

MOTOROLA

MCS 2000 Mobile Radio Service Instructions

Volume 2c

UHF 110W Range 1 Frequency Range Specific

Safety Information

Every radio, when transmitting, radiates energy into the atmosphere which may, under certain conditions, cause the generation of a spark.

All users of vehicles fitted with radios should be aware of the following warnings:

Do not operate radio near flammable liquids or in the vicinity of explosive devices.

To ensure personal safety, please observe the following simple rules:

Check the laws and regulations on the use of two-way mobile radios in the areas where you drive. Always obey them. Also, when using your radio while driving, please:

- Give full attention to driving,
- Use hands-free operation, if available and
- Pull off the road and park before making or answering a call if driving conditions so require.

Airbag Warning

VEHICLES EQUIPPED WITH AIR BAGS

An air bag inflates with great force. DO NOT place objects, including communication equipment, in the area over the air bag or in the air bag deployment area. If the communication equipment is improperly installed and the air bag inflates, this could cause serious injury.

Installation of vehicle communication equipment should be performed by a professional installer/technician qualified in the requirements for such installations.

An air bag's size, shape and deployment area can vary by vehicle make, model and front compartment configuration (e.g., bench seat vs. bucket seats). Contact the vehicle manufacturer's corporate headquarters, if necessary, for specific air bag information for the vehicle make, model and front compartment configuration involved in your communication equipment installation.

LP Gas Warning

It is mandatory that radios installed in vehicles fuelled by liquefied petroleum gas conform to the National Fire Protection Association standard NFPA 58, which applies to vehicles with a liquid propane (LP) gas container in the trunk or other sealed off space within the interior of the vehicle. The NFPA58 requires the following:

- Any space containing radio equipment shall be isolated by a seal from the

space in which the LP gas container and its fittings are located.

- Removable (outside) filling connections shall be used.
- The container space shall be vented to the outside.

Anti-Lock Braking System (ABS) and Anti-Skid Braking System Precautions



WARNING

Disruption of the anti-skid/anti-lock braking system by the radio transmitter may result in unexpected vehicle motion.

Motorola recommends the following radio installation precautions and vehicle braking system test procedures to ensure that the radio, when transmitting, does not interfere with operation of the vehicle braking system.

Installation Precautions

1. Always provide as much distance as possible between braking modulator unit and radio, and between braking modulator unit and radio antenna and associated antenna transmission line. Before installing radio, determine location of braking modulator unit in vehicle. Depending on make and model of vehicle, braking modulator unit may be located in trunk, under dashboard, in engine compartment, or in some other cargo area. If you cannot determine location of braking modulator unit, refer to vehicle service manual or contact a dealer for the particular make of vehicle.
2. If braking modulator unit is located on left side of the vehicle, install radio on right side of vehicle, and conversely.
3. Route all radio wiring including antenna transmission line as far away as possible from braking modulator unit and associated braking system wiring.
4. Never activate radio transmitter while vehicle is in motion and vehicle trunk lid is open.

Braking System Tests

The following procedure checks for the most common types of interference that may be caused to vehicle braking system by a radio transmitter.

1. Run vehicle engine at idle speed and set vehicle transmission selector to PARK. Release brake pedal completely and key radio transmitter. Verify that there are no unusual effects (visual or audible) to vehicle lights or other electrical equipment and accessories while microphone is NOT being spoken into.
2. Repeat step 1. except do so while microphone IS being spoken into.
3. Press vehicle brake pedal slightly just enough to light vehicle brake light(s). Then repeat step 1. and step 2.
4. Press the vehicle brake pedal firmly and repeat step 1. and step 2.
5. Ensure that there is a minimum of two vehicle lengths between front of vehicle and any object in vehicle's forward path. Then, set vehicle

transmission selector to DRIVE. Press brake pedal just far enough to stop vehicle motion completely. Key radio transmitter. Verify that vehicle does not start to move while microphone is NOT being spoken into.

6. Repeat step 5. except do so while microphone IS being spoken into.
7. Release brake pedal completely and accelerate vehicle to a speed between 15 and 25 miles/25 and 40 kilometers per hour. Ensure that a minimum of two vehicle lengths is maintained between front of vehicle and any object in vehicle's forward path. Have another person key radio transmitter and verify that vehicle can be braked normally to a moderate stop while microphone is NOT being spoken into.
8. Repeat step 7. except do so while microphone IS being spoken into.
9. Release brake pedal completely and accelerate vehicle to a speed of 20 miles/30 kilometers per hour. Ensure that a minimum of two vehicle lengths is maintained between front of vehicle and any object in vehicle's forward path. Have another person key radio transmitter and verify that vehicle can be braked properly to a sudden (panic) stop while microphone is NOT being spoken into.
10. Repeat step 9. except do so while microphone IS being spoken into.
11. Repeat step 9. and step 10. except use a vehicle speed of 30 miles/50 kilometers per hour.

LIST OF EFFECTIVE PAGES

MCS 2000 Mobile Radio Service Instructions

Volume 2c

UHF 110W Range 1 Specific Information

Motorola Publication Number 68P81080C42-A

Issue Dates of Original and Revised Pages are:

Original: March 1997
Revision A: February 1999

The Number of pages in this publication is 138 consisting of the following:

<u>Page Number</u>	<u>Revision Letter</u>	<u>Page Number</u>	<u>Revision Letter</u>
Front cover	O	23 through 34	O
Inside front cover (blank)	O	35 and 36	A
Title	A	37	O
Safety 0 through Safety 2	O	38 through 124	A
A	A	Questionnaire (Front)	O
B	O	Questionnaire (Back)	O
i and ii	A	Replacement Parts Ordering (Inside back cover)	O
1 through 22	A	Back cover	O

NOTE: The letter O in the Revision Letter column in the table above denotes an original page. Original pages ARE NOT identified as such in the page footers except for the absence of a change letter and date.

IMPORTANT
ELECTROMAGNETIC
EMISSION
INFORMATION

In August, 1996, The Federal Communications Commission (FCC) adopted an updated safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment. Motorola subscribes to this same updated safety standard for the use of its products.

In keeping with sound installation practice and to maximize radiation efficiency, a one-quarter (1/4) wave length antenna should be installed at the center of the vehicle roof. If it is necessary to mount the antenna on the vehicle's trunk lid, an appropriate 3db gain antenna should be used. This installation procedure will assure that vehicle occupants will be exposed to radio frequency energy levels lower than the limits specified in the standard adopted by the FCC in General Docket 79144.

To assure that radio frequency (RF) energy exposure to bystanders external to a vehicle is lower than that recommended by FCC adopted standard, transmit with any mobile radio only when bystanders are at least two (2) feet away from a properly installed externally mounted antenna for radios with less than 50 watts of output power, or three (3) feet away for radios with 50 watts or greater power.

Control Station Operation

In the event of Control Station operation, to assure operators and bystanders are exposed to radio frequency (RF) energy levels lower than the limits specified in the FCC adopted standard, the antenna should be installed outside of any building, but in no instance shall the antenna be within two feet (less than 50 watts power output) or within three feet (50 watts or higher power output) of station operators or bystanders.

Table of Contents

- Safety Information Safety 0
- List of Effective Pages A
- Important Electromagnetic Emission Information.B
- List of Figures ii
- 1- Introduction. 1
- 2- Theory of Operation3
 - Introduction 4
 - Block Diagram Level Theory of Operation. 4
 - Receiver Detailed Functional Description 7
 - Receiver Front End 7
 - Receiver Intermediate Frequency (IF). 9
 - Receiver Back End. 9
 - Transmitter Detailed Functional Description. 11
 - Synthesizer Detailed Functional Description. 11
 - Power Amplifier 13
 - Overall PA 13
 - PA Power Control 16
 - Controller Detailed Functional Description. 17
 - Dc Power Supply and Regulation Detailed Functional Description 17
- 3 - Troubleshooting21
- 4 - Reference Drawings39

List of Figures

Figure 1. Overall Radio Functional Block Diagram 5

Figure 2. PA Power Control Simplified Schematic Diagram. 19

Figure 3. Main Board and PA Board Interconnected 41

Figure 4. Main Board Section Locations 42

Figure 5. PA Board Section Locations 43

Figure 6. Schematic Diagrams Hierarchy 44

Note: Troubleshooting charts are listed on pages 21; Reference drawings (component locations, schematic diagrams, and parts lists) are listed on pages 39 and 40.

List of Tables

Table 1. Schematic Diagram Interconnect List 87

Introduction

1

This publication (Service Manual Volume 2c for MCS 2000 Radios, Motorola Publication Number 68P81080C42) provides frequency-range-specific information for 110-Watt MCS 2000 Radios that operate in the UHF Range 1 frequency range. It is a companion volume to Service Manual Volume 1 for MCS 2000 Radios, Motorola Publication Number 68P81083C20, which provides non-frequency-range-specific information for all MCS 2000 Radios.

Service personnel must have both Volume 1 and Volume 2c of the MCS 2000 Service Manual in order to have all service information for 110-Watt MCS 2000 UHF Range 1 Radios. In addition, for radios that are equipped with the Motorola SECURENET option, the SECURENET Option Service Manual, Motorola Stock Number 68P81080C25, is required.

There are several other Volume 2 service manuals (Volumes 2a, 2b, and 2d, etc.), which cover other models of the MCS 2000 Radio. Refer to Volume 1 of this service manual for a list of the publications related to operation and maintenance of all models of the MCS 2000 Radio, and the Motorola Publication Numbers for those documents.

Hereafter in this manual, the MCS 2000 Radio is referred to as the radio. The specific hardware portions of the radio covered in this volume of the service manual are as follows:

- Receiver Front End
- Receiver Intermediate Frequency (IF)
- Receiver Back End
- Synthesizer
- Power Amplifier

This volume of the service manual covers the following five topics for the specific hardware portions of the UHF radio listed above:

- Theory of operation
- Troubleshooting
- Component locations
- Parts lists
- Schematic diagrams

The five topics listed above for the controller section and for the control heads are covered in Volume 1 of this service manual, Motorola Publication Number 68P81083C20.

Theory of Operation

This chapter provides theory of operation information for the 110-Watt UHF Range 1 radio. It starts with a block diagram level functional description of the entire radio. This is followed by a detailed functional description for each of the receiver and transmitter functions.

Introduction

The radio is composed of the following five major functions:

- Receiver
- Transmitter
- Controller
- Operator Interface (Control Head)
- Dc Power Supply and Regulation

The radio consists of a main radio body and a control head. The main radio body contains two interconnected circuit card assemblies, a main transceiver board and a power amplifier (PA) board. The PA board is connected electrically to the (main) transceiver board with two connectors (called the 2-pin and 12-pin PA interconnects).

The operator interface function consists of the control head, which connects to the main body of the radio. There are three different control head types: the Model I for the Model I Radio; the Model II for the Model II Radio; and the Model III for the Model III Radio. The control heads are covered in their entirety in volume 1 of this service manual.

The main transceiver board is physically separated into five functional sections as follows:

- Receiver Front End
- Receiver Intermediate Frequency (IF)
- Receiver Back End [Zero Intermediate Frequency (ZIF)]
- Synthesizer
- Controller

The controller section is further divided into two sub-sections: common controller; and dc power supply and regulation. The mechanical layout of the transceiver board is illustrated in Chapter 4.

Separate component location diagrams, parts lists, and schematic diagrams are provided in this service manual for each of the five physical sections of the main transceiver board and for the control heads.

The component location diagrams, parts lists, and schematic diagrams for the controller section of the transceiver board and for the control heads are located in volume 1 of this service manual. The component location diagrams, parts lists, and schematic diagrams, for the five physical sections of the main transceiver board and for the PA board are located in this volume (Volume 2c).

Block Diagram Level Theory of Operation

The following discussion refers to the overall functional block diagram for the radio, Figure 1.

The receiver function of the radio detects, demodulates, amplifies, and outputs via the loudspeaker, radio signals picked up by the vehicle or fixed-station antenna. The radio signals picked up by the antenna are signals that have been re-broadcast by trunked or conventional repeaters, or that have been broadcast directly by other mobile or fixed station radios. The receiver input signal from the antenna reaches the receiver via the antenna switch, which is located in the transmitter function of the radio.

The receiver function of the radio consists of: the receiver front end section; the receiver intermediate frequency (IF) section; the receiver back end section; and the audio signal filter (ASFIC) and receiver audio power amplifier circuits in the controller section.

The receiver function of the radio uses the double conversion superheterodyne design to optimize image rejection and selectivity.

The 110W UHF Range 1 radio covered in this volume (Volume 2c) of the service manual is available with two different receiver configurations, one that includes a preamplifier in the receiver front end and the other that does not. Except when specifically stated otherwise, the discussion that follows applies to both the preamplifier and non-preamplifier versions of the radio.

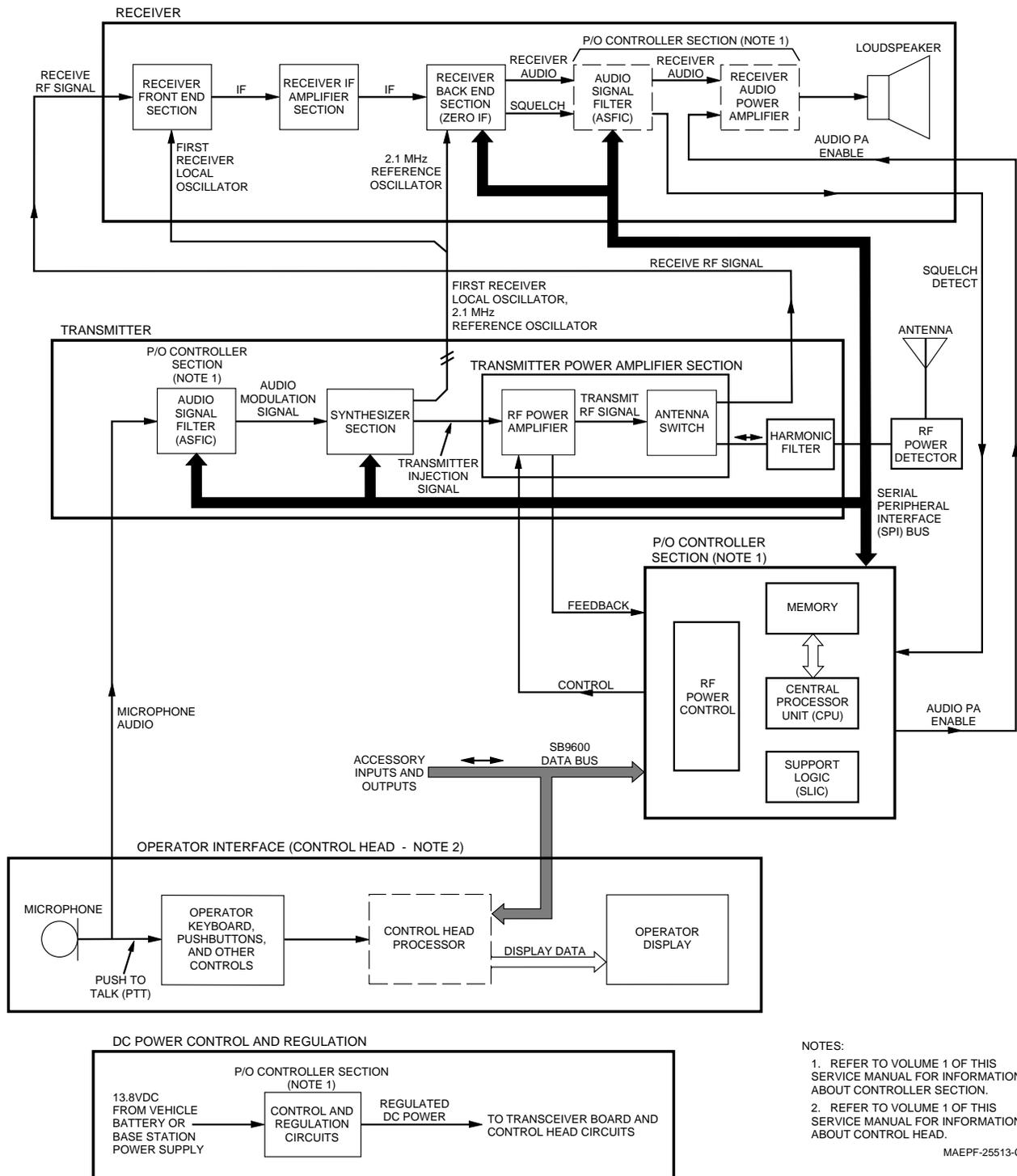


Figure 1 Overall Radio Functional Block Diagram

The receiver front end section converts the receiver input signal to a first intermediate frequency (IF) of 109.65 MHz. It does so by mixing the receiver input signal with a receiver first local oscillator signal. Therefore, the channel frequency of the received signal is determined by the frequency of the receiver first local oscillator signal, which is 109.65 MHz above the frequency of the receiver input signal. The local oscillator signal is produced by the synthesizer section of the radio.

In the preamplifier versions only, a preamplifier in the receiver front end section amplifies the receiver input signal from the antenna switch before it is converted to the first IF.

The IF output signal from the receiver front end section passes through the receiver IF section where it is filtered and amplified. The output signal from the receiver IF section goes to the input of the receiver back end section.

In the receiver back end section, which contains an integrated circuit (IC) called the zero intermediate frequency (ZIF), the receiver IF signal is demodulated to produce receiver audio, signalling, and squelch signals. The ZIF IC contains a number of phase locked loops, which are synchronized by a 2.1-MHz reference oscillator signal provided by the synthesizer section of the radio. The output signals from the receiver back end section go to the input of the receiver audio circuits in the controller section of the radio.

In the controller section of the radio, the receiver audio and squelch signal outputs from the receiver back end section are processed, by an audio signal filter integrated circuit (ASFIC), to generate filtered receiver audio and squelch detect signals. The filtering characteristics and other processes of the ASFIC are controlled by the central processor unit (CPU) in the controller section.

The filtered receiver audio signal from the output of the ASFIC goes to the input of the receiver audio power amplifier circuit, which is located in the controller section of the radio. The receiver audio power amplifier circuit passes the receiver audio signal to the loudspeaker only when it receives an audio PA enable signal from the controller section of the radio. This is known as a squelch function. Its purpose is to prevent receiver noise from passing to the loudspeaker whenever there is no signals being received by the radio.

The controller generates the audio PA enable signal based on such variables as the level of the received signal, the channel frequency, and the operating mode of the radio. When the audio PA enable signal is generated, the audio power amplifier (PA) is activated and passes the receiver audio signal to the loudspeaker.

The (RF) output signal is frequency modulated by an audio signal from the microphone or from another source such as a keypad, handset, or external modem.

The transmitter function of the radio consists of: the audio signal filter integrated circuit (ASFIC) in the controller section; the synthesizer section; and the power amplifier (PA) section. The ASFIC develops a modulation signal by amplifying an audio signal from the

microphone, keypad, or handset. The synthesizer section generates a radio frequency carrier signal upon which the transmitter portion of the radio operates. The radio frequency carrier signal generated by the synthesizer section is frequency modulated in the synthesizer section by the modulation signal output from the ASFIC.

The frequency modulated output signal from the synthesizer section is amplified to the required 110-Watt power level by the (PA) section. The RF output from the PA section passes through the antenna switch, harmonic filter, and RF power detector and is radiated into space by the vehicle or control-station antenna. Transmitter output power is monitored continuously and is adjusted by the RF power control circuit in the controller section of the radio.

The controller section of the radio contains a microprocessor that controls the radio in accordance with its built in programming as well as commands input manually by the radio operator. The radio operator inputs manual commands to the controller section using the pushbuttons and other controls located on the control head. In addition to its controlling functions, the controller section provides audio amplification of the audio output signal in the receiver function. It also contains squelch detect circuitry based on a buffered discriminator signal from the Zero Intermediate Frequency Integrated Circuit (ZIF IC).

The operator interface function of the radio consists of: a microphone or the microphone portion of a handset; a keypad if used; the pushbuttons and other controls on the control head; and the digital and graphics displays on the control head. The pushbuttons and other controls on the control head provide digital commands to the controller section, and in some instances, hardwired commands to controlled circuits. The digital and graphics displays receive display data from the controller section.

The control head contains its own microprocessor, which communicates with the controller section of the radio via an SB9600 serial digital data bus.

The DC power supply and regulation function regulates and distributes DC voltage, to the various sections of the radio, DC power from the vehicle battery, alternator, or fixed station power supply.

Receiver Detailed Functional Description

The portion of the receiver function that is not part of the controller section of the radio is composed of three sections: receiver front end; receiver If, and receiver back end.

Receiver Front End

The following discussion is based on the schematic diagram for the receiver front end section on pages 49 and 51.

The radio signal enters the receiver front end through capacitor C5268. In the preamplifier version of the radio, the radio signal passes from capacitor C5268 to the input of the RF preamplifier composed of transistor Q5255 and associated components. The output from the RF preamplifier passes through capacitor C5262 to the input of the

passband filter section, which includes ceramic filters HY5250 and HY5251 and diode switches D5250 through D5253. In the standard (non-preamplifier) version of the radio, the radio signal passes from C5268, through 0-ohm resistors R5267 and R5269, to the input of the passband filter section. In the preamplifier version of the radio, the radio signal passes from capacitor C5268 to the RF Preamplifier section.

RF Preamplifier Section (Preamplifier Version Only)

In the preamplifier version of the radio only, the radio signal passes from capacitor C5268 through a high pass filter (C5265, C5266, C5267, L5259, L5260) to RF preamplifier transistor Q5255. The high pass filter attenuates signals below the receiver passband (403 to 470 MHz). The main purpose of the high pass filter is to attenuate undesired signals that could otherwise frequency multiply onto channel through non-linearities in the RF preamplifier.

The RF preamplifier Q5255 is a low noise amplifier which provides 11.3 dB of gain and sets the noise figure of the receiver (2.5 dB). Components VR5250, R5257, R5258, R5261, C5258, C5262 form the bias circuit for Q5255. In normal operation, the RF preamplifier draws about 17 mA of current. It operates from a 13.6-Volt receiver front end regulator in the receiver IF section. (Refer to detailed functional description of receiver IF section for particulars.)

Passband Filter Section

The first local oscillator (LO) uses frequencies in the range of 512.65 MHz to 579.65 MHz. The main function of the passband filter section is to provide rejection of signals at the image frequencies (first LO plus radio signal). This ensures that radio signals in the image frequency range of 622.3 MHz to 689.3 MHz are not converted down to the 109.65 MHz IF by the mixer.

The passband filter section consists of two ceramic filters (HY5250 and HY5251) and two diode switches. Only one ceramic filters is switched into the receiver signal circuit at a time. This is accomplished by diode switches D5250, D5251, D5252 and D5253, which are controlled by auxiliary bit 1 of Frac-N integrated circuit U5801 in the synthesizer section of the radio. (Refer to detailed functional description of synthesizer section for particulars.)

The passband of filter HY5250 is 403 to 433 MHz and that of HY5251 is 438 to 470 MHz. The filter rolloffs overlap sufficiently to also allow receiver operation between 433- and 438 MHz but at slightly degraded performance. The ceramic filters attenuate signals below 403 MHz and above 470 MHz, providing most of the attenuation for signals at 109.65 MHz (the IF of the radio).

Mixer Section

The mixer section follows the passband filter section. The mixer (Q5254) converts the incoming signal down to the 109.65 MHz IF (intermediate frequency), using the LO (local oscillator) signal generated by the synthesizer. The frequency of the LO is always 109.65 MHz higher than the incoming RF signal frequency. The LO power level is 10 dBm going into the mixer section (when disconnected from the mixer and terminated in 50 ohms). The LO signal is passed through the LO Injection Filter (capacitors C5279 through C5291 and inductors L5265 through L5270).

The incoming RF signal and the LO reach the mixer through a matching network consisting of capacitors C5270, C5271 and C5201 and inductors L5257 through L5258 and L5271. The mixer is biased from the 13.6-Volt receiver front end regulator. The mixer draws about 16 mA of current from the regulator. The IF output signal from the mixer goes to the input of the receiver intermediate frequency (receiver IF) section of the radio.

