ERICSSON

Mobile Communications

13.8-VOLT 30-AMPERE POWER SUPPLY

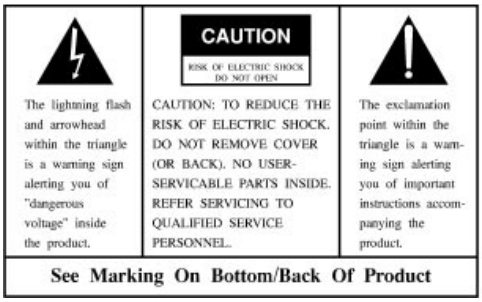
19B801020P4

CAUTION

THESE SERVICE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER ALL SERVICING TO QUALIFIED SERVICE PERSONNEL.

WARNING: TO PREVENT FIRE OR ELECTRIC SHOCK HAZARD, DO NOT EXPOSE THIS PRODUCT TO RAIN OR MOISTURE

CAUTION: TO PREVENT ELECTRIC SHOCK DO NOT USE THIS (POLARIZED) PLUG WITH AN EXTENSION CORD. RECEPTACLE OR OTHER OUTLET UNLESS THE BLADES CAN BE FULLY INSERTED TO PREVENT BLADE EXPOSURE.



Maintenance Manual

TABLE OF CONTENTS

Figures

Copyright © September 1993, Ericsson GE Mobile Communications Inc.

SPECIFICATIONS*

GENERAL

Size (H x W x D)	115 x 121 x 270 mm (2.92 x 3.07 x 6.86 inches)
Weight	2693 grams (95.0 ounces)
Operating Temperature Range	-40°C to +60°C
Cooling	free air convection (no fan)

ELECTRICAL

Input Voltage Ranges	
Low Range (120 Vac nominal)	90 - 135 Vac
High Range (240 Vac nominal)	180 - 270 Vac
Input Voltage Range	selectable with internal jumper
Input Current	7A maximum at 100 Vac 4A maximum at 200 Vac
Input Power Fuse	10A time delay
Input AC Frequency	50 - 65 Hz
Output Voltage	13.8 Vdc
Output Voltage Stability	better than ±1%
Output Voltage Adjustable Range	±5% with internal potentiometer
Output Current Capability	
Continuous	15 A
Intermittent	30 A
Output Current Duty Cycle at 30 A	20% (one minute on, four minutes off or five minutes on, fifteen minutes off)

WARNING

This unit contains dangerous voltage levels. It is strongly recommended that defective units be returned to the manufacturer for repairs.

If field repair is necessary, remove the input power and then use a load resistor to manually discharge each capacitor before servicing.

IMPORTANT SAFETY INFORMATION

1. **SAVE THIS MANUAL**·- It contains important safety and operating instructions.

2. Before using the product, please follow and adhere to all warnings, safety and operating instructions located on the product and in this manual.

3. Do not use auxiliary equipment not recommended or sold by the manufacturer. To do so may result in a risk of fire, electrical shock or injury to personnel.

4. DO NOT expose product to rain, snow or other type of moisture.

5. Care should be taken so objects do not fall or liquids do not spill into the product.

6. DO NOT expose product to extreme temperatures.

7. To reduce risk of damage to electrical cord, pull by plug rather than cord when disconnecting unit.

8. Make sure the cord is located so it will not be stepped on, tripped over or otherwise subjected to damage or stress.

9. An extension cord should not be used unless absolutely necessary. Use of an improper extension cord could result in a risk of fire and electric shock. If an extension cord must be used, make sure:

   a. That pins on the plug of the extension cord are the same number, size and shape as those of the plug on the power supply.

   b. That the extension cord is properly wired in good condition, and

   c. That the wire size is large enough for the AC ampere rating of unit.

10. DO NOT operate unit with a damaged cord or plug - replace them immediately.

11. Do not operate unit if it has received a sharp blow, been dropped, or otherwise damaged in any way. Return to a qualified service shop.

12. Do not disassemble unit. Return to a qualified service shop when service or repair is required. Incorrect reassembly may result in a risk of electrical shock or fire.

13. DO NOT operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

14. To reduce risk of electric shock, unplug unit from outlet before attempting any maintenance or cleaning.

15. DO NOT operate this product with covers or panels removed. This unit does not contain any user serviceable components.

16. Use only fuses of the correct type, voltage rating and current rating as specified in the parts list. Failure to do so can result in fire hazard.

17. **GROUNDING AND AC POWER CORD CONNECTION** - To reduce risk of electrical shock use only a properly grounded outlet. The unit is equipped with an electric cord having an equipment - grounding conductor and a grounding plug. Be sure the outlet is properly installed and grounded in accordance with all local codes and ordinances.

18. DANGER - Never alter the AC cord or plug. Plug into an outlet properly wired by a qualified electrician. Improper connection or loss of ground connection can result in risk of an electrical shock

