolated by lifting the various connectors and/or pressing the RESET buttons one at a time.

I. Measure the power transformer windings with the ohmmeter. Replace if bad.

4.3.9 PANEL INDICATORS

A. If more than one light is on at a time, skip to N.

B. If problem is not with FAULT light, skip to E.

C. If the FAULT light is not lighting properly, measure pin 11 of the charger IC with the dc voltmeter. There should be at least 10 Vdc during a fault condition. If not, replace IC.

D. If voltage is present but light is still not lit, check the light itself and its associated series resistor wiring.

E. Measure voltage on non-inverting input pin of op amp. Should be 1.2 to 1.5 Vdc. If not, measure for short to ground there. If no short, check bias diodes and series 10-kΩ resistor.

F. If problem is with READY light, skip to J.

G. Problem is with CHARGING light. During charging mode, measure op amp output voltage. It should be 15 Vdc or higher. If not, measure voltage on inverting pin of op amp. It should be 0 Vdc. If not, replace IC.

H. Check condition of 2N2222 transistor on display board. If this transistor is always in conduction, CHARGING and READY lights can never come on.

I. Check wiring.

J. Measure dc voltage at output of 12-V regulator IC on display board. It should be 12 V ±0.5.

K. If not, disconnect power and measure for short to ground at output of regulator. If no short, replace regulator.

L. During ready mode, measure op-amp output voltage. It should be 2 Vdc or less. If not, measure voltage on inverting pin of op amp. It should be greater than 1.5 Vdc. If not, replace IC.

M. Continue with steps H and I.

N. If FAULT light is on at same time as others, replace transistor on display board and continue with step C.

O. Check diodes on display board with ohmmeter.

P. Continue with steps H and I.

CHAPTER 5
TECHNICAL CIRCUIT DESCRIPTION

5.1 GENERAL

This chapter describes the circuitry of the PRC-BC4 in great enough detail so the technician can have a good understanding of the design. Note that there are four identical charger circuits. The description of that section therefore is limited to one of the charger circuits.

5.2 AC POWER SUPPLY

The internal ac power supply is a standard, full-wave design. The power transformer has a split primary so that it can be strapped for either 110- or 220-Vac operation. See section 2.3 for configuration instructions. The "phase" leg of the primary is switched and fused.

A full-wave monolithic diode bridge is used as the rectifier element, and C14, C15 and C16 form the filter. Peak-to-peak ac ripple is limited to about 2 V at full rated output.

S5 is a normally closed thermostat which opens at approximately 75 degrees C. It is wired in series with the dc fuse, so that if the chassis temperature is exceeded, the equipment is temporarily disabled.

A transient absorbing device, D13, is located on the display board. It will fail in a shorted mode if any transient exceeding 32 Vdc appears on the raw dc supply line, thus blowing the fuse.

5.3 DC POWER INPUT

A separate dc input is provided so the equipment can be operated from an external 20- to 30-Vdc source. Operating current from this source is fed directly to the filter capacitors through the reverse protection diode, D5. This diode prevents current from being drawn back out of the dc input connector while operating from the ac supply. The dc input power is also switched via the power switch.

5.4 CHARGER CIRCUIT

Only one of the charger circuits is described here, but the other three are identical and their individual components can be referred to by analogy.

Operation of this charger is best understood by tracing a charge cycle. There are three levels of charge state in each cycle: bulk charge, overcharge, and float charge.

5.4.1 BULK CHARGE STATE

The bulk charge state is initiated by the presence of a source of voltage, such as a battery, at the battery terminals of the charger. The charger IC samples the voltage there through the resistive divider formed by R2 and R5. Pin 12 of the IC is the sampling input, and pin 7 is the lower reference for the divider. Pin 7 is at ground potential whenever the power is applied to the IC. When the power is removed, pin 7 essentially floats. This is done so that no current can flow out of the battery when the power is shut off.

When the pin 12 voltage exceeds 2.5 Vdc, the bulk charge state is initiated. This corresponds to a battery voltage of 5.0 Vdc. If the battery voltage is lower than this, the charger remains in the fault condition where it started, and no current is supplied to the battery. This is done so that current will not be pumped into batteries which have shorted cells, or which are connected in reverse.

In the bulk charge state, the charger pulls current through the base of the series pass transistor Q1 via its driver at pin 16. R4, a current sensing resistor, is connected in series with the pass device and also to sensing pins on the IC. The charger only pulls just enough base current so that the voltage across this resistor is exactly 0.25 Vdc. In this design, that corresponds to a bulk charge current of 1.1 A.

