MCS 2000 Mobile Radio
Service Instructions

Volume 2h

UHF Frequency Range 25W Specific

8000 West Sunrise Boulevard
Ft. Lauderdale, FL 33322

68P81080C49-O, Issued 11/98

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 2h

UHF 25W Range 1, Range 2 Specific

Motorola Publication Number 68P81080C49-O

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A and B	O	Back cover	O
i and ii	O		

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 lowerthan 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.

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Note**:** Reference drawings (component locations, schematic diagrams, and parts lists) are listed on page 25**.**

1 Introduction

This publication (Service Manual Volume 2h, Motorola Publication 68P81080C49) provides frequency-range-specific information for the 25-Watt MCS 2000 radios that operate in UHF range 1 (403 MHz to 470 MHz) and UHF range 2 (450 MHz to 520 MHz) frequency ranges. The coverage in this publication includes both non-data-capable and data-capable radios.

This publication is a companion volume to Service Manual Volume 1 for MCS 2000 Radios, Motorola Publication 68P81083C20, which provides non-frequency-range-specific information for all MCS 2000 Radios. Service personnel must have both Volume 1 and Volume 2h of this Service Manual in order to have all service information for the 25-Watt MCS 2000 Radios that operate in the UHF frequency range.

There are other Volume 2 service manuals (e.g., Volume 2a, 2b, 2c), which cover models of the MCS 2000 Radio for other frequency ranges and power levels. Refer to Volume 1 of this service manual for a list of the manuals related to operation and maintenance of all models of the MCS 2000 Radio, and the Motorola publication numbers for those manuals.

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
- Power Amplifier (PA)
- Synthesizer

This volume (Volume 2h) of the service manual covers the following four topics for the specific hardware portions of the UHF radios:

- Theory of operation
- Component locations
- Parts lists
- Schematic diagrams and associated interconnect information

The four 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.

All the radios covered in this service manual contain a single circuit card assembly (a printed circuit board with components mounted), which is called the transceiver board. The transceiver board in each version of the radio is identified by a unique Motorola kit number (e.g., HUE4012C1).

Theory of Operation

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This chapter provides theory of operation information for the Low Power UHF, 25W, Range 1 (Kit HUE4012C1) and Range 2 (Kit HUE4011B2) radios. This includes block diagram level functional descriptions and detailed circuit descriptions referenced to the schematic diagrams located in Chapter 3 of this manual.

Introduction

The radio consists of the following four major functional areas:

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

The receiver/transmitter (transceiver) and dc power control and regulation functions are contained on a single circuit card assembly located in the main body of the radio. The operator interface function consists of the control head, which plugs into 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 functional descriptions and theory for the three control heads are covered in Volume 1 of this service manual.

The radio transceiver board is separated into six functional sections as follows:

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

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

The component location diagrams, parts lists, and schematics diagrams for the controller section of the transceiver board and for the three types of control heads are located in Volume 1 of this service manual. The component location diagrams, parts lists, and schematic diagrams for the other five physical sections of the transceiver board are located in this volume.

Block Diagram Level Theory of Operation

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

The receiver function of the radio detects, demodulates, amplifies, and outputs via a loudspeaker, radio signals picked up by a vehicle or fixed-station antenna. The radio signal input reaches the receiver from the antenna via the antenna switch, which is located in the transmitter function of the radio. 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 radio receiver section consists of a receiver front end, receiver intermediate frequency (IF), receiver back end, and 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 receiver front end section converts the receiver input signal to a first IF of 73.35 MHz. The frequency the receiver operates at is determined by a first local oscillator signal generated by the synthesizer section. For the purpose of this discussion, the synthesizer section is considered to be part of the transmitter function of the radio.

The 73.35 MHz IF output signal from the receiver front end section passes through the receiver IF section where it is filtered and amplified. The output of the receiver IF section goes to the receiver back end section. In the receiver back end section, which contains the zero intermediate frequency (ZIF) integrated circuit (IC), the receiver IF signal is demodulated to produce receiver audio and squelch signals.

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

The receiver audio signal (filtered) 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 does not pass the receiver audio signal to the loudspeaker until it receives an audio PA enable signal from the controller section of the radio. The reason is that the receiver portion of the radio includes a squelch function, which prevents receiver noise from passing to the loudspeaker during periods of no signal reception.

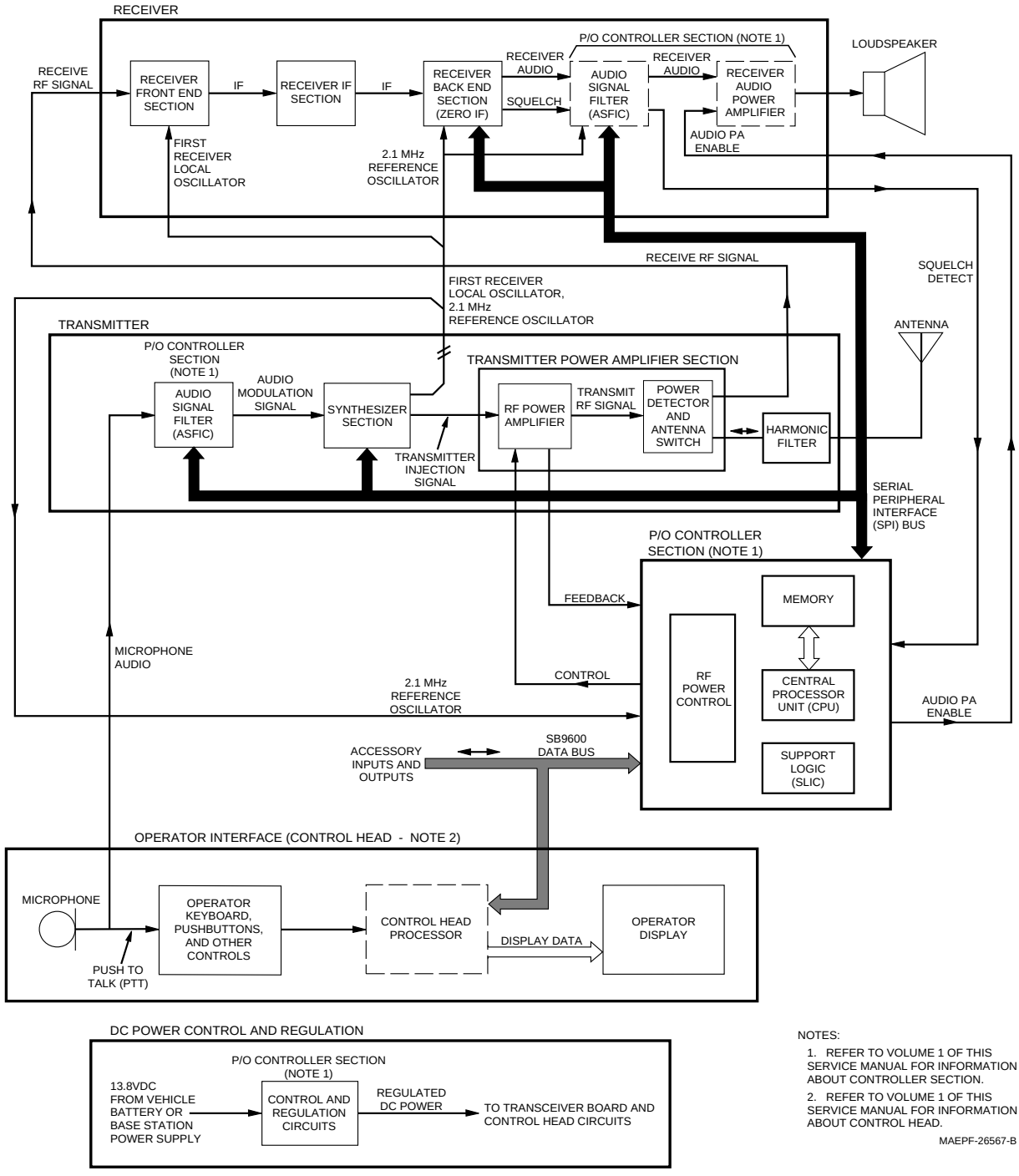


Figure 1. Overall Radio Functional Block Diagram

The controller generates the audio PA enable signal based on such variables as the level of the received signal, the frequency channel, 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 transmitter function of the radio produces a nominal 25-Watt radio frequency output signal. The radio frequency output signal is frequency modulated by an audio signal from the microphone or from another source such as a telephone keypad or handset.

The transmitter section of the radio consists of an Audio Signal Filter Integrated Circuit (ASFIC) in the controller section, synthesizer, and transmitter power amplifier (PA). 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 that the transmitter portion of the radio operates upon.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 is amplified to the required 25-Watt power level by the PA. The output of the PA passes through the antenna switch and is radiated by the vehicle antenna or fixed-station antenna.

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 telephone handset, telephone keypad if used, 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 control and regulation function regulates and distributes to the various sections of the radio, DC power from the vehicle battery or fixed station power supply.

Receiver Detailed Functional Description (Kit HUE4012C1)

The portion of the receiver that is not part of the controller section of the radio consists of the receiver front end, receiver intermediate frequency (IF), and receiver back end.

Receiver Front End

The following discussion is based on the schematic diagram for the receiver front end located on page 29.

Varactor Tuned Bandpass Filter

The received RF signal (RX_IN) from the antenna switch in the power amplifier section of the radio is routed to the first filter. This filter is varactor tuned via control line RX_CONTL_I, which is set by the controller section of the radio through a digital-to-analog (D/A) converter to suit the frequency of the current channel selection. The DC voltage for this function is measured at a common node located between R5250, C5251 and R5251. The tuning voltage is applied to varactor diodes CR5250 through CR5253.

After the varactor tuned filter, the signal is fed to a pair of hot carrier limiter diodes (CR5254) placed in front of the RF preamplifier. These diodes limit strong signals from overdriving and damaging the RF preamplifier. These diodes also help to prevent large signals from degrading intermodulation performance.

RF Preamplifier

The RF preamplifier (Q5251) is a bipolar junction transistor (BJT) device with emitter feedback resistors as well as collector to base feedback. Transistor Q5250 is an active bias circuit with associated resistors that sets both the collector voltage and emitter current for Q5251.

Fixed Tuned Band-pass Filter

The output of rf preamplifier Q5251 is routed to a four pole band-pass filter. The filter is fixed tuned to the UHF frequency range. Therefore, no tuning or voltage monitoring is required.

Mixer

The mixer (Q5252) is the double balanced active gallium arsenide type. The RF signal from the fixed tuned filter enters mixer Q5252 via transformer T5251. Local oscillator injection frequency (RX_INJ) enters the mixer via transformer T5250. The bias for the mixer is set by resistor R5265. The output of the mixer is 73.35 MHz below the RF signal and is routed to the receiver IF section via transformer T5252.

Receiver Intermediate Frequency (IF)

The following discussion is based on the schematic diagram for the receiver IF section located on page 31.

IF Amplifier

A resistive pi pad (R5376, R5377, R5378, R5392) matches the output impedance of the mixer in the receiver front end section to the impedance of first crystal filter Y5376 in the receiver IF section.

Further impedance matching takes place between the first crystal filter and IF amplifier Q5388. The IF amplifier has a similar configuration to RF preamplifier Q5251 in the receiver front end section, in that it is an actively biased BJT amplifier using emitter and collector base feedback to help improve intermodulation performance. Bias is provided for IF amplifier Q5382 and associated circuits, which set the Q5388 collector voltage and the emitter current.

The signal from the IF amplifier is routed through an additional impedance matching circuit to the second 73.35 MHz crystal filter (Y5377), then output to the receiver back end section as IF_OUT.

Receiver Back End

The following discussion is based on the schematic diagram for the receiver back end section located on page 35.

Zero IF (ZIF) Isolation Amplifier

After further matching, the IF input signal (IF_OUT) is routed to a second IF amplifier (Q3203). At the base of this amplifier is a pair of hot carrier limiter diodes (CR3202). These are placed in the circuit to protect the zero IF (ZIF) IC (U3201) from strong signal overload conditions. The output of IF amplifier Q3203 is fed to attenuating PIN diode CR3203. The PIN diode attenuation is a function of the level detected by the internal automatic gain control (AGC) circuit in the ZIF IC. As this AGC circuit detects more RF level, CR3203 begins to turn on and conduct IF power to ground, helping to attenuate the power to the ZIF IC.

The ZIF IC mixes the IF down to baseband where it is limited and FM demodulated. The mixing to baseband uses the second local oscillator (LO) circuit consisting of Q3201, which is a BJT oscillator and part of the ZIF phase lock loop (PLL).

A second LO synthesizer, internal to the ZIF, controls the frequency of external oscillator Q3201. The control voltage from pin 18 of the ZIF (U3201-18) is dropped across varactor CR3201 to control the frequency of the oscillator.

The demodulated audio (DISC) from the ZIF (U3201-28) is then fed to the audio signal filtering IC (ASFIC), which is located in the controller section of the radio.

Transmitter Detailed Functional Description (Kit HUE4012C1)

The transmitter function of the radio is distributed between the controller, synthesizer, and power amplifier (PA) sections of the radio.

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 Detailed Functional Description*, which follows these paragraphs.

The remaining part of the transmitter function of the radio is located in the power amplifier section, which is described after the synthesizer section.

Synthesizer

The synthesizer section of the transmitter receives the amplified and processed audio signal from the controller section of the radio and produces a frequency-modulated radio frequency carrier signal (transmitter injection signal), which is input to the transmitter power amplifier (PA) section.

The synthesizer section of the radio also generates the first conversion local oscillator signal (329.65 to 396.65 MHz) and the second

conversion reference oscillator signal (2.1 MHz) for the receiver and controller sections of the radio.

The following discussion is based on the schematic diagrams for the synthesizer section located on pages 39 and 40.

The synthesizer consists of a Pendulum reference oscillator (U5800), Fractional-N synthesizer IC (U5801), dual-band voltage controlled oscillator (U5803), buffer (Q5781), and feedback amplifier (Q5774).

The Pendulum reference oscillator (U5800) contains a temperature compensated crystal that has an oscillation frequency of 16.8 MHz. The output of the oscillator (U5800-10) is applied to U5801-14 (XTAL_1) of the Fractional-N synthesizer via C5754 and R5750.

The VCO module (U5803) is a varactor tuned voltage controlled oscillator controlled by the voltage applied to U5803-7 (TX_V_CONTROL) and U5803-10 (RX_V_CONTROL) of the VCO. The control voltage ranges from 2 to 11 VDC. A small control voltage produces a lower frequency and a large control voltage produces a higher frequency.

Through use of a dual-band oscillator, the VCO covers the 329.65 to 396.65 MHz and 403 to 470 MHz frequency bands. The low band VCO (329.65 to 396.65 MHz) provides the first receiver LO injection frequency, which is 73.35 MHz below the carrier frequency. The low band VCO is selected when U5803-16 (RX_BIAS) goes high and U5803-21 (TX_BIAS) goes low. The high band VCO (403 to 470 MHz) provides the transmit injection frequency, which is selected by pulling U5803-21 high and U5803-16 low.

Buffer stage Q5781 and feedback amplifier Q5774 provide the necessary gain and isolation for the synthesizer loop.

The Franctional-N synthesizer integrated circuit (U5801) contains the following circuits:

- Prescaler
- Programmable loop divider
- Control divider logic
- Phase detector
- Charge pump
- A/D converter for low frequency modulation
- Modulation low frequency/high frequency balance attenuator
- Serial interface for control
- Super filter

Q5770 is used as a current amplifier for the super filter. The super filter drops 9.3 VDC (emitter of Q5770) to about 8.6 VDC (collector of Q5770). The 8.6 VDC supplies the oscillator circuit, modulation circuit, VCO switching circuits, and the synthesizer charge pump resistor network.

Feedback amplifier Q5774 provides the necessary amplitude and isolation to drive the prescaler input (pin 21) of U5801. A three-terminal regulator U5802 drops 9.3 VDC from the controller section of the radio to 5 VDC as required by the Fractional-N synthesizer IC.

To generate a high voltage to supply the phase detector (charge pump) output stage at pin VCP (U5801-36), a voltage of 13 VDC is generated by a positive voltage multiplier circuitry (CR5750, C5759, C5760) CR5750-1. This positive voltage multiplier is basically a diode capacitor network driven by two 1.05 MHz, 180 degrees out of phase signals (U5801-8 and U5801-9).

The serial interface (SRL) is connected to the microprocessor in the controller section of the radio via data line U5801-2, clock line U5801-3, and chip enable line U5801-4. Proper enabling of these lines allows the microprocessor to load the Fractional-N synthesizer IC.

The output of the VCO (U5803-20) is fed to the input of buffer Q5781 through attenuator network R5781 through R5783. The output of the buffer, Q5781, is applied to the input of feedback amplifier Q5774 through resistor R5771. To close the synthesizer loop, the output of Q5774 is connected to the PREIN port of the Fractional-N synthesizer at U5801-21. The buffer output (Q5781) also provides signals for the receiver LO injection and transmit injection string circuits.

The charge pump outputs a current at U5801-31. The loop filter, which consists of R5760 through R5762 and C5775 through C5778, transforms this current into a voltage, which is applied to U5803-7 and U5803-10 to alter the VCO output frequency.

The prescaler in the synthesizer (Fractional-N IC U5801) is basically a dual modulus prescaler with selectable divider ratios. The divider ratio of the prescaler is controlled by a loop divider, which in turn receives its inputs via the SRL. The output of the prescaler is applied to the loop divider.

The output of the loop divider is connected to the phase detector, which compares the loop divider output signal with a reference signal. The reference signal is generated by dividing down the signal of the reference oscillator (Pendulum U5800).

The output signal of the phase detector is a pulsed DC signal, which is routed to the charge pump. The current can be set to a value fixed in the Fractional-N or to a value determined by the currents flowing into CPBIAS 1 (U5801-29) or CPBIAS 2 (U5801-28). The currents are set by the values of R5752 and R5753 or R5756 and R5757, respectively. Selection of one of the three different bias sources is done by software programming.

To reduce synthesizer lock time, when new frequency data has been loaded into the synthesizer, the magnitude of the loop current is increased by enabling the I ADAPT line (U5801-34) for a certain software programmable time (Adapt Mode). Additionally the loop current is increased by bypassing R5752 and R5753 with Q5750 and R5756 and R5757 with Q5751. Bypassing starts when the Fractional-N CE line transitions from high to low and ends a certain delay time after the subsequent low to high transition.

The adapt mode timer and the bypassing delay are both started by a low to high transition of the Fractional-N CE line. The adapt time is programmed to be somewhat shorter than the bypassing delay time, which is hardware dependent. This causes two different current levels during frequency acquisition of the PLL. When the synthesizer is within the lock range, the current is determined only by the resistors connected to CPBIAS 1, CPBIAS 2, or by the internal current source.

To modulate the PLL, the audio signal is applied to both the A/D converter, low frequency path, as well as the balance attenuator high frequency path via U5801-5. The A/D converter converts the low frequency analog modulating signal into a digital code, which is applied to the loop divider thereby causing the carrier to deviate. The balance attenuator adjusts the VCO deviation sensitivity to high frequency modulating signals. The output of the balance attenuator is present at the MODOUT port (U5801-30). The audio signal from the MODOUT port (U5801-30) is connected to the external VCO modulation port (U5803-22).

Transmit Injection Amplifier

The transmit injection string consists of two amplifier stages (Q5782 and Q5784) whose main purpose is to maintain a constant output to drive the PA and provide isolation. The TX Injection String is only on during the transmit mode with TX 9.1 V present.

Power Amplifier (PA)

The power amplifier (PA) is a radio frequency (RF) power amplifier, which amplifies the output from the injection string (TX_INJ) to an RF output power level of 25 Watts.

The following discussion is based on the schematic diagrams for the power amplifier section located on pages 42 and 43.

Overall PA

The PA is a four stage amplifier used to amplify the output from the injection string to the radio transmit level. The first two stages (Q5500 and Q5510) are bipolar, followed by two MOSFET devices (Q5530 and Q5540).

The last three stages, Q5510, Q5530, and Q5540 all operate off the A+ supply voltage. Transistor Q5510 is controlled from Q5500 via the PA control line. If the control line is raised, the base voltage of Q5502 is also rises causing more current to flow to the collector of Q5502 turning on Q5501 harder and increasing current flow through Q5500.

The power output from Q5500 is proportional to the collector current causing the rising control voltage on the PA control line to raise the collector current of Q5500 thus causing more power out of the stage. Conversely, decreasing the control line decreases the power delivered into the next stage. By controlling the drive power to Q5510 and the stages that follow in the power amplifier lineup, the automatic level control (ALC) loop is able to regulate the output power of the transmitter. Diode CR5500 in series with the base of Q5500 decreases the amount of power coming out of the radio under the following conditions:

- When the keyed 9.1 (K9.1) line is high, but V_CNTL line has not begun to rise.
- In a transient condition, when power is being turned on.

