MAINTENANCE MANUAL
ORION™

900 MHz POWER AMPLIFIER UNITS

344A4575P1	**JHM-971PL**	**12 WATT**
344A4575P2	**JHM-971PH**	**30 WATT**

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ILLUSTRATIONS

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

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LBI-39054

DESCRIPTION

The **R**adio **F**requency (**RF**) Power Amplifiers for the **ORION**™ 900 MHz mobile radio are provided in two different frequency ranges and power levels designated as follows:

- 344A4575P1 (CAH-590L) - 12 Watt used in low power applications
- 344A4575P2 (CAH-590H) - 30 Watt used in high power applications

The exciter for each of the two power amplifiers is located on Synthesizer/Receiver/Exciter board CMN-359-1. This exciter circuit provides approximately 9 milliwatt input to the PA (refer to Maintenance Manual LBI-39057).

The PA assembly uses two power modules to provide 12 Watts of output power for the 12-Watt amplifier. A power transistor is used to amplify the 12 Watts up to 30 Watts of output power for the 30-Watt amplifier (Refer to Figures 1&2). Each power amplifier is provided with an antenna switching circuit to isolate the receive circuit from the transmit circuit, limiting the receiver input from being over driven due to large RF signals. Each power amplifier has a power detect circuit which controls an **A**utomatic **P**ower **C**ontrol (**APC**) circuit to keep the power output constant. A low-pass filter is provided in the antenna circuit to reduce harmonic emissions. A keyed **TX 9V** regulator is provided to power the APC circuits.

Test **P**oints (**TP**) are printed circuit board terminals for measuring control voltages.Typical voltages are as follows:

	12-Watt Amplifier	30-Watt Amplifier
• TP1 (A+)	13.5 V	13.2 V
• TP2 (Control Voltage)	3.83 V	3.32 V
• TP3 (Forward Power Detect)	1.71 V	2.04V
• TP4 (TX 9V)	8.93 V	8.54 V
• TP5 (APC Voltage on output of DC AMPL IC2-1)	1.71 V	2.04 V
• TP6 (Voltage to HC1, Pins 3 &4)	12.5 V	12.3 V
• (TP7 APC Voltage)	3.40 V	3.40 V

CIRCUIT ANALYSIS

SUPPLY VOLTAGE

Supply voltage for the power amplifier is connected from power leads on the System Interface Board to J3 (A+) and G (A-) on the PA Board. Diode CD7 is a surge protector to suppress pulses on the power leads. *(Diode CD1001 in the PA UNIT will cause a fuse to blow if the voltage polarity is reversed. Refer to the PA INTERCONNECTION DIAGRAM)*

12-WATT AMPLIFIER

The Exciter output is coupled through connector J151 on the Synthesizer/Receiver/Exciter Board to input connector P1 on the PA board. The 9 milliwatt (typical) RF input at P1 is coupled to power module HC1 through an attenuator pad consisting of resistors R1-R3. This pad provides isolation between Exciter and PA. The power module (HC1) amplifies the exciter input to 0.6 watts.

Power module HC1 consists of a three stage RF amplifier (Refer to IC DATA). The supply voltage for all stages of this amplifier is provided by TX 9V regulator IC1. This voltage can be measured at TP4. The 0.6 Watts from the output of HC1 is coupled to power module HC2 through an attenuator pad consisting of resistors R4-R7. This pad reduces the 0.6 watts to 400 milliwatt.

Power module HC2 consists of a three-stage RF amplifier and amplifies the 400 milliwatt input to 12 Watts output (Refer to **IC DATA**). The first stage power supply voltage is supplied by the IC1 (TX 9V).The second stage is powered by the power control circuit. This voltage can be measured at TP2. The second and third stage power supply voltage is supplied by **SMOOTHING FILTER** transistor TR2. The second and third stage RF amplifiers operate as class C.

The 12 Watts output is coupled to the **ANTENNA** and **ANTENNA SWITCHING** circuits through 50 ohm stripline Z3.

30-WATT AMPLIFIER

The 12 Watts output of HC2 is coupled to the base circuit of power amplifier transistor TR1 through , impedance matching components consisting of capacitors C13 through C16, inductor L2 and impedance matching network Z1 through coupling capacitor C12. Transistor TR1 amplifies the 12 Watt level to 30 Watts. The output of TR1 is coupled to the **ANTENNA** and **ANTENNA SWITCH** through impedance matching components consisting of impedance matching network Z2, capacitors C17, C18, C23, C24, C25, C67 and inductor L6 through coupling capacitor C33 and 50 ohm stripline Z3.

ANTENNA SWITCHING

The Antenna Switching circuit consists of two PIN diodes, CD3 and CD5, and a quarter-wave circuit with "lumped" constants capacitor C43 and inductor L9. Capacitor C43 and inductor L9 take the place of a quarter-wave micro stripline. When **TX 9V** output goes high, bias current flows through switching diodes CD3 and CD5. A low impedance now exists at the anode of CD5 and a high impedance exists at the node connection of C43 and L9. This isolates the transmitter power from the receiver. Diode CD3 is now an RF short and along with capacitor C33, couples the power to the lowpass filter and on to the antenna.

TX 9V SWITCH

When the **$\overline{\text{TX ENB}}$** lead, located on the Synthesizer/Receiver/Exciter board, goes low, the DC voltage on J151 goes low. On the PA board, the DC voltage on P1 also goes low completing the circuit for diode CD8. With CD8 conducting, **TX 9V** Switch PNP transistor TR6 conducts, applying A+ (13.32 V) to the input of +9 Volt Regulator IC1. The regulated +9 volts applies bias to power modules HC1 and HC2, operational amplifier IC2, switching diodes CD3 and CD4 and on the 30-Watt amplifier, transistor TR6 through biasing resistor R25. This voltage can be measured at TP4.

