1. DESCRIPTION
(Refer to Figure 1)

1.1 Model TPN1191A Standard Power Supply is a high efficiency, solid state, power source for operation of base and repeater radio stations. The power supply consists of three main sections: transformer/rectifier/filter, distribution board, and auxiliary regulator board. Refer to Table 1 for the power supply model complement.

1.2 The transformer has a primary winding, a high current secondary winding, and a resonant secondary winding. Under normal operations, the current in the resonant winding causes the transformer core to saturate, limiting the transformer output voltage. Rectifying and filtering the transformer output produces a stable direct current output.

1.3 The distribution board consists of four power supply fuses and circuitry for overvoltage protection. Transistorized circuitry senses a high dc voltage and adds loading for voltage reduction.

1.4 The auxiliary regulator board consists of two current limited linear series pass regulators. These regulators are set for 9.4 V and 13.9 V. The 9.4 V regulator draws power from the main ferroresonant supply output. The 13.9 V regulator draws full-wave rectified power directly from the ferroresonant transformer.

1.5 The features of this power supply include short circuit protection which is inherent in the ferroresonant power transformer, and overvoltage protection. Refer to Table 2 for performance specifications.
2. THEORY OF OPERATION

2.1 TRN5336A STANDARD POWER SUPPLY

The TRN5336A Power Supply performs the conversion of ac line voltage to the dc voltages required by the radio. The supply consists of rectification, filtering, and regulation.

2.1.1 Rectification and Filtering

The secondary voltage of transformer T601 is rectified by CR601 and CR602. Ground connection for the diodes is provided through the heat sink to chassis. Output filtering is provided by the network of C602, C603, L601, and C604.

2.1.2 Regulation

Line and load regulation is provided by the ferroresonant action in the secondary resonant winding of the power transformer T601. The high voltage winding resonates with C601, causing the secondary to saturate and restrict the secondary output voltage.

2.2 TPN6138B DISTRIBUTION BOARD

The TPN6138B Distribution Board provides overcurrent and overvoltage protection for the power supply. Refer to the functional and schematic diagrams for circuit details. Secondary voltage fusing is provided by F602 thru F605. Overvoltage protection is provided by a surge protection circuit consisting of Q601 thru Q604. A surge in excess of 18 V causes VR601 to conduct. Forward bias current through R602 and base-emitter junction of Q604, turns on Q604. The other transistors turn on, and the chassis mounted R601 acts as a pull-down lead for the line voltage surge.

2.3 TRN5119A AUXILIARY REGULATOR BOARD

The TRN5119A Auxiliary Regulator Board provides regulated 9.4 V and 14 V for the radio. The board circuitry consists of a reference voltage, 9.4 V and 14 V regulators, temperature compensated overcurrent amplifier, and a local control inhibit inverter.

Table 2. Performance Specifications

<table>
<thead>
<tr>
<th>Operating Temp</th>
<th>Input Voltage</th>
<th>Line Current*</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°C to +80°C</td>
<td>96-132 V, 60 Hz</td>
<td>8A max at full load, power supply output</td>
</tr>
</tbody>
</table>

HIGH CURRENT OUTPUT

<table>
<thead>
<tr>
<th>Steady State Output Voltage</th>
<th>13.1 or 16.3 Vdc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Current</td>
<td>30.4A at 14.1 V</td>
</tr>
<tr>
<td>Load Transient</td>
<td>Shall not drop below 11.5 V for a 2A to 36A transient</td>
</tr>
<tr>
<td>Output Ripple</td>
<td>50 mV typ at 25°C</td>
</tr>
<tr>
<td></td>
<td>Dc max at -30°C</td>
</tr>
</tbody>
</table>

9.4 OUTPUT

<table>
<thead>
<tr>
<th>Output Voltage</th>
<th>9.4 V dc, set nominal (9.1-9.7 Adjustable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Ripple</td>
<td>Less than 18 mV rms when installed in station</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>Shall not change more than 50 mV over input range</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>Shall not change more than 150 mV from no load to full load</td>
</tr>
<tr>
<td>Max. Output Current</td>
<td>1.1A at +80°C</td>
</tr>
<tr>
<td>Current Limit</td>
<td>2.3A typ at 25°C</td>
</tr>
<tr>
<td>Short Circuit Current</td>
<td>0.77 mV typ at 25°C</td>
</tr>
</tbody>
</table>

