MAINTENANCE MANUAL
ORION™
800 MHz POWER AMPLIFIER UNITS

344A4574P1	**JHM-871PL**	**12 WATT**
344A4574P2	**JHM-871PH**	**35/30 WATT**

TABLE OF CONTENTS

ILLUSTRATIONS

DESCRIPTION

The **R**adio **F**requency (**RF**) Power Amplifiers for the 800 MHz **ORION**™ mobile radio are provided in frequency ranges and power levels designated as follows:

- 344A4574P1 (CAH-585L) - 806-870 MHz, 12 Watt used in low power applications
- 344A4574P2 (CAH-585H) - 806-870 MHz, 35/30 Watt used in high power applications.

The exciter for each of the two power amplifiers is located on Synthesizer/Receiver/Exciter board CMN-358-1. This exciter circuit provides approximately 9 milliwatt input to the PA (refer to Maintenance Manual LBI-39070).

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 35/30 Watts of output power for the 35/30-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.

ERICSSON

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Test Points (TP) are the printed circuit board terminals for measuring control voltages. Typical voltages are as follows:

	12-Watt Amplifier	35/30-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 RF input at P1 is coupled to power module HC1 through an attenuator pad consisting of resistors R1-R3. This pad attenuates the power input to HC1 and 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. 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. Amplifier HC2 amplifies the 0.6 Watt input to 12 Watts output.

This power module consists of a three-stage RF amplifier (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.

35/30-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 C15, inductor L2 and impedance matching network Z1 through coupling capacitor C12. Transistor TR1 amplifies the 12 Watt level to 35/30 Watts. The output of TR1 is coupled to the ANTENNA and ANTENNA SWITCH through an impedance matching components consisting impedance matching network Z2, capacitors C17, C18, C23, C24, C25 and C67, inductors L6 and L11 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, PNP **TX 9V** Switch 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, and switching diodes CD3 and CD4. 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 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 35/30 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 R28. When the heat sink temperature rises above 120-degrees Centigrade, the resistance of R34 increases and the power output is reduced.

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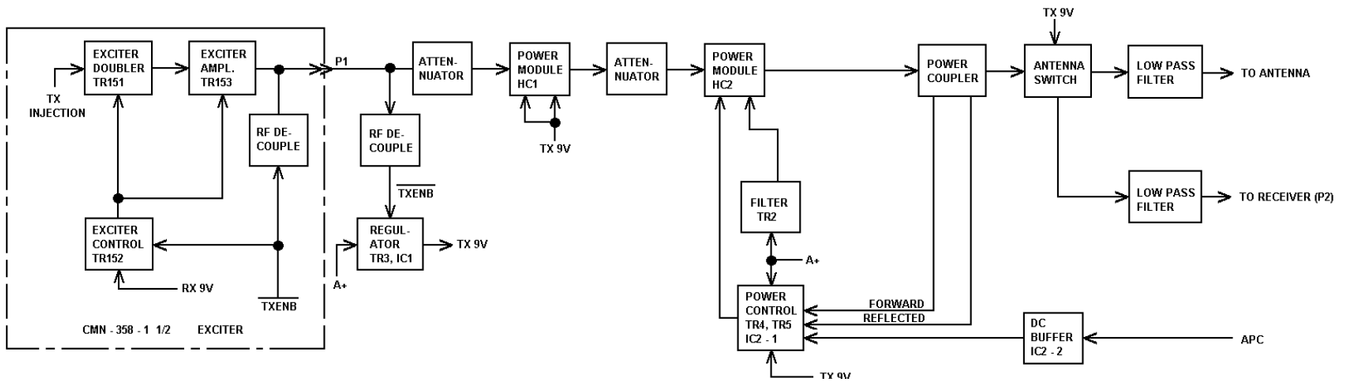