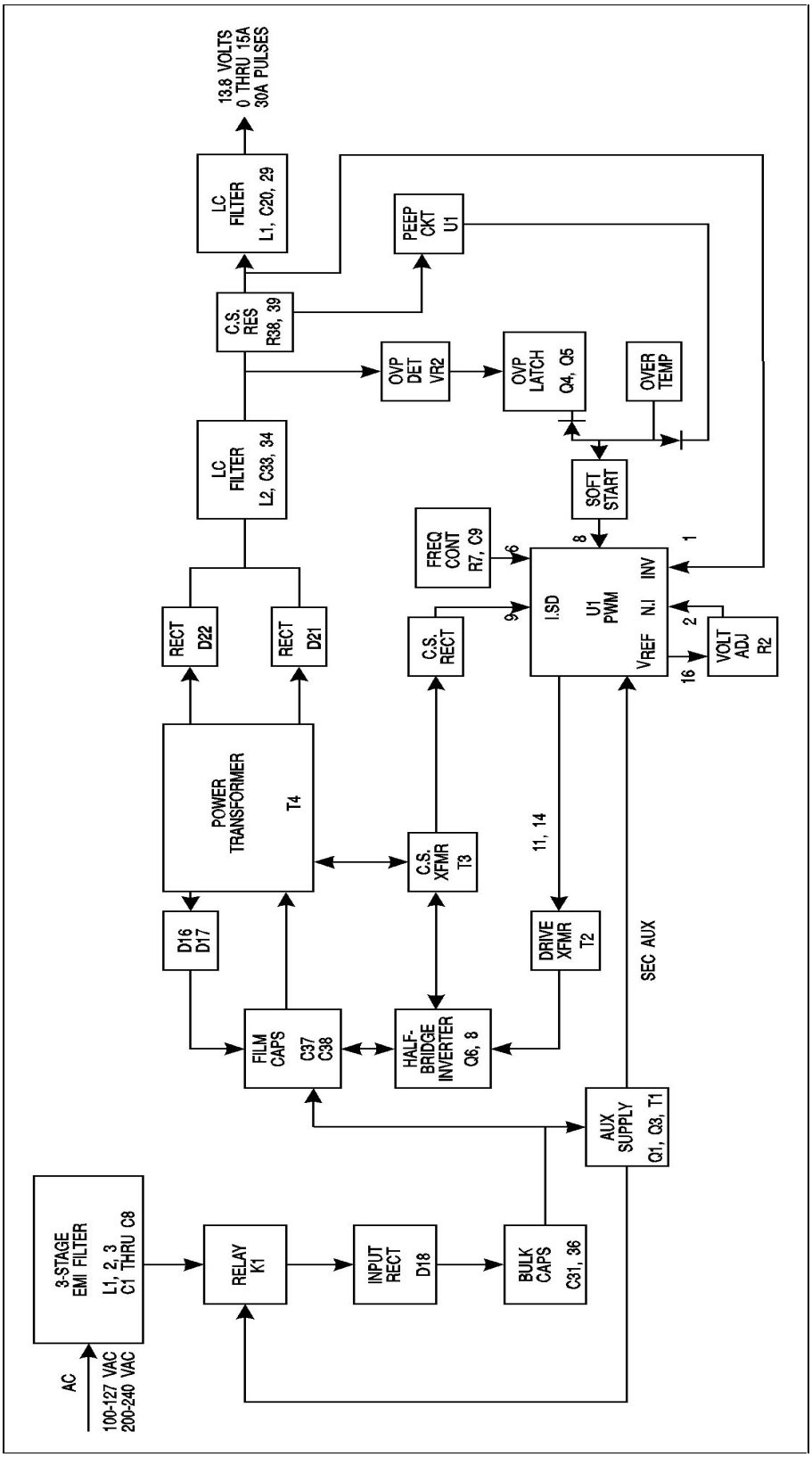


Figure 1 - 30 Amp Power Supply Block Diagram

DESCRIPTION

Power Supply 19B801020P4 is a 13.8-Volt 30-ampere power supply used in the Ericsson GE desk-top stations. It features pulse-width modulated switching regulator technology and MOSFET (Metal-Oxide Semiconductor Field Effect Transistor) driver transistors to produce a compact and efficient design. Application of the MOSFET drivers eliminates the need for large external heat sinks that are normally required with high-current regulated DC power supplies. The supply can be configured for a nominal AC input voltage of 120 Vac or 240 Vac. Voltage selection is accomplished with an internal jumper located on the Power Supply Board. See the Block Diagram in Figure 1.

CIRCUIT ANALYSIS

LINE FILTER BOARD

The Line Filter Board provides EMI and RFI filtering for the supply. It also includes slow-blow 10-ampere line fuse F2.

AC input power from the line cord is applied to the Line Filter Board at terminals TB1 and TB5. Terminal TB4 is the AC ground connection. The pi-section filters on this board utilize two (2) common-mode chokes, L1 and L2. Terminals TB2 and TB6 deliver the AC power to TB4 and TB6 on the Power Supply Board.

POWER SUPPLY BOARD

AC Input, Rectifier, And Input Filter Capacitors

AC input power from the Line Filter Board is applied to terminals TB4 and TB6. Terminal TB1 on the Power Supply Board is the ac ground connection. At turn-on, surge protection relay K1 contacts are open. The AC input power is therefore applied to diode bridge rectifier D18 via RT1 and R41. D18 rectifies the AC input power and charges input filter capacitors C31 and C36. Shortly after turn-on, K1 energizes and its contacts close to apply full AC power to D18. The turn-on surge protection relay control circuit is described in greater detail in the section that follows. Each filter capacitor charges to approximately 165 Vdc when the power supply's output is not loaded.

NOTE

If the supply is configured for a 120 Vac nominal input, terminals TB5 and TB7 are jumpered. If it is configured for a 240 Vac nominal input, terminals TB7 and TB8 are jumpered.

Turn-On Surge Protection Relay Control And VCC Source

Transformer T1, transistors Q1, Q3, and associated components form an aux converter circuit that provides DC power to energize turn-on surge protection relay K1. It also provides the VCC power source for the switching regulator circuit. Transformer T1 has 4 windings: a primary winding, a feedback winding, a winding to energize the in-rush current limiting relay and a winding to provide the secondary (aux) voltage.

The primary section of the converter circuit operates as follows: Filtered DC power from the input filter capacitors is applied to the primary winding of T1 (pins 12 to 8) by resistor R42. Feedback winding (pins 2 to 4) drives transistor Q1 and the remaining components in the feedback loop set the oscillator's frequency to approximately 150 kHz. Transistor Q3 senses the current through Q1 and the primary of T1 so it can turn Q1 off before the transformer reaches the core saturation point.

The turn-on surge protection circuit's primary purpose is to limit the $\mathbf{I^2_t}$ product, thus increasing the life of breakers, fuses, connectors, switches, feed-throughs and rectifier diodes in the circuit for charging the bulk caps. It also reduces the noise spike (voltage drop) on the line when the supply is turned on. This circuit energizes relay K1 approximately 100 milliseconds after turn-on to apply full AC power to bridge rectifier D18. Alternating current from T1's secondary winding (pins 1 to 2) is half-wave rectified by D15. This source charges C32 to approximately 12 Vdc and energizes K1.

The VCC source is developed by the other secondary winding (pins 9 to 11), rectifier diode D1 and filter capacitor C22. This source operates at approximately 15 Vdc.

SWITCHING REGULATOR CIRCUIT

The switching regulator circuit is formed by integrated circuit U1, transformers T2 through T4,

transistors Q2, Q6 through Q9, and associated components. Switching regulator U1 (UC1825J) is the heart of the circuit. This pulse-width modulated regulator IC switches the MOSFET driver transistors on and off at approximately 150 kHz to develop alternating currents in the primary of T4. The power transformer undergoes a complete cycle every 2 clock cycles making the converter a 75 kHz half-bridge. The resulting secondary currents are rectified by dual-diodes D21 and D22, filtered by the output pi-filter network and applied to the output terminals of the power supply.

The 13.8 Vdc regulator circuit samples the voltage at the junction of L1, L2 and C34 (point #47). This sampled feedback voltage is applied to U1 pin 1 by the attenuator network formed by resistors R13 and R20. U1 pin 1 is the inverting input of an error amplifier in U1. This error amplifier compares this feedback voltage to a reference voltage applied to its non-inverting input. This reference voltage is set with output voltage adjust trimmer R2. When the supply is in regulation the junction of R13 and R20 will be 2.5 Vdc. The error amplifier's output controls the pulse-width modulating (PWM) switching control circuitry in U1 to maintain a regulated 13.8 Vdc output.

MOSFETs Q6 and Q8 operate in a push-pull mode to alternately pump current through each half of the primary of output transformer T4. Each MOSFET is driven by a secondary winding of transformer T2 using rectifier diodes D26 and D27. Transistors Q7 and Q9 are for fast turn-off of Q6 and Q8, respectively. These along with zener diodes VR3 and VR4 clamp the MOSFET gate voltages to within safe limits. To dissipate heat, Q6 and Q8 are mounted to the chassis. However, since these devices are operating in a switching mode, they generate very little heat under normal operating conditions. Switching regulator U1 drives the primary winding of T2 using its OUTA and OUTB outputs (pins 11 and 14 respectively). Schottky diodes D3 - D6 prevent reverse currents from going through the substrate of U1 which can cause confusion in the internal logic.

Switching regulator U1 senses the peak current through the MOSFETs and the primary of T4 using transformer T3, diodes D7 - D10 and the associated components. These four diodes are wired as a full-wave bridge rectifier to rectify the secondary power from T3. The resulting DC voltage is applied to the current sense input on U1 at pin 9 and the ramp control at U1 pin 7. As the primary current increases, the voltage at U1 pin 9 increases proportionately.

SHUTDOWN CIRCUITS

The supply incorporates over-current, over-voltage and thermal shutdown circuitry. This circuitry turns the switching regulator circuit (and thus the supply's output) off if the supply is not operating within safe limits. The switching regulator circuit is turned off by pulling U1's shutdown input (pin 8) low.