AUTOMATIC POWER CONTROL

The **A**uto **P**ower **C**ontrol (**APC**) circuit protects the transmitter PA from damage due to:

a. excessive output power

b. excessive reflected power

or

c. excessive temperature

The output power control circuit allows the RF output power to be set at rated power by the APC voltage from the Logic/IF/Audio Board. If the output power of the PA increases, the detected voltage and the APC input to operational amplifier IC2-2 increases. The output voltage of operational amplifier IC2-2 decreases. This causes **DC DRIVER** transistor TR5 to conduct less. This increases the base voltage on PNP **DC PASS** transistor TR4, causing it to conduct less. This results in less voltage being applied to the first amplifier stage in RF power module HC2, reducing the output power of the PA in proportion to the increases in output power detected by the circuit.

To protect the PA against badly mismatched loads, a reverse (reflected) power detector circuit (**VSWR**) consisting of diode CD1, transistor TR5, operational amplifier IC2-2 and pass transistor TR4 detects reverse (reflected) power. When sufficient power is detected by CD1 to cause it to conduct, the voltage at the output of IC2-2 decreases, causing the power module to lower the output power, protecting the PA. The reverse power level is set by resistor R16 connected in series with diode CD1.

The 30-watt PA is protected against temperature increases by a thermal detector circuit. This circuit consists of resistor R34, **THERMAL DETECT** transistor TR6, **DC DRIVER** transistor TR5 and **DC PASS** transistor TR4 and operational amplifier IC2-1. As temperature increases, the resistance to ground through thermal detector resistor R34 increases. This causes IC2-1 to conduct less, causing a decrease in PA output until the temperature level is reduced. The temperature level is set by resistor R34. When the heat sink temperature rises above 120-degrees Centigrade, the resistance of R34 increases and the power output is reduced.

LBI-39054

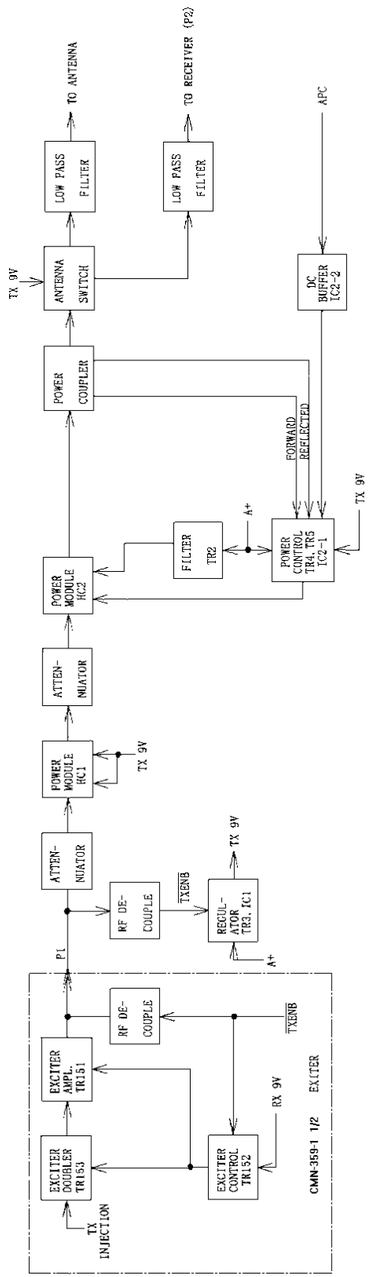


Figure 1 - 12-Watt Power Amplifier Block Diagram

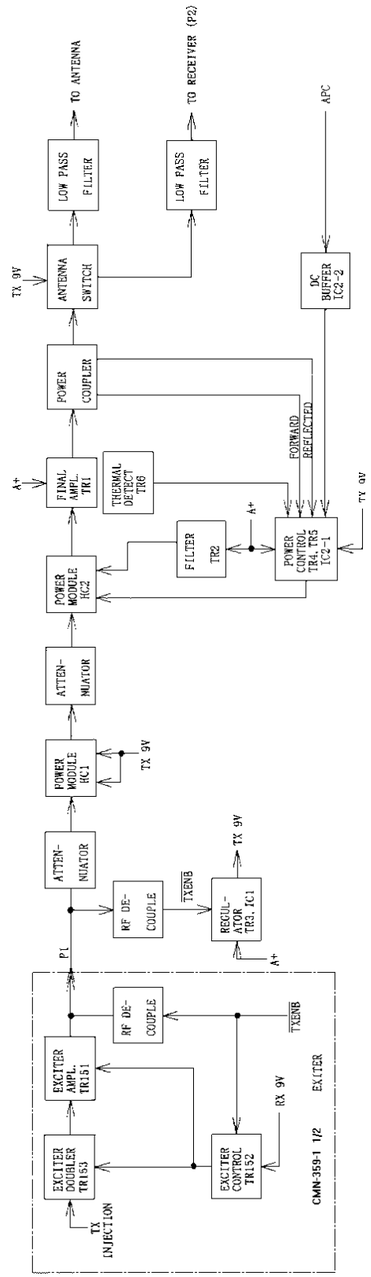
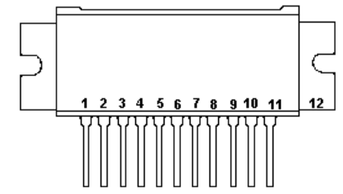
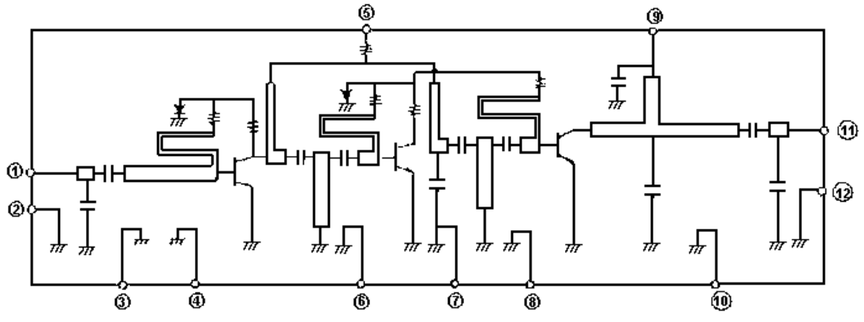