Figure 1- 12-Watt Power Amplifier Block Diagram

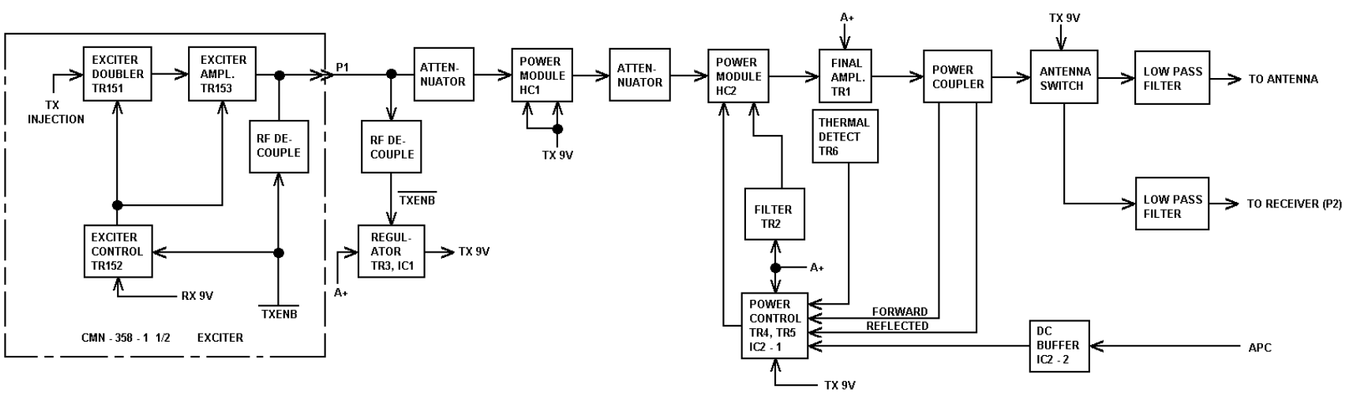
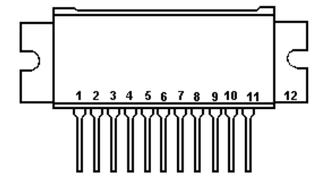
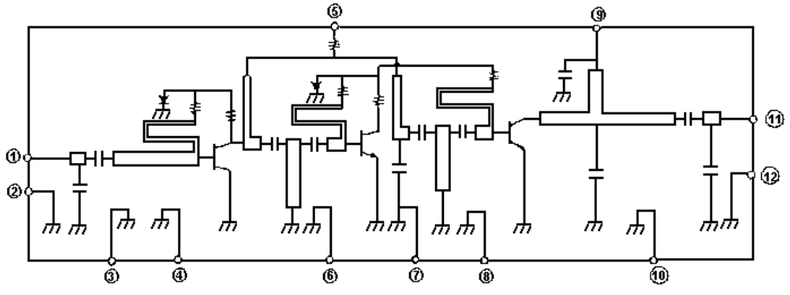


Figure 2 - 35/30-Watt Power Amplifier Block Diagram

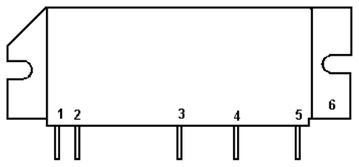
806-870 MHz, 12-WATT POWER MODULE HC1



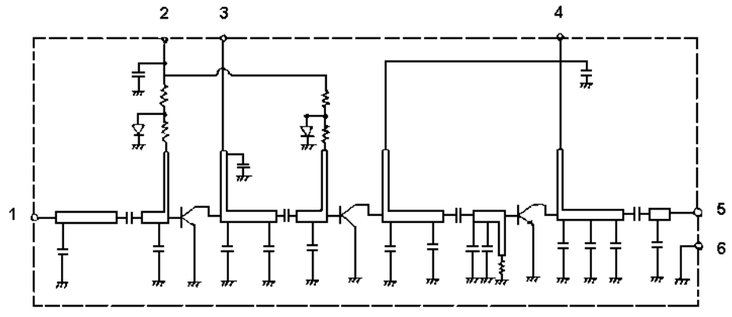
1. INPUT
2 - 4. GND
5. Vcc1
6 - 8. GND
9. Vcc2
10. GND
11. OUTPUT
12. GND (FIN)



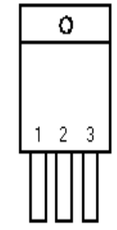
806-870 MHz, 35/30-WATT POWER MODULE HC2