5.4.2 OVERCHARGE STATE

The bulk charge state continues until the battery voltage reaches a preset level. This level is determined by the ratio of resistors R1, R3 and R6. These resistors are made to be 1 % values so that the various cutoff voltages are very precise. This helps to ensure meeting more exactly the battery's specifications under charge and therefore a longer battery life. The battery voltage is hence sampled very precisely at pin 13 by the IC. During the bulk charge state pin 10 of the IC is essentially grounded, which effectively replaces R1 in parallel with R3.

In this design the preset level is 14.0 Vdc. The charger then enters the overcharge state.

In the overcharge state, the battery voltage is held at 14.0 Vdc until the current decreases to one tenth (10 %) of the bulk charge rate, or 110 mA. This state is necessary to bring the battery back to full capacity without damaging the cells.

5.4.3 FLOAT STATE

The charger then enters the float state. At this time, pin 10 of the IC goes to a high impedance condition. This changes the voltage at which the charger maintains the battery to 13.3 Vdc. Whatever current the battery requires to stay at this voltage is provided up to 1.1 A. The battery is then considered fully charged and can be left on the charger for many years in this state.

5.4.4 REVERSION TO BULK CHARGE STATE

If for some reason the battery voltage drops below about 12 Vdc, the charger enters to bulk charge state once again.

A new charge cycle is begun and operation is identical with the above.

5.5 OTHER CHARGER FUNCTIONS

Pin 1 of the IC is a charge state output which toggles when the charge current drops to one-tenth (10 %) of the bulk charge rate. It is connected to pin 8 of the IC, the overcharge terminate pin. This forces the charger into the float state at that time. Pin 5 is the power supply input to the IC, and pin 6 is ground. The capacitor at pin 14 is simply a filter for the internal driver for the pass device. In order to avoid discharging the battery when the power is turned off, a series diode, D1, is used.

5.6 INDICATOR LIGHTS

The charge state of the circuit can be deduced by the levels of two signals available at the charger IC. These are the enable comparator output pin 11 and the state level output pin 10.

Pin 11 drives the FAULT light directly through current limiting resistor R2. This signal also drives the base of Q1, which when conducting, shunts voltage away from the CHARGING and READY lights through D1 and D2 so that they cannot light.

The CHARGING and READY lights are driven from the op-amp output, U5 pin 7. When the op-amp output is low, or near ground potential, the READY light conducts through D3 and R5. Voltage for this light is provided by the +12-Vdc supply. When the op-amp output goes high, its output voltage will be near the B+ voltage, but always greater than the +12 Vdc. Therefore, the READY light is reverse biased and cannot light. The CHARGING light then conducts through R8.

The op amp is configured as a voltage comparator. A fixed 1.3 Vdc is applied to the noninverting input using forward biased diodes D12 and D13. The inverting input is connected to pin 10 of the charger IC. During the bulk charge or overcharge states, pin 10 is at ground potential, and the op-amp output goes high. During the float charge state, pin-10 goes to the high impedance condition, and the pin 10 voltage is then equal to the pin-13 voltage. This is-normally about 2.5 Vdc, and the op amp output goes low.

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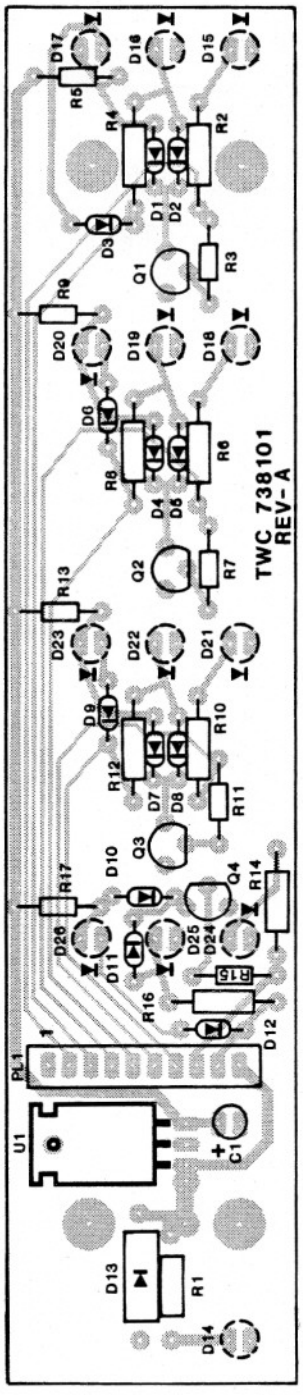

FIGURE 5-1.
Component Locations, Display Board.