14V OUTPUT

<table>
<thead>
<tr>
<th>Output Voltage</th>
<th>17.5 V dc, set nominal (13.5-14.1 Adjustable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Ripple</td>
<td>Less than 18 mV rms when installed in station</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>Shall not change more than 25% over input range</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>Shall not change more than 150 mV from no load to full load</td>
</tr>
<tr>
<td>Max. Output Current</td>
<td>1.66A at +80°C</td>
</tr>
<tr>
<td>Current Limit</td>
<td>2.5A typ at 25°C</td>
</tr>
<tr>
<td>Short Circuit Current</td>
<td>0.07A max, 0.25A</td>
</tr>
</tbody>
</table>

* When calculating primary power requirements do not use Line Current to calculate dissipated power. Use a power meter with provisions for non-unity Power Factor.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE
2.3.1 Reference Voltage

The operational amplifiers on the circuit board requires a stable reference voltage. This reference voltage is produced in two stages of circuitry. The first stage consists of VR-4 and R40 which are connected to J1-1 and main 13.8 V. Diode VR-4 regulates at 9.6 V. The second stage which operates from this 9.6 V is temperature compensated and consists of VR1, CR2, and R39. The resultant 6.5 V reference is feed to each of the operational amplifiers.

2.3.2 9.4 V Regulator

2.3.2.1 The 9.4 V regulator is a series pass type circuit using a PNP transistor (Q6). A PNP type transistor can provide voltage regulation with as little as 0.7 V differential between collector and emitter. This means that the input voltage can go as low as 10.4 V, and the circuit will still maintain voltage regulation. The voltage regulator circuitry provides output voltage adjustment, correction for changes of input voltage and load and overcurrent protection.

2.3.2.2 The 9.4 V regulator output voltage (J5-6) is set by the 9.4 V VOLTAGE ADJUST potentiometer, R35. The voltage from R35 goes to U1A-2 and is compared to U1A-3, the reference voltage input. The differential voltage appears at U1A-1. For example, if U1A-2 becomes less positive, the output at U1A-1 becomes more positive, causing Q7 to conduct harder. Increased collector current at Q7 causes increased base-emitter current at Q6. As a result, Q6 conducts harder, with a resultant higher (more positive) regulated output voltage at J5-6.

2.3.2.3 The circuitry described in the previous paragraph is a negative feedback loop. It maintains a constant output voltage for changes in load or input voltage. The feedback loop has typically 40 dB of gain at dc to give a load-line regulation of ±0.1 V dc maximum from no load to full load. As an example, for an increase in load current, the regulator output voltage would normally decrease. The reduced output voltage is sensed at U1A-2, which is now less positive than U1A-3, the reference voltage. U1A-1 goes more positive and drives Q7 into further conduction. An increase in collector current of Q7 causes increased conduction of Q6 which returns the regulated output voltage to normal. A decrease in load current causes the opposite action.

2.3.2.4 The overcurrent protection circuitry is of the current foldback type. As the load increases beyond the knee, the output voltage and current decrease simultaneously to a final short circuit current of 0.77 amp maximum. The current is sensed across R20. When this voltage exceeds about 0.3 volts (representing a load current of about 2.3 amps), Q8 is forward biased and starts to conduct. Its collector goes positive, causing Q9 to conduct thru R23 and R25. Q9 conducting lowers the voltage at R28 (VREF). As the voltage on U1A-3 lowers, it causes the voltage on U1A-1 to go lower, forcing Q7 and Q6 to conduct less. As a result, the output voltage (9.4 V regulated) decreases. As output current increases, Q8 and Q9 conduct harder resulting in higher Q6 impedance. This action continues until the output voltage decreases to about 6.5 V. At this point, CR10 becomes forward biased, and the emitter current of Q10 increases. This results in an increased voltage across R21. This will forward bias Q8 harder. As a result less output current can be drawn under a short circuit condition. This is desirable because the power dissipated in Q6 is now reduced.

2.3.3 14 V Regulator

2.3.3.1 The 14 V regulator is a series pass type circuit using PNP transistors (Q1 and Q11). A PNP type transistor can provide voltage regulation with as little as 0.7 V differential between collector and emitter. This means that the input voltage can go as low as 14.7 V, and the circuit will still maintain voltage regulation. The voltage regulator circuitry provides output voltage adjustment, correction for changes of input voltage and load current, and overcurrent protection.