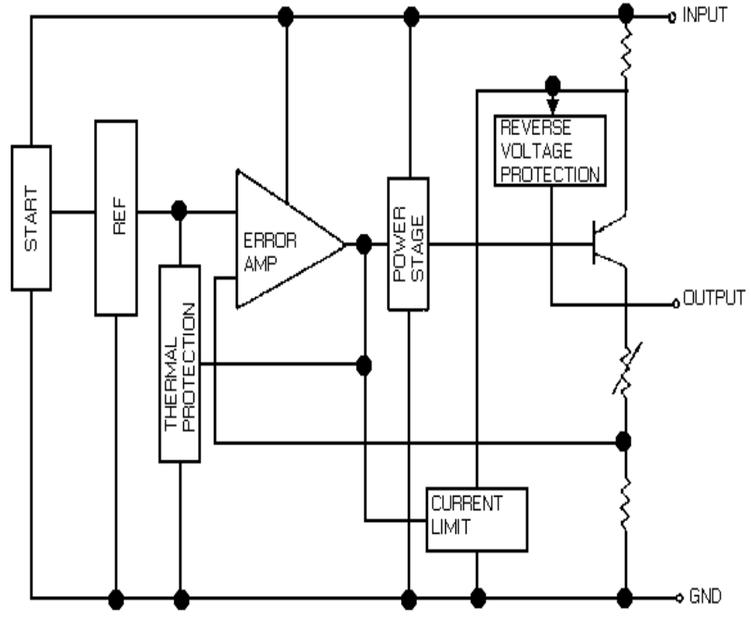
1. INPUT
2. Vbb
3. Vcc1
4. Vcc2
5. OUTPUT
6. GND (FIN)



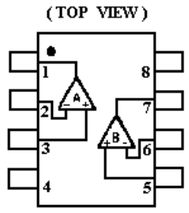
9 VOLT REGULATOR IC1



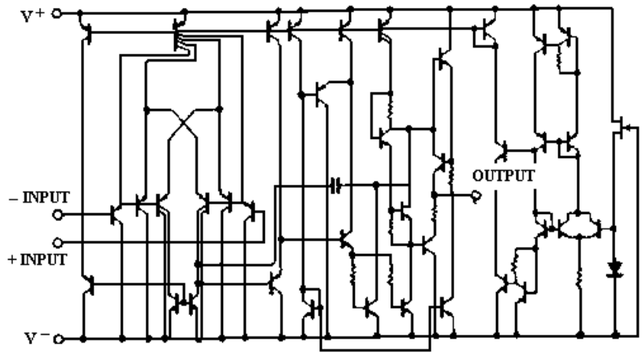
1. INPUT
2. GND
3. OUTPUT



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
344A4574P1/JHM-871L, 344A4574P2/JHM-871H
Issue 2

SYMBOL	PART NUMBER	DESCRIPTION
		----------ASSEMBLIES----------
A1001	NOTE: Parts listed are for reference only. Refer to Service Section for serviceable parts.	PA CIRCUIT CAH-585L (Used in 344A4574P1).
A1001		PA CIRCUIT CAH-585H (Used in 344A4574P2).
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: ALB-05 (Used in P1, P2).
J1002		CCT9402-0501R (Used in P1, P2).
		----------WIRES----------
ZC1002		H-6ZCLD41060 (Used in P1, P2).
ZC1003		H-6ZCLD40009 (Used in P1, P2).
TB1		ALB-01A (Used in P1, P2)

PA CIRCUIT CAH-585L (Used in 344A4574P1)
PA CIRCUIT CAH-585H (Used in 344A4574P2)
Issue 2