The base of Q5510 is biased to the resistor divider network consisting of R5510 and R5511. Under normal conditions, with no drive applied, the base voltage should rise to about 0.25 volts. The MOSFET devices, Q5530 and Q5540, are enhancement mode N-Channel MOSFETS.

These devices require a positive gate bias and a quiescent current flow with no drive for proper operation. To achieve this result, the gates are biased through the network consisting of R5530 and R5533 for Q5530

and similarly R5540 and R5543 for Q5540. The actual value of the voltage at this gate is device dependent and determined by trim in the factory when the radio is built.

The output of Q5540 goes through a matching network consisting of four transmission lines and capacitors C5544, C5545, C5546 and C5549 to the antenna switch. The antenna switch is switched synchronously with the keyed 9.1 (K9.1) voltage. In the transmit mode, K9.1 voltage is high and current flow is through R5581 and R5580 through L5580 to turn on diodes CR5580 and CR5581. When these diodes are on, they form a load impedance to the RF transmit path to allow the signal to pass through them. Diode CR5581 forms a low impedance that is reflected up through L5582 in front of the harmonic filter. In this way, no power is delivered into the receiver.

Diode CR5582 is also turned on in the transmit mode further isolating the receiver port from transmitter energy. In the receive mode, both of these diodes are off. Power coming in the receive mode is channelled through L5582 and out to the RX port.

Harmonics of the transmitter are attenuated by the harmonic filter formed by components L5590 through L5592, and capacitors C5590 through C5593. This network is a low-pass filter used to attenuate harmonic energy out of the transmitter to specifications level.

Following the harmonic filter, is a forward power detector, which is a microstrip printed circuit that couples a small amount of the forward energy off and sends it to diode CR5600 where it is rectified. This signal combined with a slight DC bias applied through R5604 and R5600 forms the V detect voltage, which the power control circuit holds constant. Holding this voltage constant, which is proportional to the rectified RF energy appearing across the diode, ensures the forward power out of the radio is held to a constant value.

PA Power Control

The PA power control, located in the controller section of the radio, regulates power with an automatic level control (ALC) loop and provides protection against overcurrent, excessive control voltage, and high operating temperature. Power and current limit are adjusted under microprocessor control using a digital to analog (D/A) converter (U0551).

The control voltage limit is set by resistor ratio on the transmitter, or D/A output for those radios that must minimize adjacent channel splatter. The D/A adjustable control voltage limit increases transmitter rise time and reduces adjacent channel splatter as it is adjusted closer to the actual operating control voltage.

The microprocessor controls K9.1 signal to bias the PA and antenna switch, PA disable (PA DIS) to disable the PA control voltage, and power range (PWR RANGE) to adjust the number of D/A steps per watt.

Through an A/D input the microprocessor reads the PA control voltage for adjusting the D/A control voltage limit during the tuning process.

The ALC loop regulates power by adjusting the PA control line PA CNTL to keep the forward power voltage VFORWARD at a constant level. VFORWARD is amplified with a gain of 3 and added to the PWR SET D/A output U0551-2 through resistors R0577, R0553 and R0554. The result is connected to operational amplifier inverting input U0550-9, which is compared with a 4.6 volt reference present at

noninverting input U0550-10. The 4.6 volt reference is set by a divider circuit connected to ground and 9.3 volts by 47k 1% resistors R0587 and R0588.

The power range line PWR RANGE controls the gain of the VFORWARD amplifier. For operation at 6 watts and above PWR RANGE is set to zero volts for a gain near 3. For low power operation under 6 watts, PWR RANGE may be set high to increase gain to 5.4, increasing the number of D/A steps for a given change in power.

The PA disable line PA DIS prevents transmitter operation by keeping the PA control voltage PA CNTL near zero volts. This effectively makes the control voltage limit equal to zero and pulls the 4.6 volt reference at noninverting input U0550-10 to ground through transistor Q0551. The ALC operational amplifier output at U0550-8 is prevented from rising above zero since the noninverting input is grounded.

During normal transmitter operation the voltages at the operational amplifier inputs U0550-9 and U0550-10 is approximately 4.6 volts and the PA control voltage output at U0550-8 is between 4 and 7 volts. If power falls below the desired setting, VFORWARD decreases, causing the inverting input at UO550-9 to decrease, increasing the output at U0550-8 and increasing the PA control voltage PA CNTL until VFORWARD increases to the desired level.

The power set D/A output voltage PA PWR SET at U0551-2 adjusts power in 1 Watt steps by adjusting the required value of VFORWARD. As PA PWR SET decreases, transmitter power increases to make VFORWARD larger and keep the inverting input U0550-9 at 4.6 volts.

Loop frequency response is controlled by operational amplifier feedback components R0570 and C0568 and the output lowpass filter R0571 and C0569.

Rise and fall time is controlled by the D/A adjustable control voltage limit circuit attached to the reference voltage at U0550-10 via transistor Q0555. The reference voltage at U0550-10 is pulled low by Q0555 when the PA control voltage approaches the limit set by the D/A output PA CNTL LIM, U0551-13.

The PA control voltage at U0550-8 connects to operational amplifier noninverting input U0202-3 through the voltage divider formed by R0592 and R0591 and lowpass capacitor C0572. Control voltage limit is set by the D/A output PA CNTL LIM at U0551-13, which connects to inverting input U0202-2 through R0584, Q0556 and R0590. Transistor Q0556 is connected to the PA disable line, PA DIS, which effectively pulls the control voltage limit to zero volts, and activates Q0555 to pull the reference voltage to zero when control voltage is greater than zero.

Protection features are provided to limit PA control voltage, limit final PA device temperature, and limit PA final device current. These features operate by adding current to the ALC loop inverting input at U0550-9 through diodes CR0550 and CR0551 and decreasing the PA control voltage.

When the voltage exceeds 5 volts at the cathode of diode CR0550 and CR0551, current begins to flow into the ALC loop increasing the voltage at the inverting input U0550-9. As a result the PA control voltage at U0550-8 decreases in response to excessive PA control voltage, final device temperature, and final device current.

Thermal shutback limits the PA temperature by reducing the PA control voltage as temperature increases during extended periods of transmitter operation or high ambient temperatures.

PA temperature is sensed by negative temperature coefficient thermistor RT5610, located on the ground plane near the PA final device Q5540.

At 25°C the thermistor's high resistance is near 100K ohms. At 85°C the resistance is near 9.7 K ohms. The thermistor attaches to ground in the PA section and the PA TEMP line, which goes to the controller section. In the controller section PA TEMP connects to the 9.3 volt supply through resistors R0587 and R0588. As a result the voltage on PA TEMP drops as temperature increases.

PA TEMP connects to an inverting amplifier through resistor R0550 to inverting input U0550-2. The noninverting input U0550-3 is connected to a 4.6 volt reference formed by voltage divider resistors R0576 and R0582, which connect to ground and the 9.3 volt supply. The output of the inverting amplifier at U0550-1 is the product of the amplifier gain as determined by the ratio of R0551 divided by R0550 and the difference between amplifier inputs U0550-2 and U0550-3. When the PA TEMP input is greater than 4.6 volts the amplifier output is zero.

As the temperature rises, the voltage on the PA TEMP line falls, inverting amplifier output at U0550-1 rises, current begins to flow through R0552 and CR0550 into the ALC loop at the inverting input of U0550-9. This decreases the PA control voltage (PA CNTL) and results in reduced transmitter output.

Current limit is provided to protect the PA final device Q5540 from overcurrent caused by low line voltage and/or mismatched antennas.

Current is measured by sensing the voltage drop across PA shunt resistor R5612, which is in series with the supply lead to the final device. As the current through the final device increases, so does the difference in voltage across R5612. The differential current sense amplifier amplifies the voltage difference and produce an output over 5 volts at maximum current to reduce the PA control voltage and protect the final device. The maximum current is adjusted by the D/A line CUR LIM SET.

The current sense lines CURRENT SENSE+ and CURRENT SENSE- are connected in shunt across R5612 to the supply and load sides, respectively. Voltage dividers on current sense lines formed by resistors R0557, R0558, R0559, and R0560 protect the inputs of U0550-5 and U0550-6 from excessive voltages. CURRENT SENSE+ connects to the noninverting input UO550-5 through resistors R0557 and R0558. CURRENT SENSE- connects to the inverting input U0550-6 through resistors R0559 and R0560.

As current through the final device increases, voltage drop through R5612 increases and CURRENT SENSE- decreases with respect to CURRENT SENSE+, increasing the difference between inverting and noninverting inputs, causing the amplifier output at U0550-7 to increase to over 5 volts. As the amplifier output increases to over 5 volts, the current through resistor R0556 and diode CR0550 becomes sufficient to reduce the PA control voltage reducing the PA device current.

The D/A line CUR LIM SET at U055-4 adjusts the maximum allowed current by creating an offset voltage at the non-inverting input U0550-5 that is approximately equal to the voltage present at the inverting input during the maximum current voltage drop through R5612.

Controller Detailed Functional Description

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

DC Power Control and Regulation Detailed Functional Description

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

Receiver Detailed Functional Description (Kit HUE4011B2)

The portion of the receiver that is not part of the controller section of the radio consists of the receiver front end, receiver intermediate frequency (IF), and receiver back end.

Receiver Front End

The following discussion is based on the schematic diagram for the receiver front end located on page 29.

This version of the radio (HUE4011B2), includes an alternative attenuator located in front of the crystal filters.

Varactor Tuned Bandpass Filter

The received RF signal (RX_IN) from the antenna switch in the power amplifier section of the radio is routed to the first filter. This filter is varactor tuned via control line RX_CONTL_I, which is set by the controller section of the radio through a digital-to-analog (D/A) converter to suit the frequency of the current channel selection. The DC voltage for this function is measured at a common node located between R5250, C5251 and R5251. The tuning voltage is applied to varactor diodes CR5250 through CR5253.

After the varactor tuned filter, the signal is fed to a pair of hot carrier limiter diodes (CR5254) placed in front of the RF preamplifier. These diodes limit strong signals from overdriving and damaging the RF preamplifier. These diodes also help to prevent large signals from degrading intermodulation performance.

RF Preamplifier

The RF preamplifier (Q5251) is a bipolar junction transistor (BJT) device with emitter feedback resistors as well as collector to base feedback. Transistor Q5250 is an active bias circuit with associated resistors that sets both the collector voltage and emitter current for Q5251.

Fixed Tuned Band-pass Filter

The output of rf preamplifier Q5251 is routed to a four pole band-pass filter. The filter is fixed tuned to the UHF frequency range. Therefore, no tuning or voltage monitoring is required.

Mixer

The mixer (Q5252) is the double balanced active gallium arsenide type. The RF signal from the fixed tuned filter enters mixer Q5252 via transformer T5251. Local oscillator injection frequency (RX_INJ) enters the mixer via transformer T5250. The bias for the mixer is set by resistor R5265. The output of the mixer is 73.35 MHz below the RF signal and is routed to the receiver IF section via transformer T5252.

Receiver Intermediate Frequency (IF)

The following discussion is based on the schematic diagram for the receiver IF section located on page 33.

IF Amplifier

A resistive pi pad (R5376, R5377, R5378, R5392) matches the output impedance of the mixer in the receiver front end section to the impedance of first crystal filter Y5376 in the receiver IF section.

Further impedance matching takes place between the first crystal filter and IF amplifier Q5388. The IF amplifier has a similar configuration to RF preamplifier Q5251 in the receiver front end section, in that it is an actively biased BJT amplifier using emitter and collector base feedback to help improve intermodulation performance. Bias is provided for IF amplifier Q5382 and associated circuits, which set the Q5388 collector voltage and the emitter current.

The signal from the IF amplifier is routed through an additional impedance matching circuit to the second 73.35 MHz crystal filter (Y5377), then output to the receiver back end section as IF_OUT.

Receiver Back End

The following discussion is based on the schematic diagram for the receiver back end section located on page 37.

Zero IF (ZIF) Isolation Amplifier

After further matching, the IF input signal (IF_OUT) is routed to a second IF amplifier (Q3203). At the base of this amplifier is a pair of hot carrier limiter diodes (CR3202). These are placed in the circuit to protect the zero IF (ZIF) IC (U3201) from strong signal overload conditions. The output of IF amplifier Q3203 is fed to attenuating PIN diode CR3203. The PIN diode attenuation is a function of the level detected by the internal automatic gain control (AGC) circuit in the ZIF IC. As this AGC circuit detects more RF level, CR3203 begins to turn on and conduct IF power to ground, helping to attenuate the power to the ZIF IC.

The ZIF IC mixes the IF down to baseband where it is limited and FM demodulated. The mixing to baseband uses the second local oscillator (LO) circuit consisting of Q3201, which is a BJT oscillator and part of the ZIF phase lock loop (PLL).

A second LO synthesizer, internal to the ZIF, controls the frequency of external oscillator Q3201. The control voltage from pin 18 of the ZIF (U3201-18) is dropped across varactor CR3201 to control the frequency of the oscillator.

The demodulated audio (DISC) from the ZIF (U3201-28) is then fed to the audio signal filtering IC (ASFIC), which is located in the controller section of the radio.

Transmitter Detailed Functional Description (Kit HUE4012C1)

The transmitter function of the radio is distributed between the controller, synthesizer, and power amplifier (PA) sections of the radio.

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 Detailed Functional Description*, which follows these paragraphs.

The remaining part of the transmitter function of the radio is located in the power amplifier section, which is described after the synthesizer section.

Synthesizer

The synthesizer section of the transmitter receives the amplified and processed audio signal from the controller section of the radio and produces a frequency-modulated radio frequency carrier signal (transmitter injection signal), which is input to the transmitter power amplifier (PA) section.

The synthesizer section of the radio also generates the first conversion local oscillator signal (329.65 to 396.65 MHz) and the second conversion reference oscillator signal (2.1 MHz) for the receiver and controller sections of the radio.

The following discussion is based on the schematic diagrams for the synthesizer section located on pages 39 and 40.

The synthesizer consists of a Pendulum reference oscillator (U5800), Fractional-N synthesizer IC (U5801), dual-band voltage controlled oscillator (U5803), buffer (Q5781), and feedback amplifier (Q5774).

The Pendulum reference oscillator (U5800) contains a temperature compensated crystal that has an oscillation frequency of 16.8 MHz. The output of the oscillator (U5800-10) is applied to U5801-14 (XTAL_1) of the Fractional-N synthesizer via C5754 and R5750.

The VCO module (U5803) is a varactor tuned voltage controlled oscillator controlled by the voltage applied to U5803-7 (TX_V_CONTROL) and U5803-10 (RX_V_CONTROL) of the VCO. The control voltage ranges from 2 to 11 VDC. A small control voltage produces a lower frequency and a large control voltage produces a higher frequency.

Through use of a dual-band oscillator, the VCO covers the 329.65 to 396.65 MHz and 403 to 470 MHz frequency bands. The low band VCO (329.65 to 396.65 MHz) provides the first receiver LO injection frequency, which is 73.35 MHz below the carrier frequency. The low band VCO is selected when U5803-16 (RX_BIAS) goes high and U5803-21 (TX_BIAS) goes low. The high band VCO (403 to 470 MHz) provides the transmit injection frequency, which is selected by pulling U5803-21 high and U5803-16 low.

Buffer stage Q5781 and feedback amplifier Q5774 provide the necessary gain and isolation for the synthesizer loop.

The Franctional-N synthesizer integrated circuit (U5801) contains the following circuits:

- Prescaler
- Programmable loop divider
- Control divider logic
- Phase detector
- Charge pump
- A/D converter for low frequency modulation
- Modulation low frequency/high frequency balance attenuator
- Serial interface for control
- Super filter

Q5770 is used as a current amplifier for the super filter. The super filter drops 9.3 VDC (emitter of Q5770) to about 8.6 VDC (collector of Q5770). The 8.6 VDC supplies the oscillator circuit, modulation circuit, VCO switching circuits, and the synthesizer charge pump resistor network.

Feedback amplifier Q5774 provides the necessary amplitude and isolation to drive the prescaler input (pin 21) of U5801. A three-terminal regulator U5802 drops 9.3 VDC from the controller section of the radio to 5 VDC as required by the Fractional-N synthesizer IC.

To generate a high voltage to supply the phase detector (charge pump) output stage at pin VCP (U5801-36), a voltage of 13 VDC is generated by a positive voltage multiplier circuitry (CR5750, C5759, C5760) CR5750-1. This positive voltage multiplier is basically a diode capacitor network driven by two 1.05 MHz, 180 degrees out of phase signals (U5801-8 and U5801-9).

The serial interface (SRL) is connected to the microprocessor in the controller section of the radio via data line U5801-2, clock line U5801-3, and chip enable line U5801-4. Proper enabling of these lines allows the microprocessor to load the Fractional-N synthesizer IC.

The output of the VCO (U5803-20) is fed to the input of buffer Q5781 through attenuator network R5781 through R5783. The output of the buffer, Q5781, is applied to the input of feedback amplifier Q5774 through resistor R5771. To close the synthesizer loop, the output of Q5774 is connected to the PREIN port of the Fractional-N synthesizer at U5801-21. The buffer output (Q5781) also provides signals for the receiver LO injection and transmit injection string circuits.

The charge pump outputs a current at U5801-31. The loop filter, which consists of R5760 through R5762 and C5775 through C5778, transforms this current into a voltage, which is applied to U5803-7 and U5803-10 to alter the VCO output frequency.

The prescaler in the synthesizer (Fractional-N IC U5801) is basically a dual modulus prescaler with selectable divider ratios. The divider ratio of the prescaler is controlled by a loop divider, which in turn receives its inputs via the SRL. The output of the prescaler is applied to the loop divider.

The output of the loop divider is connected to the phase detector, which compares the loop divider output signal with a reference signal.

The reference signal is generated by dividing down the signal of the reference oscillator (Pendulum U5800).

The output signal of the phase detector is a pulsed DC signal, which is routed to the charge pump. The current can be set to a value fixed in the Fractional-N IC or to a value determined by the currents flowing into CPBIAS 1 (U5801-29) or CPBIAS 2 (U5801-28). The currents are set by the values of R5752 and R5753 or R5756 and R5757, respectively. Selection of one of the three different bias sources is done by software programming.

To reduce synthesizer lock time, when new frequency data has been loaded into the synthesizer, the magnitude of the loop current is increased by enabling the I ADAPT line (U5801-34) for a certain software programmable time (Adapt Mode). Additionally the loop current is increased by bypassing R5752 and R5753 with Q5750 and R5756 and R5757 with Q5751. Bypassing starts when the Fractional-N CE line transitions from high to low and ends a certain delay time after the subsequent low to high transition.

The adapt mode timer and the bypassing delay are both started by a low to high transition of the Fractional-N CE line. The adapt time is programmed to be somewhat shorter than the bypassing delay time, which is hardware dependent. This causes two different current levels during frequency acquisition of the PLL. When the synthesizer is within the lock range, the current is determined only by the resistors connected to CPBIAS 1, CPBIAS 2, or by the internal current source.

To modulate the PLL, the audio signal is applied to both the A/D converter, low frequency path, as well as the balance attenuator high frequency path via U5801-5. The A/D converter converts the low frequency analog modulating signal into a digital code, which is applied to the loop divider thereby causing the carrier to deviate. The balance attenuator adjusts the VCO deviation sensitivity to high frequency modulating signals. The output of the balance attenuator is present at the MODOUT port (U5801-30). The audio signal from the MODOUT port (U5801-30) is connected to the external VCO modulation port (U5803-22).

Transmit Injection Amplifier

The transmit injection string consists of two amplifier stages (Q5782 and Q5784) whose main purpose is to maintain a constant output to drive the PA and provide isolation. The TX Injection String is only on during the transmit mode with TX 9.1 V present.

Power Amplifier (PA)

The power amplifier (PA) is a radio frequency (RF) power amplifier, which amplifies the output from the injection string (TX_INJ) to an RF output power level of 25 Watts.

The following discussion is based on the schematic diagrams for the power amplifier section located on pages 42 and 43.

Overall PA

The PA is a four stage amplifier used to amplify the output from the injection string to the radio transmit level. The first two stages (Q5500 and Q5510) are bipolar, followed by two MOSFET devices (Q5530 and Q5540).

The last three stages, Q5510, Q5530, and Q5540 all operate off the A+ supply voltage. Transistor Q5510 is controlled from Q5500 via the PA control line. If the control line is raised, the base voltage of Q5502 is

also rises causing more current to flow to the collector of Q5502 turning on Q5501 harder and increasing current flow through Q5500.

The power output from Q5500 is proportional to the collector current causing the rising control voltage on the PA control line to raise the collector current of Q5500 thus causing more power out of the stage. Conversely, decreasing the control line decreases the power delivered into the next stage. By controlling the drive power to Q5510 and the stages that follow in the power amplifier lineup, the automatic level control (ALC) loop is able to regulate the output power of the transmitter. Diode CR5500 in series with the base of Q5500 decreases the amount of power coming out of the radio under the following conditions:

- When the keyed 9.1 (K9.1) line is high, but V_CNTL line has not begun to rise.
- In a transient condition, when power is being turned on.