2.3.3.2 The input filter circuitry provides power to the 14 V regulator. CR1 and CR15 rectify ac to dc (26-34 V). Resistors R47 and R48 limit the surge and reduce the ripple current filter capacitor C1.

2.3.3.3 The 14 V regulated (J5-2) is set by the 14 V VOLTAGE ADJUST potentiometer, R7. The voltage from R7 goes to U1C-9 and is compared to U1C-10, the reference voltage input. The differential voltage appears at U1C-8. For example, if U1C-9 becomes less positive, the output at U1C-8 becomes more positive, causing Q2 to conduct harder. Increased collector current at Q2 causes increased base-emitter current at Q1 and Q11. As a result Q1 and Q11 conduct harder, with a resultant higher (more positive) regulated output voltage at J5-2.

2.3.3.4 The circuitry described in the previous paragraph is a negative feedback loop. It maintains a constant output voltage for changes in load or input voltages. The feedback loop has typically 40 dB of gain at dc to give a load-line regulation of ±0.1 V dc maximum from no load to full load. As an example, for an increase in load current, the regulator output voltage would normally decrease. The reduced output voltage is sensed at U1C-9, which is now less positive than U1C-10, the reference voltage input. U1C-8 goes more positive and drives Q2 into further conduction. An increase in collector current of Q2 causes increased conduction of Q1 and Q11. The regulator output returns to normal. A decrease in load current causes the opposite action.

2.3.3.5 The overcurrent protection circuitry is of the current foldback type. As the load increases
beyond the knee, the output voltage and current decrease simultaneously to a final short circuit current of 0.77 ampere maximum. The current is sensed across R10. When this voltage exceeds about 0.3 volts (representing a load current of about 2.3 amperes), Q3 is forward biased and starts to conduct. Its collector goes positive, causing Q4 to conduct through R13 and R14. Q4 conducting lowers the voltage at R9 (V REF). As the voltage on U1C-10 lowers, it causes the voltage on U1C-8 to go lower forcing Q2, Q1, and Q11 to conduct less. As a result, the output voltage (14 V regulated) decreases. As output current increases, Q3 and Q4 conduct harder, resulting in higher Q1 and Q11 impedance. This action continues until the output voltage decreases to about 6.5 V. At this point, CR5 becomes forward biased, and the emitter current of Q5 increases. This results in an increased voltage across R11. This will forward bias Q3 harder. As a result less output current can be drawn under a short circuit condition. This is desirable because the power dissipated in Q1 and Q11 is now reduced.

2.3.4 Temperature Compensated Overcurrent Amplifier

The temperature compensated overcurrent amplifier (U1D) compensates the knee of the 9.4 V and 14 V overcurrent detect circuits (Q3 and Q8). Compensation allows operation from −30°C to +80°C without major degradation in available output current. Compensation begins at diodes CR13 and CR14. These diodes are temperature sensitive, having a voltage decrease of about 2 mV from an increase of each degree centigrade. A temperature increase makes U1D-14 less positive. Both Q5 and Q10 reduce collector current with a reduction in voltage drop across R11 and R21. The reduced bias voltage developed across these resistors counteracts the effects of high ambient temperatures on Q3 and Q8.

2.3.5 Local Control Inhibit Inverter

The local control inhibit inverter (U1B) is used to turn off the 9.4 V and 14 V voltage regulators externally for local control operation. When used, jumper JU2 is removed, and J5-5 is connected to ground through the normally closed contacts of a switch. Opening the switch contacts causes U1B-7 to go high. Both Q4 and Q9 are driven into saturation. U1C-8 and U1A-1 are pulled low which cuts off Q6, Q1, and Q11.

3. REGULATED OUTPUT VOLTAGE ADJUSTMENT PROCEDURE

The regulated output voltages can be adjusted with the auxiliary regulator board in the radio or on the service bench. If adjusted on the test bench, the regulator must be supplied 14 V at J1-1 and +28 V at J1-6 or J1-7. The outputs must be loaded to 1.1 ampere each.

Step 1. Measure the regulated output voltages at TP101 (9.4 V) and TP111 (14 V).
Step 2. Set R35 for 9.4 V ± 0.1 V.
Step 3. Set R7 for 13.9 ± 0.1 V.