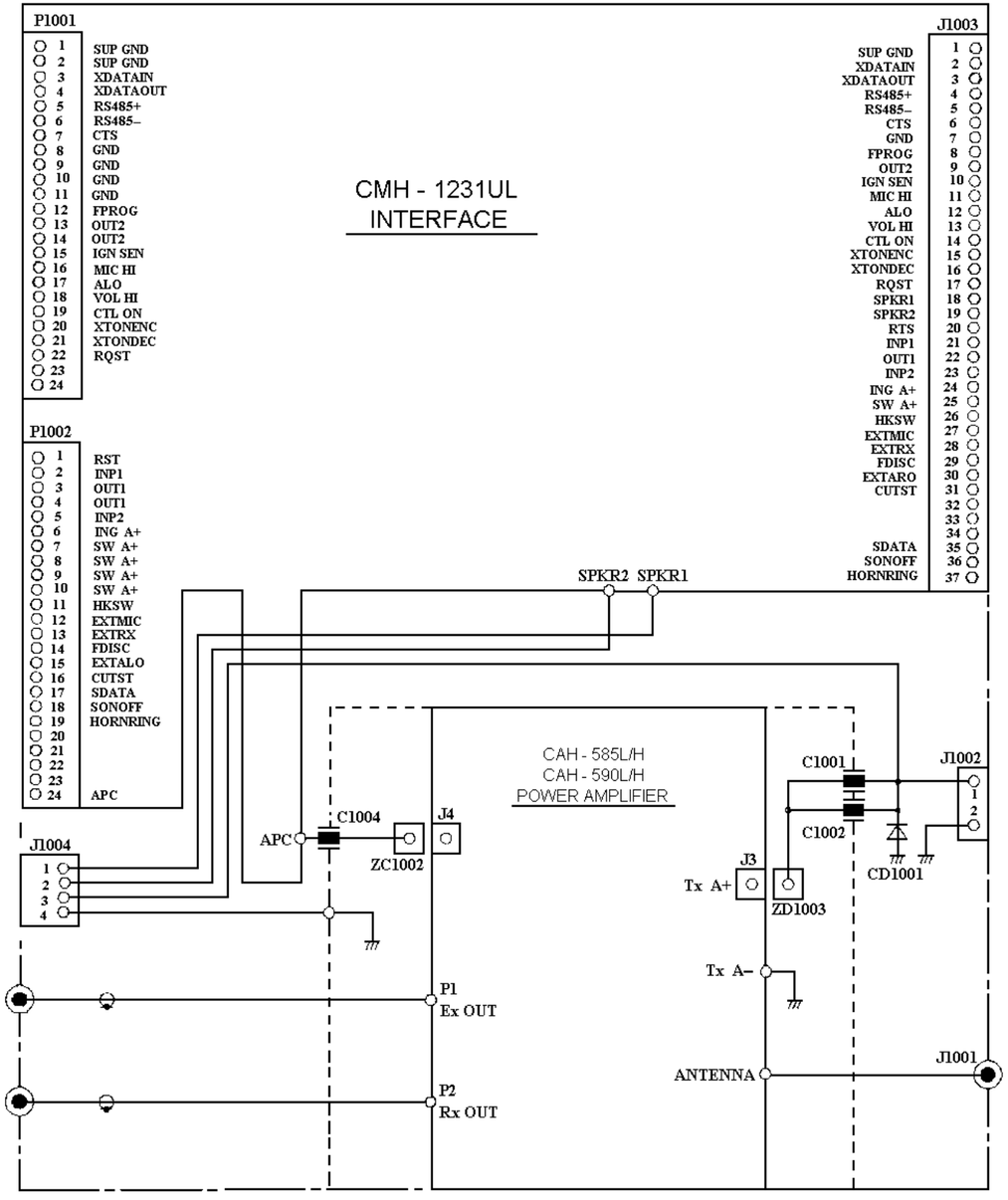
SYMBOL	PART NUMBER	DESCRIPTION
		----------CAPACITORS----------
C1 thru C3	NOTE: Parts listed are for reference only. Refer to Service Section for serviceable parts.	Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C4		Electrolytic: 10 µF ±20% 25 VDCW, tempcoef ±20%.
C5		Ceramic: 1000 pF ±10% 50 VDCW, temp coef 015%.
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 F ±20% 25 VDCW, temp coef ±20%.
C12		Ceramic: 33 pF ±5% 500 VDCW, temp coef 0±60 PPM (Used in H).
C14		Ceramic: 3.0 pF 0.25 pF 500 VDCW, temp coef 0±30 PPM (Used in H).

* COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

SYMBOL	PART NUMBER	DESCRIPTION
C15 and C16		Ceramic: 15 pF ±5% 500 VDCW, temp coef 0±60 PPM (Used in H).
C17		Metal mica: 22 pF ±5% 100 VDCW (Used in H).
C18		Metal mica: 22 pF ±5% 100 VDCW (Used in H).
C19		Ceramic: 100 pF ±5% 500 VDCW, temp coef 0±60 PPM.
C20		Ceramic: 0.1 F ±10% 50 VDCW, temp coef ±15% (Used in H).
C21		Electrolytic: 22F ±20% 40 VDCW (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 and C27		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 (Used in L).
C28		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30%.
C29		Ceramic: 1000 pF ±10% 50 VDCW, temp coef 015%.
C30		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30%.
C31		Ceramic: 1000 pF ±10% 50 VDCW, temp coef 0±15%.
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: 1.5 pF ±0.25 pF 500 VDCW, temp coef 0±250 PPM.
C43		Mica: 2.5 pF ±0.25 pF 500 VDCW.
C44		Ceramic: 4 pF ±0.25 pF 500 VDCW, temp coef 0±60 PPM.
C45		Ceramic: 2.5 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%.
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.