The base of Q5510 is biased to the resistor divider network consisting of R5510 and R5511. Under normal conditions, with no drive applied, the base voltage should rise to about 0.25 volts. The MOSFET devices, Q5530 and Q5540, are enhancement mode N-Channel MOSFETS.

These devices require a positive gate bias and a quiescent current flow with no drive for proper operation. To achieve this result, the gates are biased through the network consisting of R5530 and R5533 for Q5530 and similarly R5540 and R5543 for Q5540. The actual value of the voltage at this gate is device dependent and determined by trim in the factory when the radio is built.

The output of Q5540 goes through a matching network consisting of four transmission lines and capacitors C5544, C5545, C5546 and C5549 to the antenna switch. The antenna switch is switched synchronously with the keyed 9.1 (K9.1) voltage. In the transmit mode, K9.1 voltage is high and current flow is through R5581 and R5580 through L5580 to turn on diodes CR5580 and CR5581. When these diodes are on, they form a load impedance to the RF transmit path to allow the signal to pass through them. Diode CR5581 forms a low impedance that is reflected up through L5582 in front of the harmonic filter. In this way, no power is delivered into the receiver.

Diode CR5582 is also turned on in the transmit mode further isolating the receiver port from transmitter energy. In the receive mode, both of these diodes are off. Power coming in the receive mode is channelled through L5582 and out to the RX port.

Harmonics of the transmitter are attenuated by the harmonic filter formed by components L5590 through L5592, and capacitors C5590 through C5593. This network is a low-pass filter used to attenuate harmonic energy out of the transmitter to specifications level.

Following the harmonic filter, is a forward power detector, which is a microstrip printed circuit that couples a small amount of the forward energy off and sends it to diode CR5600 where it is rectified. This signal combined with a slight DC bias applied through R5604 and R5600 forms the V detect voltage, which the power control circuit holds constant. Holding this voltage constant, which is proportional to the rectified RF energy appearing across the diode, ensures the forward power out of the radio is held to a constant value.

PA Power Control

The PA power control, located in the controller section of the radio, regulates power with an automatic level control (ALC) loop and provides protection against overcurrent, excessive control voltage, and high operating temperature. Power and current limit are adjusted under microprocessor control using a digital to analog (D/A) converter (U0551).

The control voltage limit is set by resistor ratio on the transmitter, or D/A output for those radios that must minimize adjacent channel splatter. The D/A adjustable control voltage limit increases transmitter rise time and reduces adjacent channel splatter as it is adjusted closer to the actual operating control voltage.

The microprocessor controls K9.1 signal to bias the PA and antenna switch, PA disable (PA DIS) to disable the PA control voltage, and power range (PWR RANGE) to adjust the number of D/A steps per watt.

Through an A/D input the microprocessor reads the PA control voltage for adjusting the D/A control voltage limit during the tuning process.

The ALC loop regulates power by adjusting the PA control line PA CNTL to keep the forward power voltage VFORWARD at a constant level. VFORWARD is amplified with a gain of 3 and added to the PWR SET D/A output U0551-2 through resistors R0577, R0553 and R0554. The result is connected to operational amplifier inverting input U0550-9, which is compared with a 4.6 volt reference present at noninverting input U0550-10. The 4.6 volt reference is set by a divider circuit connected to ground and 9.3 volts by 47k 1% resistors R0587 and R0588.

The power range line PWR RANGE controls the gain of the VFORWARD amplifier. For operation at 6 watts and above PWR RANGE is set to zero volts for a gain near 3. For low power operation under 6 watts, PWR RANGE may be set high to increase gain to 5.4, increasing the number of D/A steps for a given change in power.

The PA disable line PA DIS prevents transmitter operation by keeping the PA control voltage PA CNTL near zero volts. This effectively makes the control voltage limit equal to zero and pulls the 4.6 volt reference at noninverting input U0550-10 to ground through transistor Q0551. The ALC operational amplifier output at U0550-8 is prevented from rising above zero since the noninverting input is grounded.

During normal transmitter operation the voltages at the operational amplifier inputs U0550-9 and U0550-10 is approximately 4.6 volts and the PA control voltage output at U0550-8 is between 4 and 7 volts. If power falls below the desired setting, VFORWARD decreases, causing the inverting input at UO550-9 to decrease, increasing the output at U0550-8 and increasing the PA control voltage PA CNTL until VFORWARD increases to the desired level.

The power set D/A output voltage PA PWR SET at U0551-2 adjusts power in 1 Watt steps by adjusting the required value of VFORWARD. As PA PWR SET decreases, transmitter power increases to make VFORWARD larger and keep the inverting input U0550-9 at 4.6 volts.

Loop frequency response is controlled by operational amplifier feedback components R0570 and C0568 and the output lowpass filter R0571 and C0569.

Rise and fall time is controlled by the D/A adjustable control voltage limit circuit attached to the reference voltage at U0550-10 via

transistor Q0555. The reference voltage at U0550-10 is pulled low by Q0555 when the PA control voltage approaches the limit set by the D/A output PA CNTL LIM, U0551-13.

The PA control voltage at U0550-8 connects to operational amplifier noninverting input U0202-3 through the voltage divider formed by R0592 and R0591 and lowpass capacitor C0572. Control voltage limit is set by the D/A output PA CNTL LIM at U0551-13, which connects to inverting input U0202-2 through R0584, Q0556 and R0590. Transistor Q0556 is connected to the PA disable line, PA DIS, which effectively pulls the control voltage limit to zero volts, and activates Q0555 to pull the reference voltage to zero when control voltage is greater than zero.

Protection features are provided to limit PA control voltage, limit final PA device temperature, and limit PA final device current. These features operate by adding current to the ALC loop inverting input at U0550-9 through diodes CR0550 and CR0551 and decreasing the PA control voltage.

When the voltage exceeds 5 volts at the cathode of diode CR0550 and CR0551, current begins to flow into the ALC loop increasing the voltage at the inverting input U0550-9. As a result the PA control voltage at U0550-8 decreases in response to excessive PA control voltage, final device temperature, and final device current.

Thermal shutback limits the PA temperature by reducing the PA control voltage as temperature increases during extended periods of transmitter operation or high ambient temperatures.

PA temperature is sensed by negative temperature coefficient thermistor RT5610, located on the ground plane near the PA final device Q5540.

At 25°C the thermistor's high resistance is near 100K ohms. At 85°C the resistance is near 9.7 K ohms. The thermistor attaches to ground in the PA section and the PA TEMP line, which goes to the controller section. In the controller section PA TEMP connects to the 9.3 volt supply through resistors R0587 and R0588. As a result the voltage on PA TEMP drops as temperature increases.

PA TEMP connects to an inverting amplifier through resistor R0550 to inverting input U0550-2. The noninverting input U0550-3 is connected to a 4.6 volt reference formed by voltage divider resistors R0576 and R0582, which connect to ground and the 9.3 volt supply. The output of the inverting amplifier at U0550-1 is the product of the amplifier gain as determined by the ratio of R0551 divided by R0550 and the difference between amplifier inputs U0550-2 and U0550-3. When the PA TEMP input is greater than 4.6 volts the amplifier output is zero.

As the temperature rises, the voltage on the PA TEMP line falls, inverting amplifier output at U0550-1 rises, current begins to flow through R0552 and CR0550 into the ALC loop at the inverting input of U0550-9. This decreases the PA control voltage (PA CNTL) and results in reduced transmitter output.

Current limit is provided to protect the PA final device Q5540 from overcurrent caused by low line voltage and/or mismatched antennas.

Current is measured by sensing the voltage drop across PA shunt resistor R5612, which is in series with the supply lead to the final

device. As the current through the final device increases, so does the difference in voltage across R5612. The differential current sense amplifier amplifies the voltage difference and produce an output over 5 volts at maximum current to reduce the PA control voltage and protect the final device. The maximum current is adjusted by the D/A line CUR LIM SET.

The current sense lines CURRENT SENSE+ and CURRENT SENSE- are connected in shunt across R5612 to the supply and load sides, respectively. Voltage dividers on current sense lines formed by resistors R0557, R0558, R0559, and R0560 protect the inputs of U0550-5 and U0550-6 from excessive voltages. CURRENT SENSE+ connects to the noninverting input UO550-5 through resistors R0557 and R0558. CURRENT SENSE- connects to the inverting input U0550-6 through resistors R0559 and R0560.

As current through the final device increases, voltage drop through R5612 increases and CURRENT SENSE- decreases with respect to CURRENT SENSE+, increasing the difference between inverting and noninverting inputs, causing the amplifier output at U0550-7 to increase to over 5 volts. As the amplifier output increases to over 5 volts, the current through resistor R0556 and diode CR0550 becomes sufficient to reduce the PA control voltage reducing the PA device current.

The D/A line CUR LIM SET at U055-4 adjusts the maximum allowed current by creating an offset voltage at the non-inverting input U0550-5 that is approximately equal to the voltage present at the inverting input during the maximum current voltage drop through R5612.

Controller Detailed Functional Description

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

DC Power Control and Regulation Detailed Functional Description

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

Reference Drawings

3

This section contains the reference drawings listed below for the overall radio, receiver (front end, IF, and back end), and transmitter (synthesizer and power amplifier) portions of the radio.

- **Overall Radio:**
  - Transceiver Board Section Locations - Page 26
  - Schematic Diagram Interconnection List, Table 1 - Page 45 and Table 2 - Page 52
- **Receiver:**
  - Receiver Front End Component Locations and Parts List - Page 28
  - Receiver Front End Schematic Diagram - Page 29
  - Receiver IF Component Locations and Parts List - Pages 30 and 32
  - Receiver IF Schematic Diagram - Pages 31 and 33
  - Receiver Back End Component Locations and Parts List - Pages 34 and 36
  - Receiver Back End Schematic Diagram - Pages 35 and 37
- **Transmitter:**
  - Synthesizer Component Locations and Parts List - Page 38
  - Synthesizer Schematic Diagram - Pages 39 and 40
  - Power Amplifier Component Locations and Parts List - Page 41
  - Power Amplifier Schematic Diagram - Pages 42 and 43

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

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

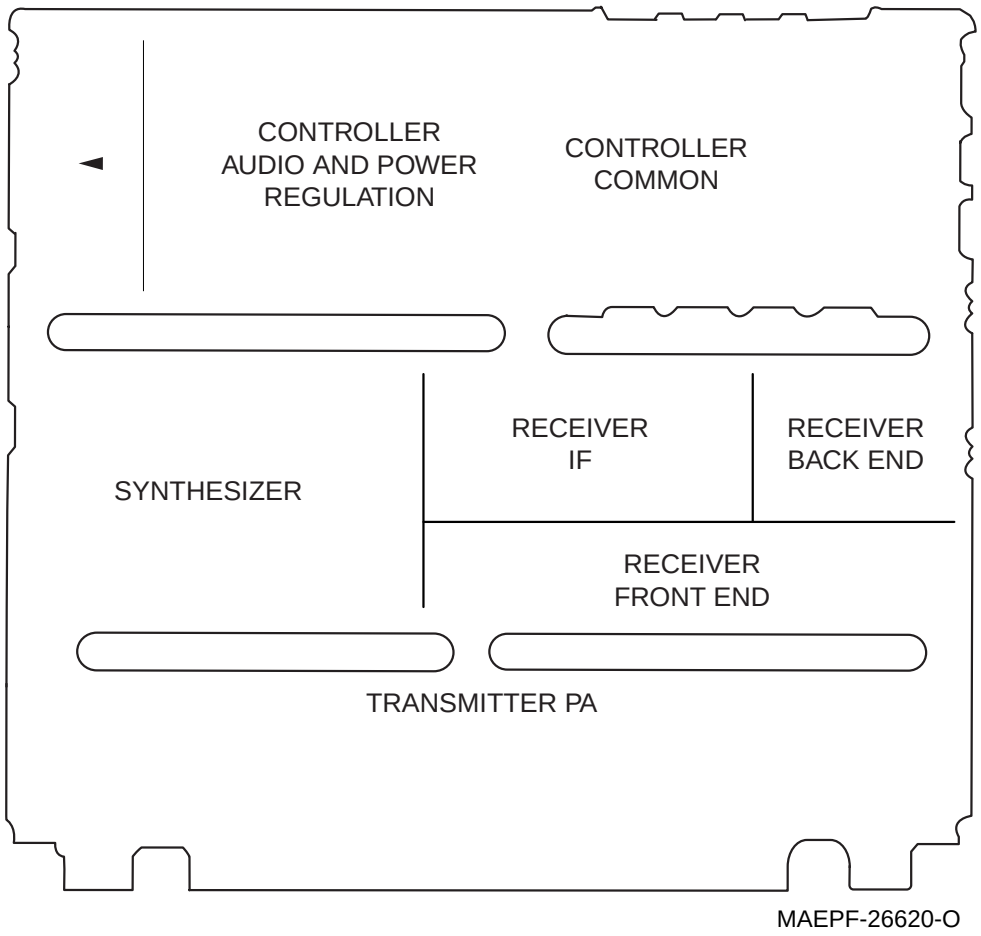
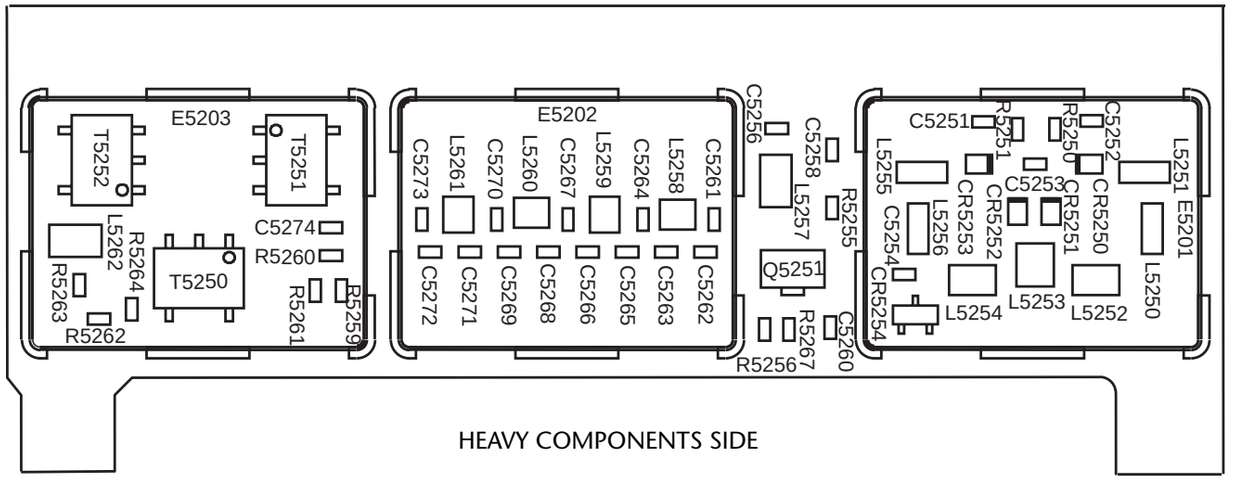


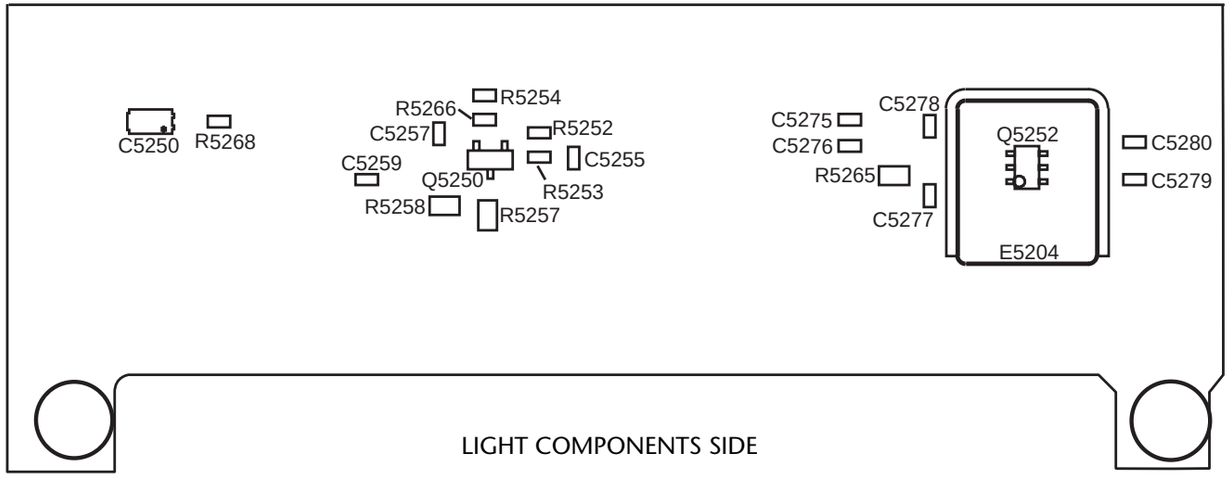
Figure 2. Transceiver Board Sections Locations

NOTES

RECEIVER FRONT END COMPONENT LOCATIONS



MAEPF-26606-O



MAEPF-26607-O

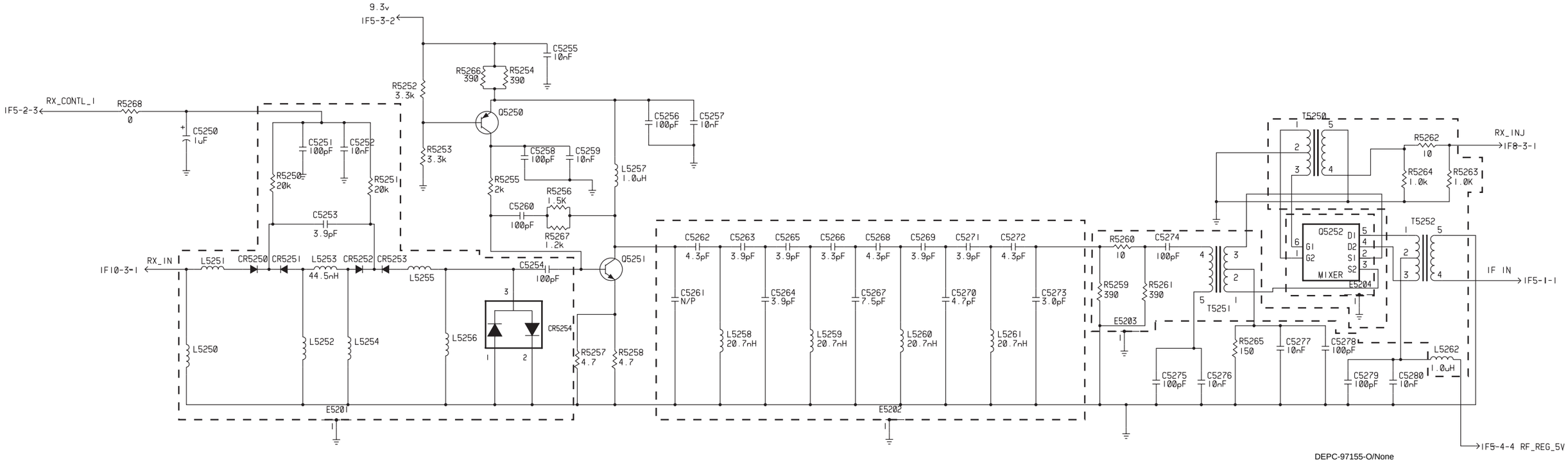
RECEIVER FRONT END PARTS LIST

Reference Designator	Motorola Part Number	Description
		CAPACITORS:
C5250	2311049A07	1 uF
C5251	2113740F51	100
C5252	2113741F49	0.01 uF
C5253	2113740F17	3.9 pF
C5254	2113740F51	100 pF
C5255	2113741F49	0.01 uF
C5256	2113740F51	100 pF
C5258	2113740F51	100 pF
C5259	2113741F49	0.01 uF
C5260	2113740F51	100 pF
C5261	2113740F09	1.8 pF
C5262	2113740F18	4.3 pF
C5263	2113740F17	3.9 pF
C5264	2113740F17	3.9 pF
C5265	2113740F17	3.9 pF
C5266	2113740F15	3.3 pF
C5267	2113740F24	7.5 pF
C5268	2113740F18	4.3 pF
C5269	2113740F17	3.9 pF
C5270	2113740F19	4.7 pF
C5271	2113740F17	3.9 pF
C5272	2113740F18	4.3 pF
C5273	2113740F14	3.0 pF
C5274	2113740F51	100 pF
C5275	2113740F51	100 pF
C5276	2113741F49	0.01 uF
C5277	2113741F49	0.01 uF
C5278	2113740F51	100 pF
C5279	2113740F51	100 pF
C5280	2113741F49	0.01 uF
		DIODES:
CR5250	4862824C01	Varactor
CR5251	4862824C01	Varactor
CR5252	4862824C01	Varactor
CR5253	4862824C01	Varactor
CR5254	4880154K03	Dual Schottky
		SHIELDS:
E5201*	2605915V01	Varactor Filter
E5202*	2605915V01	Bandpass Filter
E5203*	2605915V01	Mixer
E5204*	2605915V01	Mixer IC
		INDUCTORS:
L5250	2460591W03	4.4 nH
L5251	2460591W03	4.4 nH
L5252	2460591L05	10.12 nH
L5253	2460591N36	43.67 nH
L5254	2460591L05	10.12 nH
L5255	2460591W03	4.4 nH
L5256	2460591W03	4.4 nH
L5257	2462587T30	1000 nH
L5258	2460591B80	19.61 nH
L5259	2460591B80	19.61 nH
L5260	2460591B80	19.61 nH
L5261	2460591B80	19.61 nH
L5262	2462587T30	1000 nH
		TRANSISTORS:
Q5250	4813824A17	PNP
Q5251	4882971R01	NPN
Q5252	5105625U28	Mixer
		RESISTORS:
R5250	0662057A80	20K
R5251	0662057A80	20K
R5252	0662057A61	3300
R5253	0662057A61	3.3K
R5254	0662057A39	390
R5255	0662057A56	2.0K
R5256	0662057A53	1.5K
R5257	0662057C19	4.7
R5258	0662057C19	4.7
R5259	0662057A39	390
R5260	0662057A01	10
R5261	0662057A39	390
R5262	0662057A01	10
R5263	0662057A49	1.0K
R5264	0662057A49	1.0K
R5265	0662057C55	150
R5266	0662057A39	390
R5267	0662057A51	1.2K
R5268	0662057B47	0
		TRANSFORMERS:
T5250	2505515V03	Mixer 4:1
T5251	2505515V04	Mixer 5:1
T5252	2505515V07	Mixer 25:1
		PRINTED CIRCUIT BOARD (For Reference Only):
	8405386Y03	For Kit HUE4012C1
	8902372X01	For Kit HUE4011B2