The over-current shutdown circuit prevents damage to the load (desk-top station) and the supply in case of excessive current draw by the load. This circuit is made from dual comparator U2, diodes D2 and D12, and the associated components. Resistors R38 and R39 are located in ground path of the supply; they are used as shunts so U2 can sense the load current. Resistors R14 and R18 bias the non-inverting input (+) of the comparator (pin 5) to approximately 30 millivolts during minimal load conditions. This keeps the output at U2 pin 7 high. (U2 has open-collector outputs which are pulled high by R15 and R26.) If current output of the supply exceeds approximately 30 amperes, the voltage drop across R38 and R39 will cause U2 pin 7 to transition low (0 Vdc). Since the inverting input (-) at U2 pin 2 is biased to 10 Vdc, U2 pin 1 pulls low and D12 becomes forward biased. The anode of D12 is connected to the shutdown input of switching regulator U1; therefore, the switching regulator circuit shuts down until the current demand drops below 30 amperes. C13, C19, D2 and R16 provide turn-on and turn-off delay for this circuit.

The over-voltage shutdown circuitry is made from D11, Q4, Q5, VR2 and associated components. The anode of Schottky diode D11 is connected to the shutdown input of switching regulator U1. During normal supply operation D11 is reversed biased. If the output of the power supply exceeds 15 Vdc, zener diode VR2 conducts and turns Q5 on. When Q5 turns on, its collector pulls to ground. This action turns Q4 on to latch Q5 on. With Q5 latched on, D11 is forward biased and U1's shutdown input is pulled low (approximately 0.3 Vdc). This turns the switching regulator off until the supply is cycled off and back on.

A thermal switch is mounted to the chassis. This normally-open switch is connected to TB2 and TB3 on the Power Supply Board. If safe operating temperature is exceeded, this switch will close and pull U1's shutdown input on pin 8 low. This action turns the switching regulator off until the supply has cooled.

TROUBLESHOOTING

WARNING

This unit contains dangerous voltage levels. It is strongly recommended that defective units be returned to the manufacturer for repairs.

If field repairs are necessary, remove input power and then use a load resistor to manually discharge each capacitor before working on the circuits.

INITIAL CHECKS

1. Verify ac power cord is properly connected.

2. Check fuse F2 on the Line Filter Board.

3. Verify the Power Supply is configured for the proper AC input voltage range. For 120 Vac (nominal) operation, a jumper should be between TB5 and TB7 on the Power Supply Board. For 240 Vac (nominal) operation, a jumper should be between TB7 and TB8.

4. Verify the load (desk-top station) does not have a short. A shorted load will cause the supply's current shutdown circuits to limit the output current at approximately 30 amperes. This condition will cause the supply's output voltage to drop to near 0 Vdc.

SYMPTOM/CAUSE TROUBLESHOOTING STEPS

The following procedures will help trace supply failure to the component level. Select the procedure that best matches the supply failure symptom and then follow it step-by-step until the faulty component (or components) is located. After the component(s) has been replaced, the Power Supply should be tested to verify it meets the minimum specifications.

Fuse F2 Blows Again After Replacement

1. Remove ac power and disconnect all loads from output of the Power Supply.

2. Disconnect the lead from the Line Filter Board that is connected to TB4 on the Power Supply Board.

3. With an ohmmeter, measure the resistance between the ac line input terminals at the power cord's plug. If the measured resistance is less than 100K ohms, troubleshoot the Line Filter Board for a shorted C1 or C3, or shorted turns in common-mode inductor L1.

4. Install a new fuse, connect ac power and turn the power switch on. Verify F2 does not blow again. If it does, suspect C2 or C7 - C8 on the Line Filter Board.

5. Turn the power switch off and remove ac power. Reconnect the lead from the Line Filter Board that was disconnected from TB4.

6. Remove diode D1. This will kill the VCC supply to U1 and therefore prevent any drive signal from turning the MOSFETs on. This will help isolate a short in the secondary side of T4, if it exists.

7. Re-apply ac power and turn the power switch on. If F2 blows again, first suspect C31, C36, C37, C38 or bridge rectifier D18. In addition, one or both MOSFETs could be shorted. If F2 does not blow, there is most likely a problem in the secondary side of T4 such as a shorted filter capacitor (C33 or C34) or a shorted rectifier diode (D21 or D22). Follow this procedure to test for shorted output rectifier diodes or filter capacitors:

   a. Remove ac power.

   b. Using an external 13.8 Vdc power supply (rated at 0.5 ampere minimum) and a 47-ohm current limiting resistor (5-watt minimum), attempt to charge the output filter capacitors by connecting the external power supply and the 47-ohm resistor in series with the Power Supply's output terminals. Observe polarity. The filter capacitors should charge above 12 Vdc within one (1) minute.

8. Follow this procedure to test for shorted MOSFETs and to eliminate a problem with the primary dc power source:

   a. Remove ac power.

   b. Remove both MOSFETs (Q6 and Q8) from the Power Supply Board. Label each MOSFET as it is removed.

   c. Use an appropriate test instrument and/or method to test for MOSFET failure. Normally this can be done with an ohmmeter. If only one device has

failed, replacement of both MOSFETs is recommended. In addition, replacement of the active devices in the drive circuit associated with the failed device (D19, D26, Q7 and VR3 for Q6; D20, D27, Q9 and VR4 for Q8) is also recommended.

d. Before installing good MOSFETs, re-apply AC power and turn the power switch on. If F2 blows again, suspect C31, C36, C37, C38 or bridge rectifier D18. If F2 does not blow, carefully measure the primary DC supply voltage between the positive (+) terminal of C36 and the negative (-) terminal of C31 (primary ground). This voltage should be approximately 340 Vdc. The voltage across each filter capacitor should be approximately 165 Vdc.

e. Using known good devices, re-install both MOSFETs.

9. Replace U1 and re-install D1.

Turn-On Surge Protection Relay Does Not Energize

The Power Supply will not operate with a load if turn-on surge protection relay K1 does not energize. This relay should energize approximately 100 milliseconds after the supply is turned on to apply full AC power to bridge rectifier D18. Follow these steps if K1 fails to energize:

1. Disconnect all loads from the supply's output and connect AC power to the Power Supply. Turn the power switch on.

2. Carefully measure the AC input voltage between TB4 and TB6 for either the 120 Vac (nominal) or the 240 Vac (nominal). If no voltage is present, suspect an open fuse F2 or an open inductor on the Line Filter Board. See the symptom entitled "Fuse F2 Blows Again After Replacement" if this is a problem.

3. Carefully measure the primary DC supply voltage between the positive (+) terminal of C36 and the negative (-) terminal of C31 (primary ground). This voltage should be approximately 340 Vdc. If not, suspect RT1, R41 or bridge rectifier D18. The voltage across each filter capacitor should be approximately 165 Vdc.

4. Measure the voltage across K1's coil. If the voltage is near 12 Vdc, replace K1 - its coil is open. Test for proper operation. If the voltage is at or near 0 Vdc, C32 may be shorted or D15 may be open; however, there is most likely a problem in the aux converter circuit made from T1 and associated components. Proceed with the next step.

5. At this point, if there is no DC voltage across C32 (normally about 12 Vdc) and no voltage across C22 (normally about 15 Vdc) there is a problem in the aux converter circuit. Troubleshoot this circuit as follows:

   a. Carefully measure the DC voltage at the junction of T1, R1, R5 and R42 (ground reference = negative terminal of C31). If this voltage is 0 Vdc, suspect R42. This junction is normally greater than 300 Vdc.

   b. Remove ac power and then remove D1 and D15.

   c. Connect an AC voltmeter across the T1's secondary coils (pins 9 and 11). Turn the power supply on. If the aux converter is oscillating, this meter will indicate approximately 19 Vac. This indicates that the primary circuits of the aux converter are most likely good and there is a short in one of the secondary circuits. Suspect C22, C32, D1, D15 or U1.

   d. Suspect C4 or the semiconductor devices in the primary circuit. Re-install D1 and D15 after the faulty component is located and test for proper operation.