4. MAINTENANCE

4.1 INTRODUCTION

Maintenance and repairs of this power supply demands a thorough understanding of its operation. Refer to the Power Supply Theory of Operation for this information.

4.2 TEST EQUIPMENT REQUIRED

The following test equipment is necessary for efficient, accurate servicing in the event that maintenance is required.

- 3-1/2 digit DVM (Motorola Model R1001A or equivalent).
- DC current meter (50 amperes)
- Load resistor (variable from 0 ohms to 15 ohms, and capable of carrying 50 amperes).
- Variable voltage ac line transformer (0-130 volts).
- Oscilloscope.
- Bench service cord consisting of:

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15-83182N01</td>
<td>Housing</td>
</tr>
<tr>
<td>2</td>
<td>39-83143N01</td>
<td>Contact</td>
</tr>
<tr>
<td>1</td>
<td>39-83143N02</td>
<td>Contact</td>
</tr>
<tr>
<td>1</td>
<td>30-865903</td>
<td>Cord</td>
</tr>
</tbody>
</table>

4.3 AUXILIARY REGULATOR CHASSIS REMOVAL
(Refer to Figure 2)

The circuitry on the auxiliary regulator chassis can be serviced without removing the entire power supply. The auxiliary chassis below the main chassis can be disconnected and removed separately.

Step 1. Disconnect P1 and P5.
Step 2. Remove the three screws holding the auxiliary chassis to the main chassis. Use a magnetic screwdriver.
Step 3. Lift the auxiliary regulator chassis out of the cabinet.
Step 4. Remove circuit board(s) by compressing the plastic locking tabs.

4.4 POWER SUPPLY REMOVAL
(Refer to Figures 2 thru 5)

**WARNING**
The power supply is unexpectedly heavy, and balances sharply to the right. Follow the removal instructions carefully.
Figure 2. Power Supply Mounting Hardware

Figure 3. Power Supply Chassis Travel Distance

Figure 4. Properly Gripped Chassis
Step 1. Disconnect P5 and P103 (for battery power supply). Open tie wraps and reposition cable.

Step 2. Remove MAIN CHASSIS SCREWS and loosen MAIN CHASSIS CAPTIVE SCREWS. Remove the two shipping screws (Motorola Part No. 3-83498N08) and washers (Motorola Part No. 4-135873) located under the main chassis side rails. These screws need not be replaced when re-installing the power supply unless the station is to be shipped to another location. Retain the screws for further shipping needs.

Step 3. Slide power supply chassis toward you until chassis is flush with cabinet as shown in Figure 3.

---

**WARNING**

Do not allow chassis to slide freely beyond front of cabinet: Cabinet rail support ends abruptly.

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Step 4. Grip the main chassis with the right hand as shown in Figure 4. Find a comfortable grip around the flattened parts of the metal. Adjacent parts have sharp edges.

Step 5. Plant your feet firmly with good balance to receive a heavy weight.

Step 6. Slide the power supply toward you. Slightly tilt the chassis toward you and reach the left hand over the top to balance the chassis on the cabinet rails. Press the chassis firmly against the rails or the chassis will suddenly slide out of the cabinet. See Figure 5.

Step 7. Reposition the left hand from balancing the chassis to a firm grip.