Figure 2 - 30-Watt Power Amplifier Block Diagram

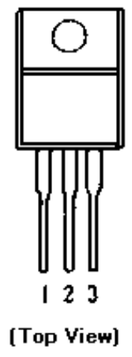
12-WATT POWER MODULE HC1

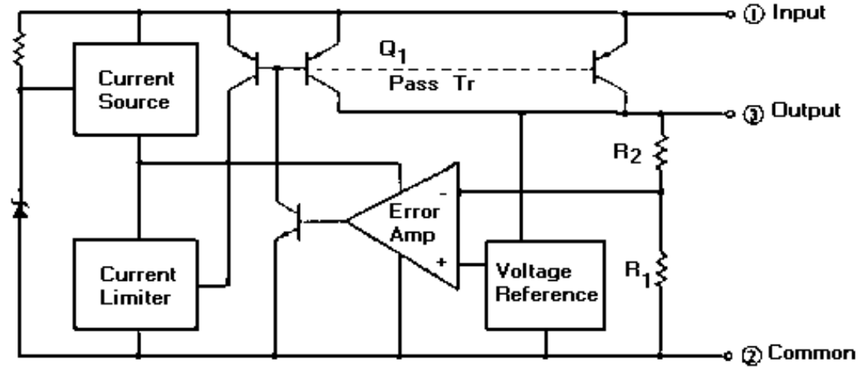


1. INPUT
2-4. GND
5. Vcc1
6-8. GND
9. Vcc2
10. GND
11. OUTPUT
12. GND (FIN)

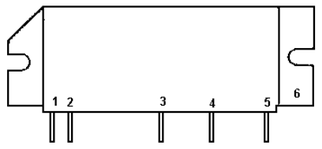


9 VOLT REGULATOR IC1

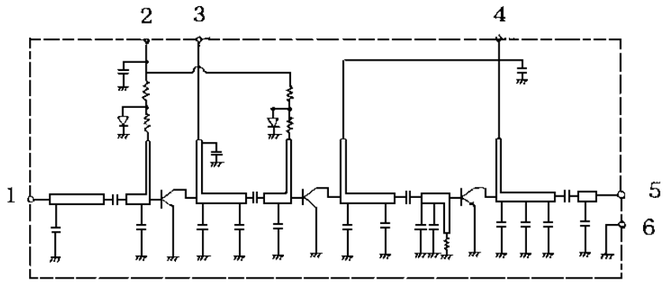




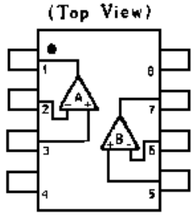
30 -WATT POWER MODULE HC2



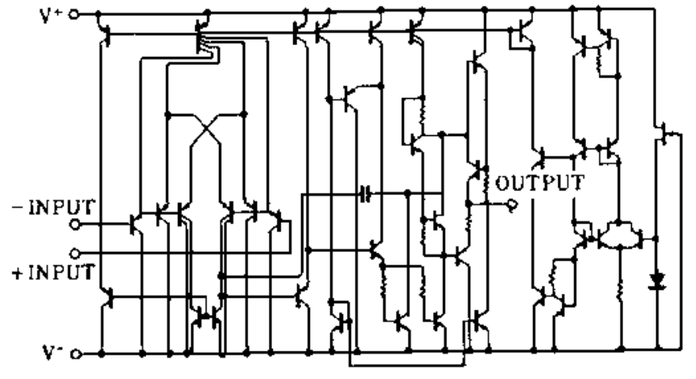
1. INPUT
2. Vbb
3. Vcc1
4. Vcc2
5. OUTPUT
6. GND (FIN)



OPERATIONAL AMPLIFIER IC2



1. A OUTPUT
2. A−INPUT
3. A+INPUT
4. V⁻
5. B+INPUT
6. B−INPUT
7. B OUTPUT
8. V+



PA UNIT
344A4575P1/JHM-971L, 344A4575P2/JHM-971H
Issue 1

SYMBOL	PART NUMBER.	DESCRIPTION
		----------ASSEMBLIES----------
A1001	NOTE: Parts listed are for reference only. Refer to Service Section for serviceable parts.	PA CIRCUIT CAH-590L (Used in 344A4575P1)
A1001		PA CIRCUIT CAH-590H (Used in 344A4575P2)
A1002		INTERFACE CMH-1231UL (Used in P1 & P2)
		----------CAPACITORS----------
C1001		Ceramic: 1000 pF +200%,-0%, 50 VDCW temp coef +20%,-55% (Used in P1, P2).
C1004		Ceramic: 1000 pF +50-±20% 50 VDCW (Used in P1, P2).
		----------DIODE----------
CD1001		Silicon fwd current 3A, 200 PIV ;sim to MOTOROLA MR751 (Used in P1, P2).
		----------JACKS----------
J1001		Connector: TNC-R888 (Used in P1, P2).
J1002		CCT9402-0501R (Used in P1, P2).
J1004		2-171822-4 (Used in P1, P2).
J1004-1 thru J1004-4		170204-4 (Used in P1, P2).
		----------WIRES----------
W1001		250V-HV-19/0.18-(1) (Used in P1, P2).
W1002		250V-HV-19/0.18-(9) (Used in P1, P2.
W1003		250V-HV-19/0.18-(2) (Used in P1, P2).
W1004		250V-HV-19/0.18-(0) (Used in P1, P2).
W1004-1		RAG terminal: 1.25-3
ZC1002		H-6ZCLD410±60 (Used in P1, P2).
ZC1003		H-6ZCLD40009 (Used in P1, P2).
TB1		ALB-01A (Used in P1, P2)

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PA CIRCUIT CAH-590L (Used in 344A4575P1)
PA CIRCUIT CAH-590H (Used in 344A4575P2)
Issue 1