Poor Output Regulation Or No DC Output

The supply should maintain a well regulated 13.8 Vdc (±1%) output voltage with wide AC input voltages and varying DC output current demands. See the specifications page for details. If the supply's output voltage is well regulated with varying DC output current demands but it is not within the 1% of 13.8 Vdc, adjust the output to 13.8 Vdc ±50 mV using trimmer R2. The following procedure will help isolate regulation problems or a dead DC output.

1. Verify fuse F2 is not blow. If a replacement fuse also blows, see the section entitled "Fuse F2 Blows Again After Replacement".

2. Verify the turn-on surge protection relay is energizing. If it does not, see the section entitled "Turn-On Surge Protection Relay Does Not Energize" to troubleshoot the problem.

3. Verify the VCC voltage is approximately 15 Vdc by measuring between U1 pin 12 (-) and U1 pin 15 (+). If not, suspect C22, D1 or U1.

4. Verify the VREF reference voltage at U1 pin 16 is 5.0 Vdc. If not, replace U1.

5. Verify U1 pin 2 is 2.5 Vdc. If not suspect trimmer R2, or R9 - R11.

6. The feedback attenuator circuit can be tested by comparing the supply's output voltage to the voltage on U1 pin 1. U1 pin 1 should be 18% of the supply's output voltage. If not suspect C2, R12, R13 or R20.

7. Monitor U1 pin 8 with an oscilloscope or DC voltmeter. If this pin is less than 0.5 Vdc, one of the shutdown circuits is turning the switching regulator off. See the section entitled "Shutdown Circuit Problem" to troubleshoot this problem.

Shutdown Circuit Problem

1. Monitor U1 pin 8 with an oscilloscope or DC voltmeter. This pin should normally be above 5.0 Vdc. It is pulled to less than 0.5 Vdc by D11 (and the over-voltage shutdown circuit), or D12 (and the over-current shutdown circuit), or the thermal switch. If U1 pin 8 is less than 0.5 Vdc, one of the shutdown circuits is turning the supply's output off. This could be caused by a failure in one of the shutdown circuits; however, the circuits are most likely operating as designed and there is a problem elsewhere in the supply. If U1 pin 8 is less than 0.3 Vdc the supply is most likely being shut-down by the thermal switch or the over-voltage shutdown circuit, not the current-limit circuit.

2. Remove AC power and then temporarily disconnect the lead from the thermal switch that is connected to TB3 on the Power Supply Board.

3. Re-apply AC power and test for proper operation. Replace the thermal switch if the supply operates normally with the thermal switch disconnected. If it still shuts down, continue with the next step to isolate the problem.

CAUTION

The over-voltage shutdown circuit should not be disabled until it is determined that there is not a problem in the regulator circuit. Damage to the output filter capacitors may occur if the over-voltage shutdown circuit is disabled when a problem exists with the Power Supply's regulator circuitry.

4. Measure the voltage at the cathode of D11. If this point is less than 0.2 Vdc the over-voltage shutdown circuit is turning the supply's output off. The following procedure should help isolate the problem:

   a. See the section entitled "Poor Output Regulation Or No DC Output" to determine if there is an over-voltage problem in the regulator circuits.

   b. Remove AC power.

   c. Using an external power supply set to 20 Vdc (rated at 0.5 ampere minimum) and a 47-ohm current limiting resistor (5-watt minimum), charge the output filter capacitors by connecting the external power supply and the 47-ohm resistor in series with the Power Supply's output terminals. Observe polarity. Allow the capacitors to charge to at least 15.5 Vdc before proceeding.

   d. Measure the DC voltage across zener diode VR2. If this voltage is less than 14.5 Vdc, replace VR2 and then test the supply for proper operation. Disconnect the external power supply and allow the filter capacitors to discharge through bleed resistor R40 before proceeding.

   e. At this point, suspect a defective (shorted) Q4 or Q5 in the over-voltage shutdown circuit. Remove and test each transistor.

5. Monitor the cathode of D12 with an oscilloscope with no load connected to the supply. If this point is less than 0.5 Vdc or periodically pulsing, the over-current shutdown circuit is turning the supply's output off. The following procedure should help isolate the problem:

   a. Verify there is no short at the output connector.

   b. Verify C20 and C29 are not shorted.

c. Verify R38 and R39 are good and well soldered to the board.

d. With no load connected to the supply's output, U2 pin 5 should be 30 mV ±5 mV. If not, suspect R14, R17, R18, R38 or R39.

e. U2 pin 1 should transition low (less than 0.5 Vdc) when a load greater than 30 amperes is applied to the supply. If it does not, suspect U2 or C19.

THERMAL SHUTDOWN AFTER EXTENDED OPERATION

Extreme heat build-up may be caused by excessive loads applied for long periods or by a problem with the supply.

1. Verify the ventilation holes on the Power Supply and the desk-top station are not obstructed.

2. Verify a defect in the load (desk-top station's mobile radio, control circuits, etc.) is not placing an excessive load on the Power Supply.

3. The thermal switch should close and shut the supply down if the supply becomes too hot. This switch closes at approximately 90°C and will re-open at approximately 87°C.

4. Verify all components in the primary circuit of T4 are operating correctly. The MOSFETs are driven 180° out of phase.

.

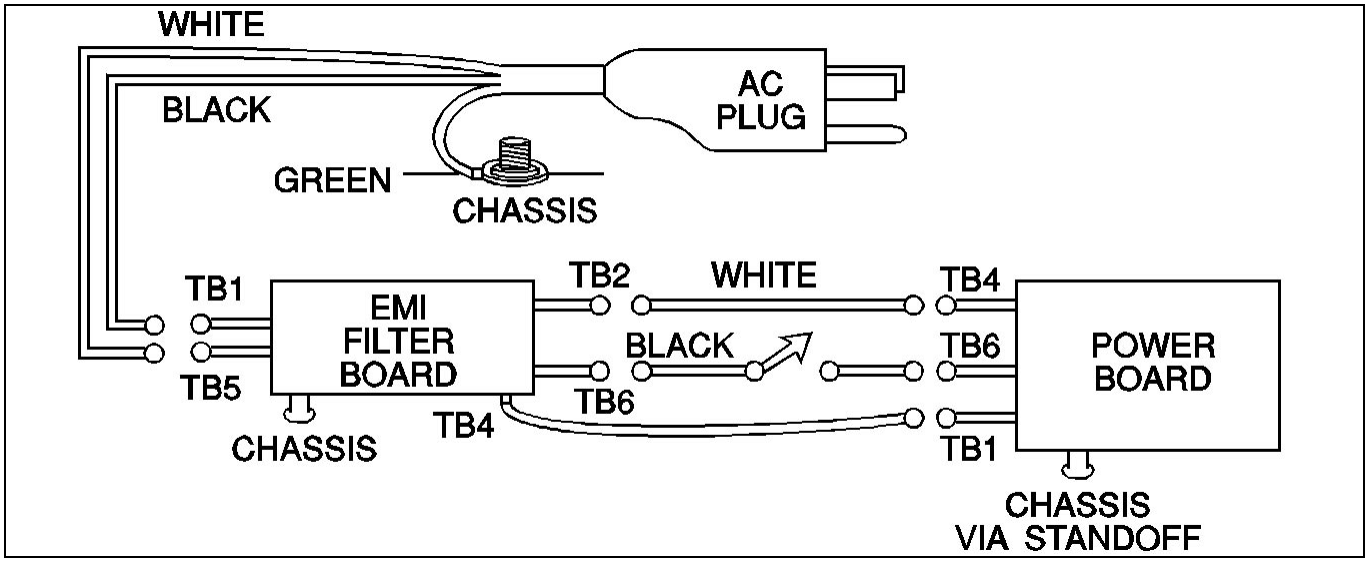


Figure 2 - 30 Amp Power Supply Interconnection Diagram

ERICSSON
Ericsson GE Mobile Communications Inc.
Mountain View Road • Lynchburg, Virginia 24502

Printed in U.S.A.

