

EC600U Series

Reference Design

LTE Standard Module Series

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Status: Released



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About the Document

Revision History

Version	Date	Author	Description
-	2021-06-21	Manli CHEN	Creation of the document
1.0	2021-07-13	Manli CHEN	First official release
1.1	2022-01-28	Manli CHEN	<ol style="list-style-type: none"> Added the design for the optional (U)SIM2 interface (Sheet 3&7). Added the note on I2C interface (Sheet 8). Updated the note on ESD protection components (Sheet 9). Changed the unidirectional TVS diodes to bidirectional ones (Sheet 10). Updated the formation of matrix keypad to 5 × 6 (Sheet 13).
1.2	2022-08-22	Denny QIN	<ol style="list-style-type: none"> Selected pin names have been updated: Pin 64: from LCD_SPI_RST to LCD_RST; Pin 65: from LCD_CS to LCD_SPI_CS; Pin 96: from AP_26M_OUT to RESERVED; Pin 136: from RESERVED to USIM2_VDD (Sheet 3). Added ADC voltage divider circuit and NOTE 4, and a TVS on VDD_EXT trace and NOTE 7 (Sheet 3). Added the circuit for waking up the module from PSM (Sheet 4). Changed the position of TVS diodes of the handset circuit (Sheet 10). Added filter capacitors for LCD_VDDIO (Sheet 12).

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1 Reference Design

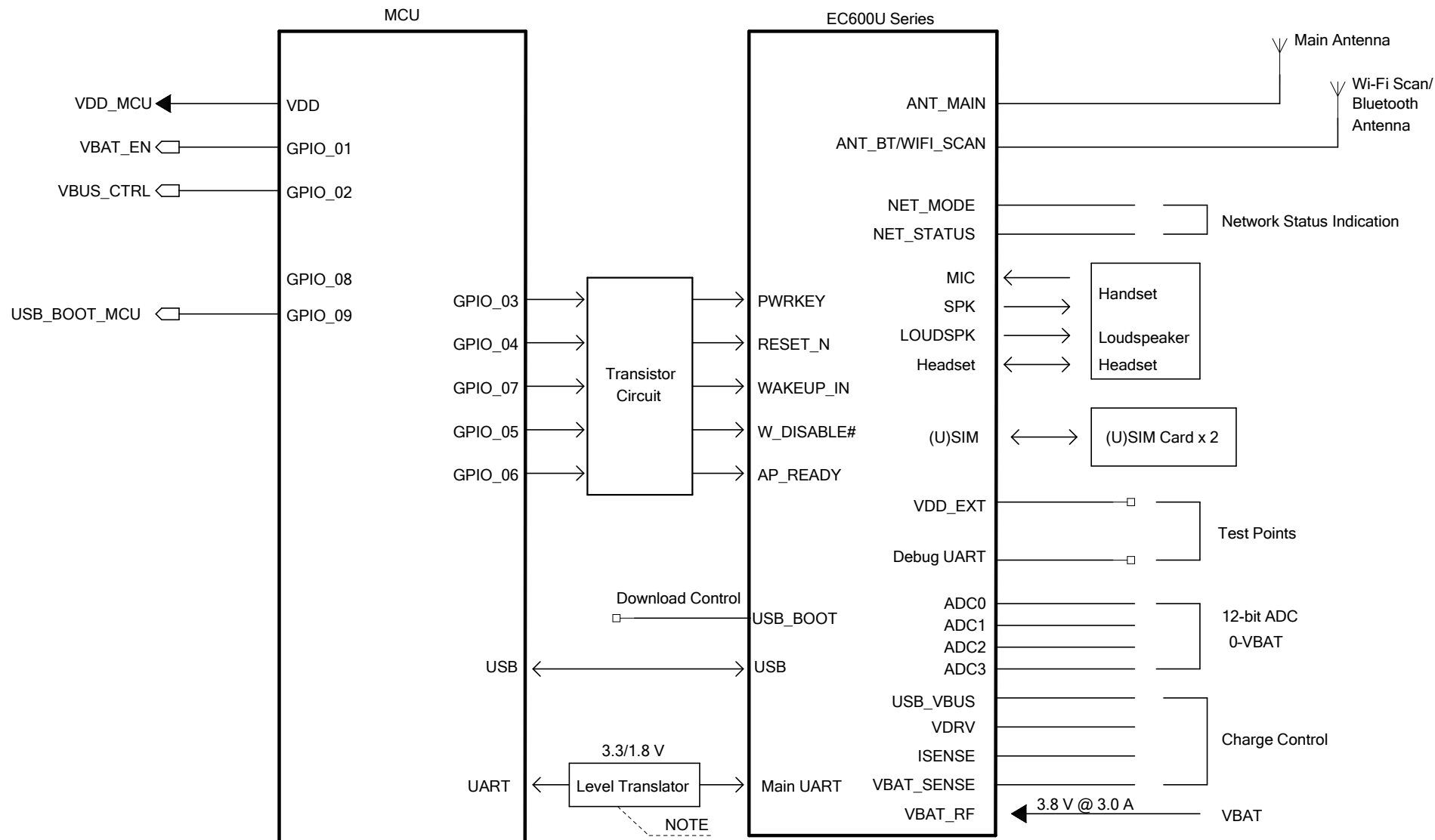
1.1. Introduction

This document provides the reference design for Quectel EC600U series module. This reference design mainly includes block diagrams of module design, power supply, antenna interfaces, (U)SIM interfaces, camera interface, analog audio interfaces, UART, LCM interface, matrix keypad, and indicators.

1.2. Schematics

The schematics illustrated in the following pages are provided for your reference only.

Reference Design Block Diagram

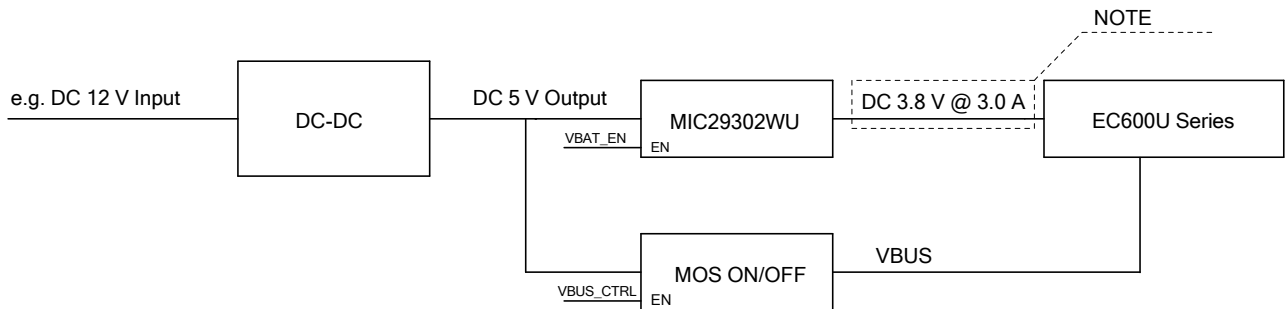


NOTE:

A level-shifting circuit with triode or a level translator TXS0108EPWR provided by Texas Instruments is recommended.