SYMBOL	PART NUMBER	DESCRIPTION
		----------CAPACITORS----------
C1 thru C3	NOTE: Parts listed are for reference only. Refer to Service Section for serviceable parts.	Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C4		Electrolytic: 10 µF ±20% 25 VDCW, temp coef ±20%.
C5		Ceramic: 1000 pF ±10% 50 VDCW, temp coef 01±5%.
C6		Ceramic: 0.1 µF +80,-±20% 25 VDCW, temp coef +30,-80%.
C8		Electrolytic: 47 µF ±20% 25 VDCW, temp coef ±20%.
C9		Ceramic: 0.01 µF ±10% 50 VDCW, temp coef 15 %.
C11		Electrolytic: 220 µF ±20% 25 VDCW, temp coef ±20%.
C12		Ceramic: 33 pF ±5% 500 VDCW, temp coef 0±60 PPM (Used in H).
C14		Ceramic: 2 pF ±0.25 pF 500 VDCW, temp coef 0±250 PPM (Used in H).
C15 and C16		Ceramic: 12 pF ±5% 500 VDCW, temp coef 0±60 PPM (Used in H).
C17		Metal mica: 15 pF ±5% 100 VDCW (Used in H).
C18		Metal mica: 18 pF ±5% 100 VDCW (Used in H).
C19		Ceramic: 100 pF ±5% 500 VDCW, temp coef 0±60 PPM.
C20		Ceramic: 0.1 µF ±10% 50 VDCW, temp coef 15 % (Used in H).
C21		Electrolytic: 22 µF ±20% 40 VDCW (Used in H).
C22		Variable: 4 pF Max (Used in H).
C24		Ceramic: 1 pF ±0.25 pF 500 VDCW, temp coef 0±250 PPM (Used in H).
C25		Mica: 18 pF ±5% 500 VDCW (Used in H).
C26		Ceramic: 1 pF ±0.25 pF 50 VDCW, temp coef 0±30 PPM (Used in L).
C26		Ceramic: 3 pF ±0.25 pF 50 VDCW, temp coef 0±30 PPM (Used in H).
C27		Ceramic: 2 pF ±0.25 pF 50 VDCW, temp coef 0±30 PPM.
C28		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30%.
C29		Ceramic: 1000 pF ±10% 50 VDCW, temp coef 01±5%.
C30		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30%.
C31		Ceramic: 1000 pF ±10% 50 VDCW, temp coef 01±5%.
C32		Mica: 10 pF ±0.5 pF 500 VDCW.
C33		Mica: 8 pF ±0.5 pF 500 VDCW.
C35		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30%.
C36		Mica: 2.5 pF ±0.25 pF 500 VDCW.
C38		Ceramic: 3 pF ±0.25 pF 500 VDCW, temp coef 0±120 PPM.
C39		Mica: 6 pF ±0.5 pF 500 VDCW.
C40 and C41		Mica: 5 pF ±0.25 pF 500 VDCW.
C42		Ceramic: 1 pF ±0.25 pF 500 VDCW, temp coef 0±250 PPM.
C43		Mica: 2 pF ±0.25 pF 500 VDCW.
C44		Ceramic: 3 pF ±0.25 pF 500 VDCW, temp coef 0±120 PPM.
C45		Ceramic: 2 pF ±0.25 pF 500 VDCW, temp coef 0±250 PPM.
C46		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C47		Electrolytic: 47 µF ±20% 25 VDCW, temp coef ±20%.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

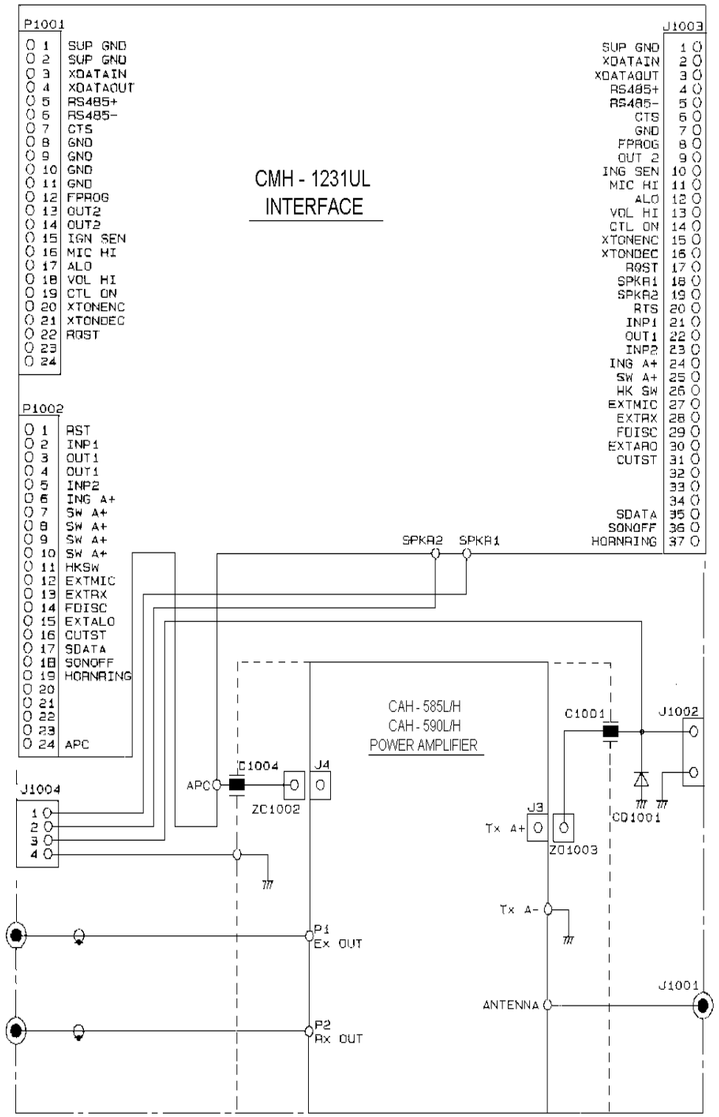
SYMBOL	PART NUMBER	DESCRIPTION
C48		Tantalum: 10 µF ±10% 16 VDCW.
C51		Tantalum: 4.7 µF ±10% 16 VDCW.
C52		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C53		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM (Used in H).
C54		Ceramic: 0.1 µF +80,-±20% 25 VDCW, temp coef +30,-80%.
C55 thru C57		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C58		Tantalum: 1 µF ±5% 16 VDCW, temp coef 0±60 PPM.
C59 and C60		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C62		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C65		Ceramic: 2 pF ±0.25 pF 500 VDCW, temp coef 0±250 PPM.
		----------DIODES----------
CD1		MA741WK-TX
CD2		MA741WK-TX
CD3 thru CD6		Pin Diode
CD7		22ZR-10D
CD8		Silicon: fast recovery (2 diodes in cathode common);sim to TOSHIBA 1SS184 .
HC1		M57781-24-A
HC2		M67760H-38
IC1		Linear: Positive Voltage Regulator; sim to NEC UPC2409HF
IC2		Linear: OP AMP
J3		Connector.
J4		Connector.
L1		Coil: RF
L2		Coil: RF (Used in H)
L3		Coil: RF (Used in H)
L4		Coil: RF (Used in H)
L5		Coil: RF (Used in H)
L6		Coil: RF (Used in H)
L7		Coil: RF
L8		Coil: RF
L9 and L10		Coil: RF
P1		Coaxial cable with connector.
P2		Coaxial cable with connector.
		----------RESISTORS----------
R1		Metal film: 22 ohms ±5%, 100 VDCW 1/10W.
R2 and R3		Metal film: 220 ohms ±5%, 100 VDCW 1/10W.
R4 and R5		Metal film: 12 ohms ±5%, 100 VDCW 1/10W.
R6 and R7		Metal film: 820 ohms ±5%, 100 VDCW 1/10W.
R8		Metal film: 3.3 ohms ±5%, 200 VDCW 1/2W.
R9		Metal film: 5.6 ohms ±5%, 100 VDCW 1/8W.
R10		Metal film: 120 ohms ±5%, 100 VDCW 1/10W.
R11 thru R13		Metal film: 100 ohms ±5%, 100 VDCW 1/10W.
R14 and R15		Metal film: 120 ohms ±5%, 250 VDCW 1W.
R16		Metal film: 100 ohms ±5%, 100 VDCW 1/10W.