TABLE 5-1.
Parts List, Display Board.

C1	241020	Capacitor, Tantalum 2.2μF
D1-D12	320002	Diode, 1N4148
D13	320211	Diode, 1N6283A 28 V Transorb
D14	320416	Diode, LED green
D15	320415	Diode, LED red
D16	320417	Diode, LED yellow
D17	320416	Diode, LED green
D18	320415	Diode, LED red
D19	320417	Diode, LED yellow
D20	320416	Diode, LED green
D21	320415	Diode, LED red
D22	320417	Diode, LED yellow
D23	320416	Diode, LED green
D24	320415	Diode, LED red
D25	320417	Diode, LED yellow
D26	320416	Diode, LED green
Q1-Q4	310057	Transistor, NPN PN2222A
R1	137332	Resistor, Film 1/2 W 5% 3.3 kΩ
R2	137272	Resistor, Film 1/2 W 5% 2.7 kΩ
R3	124103	Resistor, Film 1/4 W 5% 10 kΩ
R4	137332	Resistor, Film 1/2 W 5% 3.3 kΩ
R5	124182	Resistor, Film 1/4 W 5% 1.8 kΩ
R6	137272	Resistor, Film 1/2 W 5% 2.7 kΩ
R7	124103	Resistor, Film 1/4 W 5% 10 kΩ
R8	137332	Resistor, Film 1/2 W 5% 3.3 kΩ
R9	124182	Resistor, Film 1/4 W 5% 1.8 kΩ
R10	137272	Resistor, Film 1/2 W 5% 2.7 kΩ
R11	124103	Resistor, Film 1/4 W 5% 10 kΩ
R12	137332	Resistor, Film 1/2 W 5% 3.3 kΩ
R13	124182	Resistor, Film 1/4 W 5% 1.8 kΩ
R14	137272	Resistor, Film 1/2 W 5% 2.7 kΩ
R15	124103	Resistor, Film 1/4 W 5% 10 kΩ
R16	137332	Resistor, Film 1/2 W 5% 3.3 kΩ
R17	124182	Resistor, Film 1/4 W 5% 1.8 kΩ
U1	330007	IC, 7812CP

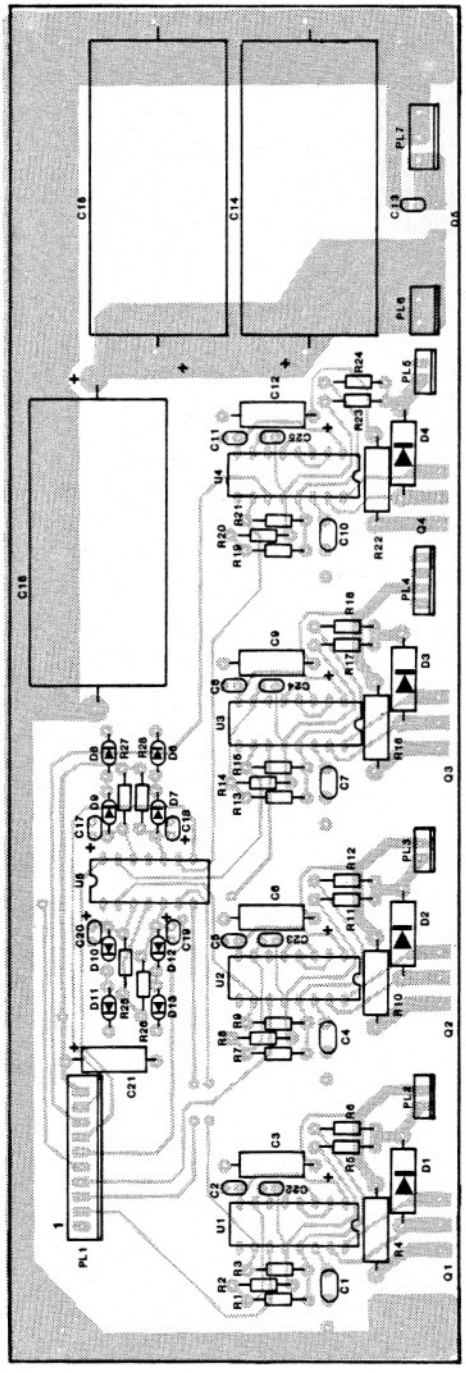

FIGURE 5-2.
Component Locations, Battery Charger Board.