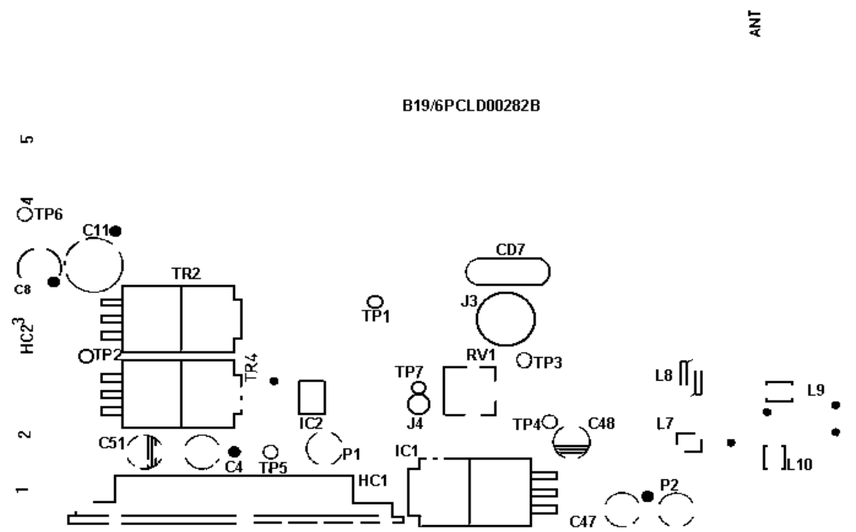
SYMBOL	PART NUMBER	DESCRIPTION
C58		Tantalum: 1 µF ±5% 16 VDCW, temp coef 0±60 PPM.
C59 and C60		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C62		Ceramic: 100 pF ±5% 50 VDCW, temp coef 0±30 PPM.
C65		Ceramic: 2 pF ±0.25 pF 500 VDCW, temp coef 0±250 PPM.
C66		Ceramic: 1.5 pF ±0.25 pF 50 VDCW, temp coef 0±30 PPM.
C67		Mica: 3 pF ±0.25 pF 500 VDCW.
CV1	Variable: 4 pF Max.	
		----------DIODES----------
CD1		MA728-TX.
CD2		MA728-TX.
CD3 thru CD6		Pin Diode. M1809-T11.
CD7		22ZR-10D.
CD8		Silicon: fast recovery (2 diodes in cathode common); sim to TOSHIBA 1SS184.
HC1		M57775-24.
HC2		M67760L-38.
IC1		Linear: Positive Voltage Regulator; sim to NEC µPC2409HF.
IC2		Linear: OP AMP. NJM3404AM-T1.
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.
L11		Coil: RF (Used in H).
P1		Coaxial cable with connector.
P2		Coaxial cable with connector.
		----------RESISTORS----------
R1		Metal film: 15 ohms ±5%, 100 VDCW 1/10W.
R2 and R3		Metal film: 270 ohms ±5%, 100 VDCW 1/10W.
R4 and R5		Metal film: 33 ohms ±5%, 100 VDCW 1/10W.
R6 and R7		Metal film: 270 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.

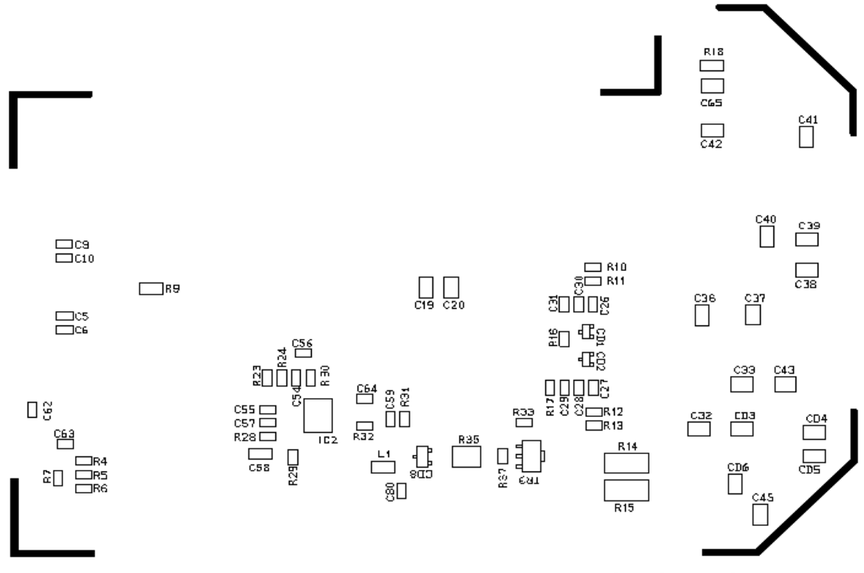
SYMBOL	PART NUMBER	DESCRIPTION
R11 thru R13		Metal film: 100 ohms ±5%, 100 VDCW 1/10W.
R14 and R15		Metal film: 120 ohms ±5%, 250 VDCW 1W.
R16		Metal film: 100 ohms ±5%, 100 VDCW 1/10W.
R17		Metal film: 2.2K ohms ±5%, 100 VDCW 1/10W (Used in L).
R17		Metal film: 4.7K ohms ±5%, 100 VDCW 1/10W (Used in 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: 680K 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: 18K 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 1/2 W.
R37		Metal film:3.3K ohms ±5%, 100 VDCW 1/10 W.
R38		Metal film: 4.7 ohms ±5%, 200 VDCW 1/4 W. (Used in H).
RV1		Variable: 10K ohms 30%, 0.1 W.
		----------TRANSISTORS----------
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 DV3 (Used in H).
TR2-1		Accessory: ALB-02A
TR4-1		Accessory: ALB-02A