Receiver Intermediate Frequency (IF)

The following discussion is based on the schematic diagram for the receiver IF section on pages 53 and 55. The main functions of the IF section are to provide optimum selectivity, high signal gain, and low noise. The IF section of the UHF radio consists of the IF amplifier, two crystal filters, a resistive pad (R5376, R5377, R5378) for impedance stabilization, a termination for a mixer (not included in the VHF version of the radio), and a 13.6-Volt receiver front end regulator (also not included in the VHF version).

The receiver front end regulator consists of (R5390, Q5390, C5410, C5411, R5395, and VR5371). The output voltage of the regulator tracks SW-B+ up to 13.6 Volts, at which point it clamped by VR5371 and Q5390.

The UHF mixer termination (L5374, C5371, R5375, C5370, C5412) supplies the UHF mixer with an approximate 50 ohm match on UHF radios. Thus, R5375 should be the only component placed among these on VHF radios.

The two pole crystal filters (Y5378 and Y5379) provide some adjacent channel selectivity and excellent spurious rejection further away from 109.65 MHz, thus, essentially rejecting all signals except the on-channel 109.65 MHz signal that is to be demodulated.

The IF amplifier (Q5388, L5301, R5379, C5301, R5388, R5301, C5386, R5387, C5382) is actively biased (R5386, C5385, C5418, L5380, C5384, C5417, Q5382, R5385, R5384, R5382, L5399, C5383, C5415) by Q5382 and provides about 12 dB of gain with a noise figure of about 3 dB. It operates from 9.3 volts and draws about 30 mA of current in normal operation.

The other capacitors and inductors (C5377, C5376, L5376, C5378, C5379, L5377, L5378, C5380, C5381, L5379, C5375, C5387, C5303, C5372, L5381, C5388, C5389, L5382, C5390, L5383, C5391, C5302, L5302) provide an impedance match from the 50 ohm IF section input to the first crystal filter, from the first crystal filter to the IF amplifier, from the IF amplifier to the second crystal filter, and from the second crystal filter to the back end section.

A 150 ohm resistor (R5389) is used at the output of the IF section to provide impedance stabilization between the receiver back end section and the second crystal filter in the receiver IF section. The crystal filter input and output impedances are approximately 200 ohms.

Receiver Back End

The following discussion is based on the schematic diagram for the receiver back end section on pages 57 and 59. The selectivity of the receiver back-end is provided by programmable filters contained in the Zero Intermediate Frequency Integrated Circuit (ZIF IC) circuitry. The

filter bandwidth is adjusted automatically by the controller section of the radio to a bandwidth appropriate for the channel spacing.

The ZIF IC (U3201) uses a type of direct conversion process, whereby the second local oscillator (LO) frequency is very close to the frequency of the received IF signal. The voltage controlled oscillator (VCO) in the synthesizer section of the radio is phase-locked to the IF signal and tracks it with a small offset frequency.

In the absence of an IF signal, the second LO VCO searches for a signal. When an IF signal is received, the second LO VCO locks on the signal. The second LO VCO is a Vackar oscillator built around transistor Q3201. A varactor diode (CR3201) adjusts the frequency of the VCO according to feedback voltage from the ZIF IC. This voltage is normally in the range of 1.0 to 3.5 volts.

The feedback voltage is routed through a loop filter consisting of R3215, R3204, C3214, C3215, R3203 and C3233.

The ZIF IC performs several other functions. In addition to providing selectivity, it also provides limiting and FM demodulation functions. The ZIF IC provides a received signal-strength indicator (RSSI) and a squelch output. The RSSI DC voltage is routed from the receiver back-end to the controller. The RSSI voltage, after buffering in the controller section of the radio, is available as an auxiliary output at pin 22 of the radio's accessory connector. RSSI is also routed to the option connectors located in the controller section of the radio.

The ZIF IC also provides a squelch output on pin 29. The squelch signal is routed to shaping and detection circuits in the Audio Signalling Filter Integrated Circuit (ASFIC) in the controller section of the radio. The ASFIC has squelch detect and channel activity outputs that are routed to the controller section of the radio, which in turn controls audio muting and unmuting.

Refer to the discussion under the title receive audio circuits, which is located in the theory of operation portion in volume 1 section 7 of this service manual, for further discussion of the squelch function.

The ZIF IC has both internal and external automatic gain control (AGC) circuitry. This circuitry is used to prevent strong signal overload of the filter circuits in the ZIF IC. The external AGC circuitry includes components used to set the AGC time constants, as well as a PIN diode variable attenuator. The PIN diode attenuator consists of CR5375 and CR5376 and associated bias components. The PIN diodes are biased by an operational-amplifier controller circuit (U5375 and associated components) and act as variable resistors in response to an AGC feedback voltage from the ZIF IC. The variable resistance of the PIN diode allows a portion of the IF signal to be shunted to ground at the input of the IF string. The feedback voltage is directly proportional to the amplitude of the IF signal, thus causing the IF signal to be attenuated in cases of strong signal strength.

Transmitter Detailed Functional Description

The transmitter function of the radio is distributed between the controller, the synthesizer, and the transmitter power amplifier (PA) sections. This is shown on the overall functional block diagram for the radio, Figure 1.

The portion of the transmitter function physically located in the controller section is described in the controller section theory of operation located in volume 1 of this service manual. That portion includes the audio circuits that filter, amplify, and otherwise process the audio signal from the microphone and/or telephone handset.

The portion of the transmitter function located in the synthesizer section of the radio is described in the synthesizer section theory of operation in this volume of the service manual. The synthesizer section of the transmitter receives the amplified and processed audio signal from the controller section and produces a frequency-modulated radio frequency carrier (injection) signal, which is input to the transmitter power amplifier (PA) section.

The remaining part of the transmitter function is physically located in the PA section. The following two discussions (one for the 40-Watt radio and the other for the 110-Watt radio) cover the part of the transmitter function that is located in the PA section.

Synthesizer Detailed Functional Description

The synthesizer section of the radio generates the local oscillator signal for the receiver portion of the radio. It also generates the transmitter RF carrier signal, which is frequency modulated by the amplified and processed audio signal from the output of the audio signal filter integrated circuit (ASFIC) in the controller section. The frequency modulated transmitter RF carrier signal, called the transmitter injection signal, is amplified by the power amplifier (PA) section of the radio.

The following discussion is based on the schematic diagrams for the synthesizer section on pages 61 and 63 through 69. The synthesizer section consists of a Pendulum reference oscillator (U5800) and a phase locked loop (PLL), which is made up of a fractional-n (Frac-N) synthesizer integrated circuit (IC) (U5801), a loop filter, three voltage controlled oscillators (VCOs), buffer amplifiers, and a feedback amplifier. Two of the VCOs (one at the time) generate the receiver local oscillator. The third VCO generates the transmitter injection signal.

The Pendulum reference oscillator (U5800) contains a temperature compensated crystal, which has an oscillation frequency of 16.8 MHz. The output of the oscillator is applied to pin 14 of U5801 via C5754 and R5750. The Frac-N synthesizer IC, U5801, consists of a prescaler, a programmable loop divider, control divider logic, a phase detector, a charge pump, an A/D converter for low frequency digital modulation, a balance attenuator to balance the low and high frequency analog modulation, a 13V positive voltage multiplier, a serial interface for control, and a super filter for the regulated 9.3 V.

The super filter uses Q5770 as a current amplifier. The super filter drops the 9.3V to 8.5V. The resultant super-filtered 8.5 V source

supplies the operating voltage for the voltage-controlled oscillators (VCOs), their corresponding buffers, and the synthesizer charge pump resistor network (R5754). The synthesizer supply voltage is provided by the 5 Volt regulator U5802. The 2.1 MHz reference signal is generated by dividing down the signal of the reference oscillator after it is applied to pin14 of U5801.

The charge pump output stage at pin VEE2 (pin 36 of U5801) is 13V generated at pin 1 of CR5750 by the positive voltage multiplier circuitry (CR5750). This voltage multiplier is basically a diode capacitor network driven by two signals that are 180-degrees out of phase with one another (pins 8 and 9 of U5801).

The serial interface (SPI) is connected to the controller section of the radio via the data line (pin 2 of U5801), clock line (pin 3 of U5801) and chip enable line (pin 4 of U5801). Proper enabling of these lines allows the controller section to program the fractional-N synthesizer IC.

All three VCOs are varactor tuned. The VCO frequencies are controlled by the voltage output voltage of the loop filter. This control voltage ranges from approximately 2.5 to 10.5V. A smaller control voltage produces a lower frequency and a larger control voltage produces a higher frequency.

Frequency modulation is controlled by the Frac-N IC (U5801). The audio signal from the controller section of the radio is applied to pin 5 of the Frac-N synthesizer IC. An A/D converter in the FracN synthesizer IC converts the low frequency portion of the analog modulating signal into a digital code, which is applied to a loop divider. This causes the carrier frequency to deviate.

A balanced attenuator is used to adjust the VCO deviation sensitivity to high frequency modulating signals. The output of the balanced attenuator is present at the MOD OUT (pin 30 of U5801). This signal then goes through a resistive divider and is capacitively coupled to the loop filter via C5781. This changes the control voltage to the transmit VCO thereby frequency modulating the carrier.

The loop filter (which consists of R5760, R5761, R5762, C5775, C5776, C5777) transforms the current produced by the charge pump into a voltage. The loop filter also acts as a low-pass filter to eliminate spurious signals. The output of the loop filter is sent to varactor diodes, which changes the frequency. In transmit mode the voltage is applied to pin 22 of the TX VCO module (U5803). In receive mode, the voltage is applied to pin 3 of CV5903 and CV5904 for the low VCO and pin 3 of CV5901 and CV5902 for the high VCO.

There is one transmit VCO and two receive VCOs. The VCOs are activated by the auxiliary lines on the Frac-N synthesizer IC. Aux2 (pin 38 of U5801) and Aux4 (pin 40 of U5801) turn on the low and high receive VCOs, respectively. Aux3 (pin 39 of U5801) turns on the transmit VCO.

The transmit VCO module, U5803, generates the RF carrier and operates from 403-470 MHz. The RX VCOs provide the LO injection signal for the receiver, which is 109.65 MHz above the carrier frequency.

Two receiver VCOs are included in the radio. One VCO, Q5904 and associated circuitry, operates in the frequency range of 255 MHz to 273 MHz, and the other, Q5903 and associated circuitry, operates from 273 to 290 MHz. The receiver operates from the 2nd harmonic produced by the receiver VCOs, which is extracted using the receiver VCO high pass filter composed of C5913 through C5915 and L5909 through L5910. The second harmonics thus produced are in the range of 510- through 546-MHz and 546- through 580-Mhz.

The receiver injection string following the RX VCO high-pass filter is a two-stage amplifier. The first stage is a buffer (Q5905), which provides gain and isolation. The output from the buffer stage feeds into a second amplifier stage (Q5930) to provide additional LO signal strength. A feedback tap to the synthesizer loop is provided through C5796 and is then applied to the input of the feedback amplifier (Q5940). To close the synthesizer loop, the output of Q5940 is connected to the PREIN port (pin 21) of the synthesizer, U5801.

The transmit injection string in the synthesizer consists of three amplifier stages (Q5942, Q5931, Q5932) whose main purpose is to maintain a constant output to drive the RF power amplifier. Increased isolation is achieved with attenuators R5968 through R5970, R5954 through R5956 and R5961 through R5963. The output of Q5931 is fed back to the synthesizer loop through C5811. The TX injection string is on only with K9.1V activated during transmit mode

Power Amplifier

Overall PA

The following discussion is based on the schematic diagrams for the power amplifier (PA) on pages 71, 73 through 83, and 85. The PA consists of a five stage RF power amplifier (PA) followed by an antenna switch, harmonic filter, and power detector. The five stages of the power amplifier are: controlled stage Q5500; second stage Q5520; pre-driver Q5530; driver Q5550; and final amplifier pair Q5560 and Q5561.

In the transmit mode, the PA amplifies the TX injection signal (20 milliwatt amplitude via J5500, Pin 5) to a nominal 110 watt level at the antenna connector (J5503) while providing isolation to the receiver front end. In the receive mode, the PA provides a low loss path from the antenna connector to the RX interface connector (J5501). It also distributes A+ voltage from the A+ connector (J5502) to the main board (J5500, Pin 1).

The first PA stage (controlled stage) provides a gain that is a function of control voltage (PA_CNTRL, J5500, Pin 8). This control voltage comes from the power control section in the controller section of the radio. The control voltage magnitude depends on PA forward output power, temperature, and final amplifier current drain. For a detailed explanation of the power control circuitry, refer to Volume 1 of this service manual.

The gain of the controlled stage device (Q5500) gain is determined by its collector current. The Q5500 BJT device and associated circuitry (Q5501, Q5502, R5509 and R5506) are best described as a voltage-controlled current source. This means that the Q5500 collector current

is controlled by the control voltage magnitude. As the controlled voltage is increased, Q5500 collector current increases. By controlling the output power of the Q5500 Class A stage and in turn the input power of the following stages, the power control loop is able to regulate the transmitter output power.

The controlled stage 200 milliwatt nominal output power is transferred to the second PA stage input by a bandpass match consisting of L5500, C5505, C5508, C5509 and transmission lines.

The second stage device (Q5520) is an enhancement mode N-channel MOSFET which requires a positive gate bias to set its quiescent drain current for proper Class A-B operation. The gate bias voltage is determined by a voltage divider resistor network connected to K9.1 (J5500, Pin 11). The voltage divider consists of R5520, R5521, R5523 and R5524. R5523 and R5524, which are laser trimmed at the factory to set quiescent drain current to the proper value when the power amplifier board is manufactured. The resistance value of R5595 is adjusted to set device bias and, therefore quiescent drain current, during field service of the radio.

Components R5510, R5522 and C5509 provide greater Q5520 device stability under low drive conditions and the network consisting of L5521, C5519 and C5520 provide A+ to the Q5520 drain. The second stage nominal output power is 1.5 watts and is heat-sinked to the chassis via E5502.

A matching network, consisting of C5527, C5523, C5518, C5524 and transmission lines, transfers power to the input of the third (pre-driver) PA stage. The pre-driver stage BJT (Q5530) is operated Class AB with R5530, R5531 and R5536 determining the base bias. R5535 is also laser trimmed at the factory to achieve the desired quiescent drain current when the power amplifier board is manufactured. The resistance value of R5596 is adjusted to set device bias during field service of the radio. A+ is distributed to the Q5530 collector by L5531, C5531, C5534, C5525, and C5530. This stage's output power is nominally 15 watts and the Q5530 device heat sink is screwed directly to the chassis.

The matching network between the pre-driver and driver stages consists of C5532 and C5533 and transmission lines. Additional input impedance matching to the driver stage (Q5550) is provided by C5550 and C5551 mounted at the base of Q5550. The driver stage is operated Class C with R5550, C5555 and L5550 providing the zero-volt DC base bias. A+ is distributed to the Q5550 collector by L5553, R5554, L5551, C5559 and C5558. An immediate output impedance transformation is provided by C5553 and C5554 mounted at the collector of Q5550. This stage's output power is nominally 50 watts with the heat sink screwed directly to the chassis.

The final amplifier stage is the parallel combination of two RF transistors (Q5560 and Q5561). The network from the Q5550 collector to the Q5560/Q5561 bases utilizes several capacitors, inductors and transmission lines that function as matching and power splitter networks. A+ is fed to both devices through L5564, L5566, R5570, C5620 and C5624. Both Q5560 and Q5561 utilize a series RLC feedback network to suppress parasitic oscillations.

The final amplifier stage devices are operated near Class B. The base bias voltage of each device is supplied by a regulated power supply consisting of U5500, Q5603, Q5562, CR5560 and associated bias resistors, choke inductors and bypass capacitors. The base bias voltage is switched on only in transmit mode when the K9.1 supply is activated.

The final stage output network serves the dual purpose of impedance matching and power combining the outputs of the two final stage devices. This network consists of several capacitors and transmission lines, which transfer approximately 125 watts to a 50 ohm circuit impedance point at C5578 before the antenna switch. R5571, R5572 and R5573 suppress odd mode oscillations and balance the load impedances presented to the Q5560 and Q5561 collectors. A+ is supplied to both final devices via L5566, R5570, C5624, L5564 and C5620, CR5610 and the current sense resistor R5612. The transistor diode CR5610 in conjunction with a spring contact in the chassis provides reverse polarity and over-voltage protection to the radio. The heat sinks of Q5560 and Q5561 are mounted directly to the chassis and are used to channel heat from the PC board to the chassis. Heat sinks MP5501 and MP5502 provide extra heat sinking for the PC board.

The antenna switch utilizes PIN diodes to form a low loss, high isolation RF relay. During transmit, PIN diodes CR5580, CR5581, CR5582 and CR5583 are forward biased by the K9.1 supply via L5580, L5587, R5580 and R5581 and R5583. In this state, a low loss path exists from the final amplifier through CR5580 into the harmonic filter and at the same time provides protection to the receiver front end from excessive RF levels. During receive the four diodes remain unbiased and provide a low loss path from the harmonic filter to the receiver front end. Capacitors C5585, C5546, C5547, C5548 and L5583 provide impedance matching and additional low-pass filtering in receive mode.

Resistors R5584 and R5585 channel heat away from CR5580 while in transmit mode.

A low-pass harmonic filter, consisting of capacitors C5594 through C5599 and inductors L5584, L5585 and L5586 follows the antenna switch. The filter's primary function is to attenuate harmonic energy, generated by the amplifier stages, but it also adds some selectivity for the receiver. R5590 is a large resistor used to dissipate static energy on the antenna. The filter is shielded via E5501 to lessen the amount of harmonic energy bypassing the filter.

The power detector (a directional coupler) is the last circuit block before the antenna connector. The detector is composed of a pair of parallel microstrip transmission lines, which form a forward power sensing directional coupler and detector. The output of the directional coupler/detector is a DC voltage proportional to the forward RF power output from the PA. CR5600 rectifies the RF energy appearing across the diode, which is then divided by R5602, RT5611, R5605 and R3607 and routed back the power control circuit block (V_FORWARD, J5500, Pin 12) on the main board. The power detector is shielded by E5501 to prevent harmonic energy from being radiated onto the coupler, therefore bypassing the harmonic filter.

The following discussion is based on the simplified schematic diagram for the PA power control function, Figure 2. The first (controlled) stage of the 110-Watt PA provides a gain that is a function of control voltage (PA_CNTRL, J3500-8). The control voltage is routed from the power control section in the controller section of the radio. The magnitude of the control voltage depends on PA forward power, PA temperature, and final amplifier current drain.

The coupler detect voltage (V_FORWARD, J5500-12), which is proportional to PA forward power, is buffered and summed with PA_PWR_SET provided by the D/A converter (U0551). The resultant voltage level is compared with a reference voltage at U0550-4. Any voltage level difference between U0550-4, pins 9 and 10 causes an increase or decrease in PA_CNTRL, which results in a corresponding change in the V_FORWARD voltage level from the PA. The loop operates in this manner unless it is limited by one or more of the three protection mechanisms described below.

The first protection mechanism limits the maximum magnitude of the PA_CNTRL voltage. The maximum allowable PA_CNTRL voltage is determined by PA_CNTRL_LIM (J5500-7). If PA_CNTRL_LIM increases to a level where CR0551 is forward biased, the voltage level at pin 9 of U0550-4 is clamped and PA_CNTRL cannot increase any further. Control voltage limiting protects the power amplifier against being overdriven and foldback.

The next protection mechanism limits the maximum dc current input to the final devices (U5560 and U5561) in the PA. The dc current input to the final devices is measured by the voltage drop across series resistor R5617. CURRENT_SENSE+ (J5500-2), the A+ side of R5517, is summed with CUR_LIM_SET from the D/A Converter (U0551). The sum is compared with CURRENT_SENSE- (J5500-10), the device side of R5517, at U0550-2. A change in the voltage level difference between pins 5 and 6 of U0550-2 causes a corresponding increase or decrease at pin 2 of U0550-2. If the voltage at pin 2 of U0550-2 increases to a level where CR0550 (diode 2-3) is forward biased, the voltage level at pin 9 of U0550-4 is clamped and PA_CNTRL cannot increase any further. Thus if the voltage drop across R5617 in the PA increases due to increasing final stage current and the voltage at pin 2 of U0550-2 increases to the clamping level, the PA is current limited. Current limiting protects the final amplifier stage from excessive current drain.

The last protection circuit is temperature limiting. Thermistor RT5610, which is physically located near the final PA devices, determines the voltage level at U0550-1, pin 2. This level is compared with a set reference level at U0550-1, pin 3. If the voltage level difference at the input of U0550-1 results in an increase in the output voltage sufficient to forward bias CR0551 (diode 1-3), the voltage level at U0550-4, pin 9 is clamped and PA_CNTRL cannot increase any further. Temperature limiting protects the radio from reaching an excessive temperature.

For a more detailed description and a schematic diagram, refer to the controller theory of operation in Volume 1 of this service manual.

Controller Detailed
Functional
Description

The theory of operation for the controller section of the radio is located in Volume 1 of this service manual.

D.C. Power Supply
and Regulation
Detailed Functional
Description

The theory of operation for the dc power supply and regulation section of the radio is located in Volume 1 of this service manual.

NOTES

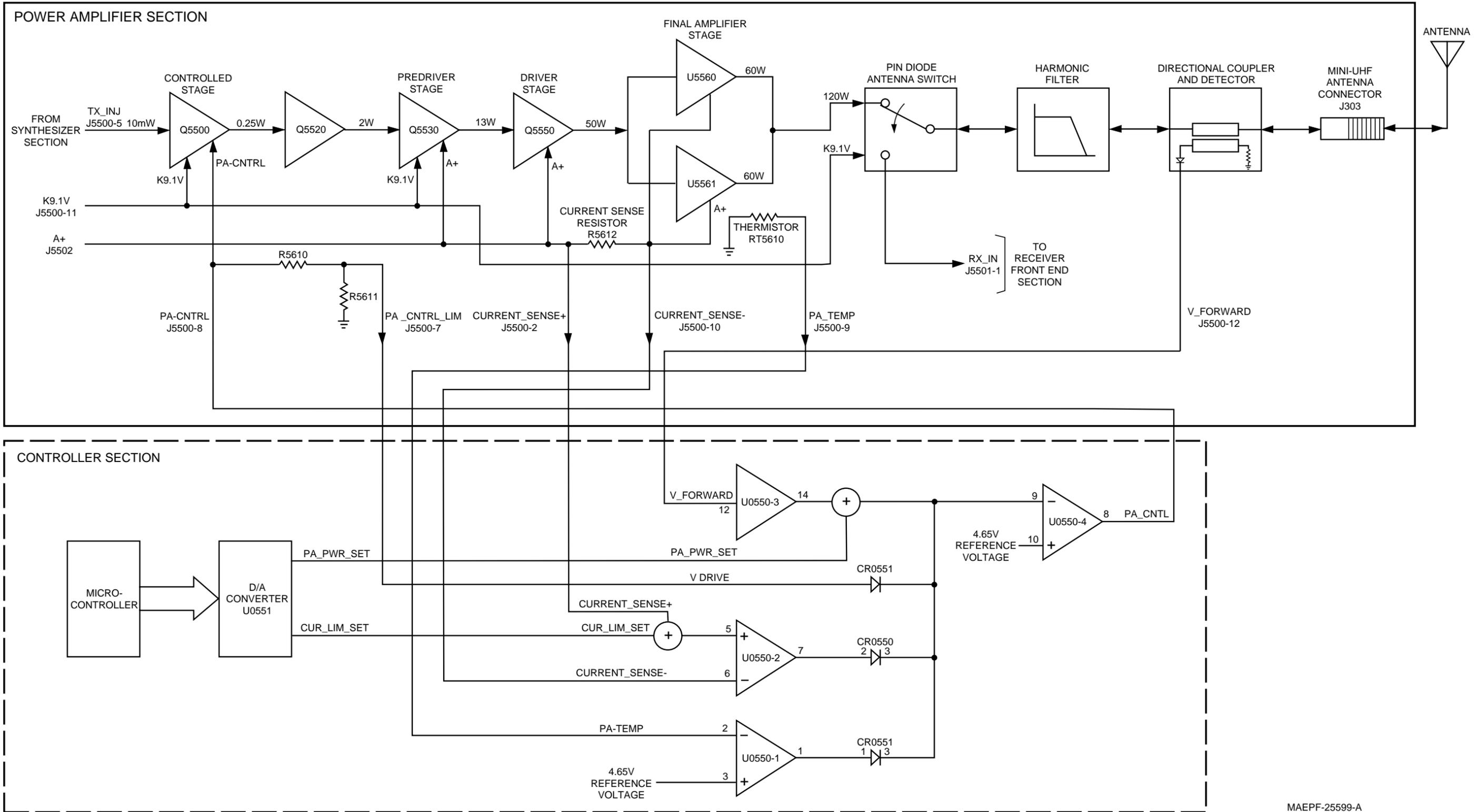


Figure 2 PA Power Control Simplified Schematic Diagram

NOTES

Troubleshooting

3

This chapter provides the troubleshooting charts listed below for the receiver, synthesizer, and power amplifier sections of the radio, which are unique for each frequency range.