TABLE 5-2.
Parts List, Battery Charger Board.

C1	254224	Capacitor, Mylar 100 V 0.22 µF
C2	275104	Capacitor, Monolithic 50 V 0.1 µF
C3	230020	Capacitor, Electrolytic 2.2 µF
C4	254224	Capacitor, Mylar 100 V 0.22 µF
C5	275104	Capacitor, Monolithic 50 V 0.1 µF
C6	230020	Capacitor, Electrolytic 2.2 µF
C7	254224	Capacitor, Mylar 100 V 0.22 µF
C8	275104	Capacitor, Monolithic 50 V 0.1 µF
C9	230020	Capacitor, Electrolytic 2.2 µF
C10	254224	Capacitor, Mylar 100 V 0.22 µF
C11	275104	Capacitor, Monolithic 50 V 0.1µF
C12	230020	Capacitor, Electrolytic 2.2 µF
C13	275104	Capacitor, Monolithic 50 V 0.1 µF
C14-C16	230502	Capacitor, Electrolytic 35 V 5,000 µF
C17-C20	241020	Capacitor, Tantalum 2.2 µF
C21	230020	Capacitor, Electrolytic 2.2 µF
C22-C25	275104	Capacitor, Monolithic 50 V 0.1 µF
D1-D4	320103	Diode, 3 A 50 V
D5*	320130	Diode, MBR-1635
D6-D13	320002	Diode, 1N4148
R1	127203	Resistor, Metal Film 1/4 W 1% 20 kΩ
R2	124104	Resistor, Film 1/4 W 5% 100 kΩ
R3	127334	Resistor, Metal Film 1/4 W 1% 330 kΩ
R4	144002	Resistor, Metal Film 1/4 W 22 Ω
R5	124104	Resistor, Film 1/4 W 5% 100 kΩ
R6	127104	Resistor, Metal Film 1/4 W 5% 100 kΩ
R7	127203	Resistor, Metal Film 1/4 W 1% 20 kΩ
R8	124104	Resistor, Film 1/4 W 5% 100 kΩ
R9	127334	Resistor, Metal Film 1/4 W 1% 330 kΩ
R10	144002	Resistor, Metal Film 1 W 22 Ω
R11	124104	Resistor, Film 1/4 W 5% 100 kΩ
R12	127104	Resistor, Metal Film 1/4 W 1% 100 kΩ
R13	127203	Resistor, Metal Film 1/4 W 1% 20 kΩ
R14	124104	Resistor, Film 1/4 W 5% 100 kΩ
R15	127334	Resistor, Metal Film 1/4 W 1% 330 kΩ
R16	144002	Resistor, Metal Film 1 W 22 Ω
R17	124104	Resistor, Film 1/4 W 5% 100 kΩ
R18	127104	Resistor, Metal Film 1/4 W 1% 100 kΩ
R19	127203	Resistor, Metal Film 1/4 W 1% 20 kΩ
R20	124103	Resistor, Film 1/4 W 5% 100 kΩ
R21	127334	Resistor, Metal Film 1/4 W 1% 330 kΩ
R22	144002	Resistor, Metal Film 1 W 22 Ω
R23	124104	Resistor, Film 1/4 W 5% 100 kΩ
R24	127104	Resistor, Metal Film 1/4 W 1% 100 kΩ
R25-R28	124103	Resistor, Film 1/4 W 5% 10 kΩ
U1-U4	330325	IC, UC3906N
U5	330030	IC, LM324N

* Part located on the heatsink.

TABLE 5-3.
Parts List, Mainframe.

BR1	320501	Diode Bridge, 35 A 100 V
F1	550018	Fuse, 3AG 1.5 A (110 V)
	550040	Fuse, Slow-blow 0.75 A (220 V)
F2	550008	Fuse, 3AG 7 A
J1-J3	613120	Connector, Dc Output
J4	610086	Connector, Dc Output
J5	613097	Connector, Dc Input
J6	610401	Connector, Ac Input
S1-S4	530030	Switch, Reset
S5	560001	Switch, Thermostat
S6	520018	Switch, Ac/dc
T1	410026	Transformer, 14.5 V 12 A

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