NOTES:

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

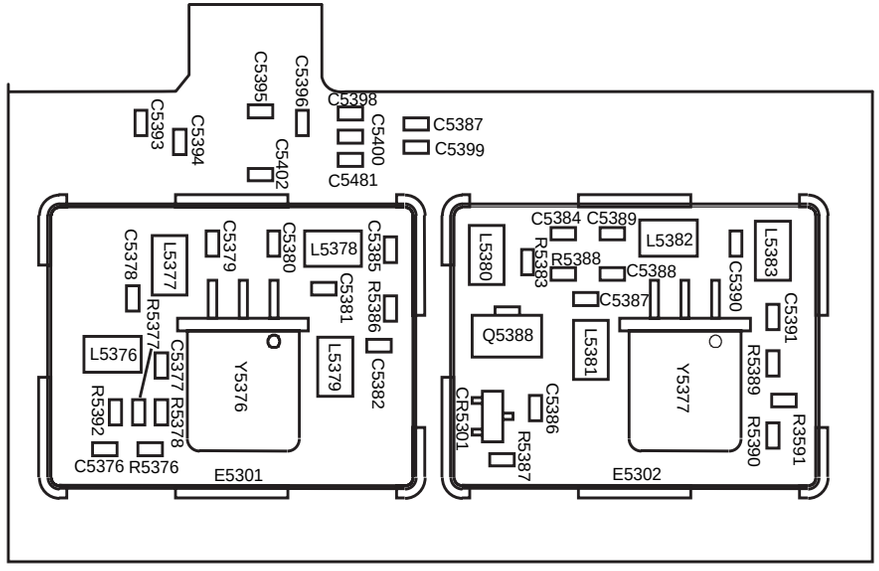
* Kit HUE4011B2 only



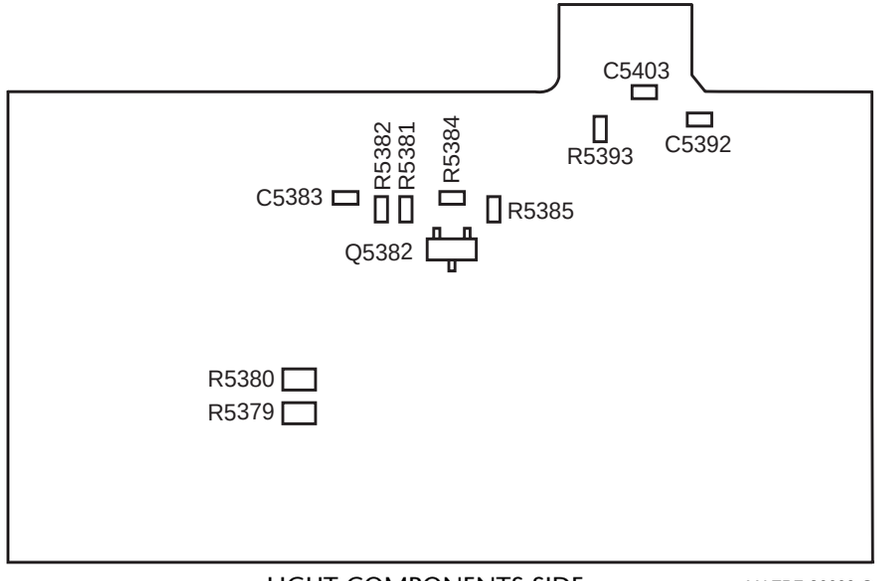
DEPC-97155-O/None

Receiver Front End (Kit HUE4012C1, HUE4011B2) Schematic Diagram

RECEIVER IF COMPONENT LOCATIONS



HEAVY COMPONENTS SIDE MAEPF-26608-O



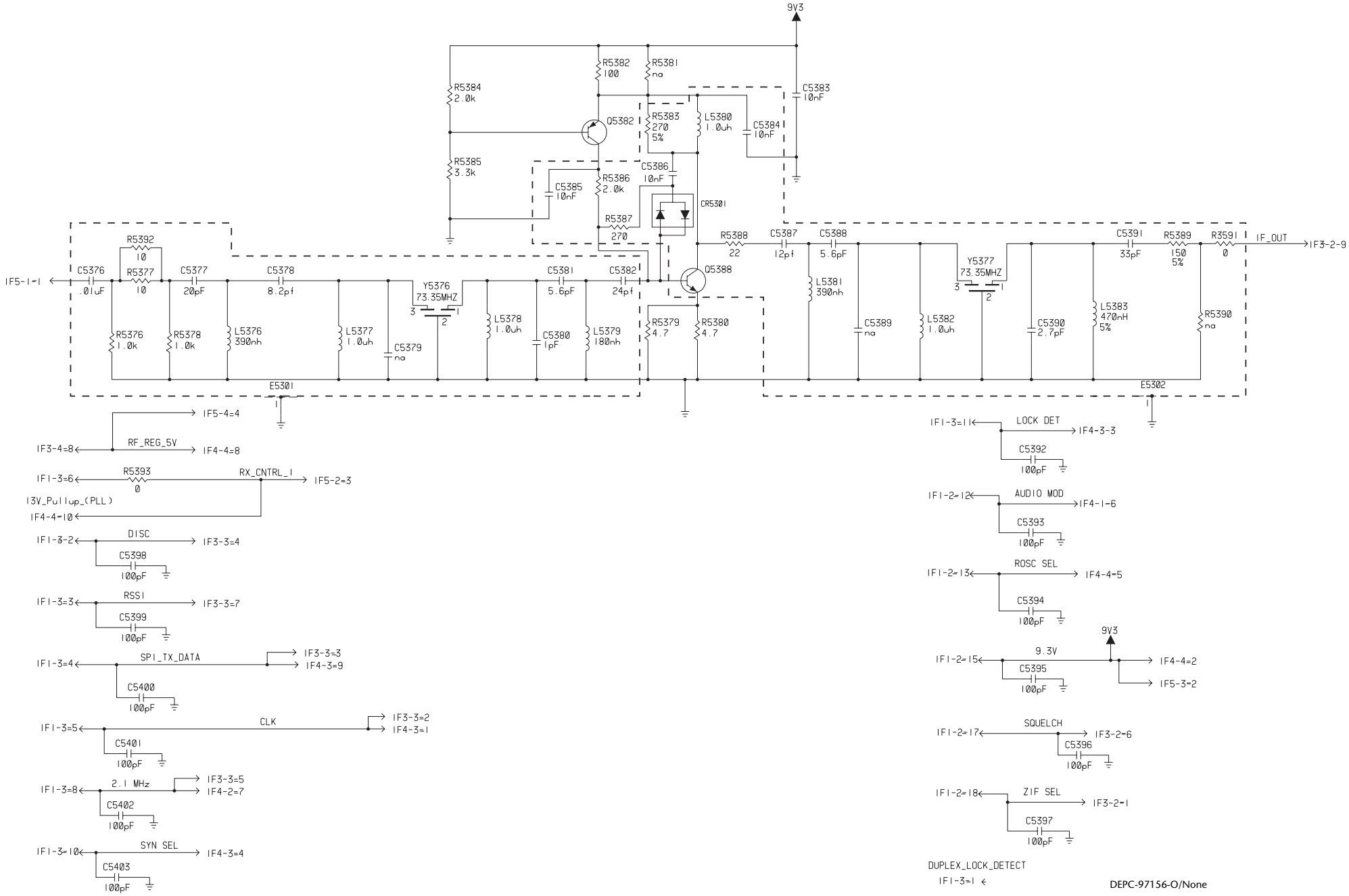
LIGHT COMPONENTS SIDE MAEPF-26609-O

RECEIVER IF PARTS LIST

Reference Symbol	Motorola Part Number	Description
		CAPACITORS:
C5376	2113741F49	0.01 uF
C5377	2113740F34	20 pF
C5378	2113740F25	8.2 pF
C5380	2113740F03	1.0 pF
C5381	2113740F21	5.6 pF
C5382	2113740F36	24 pF
C5383	2113741F49	0.01 uF
C5384	2113741F49	0.01 uF
C5385	2113741F49	0.01 uF
C5386	2113741F49	0.01 uF
C5387	2113740F29	12 pF
C5388	2113740F21	5.6 pF
C5390	2113740F13	2.7 pF
C5391	2113740F39	33 pF
C5392	2113740F51	100 pF
C5393	2113740F51	100 pF
C5394	2113740F51	100 pF
C5395	2113740F51	100 pF
C5396	2113740F51	100 pF
C5397	2113740F51	100 pF
C5398	2113740F51	100 pF
C5399	2113740F51	100 pF
C5400	2113740F51	100 pF
C5401	2113740F51	100 pF
C5402	2113740F51	100 pF
C5403	2113740F51	100 pF
		DIODES:
CR5301	4880154K03	Dual Schottky
		INDUCTORS:
L5376	2462587T22	390 nH
L5377	2462587T30	1000 nH
L5378	2462587T30	1000 nH
L5379	2462587T18	180 nH
L5380	2462587T30	1000 nH
L5381	2462587T22	390 nH
L5382	2462587T30	1000 nH
L5383	2462587T23	470 nH
		TRANSISTORS:
Q5382	4813824A17	PNP
Q5388	4882971R01	NPN
		RESISTORS:
R5376	0662057A49	1K
R5377	0662057A01	10
R5378	0662057A49	1K
R5379	0662057C19	4.7
R5380	0662057C19	4.7
R5381	0662057A25	100
R5383	0662057A35	270
R5384	0662057A56	2K
R5385	0662057A61	3.3K
R5386	0662057A56	2K
R5387	0662057A35	270
R5388	0662057A09	22
R5389	0662057A29	150
R5392	0662057A01	10
R5393	0662057B47	0
		FILTERS:
Y5376	4805846W02	Crystal, 73.35 MHz
Y5377	4805846W04	Crystal, 73.35 MHz
		PRINTED CIRCUIT BOARD (For Reference Only):
	8405386Y03	For Kit HUE4012C1

NOTES:

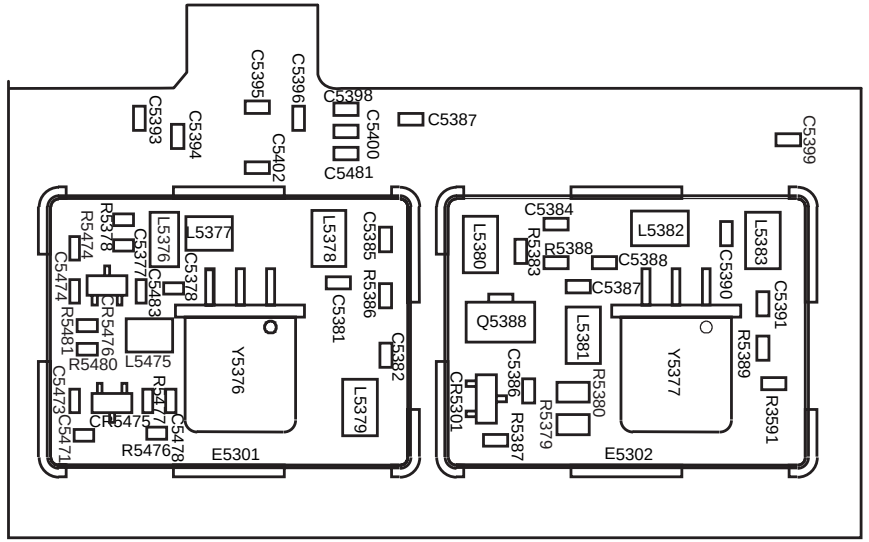
1. All resistance values are in ohms unless indicated otherwise.
2. Components shown on parts location and schematic diagrams but not included in parts list are not placed.



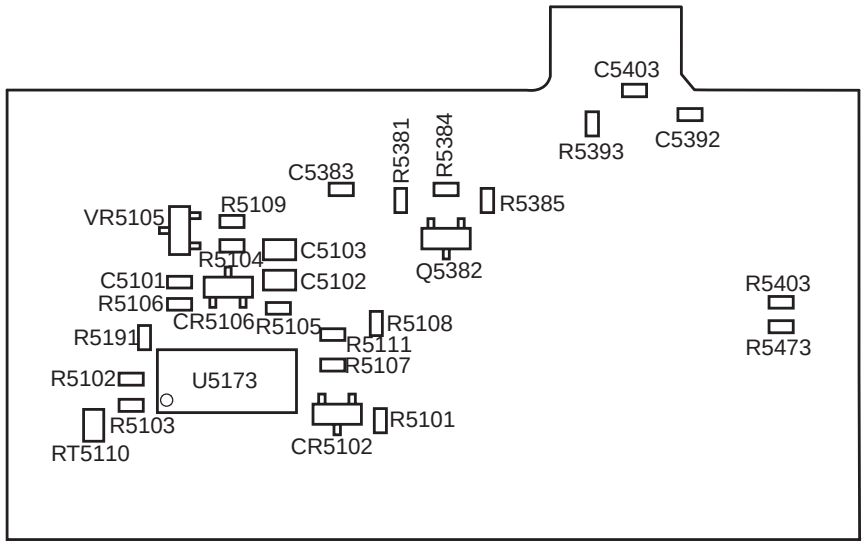
DEPC-97156-O/None

Receiver IF (Kit HUE4012C1) Schematic Diagram

RECEIVER IF COMPONENT LOCATIONS



HEAVY COMPONENTS SIDE MAEPF-26610-O



MAEPF-26611-O

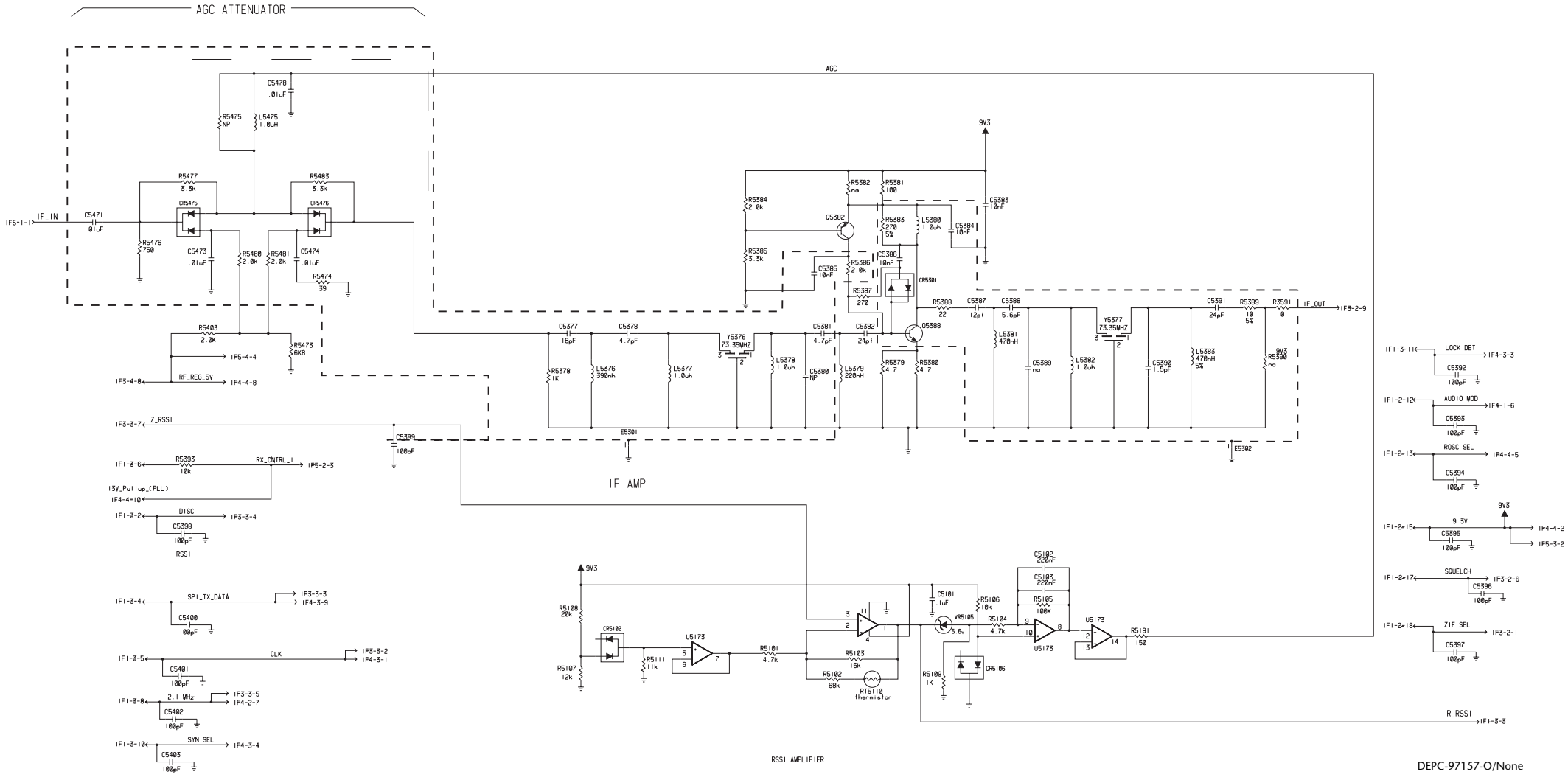
LIGHT COMPONENTS SIDE

RECEIVER IF PARTS LIST

Reference Symbol	Motorola Part Number	Description
		CAPACITORS:
C5101	2113743K15	0.1 uF
C5102	2113743A23	0.22 uF
C5103	2113743A23	0.22 uF
C5377	2113740F33	18 pF
C5378	2113740F19	4.7 pF
C5381	2113740F21	5.6 pF
C5382	2113740F36	24 pF
C5383	2113741F49	0.01 uF
C5384	2113741F49	0.01 uF
C5385	2113741F49	0.01 uF
C5386	2113741F49	0.01 uF
C5387	2113740F29	12 pF
C5388	2113740F21	5.6 pF
C5390	2113740F07	1.5 pF
C5391	2113740F36	24 pF
C5392	2113740F51	100 pF
C5393	2113740F51	100 pF
C5394	2113740F51	100 pF
C5395	2113740F51	100 pF
C5396	2113740F51	100 pF
C5397	2113740F51	100 pF
C5398	2113740F51	100 pF
C5399	2113740F51	100 pF
C5400	2113740F51	100 pF
C5402	2113740F51	100 pF
C5403	2113740F51	100 pF
C5471	2113741F49	0.01 uF
C5473	2113741F49	0.01 uF
C5474	2113741F49	0.01 uF
C5478	2113741F49	0.01 uF
		DIODES:
CR5301	4880154K03	Dual Schottky
CR5475	4880154K05	PIN
		SHIELDS:
E5301	2605915V01	Crystal Filter
E5302	2605915V01	Crystal Filter
		INDUCTORS:
L5376	2462587T22	390 nH
L5377	2462587T30	1000 nH
L5378	2462587T30	1000 nH
L5379	2462587T19	220 nH
L5380	2462587T30	1000 nH
L5381	2462587T23	470 nH
L5382	2462587T30	1000 nH
L5383	2462587T23	470 nH
L5475	2462587t30	1000 nH
		TRANSISTORS:
Q5382	4813824A17	PNP
Q5388	4882971R01	NPN
		RESISTORS:
R5101	0662057A65	4.7K
R5102	0662057A93	68K
R5103	0662057A78	16K
R5104	0662057A65	4.7K
R5105	0662057A97	100K
R5106	0662057A73	10K
R5107	0662057A75	12K
R5108	0662057A80	29K
R5109	0662057A49	1K
R5111	0662057A74	11K
R5191	0662057A29	150
R5378	0662057A49	1K
R5379	0662057C19	4.7
R5380	0662057C19	4.7
R5381	0662057A25	100
R5383	0662057A35	270
R5384	0662057A56	2K
R5385	0662057A61	3.3K
R5386	0662057A56	2K
R5387	0662057A35	270
R5388	0662057A09	22
R5389	0662057A01	10
R5393	0662057B73	10K
R5473	0662057A69	6.8K
R5474	0662057A15	39
R5476	0662057A46	750
R5477	0662057A61	3.3K
R5480	0662057A56	2K
R5481	0662057A56	2K
		INTEGRATED CIRCUITS:
U5173	5113819A14	Operational Amplifier
		FILTERS:
Y5376	4805846W02	Crystal, 73.35 MHZ
Y5377	4805846W04	Crystal, 73.35 MHZ
		PRINTED CIRCUIT BOARD (For Reference Only):
	8902372X01	For Kit HUE4011B2

NOTES:

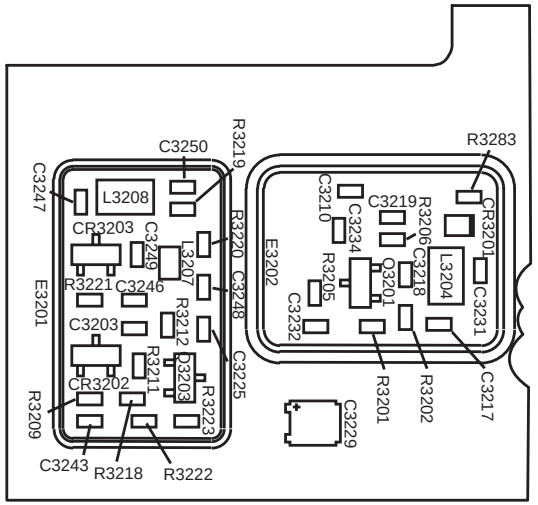
1. All resistance values are in ohms unless indicated otherwise.
2. Components shown on parts location and schematic diagrams but not included in parts list are not placed.