POWER SUPPLY BOARD
19B801020P4
ISSUE 1

SYMBOL	PART NO.	DESCRIPTION
		NOTE: When ordering replacement parts, all part numbers should be preceded with the prefix M29/.
		- - - - - - - - - - - - CAPACITORS - - - - - - - - - - -
C2	80190750000	Ceramic: 47 nF ±20%, 50 V.
C3	80193100000	Polyester: 100 nF ±10%, 100 V.
C4	80195080000	Electrolytic: 100 uF, 25 V.
C5	80193400500	Polyester: 1 nF ±5%, 50 V.
C7	80190630000	Ceramic: 100 pF ±20%, 50 V.
C9	80193400500	Polyester: 1 nF ±5%, 50 V.
C10	80190131000	Ceramic: 470 pF NPO, 50 V.
C11	80192210000	Polyester: 2.2 nF ±10%, 50 V.
C12 and C13	80190760000	Ceramic: 100 nF ±20%, 50 V.
C14	80193100000	Ceramic: 100 nF ±10%, 100 V.
C15	80190150000	Ceramic: 100 pF ±20%, 1000 V.
C16	80190630000	Ceramic: 100 pF ±20%, 50 V.
C17	80190520000	Ceramic: 1 uF ±20%, 50 V.
C18	80190760000	Ceramic: 100 nF ±20%, 50 V.
C19	80190520000	Ceramic: 1 uF ±20%, 50 V.
C20	80160400000	Electrolytic: 2200 uF, 25 V.
C22	80195080000	Electrolytic: 100 uF, 25 V.
C23	80193400500	Polyester: 1 nF ±5%, 50 V.
C24	80102240002	Ceramic: 470 nF ±10%, 50 V.
C25	80195200000	Electrolytic: 47 uF, 25 V.
C26 thru C28	80190760000	Ceramic: 100 nF ±20%, 50 V.
C29	80190520000	Ceramic: 1 uF ±20%, 50 V.
C30	80190760000	Ceramic: 100 nF ±20%, 50 V.
C31	80158300001	Electrolytic: 1200 uF, 200 V.
C32	80195080000	Electrolytic: 100 uF, 25 V.
C33 and C34	80160400000	Electrolytic: 2200 uF, 25 V.
C35	80127110000	Polyester: 1 uF ±20%, 250 V.
C36	80158300001	Electrolytic: 1200 uF, 200 V.
C37 and C38	80134600001	Polyester: 3.3 uF ±10%, 250 V.
C39	80190150001	Ceramic: 100 pF ±20%, 1000 V.
C40 thru C43	80190900001	Ceramic: 220 pF ±20%, 1000 V.
C49	80192210000	Polyester: 2.2 nF ±10%, 50 V.
C50	80122710000	Ceramic: 100 nF ±10%, 100 V.

SYMBOL	PART NO.	DESCRIPTION
		- - - - - - - - - - - - DIODES - - - - - - - - - - -
D1	81711600000	Silicon: BYV27-150.
D2	81704600000	Silicon: 1N4448.
D3 thru D6	81713600000	Schottky: MBR-140.
D7 thru D10	81704600000	Silicon: 1N4448.
D11	81713600000	Schottky: MBR-140.
D12	81704600000	Silicon: 1N4448.
D13	81722000000	Silicon: BAV20.
D14	81704600000	Silicon: 1N4448.
D15	81711600000	Silicon: BYV27-150.
D16 and D17	81706900000	Silicon: MUR460.
D18	81717900016	Silicon: Bridge Rectifier; KBPC2508.
D19 and D20	81722000000	Silicon: BAV20.
D21 and D22	81719300000	Silicon: Dual diode, common cathode; MUR3015PT.
D26 and D27	81722000000	Silicon: BAV20.
		- - - - - - - - - - - - - - RELAY - - - - - - - - - - - -
K1	82108800001	Schrack RP710-012.
		- - - - - - - - - - - - INDUCTORS - - - - - - - - - -
L1	94263901940	Coil.
L2	94548920944	Coil.
		- - - - - - - - - - - - TRANSISTORS - - - - - - - - -
Q1	81812400000	Silicon, NPN: BUX85.
Q2	81890190000	Silicon, NPN: BC237.
Q3	81890031600	Silicon, NPN: BC337-16.
Q4	81890100000	Silicon, PNP: BC307.
Q5	81890190000	Silicon, NPN: BC237.
Q6	81850520000	Silicon, MOSFET: IFRP460.
Q7	818139001M0	Silicon: MJE210.
Q8	81850520000	Silicon, MOSFET: IFRP460.
Q9	818139001M0	Silicon: MJE210.
		- - - - - - - - - - - - RESISTORS - - - - - - - - - -
R1	81147405047	470K ohms ±5%, 1/4 W.
R2	81525310000	Trimmer: 1K ohms; Murata 3102X-3296X.
R3	81122205047	2.2K ohms ±5%, 1/4 W.
R4	81122005047	22 ohms ±5%, 1/4 W.