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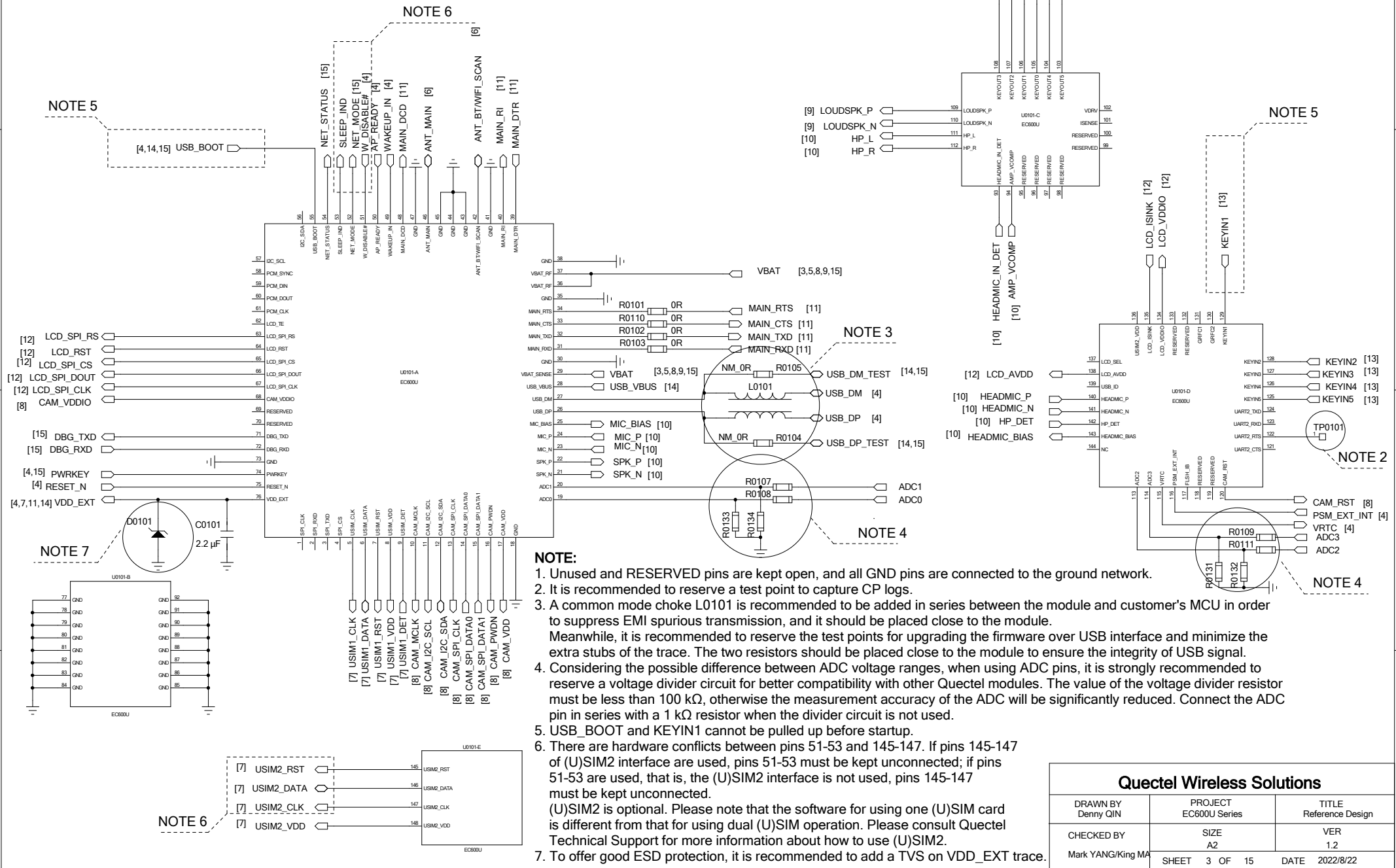
Power Supply Block Diagram



NOTE:
 The power supply for EC600U-CN should be at least 2 A of current and at least 3 A of current for EC600U-EU.

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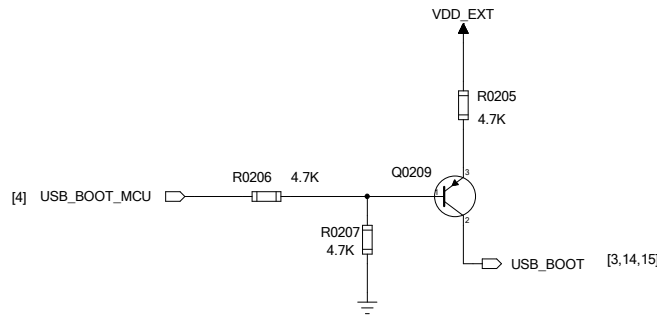
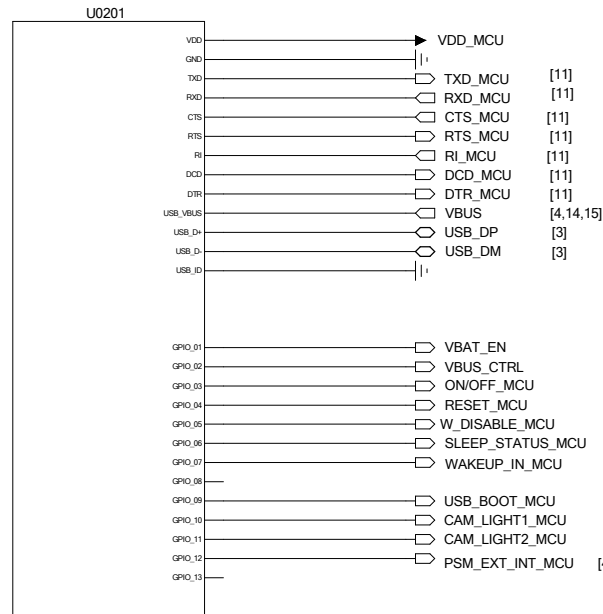
Module Interface



- NOTE:**
- Unused and RESERVED pins are kept open, and all GND pins are connected to the ground network.
 - It is recommended to reserve a test point to capture CP logs.
 - A common mode choke L0101 is recommended to be added in series between the module and customer's MCU in order to suppress EMI spurious transmission, and it should be placed close to the module. Meanwhile, it is recommended to reserve the test points for upgrading the firmware over USB interface and minimize the extra stubs of the trace. The two resistors should be placed close to the module to ensure the integrity of USB signal.
 - Considering the possible difference between ADC voltage ranges, when using ADC pins, it is strongly recommended to reserve a voltage divider circuit for better compatibility with other Quectel modules. The value of the voltage divider resistor must be less than 100 kΩ, otherwise the measurement accuracy of the ADC will be significantly reduced. Connect the ADC pin in series with a 1 kΩ resistor when the divider circuit is not used.
 - USB_BOOT and KEYIN1 cannot be pulled up before startup.
 - There are hardware conflicts between pins 51-53 and 145-147. If pins 145-147 of (U)SIM2 interface are used, pins 51-53 must be kept unconnected; if pins 51-53 are used, that is, the (U)SIM2 interface is not used, pins 145-147 must be kept unconnected. (U)SIM2 is optional. Please note that the software for using one (U)SIM card is different from that for using dual (U)SIM operation. Please consult Quectel Technical Support for more information about how to use (U)SIM2.
 - To offer good ESD protection, it is recommended to add a TVS on VDD_EXT trace.