(DD00-JHM-871P)

COMPONENT SIDE

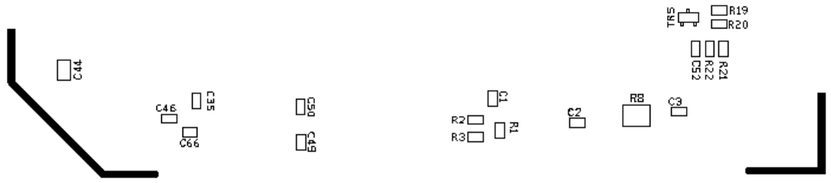




12-WATT POWER AMPLIFIER
CAH-585L

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

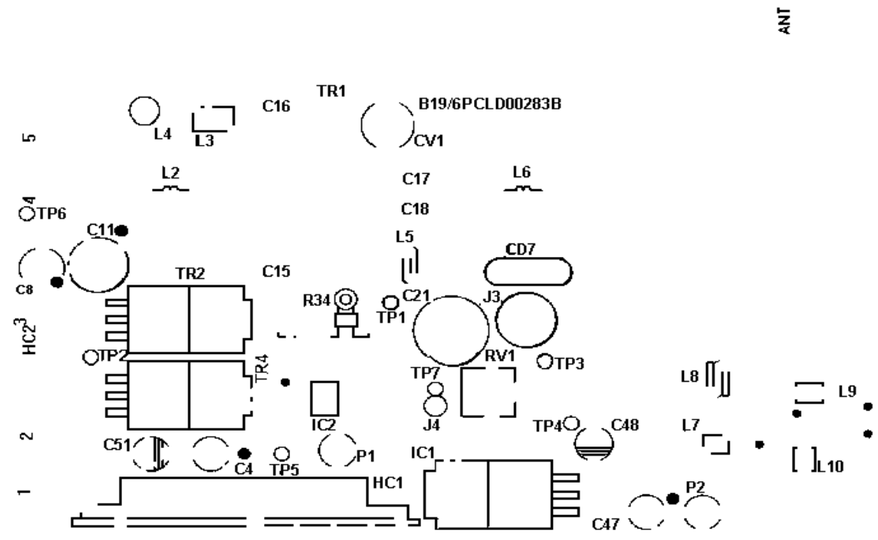
SOLDER SIDE

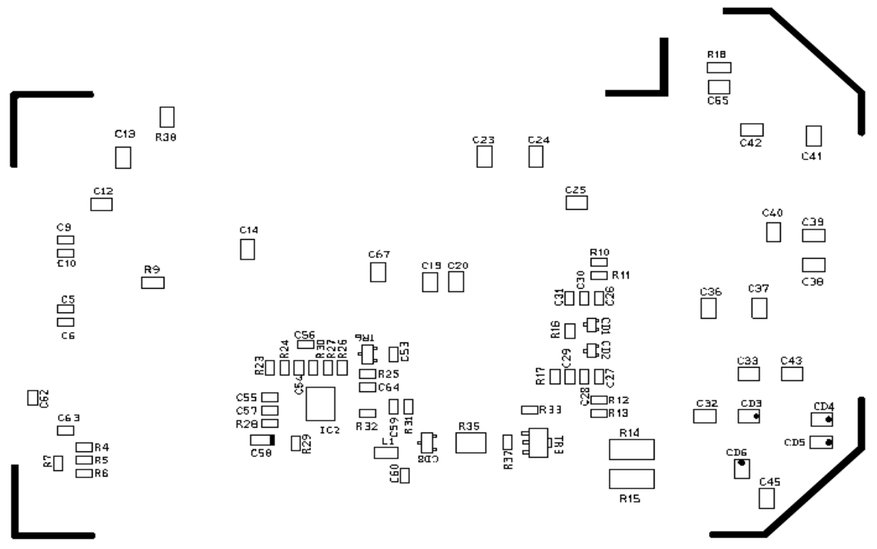


12-WATT POWER AMPLIFIER
CAH-585L

(B19/6PCLD00282B, Chip Components)