SYMBOL	PART NO.	DESCRIPTION
R5	81147105024	Flameproof: 470 ohms ±5%, 1/2 W.
R6	81180010000	10K ohms ±1%, 0.4 W.
R7	81180005620	5.62K ohms ±1%, 0.4 W.
R8	81110305047	10K ohms ±5%, 1/4 W.
R9	81180005760	5.76K ohms ±1%, 0.4 W.
R10	81110205047	1K ohms ±5%, 1/4 W.
R11	81180006040	6.04K ohms ±1%, 0.4 W.
R12	81110205047	1K ohms ±5%, 1/4 W.
R13	81180002490	2.49K ohms ±1%, 0.4 W.
R14	81180004990	4.99K ohms ±1%, 0.4 W.
R15	81110405047	100K ohms ±5%, 1/4 W.
R16 and R17	81110205047	1K ohms ±5%, 1/4 W.
R18	811800030.1	30.1 ohms ±1%, 0.4 W.
R19	81110305047	10K ohms ±5%, 1/4 W.
R20	81180011300	11.3K ohms ±1%, 0.4 W.
R21	81180015800	15.8K ohms ±1%, 0.4 W.
R22	81180001000	1K ohms ±1%, 0.4 W.
R23	81180000475	475 ohms ±1%, 0.4 W.
R24	81110205047	1K ohms ±5%, 1/4 W.
R25	81122305047	22K ohms ±5%, 1/4 W.
R26	81110305047	10K ohms ±5%, 1/4 W.
R27	81110205047	1K ohms ±5%, 1/4 W.
R28	81147905104	4.7 ohms ±5%, 1 W.
R29	81147205047	4.7K ohms ±5%, 1/4 W.
R30	81110405022	100K ohms ±5%, 1/2 W.
R31	81110005047	10 ohms ±5%, 1/4 W.
R32	81110005022	10 ohms ±5%, 1/2 W.
R33 and R34	81110205047	1K ohms ±5%, 1/4 W.
R35	81147105047	470 ohms ±5%, 1/4 W.
R36 and R37	81180000018	18 ohms ±1%, 0.4 W.
R38 and R39	91582100211	.0025 ohms.
R40	81147105102	470 ohms ±5%, 1 W.
R41	81110005704	10 ohms ±5%, 7 W.
R42	81110005204	Flameproof: 10 ohms ±5%, 2 W.
R43	81122105304	Flameproof: 220 ohms ±5%, 3 W.
R44 and R45	81147005204	Flameproof: 47 ohms ±5%, 2 W.
R46 and R47	81122105104	220 ohms ±5%, 1 W.
R48 and R49	81147005204	Flameproof: 47 ohms ±5%, 2 W.
R50	81110405022	100K ohms ±5%, 1/2 W.
R55	81147105047	470 ohms ±5%, 1/4 W.
R56	81110205047	1K ohms ±5%, 1/4 W.
		- - - - - - - - - - - - THERMISTOR - - - - - - - - - -
RT1	81404400000	22 ohms ±20% NTC, 3 W.
		- - - - - - - - - - TRANSFORMERS - - - - - - - - - -
T1	94539900964	Auxiliary Transformer.
T2	94539900965	Drive Transformer.
T3	94565900938	Current Sense Transformer.
T4	94548940913	Output Transformer.
		- - - - - - - - INTEGRATED CIRCUITS - - - - - - -
U1	80324100001	Linear: PWM Switching Regulator; UC1825J.
U2	80313210000	Linear: Dual Comparator; LM193J.
		- - - - - - - - - - - - ZENER DIODES - - - - - - - - -
VR1	81713500000	Silicon: 6.2 V, 400 mW: BZX79C.
VR2	81705000000	Silicon: 15 V ±2%, 1000 mW: BZX85B.
VR3 and VR4	81702400000	Silicon: 18 V ±5%, 500 mW: BZX79C.

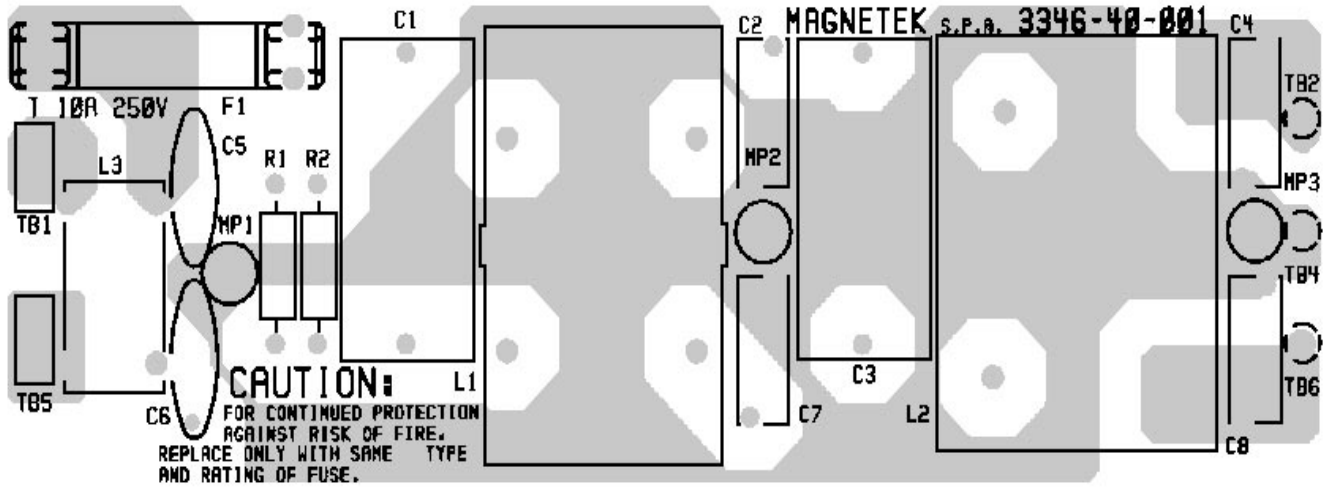
LINE FILTER BOARD
ISSUE 1

SYMBOL	PART NO.	DESCRIPTION
		NOTE: When ordering replacement parts, all part numbers should be preceded with the prefix M29/.
		- - - - - - - - - - - CAPACITORS- - - - - - - - - -
C2	80109600000	Ceramic: 2.2 nF, 4000 V.
C3	80127110000	Polyester: 1 uF ±20%, 250 Vac.
C4	80109600000	Ceramic: 2.2 nF, 4000 V.
C5 and C6	80103300000	Ceramic: 220 pF, 4000 V.
C7 and C8	80109600000	Ceramic: 2.2 nF, 4000 V.
		- - - - - - - - - - - - - - - FUSE - - - - - - - - - - - - -
F2	82125200000	Slow-blow: 10 A, 250 V.