DEPC-97157-O/None

Receiver IF (Kit HUE4011B2)
Schematic Diagram

RECEIVER BACK END COMPONENT LOCATIONS



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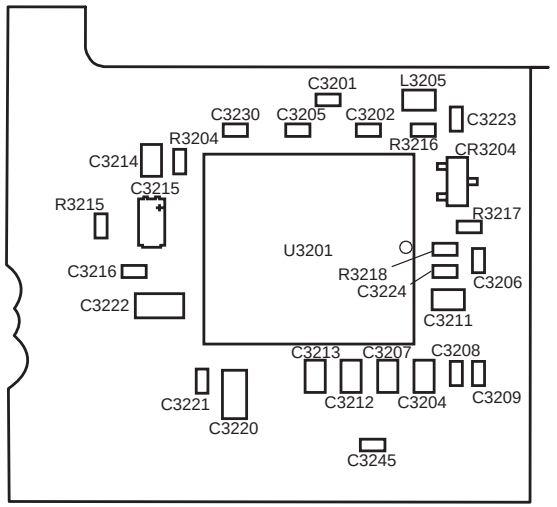
HEAVY COMPONENTS SIDE



MAEPF-26613-O

LIGHT COMPONENTS SIDE

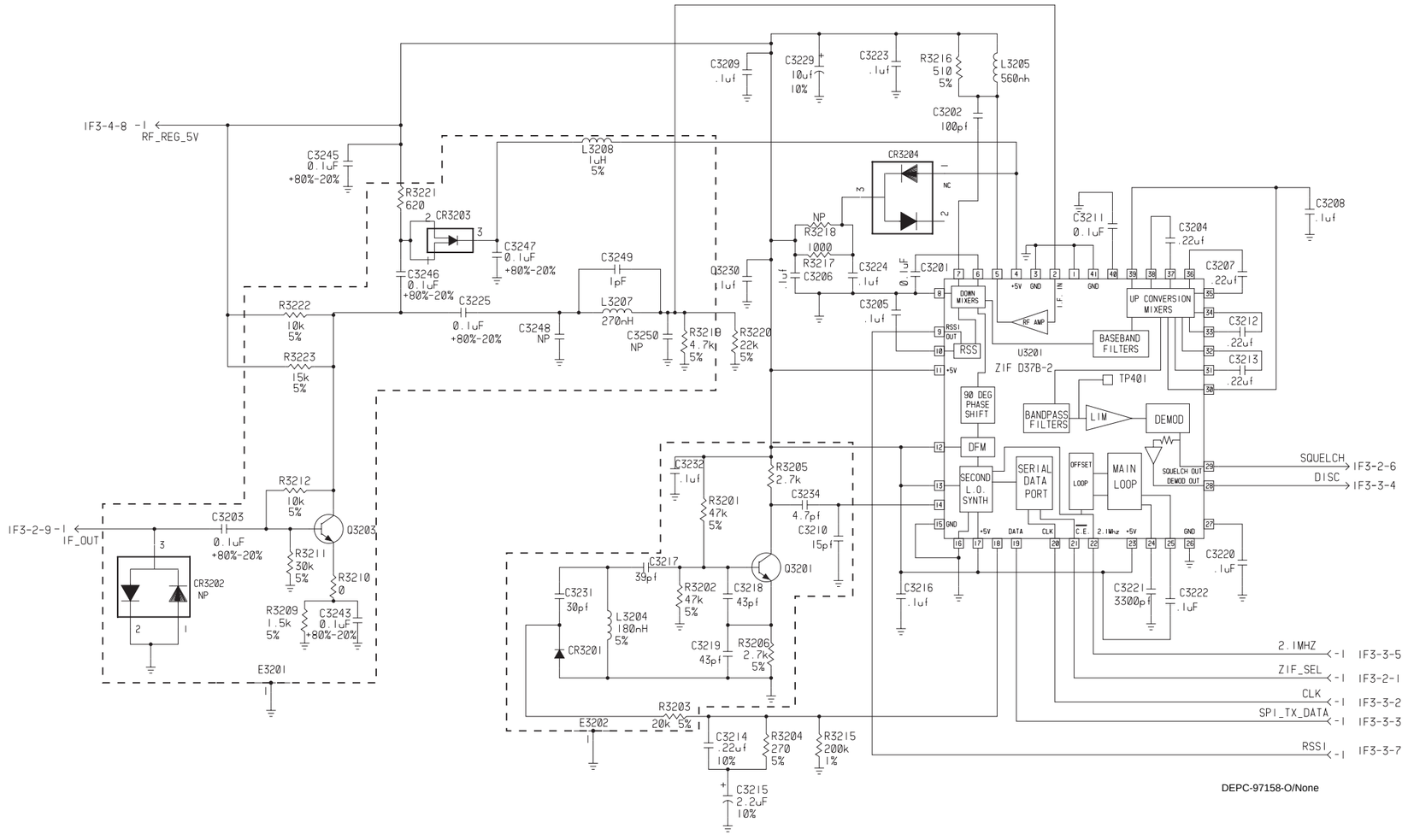
RECEIVER BACK END PARTS LIST

Reference Symbol	Motorola Part Number	Description
		CAPACITORS:
C3201	2113743K15	100 uF
C3202	2113740F51	100 pF
C3203	2113743K15	100 uF
C3204	2113743A23	220 uF
C3205	2113743K15	100 uF
C3206	2113743K15	100 uF
C3207	2113743A23	220 uF
C3208	2113743K15	100 UF
C3209	2113743K15	100 UF
C3210	2113740F41	39 pF
C3211	2113743A19	100 uF
C3212	2113743A23	220 uF
C3213	2113743A23	220 uF
C3214	2113741A51	18 pF
C3214	2113743A23	220 uF
C3215	2311049A02	15 uF
C3215	2311049A09	2.2 uF
C3216	2113743K15	100 uF
C3217	2113740F37	27 pF
C3218	2113740F41	39 pF
C3219	2113740F42	43 pF
C3220	2109720D14	1 uF
C3221	2113741A33	3.3 nF
C3221	2113741F17	470 uF
C3222	2109720D14	1 uF
C3222	2311049A07	1 uF
C3223	2113743K15	100 uF
C3224	2113743K15	100 uF
C3225	2113743K15	100 uF
C3229	2311049J23	10 uF
C3230	2113743K15	100 uF
C3231	2113741F25	30 pF
C3232	2113743K15	100 uF
C3234	2113740F19	4.7 pF
C3243	2113743K15	100 uF
C3245	2113743K15	100 uF
C3246	2113743K15	100 uF
C3247	2113741F49	0.01 uF
C3249	2113740F15	3.3 pF
C3250	2113740F22	6.2 pF
		DIODES:
CR3201	4862824C01	Varactor
CR3203	4805129M96	Dual
CR3204	4880154K03	Dual Schottky
		SHIELDS:
E3201	2602660J02	Second IF
E3202	2605261V01	Oscillator
		INDUCTORS:
L3204	2462587T23	470 nH
L3205	2462587Q44	560 nH
L3207	2462587T23	470 nH
L3208	2462587T30	1000 nH

Reference Symbol	Motorola Part Number	Description
		TRANSISTORS:
Q3201	4882022N70	NPN
Q3203	4882022N70	NPN
		RESISTORS:
R3201	0662057A89	47K
R3202	0662057A89	47K
R3203	0662057A80	20K
R3204	0662057A59	2.7K
R3205	0662057A59	2.7K
R3206	0662057A59	2.7K
R3209	0662057A53	1.5K
R3210	0662057B47	0
R3211	0662057A84	30K
R3212	0662057A73	10K
R3215	0662057B05	200K
R3216	0662057A42	510
R3217	0662057A53	1.5K
R3218	0662057A53	1.5K
R3219	0662057A65	4.7K
R3220	0662057A81	22K
R3221	0662057A53	1.5K
R3222	0662057A73	10K
R3223	0662057A77	15K
		INTEGRATED CIRCUITS:
U3201	5186296A02	Zero IF , F91 P-3
		PRINTED CIRCUIT BOARD (For Reference Only):
	8405386Y03	For Kit HUE4012C1

NOTES:

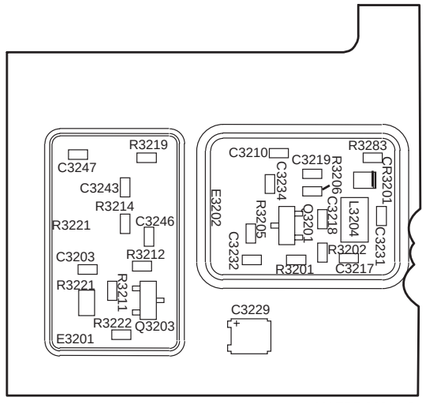
1. All resistance values are in ohms unless indicated otherwise.
2. Components shown on parts location and schematic diagrams but not included in parts list are not placed.



DEPC-97158-O/None

Receiver Back End (Kit HUE4012C1)
Schematic Diagram

RECEIVER BACK END COMPONENT LOCATIONS



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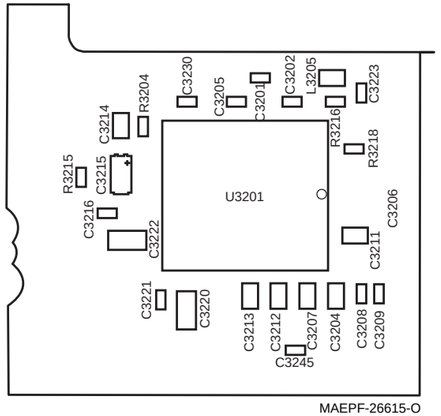
HEAVY COMPONENTS SIDE



MAEPF-26615-O

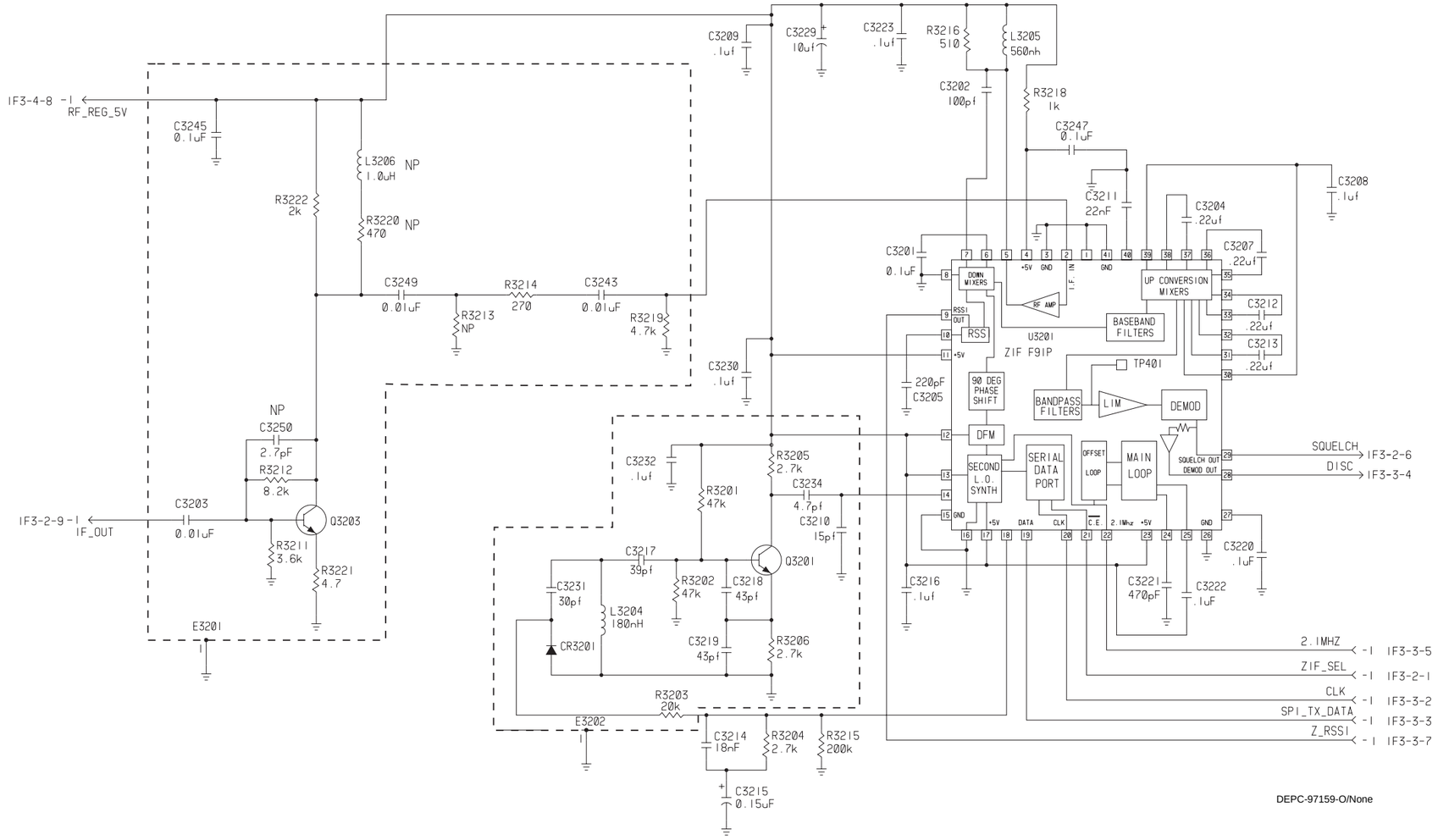
LIGHT COMPONENTS SIDE

RECEIVER BACK END PARTS LIST

Reference Symbol	Motorola Part Number	Description
		CAPACITORS:
C3201	2113743K15	100 uF
C3202	2113740F51	100 pF
C3203	2113743F49	0.01 uF
C3204	2113743A23	0.22 uF
C3205	2113743F59	220 uF
C3207	2113743A23	0.22 uF
C3208	2113743K15	100 uF
C3209	2113743K15	100 uF
C3210	2113740F31	15 pF
C3211	2113741M53	22 pF
C3212	2113743A23	0.22 uF
C3213	2113743A23	0.22 uF
C3214	2113741A51	18 pF
C3215	2311049A02	15 uF
C3216	2113743K15	100 uF
C3217	2113740F41	39 pF
C3218	2113740F42	43 pF
C3219	2113740F42	43 pF
C3220	2109720D14	0.1 uF
C3221	2113741F17	470 uF
C3222	2311049A07	1 uF
C3223	2113743K15	0.1 uF
C3229	2311049J23	10 uF
C3230	2113743K15	0.1 uF
C3231	2113741F38	30 uF
C3232	2113743K15	0.1 uF
C3234	2113740F19	4.7 pF
C3243	2113743F49	0.01uF
C3245	2113743K15	0.1 uF
C3247	2113741K15	0.1 uF
C3249	2113740F49	0.01uF
		DIODES:
CR3201	4862824C01	Varactor
		INDUCTORS:
L3204	2462587T18	180 nH
L3205	2462587Q44	560 nH
		TRANSISTORS:
Q3201	4882022N70	NPN
Q3203	4882022N70	NPN
		RESISTORS:
R3201	0662057A89	47K
R3202	0662057A89	47K
R3203	0662057A80	20K
R3204	0662057A59	2.7K
R3205	0662057A59	2.7K
R3206	0662057A59	2.7K
R3211	0662057A62	3.6K
R3212	0662057A71	8.2K
R3214	0662057A35	270K
R3215	0662057B05	200K
R3216	0662057A42	510
R3218	0662057A49	1K
R3219	0662057A65	4.7K
R3221	0662057C19	4.7
R3222	0662057A56	2K
		INTEGRATED CIRCUITS:
U3201	5105835U88	Zero IF, F91 P-3
		PRINTED CIRCUIT BOARD (For Reference Only):
	8902372X01	For Kit HUE4011B2

NOTES:

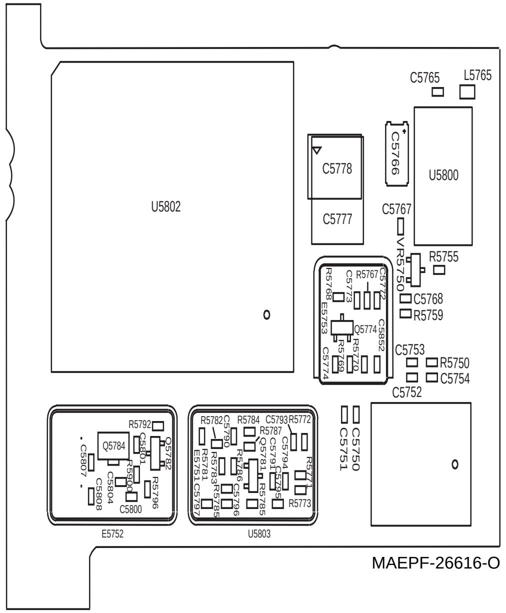
1. All resistance values are in ohms unless indicated otherwise.
2. Components shown on parts location and schematic diagrams but not included in parts list are not placed.