COMPONENT SIDE





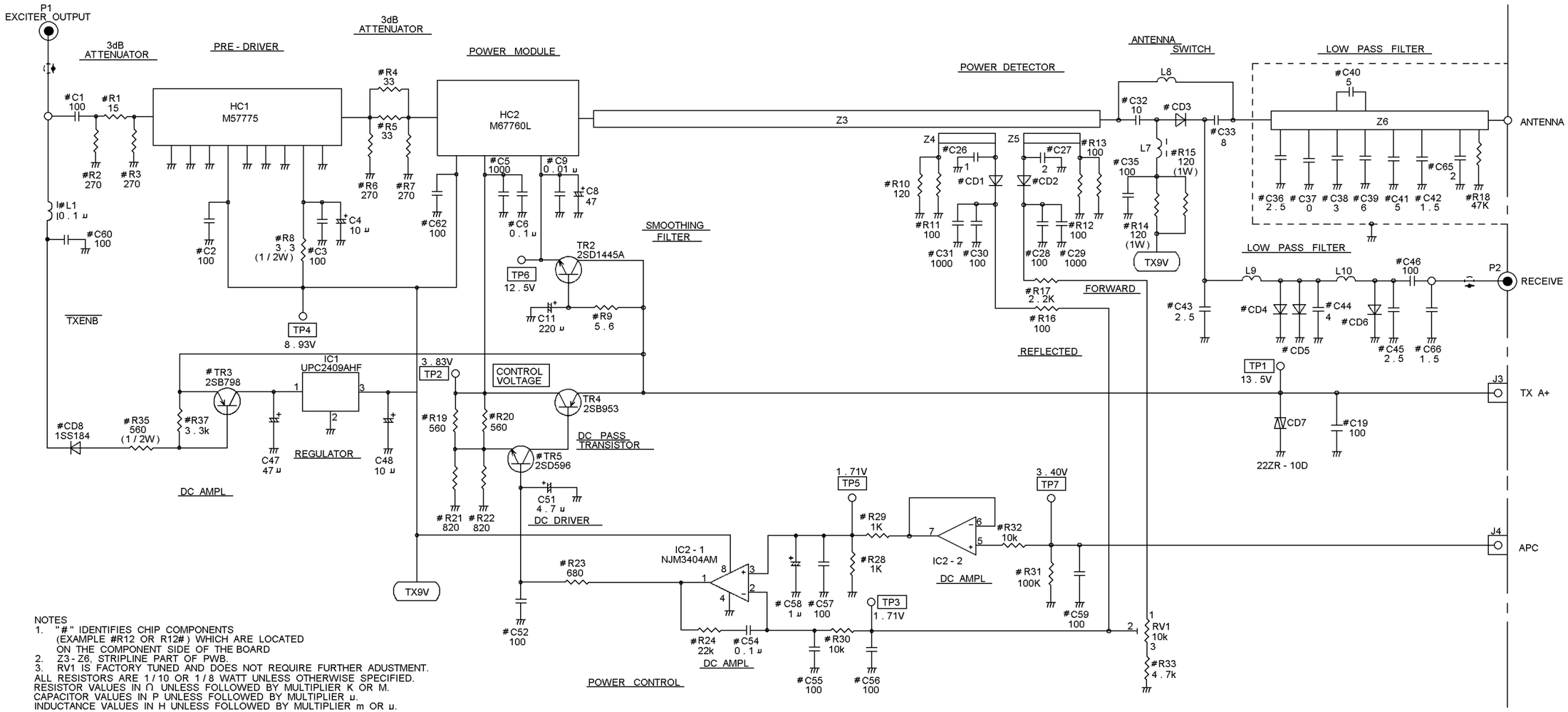
35/30 WATT POWER AMPLIFIER
CAH-585H

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

SOLDER SIDE

35/30 WATT POWER AMPLIFIER
CAH-585H

(19B/6PCLD00283B, Chip Components)