SYMBOL	PART NUMBER	DESCRIPTION
R17		Metal film: 2.2K ohms ±5%, 100 VDCW 1/10W (Used in L).
R17		Metal film: 4.7K ohms ±5%, 100 VDCW 1/10W (Used in H).
R18		Metal film: 47K ohms ±5%, 200 VDCW 1/8W.
R19 and R20		Metal film: 560 ohms ±5%, 100 VDCW 1/10W.
R21 and R22		Metal film: 820 ohms ±5%, 100 VDCW 1/10W.
R23		Metal film: 330 ohms ±5%, 100 VDCW 1/10W (Used in L)
R23		Metal film: 1K ohms ±5%, 100 VDCW 1/10W (Used in H).
R24		Metal film: 22K ohms ±5%, 100 VDCW 1/10W.
R25		Metal film: 27K ohms ±5%, 100 VDCW 1/10W (Used in H).
R27		Metal film: 10K ohms ±5%, 100 VDCW 1/10W (Used in H).
R28		Metal film: 1K ohms ±5%, 100 VDCW 1/10W (Used in L).
R28		Metal film: 12K ohms ±5%, 100 VDCW 1/10W (Used in H).
R29		Metal film: 1K ohms ±5%, 100 VDCW 1/10 (Used in L)
R29		Metal film: 8.2K ohms ±5%, 100 VDCW 1/10W (Used in H).
R30		Metal film: 10K ohms ±5%, 100 VDCW 1/10W.
R31		Metal film: 100K ohms ±5%, 100 VDCW 1/10W.
R32		Metal film: 10K ohms ±5%, 100 VDCW 1/10W.
R33		Metal film: 4.7K ohms ±5%, 100 VDCW 1/10W.
R34		Posistor: PTH9M04BB222TS2F333 (Used in H).
R35		Metal film: 560 ohms ±5%, 200 VDCW 1/2W.
R37		Metal film: 3.3K ohms ±5%, 100 VDCW 1/10W.
RV1		Variable: 10K ohms ±30%, 0.1W.
		----------TRANSISTOR----------
TR1		Silicon, NPN: sim to MITSUBISHI 2SC4624 (Used in H).
TR2		Silicon, NPN: sim to PANASONIC 2SD1445A.
TR3		Silicon, PNP: sim to NEC 2SB798DL-T1
TR4		Silicon PNP: sim to PANASONIC 2SB953A.
TR5		Silicon, NPN: sim to NEC 2SD596-T1B DV3.
TR6		Silicon, NPN: sim to NEC 2SD596-T1B DV (Used in H)3.
TR2-1		Accessory: ALB-02A
TR4-1		Accessory: ALB-02A