DEPC-97159-O/None

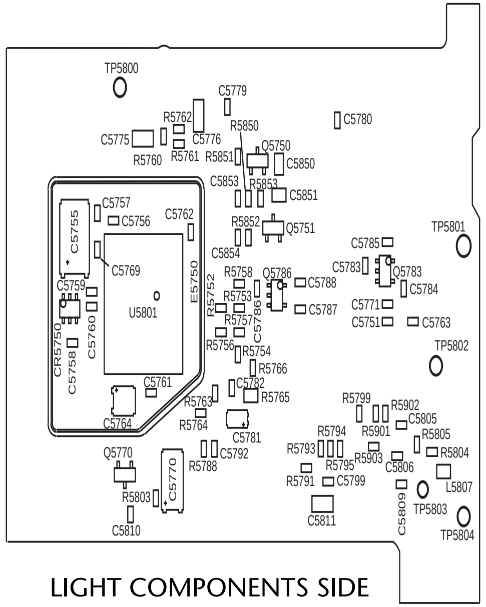
Receiver Back End (Kit HUE4011B2)
Schematic Diagram

SYNTHESIZER SECTION COMPONENT LOCATIONS



MAEPF-26616-O

HEAVY COMPONENTS SIDE



LIGHT COMPONENTS SIDE

MAEPF-26617-O

Synthesizer Parts List

Reference Symbol	Motorola Part Number	Description
		CAPACITORS:
C5250	2311049A07	1 uF
C5750	2113740F51	100 pF
C5751	2113743E07	0.022 uF
C5752	2113740F51	100 pF
C5753	2113743K07	47 uF
C5754	2113743E07	0.022 uF
C5755	2311049A19	1 uF
C5756	2113740F51	100 pF
C5757	2113743K15	0.1 uF
C5758	2113743K15	0.1 uF
C5759	2113743K15	0.1 uF
C5760	2113743K15	0.1 uF
C5761	2113740F51	100 pF
C5762	2113743E07	0.022 uF
C5763	2113743K15	0.1 uF
C5764	2311049J23	10 uF
C5765	2113743K15	0.1 uF
C5766	2311049J26	10 uF
C5767	2113743K15	0.1 uF
C5768	2113740F51	100 pF
C5769	2113740F51	100 pF
C5770	2311049J26	10 uF
C5771	2113740F51	100 pF
C5772	2113740F51	100 pF
C5773	2113740F51	100 pF
C5774	2113740F51	100 pF
C5775	2109720D14	1 uF
C5776	2109720D14	1 uF
C5777	0811051A19	1 uF
C5779	2113740F51	100 pF
C5780	2113740F51	100 pF
C5781	2311049A07	1 uF
C5782	2113740F51	100 pF
C5783	2113740F51	100 pF
C5784	2113740F51	100 pF
C5785	2113740F51	100 pF
C5786	2113740F51	100 pF
C5787	2113740F51	100 pF
C5788	2113740F51	100 pF
C5790	2113743K15	0.1 uF
C5791	2113743K15	0.1 uF
C5792	2113743K15	0.1 uF
C5793	2113740F15	3.3 pF
C5794	2113740F03	1 pF
C5795	2113740F15	3.3 pF
C5796	2113740F15	3.3 pF
C5797	2113743K15	0.1 uF
C5799	2113743K15	0.1 uF
C5800	2113743K15	0.1 uF

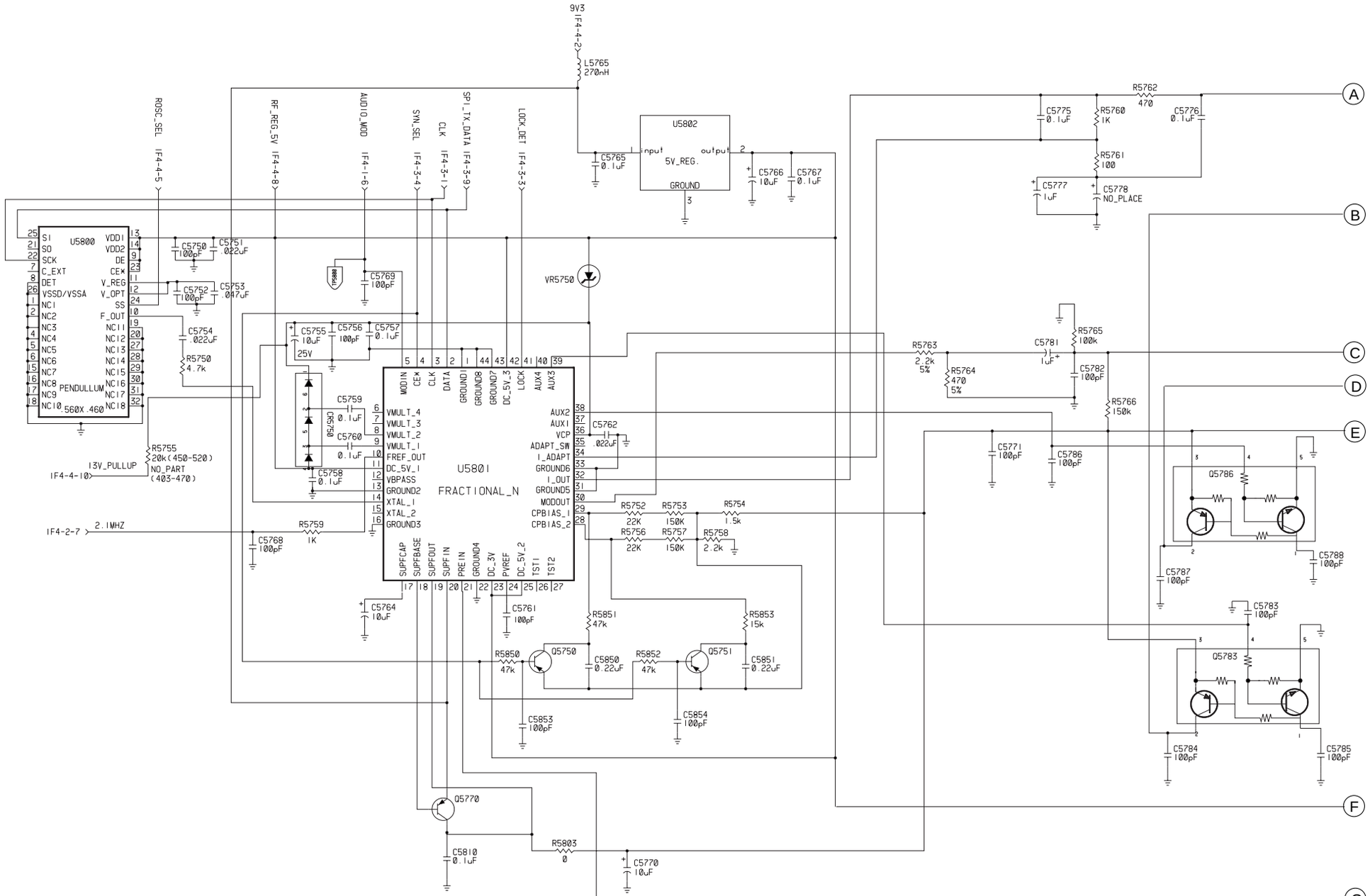
Reference Symbol	Motorola Part Number	Description
C5801	2113743K15	0.1 uF
C5805	2113743K15	0.1 uF
C5806	2113740F11	2.2 pF
C5807	2113740F15	3.3 pF
C5808	2113740F33	18 pF
C5809	2113740F15	3.3 pF
C5809	2113740F22	6.2 pF
C5810	2113743K15	0.1 uF
C5811	2109720D14	1 uF
C5811	2113743K15	0.1 uF
C5850	2113743A23	220 uF
C5851	2113743A23	220 uF
C5852	2113743K15	0.1 uF
C5853	2113740F51	100 pF
C5854	2113740F51	100 pF
		DIODES:
CR5750	4802233J09	Triple
VR5750	4813830A23	Zener
		SHIELDS:
E5750	2602660J02	Fractal-N
E5751	2602660J02	Buffer
E5752	2602660J02	Amplifier
E5753	2605261V01	Amplifier
		INDUCTORS:
L5765	2462587Q40	270 nH
L5807	2462587Q40	270 nH
		TRANSISTORS:
Q5750	4813824A17	PNP
Q5751	4813824A17	PNP
Q5770	4813824A17	PNP
Q5774	4882022N70	NPN
Q5781	4882022N70	NPN
Q5782	4882022N70	NPN
Q5783	4805921T02	Special RF Power Amplifier
Q5784	4882971R01	NPN
Q5786	4805921T02	Special RF Power Amplifier
		RESISTORS:
R5750	0662057A65	4.7K
R5751	0662057B47	0
R5752	0662057A81	22K
R5753	0662057B02	150K
R5754	0662057A53	1.5K
R5755	0662057A80	20K
R5756	0662057A81	22K
R5757	0662057B02	150K
R5758	0662057A57	2.2K
R5759	0662057A49	1K
R5760	0662057A49	1K
R5761	0662057A25	100

Reference Symbol	Motorola Part Number	Description
R5762	0662057A41	470
R5763	0662057A56	2K
R5764	0662057A43	560
R5764	0662057A49	1K
R5765	0662057G13	100K
R5766	0662057B02	150K
R5767	0662057A37	330
R5768	0662057A65	4.7K
R5769	0662057A57	2.2K
R5770	0662057A09	22
R5771	0662057A37	330
R5772	0662057A15	39
R5781	0662057A37	330
R5782	0662057A01	10
R5783	0662057A37	330
R5784	0662057A53	1.5K
R5785	0662057A01	10
R5786	0662057A65	4.7K
R5787	0662057A37	330
R5788	0662057A25	100
R5789	0662057A09	22
R5789	0662057A13	33
R5791	0662057A49	1K
R5792	0662057A01	10
R5793	0662057A65	4.7K
R5796	0662057A29	150
R5799	0662057A53	1.5K
R5799	0662057A57	2.2K
R5803	0662057B47	0
R5804	0662057A18	51
R5805	0662057A18	51
R5850	0662057A89	47K
R5851	0662057A89	47K
R5852	0662057A89	47K
R5853	0662057A77	15K
R5902	0662057A01	10
R5902	0662057A09	22
R5903	0662057A65	4.7K
		INTEGRATED CIRCUITS:
U5800*	5105279V31	16.8 MHz
U5800	5105279V38	16.8 MHz
U5801	5105457W73	Fractional-N
U5802	5113816A07	5V Regulator
U5803	5105279V47	Hybrid
U5803*	5105279V76	Hybrid
		PRINTED CIRCUIT BOARD (For Reference Only):
	8405386Y03	For Kit HUE4012C1
	8902372X01	For Kit HUE4011B2

NOTES:

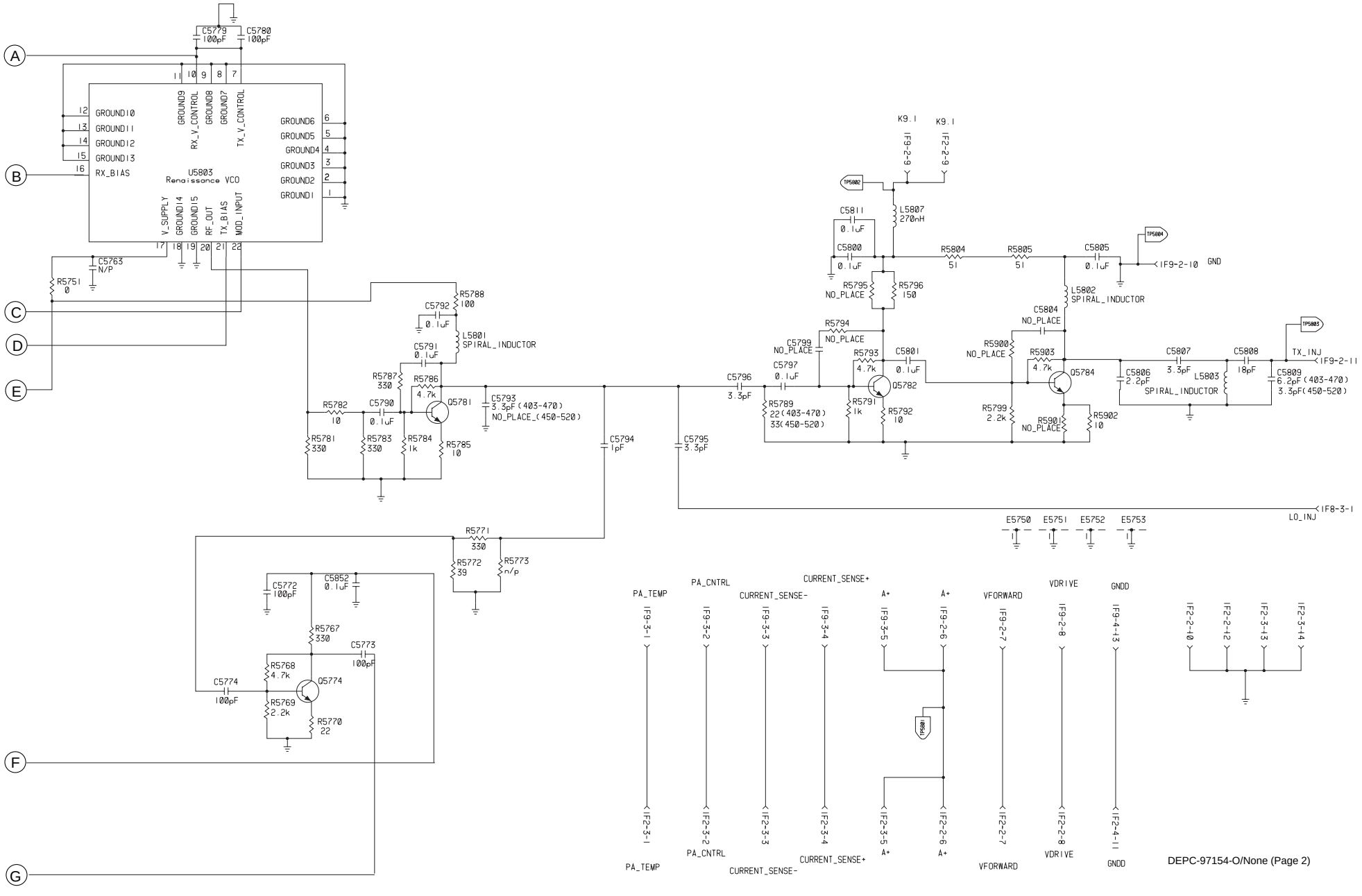
1. All resistance values are in ohms unless indicated otherwise.
2. Components shown on parts location and schematic diagrams but not included in parts list are not placed.

* Kit HUE4011B2 only



DEPC-97154-O/None (Page 1)

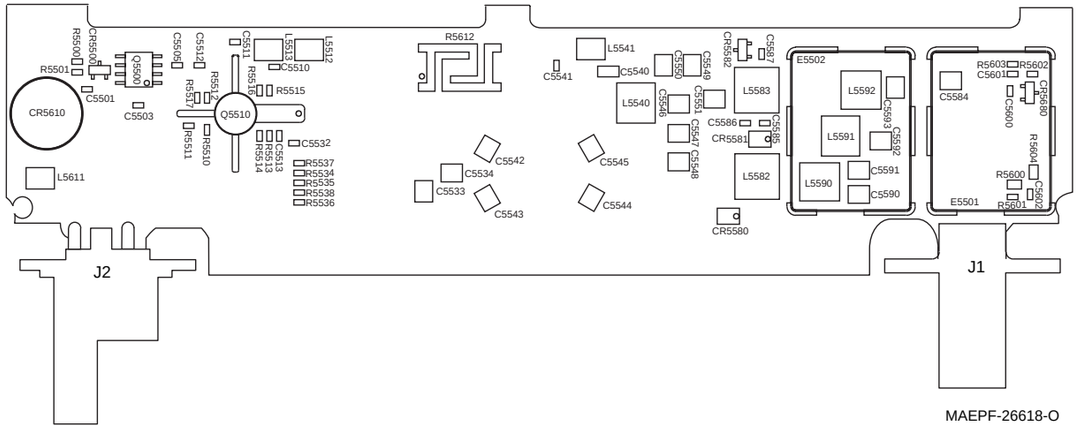
Synthesizer (Kit HUE4012C1, HUE4011B2)
Schematic Diagram, 1 of 2



DEPC-97154-O/None (Page 2)

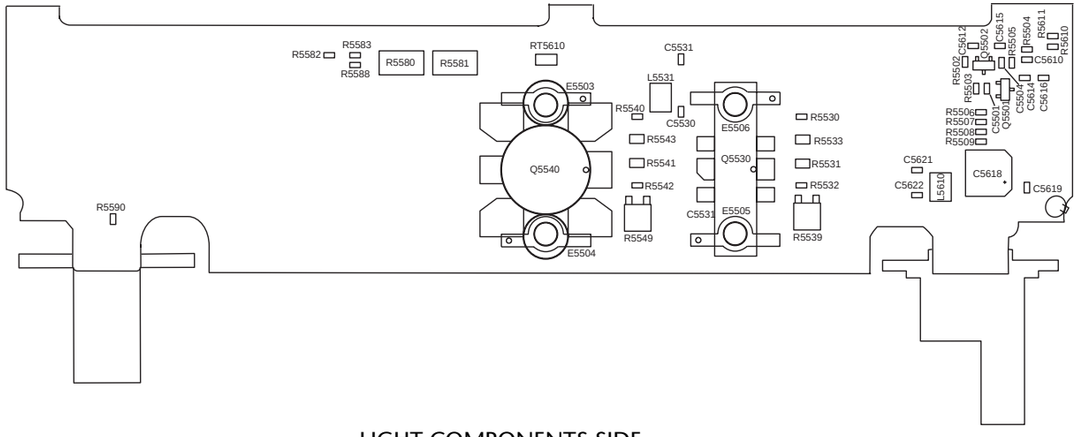
Synthesizer (Kit HUE4012C1, HUE4011B2) Schematic Diagram, 2 of 2