Troubleshooting Charts 1-1 through 1-13 for the overall radio and for the sections of the radio that are common in design for all frequency ranges (i.e., controller, power control, and control heads) are located in Volume 1 of this Service Manual, Motorola Publication Number 68P81083C20.

Troubleshooting information and troubleshooting Charts related to the SECURENET Option for the radio are located in the SECURENET Option Service Manual, Motorola Publication 68P81083C25.

- **Receiver:**

- Troubleshooting Chart 2c-1, Receiver Front End - Page 23
- Troubleshooting Chart 2c-2, Receiver IF - Page 24
- Troubleshooting Chart 2c-3 Receiver Back End - Page 26

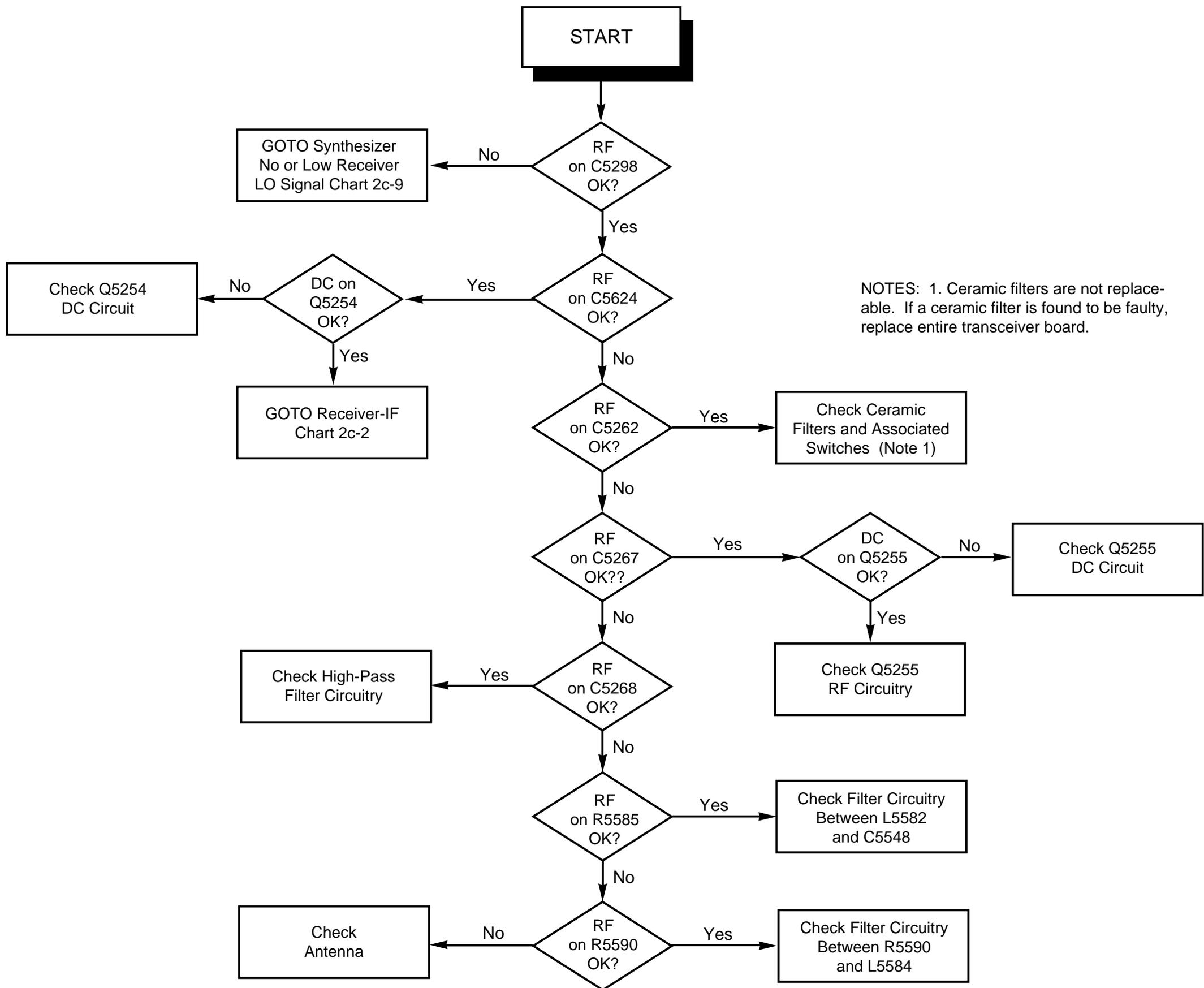
- **Synthesizer:**

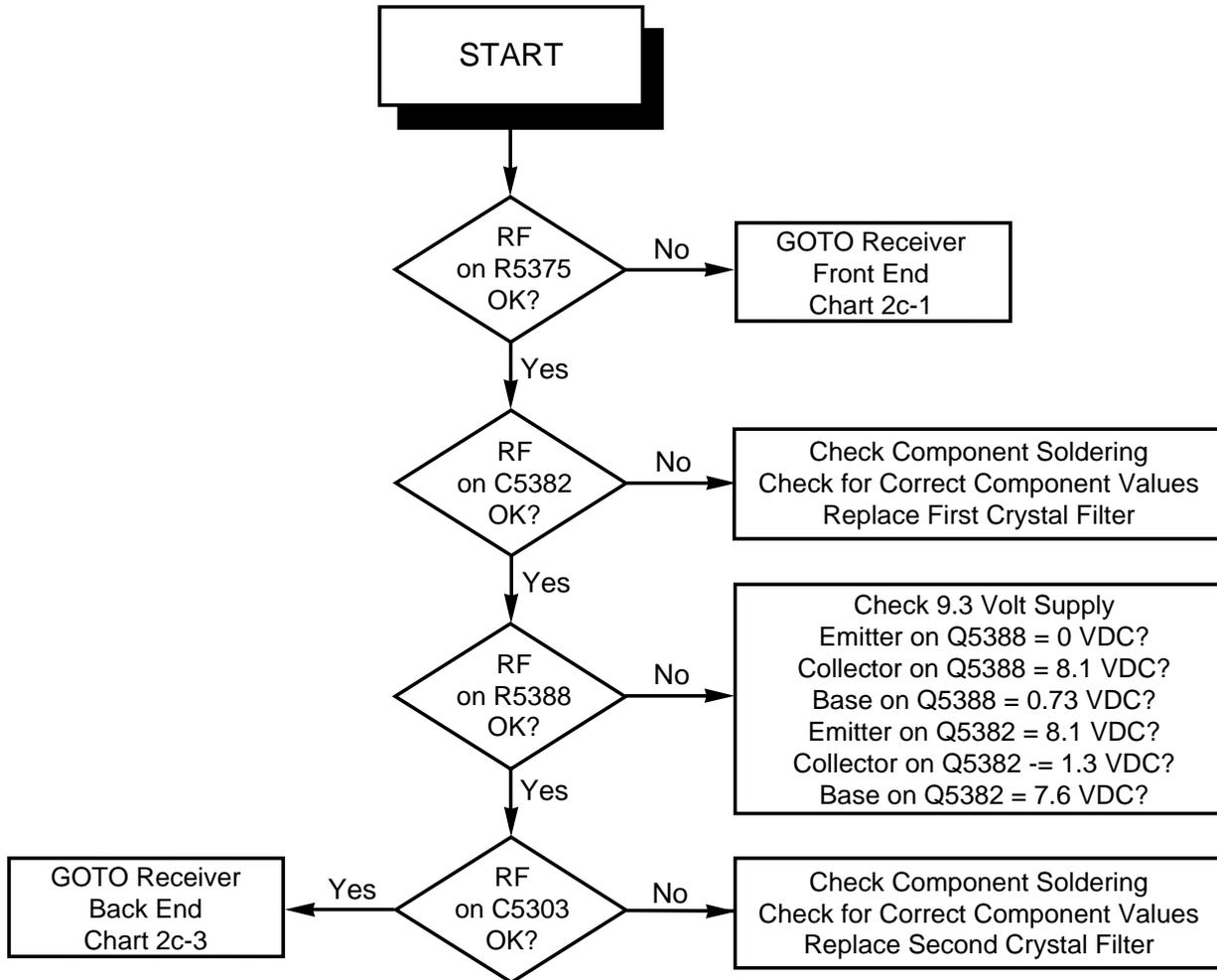
- Troubleshooting Chart 2c-4, Synthesizer Deviation - Page 27
- Troubleshooting Chart 2c-5, Synthesizer Pendulum Oscillator - Page 30
- Troubleshooting Chart 2c-6, Synthesizer Main - Page 31
- Troubleshooting Chart 2c-7, Synthesizer No Transmitter Injection Signal - Page 32

- **Power Amplifier:**

- Troubleshooting Chart 2c-8, Power Amplifier - Page 38

NOTES





MAEPF-25590-A

Notes for Receiver Back End Troubleshooting Chart

2c-3

1. If zero IF local oscillator (ZIF LO) is locked, the frequency should be very close to 109.65 MHz. If the ZIF LO is not locked, the frequency can be in the range of 100 to 120 MHz.
2. The ZIF must be programmed properly by the controller section of the radio in order for the ZIF LO to lock on frequency. Verify proper operation of controller section before proceeding.

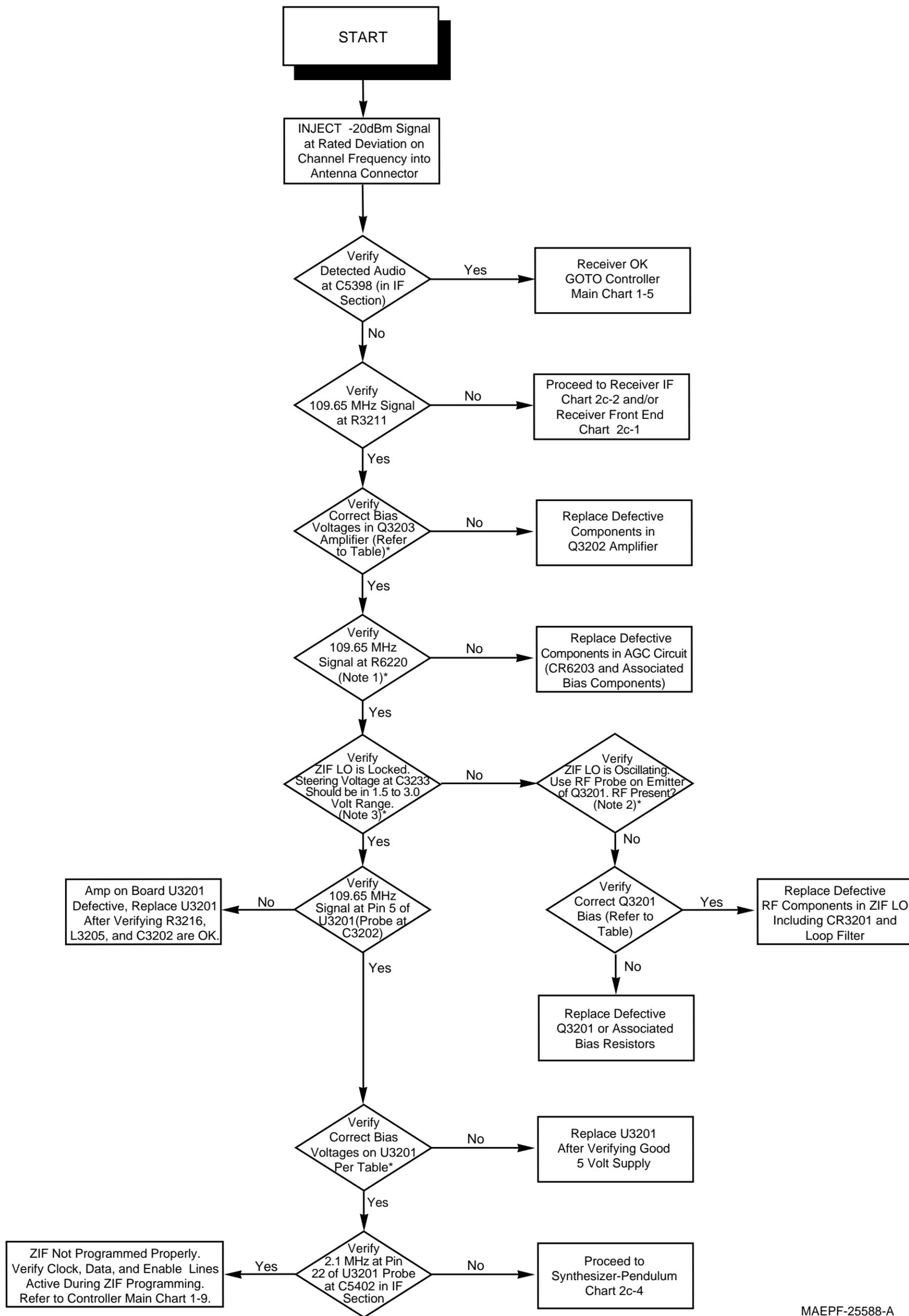
Table 1 Voltage Table (Transistors)

Transistor	Emitter	Base	Collector
Q3201	0.02V	0.7V	2.9V
Q3203	0.0V	0.7V	2.4V

Table 2 Voltage Table (ZIF IC)

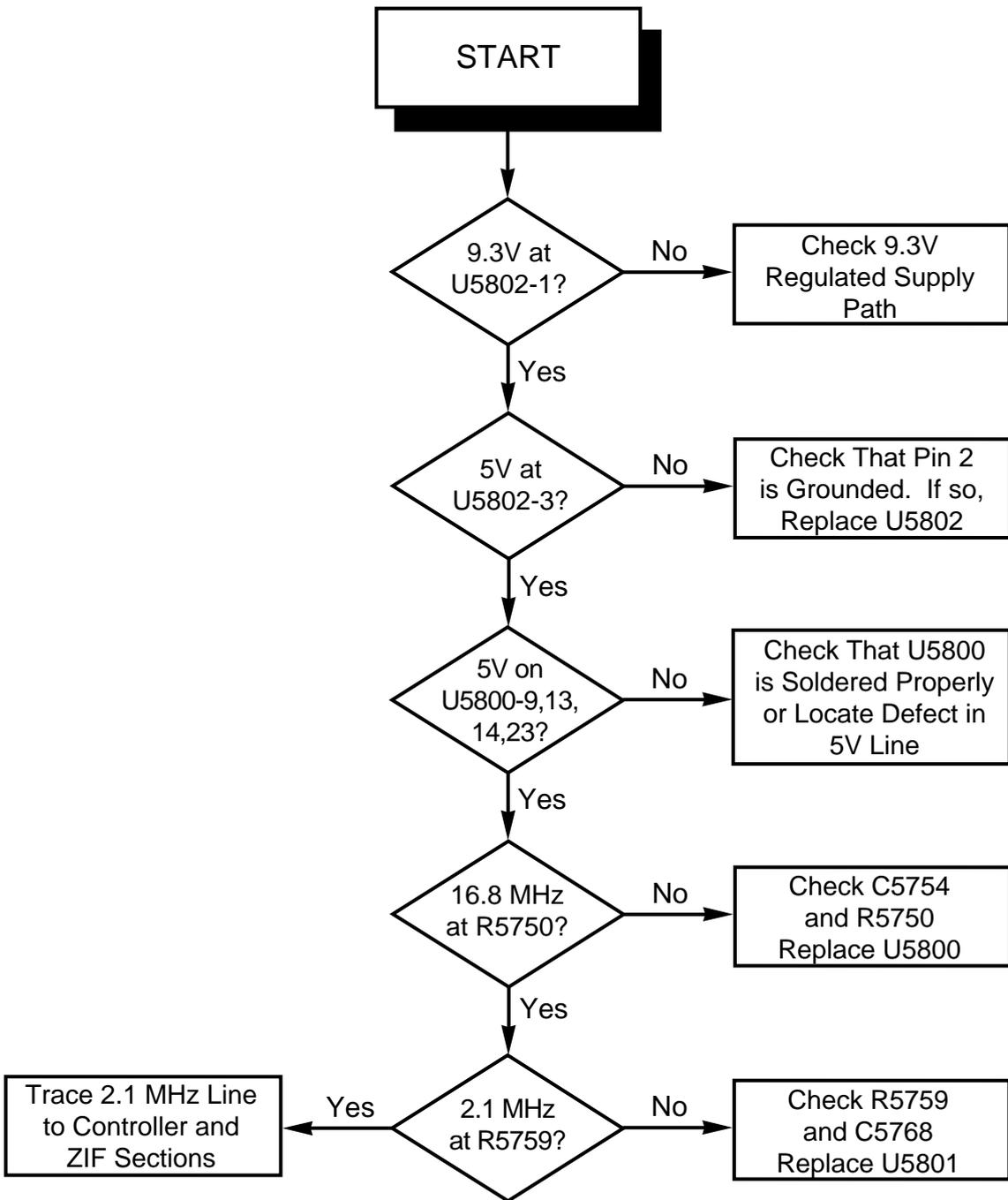
U3201 Pin No.	Probe At	Voltage
2	R3220	2.1
27	C3220	2.5
28	C5398	2.5
35	C3207	2.4
6	C3201	1.6

NOTE: Primary supply for the ZIF IC is 5 Volts. The supply originates in the synthesizer section of the radio.



MAEPF-25588-A

* Refer to Notes for Receiver Back End Troubleshooting Chart located on a separate page.



MAEPF-25592-O

Notes for Synthesizer Troubleshooting Charts 2c-5 through 2c-9

1. Check that C5759 and C5760 both have a 2.5 V square wave present. If they do not replace the FRAC-N (U5801). If squarewaves are present, check that 5 V is present at pin 4 of CR5750. If 5 V is not present at pin 4, replace CR5750.
2. Refer to the table below and determine which auxiliary bit should be on depending on the programmed receive frequency.

Frequency Range	Auxiliary Bit On
403.0 to 435.5 MHz	2
435.5 to 470.0 MHz	4

3. Use an RF probe as an antenna to examine the area of the active RX VCO to verify that the VCO is oscillating. The table below shows the active component of VCO which is in operation:

Frequency Range	Active Component
403.0 to 435.5 MHz	Q5904
435.5 to 470.0 MHz	Q5903

4. If VCO is not oscillating, probe drain and source of active component to see if it has the corresponding voltages. Drain should be at approximately 8V and source should be at 1 to 2V. Otherwise, look for shorts and opens among the components in the corresponding VCO. Replace any defective parts. If, however, the VCO will oscillate at only one frequency, replace resonators L5903 and L5907.
5. If VCO is oscillating, verify that the two RX buffers (Q5905 and Q5930) are operating properly. If the two RX buffers are not amplifying the signal, check RF path and DC Bias voltages as shown in the table below:

NOTE: The voltages listed in the table below will vary somewhat between radios. Therefore, they should be used only as a guide.

Pin	Q5905	Q5930
Collector	4.5V	6.25V
Base	0.75V	0.78V
Emitter	0.0V	0.0V

6. If there is an oscillation and the radio still exhibits an out of lock condition, it is usually the result of insufficient power getting back to the prescaler. If this is the case, check the prescaler feedback buffer for correct signal amplification and the correct biasing as shown in the table below.

Pin	Q5940
Collector	2.6V
Base	0.75V
Emitter	0.0V

NOTE: Although the amount of power getting back to the prescaler will vary with frequency channel, a level higher than -7 dBm is sufficient to obtain lock.

7. If the radio will not transmit because a synthesizer or TX VCO error exists, the red transmit light will flash when the radio is keyed. Before proceeding make sure that the FAIL 001 error message is not displayed when the radio is in standby mode. If the FAIL 001 message is displayed, go to the FAIL 001 troubleshooting chart.

When there is a transmit error the radio is much easier to troubleshoot if the Lock Detect line is tied to 5V. This will make the radio think that it is in a locked state when in transmit mode. Otherwise, once the PTT is pressed and the synthesizer does not lock in an allotted time period it goes back into receive mode. The following troubleshooting will assume the Lock Det line is forced high and that the radio is keyed.

8. Determine if the AUX3 bit is on.

NOTE: There should be approximately 4.2V at pin 4 of the corresponding switching transistor if the FRAC-N is functioning correctly.

9. Check that there is 8.3V on pin 3 of Q5783.
10. Check that there is 8.3V on pin 2 of Q5783.
11. Use an RF probe as an antenna to examine the area of the TX VCO to verify that the VCO is oscillating.

12. If VCO is oscillating, verify that the three TX buffers (Q5942, Q5931, and Q5932) are operating properly. If the two stages are not amplifying the signal then check the DC Bias voltages in the table below:

NOTE: The voltages listed in the table below will vary somewhat between radios. Therefore, they should be used only as a guide.

Pin	Q5942	Q5931	Q5932
Collector	6.0V	6.0V	7.9V
Base	0.9V	0.9V	0.4V
Emitter	0.15V	0.15V	0.0V

13. If there is an oscillation but it is at the wrong frequency, this is usually caused by insufficient power going to the prescaler. Check the prescaler feedback buffer for signal amplification and the correct biasing shown below.

Pin	Q5940
Collector	2.6V
Base	0.75V
Emitter	0.0V

NOTE: Although the amount of power getting back to the prescaler will vary with frequency channel, a level above -7 dBm is adequate to obtain lock.

14. If the red transmit light does not stay illuminated when the radio is keyed, there is a synthesizer problem. Go to the synthesizer no transmit troubleshooting chart (chart 7C).