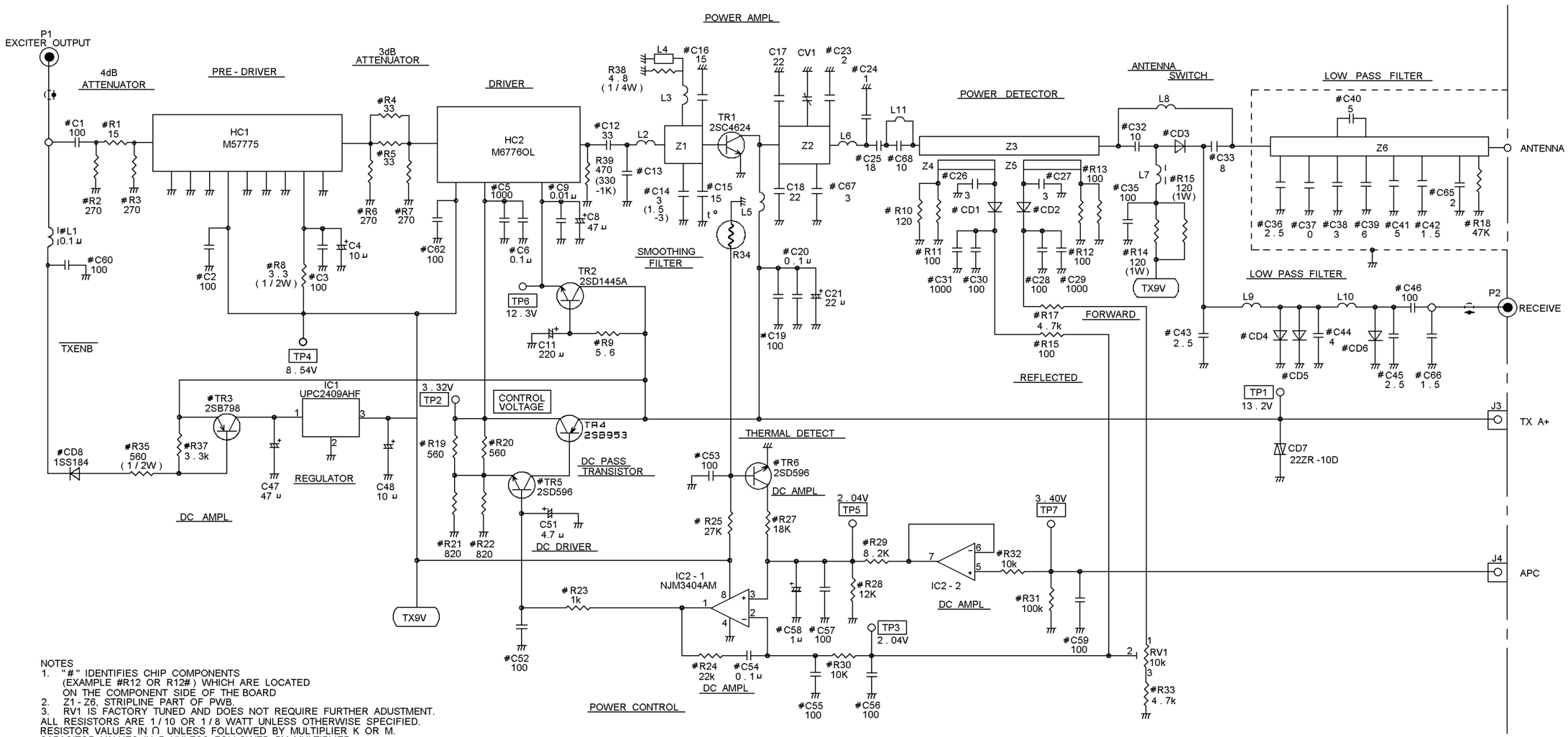


NOTES
1. "#" IDENTIFIES CHIP COMPONENTS (EXAMPLE #R12 OR R12#) WHICH ARE LOCATED ON THE COMPONENT SIDE OF THE BOARD
2. Z3 - Z6, STRIPLINE PART OF PWB.
3. RV1 IS FACTORY TUNED AND DOES NOT REQUIRE FURTHER ADUSTMENT.

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 MULTIPLIER μ.
INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m OR μ.

12 WATT POWER AMPLIFIER
CAH-585L

(DD02-CAH-585L)



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 ADUSTMENT.

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 MULTIPLIER µ.
INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m OR µ.

POWER AMPLIFIER
35 WATT (806-825 MHz)
30 WATT (851-870 MHz)
CAH-585H

(DD02-CAH-585H)