POWER AMPLIFIER COMPONENT LOCATIONS



HEAVY COMPONENTS SIDE

MAEPF-26618-O



LIGHT COMPONENTS SIDE

MAEPF-26619-O

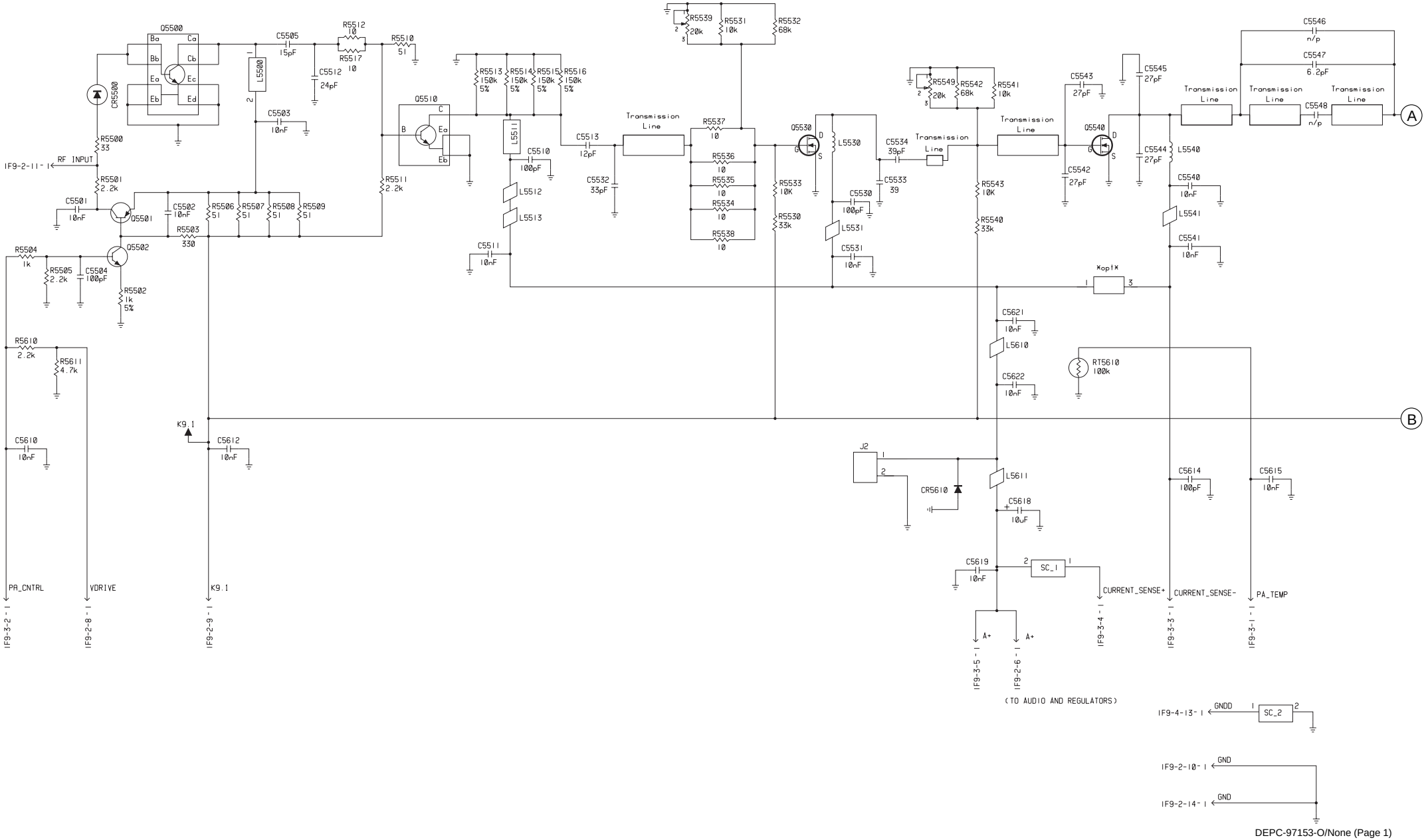
POWER AMPLIFIER PARTS LIST

Reference Symbol	Motorola Part Number	Description
		CAPACITORS:
C5501	2113741F49	0.01 uF
C5502	2113741F49	0.01 uF
C5503	2113741F49	0.01 uF
C5504	2113740F51	100 pF
C5505	2113740F31	15 pF
C5510	2113740F51	100 pF
C5511	2113741F49	0.01 uF
C5512	2113740F36	24 pF
C5513	2113740F29	12 pF
C5513	2113740F33	18 pF
C5530	2113740F51	100 pF
C5531	2113741F49	0.01 uF
C5532	2113740F39	33 pF
C5533	2111078B32	39 pF
C5534	2111078B32	39 pF
C5540	2109720D14	0.1 UF
C5541	2113741F49	0.01 uF
C5542*	2111078B25	27 pF
C5542	2111078B31	36 pF
C5543*	2111078B25	27 pF
C5543	2111078B31	36 pF
C5544	2108226X02	25.6pF To 27.0 pF
C5545	2108226X02	25.6pF To 27.0pF
C5547*	2111078B08	6.2 pF
C5547	2111078B11	8.2 pF
C5551	2111078B42	100 pF
C5584	2111078B42	100 pF
C5585	2113740F20	5.1 pF
C5586	2113740F51	100 pF
C5587	2113740F51	100 pF
C5588	2113740F51	100 pF
C5590*	2111078B13	Coil
C5590	2111078B14	10 pF
C5591*	2111078B13	Coil
C5591	2111078B16	10 pF
C5592*	2111078B13	Coil
C5592	2111078B16	10 pF
C5593*	2111078B01	3.3 pF
C5593	2111078B05	4.7 pF
C5600	2113740F29	12 pF
C5601	2113740F51	100 pF
C5602	2113740F51	100 pF
C5610	2113741F49	0.01 uF
C5612	2113741F49	0.01 uF
C5614	2113740F51	100 pF
C5615	2113741F49	0.01 uF
C5618	2380090M24	10 uF
C5619	2113741F49	0.01 uF
C5621	2113741F49	0.01 uF
C5622	2113741F49	0.01 uF
		DIODES:
CR5500	4880142L01	PIN
CR5580	4802482J02	PIN
CR5581	4802482J02	PIN
CR5582	4880142L01	PIN
CR5600	4880236E05	Hot Carrier
CR5610	4880222R01	Zener, 28 Volts
		SHIELDS:
E5501	2605915V01	Coupler
E5502	2605915V03	Filter
		CONNECTORS:
J1	0905901V06	Antenna
J2	0905902V04	DC Power
		INDUCTORS:
L5512	2484657R01	Bead
L5513	2484657R01	Bead
L5531	2484657R01	Bead
L5540	2460591X01	21 nH
L5541	2484657R01	Bead
L5582	2460591X01	21 nH
L5583	2460591X01	21 nH
L5590	2460591X01	21 nH
L5591	2460591X01	21 nH
L5592	2460591X01	21 nH
L5610	2484657R01	Bead
L5611	2484657R01	Bead
		TRANSISTORS:
Q5500	4813827A26	NPN
Q5501	4813824A17	PNP
Q5502	4813824A10	NPN
Q5510	4813827D13	NPN
Q5530	4805537W01	FET
Q5540	4805538W01	FET
		RESISTORS:
R5500	0662057A13	33
R5501	0662057A57	2.2K
R5502	0662057A49	1K
R5503	0662057A37	330
R5504	0662057A49	1 K
R5505	0662057A57	2.2K
R5506	0662057A18	51
R5507	0662057A18	51
R5508	0662057A18	51
R5509	0662057A18	51
R5510	0662057A18	51
R5511	0662057A57	2.2K
R5512	0662057A01	10
R5513	0662057B02	150K
R5514	0662057B02	150K
R5515	0662057B02	150K
R5516	0662057B02	150K
R5517	0662057A01	10
R5530	0662057A85	33K
R5531	0660081A73	10K
R5532	0662057A81	22K
R5532	0662057A93	68K
R5533	0660081A73	10K
R5534	0662057A01	10
R5535	0662057A01	10
R5536	0662057A01	10
R5537	0662057A01	10
R5538	0662057A01	10
R5540	0662057A85	33K
R5540	0662057A89	47K
R5541	0660081A73	10K
R5542	0662057A85	33K
R5542	0662057A93	68K
R5543	0660081A73	10K
R5580	0680194M18	51
R5581	0680194M18	51
R5582	0662057A49	1K
R5583	0662057A49	1K
R5590	0662057A97	100K
R5600	0662057C55	150
R5601	0662057A35	270
R5602	0662057A18	51
R5603	0662057A81	22K
R5604	0662057E49	5.6K
R5610	0662057A57	2.2K
R5611	0662057A65	4.7K
R5612	1705603W01	30 m Shunt
RT5610	0680149M02	Thermistor Chip 100K
		PRINTED CIRCUIT BOARD (For Reference Only):
	8405386Y03	For Kit HUE4012C1
	8902372X01	For Kit HUE4011B2

NOTES:

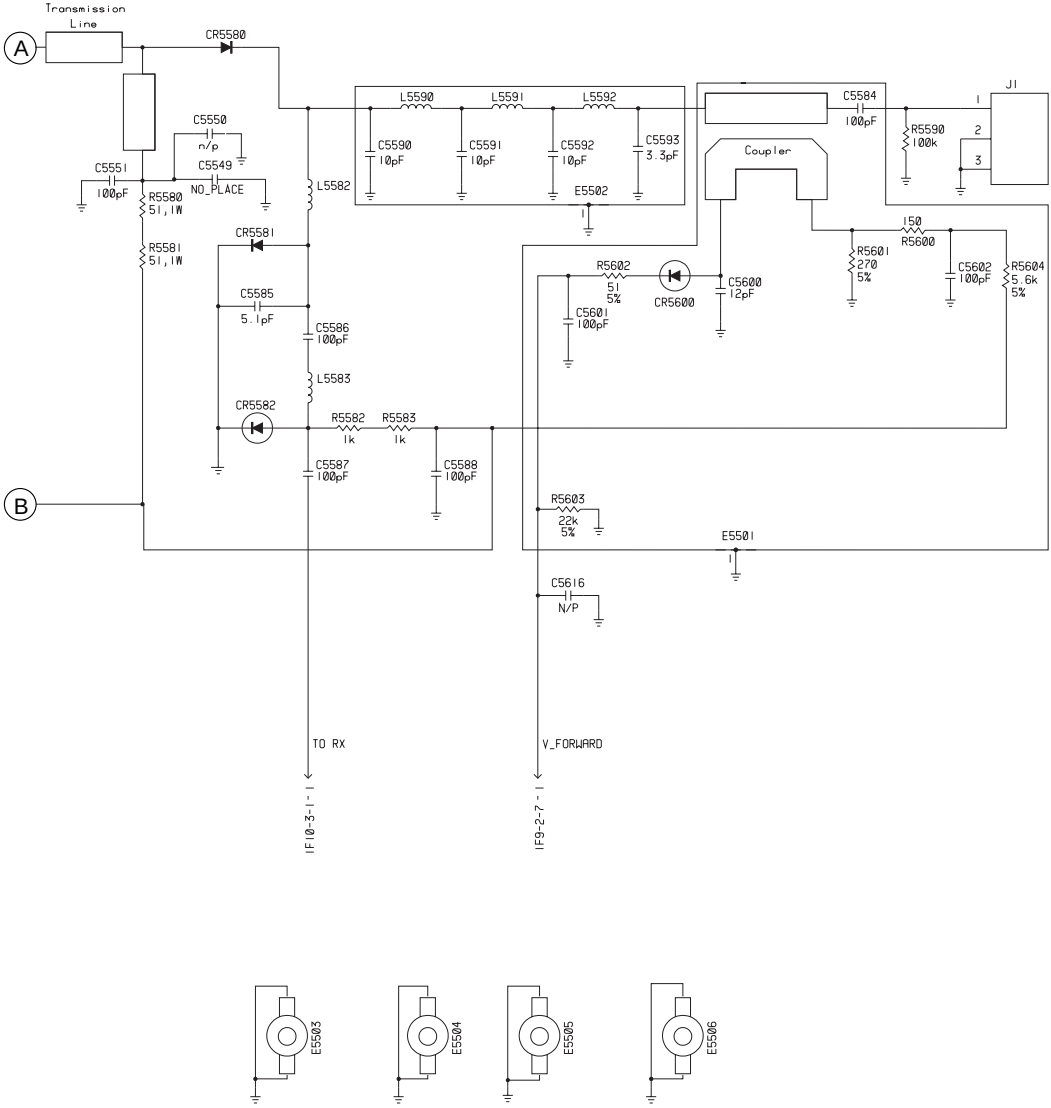
1. All resistance values are in ohms unless indicated otherwise.
2. Components shown on parts location and schematic diagrams but not included in parts list are not placed.
3. When replacing components Q5510, R5510, or R5511, take precautions not to damage resistors R5513 through R5516.

* Kit HUE4011B2 only



DEPC-97153-O/None (Page 1)

Power Amplifier (Kit HUE4012C1, HUE4011B2) Schematic Diagram, 1 of 2



DEPC-97153-O/None (Page 2)

Power Amplifier (Kit HUE4012C1, HUE4011B2) Schematic Diagram, 2 of 2

NOTES

Table 1. Schematic Diagram Interconnection List (Kit: HUE4012C1)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF1-2-12	AUDIO_MOD	Main Controller Block Diagram	68P81083C20	IF1-2-12	AUDIO_MOD	Receiver IF	68P81080C49
IF1-2-13	ROSC_SEL	Main Controller Block Diagram	68P81083C20	IF1-2-13	ROSC_SEL	Receiver IF	68P81080C49
IF1-2-14	GND	Main Controller Block Diagram	68P81083C20	IF1-2-14	Not Indicated		
IF1-2-15	9V3	Main Controller Block Diagram	68P81083C20	IF4-4-2 IF5-3-2	9.3V	Receiver Front End and Receiver IF	68P81080C49
IF1-2-16	PA_CNTL_LIM	Main Controller Block Diagram	68P81083C20	IF1-2-16	Not Indicated		
IF1-2-17	SQUELCH	Main Controller Block Diagram	68P81083C20	IF1-2-17	SQUELCH	Receiver IF	68P81080C49
IF1-2-18	ZIF_SEL	Main Controller Block Diagram	68P81083C20	IF1-2-18	ZIF_SEL	Receiver IF	68P81080C49
IF1-2-19	DUPLEX_SYN_SEL	Main Controller Block Diagram	68P81083C20	IF1-2-19	Not Indicated		
IF1-3-1	DUPLEX_LOCK_DET	Main Controller Block Diagram	68P81083C20	IF1-3-1	DUPLEX_LOCK_DETECT	Receiver IF	68P81080C49
IF1-3-2	DISC	Main Controller Block Diagram	68P81083C20	IF1-3-2	DISC	Receiver IF	68P81080C49
IF1-3-3	RSSI	Main Controller Block Diagram	68P81083C20	IF1-3-3	RSSI	Receiver IF	68P81080C49

Table 1. Schematic Diagram Interconnection List (Kit: HUE4012C1)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF1-3-4	SDATA	Main Controller Block Diagram	68P81083C20	IF1-3-4	SPI_TX_DATA	Receiver IF	68P81080C49
IF1-3-5	SCLK	Main Controller Block Diagram	68P81083C20	IF1-3-5	CLK	Receiver IF	68P81080C49
IF1-3-6	RX_CNTL_I_SRC	Main Controller Block Diagram	68P81083C20	IF1-3-6	Not Indicated		
IF1-3-7	GND	Main Controller Block Diagram	68P81083C20	IF1-3-7	Not Indicated		
IF1-3-8	2.1MHz	Main Controller Block Diagram	68P81083C20	IF1-3-8	2.1MHz	Receiver IF	68P81080C49
IF1-3-9	GND	Main Controller Block Diagram	68P81083C20	IF1-3-9	Not Indicated		
IF1-3-10	SYN_SEL	Main Controller Block Diagram	68P81083C20	IF1-3-10	SYN_SEL	Receiver IF	68P81080C49
IF1-3-11	LOCK_DET	Main Controller Block Diagram	68P81083C20	IF1-3-11	LOCK_DET	Receiver IF	68P81080C49
IF2-2-6	A+	Synthesizer	68P81080C49	IF2-2-6	A+_CONT	Main Controller Block Diagram	68P81083C20
IF2-2-7	VFORWARD	Synthesizer	68P81080C49	IF2-2-7	V_FORWARD	Main Controller Block Diagram	68P81083C20
IF2-2-8	VDRIVE	Synthesizer	68P81080C49	IF2-2-8	V_CNTL	Main Controller Block Diagram	68P81083C20
IF2-2-9	K9.1	Synthesizer	68P81080C49	IF2-2-9	K9V1	Main Controller Block Diagram	68P81083C20
IF2-2-10	GND	Synthesizer	68P81080C49	IF2-2-10	Not Indicated		
IF2-2-12	GND	Synthesizer	68P81080C49	IF2-2-12	Not Indicated		

Table 1. Schematic Diagram Interconnection List (Kit: HUE4012C1)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF2-3-1	PA TEMP	Synthesizer	68P81080C49	IF2-3-1	PA_TEMP	Main Controller Block Diagram	68P81083C20
IF2-3-2	PA_CONTRL	Synthesizer	68P81080C49	IF2-3-2	PA_CNTL	Main Controller Block Diagram	68P81083C20
IF2-3-3	CURRENT_SENSE-	Synthesizer	68P81080C49	IF2-3-3	CURRENT_SENSE_-	Main Controller Block Diagram	68P81083C20
IF2-3-4	CURRENT_SENSE+	Synthesizer	68P81080C49	IF2-3-4	CURRENT_SENSE_+	Main Controller Block Diagram	68P81083C20
IF2-3-5	A+	Synthesizer	68P81080C49	IF2-3-5	A+_CONT	Main Controller Block Diagram	68P81083C20
IF2-3-13	GND	Synthesizer	68P81080C49				
IF2-3-14	GND	Synthesizer	68P81080C49				
IF2-4-11	GNDD	Synthesizer	68P81080C49	IF2-4-11	GND	Main Controller Block Diagram	68P81083C20
IF3-2-1	ZIF_SEL	Receiver IF	68P81080C49	IF3-2-1	ZIF_SEL	Receiver Back End	68P81080C49
IF3-2-6	SQUELCH	Receiver IF	68P81080C49	IF3-2-6	SQUELCH	Receiver Back End	68P81080C49
IF3-2-9	IF OUT	Receiver IF	68P81080C49	IF3-2-9	IF_OUT	Receiver Back End	68P81080C49
IF3-3-2	CLK	Receiver IF	68P81080C49	IF3-3-2	CLK	Receiver Back End	68P81080C49
IF3-3-3	SPI_TX_DATA	Receiver IF	68P81080C49	IF3-3-3	SPI_TX_DATA	Receiver Back End	68P81080C49
IF3-3-4	DISC	Receiver IF	68P81080C49	IF3-3-4	DISC	Receiver Back End	68P81080C49
IF3-3-5	2.1MHz	Receiver IF	68P81080C49	IF3-3-5	2.1Mhz	Receiver Back End	68P81080C49
IF3-3-7	RSSI	Receiver IF	68P81080C49	IF3-3-7	RSSI	Receiver Back End	68P81080C49
IF3-4-8	RF_REG_5V	Receiver Front End	68P81080C49	IF3-4-8	RF_REG_5V	Receiver Back End	68P81080C49
IF4-1-6	AUDIO_MOD	Synthesizer	68P81080C49	IF4-1-6	AUDIO_MOD	Receiver IF	68P81080C49

Table 1. Schematic Diagram Interconnection List (Kit: HUE4012C1)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF4-2-7	2.1 MHz	Synthesizer	68P81080C49	IF4-2-7	2.1MHz	Receiver IF	68P81080C49
IF4-3-1	CLK	Synthesizer	68P81080C49	IF4-3-1	CLK	Receiver IF	68P81080C49
IF4-3-3	LOCK_DET	Synthesizer	68P81080C49	IF4-3-3	LOCK_DET	Receiver IF	68P81080C49
IF4-3-4	SYN_SEL	Synthesizer	68P81080C49	IF4-3-4	SYN_SEL	Receiver IF	68P81080C49
IF4-3-9	SP1_TX_DATA	Synthesizer	68P81080C49	IF4-3-9	SPI_TX_DATA	Receiver IF	68P81080C49
IF4-4-2	9V3	Synthesizer	68P81080C49	IF4-4-2	9.3V	Receiver IF	68P81080C49
IF4-4-5	ROSC_SEL	Synthesizer	68P81080C49	IF4-4-5	ROSC_SEL	Receiver IF	68P81080C49
IF4-4-8	RF_REG_5V	Synthesizer	68P81080C49	IF4-4-8	RF_REG_5V	Receiver Front End	68P81080C49
IF4-4-10	13V_PULLUP	Synthesizer	68P81080C49	IF4-4-10	13V_PULLUP_(PLL)	Receiver IF	68P81080C49
IF5-1-1	IF_IN	Receiver IF	68P81080C49	IF5-1-1	IF_IN	Receiver Front End	68P81080C49
IF5-2-3	RX_CNTRL_1	Receiver IF	68P81080C49	1F1-2-16	RX_CNTRL_1	Receiver Front End	68P81080C49
IF5-3-2	9.3V	Receiver IF	68P81080C49	IF5-3-2	9.3V	Receiver Front End	68P81080C49
IF5-4-4	RF_REG_5V	Receiver IF	68P81080C49	IF5-4-4	RF_REG_5V	Receiver Front End	68P81080C49
IF7-1-11	SPK+	Main Controller Block Diagram	68P81083C20	IF7-1-11	SPK+	Controller Power Control	68P81083C20
IF7-1-12	SPK-	Main Controller Block Diagram	68P81083C20	IF7-2-12			
IF7-1-15	PA_CNTL	Main Controller Block Diagram	68P81083C20	IF2-3-2			
IF7-1-17	GND	Main Controller Block Diagram	68P81083C20	IF7-1-17	GND	Controller Power Control	68P81083C20
IF7-1-23	PWR_RST	Main Controller Block Diagram	68P81083C20	IF7-1-23	PWR_RST	Controller Power Control	68P81083C20

Table 1. Schematic Diagram Interconnection List (Kit: HUE4012C1)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF7-1-31	TEMP_GND	Main Controller Block Diagram	68P81083C20	IF7-4-10			
IF7-2-3	V_CNTL	Main Controller Block Diagram	68P81083C20	IF7-2-3	V_CNTL	Controller Power Control	68P81083C20
IF7-2-4	V_FORWARD	Main Controller Block Diagram	68P81083C20	IF7-2-4	V_FORWARD	Controller Power Control	68P81083C20
IF7-2-7	UNSW_5V	Main Controller Block Diagram	68P81083C20	IF7-2-7	UNSW_5V	Controller Power Control	68P81083C20
IF7-2-8	CL_UNSW_5V	Main Controller Block DIagram	68P81083C20	IF7-2-8	CL_UNSW_5V	Controller Power Control	68P81083C20
IF7-2-10	RX_AUDIO	Main Controller Block Diagram	68P81083C20	IF7-4-10			
IF7-2-12	SPK-	Main Controller Block Diagram	68P81083C20	IF7-2-12			
IF7-2-13	CURRENT_SENSE_+	Main Controller Block Diagram	68P81083C20	IF7-2-13	CURRENT_SENSE_+	Controller Power Control	68P81083C20
IF7-2-20	CLEAR	Main Controller Block Diagram	68P81083C2	IF7-2-20	CLEAR	Controller Power Control	68P81083C20
IF7-2-21	B+_IGNITION	Main Controller Block Diagram	68P81083C20	IF7-2-21	B+_IGNITION	Controller Power Control	68P81083C20
IF7-2-24	A+	Main Controller Block Diagram	68P81083C20				
IF7-2-25	A+_CONT	Main Controller Block Diagram	68P81083C20	IF7-2-25	A+_CONT	Controller Power Control	68P81083C20
IF7-2-26	9V3	Main Controller Block DIagram	68P81083C20	IF7-2-26	9V3	Controller Power Control	68P81083C20
IF7-2-27	SW_B+	Main Controller Block Diagram	68P81083C20	IF7-2-27	SW_B+	Controller Power Control	68P81083C20