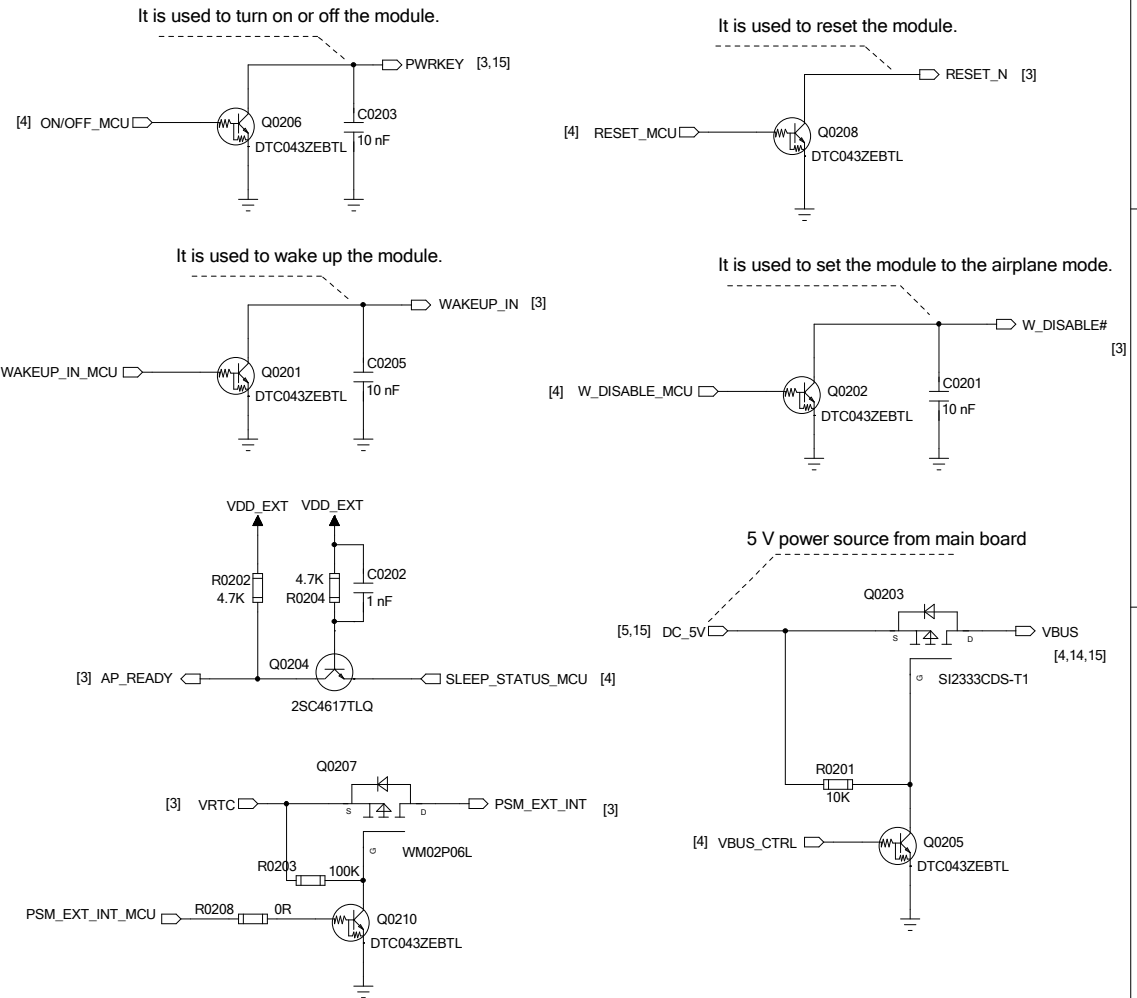
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MCU Interface



NOTE:

- U0201 represents customer's MCU. The power domain of GPIO interfaces of EC600U series module is 1.8 V; if the GPIO interfaces of U0201 share the same power domain, then the related level-shifting circuit can be omitted.
- The USB interface of the module can only be used in the USB slave mode and supports full-speed and high-speed modes of USB 2.0. To communicate with the USB interface, MCU needs to support USB host mode or USB OTG. The USB_VBUS pin of the module should be powered by an external power system for USB detection, and VBUS_CTRL is used to turn on/off the USB_VBUS power supply.
- It is recommended to select the default low-level GPIO pins of MCU as the control pins for PWRKEY and RESET_N of the module. Ensure that the maximum load capacitance of pin PWRKEY and pin RESET_N does not exceed 10 nF.
- To prevent the module from staying in download mode due to that the triode Q0209 conducts after the MCU is powered on, the USB_BOOT_MCU pin needs to be at high level by default when the MCU is powered on. For the same purpose, if the triode control method is not used, the method of reserved pins or key press can be used.



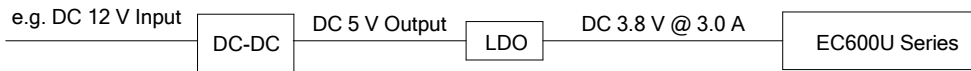
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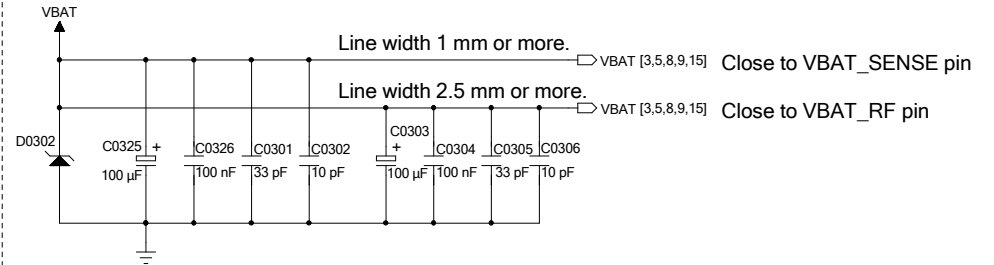
Power Supply Design

DC-DC Application

It is used when the input voltage is above 7.0 V. Use a DC-DC converter to convert a high input voltage to a 5.0 V output, and then use an LDO IC to convert to 3.8 V.