15. Check the injection string buffer for signal amplification and the correct biasing shown below.

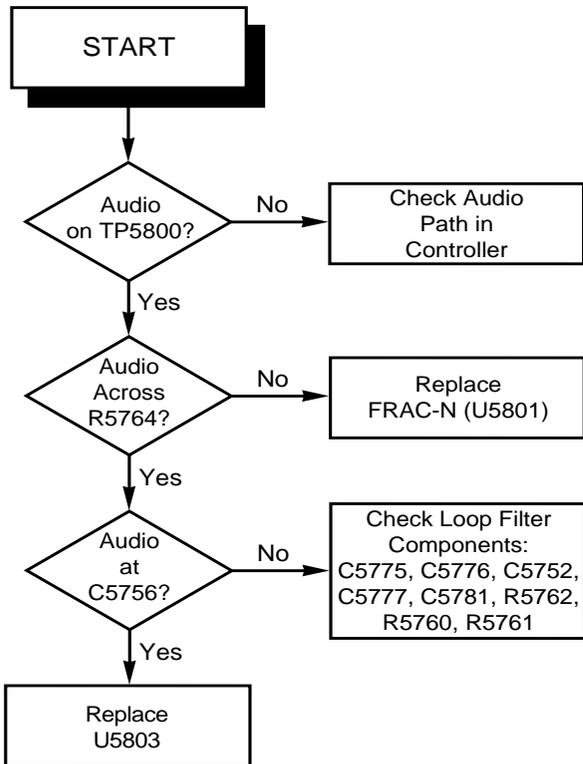
Pin	Q5932
Collector	7.9V
Base	0.4V
Emitter	0.0V

16. Check the RF path between the collector of Q5932 and R5963, including R5962, R5961, C5955 and L5951.

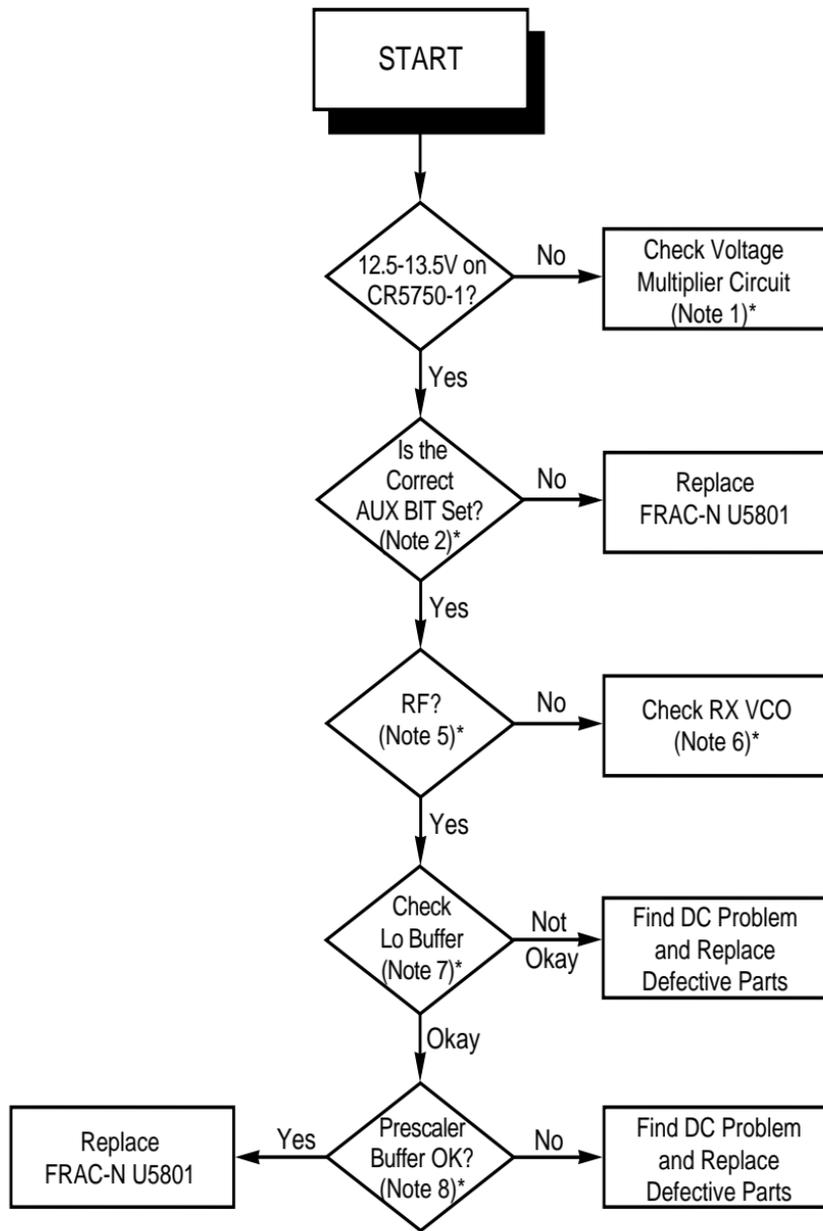
17. Check the path to J5500 pin 5 and replace any defective parts.

18. When in receive or standby mode, verify that FAIL 001 is not displayed. If FAIL 001 is displayed, go to Synthesizer FAIL 001 troubleshooting chart 2c-6.

19. If no LO is getting to the mixer and there is no out of lock error, check C5932. If it is defective or the wrong value replace it. Otherwise, check the continuity of the LO lines going to the mixer.

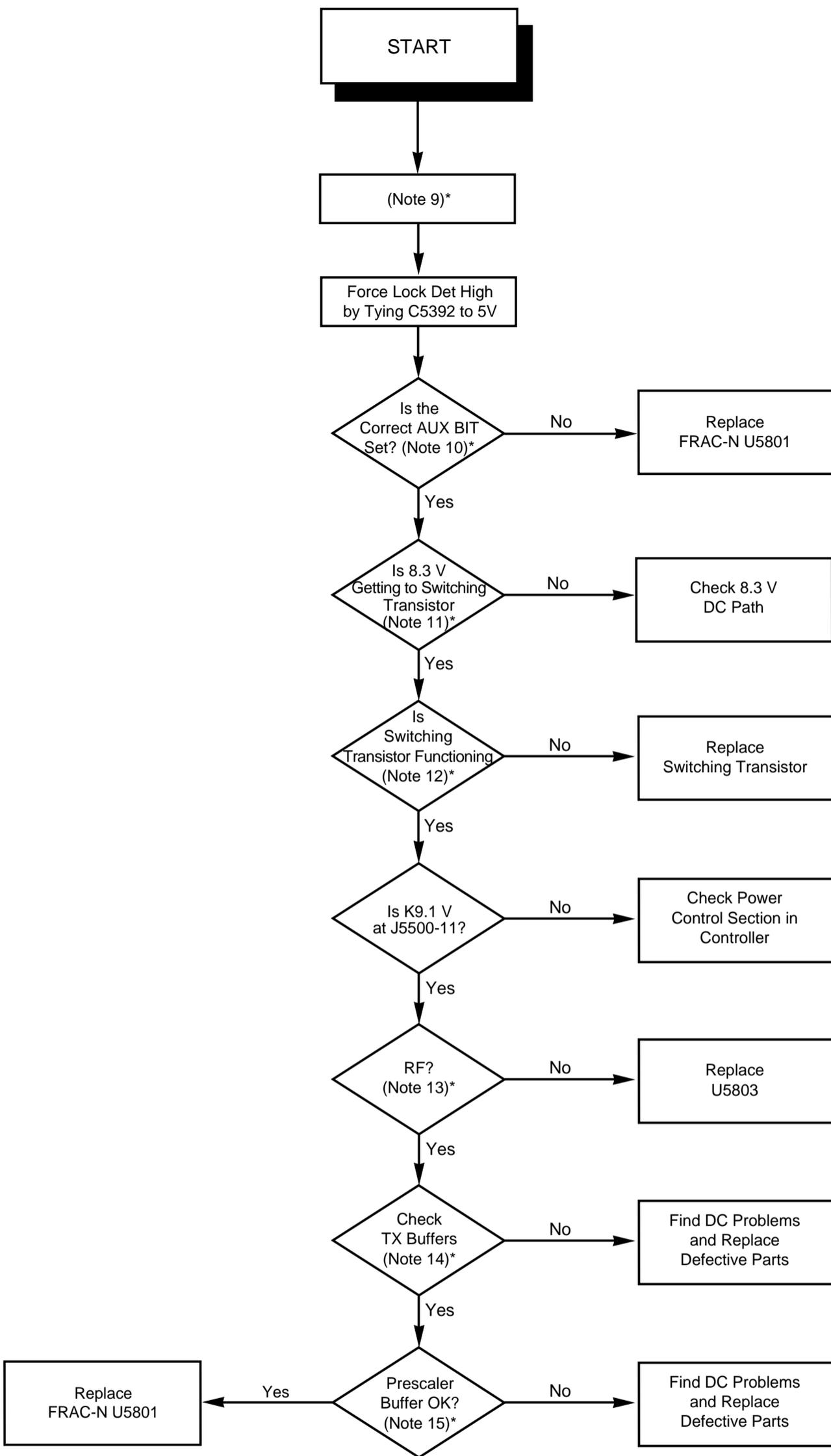


MAEPF-25591-A



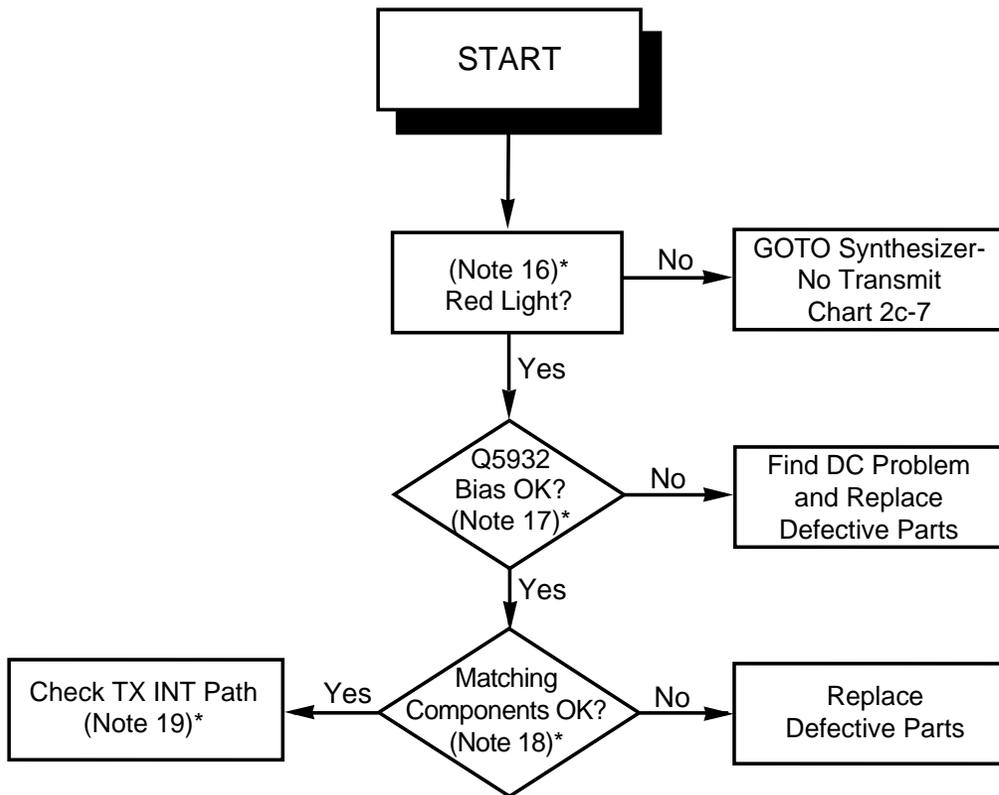
* Refer to Notes for Synthesizer Troubleshooting Charts 2c-6, 2c-7, 2c-8, and 2c-9 located on a separate page.

MAEPF-25593-A



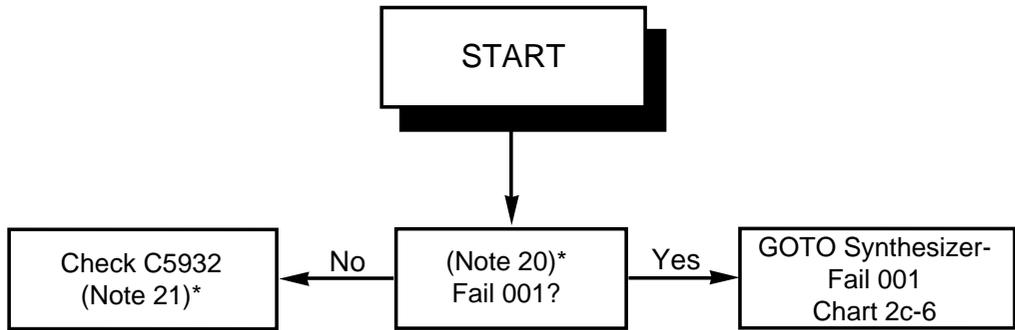
* Refer to Notes for Synthesizer Troubleshooting Charts 2c-6, 2c-7, 2c-8, and 2c-9 located on a separate page.

MAEPF-25594-A



* Refer to Notes for Synthesizer Troubleshooting Charts 2c-6, 2c-7, 2c-8, and 2c-9 located on a separate page.

MAEPF-25595-A



* Refer to Notes for Synthesizer Troubleshooting Charts 2c-6, 2c-7, 2c-8, and 2c-9 located on a separate page.

MAEPF-25596-A

Notes for Power Amplifier Troubleshooting Chart 2c-11

General Notes:

- Review the theory of operation before attempting to troubleshoot the power amplifier.
- Most transmitter circuitry is located on the side of the PC board facing down into the chassis. Therefore, a chassis eliminator (“cutaway” chassis), Motorola stock number 2705815W03), is useful while troubleshooting the radio.



WARNING

To avoid personal injury from high RF Voltages and Currents, exercise extreme care while troubleshooting the transmitter power amplifier.



Caution

To avoid permanent damage to the power amplifier, do not key transmitter unless all screws that attach PA board to chassis are in place and are tightened to a torque level between 11- and 15-inch pounds.



Caution

Keying the transmitter for an extended period of time while using the chassis eliminator can cause damage to the radio. While using chassis eliminator, cool the radio by using a fan to force air through chassis cooling fins

- Set A+ supply to 13.4 volts with current limit set to 31 Amperes.
- Ensure that any RF power attenuators used in test setups are rated for at least 500 Watts.
- Calibrate power meter regularly following the manufacture's suggested calibration method.
- Keep in mind that VSWR and insertion losses within any test setup affect the accuracy of RF power measurements.
- Table 1 on page 36 provides a list of typical voltage measurements for the 110W Power Amplifier.
- If a component is removed for troubleshooting, replace the removed part with a new part regardless of the condition of the removed part.
- To reinstall the power amplifier board into the chassis, follow reassembly instructions in volume 1 of this service manual.
- Reapply any thermal paste removed during troubleshooting.
- Use only Motorola specified parts when component replacement is required.

Q5520 Bias Measurement and Adjustment Procedure:

1. Disconnect A+ supply from radio.
2. Remove capacitor C5500 and ferrite bead L5521 from PA PCB.
3. On PA PCB, tack solder wires onto pads for L5521 temporarily and connect the wires to a digital milliammeter.
4. Reconnect A+ supply to radio. Set A+ supply to 13.4 volts, and current limit to 2.0 Amperes.
5. Key up transmitter and observe current indicated on milliammeter. If current is between 18 and 22 milliamperes, skip to step 9. Otherwise, proceed to step 6.
6. Dekey transmitter, disconnect A+ supply from radio, and permanently install potentiometer R5595 (Motorola part number 180517X01) on pads provided for it on PA PCB.
7. Reconnect A+ supply to radio, key up transmitter, and adjust R5595 so that current indicated on milliammeter is between 18 and 22 milliamperes. If current cannot be adjusted to between 18 and 22 milliamperes, proceed to step 8. Otherwise, skip to step 9.
8. Dekey transmitter, disconnect A+ supply from radio, and replace resistor R5520 with the next lowest standard value (i.e., 30K). Then repeat step 7.
9. Dekey transmitter, disconnect A+ supply from radio, and disconnect milliammeter wires from PA PCB.
10. Reinstall C5500 and L5521 on PA PCB.

Q5530 Bias Measurement and Adjustment Procedure:

1. Disconnect A+ supply from radio.
2. Remove capacitor C5523 and ferrite bead L5531 from PA PCB.
3. On PCB, tack solder wires onto pads for L5531 and connect wires to a digital milliammeter.
4. Reconnect A+ supply to radio. Set A+ supply to 13.4 volts, and current limit to 2.0 Amperes.
5. Key up transmitter and observe current indicated on milliammeter. If current is between 612 and 748 milliamperes, skip to step 9. Otherwise, proceed to step 6.
6. Dekey transmitter, disconnect A+ supply from radio, and permanently install potentiometer R5596 on pads provided for it on PA PCB.
7. Reconnect A+ supply to radio, key up transmitter, and adjust R5596 so that current indicated on milliammeter is between 612 and 748 milliamperes. If current cannot be adjusted to between 612 and 748 milliamperes, proceed to step 8. Otherwise, skip to step 9.
8. Dekey transmitter, disconnect A+ supply from radio, and replace resistor R5530 with the next lowest standard value (i.e., 27K). Then repeat step 7.
9. Dekey transmitter, disconnect A+ supply from radio, and disconnect milliammeter wires from PA PCB.
10. Reinstall C5523 and L5531 on PA PCB.

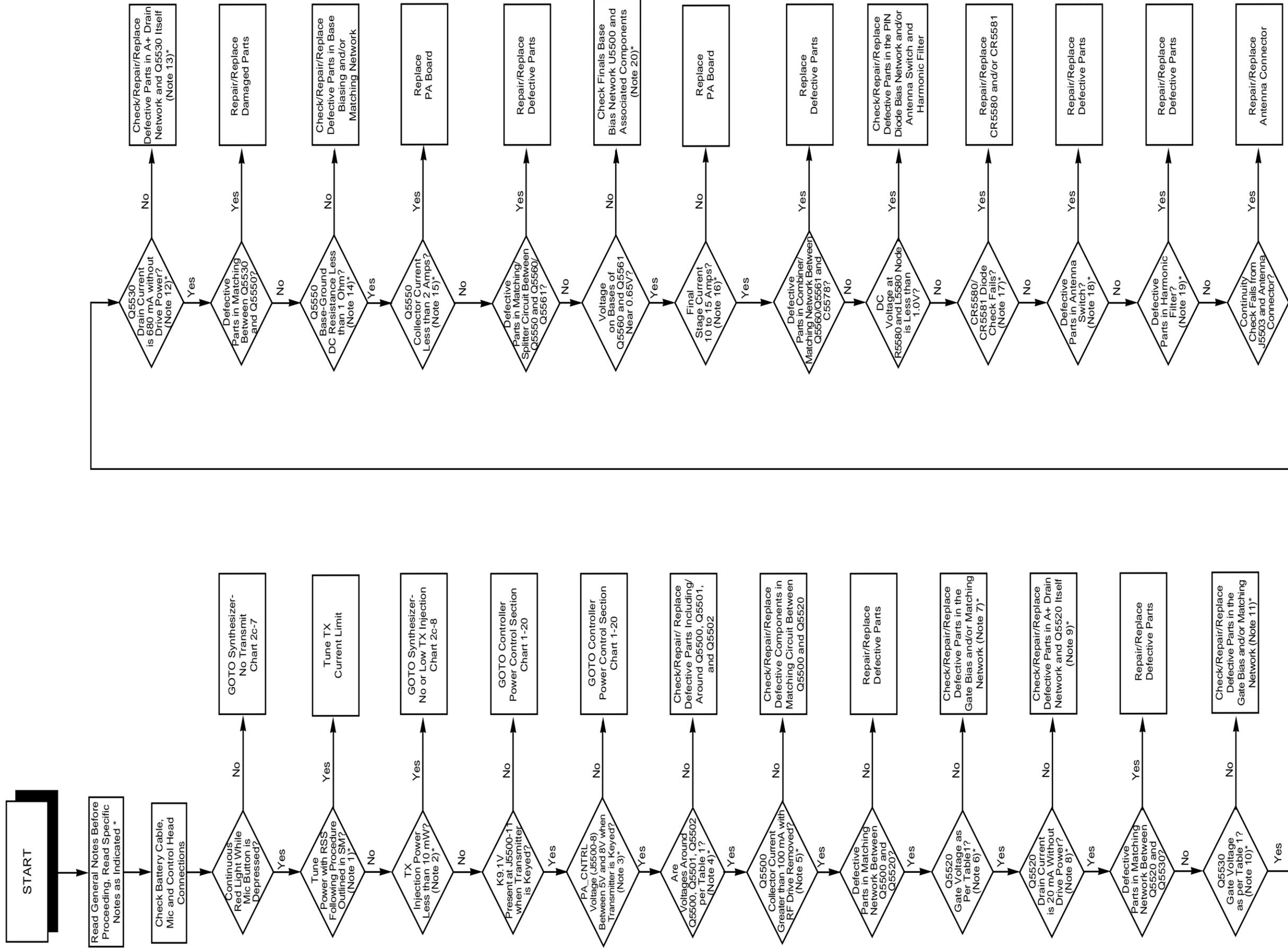
Specific (Numbered) Notes

1. Set current limit softpot to zero to disable current limit.
2. Remove capacitor C5500 and solder the center conductor of a small coaxial cable onto pin 5 of J5500. Connect ground to pin 4 or pin 6 of J3500. Attach an RF milliwatt meter and key transmitter to measure TX injection power. Then remove coaxial cable and replace C5500.

3. Measure PA_CNTRL with a DC voltmeter while transmitter is keyed.
4. Remove C5500 for RF drive off DC voltage measurements. PA_CNTRL should be greater than or equal to 7 volts with RF drive removed.
5. Remove C5500 and L5500, solder wires to remaining pads of L5500, connect milliammeter in series with Q5500 collector, and measure DC current. Remove wires and replace C5500 and L5500.
6. Remove C5500, key up radio, measure Q5520 DC gate voltage, then replace C5500.
7. If gate bias network parts are replaced, readjust gate bias voltage using the Q5520 Field Bias Trim Procedure that precedes these specific notes.
8. Disconnect A+ supply from radio. Remove C5508 and L5521. Solder wires onto remaining L5521 pads and connect minable meter in series with Q5520 drain. Reconnect A+ supply, key up transmitter, and monitor milliammeter. Remove wires and replace C5508 and L5521.
9. If gate bias and A+ supply voltage are present at gate and drain of Q5520, respectively, then Q5520 may be defective. First, check for solder defects. If none are found, replace Q5520 then readjust gate bias voltage using the Q5520 Field Bias Trim Procedure that precedes these specific notes.
10. Remove C5523, key up radio, measure Q5530 gate voltage, and replace C5523.
11. If gate bias network parts are replaced, readjust gate bias voltage using the Q5530 Field Bias Trim Procedure that precedes these specific notes.
12. Disconnect A+ supply from the radio. Remove C5523 and L5531. Solder wires onto remaining L5531 pads and connect milliammeter in series with the Q5530 drain. Reconnect A+ supply, key up transmitter, and monitor milliammeter. Remove wires and replace C5523 and L5531.
13. If gate bias and A+ supply voltage are present at gate and drain of Q5530, respectively, then Q5530 may be defective. First check for solder defects. If none are found, replace Q5530 then readjust gate bias voltage using the Q5530 Field Bias Trim Procedure that precedes these specific notes.
14. Perform this measurement only while transmitter is dekeyed.
15. Disconnect A+ supply, remove L5552 and R5554, solder 20 gauge (or larger) wires to remaining R5554 pads, and connect an Ammeter in series with the Q5550 collector. Reconnect A+ supply, key up transmitter, and monitor Ammeter. Remove wires and replace L5552 and R5554.
16. Key up the transmitter. Measure the DC voltage at the positive terminal of the battery connector and pin 1 of regulator U5500 (pin 1 of U5500 is the left pin as you view regulator with leads toward you). Subtract the two measurements and multiply by 100 to calculate final stage current in Amperes.
17. Check diodes using the diode check function of a multimeter.
18. In the antenna switch and harmonic filter, check for components that are visibly deformed, destroyed, or have become unsoldered. In the case of a destroyed component, check the circuit in the immediate area of the component against the schematic diagram for unintended shorts or open circuits.
19. Shield SH3590 must be removed with a hot-air gun to enable inspection of the harmonic filter. Be careful to lift the shield straight up. The parts within the shield will reflow before the shield and may be moved off their pads if they contact the shield.
20. Remove capacitor C5500. Key up transmitter. Check pin 1 of regulator U5500 for 13.4V. If 13.4V is not present, ensure that sense resistor R5612 is soldered down correctly. Check pin 2 of U5500 for 5V +/- 0.1V. If voltage is not present, replace U5500. Check voltages across R5577, R5578, and R5587. The magnitude of these voltages should be approximately 1.15V. If it is not, check voltages on the bases of transistors Q5560 and Q5561. These voltages, with respect to ground, should be approximately 0.65V. If they are not, replace CR5560, Q5603, and Q5562. Dekey transmitter and install C5500.