Table 1. Schematic Diagram Interconnection List (Kit: HUE4012C1)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF7-2-28	Vdd	Main Controller Block Diagram	68P81083C20	IF7-2-28	Vdd	Controller Power Control	68P81083C20
IF7-2-29	SW_B+	Controller Power Control	68P81083C20	IF7-2-27			
IF7-2-30	9V3	Main Controller Block Diagram	68P81083C20	IF7-2-30	9V3	Controller Power Control	68P81083C20
IF7-3-5	K9V1	Main Controller Block Diagram	68P81083C20	IF7-3-5	K9V1	Controller Power Control	68P81083C20
IF7-3-6	PA_TEMP	Main Controller Block Diagram	68P81083C20	IF7-3-6	PA_TEMP	Controller Power Control	68P81083C20
IF7-3-14	CURRENT_SENSE_-	Controller Power Control	68P81083C20	IF2-3-3			
IF7-3-15	PA_CNTL	Controller Power Control	68P81083C20	IF2-3-2			
IF7-3-18	Vaud	Main Controller Block Diagram	68P81083C20	IF7-3-18	Vaud	Controller Power Control	68P81083C20
IF7-3-22	+5V	Controller Power Control	68P81083C20	IF7-4-22			
IF7-4-1	VFWD_BUF	Main Controller Block Diagram	68P81083C20	IF7-4-1	VFWD_BUF	Controller Power Control	68P81083C20
IF7-4-2	VSUM	Main Controller Block Diagram	68P81083C20	IF7-4-2	VSUM	Controller Power Control	68P81083C20
IF7-4-9	AUPA_EN	Main Controller Block Diagram	68P81083C20	IF7-4-9	AUPA_EN	Controller Power Control	68P81083C20
1F7-4-10	RX_AUDIO	Main Controller Block Diagram	68P81083C20	1F7-2-10			
1F7-4-14	CURRENT_SENSE	Main Controller Block Diagram	68P81083C20	1F2-3-3			

Table 1. Schematic Diagram Interconnection List (Kit: HUE4012C1)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
1F7-4-16	A+	Main Controller Block Diagram	68P81083C20				
1F7-4-19	B+_ON_OFF	Main Controller Block Diagram	68P81083C20				
IF7-4-22	+5V	Main Controller Block Diagram	68P81083C20	IF7-3-22, IF7-4-24	A+	Controller Power Control	68P81083C20
IF8-3-1	LO_INJ	Synthesizer	68P81080C49	IF8-3-1	RX_INJ	Receiver Front End	68P81080C49
IF9-2-6	A+	Power Amplifier	68P81080C49	IF9-2-6	A+	Synthesizer	68P81080C49
IF9-2-7	V_FORWARD	Power Amplifier	68P81080C49	IF9-2-7	V_FORWARD	Synthesizer	68P81080C49
IF9-2-8	V_DRIVE	Synthesizer	68P81080C49	IF9-2-8	V_DRIVE	Synthesizer	68P81080C49
IF9-2-9	K9.1	Power Amplifier	68P81080C49	IF9-2-9	K9.1	Synthesizer	68P81080C49
IF9-2-10	GND	Power Amplifier	68P81080C49	IF9-2-10	GND	Synthesizer	68P81080C49
IF9-2-11	TX_INJ	Power Amplifier	68P81080C49	IF9-2-11	TX_INJ	Synthesizer	68P81080C49
IF9-2-14	GND	Power Amplifier	68P81083C20				
IF9-3-1	PA_TEMP	Power Amplifier	68P81080C49	IF9-3-1	PA_TEMP	Synthesizer	68P81080C49
IF9-3-2	PA_CNTL	Power Amplifier	68P81080C49	IF9-3-2	PA_CNTL	Synthesizer	68P81080C49
IF9-3-3	CURRENT SENSE -	Power Amplifier	68P81080C49	IF9-3-3	CURRENT_SENSE-	Synthesizer	68P81080C49
IF9-3-4	CURRENT SENSE +	Power Amplifier	68P81080C49	IF9-3-4	CURRENT_SENSE+	Synthesizer	68P81080C49
IF9-3-5	A+	Power Amplifier	68P81080C49	IF9-3-5	A+	Synthesizer	68P81080C49
IF9-4-13	GNDD	Power Amplifier	68P81080C49	IF9-4-13	GNDD	Synthesizer	68P81080C49
IF10-3-1	RX_IN	Power Amplifier	68P81080C49	IF10-3-1	RX_IN	Receiver Front End	68P81080C49

Table 2. Schematic Diagram Interconnection List (Kit: HUE4011B2)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF1-2-12	AUDIO_MOD	Main Controller Block Diagram	68P81083C20	IF1-2-12	AUDIO_MOD	Receiver IF	68P81080C49
IF1-2-13	ROSC_SEL	Main Controller Block Diagram	68P81083C20	IF1-2-13	ROSC_SEL	Receiver IF	68P81080C49
IF1-2-14	GND	Main Controller Block Diagram	68P81083C20	IF1-2-14	Not Indicated		
IF1-2-15	9V3	Main Controller Block Diagram	68P81083C20	IF4-4-2 IF5-3-2	9.3V	Receiver Front End and Receiver IF	68P81080C49
IF1-2-16	PA_CNTL_LIM	Main Controller Block Diagram	68P81083C20	IF1-2-16	Not Indicated		
IF1-2-17	SQUELCH	Main Controller Block Diagram	68P81083C20	IF1-2-17	SQUELCH	Receiver IF	68P81080C49
IF1-2-18	ZIF_SEL	Main Controller Block Diagram	68P81083C20	IF1-2-18	ZIF_SEL	Receiver IF	68P81080C49
IF1-2-19	DUPLEX_SYN_SEL	Main Controller Block Diagram	68P81083C20	IF1-2-19	Not Indicated		
IF1-3-1	DUPLEX_LOCK_DET	Main Controller Block Diagram	68P81083C20	IF1-3-1	DUPLEX_LOCK_DETECT	Receiver IF	68P81080C49
IF1-3-2	DISC	Main Controller Block Diagram	68P81083C20	IF1-3-2	DISC	Receiver IF	68P81080C49
IF1-3-3	R_RSSI	Main Controller Block Diagram	68P81083C20	IF1-3-3	R_RSSI	Receiver IF	68P81080C49

Table 2. Schematic Diagram Interconnection List (Kit: HUE4011B2)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF1-3-4	SDATA	Main Controller Block Diagram	68P81083C20	IF1-3-4	SPI_TX_DATA	Receiver IF	68P81080C49
IF1-3-5	SCLK	Main Controller Block Diagram	68P81083C20	IF1-3-5	CLK	Receiver IF	68P81080C49
IF1-3-6	RX_CNTL_I_SRC	Main Controller Block Diagram	68P81083C20	IF1-3-6	Not Indicated		
IF1-3-7	GND	Main Controller Block Diagram	68P81083C20	IF1-3-7	Not Indicated		
IF1-3-8	2.1MHz	Main Controller Block Diagram	68P81083C20	IF1-3-8	2.1MHz	Receiver IF	68P81080C49
IF1-3-9	GND	Main Controller Block Diagram	68P81083C20	IF1-3-9	Not Indicated		
IF1-3-10	SYN_SEL	Main Controller Block Diagram	68P81083C20	IF1-3-10	SYN_SEL	Receiver IF	68P81080C49
IF1-3-11	LOCK_DET	Main Controller Block Diagram	68P81083C20	IF1-3-11	LOCK_DET	Receiver IF	68P81080C49
IF2-2-6	A+	Synthesizer	68P81080C49	IF2-2-6	A+_CONT	Main Controller Block Diagram	68P81083C20
IF2-2-7	VFORWARD	Synthesizer	68P81080C49	IF2-2-7	V_FORWARD	Main Controller Block Diagram	68P81083C20
IF2-2-8	VDRIVE	Synthesizer	68P81080C49	IF2-2-8	V_CNTL	Main Controller Block Diagram	68P81083C20
IF2-2-9	K9.2	Synthesizer	68P81080C49	IF2-2-9	K9V2	Main Controller Block Diagram	68P81083C20
IF2-2-10	GND	Synthesizer	68P81080C49	IF2-2-10	Not Indicated		
IF2-2-12	GND	Synthesizer	68P81080C49	IF2-2-12	Not Indicated		

Table 2. Schematic Diagram Interconnection List (Kit: HUE4011B2)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF2-3-1	PA_TEMP	Synthesizer	68P81080C49	IF2-3-1	PA_TEMP	Main Controller Block Diagram	68P81083C20
IF2-3-2	PA_CONTRL	Synthesizer	68P81080C49	IF2-3-2	PA_CNTL	Main Controller Block Diagram	68P81083C20
IF2-3-3	CURRENT_SENSE-	Synthesizer	68P81080C49	IF2-3-3	CURRENT_SENSE_-	Main Controller Block Diagram	68P81083C20
IF2-3-4	CURRENT_SENSE+	Synthesizer	68P81080C49	IF2-3-4	CURRENT_SENSE_+	Main Controller Block Diagram	68P81083C20
IF2-3-5	A+	Synthesizer	68P81080C49	IF2-3-5	A+_CONT	Main Controller Block Diagram	68P81083C20
IF2-3-13	GND	Synthesizer	68P81080C49				
IF2-3-14	GND	Synthesizer	68P81080C49				
IF2-4-11	GNDD	Synthesizer	68P81080C49	IF2-4-11	GND	Main Controller Block Diagram	68P81083C20
IF3-2-1	ZIF_SEL	Receiver IF	68P81080C49	IF3-2-1	ZIF_SEL	Receiver Back End	68P81080C49
IF3-2-6	SQUELCH	Receiver IF	68P81080C49	IF3-2-6	SQUELCH	Receiver Back End	68P81080C49
IF3-2-9	IF OUT	Receiver IF	68P81080C49	IF3-2-9	IF_OUT	Receiver Back End	68P81080C49
IF3-3-2	CLK	Receiver IF	68P81080C49	IF3-3-2	CLK	Receiver Back End	68P81080C49
IF3-3-3	SPI_TX_DATA	Receiver IF	68P81080C49	IF3-3-3	SPI_TX_DATA	Receiver Back End	68P81080C49
IF3-3-4	DISC	Receiver IF	68P81080C49	IF3-3-4	DISC	Receiver Back End	68P81080C49
IF3-3-5	2.1MHz	Receiver IF	68P81080C49	IF3-3-5	2.1Mhz	Receiver Back End	68P81080C49
IF3-3-7	Z_RSSI	Receiver IF	68P81080C49	IF3-3-7	Z_RSSI	Receiver Back End	68P81080C49
IF3-4-8	RF_REG_5V	Receiver Front End	68P81080C49	IF3-4-8	RF_REG_5V	Receiver Back End	68P81080C49
IF4-1-6	AUDIO_MOD	Synthesizer	68P81080C49	IF4-1-6	AUDIO_MOD	Receiver IF	68P81080C49

Table 2. Schematic Diagram Interconnection List (Kit: HUE4011B2)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF4-2-7	2.1 MHz	Synthesizer	68P81080C49	IF4-2-7	2.1MHz	Receiver IF	68P81080C49
IF4-3-1	CLK	Synthesizer	68P81080C49	IF4-3-1	CLK	Receiver IF	68P81080C49
IF4-3-3	LOCK_DET	Synthesizer	68P81080C49	IF4-3-3	LOCK_DET	Receiver IF	68P81080C49
IF4-3-4	SYN_SEL	Synthesizer	68P81080C49	IF4-3-4	SYN_SEL	Receiver IF	68P81080C49
IF4-3-9	SP1_TX_DATA	Synthesizer	68P81080C49	IF4-3-9	SPI_TX_DATA	Receiver IF	68P81080C49
IF4-4-2	9V3	Synthesizer	68P81080C49	IF4-4-2	9.3V	Receiver IF	68P81080C49
IF4-4-5	ROSC_SEL	Synthesizer	68P81080C49	IF4-4-5	ROSC_SEL	Receiver IF	68P81080C49
IF4-4-8	RF_REG_5V	Synthesizer	68P81080C49	IF4-4-8	RF_REG_5V	Receiver Front End	68P81080C49
IF4-4-10	13V_PULLUP	Synthesizer	68P81080C49	IF4-4-10	13V_PULLUP_(PLL)	Receiver IF	68P81080C49
IF5-1-1	IF_IN	Receiver IF	68P81080C49	IF5-1-1	IF_IN	Receiver Front End	68P81080C49
IF5-2-3	RX_CNTRL_1	Receiver IF	68P81080C49	1F1-2-16	RX_CNTRL_1	Receiver Front End	68P81080C49
IF5-3-2	9.3V	Receiver IF	68P81080C49	IF5-3-2	9.3V	Receiver Front End	68P81080C49
IF5-4-4	RF_REG_5V	Receiver IF	68P81080C49	IF5-4-4	RF_REG_5V	Receiver Front End	68P81080C49
IF7-1-11	SPK+	Main Controller Block Diagram	68P81083C20	IF7-1-11	SPK+	Controller Power Control	68P81083C20
IF7-1-12	SPK-	Main Controller Block Diagram	68P81083C20	IF7-2-12			
IF7-1-15	PA_CNTL	Main Controller Block Diagram	68P81083C20	IF2-3-2			
IF7-1-17	GND	Main Controller Block Diagram	68P81083C20	IF7-1-17	GND	Controller Power Control	68P81083C20
IF7-1-23	PWR_RST	Main Controller Block Diagram	68P81083C20	IF7-1-23	PWR_RST	Controller Power Control	68P81083C20

Table 2. Schematic Diagram Interconnection List (Kit: HUE4011B2)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF7-1-31	TEMP_GND	Main Controller Block Diagram	68P81083C20	IF7-4-10			
IF7-2-3	V_CNTL	Main Controller Block Diagram	68P81083C20	IF7-2-3	V_CNTL	Controller Power Control	68P81083C20
IF7-2-4	V_FORWARD	Main Controller Block Diagram	68P81083C20	IF7-2-4	V_FORWARD	Controller Power Control	68P81083C20
IF7-2-7	UNSW_5V	Main Controller Block Diagram	68P81083C20	IF7-2-7	UNSW_5V	Controller Power Control	68P81083C20
IF7-2-8	CL_UNSW_5V	Main Controller Block DIagram	68P81083C20	IF7-2-8	CL_UNSW_5V	Controller Power Control	68P81083C20
IF7-2-10	RX_AUDIO	Main Controller Block Diagram	68P81083C20	IF7-4-10			
IF7-2-12	SPK-	Main Controller Block Diagram	68P81083C20	IF7-4-12			
IF7-2-13	CURRENT_SENSE_+	Main Controller Block Diagram	68P81083C20	IF7-2-13	CURRENT_SENSE_+	Controller Power Control	68P81083C20
IF7-2-20	CLEAR	Main Controller Block Diagram	68P81083C2	IF7-2-20	CLEAR	Controller Power Control	68P81083C20
IF7-2-21	B+_IGNITION	Main Controller Block Diagram	68P81083C20	IF7-2-21	B+_IGNITION	Controller Power Control	68P81083C20
IF7-2-24	A+	Main Controller Block Diagram	68P81083C20				
IF7-2-25	A+_CONT	Main Controller Block Diagram	68P81083C20	IF7-2-25	A+_CONT	Controller Power Control	68P81083C20
IF7-2-26	9V3	Main Controller Block DIagram	68P81083C20	IF7-2-26	9V3	Controller Power Control	68P81083C20
IF7-2-27	SW_B+	Main Controller Block Diagram	68P81083C20	IF7-2-27	SW_B+	Controller Power Control	68P81083C20

Table 2. Schematic Diagram Interconnection List (Kit: HUE4011B2)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
IF7-2-28	Vdd	Main Controller Block Diagram	68P81083C20	IF7-2-28	Vdd	Controller Power Control	68P81083C20
IF7-2-29	SW_B+	Controller Power Control	68P81083C20	IF7-2-27			
IF7-2-30	9V3	Main Controller Block Diagram	68P81083C20	IF7-2-30	9V3	Controller Power Control	68P81083C20
IF7-3-5	K9V1	Main Controller Block Diagram	68P81083C20	IF7-3-5	K9V1	Controller Power Control	68P81083C20
IF7-3-6	PA_TEMP	Main Controller Block Diagram	68P81083C20	IF7-3-6	PA_TEMP	Controller Power Control	68P81083C20
IF7-3-14	CURRENT_SENSE_-	Controller Power Control	68P81083C20	IF2-3-3			
IF7-3-15	PA_CNTL	Controller Power Control	68P81083C20	IF2-3-2			
IF7-3-18	Vaud	Main Controller Block Diagram	68P81083C20	IF7-3-18	Vaud	Controller Power Control	68P81083C20
IF7-3-22	+5V	Controller Power Control	68P81083C20	IF7-4-22			
IF7-4-1	VFWD_BUF	Main Controller Block Diagram	68P81083C20	IF7-4-1	VFWD_BUF	Controller Power Control	68P81083C20
IF7-4-2	VSUM	Main Controller Block Diagram	68P81083C20	IF7-4-2	VSUM	Controller Power Control	68P81083C20
IF7-4-9	AUPA_EN	Main Controller Block Diagram	68P81083C20	IF7-4-9	AUPA_EN	Controller Power Control	68P81083C20
1F7-4-10	RX_AUDIO	Main Controller Block Diagram	68P81083C20	1F7-2-10			
1F7-4-14	CURRENT_SENSE	Main Controller Block Diagram	68P81083C20	1F2-3-3			

Table 2. Schematic Diagram Interconnection List (Kit: HUE4011B2)

From/To				From/To			
Node	**Signal Name**	**Schematic Diagram Title**	**Publication**	**Node**	**Signal Name**	**Schematic Diagram Title**	**Publication**
1F7-4-16	A+	Main Controller Block Diagram	68P81083C20				
1F7-4-19	B+_ON_OFF	Main Controller Block Diagram	68P81083C20				
IF7-4-22	+5V	Main Controller Block Diagram	68P81083C20	IF7-3-22, IF7-4-24	A+	Controller Power Control	68P81083C20
IF8-3-1	LO_INJ	Synthesizer	68P81080C49	IF8-3-1	RX_INJ	Receiver Front End	68P81080C49
IF9-2-6	A+	Power Amplifier	68P81080C49	IF9-2-6	A+	Synthesizer	68P81080C49
IF9-2-7	V_FORWARD	Power Amplifier	68P81080C49	IF9-2-7	V_FORWARD	Synthesizer	68P81080C49
IF9-2-8	V_DRIVE	Synthesizer	68P81080C49	IF9-2-8	V_DRIVE	Synthesizer	68P81080C49
IF9-2-9	K9.1	Power Amplifier	68P81080C49	IF9-2-9	K9.1	Synthesizer	68P81080C49
IF9-2-10	GND	Power Amplifier	68P81080C49	IF9-2-10	GND	Synthesizer	68P81080C49
IF9-2-11	TX_INJ	Power Amplifier	68P81080C49	IF9-2-11	TX_INJ	Synthesizer	68P81080C49
IF9-2-14	GND	Power Amplifier	68P81083C20				
IF9-3-1	PA_TEMP	Power Amplifier	68P81080C49	IF9-3-1	PA_TEMP	Synthesizer	68P81080C49
IF9-3-2	PA_CNTL	Power Amplifier	68P81080C49	IF9-3-2	PA_CNTL	Synthesizer	68P81080C49
IF9-3-3	CURRENT SENSE -	Power Amplifier	68P81080C49	IF9-3-3	CURRENT_SENSE-	Synthesizer	68P81080C49
IF9-3-4	CURRENT SENSE +	Power Amplifier	68P81080C49	IF9-3-4	CURRENT_SENSE+	Synthesizer	68P81080C49
IF9-3-5	A+	Power Amplifier	68P81080C49	IF9-3-5	A+	Synthesizer	68P81080C49
IF9-4-13	GNDD	Power Amplifier	68P81080C49	IF9-4-13	GNDD	Synthesizer	68P81080C49
IF10-3-1	RX_IN	Power Amplifier	68P81080C49	IF10-3-1	RX_IN	Receiver Front End	68P81080C49

REPLACEMENT PARTS ORDERING

ORDERING INFORMATION

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the model number in which the part is used.

MAIL ORDERS

Send written orders to the following addresses:

Replacement Parts/
Test Equipment/Manuals/
Crystal Service Items:

Motorola Inc.
United States and Canada
Accessories and Aftermarket
Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Federal Government Orders:

Motorola Inc.
United States and Canada
Accessories and Aftermarket
Division
Attention: Order Processing
7230 Parkway Drive
Landover, MD 21076

International Orders:

Motorola Inc.
United States and Canada
Accessories and Aftermarket
Division
Attention: International Order
Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

TELEPHONE ORDERS

United States and Canada Accessories and Aftermarket Division:
Call: 1-800-422-4210
1-800-826-1913 (For Federal Government Orders)
1-847-538-8023 (International Orders)

Servicers Training (VHS Video Tapes):
Call: 847-576-2828

FAX ORDERS

United States and Canada Accessories and Aftermarket Division:
FAX: 847-538-8198 (Domestic)
847-576-3023 (International)
Parts ID: 847-538-8194

Federal Government Orders:
FAX: 410-712-4991
International: 410-712-6200

PARTS CUSTOMER SERVICE

United States and Canada Accessories and Aftermarket Division:
Call: 1-800-422-4210
Parts Identification:
Call: 847-538-0021

PRODUCT CUSTOMER SERVICE

Customer Response Center
(Sales and Service Assistance):
Call: 1-800-247-2346
FAX: 1-800-232-9272

MOTOROLA

MCS 2000 Mobile Radio Service Instructions

UHF 25W Range 1 AND 2 Specific

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