VBAT Design

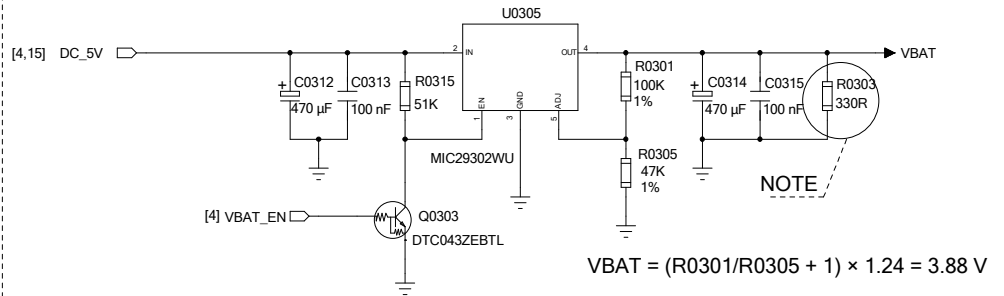


NOTE:

1. The power supply for EC600U-CN should be at least 2 A of current and at least 3 A of current for EC600U-EU.
2. VBAT traces should be routed in star structure to VBAT_SENSE and VBAT_RF pins.
3. The recommended operating voltage of VBAT is 3.3-4.3 V.

LDO Application

It is used when the input voltage is below 7.0 V. Use an LDO IC to convert the input voltage to 3.8 V.



$$VBAT = (R0301/R0305 + 1) \times 1.24 = 3.88 \text{ V}$$

NOTE: The recommended load current is greater than 10 mA.

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3

2

1

Antenna Interfaces Design

Wi-Fi Scan/Bluetooth Antenna

[3] ANT_BT/WIFI_SCAN

R0401 0R

C0401 NM

C0402 NM

J0401

NOTE 1

Main Antenna

[3] ANT_MAIN

R0402 0R

C0403 NM

C0404 NM

J0402

NOTE 1

NOTE:

1. It is highly recommended to reserve a Π type matching circuit to facilitate future debugging.
2. The single-ended impedance of the RF antenna is 50 Ω .

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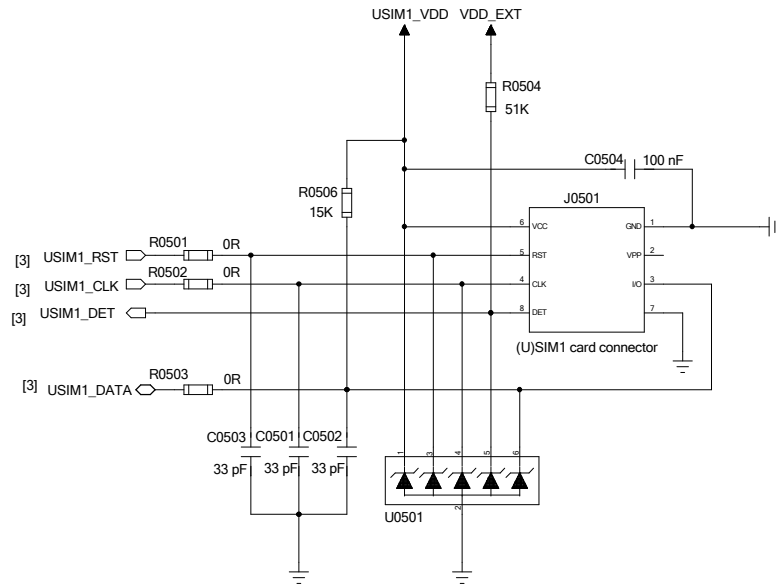
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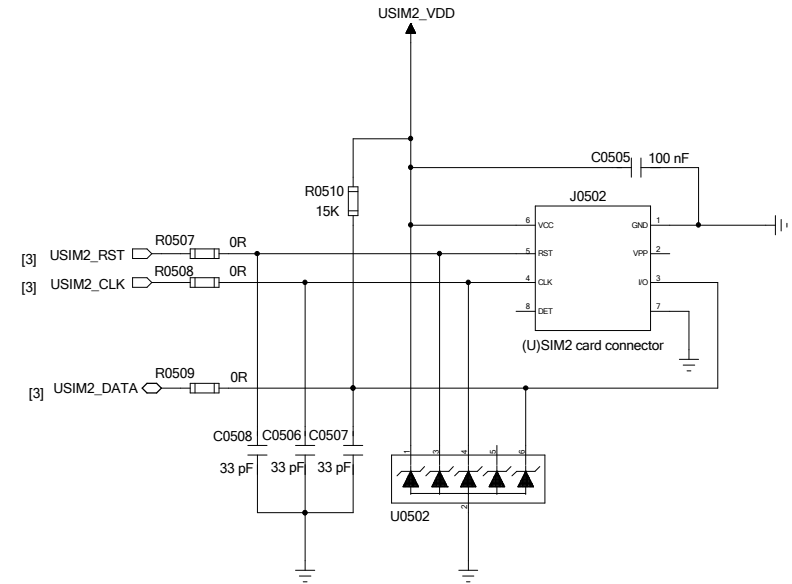
1

(U)SIM Interfaces Design

(U)SIM1 Interface



(U)SIM2 Interface



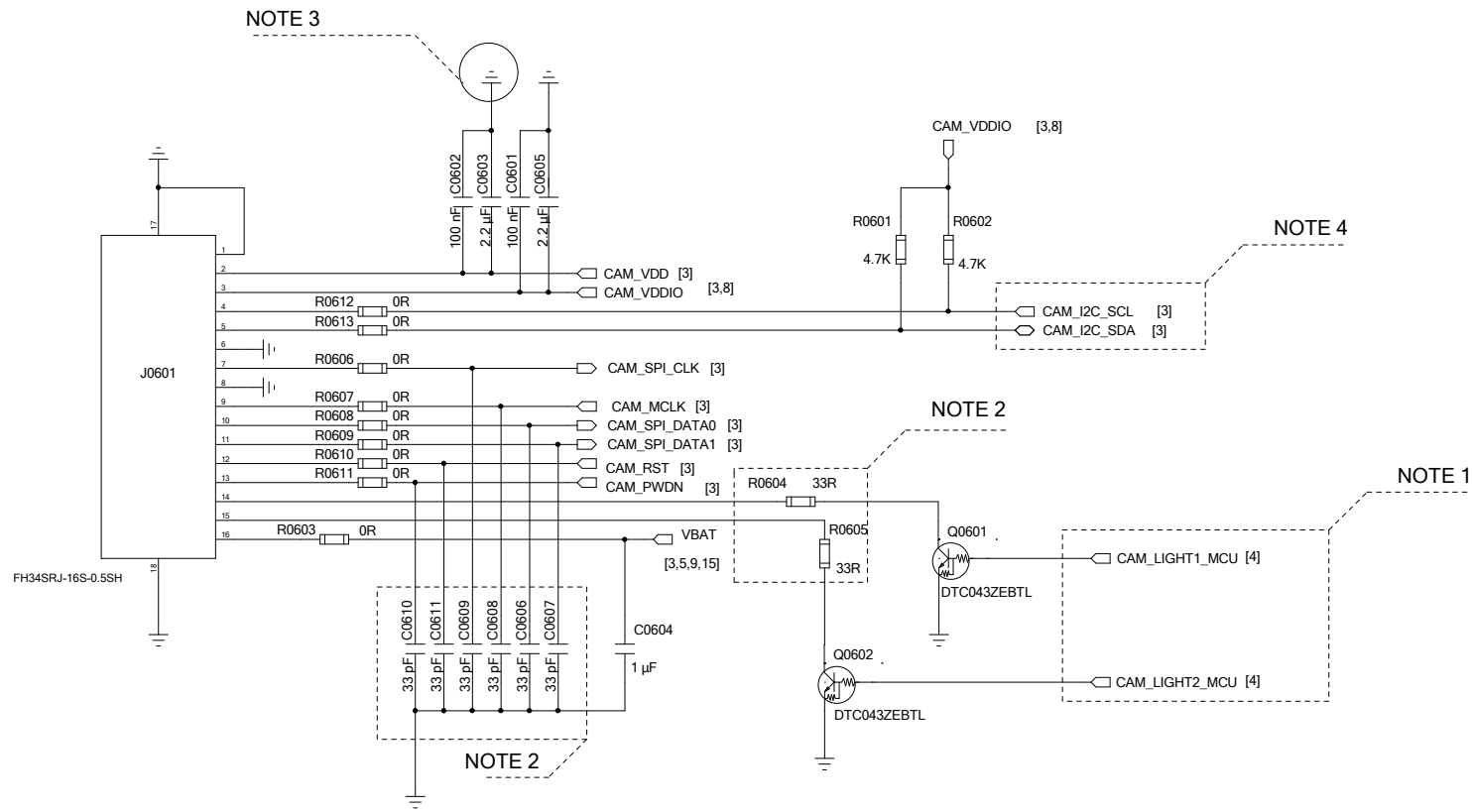
NOTE:

1. U0501 and U0502 are recommended to be used to offer good ESD protection, and the parasitic capacitance should be less than 15 pF.
2. The pull-up resistors R0506 and R0510 can improve anti-jamming capability, and should be placed close to the (U)SIM card connector.
3. R0501-R0503 and R0507-R0509 are used for debugging. C0501-C0503 and C0506-C0508 are used for filtering out RF interference.
4. The capacitance of C0504 and C0505 should be less than 1 μ F and they should be placed close to the (U)SIM card connector.
5. The GND of the (U)SIM card connector is recommended to be connected to the GND layer of customer's PCB directly .
6. The (U)SIM2 interface of the module does not support hot-plug detection.
7. For more information about the layout of (U)SIM interfaces, please refer to *Quectel_EC600U_Series_Hardware_Design*.

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Camera Interface Design



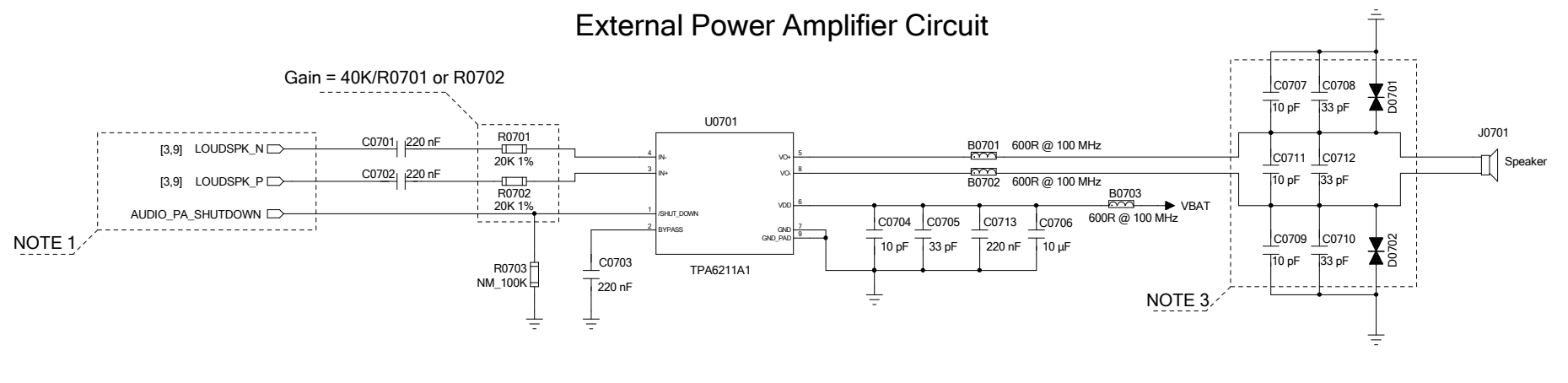
NOTE:

- CAM_LIGHT1_MCU controls the cathode of the position lamp of the camera by controlling the triode switching circuit; CAM_LIGHT2_MCU controls the cathode of the fill light of the camera by controlling the triode switching circuit. Choose GPIO pins with default pull-down status as CAM_LIGHT1_MCU and CAM_LIGHT2_MCU.
- The 33 pF capacitors of the signal pins are reserved, and they are used according to the actual debugging situation. The values of current limiting resistors of position lamp and fill light, R0604 and R0605, should be varied according to brightness requirements.
- The capacitors of the CAM_VDD power supply should be connected to the GND layer directly, otherwise there may be power noise leading to abnormalities such as white dots on the preview screen.
- If the camera interface is not required, CAM_I2C_SCL and CAM_I2C_SDA can be used as an I2C interface to connect other peripherals.

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Analog Audio Design (Loudspeaker)

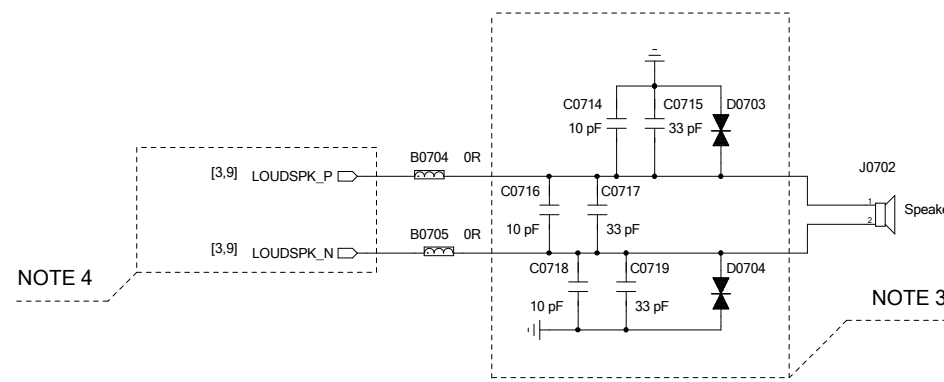
External Power Amplifier Circuit



NOTE 1

NOTE 3

Internal Power Amplifier Circuit



NOTE 4

NOTE 3

NOTE:

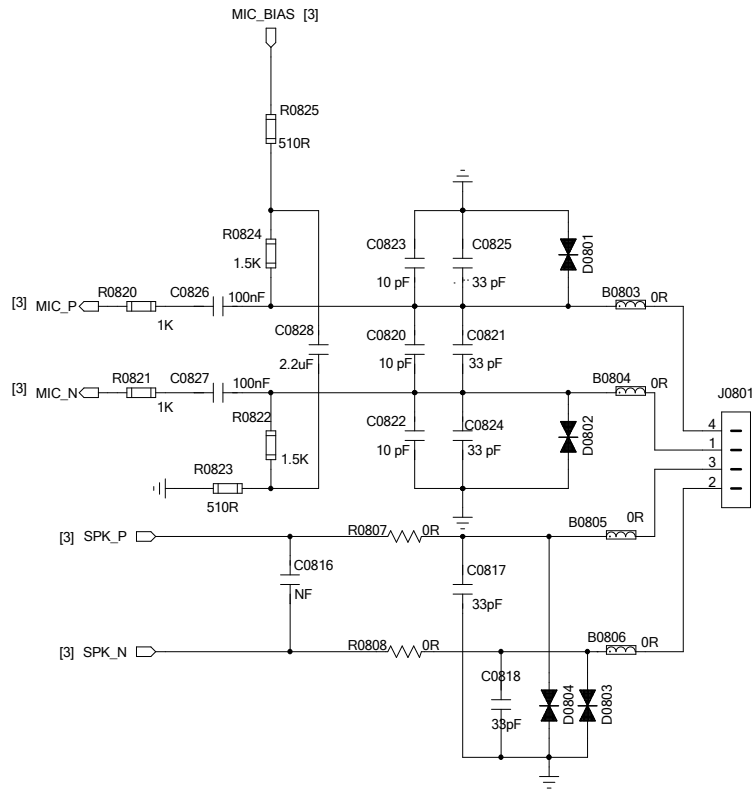
- LOUDSPK_N and LOUDSPK_P are differential outputs. To eliminate POP, it is recommended to choose one of the GPIO pins of the module as the AUDIO_PA_SHUTDOWN pin of the power amplifier. For details, please contact Quectel Technical Support.
- Choose the audio power amplifier with appropriate power according to actual needs.
- Place filter capacitors and ESD protection components close to the speaker. Choose ESD protection components according to the output voltage amplitude of the PA. To avoid damages to the ESD protection components, please ensure that the output voltage amplitude of the PA is within their maximum reverse working voltage under normal working conditions.
- The module has an internal power amplifier, of which the maximum drive power is 800 mW (8 Ω load) when set to Class D, and 500 mW (8 Ω load) when set to Class AB. The default configuration is Class AB.

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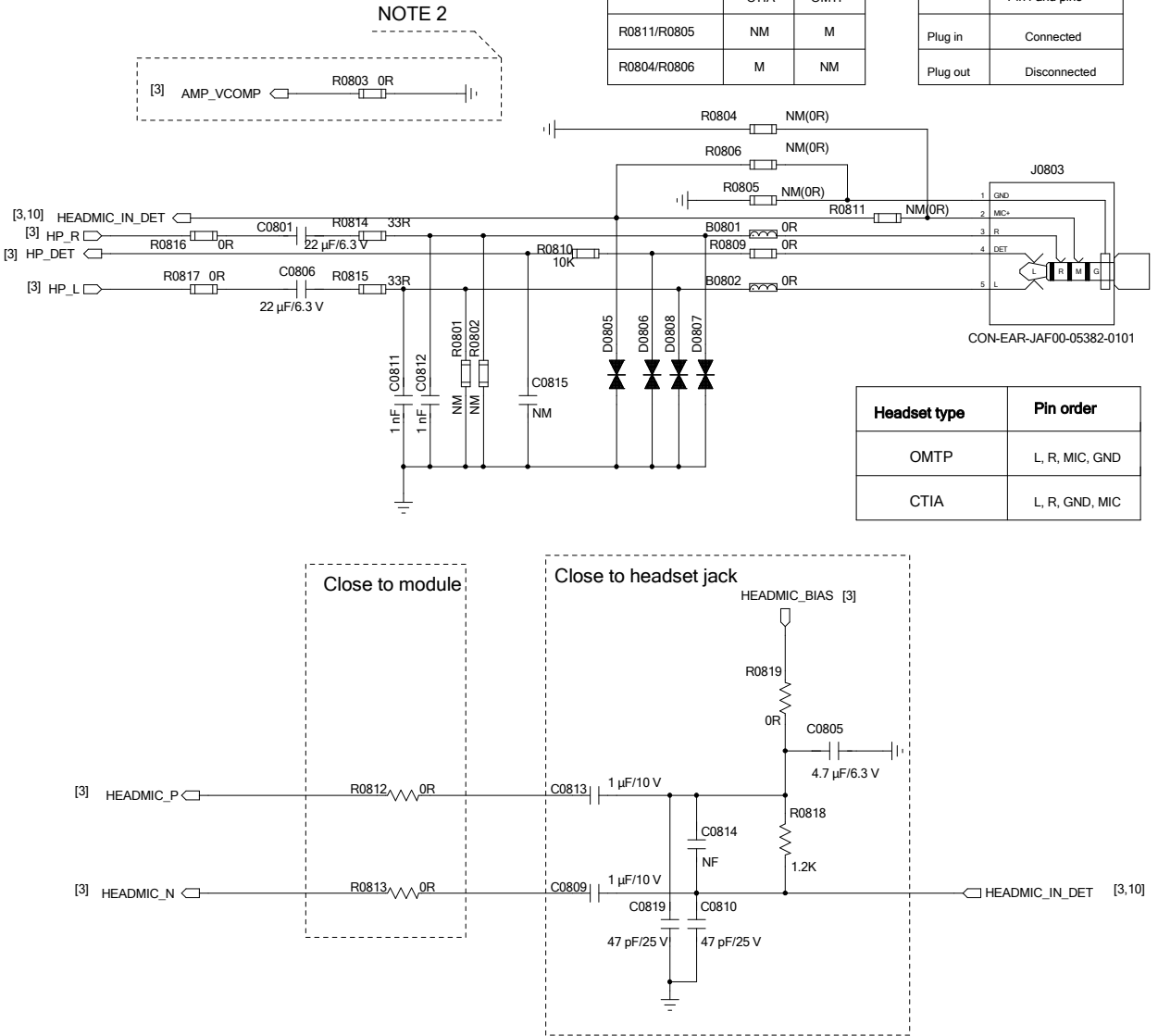
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Analog Audio Design

Handset (Microphone and Receiver)



Headset Jack



NOTE 2

Compatible design

	CTIA	OMTP
R0811/R0805	NM	M
R0804/R0806	M	NM

Headset insert detection mechanism

	Pin4 and pin5
Plug in	Connected
Plug out	Disconnected

Headset type	Pin order
OMTP	L, R, MIC, GND
CTIA	L, R, GND, MIC

Close to module

Close to headset jack

NOTE:

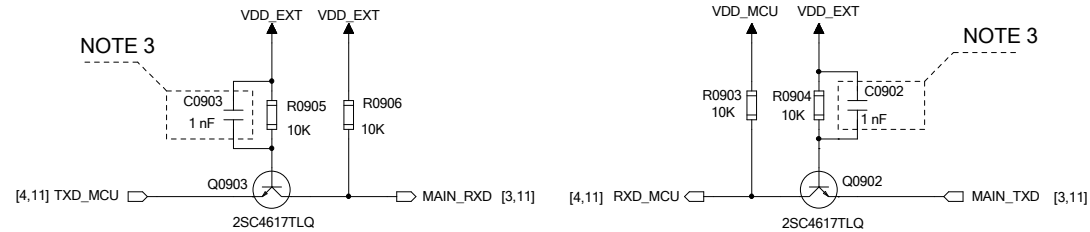
- Both the MIC and SPK signal traces need to be routed as differential pairs. All MIC and SPK signal traces should be surrounded with ground on the layer and with ground planes above and below, and far away from noise sources.
- AMP_VCOMP pin is the dedicated GND pin for headset. It should be traced between the left and right channels, and connected to the GND of the headset jack, and then directly connected to the main GND layer. Be sure to isolate it from other GNDs to avoid noise interferences.