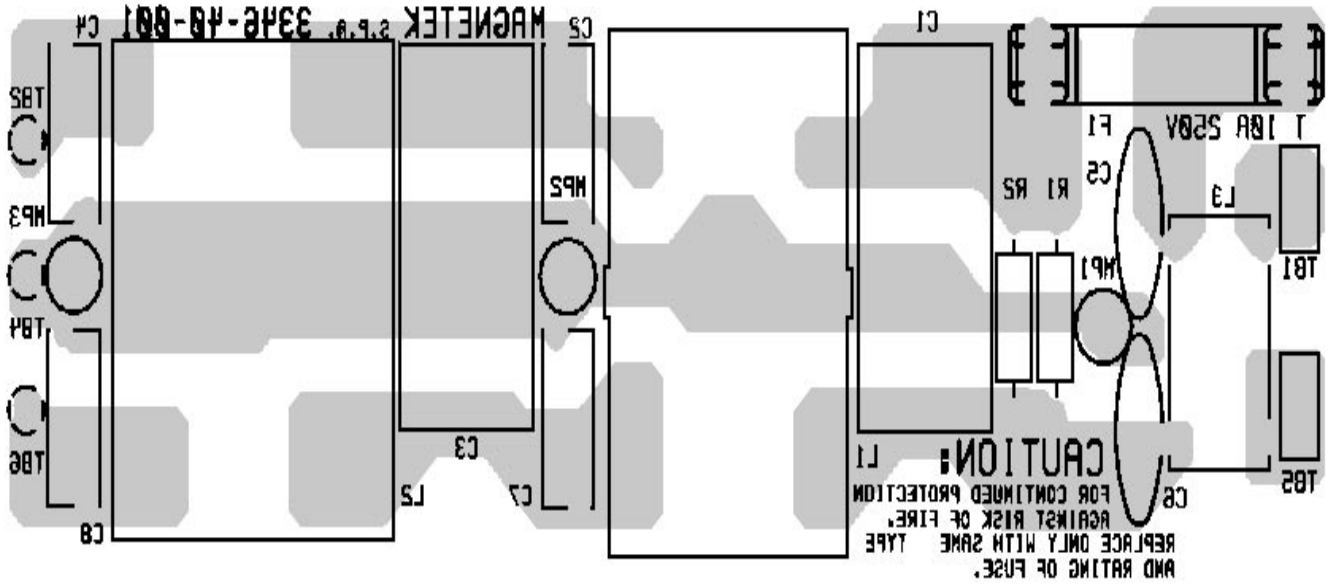
MISCELLANEOUS PARTS

SYMBOL	PART NO.	DESCRIPTION
		NOTE: When ordering replacement parts, all part numbers should be preceded with the prefix M29/.
		POWER BOARD
	83302612000	Heat Sink.
	81562900004	Cable clamp.
	81621270000	Screw: M3 x 10. (Quantitiy of 3).
	81253300000	Fastener. (Quantity of 3).
	81255100001	Terminal; sim to Molex 5033-2T. (Quantity of 2).
	81255100000	Terminal; sim to Molex 5033-4T. (Quantity of 1).
	81253100000	Terminal, PCB, 2.8 x 0.8. (Quantity of 1).
	82108800001	Switch.
	82108800001	Relay.
	83334622000	Box.
	83334622000	Cover.
	82000000443	Output connector; sim to Amp 1-480672-0. (Quantity of 1).
	82026400000	Contact, female; sim to Amp 350388-1. (Quantity of 8).
	82103600004	Thermal switch.
	81623130000	Screw: M4 x 12. (Quantity of 4).
	83319724000	Heat Sink (diode bridge).
	81622190000	Screw: M4 x 20. (Used with diode bridge).
	81660600000	Washer: M4.
	81650090000	Nut: M4.
	91513000903	Voltage change bridge.
	83334626000	Insulator. (Quantity of 2).
	81660050000	Washer: M3. (Quantity of 7).
	81650050000	Nut: M3. (Quantity of 4).
	81660010001	Washer: M3. (Quantity of 1).
		FILTER BOARD
	82106300000	Clip, fuse. (Used with F2, Quantity of 2).
	81621270000	Screw: M3 x 10. (Quantity of 3).
	81255100000	Terminal; sim to Molex 5033-4T. (Quantity of 3).
	81552400000	Cable clamp.
	81621210001	Screw: M3 x 10. (Quantity of 2).
	81660050000	Washer. (Quantity of 3).
	81650090000	Nut: M4. (Quantity of 1).
	81660200001	Washer: M4. (Quantity of 1).
	81623020000	Screw: M3.5 x 8. (Quantity of 4).