Table 1 Typical Voltage Measurements for 110W Power Amplifier

A+ = 13.4 V	RF Drive On		RF Drive Off	
	PA_CNTRL	7.5V	6V	7.5V
Q5500 Base	0.75V	0.75V	0.3V	0.3V
Q5500 Collector	7.7V	8.6V	7.7V	8.6V
Q5501 Base	7.1V	8.0V	7.1V	8.0V
Q5501 Emitter	7.7V	8.6V	7.7V	8.6V
Q5501 Collector	1.8V	1.2V	2.0V	0.8V
Q5502 Base	6.7V	4.0V	6.7V	4.0V
Q5502 Emitter	6.0V	3.3V	6.0V	3.5V
Q5502 Collector	7.1V	8.0V	7.1V	8.0V
Q5520 Gate	1.9V	1.9V	N/A	N/A
Q5530 Gate	2.9V	2.9V	N/A	N/A



* Refer to Notes for 110W PA Troubleshooting Chart 2c-11 located on a separate page.

MAEPF-25598-C

Troubleshooting Chart 2c-10 Power Amplifier - No or Low RF Power Output

NOTES

Reference Drawings

Introduction

This section contains reference drawings for the receiver (front end, IF, and back end) and transmitter (synthesizer and power amplifier) portions of the radio. Reference drawings for the control head and the controller portions of the radio are located in volume 1 of this service manual.

The hierarchy of the schematic diagrams for the radio is shown in Figure 4. The first and highest tier in the hierarchy for the radio consists of three major blocks, which are: control heads, controller, and radio frequency (RF). On the hierarchy illustration, the details for the control head and controller blocks are not provided beyond the first tier level because all the subordinate drawings for these two blocks are located in volume 1 (Motorola Publication 68P81080C20) of this service manual.

Complete details are provided for the RF block because all the reference drawings for the RF block are located in this volume of the service manual.

Complete details for the control head and controller blocks are provided in a similar hierarchy chart located in volume 1 of this service manual.

Reference Drawings Included in this Section

The following reference drawings are provided in this section of this volume of the service manual:

- **For Overall Radio:**
 - Main and Power Amplifier Boards Interconnected - Page 41
 - Main Transceiver Board Section Locations - Page 42
 - Schematic Diagrams Hierarchy - Page 44
 - Main Board Overall Schematic Diagram - Page 45
 - RF Schematic Diagram - Page 46
 - Schematic Diagrams Interconnection Table - Page 87
- **For Receiver**
 - Receiver RF Schematic Diagram - Page 47
 - Receiver Front End Component Locations and Parts List - Pages 48 and 50

- Receiver Front End Schematic Diagram - Pages 49 and 51
- Receiver IF Component Locations and Parts List - Pages 52 and 54
- Receiver IF Schematic Diagram - Pages 53 and 55
- Receiver Back End Component Locations and Parts List - Pages 56 and 58
- Receiver Back End Schematic Diagram - Pages 57 and 59
- **For Synthesizer**
 - Synthesizer Component Locations and Parts List - Pages 60 and 62
 - Synthesizer Overall Schematic Diagram - Pages 61 and 63
 - Synthesizer Receiver VCO Schematic Diagram - Pages 64 and 66
 - Synthesizer Receiver Injection String Schematic Diagram - Pages 65 and 67
 - Synthesizer Transmitter Injection String Schematic Diagram - Pages 68 and 69
- **For Power Amplifier**
 - Power Amplifier Board Section Locations - Page 43
 - Power Amplifier Component Locations and Parts List - Pages 70 and 72
 - Power Amplifier Overall Schematic Diagram - Pages 71 and 73
 - RF Power Amplifier Schematic Diagram - Pages 74 through 77
 - Antenna Switch Schematic Diagram - Pages 78 and 79
 - Harmonic Filter Schematic Diagram - Pages 80 and 81
 - Power Detector Schematic Diagram - Pages 82 and 83
 - 2-Pin and 12-Pin Power Amplifier Interconnects Component Locations and Parts List - Page 84
 - 2-Pin and 12-Pin Power Amplifier Interconnects Schematic Diagrams - Page 85

Refer to Volume 1 of this service manual (Motorola Publication Number 68P81083C20) for reference drawings for the control head and controller portions of the radio.

Refer to the Secure Option service manual (Motorola Publication Number 68P81083C25) for reference drawings for the secure option for the radio.

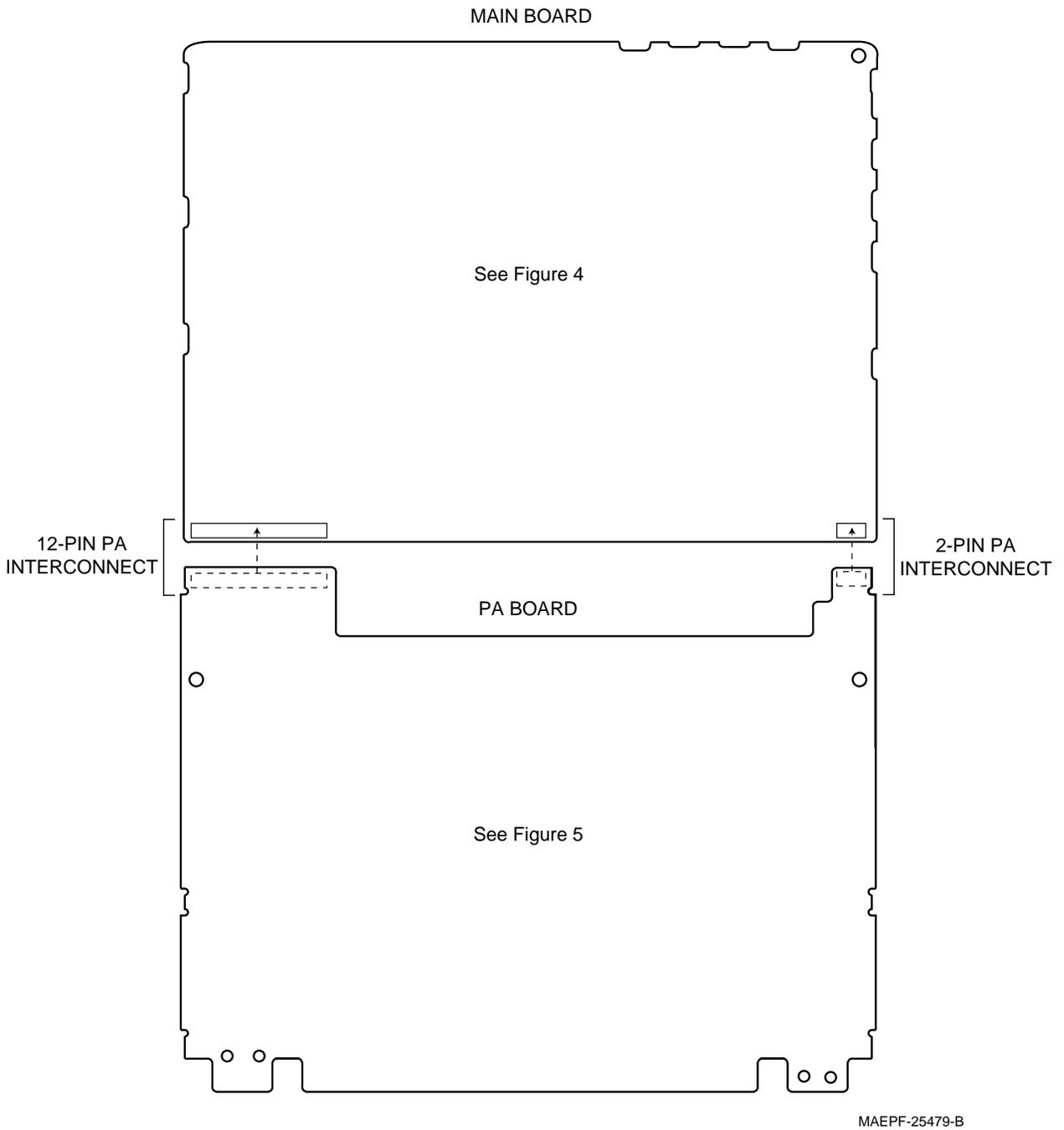
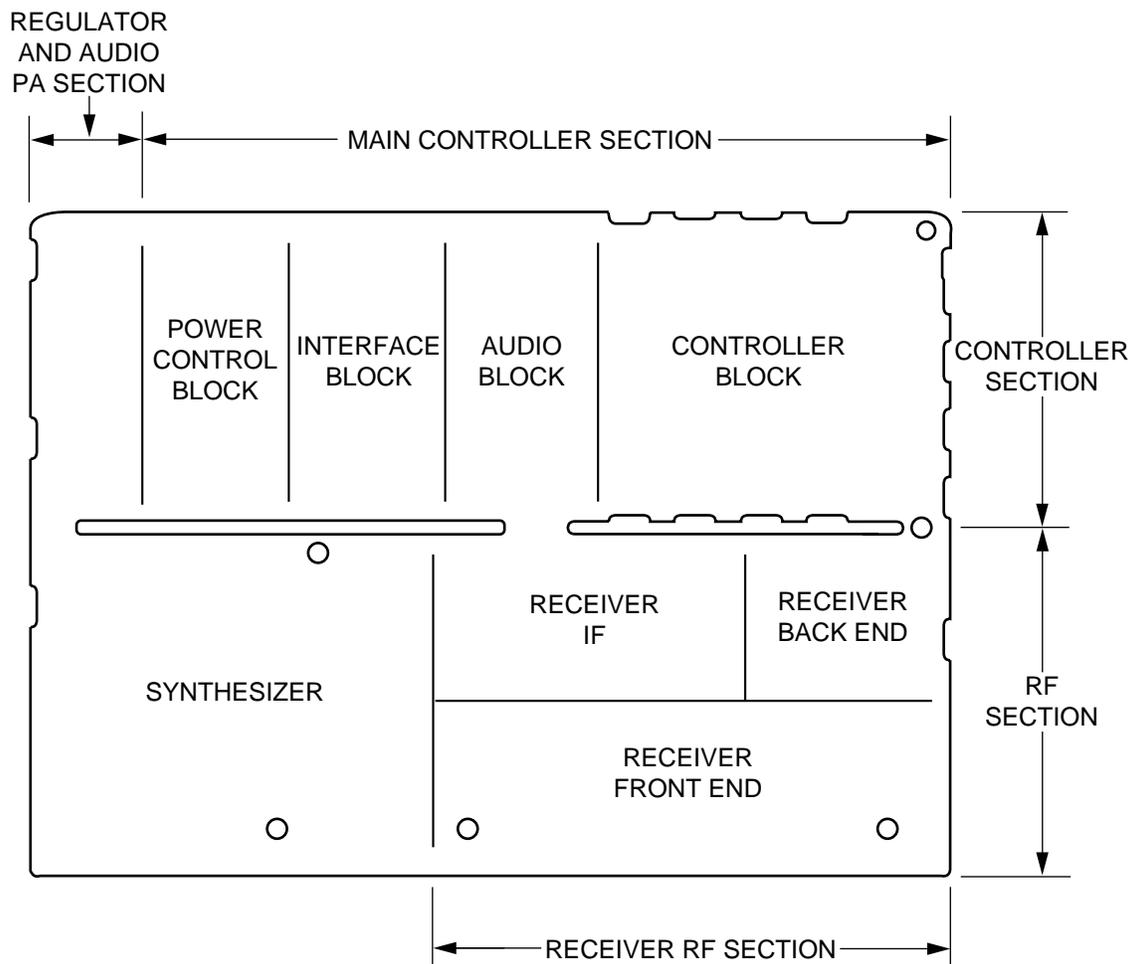


Figure 3 Main Board and PA Board Interconnected



MAEPF-25892-0

Figure 4 Main Board Section Locations

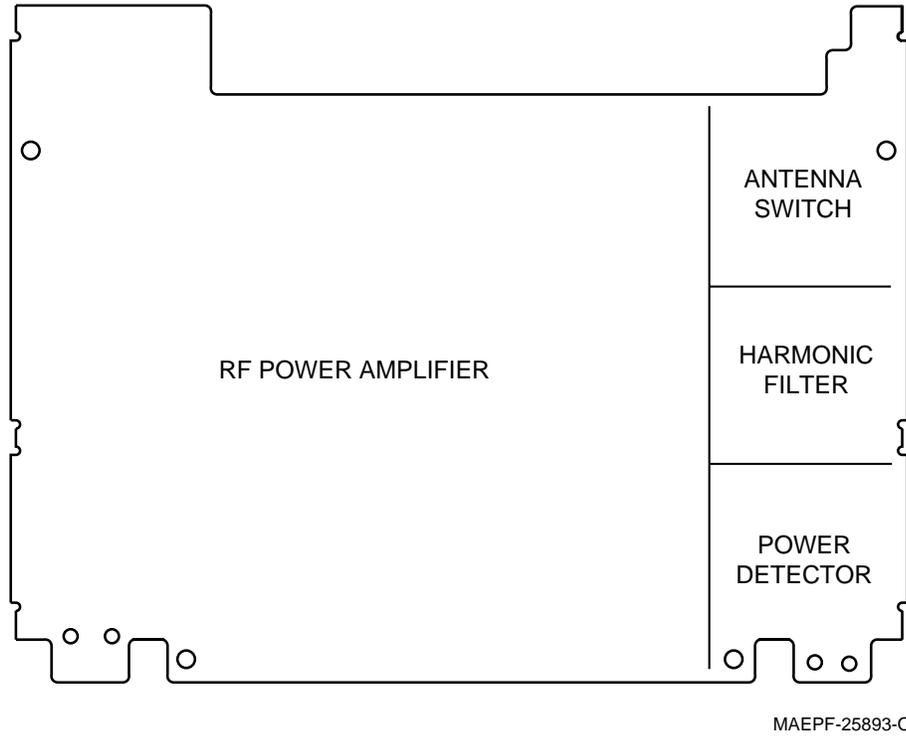
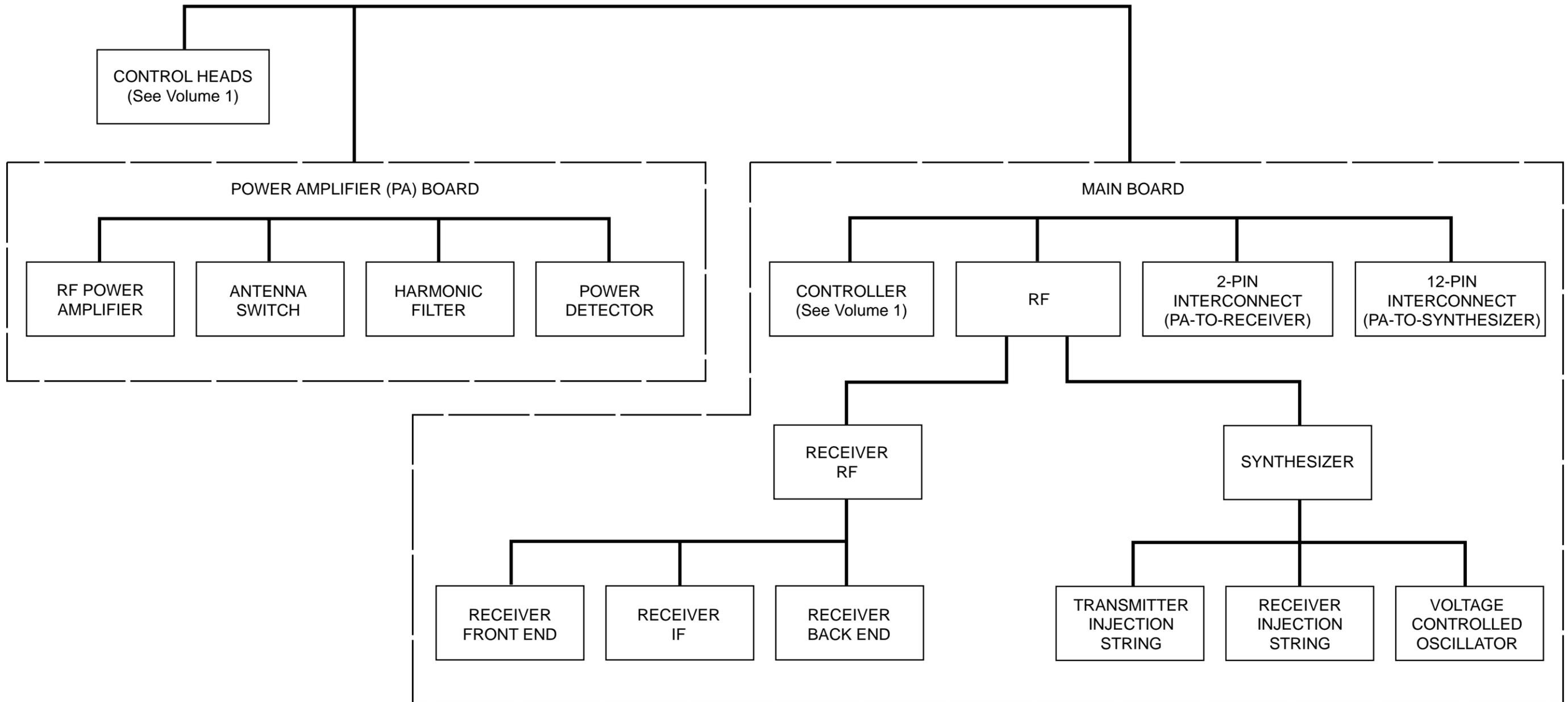
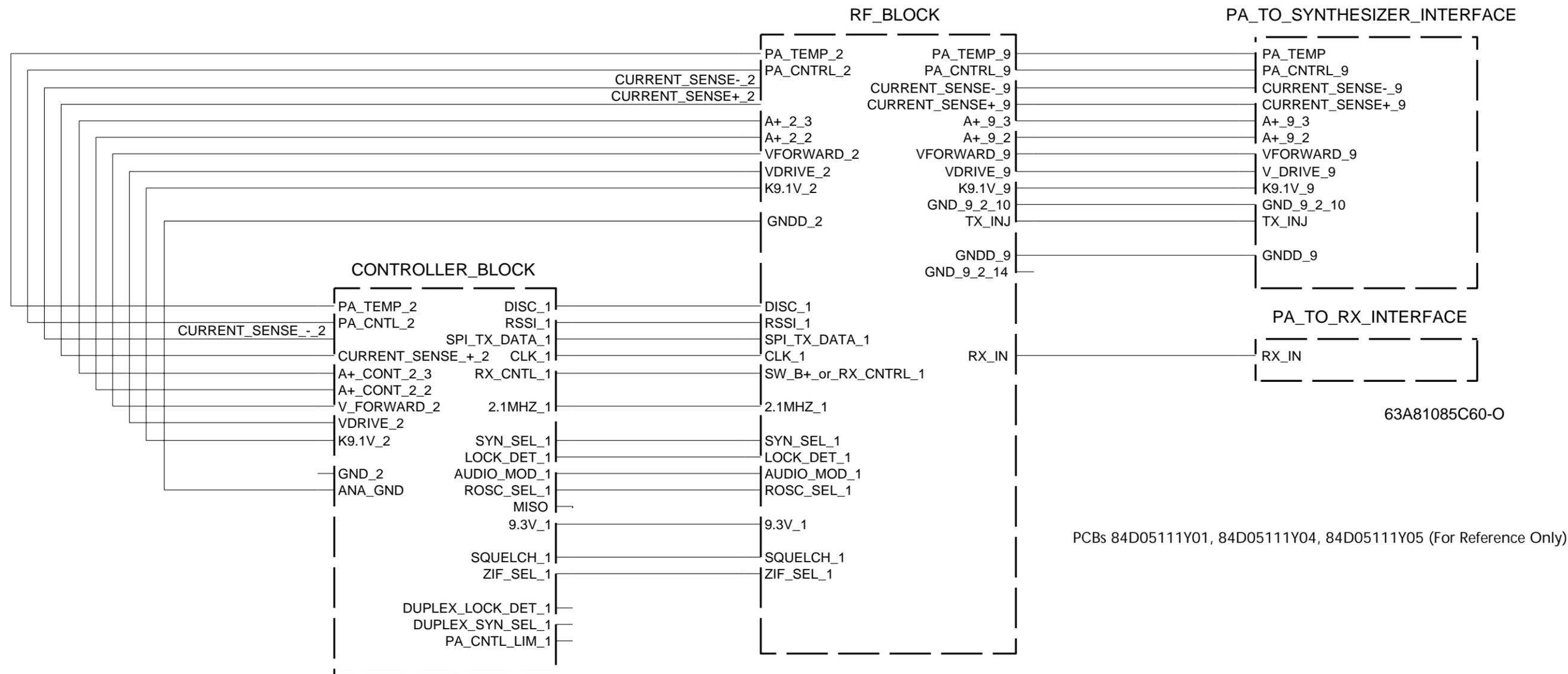


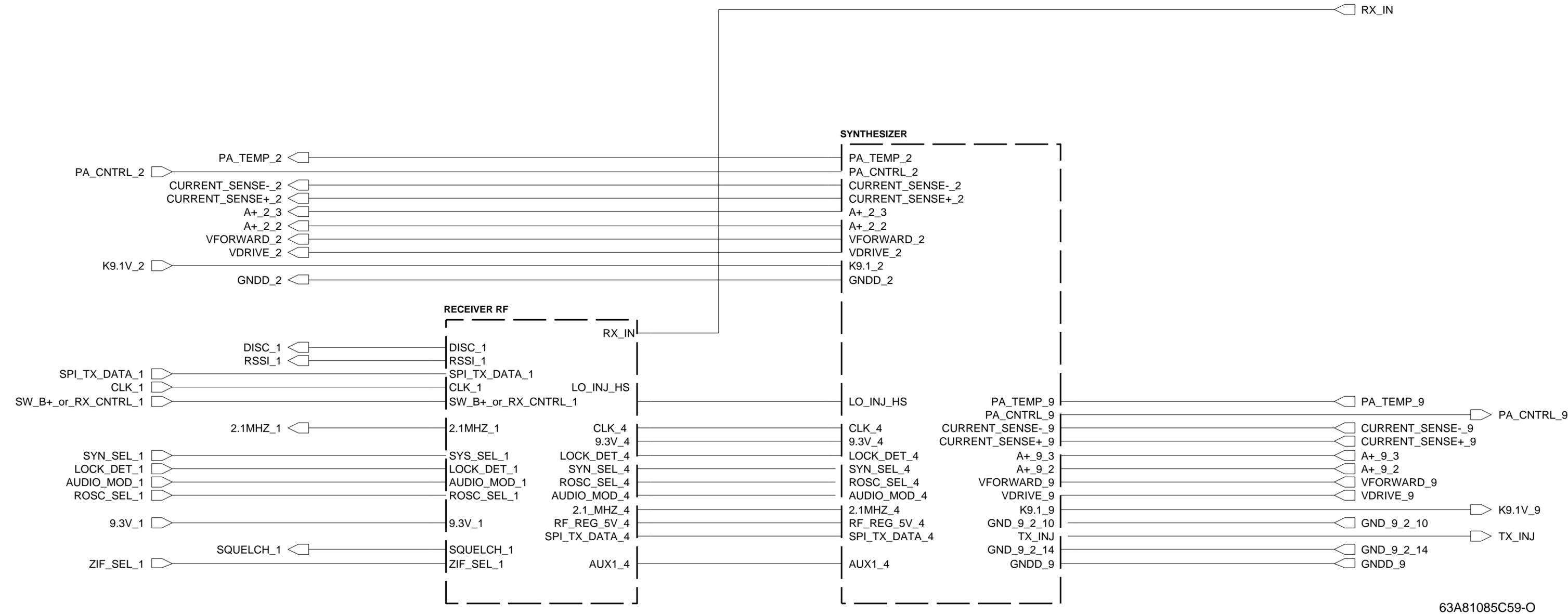
Figure 5 PA Board Section Locations



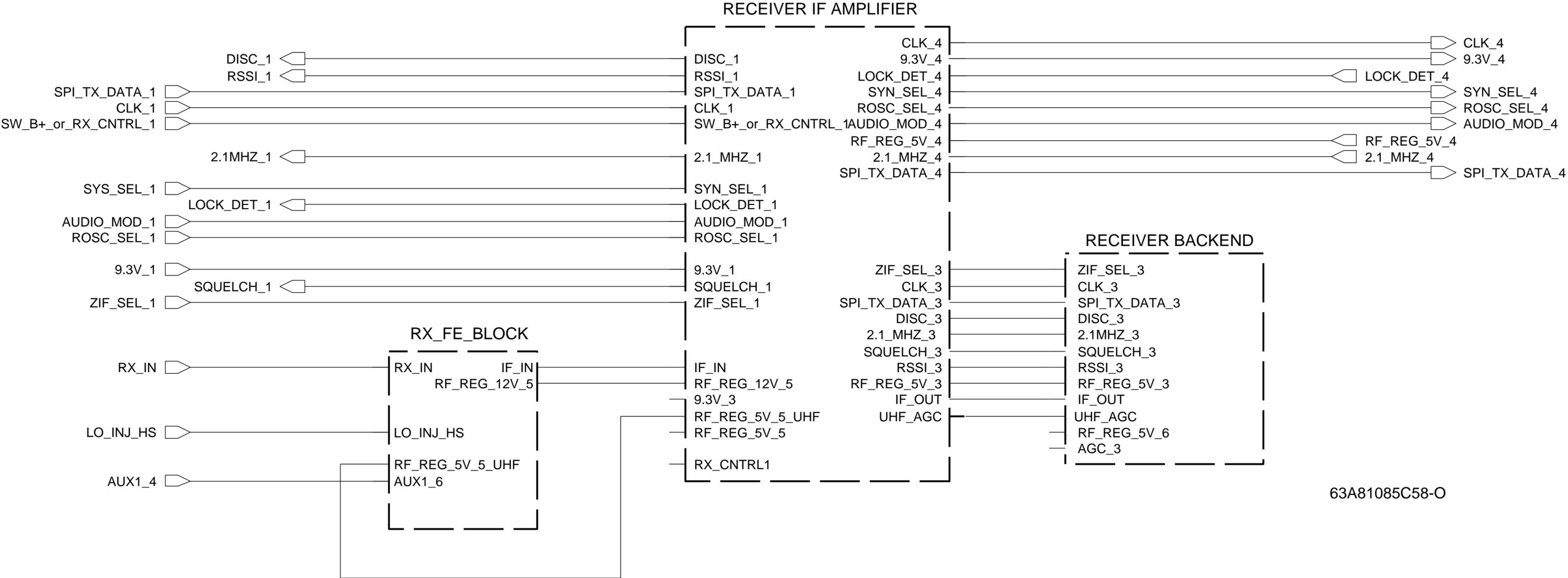
MAEPF-25894-O



PCBs 84D05111Y01, 84D05111Y04, 84D05111Y05 (For Reference Only)