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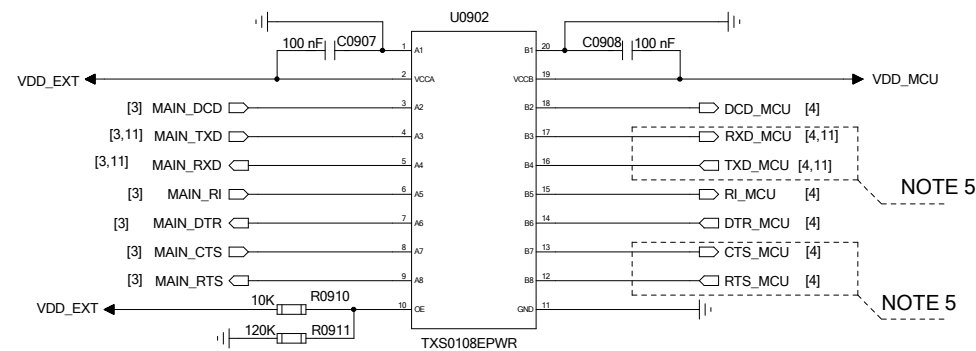
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UART Interface Design

UART Translation - Transistor Solution



UART Translation - IC Solution



NOTE:

1. There are two translation solutions: transistor solution and IC solution, and it is recommended to select the latter.

2. The power supply of TXS0108EPWR's VCCA should not exceed that of VCCB.

For more information, please refer to the datasheet of TXS0108EPWR.

3. The transistor circuit solution is not suitable for applications with baud rates exceeding 460 kbps.

The capacitors C0902 and C0903 of 1 nF can improve the signal quality.

4. The MAIN_RTS and MAIN_DTR transistor circuits are similar to that of the MAIN_RXD.

The MAIN_CTS, MAIN_RI and MAIN_DCD transistor circuits are similar to that of the MAIN_TXD.

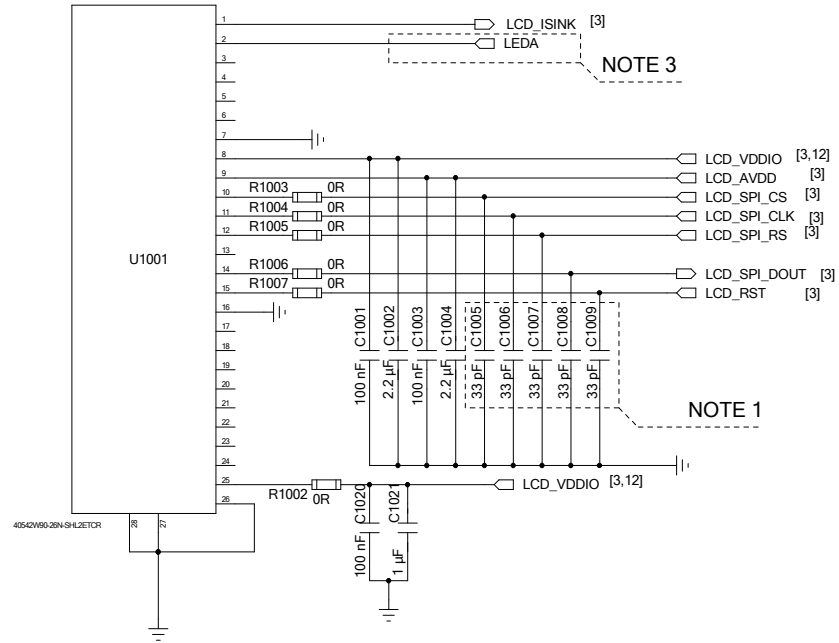
5. The hardware flow control pins CTS and RTS adopt the direct connection mode, that is, the RTS of the module is connected to the RTS of the MCU, and the CTS of the module is connected to the CTS of the MCU. Pay attention to the direction of signal input and output.

TXD and RXD adopt a cross connection mode, that is, the TXD and RXD of the module are connected to the RXD and TXD of the MCU respectively.