Step 8. Brace your body to receive a heavy weight, and lift the power supply chassis free of the cabinet.
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Corrective Action</th>
</tr>
</thead>
</table>
| A. No output voltage | 1) Check primary line connection to supply.  
2) Check transformer secondary voltage at T3601.  
3) Check power rectifiers CR601 and CR602. |
| B. No regulated output voltages | 1) Check for approximately 14 volts at J1-1. If no voltage, check fuse F603.  
2) Check for approximately 6.5 volts at TP105, 6.5 V REF. If no voltage, check CR2 and VR1.  
3) Check for grounded CR4 and CR8, REGULATOR INHIBIT lead.  
4) Check for defective U1B.  
5) Check for defective U1D. |
2) Check Q3 and Q4. TP105 should be 6.5 volts.  
3) Check U1C.  
4) Check Q2 for open circuit.  
5) Check Q1 and Q11 for open circuit.  
6) Check VR2 for short.  
7) Check for short circuit at J5-2. |
| D. 14 V regulated output: OK. No 9.4 V regulated output | 1) Check Q8 and Q9. TP104 should be 6.5 volts.  
2) Check U1A.  
3) Check Q7 for open circuit.  
4) Check Q6 for open circuit.  
5) Check VR3 for short circuit.  
6) Check for short circuit at J5-6. |
| E. Regulators cannot supply full rated current of 1.1A (output drops more than 1 volt.) | 1) Check U1D, Q3, Q4, Q8 and Q9. |
| F. Regulators short circuit current greater than 0.8A, and possibly input fuse blowing. | 1) Overcurrent detect circuits defective. Check U1D, Q3, Q4, Q8 and Q9.  
2) Check CR5 and CR10. |
| G. Regulated output voltages cannot be adjusted to 9.4 ±0.1 V and 13.9 ± 0.1 V. | 1) Check 6.5 V REF. It should be 6.5 ±0.2 volts. If not, check CR2, VR1, and VR4.  
2) Check regulator feedback loop: U1A, Q7, and Q6; U1C, Q2, Q1 and Q11.  
3) Check for defective Q2 and Q7. |
| H. High ac ripple voltage on 14 V regulated output: greater than 10 mV at 1.5A. | 1) Check filter capacitor C1 for low capacity or leakage. Ripple voltage at TP100 is greater than 4 V peak-to-peak.  
2) Check U1C for low loop gain: less than 20 dB. |
### Parts List

<table>
<thead>
<tr>
<th>REFERENCE SYMBOL</th>
<th>MOTOROLA PART NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q-011</td>
<td>46-098772</td>
<td>EMBR (GREY)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PNP, +28Vdc</td>
</tr>
<tr>
<td>Q-015</td>
<td>15-946682</td>
<td>MOUNTING, 3.1/16&quot; dia.</td>
</tr>
<tr>
<td></td>
<td>15-946683</td>
<td>HOUSING, 3.1/16&quot; dia.</td>
</tr>
<tr>
<td></td>
<td>15-946876</td>
<td>MOUNTING, 3.1/16&quot; dia.</td>
</tr>
</tbody>
</table>

**Mechanical Parts:***
- 7-149127: SNAP RING, 9/16" x 1 1/2" x 0.062
- 24-87331101: STANDOFF, 3/4" dia.
- 3-180460: SPRING, 4.5 x 0.125" dia.
- 9-1804700: SOCKET, transmitter, 3-7/16" dia.
- 1-1688103: INDUCTOR, 3-7/16" dia.
- 29-4547900: TERMINAL, (used) |

---

**57502B Hardware Kit**

<table>
<thead>
<tr>
<th>REFERENCE SYMBOL</th>
<th>MOTOROLA PART NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q-015</td>
<td>15-824494</td>
<td>CONNECTOR</td>
</tr>
<tr>
<td></td>
<td>MOUNTING, 3.1/16&quot;</td>
<td></td>
</tr>
</tbody>
</table>

**Mechanical Parts:***
- 3-14055400: STANDOFF, 3.1/16" dia. |
- 15-8244906: 2 Used |
- 43-15054101: STANDOFF, 3.1/16" dia. |
- 1-8654950: Assembly, Wire and Log Circuit, 3-7/16" dia. |
- 29-8097900: TERMINAL, 3.1/16" dia. |
- 45-0211033: TERMINAL, 3.1/16" dia. |

---

**85213B Hardware Kit**

<table>
<thead>
<tr>
<th>REFERENCE SYMBOL</th>
<th>MOTOROLA PART NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q-015</td>
<td>15-816140</td>
<td>CONNECTOR</td>
</tr>
<tr>
<td></td>
<td>MOUNTING, 3.1/16&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MOUNTING, 3.1/16&quot;</td>
<td></td>
</tr>
</tbody>
</table>

**Mechanical Parts:***
- 3-15039401: SNAP RING, 5/8" x 3/16" dia. |
- 3-15039504: SNAP RING, 7/8" dia. |
- 61-1217000: STANDOFF, 3.1/16" dia. |
- 24-1110010: TERMINAL, 3.1/16" dia. |
- 24-1110020: TERMINAL, 3.1/16" dia. |
- 46-08140101: PLUG, 3-PIN |

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**Parts Locations and Lists**

Motorola No. PRP5-14739-B

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**14031873, L & G**

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**STANDARD POWER SUPPLY**

The following parts are not listed in this document:
- TRANSFORMER (used)
- TRANSISTOR (used)