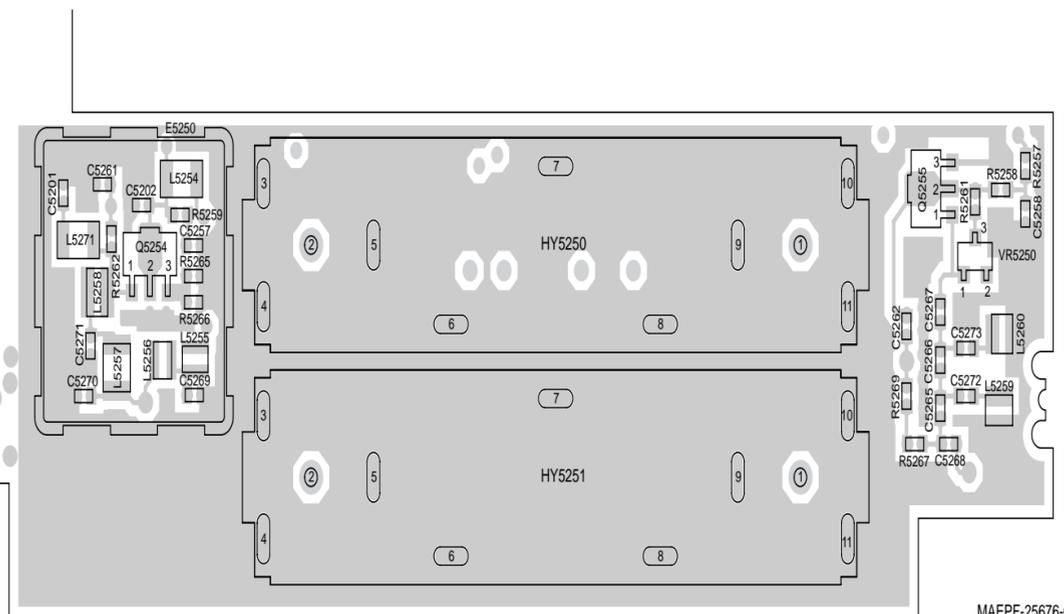


63A81085C59-O

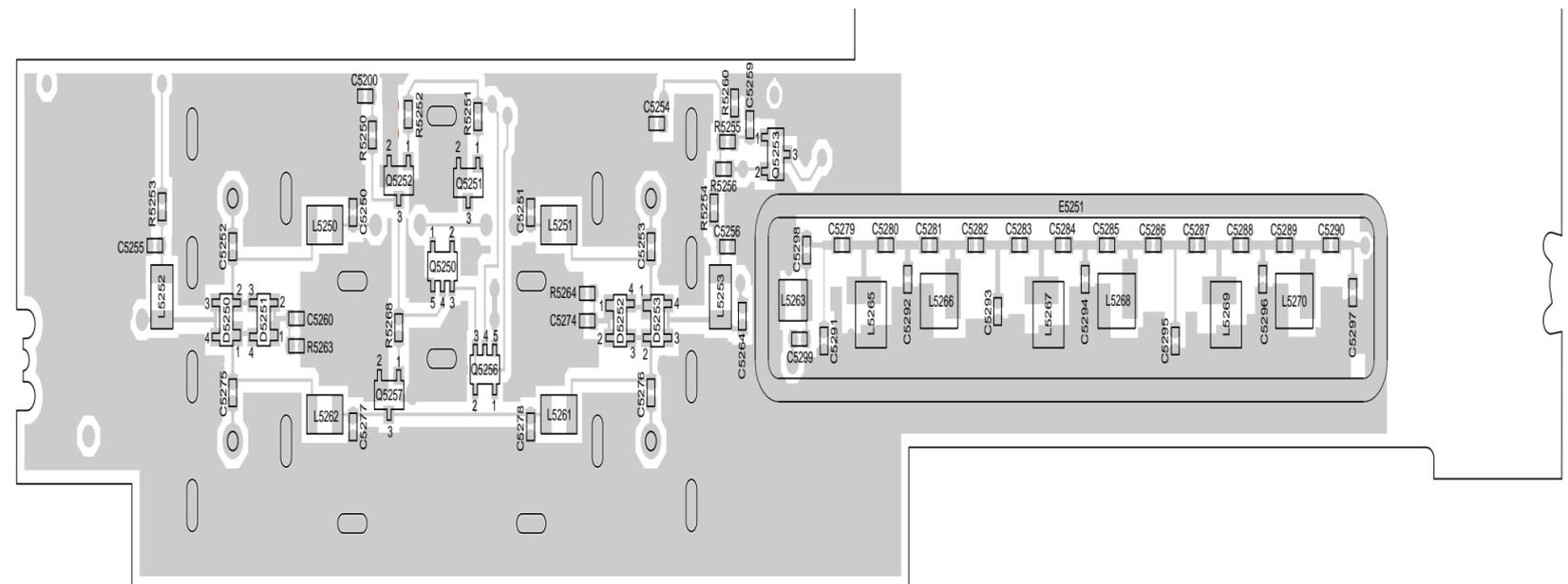


63A81085C58-O

RECEIVER FRONT END COMPONENT LOCATIONS



HEAVY COMPONENTS SIDE



LIGHT COMPONENTS SIDE

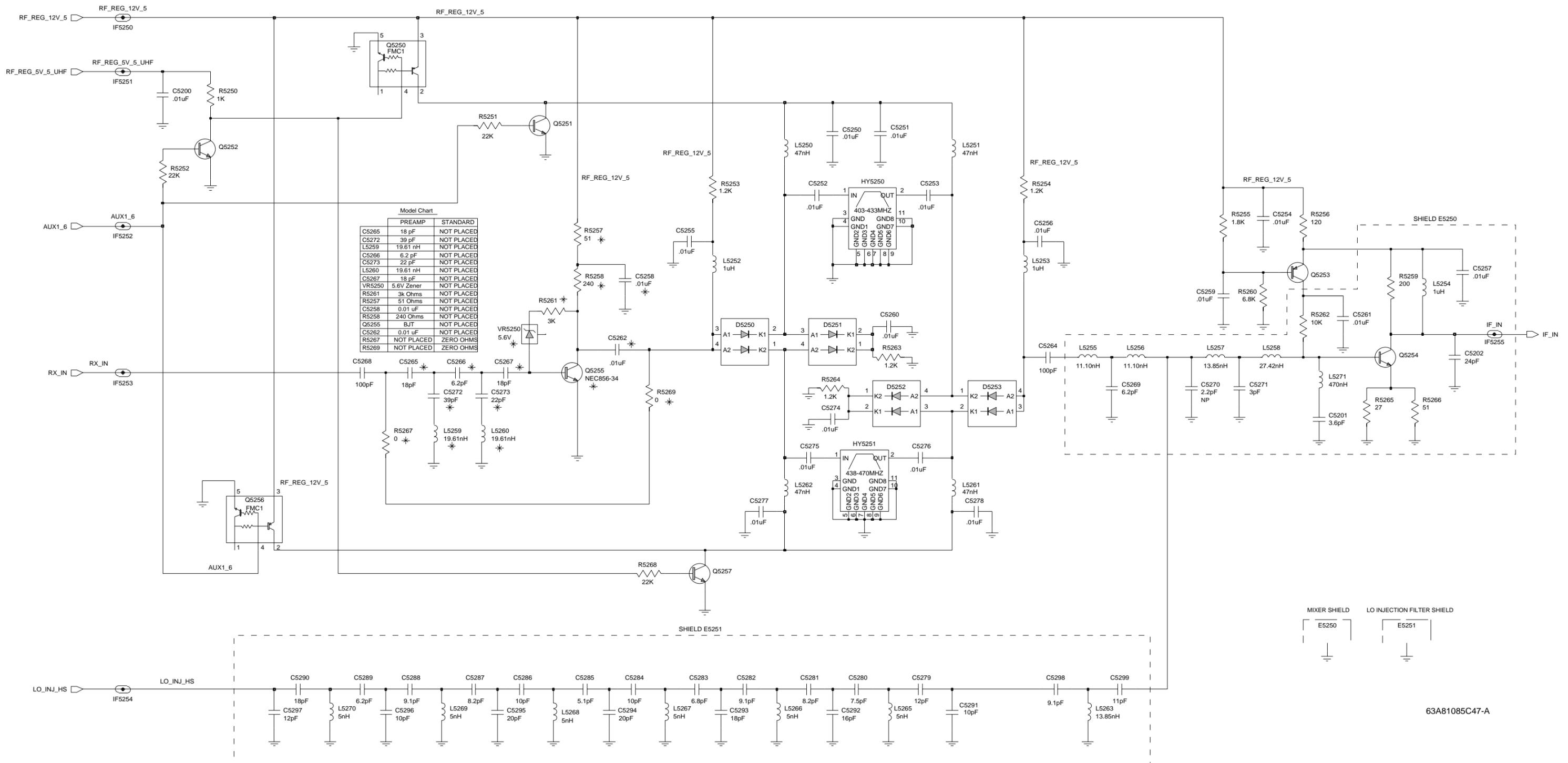
RECEIVER FRONT END PARTS LIST

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C5200	2113931F49	0..01uF
C5201	2113930F16	3.6 pF
C5202	2113930F36	24 pF
C5250	2113931F49	0.01uF
C5251	2113931F49	0.01uF
C5252	2113931F49	0.01uF
C5253	2113931F49	0.01uF
C5254	2113931F49	0.01uF
C5255	2113931F49	0.01uF
C5256	2113931F49	0.01uF
C5257	2113931F49	0.01uF
C5258 *	2113931F49	0.01uF
C5259	2113931F49	0.01uF
C5260	2113931F49	0.01uF
C5261	2113931F49	0.01uF
C5262 *	2113931F49	0.01uF
C5264	2113930F51	100pF
C5265 *	2113930F33	18 pF
C5266 *	2113930F22	6.2 pF
C5267 *	2113930F33	18 pF
C5268	2113930F51	100 pF
C5269	2113930F22	6.2 pF
C5270	2113930F11	2.2 pF
C5271	2113930F14	3 pF
C5272 *	2113930F41	3 pF
C5273 *	2113930F35	22 pF
C5274	2113931F49	0.01uF
C5275	2113931F49	0.01uF
C5276	2113931F49	0.01uF
C5277	2113931F49	0.01uF
C5278	2113931F49	0.01uF
C5279	2113930F29	12 pF
C5280	2113930F24	7.5 pF
C5281	2113930F25	8.2 pF
C5282	2113930F26	9.1 pF
C5283	2113930F23	6.8 pF
C5284	2113930F27	10 pF
C5285	2113930F20	5.1 pF
C5286	2113930F27	10 pF
C5287	2113930F25	8.2 pF
C5288	2113930F26	9.1 pF
C5289	2113930F22	6.2 pF
C5290	2113930F33	18 pF
C5291	2113930F27	10 pF
C5292	2113930F32	16 pF
C5293	2113930F33	18 pF
C5294	2113930F34	20 pF
C5295	2113930F34	20 pF
C5296	2113930F27	10 pF
C5297	2113930F29	12 pF
C5298	2113930F26	9.1 pF

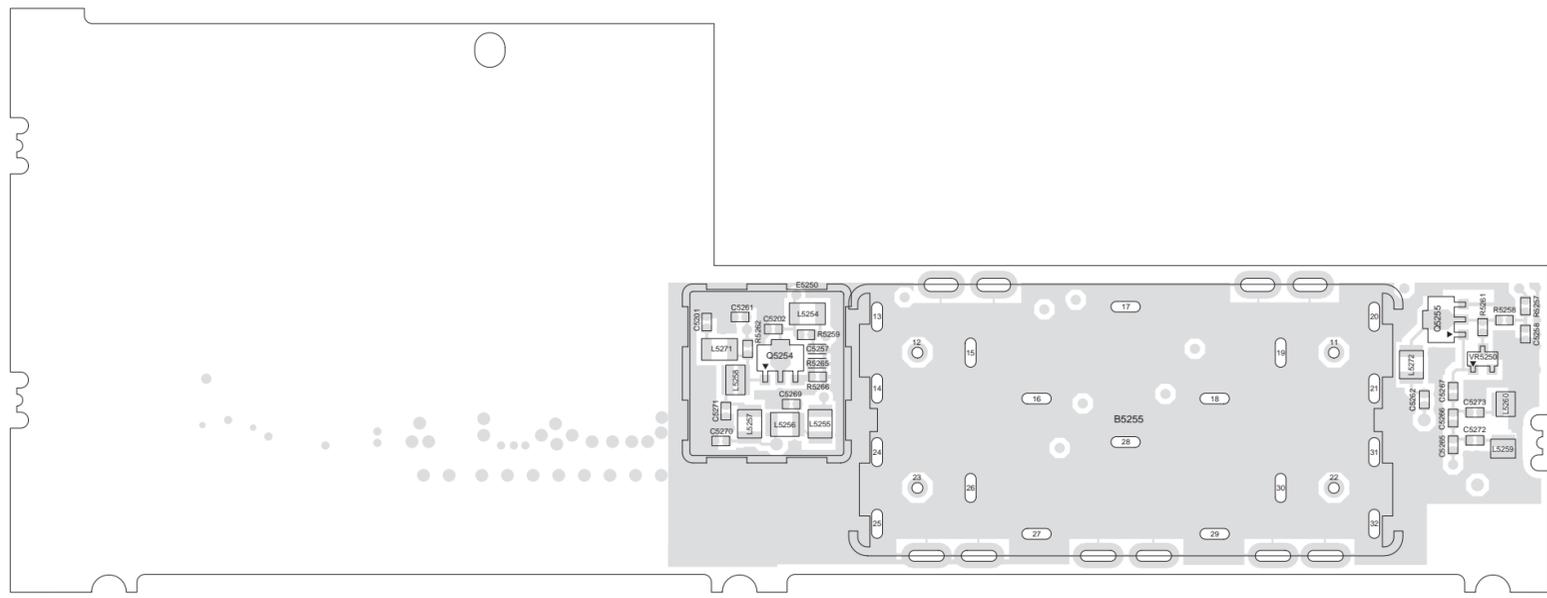
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C5299	2113930F28	11 pF
D5250	4880154K06	PIN Schottky
D5251	4880154K06	PIN Schottky
D5252	4880154K06	PIN Schottky
D5253	4880154K06	PIN Schottky
VR5250 *	4813830A15	Zener, 5.6 V
E5250	2605778Y01	RF Mixer
E5251	2604400J01	RF Front End
HY5250	9180209N06	CERAMIC, 417 MHz
HY5251	9180209N07	CERAMIC, 455MHz
L5250	2462587T11	47 nH
L5251	2462587T11	47 nH
L5252	2462587T30	1 uH
L5253	2462587T30	1 uH
L5254	2462587T30	1 uH
L5255	2460591A56	11.10 nH
L5256	2460591A56	11.10 nH
L5257	2460591C23	13.85 nH
L5258	2460591M32	27.42 nH
L5259 *	2460591B80	19.61 nH
L5260 *	2460591B80	19.61 nH
L5261	2462587T11	47 nH
L5262	2462587T11	47 nH
L5263	2460591C23	13.85 nH
L5265	2484562T20	5 nH
L5266	2484562T20	5 nH
L5267	2484562T20	5 nH
L5268	2484562T20	5 nH
L5269	2484562T20	5 nH
L5270	2484562T20	5 nH
L5271	2462587T23	470 nH
Q5250	4805921T04	Dual (Switch)
Q5251	4813824A10	NPN
Q5252	4813824A10	NPN
Q5253	4805128M16	PNP
Q5254	4882971R01	NPN
Q5255 *	4882971R01	NPN
Q5256	4805921T04	Dual (Switch)
Q5257	4813824A10	NPN
R5250	0662057A49	1K
R5251	0662057A81	22K
R5252	0662057A81	22K
R5253	0662057A51	1.2K
R5254	0662057A51	1.2K
R5255	0662057A55	1.8K
R5256	0662057A27	120

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R5257 *	0662057A18	51
R5258 *	0662057A34	240
R5259	0662057A32	200
R5260	0662057A69	6.8K
R5261 *	0662057A60	3K
R5262	0662057A73	10K
R5263	0662057A51	1.2K
R5264	0662057A51	1.2K
R5265	0662057A11	27
R5266	0662057A18	51
R5267 #	0662057B47	0
R5268	0662057A81	22K
R5269 #	0662057B47	0
	84D05111Y01	PRINTED CIRCUIT BOARD (For Reference Only) For Kits HUE4017A, HUE4025A

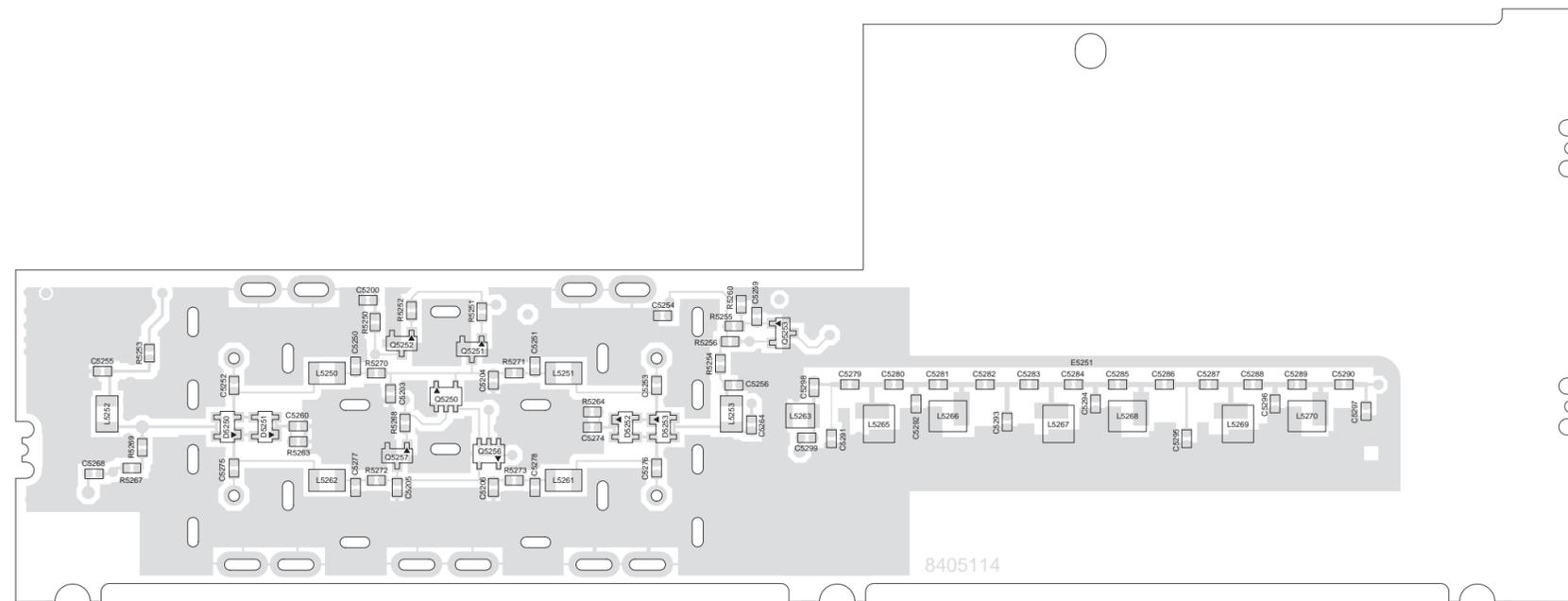
- NOTES:
- All resistance values are in ohms unless indicated otherwise.
 - Items indicated with an asterisk (*) are only placed in preamplifier models of radio.
 - Items indicated with a pound sign (#) are not placed in preamplifier models of radio.
 - Components shown in component location and schematic diagrams but not included in parts list are not placed.