PRODUCTION CHANGES

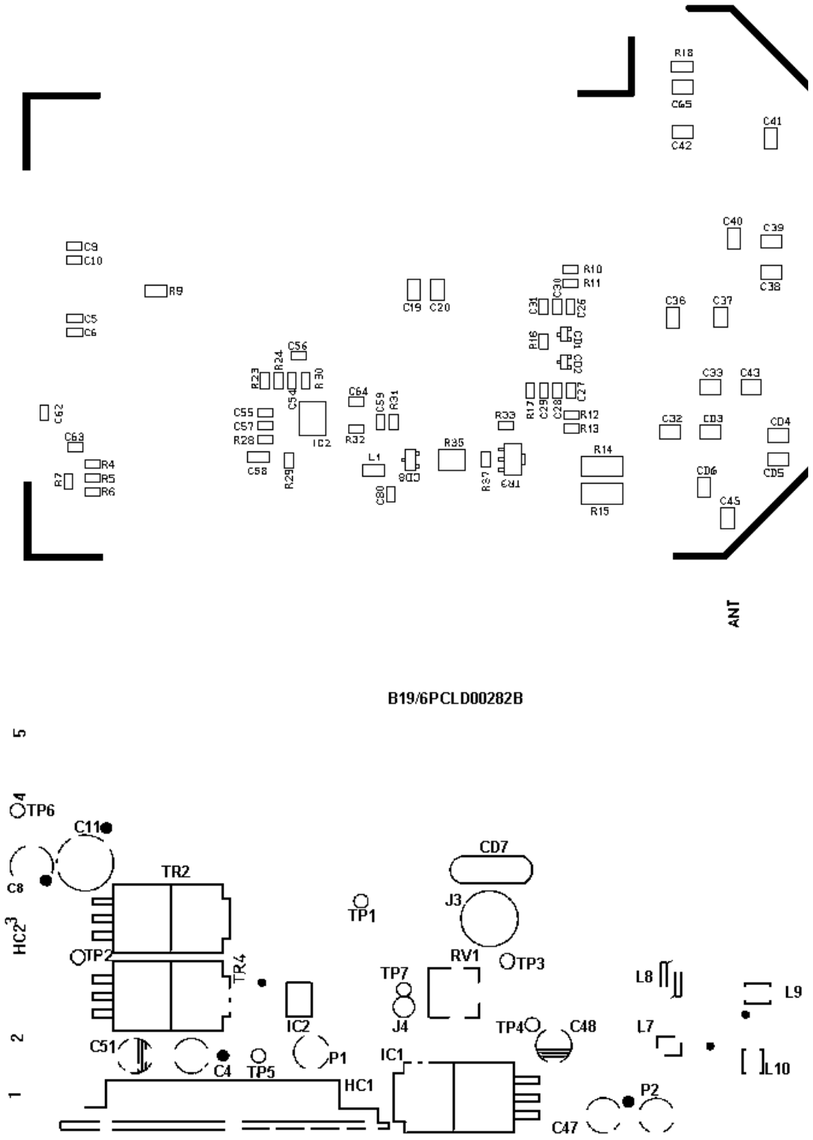
Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number on the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for the description of parts affected by these revisions.

REV. A - Power Amplifier Unit 344A45575P2
To improve power variation over duty cycle. Changed directional coupler diodes CD1 and CD2.

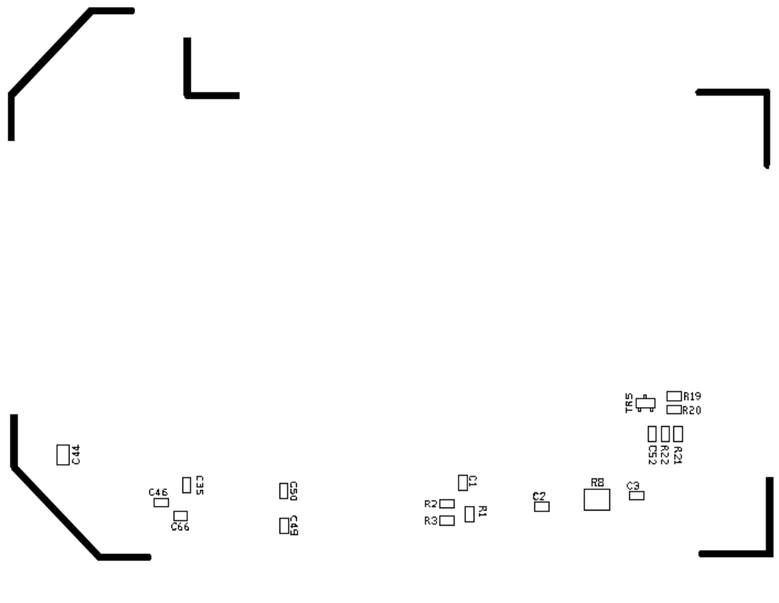


(DD00-JHM-971P)