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LCM Interface Design

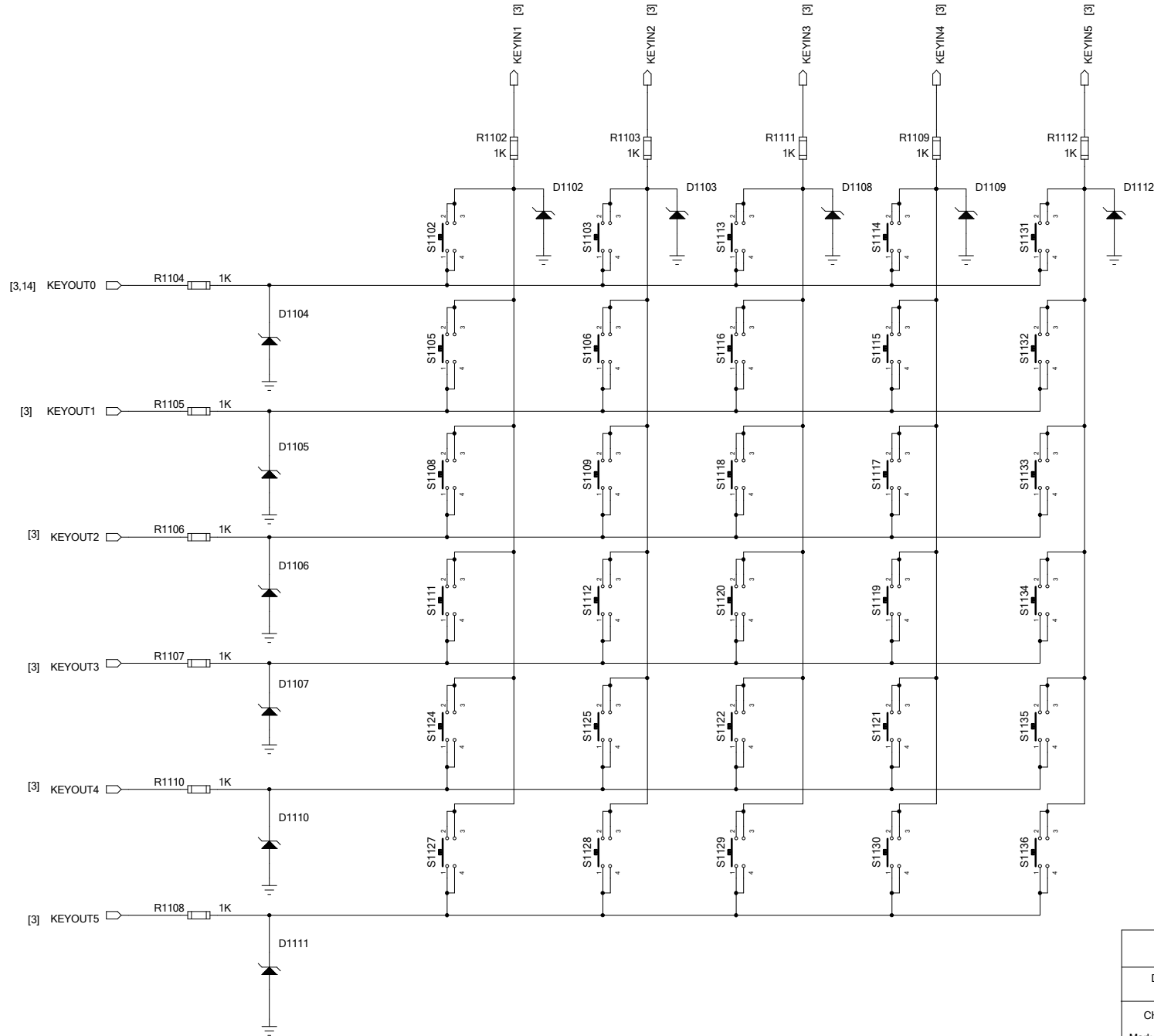


NOTE:

1. The 33 pF capacitors of the signal pins are reserved, and can be used as per the actual debugging situation.
2. To avoid abnormal LCD display caused by power fluctuation, the filter capacitors of the LCD power supply pins, LCD_AVDD and LCD_VDDIO, must be attached.
3. The power supply pin LEDA of the backlight is provided by external power supply circuit, and you can design the circuit by yourself.

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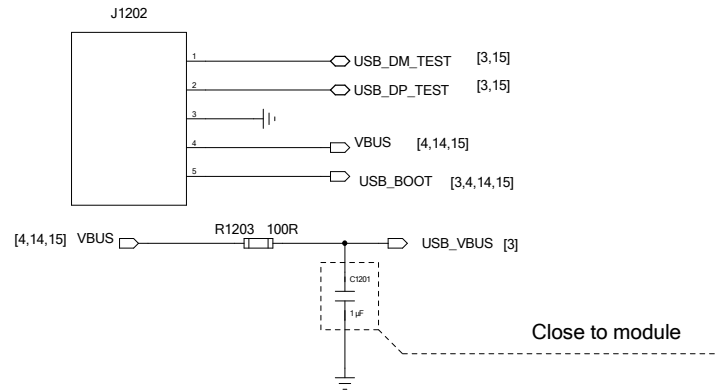
Matrix Keypad Design



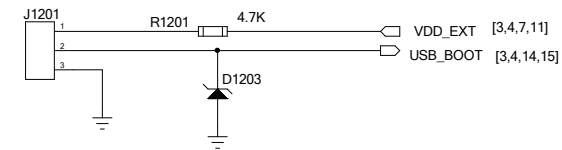
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Download Methods

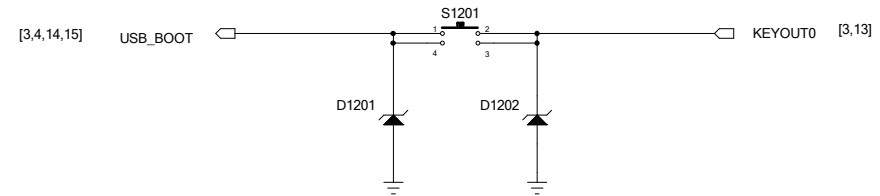
USB Interface Download Design



USB_BOOT Interface Design Method I



USB_BOOT Interface Design Method II



NOTE:

- Put the module into the download mode before upgrading the firmware. There are two ways to enter the download mode:
 Method I: Connect the USB_BOOT with VDD_EXT before power-up, and the module will enter the download mode when it is turned on;
 Method II: Press the button composed of "USB_BOOT + KEYOUT0" before power-up, and the module will enter the download mode when it is turned on.
- Be sure to reserve the USB_BOOT interface circuit (choose one of the two methods) to upgrade the firmware. If the application device has a scan button, it is recommended to adopt the download circuit design of the second method, that is, entering the download mode by pressing the button, to facilitate the firmware upgrade of the final product.
- The circuit of USB_BOOT Interface Design Method I is compatible with the method for EC600x series modules to enter the download mode:
 pulling up USB_BOOT pin for EC600U series and EC600S-CN (connect J1201.1 with J1201.2), and pulling it down for EC600N-CN (connect J1201.2 with J1201.3).

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Other Designs

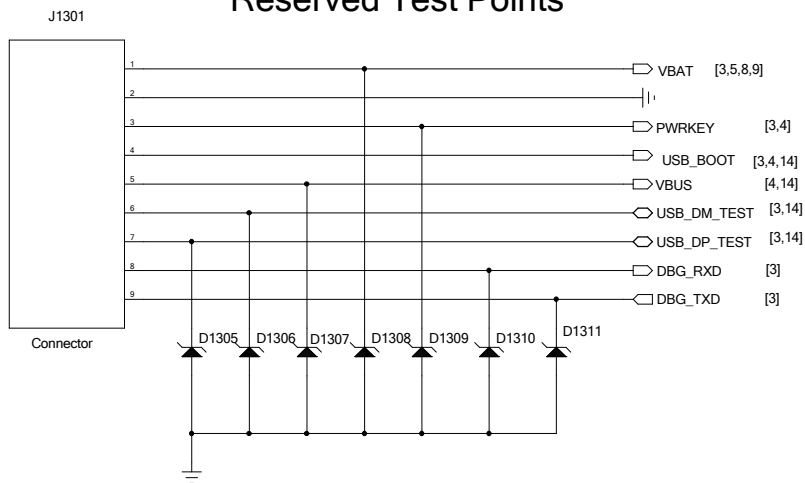
Indicators



NOTE:

1. For more details about NET_MODE and NET_STATUS, please refer to *Quectel_EC600U_Series_Hardware_Design*.
2. If the low power consumption is required when the customer's device is in sleep, replace the power supply DC_5V of the NET_MODE and NET_STATUS indicators with the external controllable ones, which can be turned off when the module is in sleep mode to reduce the power consumption.

Reserved Test Points



NOTE:

1. Test points for both USB and debug UART interfaces are recommended to be reserved for capturing logs; the USB interface can also be used to upgrade the firmware of the module.
2. The parasitic capacitance of the ESD protection components on USB data lines should be less than 2 pF.
3. The debug UART interface supports 1.8 V power domain, and a level-shifting circuit should be used if the power domain of customer's application is 3.3 V. For details, please refer to the "UART Interface Design". The debug UART only supports the baud rate of 921600 bps.
4. Put the module into the download mode before upgrading the firmware. Please refer to the "Download Methods" for the download circuit design.

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