RECEIVER FRONT END COMPONENT LOCATIONS



HEAVY COMPONENTS SIDE



LIGHT COMPONENTS SIDE

RECEIVER FRONT END PARTS LIST

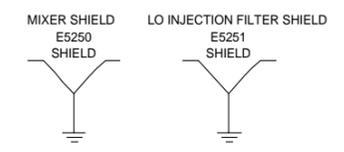
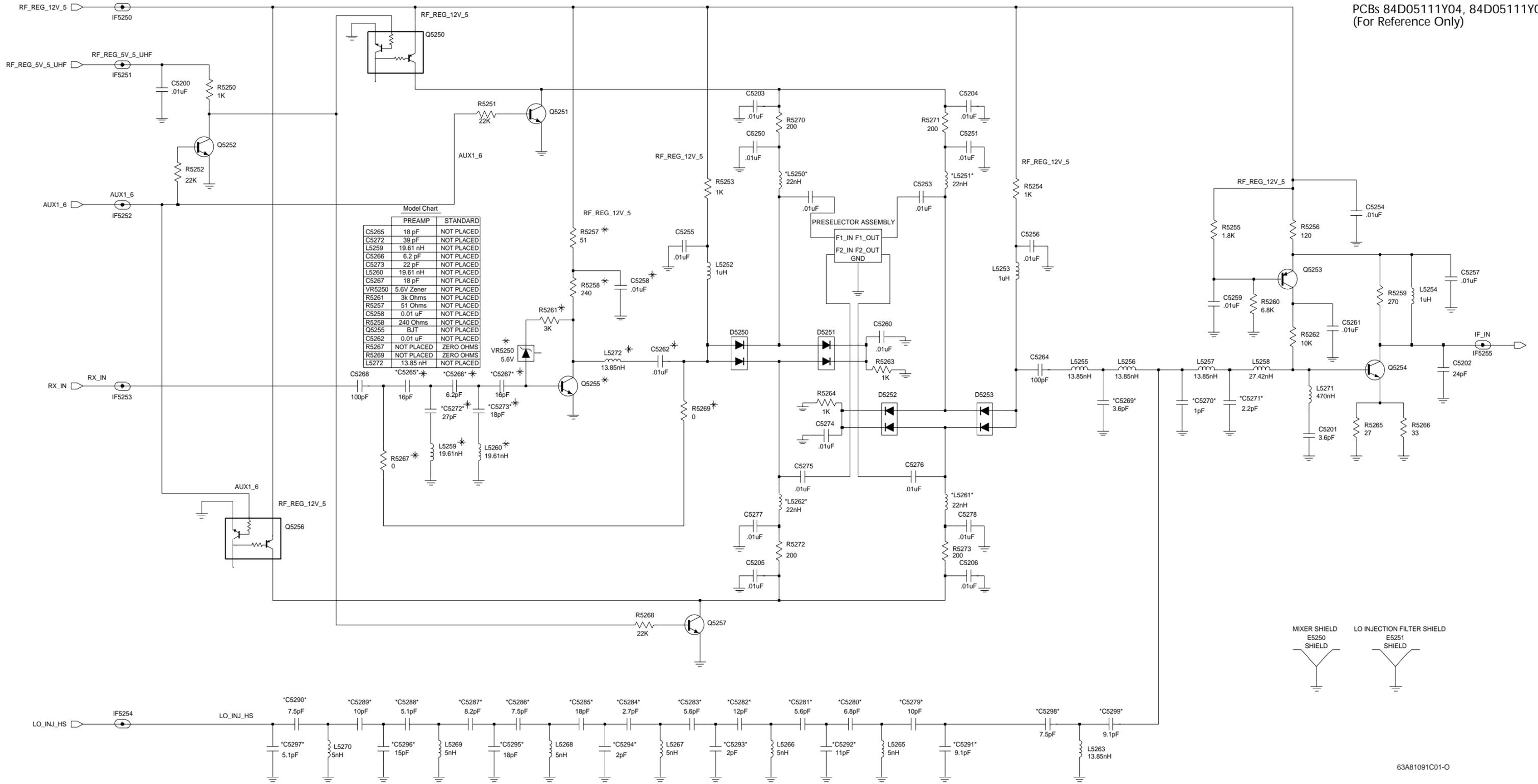
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
B5255	9180209N12	FILTERS: Dual Ceramic Filter Assembly, 417 MHz and 455 MHz
C5200	2113931F49	CAPACITORS: 0..01 uF
C5201	2113930F16	3.6 pF
C5202	2113930F36	24 pF
C5250	2113931F49	0.01 uF
C5251	2113931F49	0.01 uF
C5252	2113931F49	0.01 uF
C5253	2113931F49	0.01 uF
C5254	2113931F49	0.01 uF
C5255	2113931F49	0.01 uF
C5256	2113931F49	0.01 uF
C5257	2113931F49	0.01 uF
C5258 *	2113931F49	0.01 uF
C5259	2113931F49	0.01 uF
C5260	2113931F49	0.01 uF
C5261	2113931F49	0.01 uF
C5262 *	2113931F49	0.01 uF
C5264	2113930F51	100 pF
C5265 *	2113930F33	18 pF
C5266 *	2113930F21	5.6 pF
C5267 *	2113930F33	18 pF
C5268	2113930F51	100 pF
C5269	2113930F22	6.2 pF
C5271	2113930F14	3 pF
C5272 *	2113930F41	39 pF
C5273 *	2113930F35	22 pF
C5274 *	2113931F49	0.01 uF
C5275	2113931F49	0.01 uF
C5276	2113931F49	0.01 uF
C5277	2113931F49	0.01 uF
C5278	2113931F49	0.01 uF
C5279	2113930F29	12 pF
C5280	2113930F24	7.5 pF
C5281	2113930F25	8.2 pF
C5282	2113930F26	9.1 pF
C5283	2113930F23	6.8 pF
C5284	2113930F27	10 pF
C5285	2113930F20	5.1 pF
C5286	2113930F27	10 pF
C5287	2113930F25	8.2 pF
C5288	2113930F26	9.1 pF
C5289	2113930F22	6.2 pF
C5290	2113930F33	18 pF
C5291	2113930F27	10 pF
C5292	2113930F32	16 pF
C5293	2113930F33	18 pF
C5294	2113930F34	20 pF
C5295	2113930F34	20 pF

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C5296	2113930F27	10 pF
C5297	2113930F29	12 pF
C5298	2113930F26	9.1 pF
C5299	2113930F28	11 pF
D5250	4880154K06	DIODES: PIN Schottky
D5251	4880154K06	PIN Schottky
D5252	4880154K06	PIN Schottky
D5253	4880154K06	PIN Schottky
VR5250 *	4813830A15	Zener, 5.6 V
E5250	2605778Y01	SHIELDS: RF Mixer
E5251	2604400J01	RF Front End
L5250	2462587T11	INDUCTORS: 47nH
L5251	2462587T11	47nH
L5252	2462587T30	1 uH
L5253	2462587T30	1 uH
L5254	2462587T30	1 uH
L5255	2460591C23	13.85 nH
L5256	2460591C23	13.85 nH
L5257	2460591C23	13.85 nH
L5258	2460591M32	27.42 nH
L5259 *	2460591B80	19.61 nH
L5260 *	2460591B80	19.61 nH
L5261	2462587T11	47 nH
L5262	2462587T11	47 nH
L5263	2460591C23	13.85 nH
L5265	2484562T20	5 nH
L5266	2484562T20	5 nH
L5267	2484562T20	5 nH
L5268	2484562T20	5 nH
L5269	2484562T20	5 nH
L5270	2484562T20	5 nH
L5271	2462587T23	470 nH
Q5250	4805921T04	TRANSISTORS: Dual (Switch)
Q5251	4813824A10	NPN
Q5252	4813824A10	NPN
Q5253	4805128M16	PNP
Q5254	4882971R01	NPN
Q5255 *	4882971R01	NPN
Q5256	4805921T04	Dual (Switch)
Q5257	4813824A10	NPN
R5250	0662057A49	RESISTORS: 1K
R5251	0662057A81	22K
R5252	0662057A81	22K
R5253	0662057A51	1.2K
R5254	0662057A51	1.2K
R5255	0662057A55	1.8K
R5256	0662057A27	120

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R5257 *	0662057A18	51
R5258 *	0662057A34	240
R5259	0662057A35	270
R5260	0662057A69	6.8K
R5261 *	0662057A60	3K
R5262	0662057A73	10K
R5263	0662057A51	1.2K
R5264	0662057A51	1.2K
R5265	0662057A11	27
R5266	0662057A13	33
R5267 #	0662057B47	0
R5268	0662057A81	22K
R5269 #	0662057B47	0
	84D05111Y04,	PRINTED CIRCUIT BOARDS (For Reference Only): For Kits HUE4031B, HUE4032B
	84D05111Y05	

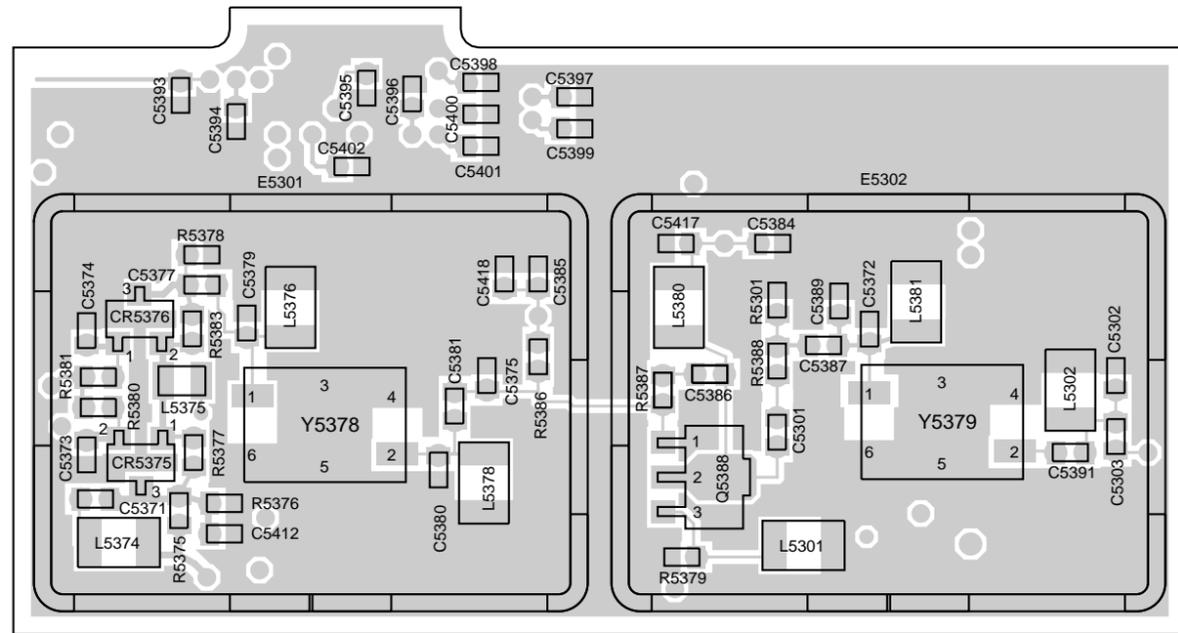
NOTES:

- All resistance values are in ohms unless indicated otherwise.
- Components indicated with an asterisk (*) are placed only in kit HUE4031A, the preamplifier version of radio.
- Components indicated with a pound sign (#) are not placed in kit HUE4031A, the preamplifier version of radio.
- Components shown in component location and schematic diagrams but not included in parts list are not placed.



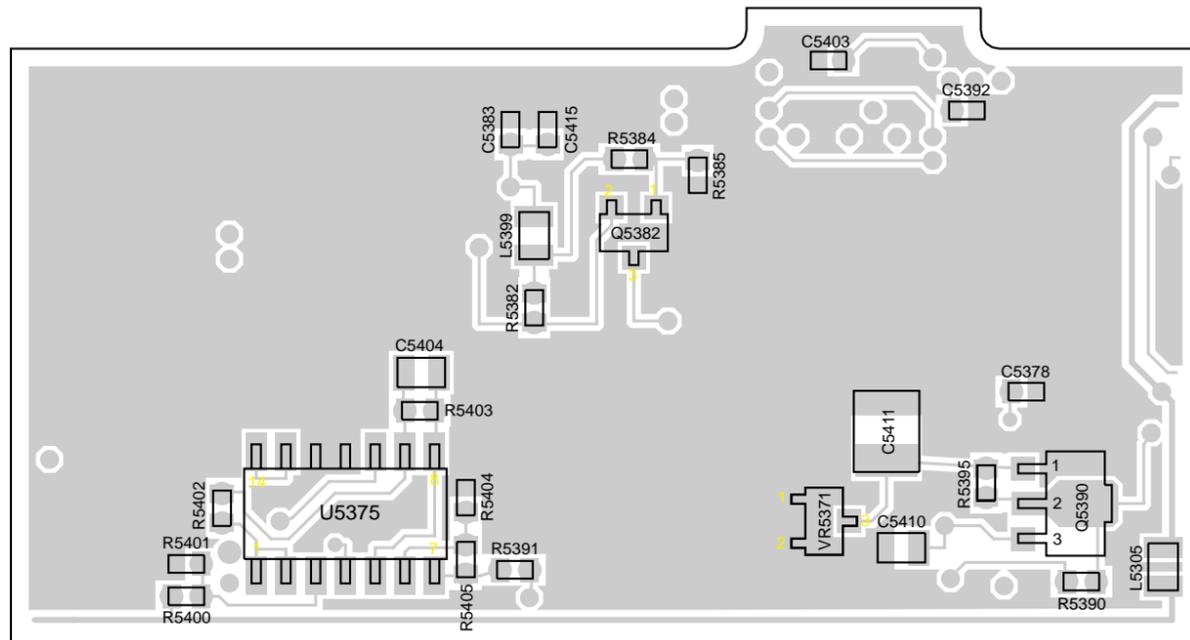
63A81091C01-O

RECEIVER IF COMPONENT LOCATIONS



MAEPF-25678-O

HEAVY COMPONENTS SIDE



MAEPF-25679-O

LIGHT COMPONENTS SIDE

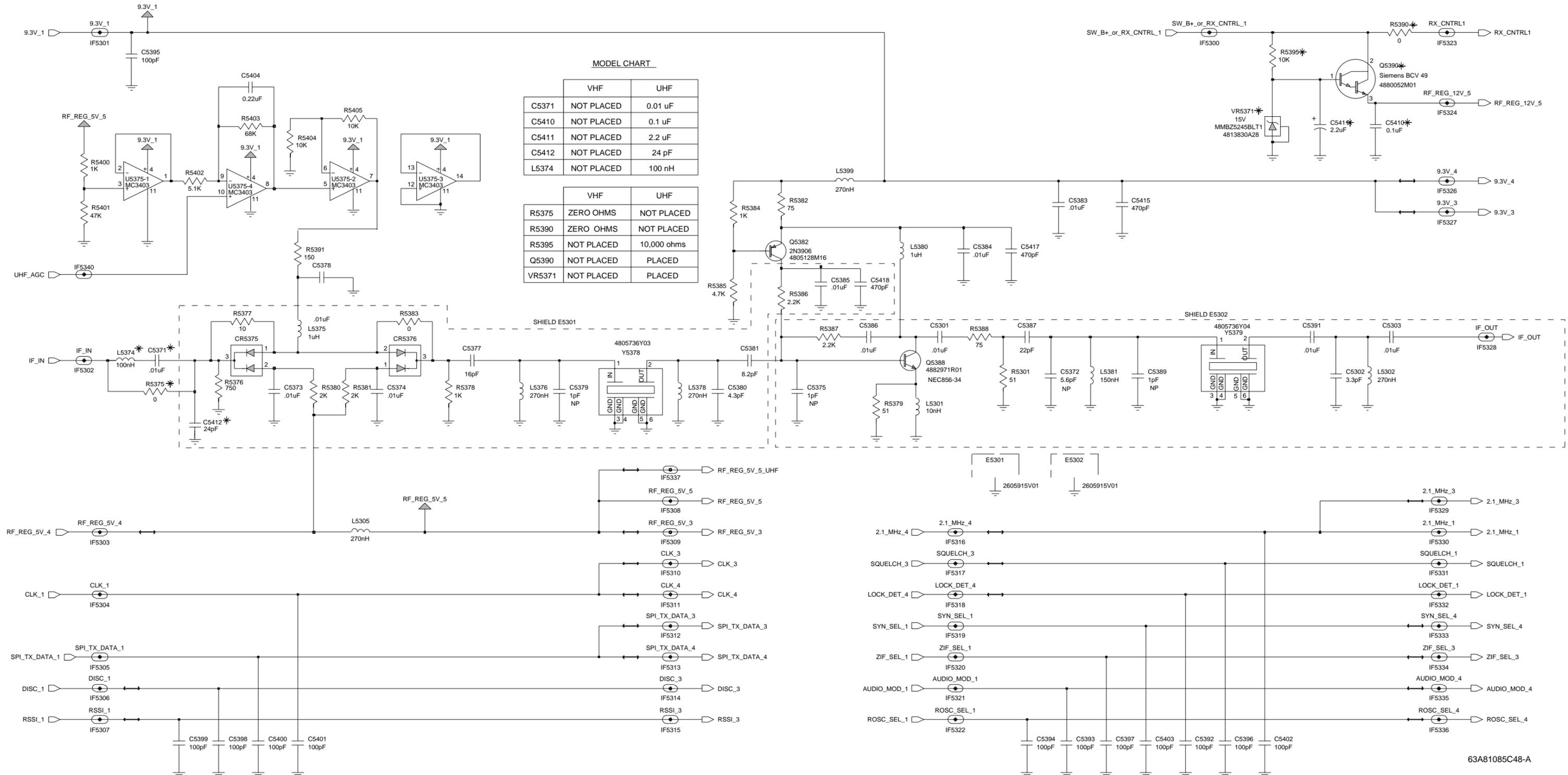
RECEIVER IF PARTS LIST

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
CAPACITORS:		
C5301	2113931F49	0.01 uF
C5302	2113930F15	3.3 pF
C5303	2113931F49	0.01 uF
C5371	2113931F49	0.01 uF
C5373	2113931F49	0.01 uF
C5374	2113931F49	.01 uF
C5377	2113930F32	16 pF
C5378	2113931F49	0.01 uF
C5380	2113930F18	4.3 pF
C5381	2113930F27	10 pF
C5383	2113931F49	0.01 uF
C5384	2113931F49	0.01 uF
C5385	2113931F49	0.01 uF
C5386	2113931F49	0.01 uF
C5387	2113930F35	22 pF
C5391	2113931F49	0.01 uF
C5392	2113930F51	100 pF
C5393	2113930F51	100 pF
C5394	2113930F51	100 pF
C5395	2113930F51	100 pF
C5396	2113930F51	100 pF
C5397	2113930F51	100 pF
C5398	2113930F51	100 pF
C5399	2113930F51	100 pF
C5400	2113930F51	100 pF
C5401	2113930F51	100 pF
C5402	2113930F51	100 pF
C5403	2113930F51	100 pF
C5404	2113743A23	0.220 uF
C5410	2113743A19	0.100 uF
C5411	2311049A09	2.2 uF
C5412	2113930F36	24 pF
C5415	2113931F17	470 pF
C5417	2113931F17	470 pF
C5418	2113931F17	470 pF
DIODES:		
CR5375	4880154K05	Dual
CR5376	4880154K05	Dual
VR5371	4813830A28	Zener, 15V
SHIELDS:		
E5301	2605915V01	
E5302	2605915V01	
INDUCTORS:		
L5301	2462587T03	10nH
L5302	2462587T20	270nH
L5305	2462587Q40	270nH
L5374	2462587T15	100nH
L5375	2462587Q47	1nH
L5376	2462587T20	270nH
L5378	2462587T20	270nH
L5380	2462587T30	1uH
L5381	2462587T17	150nH
L5399	2462587Q40	270nH
TRANSISTORS:		
Q5382	4805128M16	PNP
Q5388	4882971R01	NPN

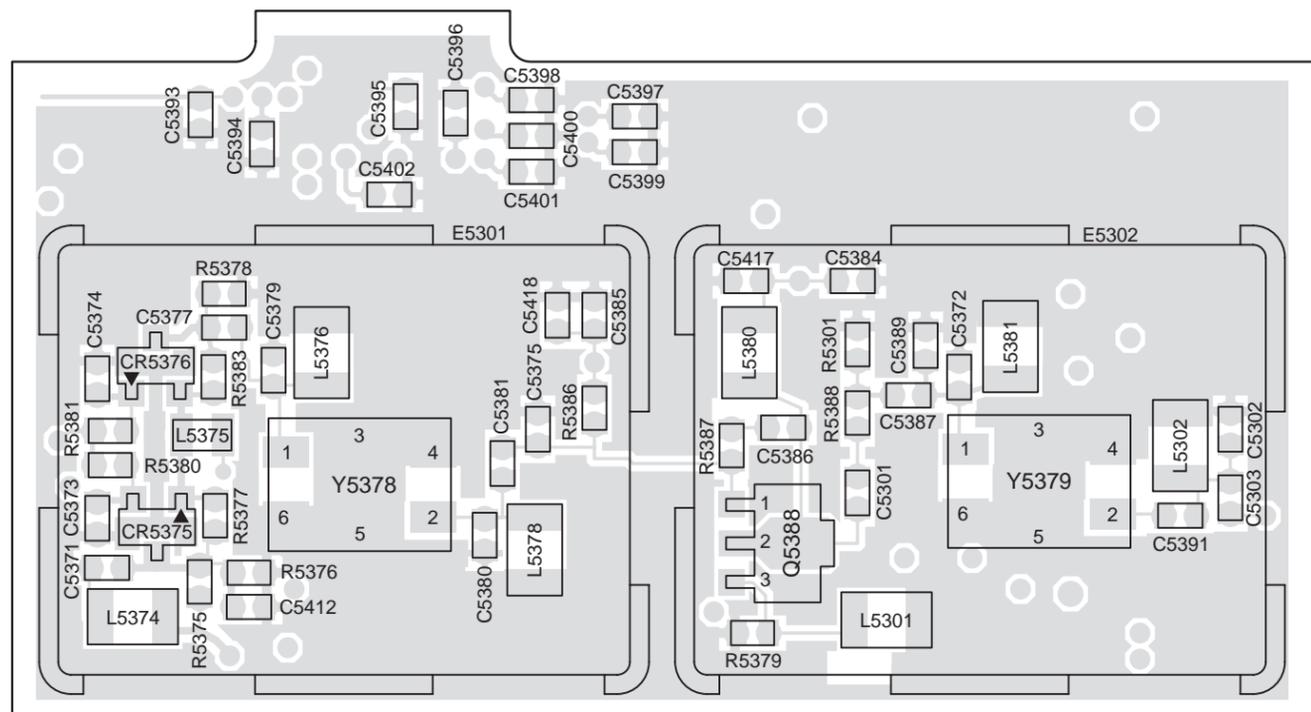
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
Q5390	4880052M01	NPN
RESISTORS:		
R5301	0662057A18	51
R5376	0662057A46	750
R5379	0662057A18	51
R5380	0662057A56	2K
R5381	0662057A56	2K
R5382	0662057A22	75
R5383	0662057B47	0
R5384	0662057A49	1K
R5385	0662057A65	4.7K
R5386	0662057A57	2.2K
R5387	0662057A57	2.2K
R5388	0662057A22	75
R5391	0662057A29	150
R5395	0662057A73	10K
R5400	0662057A49	1K
R5401	0662057A89	47K
R5402	0662057A66	5.1K
R5403	0662057A93	68K
R5404	0662057A73	10K
R5405	0662057A73	10K
INTEGRATED CIRCUITS:		
U5375	5183222M49	Operational Amplifier
FILTERS:		
Y5378	4805736Y03	Crystal, 109.65 MHZ
Y5379	4805736Y04	Crystal, 109.65 MHZ
PRINTED CIRCUIT BOARD (For Reference Only):		
	84D05111Y01	For Kits HUE4017A, HUE4025A

NOTES:

- All resistance values are in ohms unless indicated otherwise.
- Components shown in component location and schematic diagrams but not included in parts list are not placed.