COMPONENT SIDE

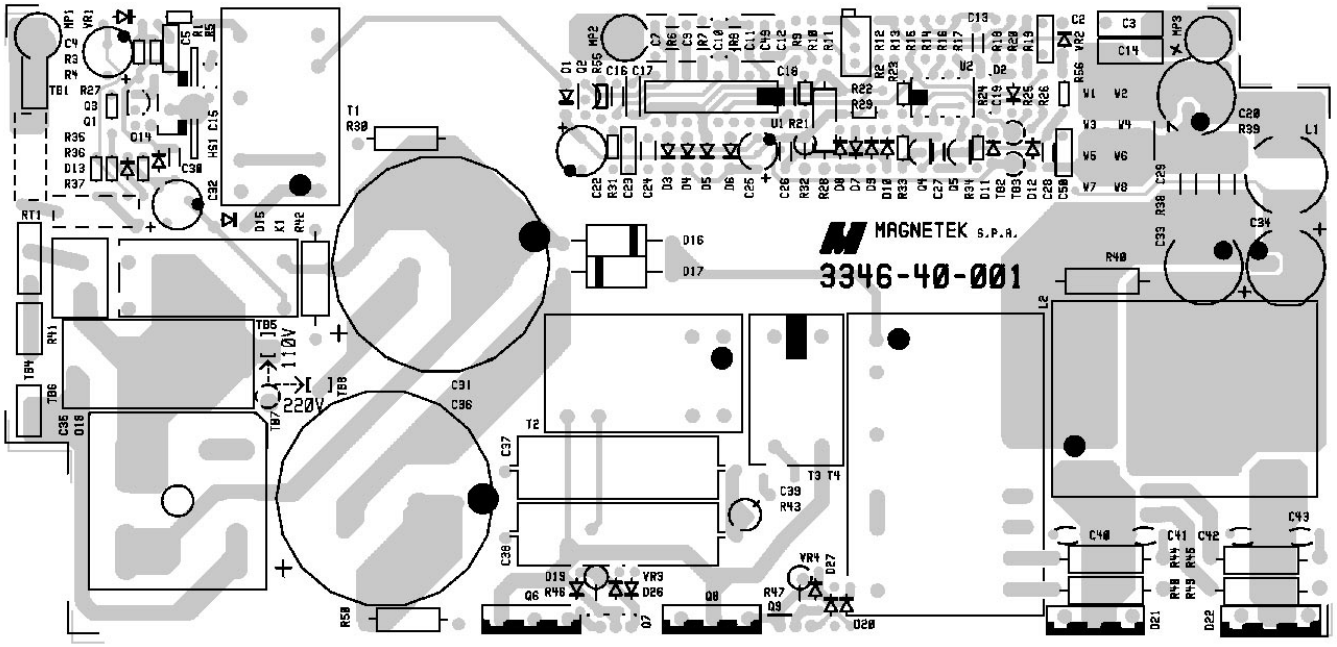


SOLDER SIDE

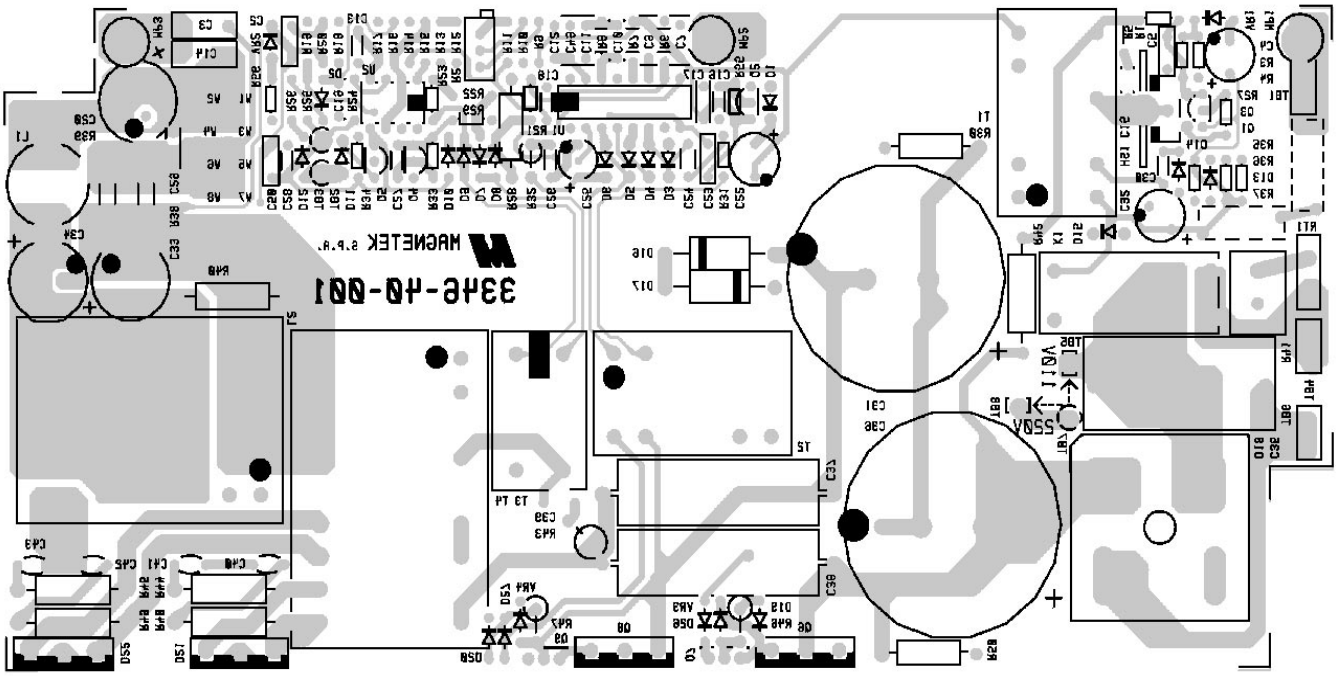


LINE FILTER BOARD

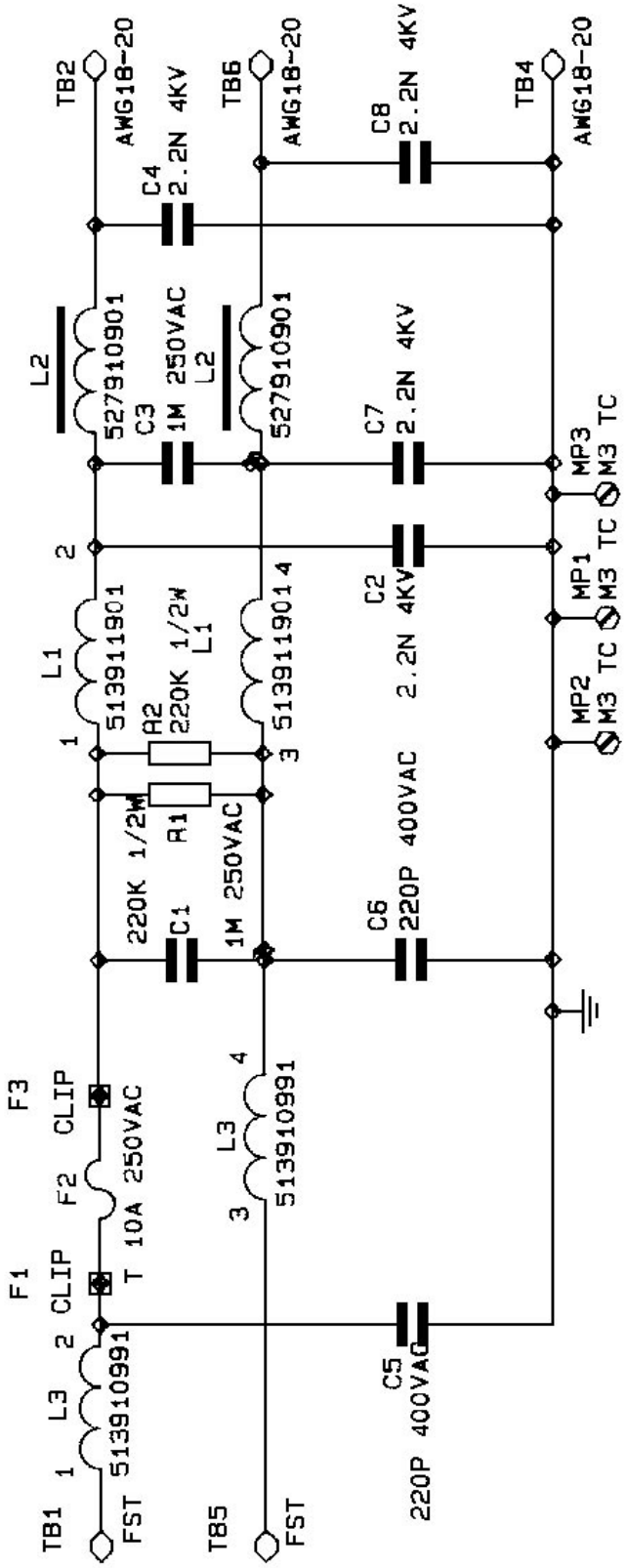
COMPONENT SIDE



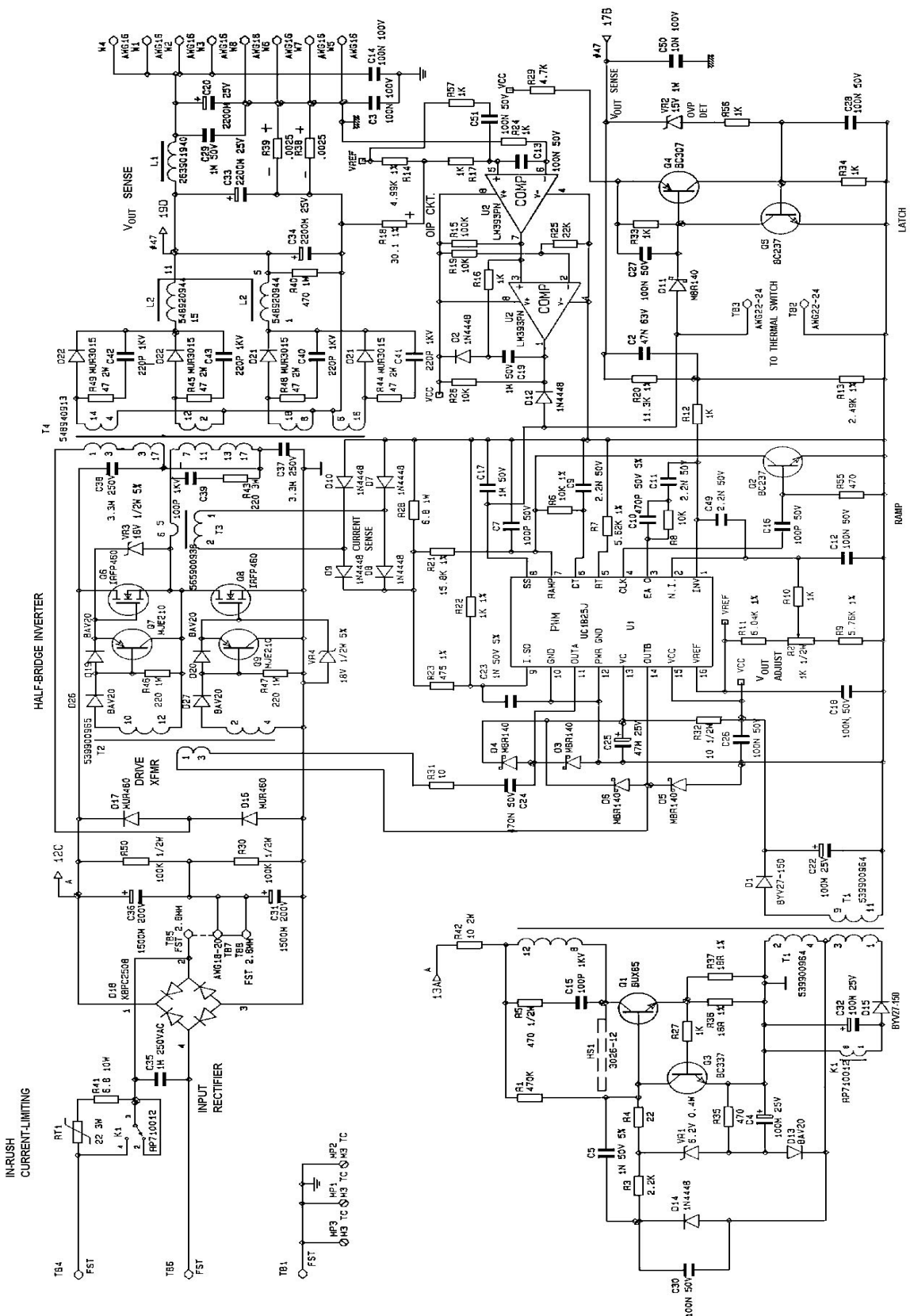
SOLDER SIDE



POWER SUPPLY BOARD



LINE FILTER BOARD



POWER SUPPLY BOARD