COMPONENT SIDE



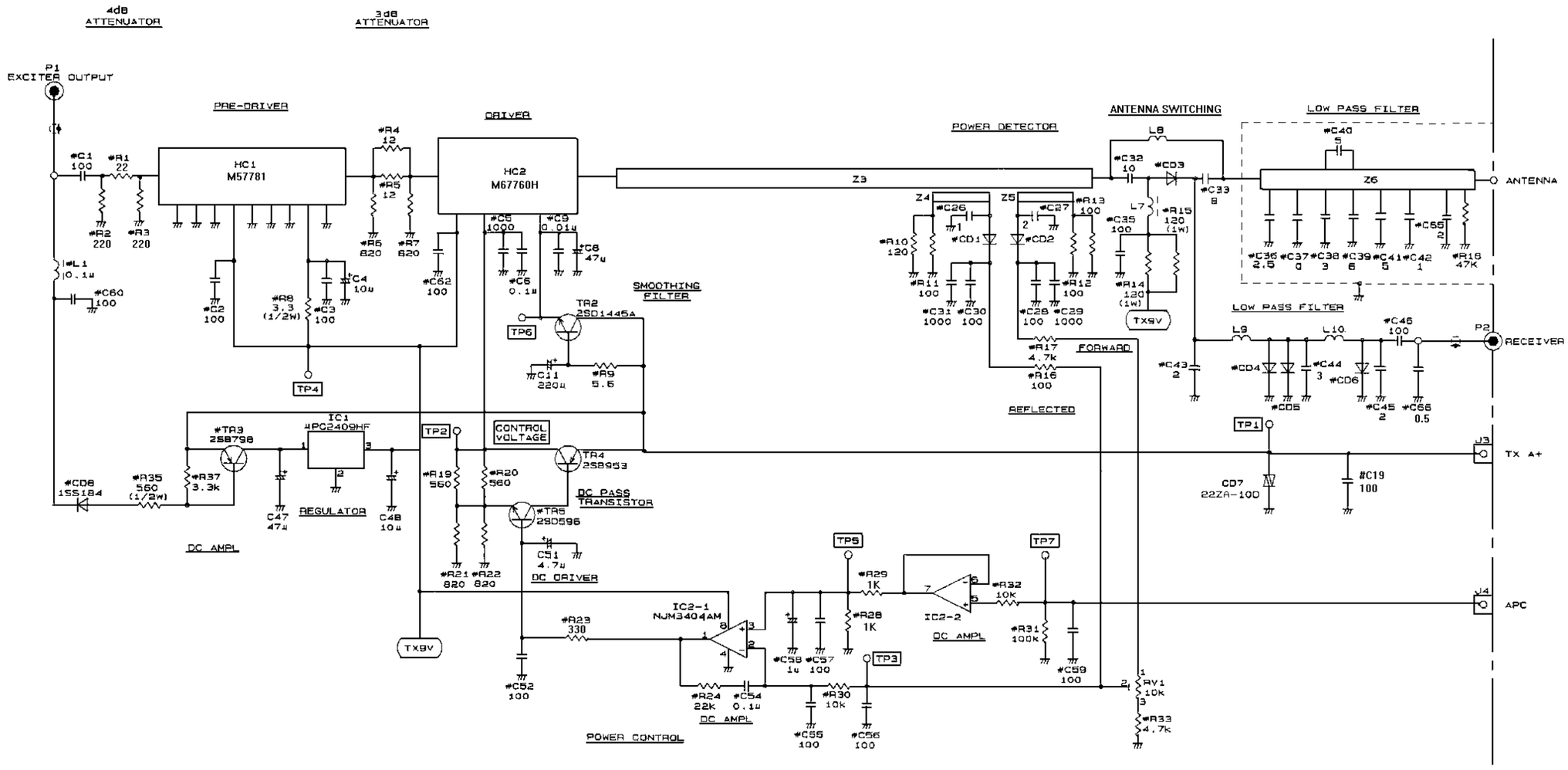
SOLDER SIDE



12-Watt Power Amplifier
CAH-590L

(B19/6PCLD00282B, Component Side Layout)
(B19/6PCLD00282B, Chip Components)

(B19/6PCLD00282B, Chip Components)

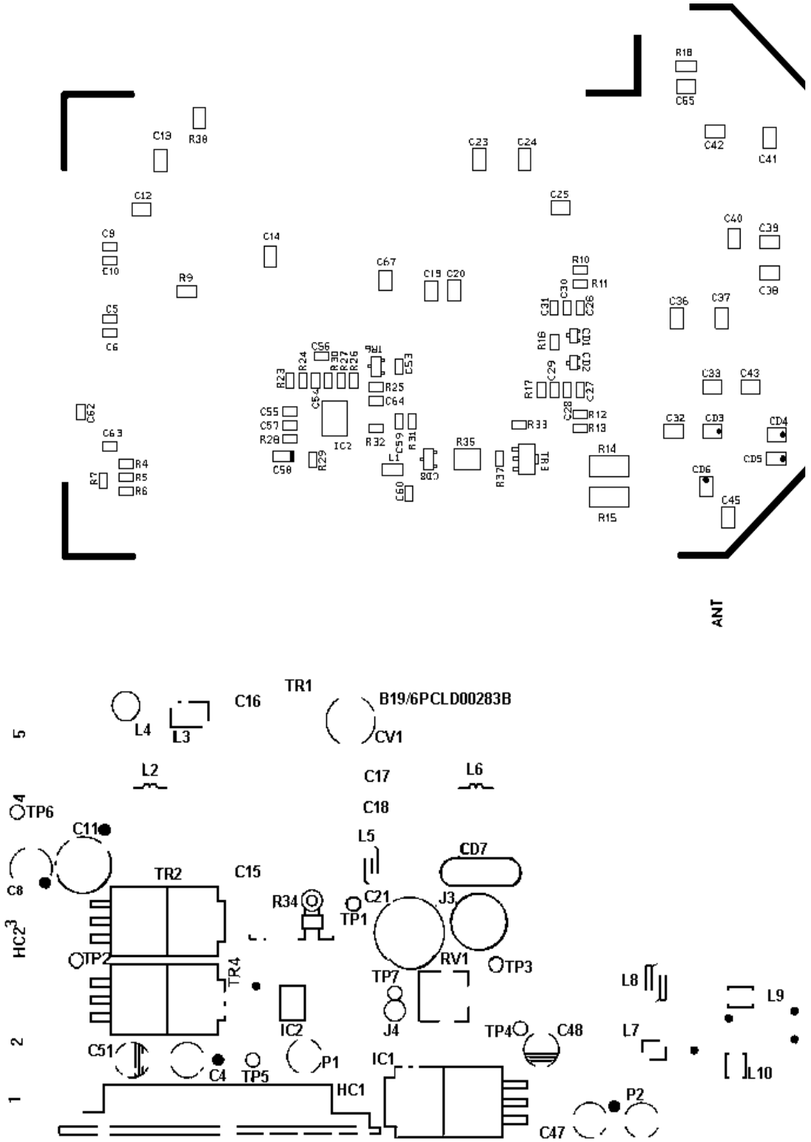


NOTES
1. "#"IDENTIFIES CHIP COMPONENTS
(EXAMPLE #R12 OR R12# WHICH ARE LOCATED ON THE COMPONENT SIDE OF THE BOARD
2. Z1-Z6, STRIPLINE PART OF PWB.
3. RV1 IS FACTORY TUNED AND DOES NOT REQUIRE FURTHER ADJUSTMENT.
ALL RESISTORS ARE 1/10 OR 1/8 WATT UNLESS OTHERWISE SPECIFIED.
RESISTOR VALUES IN Ω UNLESS FOLLOWED BY MULTIPLIER K OR M.
CAPACITOR VALUES IN P UNLESS FOLLOWED BY MULTIPLIERu .
INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m ORu