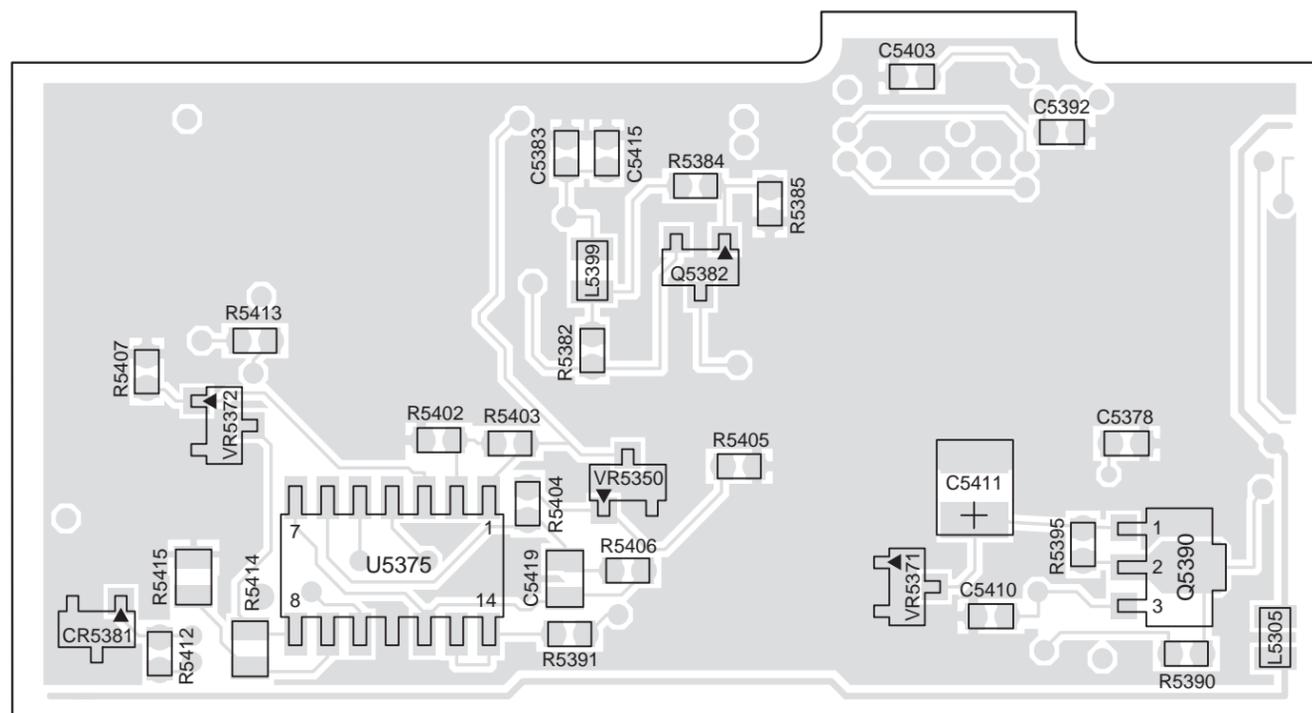


RECEIVER IF COMPONENT LOCATIONS



MAEPF-26588-O

HEAVY COMPONENTS SIDE



MAEPF-26589-O

LIGHT COMPONENTS SIDE

RECEIVER IF PARTS LIST

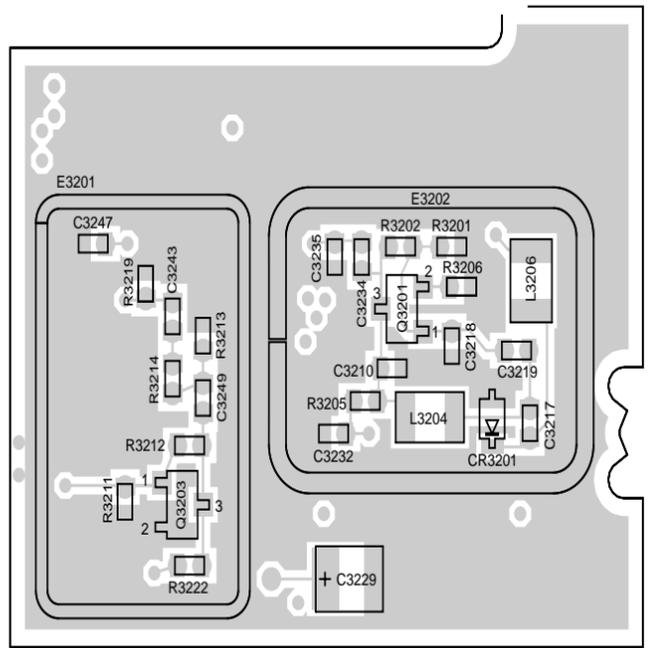
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
CAPACITORS:		
C5301	2113931F49	0.01 uF
C5302	2113930F15	3.3 pF
C5303	2113931F49	0.01 uF
C5371	2113931F49	0.01 uF
C5373	2113931F49	0.01 uF
C5374	2113931F49	0.01 uF
C5377	2113930F32	16 pF
C5378	2113931F49	0.01 uF
C5380	2113930F18	4.3 pF
C5381	2113930F27	10 pF
C5383	2113931F49	0.01 uF
C5384	2113931F49	0.01 uF
C5385	2113931F49	0.01 uF
C5386	2113931F49	0.01 uF
C5387	2113930F35	22 pF
C5391	2113931F49	0.01 uF
C5392	2113930F51	100 pF
C5393	2113930F51	100 pF
C5394	2113930F51	100 pF
C5395	2113930F51	100 pF
C5396	2113930F51	100 pF
C5397	2113930F51	100 pF
C5398	2113930F51	100 pF
C5399	2113930F51	100 pF
C5400	2113930F51	100 pF
C5401	2113930F51	100 pF
C5402	2113930F51	100 pF
C5403	2113930F51	100 pF
C5404	2113743A23	0.220 uF
C5410	2113743A19	0.100 uF
C5411	2311049A09	2.2 uF
C5412	2113930F36	24 pF
C5415	2113931F17	470 pF
C5417	2113931F17	470 pF
C5418	2113931F17	470 pF
DIODES:		
CR5375	4880154K05	Dual
CR5376	4880154K05	Dual
VR5371	4813830A28	Zener, 15 V
SHIELDS:		
E5301	2605915V01	
E5302	2605915V01	
INDUCTORS:		
L5301	2462587T03	10 nH
L5302	2462587T20	270 nH
L5305	2462587Q40	270 nH
L5374	2462587T15	100 nH
L5375	2462587Q47	1 nH
L5376	2462587T20	270 nH
L5378	2462587T20	270 nH
L5380	2462587T30	1 uH
L5381	2462587T17	150 nH
L5399	2462587Q40	270 nH
TRANSISTORS:		
Q5382	4805128M16	PNP
Q5388	4882971R01	NPN

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
Q5390	4880052M01	NPN
RESISTORS:		
R5301	0662057A18	51
R5376	0662057A46	750
R5379	0662057A18	51
R5380	0662057A56	2K
R5381	0662057A56	2K
R5382	0662057A22	75
R5383	0662057B47	0
R5384	0662057A49	1K
R5385	0662057A65	4.7K
R5386	0662057A57	2.2K
R5387	0662057A57	2.2K
R5388	0662057A22	75
R5391	0662057A29	150
R5395	0662057A73	10K
R5400	0662057A49	1K
R5401	0662057A89	47K
R5402	0662057A66	5.1K
R5403	0662057A93	68K
R5404	0662057A73	10K
R5405	0662057A73	10K
INTEGRATED CIRCUITS:		
U5375	5183222M49	Operational Amplifier
FILTERS:		
Y5378	4805736Y03	Crystal, 109.65 MHZ
Y5379	4805736Y04	Crystal, 109.65 MHZ
PRINTED CIRCUIT BOARDS (FOR REFERENCE ONLY):		
	84D05111Y04, 84D05111Y05	For Kits HUE4031B, HUE4032B

NOTES:

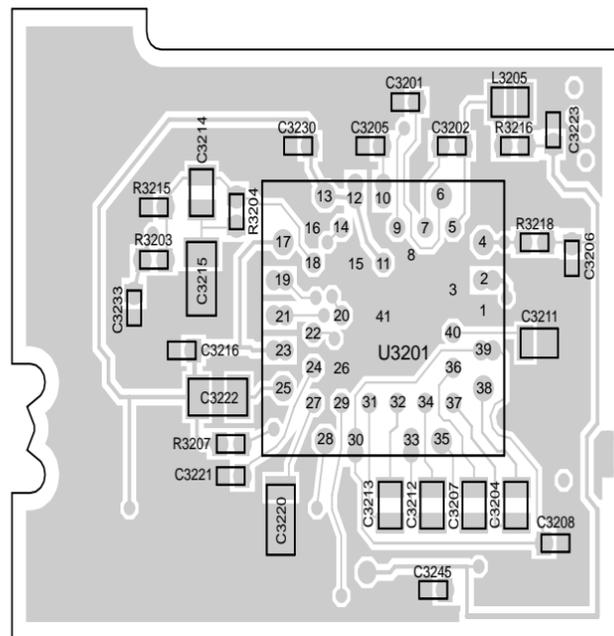
- All resistance values are in ohms unless indicated otherwise.
- Components shown in component location and schematic diagrams but not included in parts list are not placed.

RECEIVER BACK END COMPONENT LOCATIONS



MAEPF-25680-O

HEAVY COMPONENTS SIDE



MAEPF-25681-O

LIGHT COMPONENTS SIDE

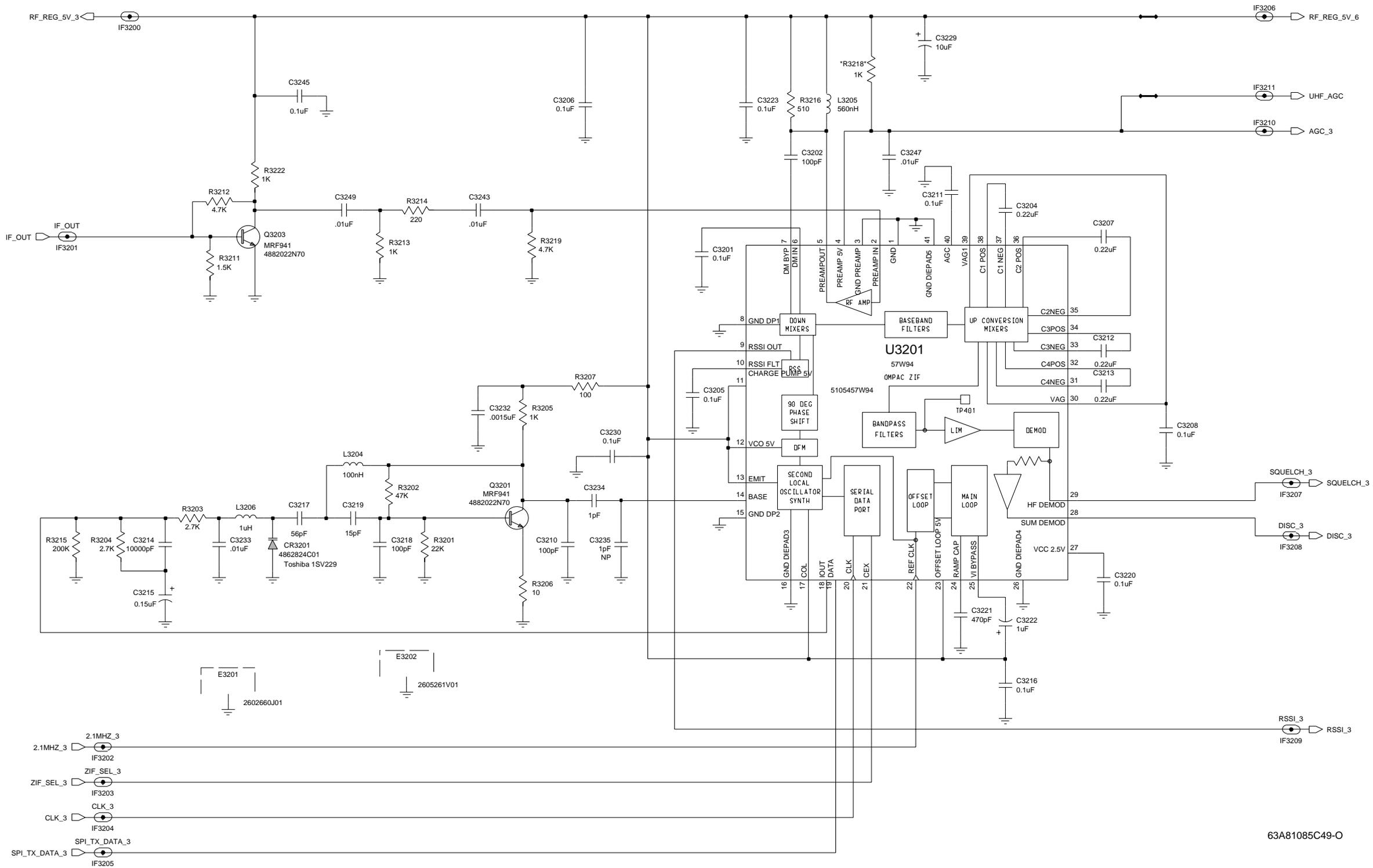
RECEIVER BACK END PARTS LIST

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C3201	2113932K15	0.1 uF
C3202	2113930F51	100 pF
C3204	2113743A23	0.220 uF
C3205	2113932K15	0.1 uF
C3206	2113932K15	0.1 uF
C3207	2113743A23	0.22 uF
C3208	2113932K15	0.1 uF
C3210	2113930F51	100 pF
C3211	2113743A19	0.100 uF
C3212	2113743A23	0.22 uF
C3213	2113743A23	0.22 uF
C3214	2113741A45	10000 pF
C3215	2311049A02	0.15 uF
C3216	2113932K15	0.1 uF
C3217	2113930F45	56 pF
C3218	2113930F51	100 pF
C3219	2113930F31	15 pF
C3220	2109720D14	0.1 uF
C3221	2113931F17	470 pF
C3222	2311049A07	1 uF
C3223	2113932K15	0.1 uF
C3229	2311049J23	10 uF
C3230	2113932K15	0.1 uF
C3232	2113931F29	0.0015 uF
C3233	2113931F49	.01uF
C3234	2113930F03	1 pF
C3235	NOTPLACED	
C3243	2113931F49	0.01 uF
C3245	2113932K15	0.1 uF
C3247	2113931F49	0.01 uF
C3249	2113931F49	0.01 uF
CR3201	4862824C01	Varactor
E3201	2602660J01	Harmonic Filter
E3202	2605261V01	Zero IF (Z1F)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L3204	2462587T15	100 nH
L3205	2462587Q44	560 nH
L3206	2462587T30	1 uH
Q3201	4882022N70	NPN
Q3203	4882022N70	NPN
R3201	0662057A81	22K
R3202	0662057A89	47K
R3203	0662057A59	2.7K
R3204	0662057A59	2.7K
R3205	0662057A49	1K
R3206	0662057A01	10
R3207	0662057A25	100
R3211	0662057A53	1.5K
R3212	0662057A65	4.7K
R3213	0662057A49	1K
R3214	0662057A33	220
R3215	0662057B05	200K
R3216	0662057A42	510
R3218	0662057A49	1K
R3219	0662057A65	4.7K
R3222	0662057A49	1K
U3201	5105457W94	INTEGRATED CIRCUITS: Zero IF (ZIF)
	84D05111Y01	PRINTED CIRCUIT BOARD (For Reference Only): For Kits HUE4017A, HUE4025A

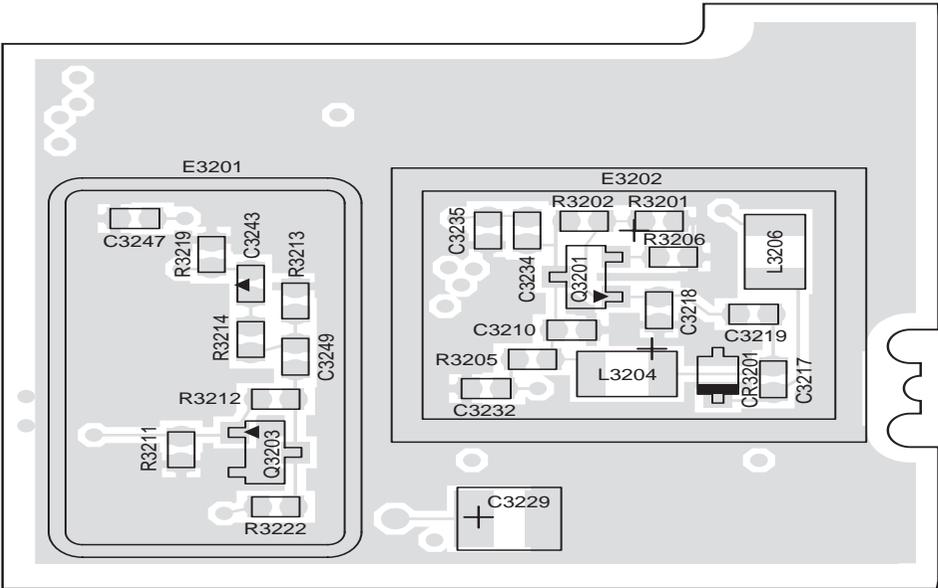
NOTE:

1. All resistance values are in ohms unless indicated otherwise.
2. Components shown in component location and schematic diagrams but not included in parts list are not placed.



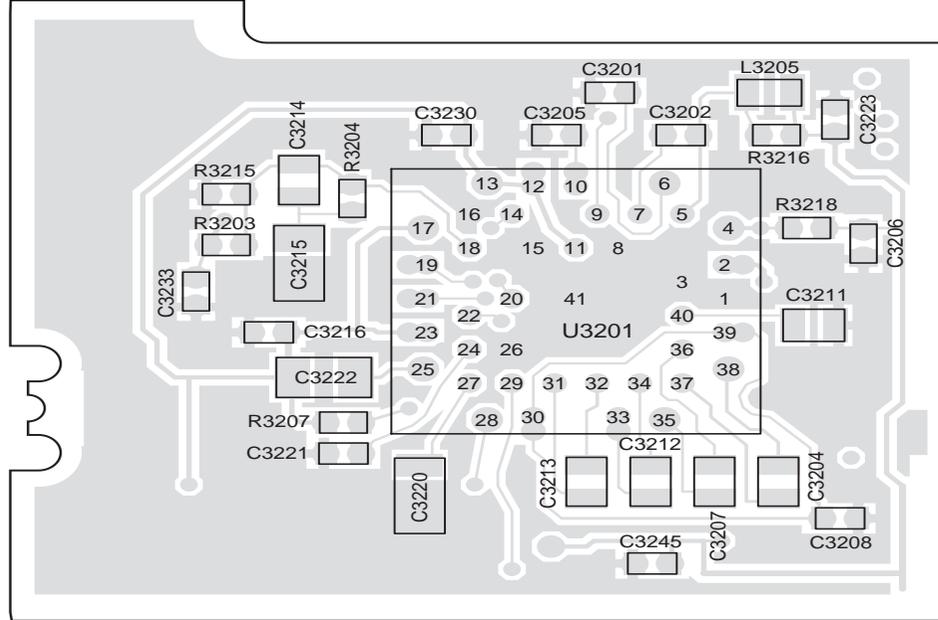
63A81085C49-0

RECEIVER BACK END COMPONENT LOCATIONS



MAEPF-26590-O

HEAVY COMPONENTS SIDE



MAEPF-26591-O

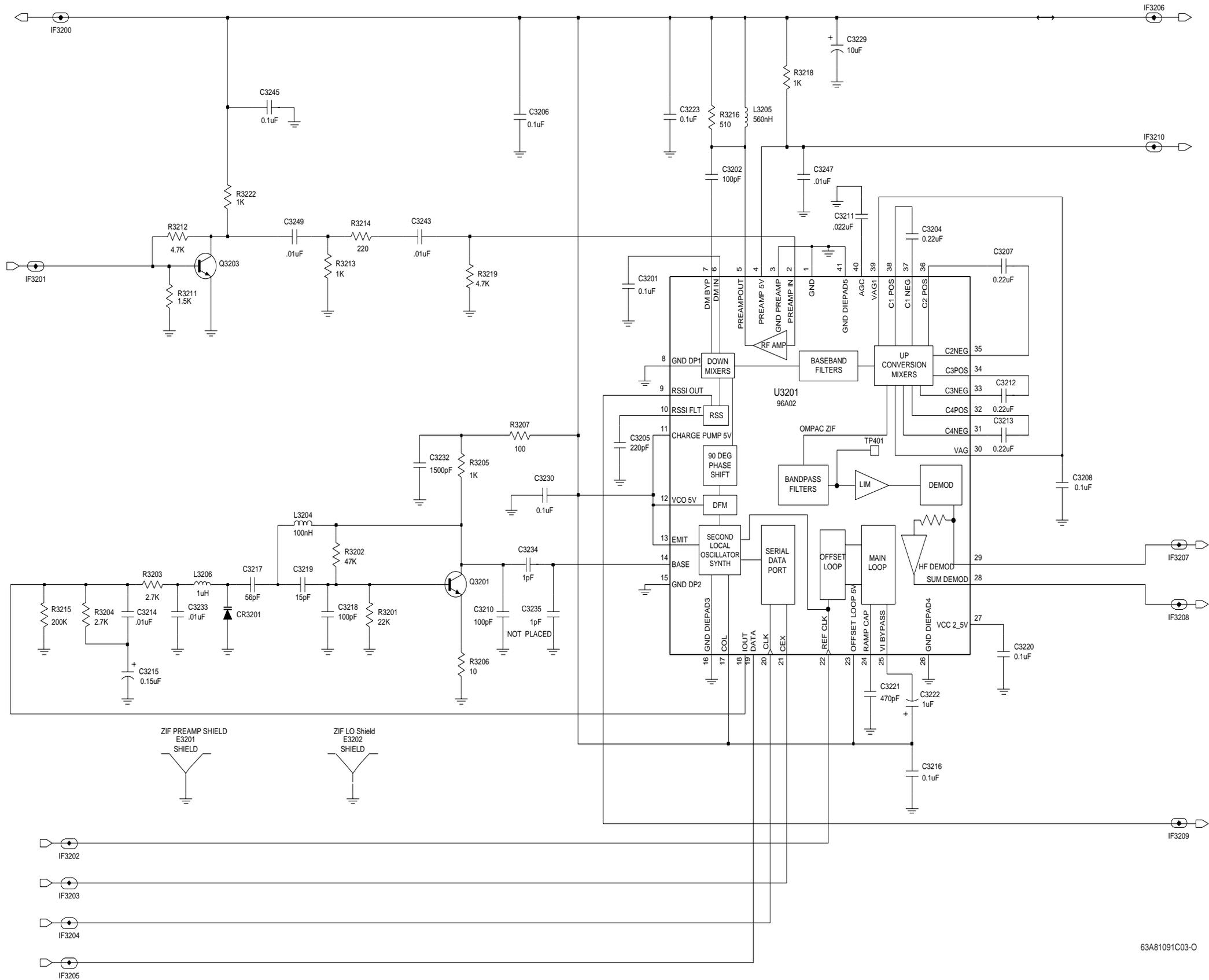
LIGHT COMPONENTS SIDE

RECEIVER BACK END PARTS LIST

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C3201	2113932K15	0.1 uF
C3202	2113930F51	100 pF
C3204	2113743A23	0.220 uF
C3205	2113932K15	0.1 uF
C3206	2113932K15	0.1 uF
C3207	2113743A23	0.22 uF
C3208	2113932K15	0.1 uF
C3210	2113930F51	100 pF
C3211	2113743A19	0.1 uF
C3212	2113743A23	0.22 uF
C3213	2113743A23	0.22 uF
C3214	2113741A45	10000 pF
C3215	2311049A02	0.15 uF
C3216	2113932K15	0.1 uF
C3217	2113930F45	56 pF
C3218	2113930F51	100 pF
C3219	2113930F31	15 pF
C3220	2109720D14	0.1 uF
C3221	2113931F17	470 pF
C3222	2311049A07	1 uF
C3223	2113932K15	0.1uF
C3229	2311049J23	10 uF
C3230	2113932K15	0.1 uF
C3232	2113931F29	.0015 uF
C3233	2113931F49	.01 uF
C3234	2113930F03	1 pF
C3235	NOTPLACED	
C3243	2113931F49	0.01 uF
C3245	2113932K15	0.1 uF
C3247	2113931F49	0.01 uF
C3249	2113931F49	0.01 uF
CR3201	4862824C01	DIODES: Varactor
E3201	2602660J01	SHIELDS: Harmonic Filter
E3202	2605261V01	Zero IF (Z1F)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L3204	2462587T15	INDUCTORS: 100nH
L3205	2462587Q44	560nH
L3206	2462587T30	1uH
Q3201	4882022N70	TRANSISTORS: NPN
Q3203	4882022N70	NPN
R3201	0662057A81	RESISTORS: 22K
R3202	0662057A89	47K
R3203	0662057A59	2.7K
R3204	0662057A59	2.7K
R3205	0662057A49	1K
R3206	0662057A01	10
R3207	0662057A25	100
R3211	0662057A53	1.5K
R3212	0662057A65	4.7K
R3213	0662057A49	1K
R3214	0662057A33	220
R3215	0662057B05	200K
R3216	0662057A42	510
R3218	0662057A49	1K
R3219	0662057A65	4.7K
R3222	0662057A49	1K
U3201	5186296A02	INTEGRATED CIRCUITS: Zero IF (ZIF)
	84D05111Y04, 84D05111Y05	PRINTED CIRCUIT BOARDS (For Reference Only): For Kits HUE4031B, HUE4032B

- NOTE:
1. All resistance values are in ohms unless indicated otherwise.
 2. Components shown in component location and schematic diagrams but not included in parts list are not placed.



PCBs 84D05111Y04,
84D05111Y05 (For
Reference Only)