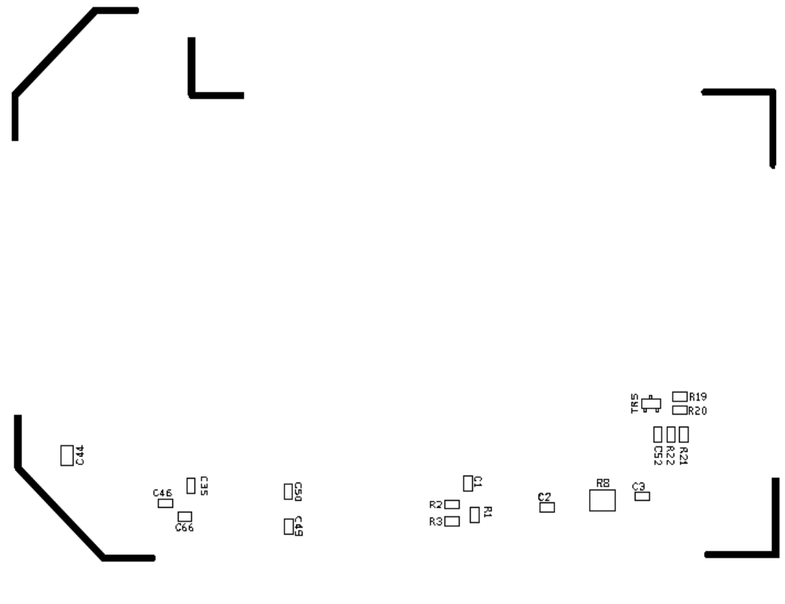
12 Watt Power Amplifier
CAH-590L

(DD00-CAH-590L)

COMPONENT SIDE



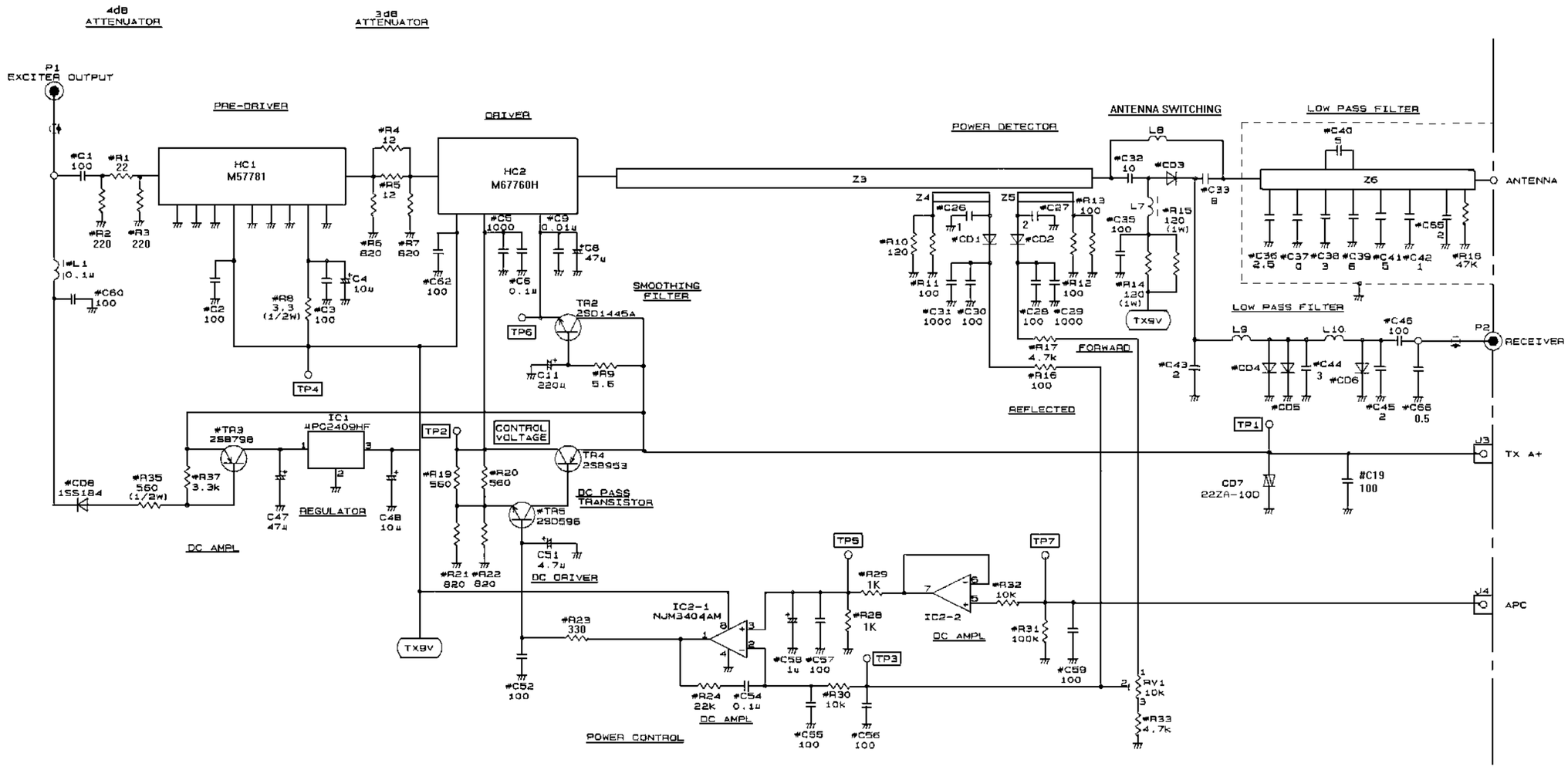
SOLDER SIDE



30 Watt Power Amplifier
CAH-590H

(19B/6PCLD00283B, Component Side Layout)
(19B/6PCLD00283B, Chip Components)

(19B/6PCLD00283B, Chip Components)



NOTES
1. "#"IDENTIFIES CHIP COMPONENTS
   (EXAMPLE #R12 OR R12# WHICH ARE LOCATED
   ON THE COMPONENT SIDE OF THE BOARD
2. Z1-Z6, STRIPLINE PART OF PWB.
3. RV1 IS FACTORY TUNED AND DOES NOT REQUIRE FURTHER ADJUSTMENT.
ALL RESISTORS ARE 1/10 OR 1/8 WATT UNLESS OTHERWISE SPECIFIED.
RESISTOR VALUES IN Ω UNLESS FOLLOWED BY MULTIPLIER K OR M.
CAPACITOR VALUES IN P UNLESS FOLLOWED BY MULTIPLIERμ .
INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m OR μ

30 Watt Power Amplifier
CAH-590H

(DD00-CAH-590H)