EC800M&EG810M Series QuecOpen Reference Design

LTE Standard Module Series

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Status: Released

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Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

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About the Document

Revision History

Version	Date	Author	Description
-	2022-06-01	Mark YANG	Creation of the document
1.0	2022-09-26	Mark YANG	First official release
1.1	2023-01-05	Howell KANG/ Cuby LI	1. Added Bluetooth Interface Design (Sheets 1, 3 and 18). 2. Reserved test points for RESET_N and VDD_EXT (Sheets 1 and 17). 3. Added USB insertion enables automatic boot circuit (Sheet 4). 4. Added 1.8 pF and 3.8 pF ceramic capacitors, a 0 Ω resistor and related notes in VBAT design (Sheet 5). 5. Added resistors R0707 and R0708 (Sheet 7). 6. Added the note about reserving 33 pF capacitor of Audio Codec Design (Sheet 14).
1.2	2024-05-23	Mark YANG/ Cuby LI	1. Incorporated the information of EC800M-CN and EG810M-CN reference design into this document. 2. Added a new variant EG810M-EU and related information. 3. Added Wi-Fi & Bluetooth interface design (Sheets 1, 2, 3, 4, 5, 8 and 19). 4. Updated the following information in module interfaces design (Sheet 3): Updated the pin 44 (RESERVED) and the pin 99 (RESERVED) to GNSS_VBCKP and 1PPS respectively, and added related notes; Updated the resistance of resistors that connected to power supply on ADC interfaces' voltage divider circuit from 100 kΩ to 100 kΩ–1 MΩ;

	Added 33 pF filter capacitors on the signal traces of USIM1 interface. 5. Updated the resistance of pull-up resistor R0608 on USIM2_DATA signal trace from 15 kΩ to 7.5 kΩ (Sheet 6).

Contents

1 Reference Design

1.1. Introduction

This document provides the reference design for Quectel EC800M-CN and EG810M series (EG810M-CN and EG810M-EU) modules in QuecOpen® solution, including block diagram, power system block diagram, module interfaces, power supply design, analog audio interface, USIM interface, UART and other designs.

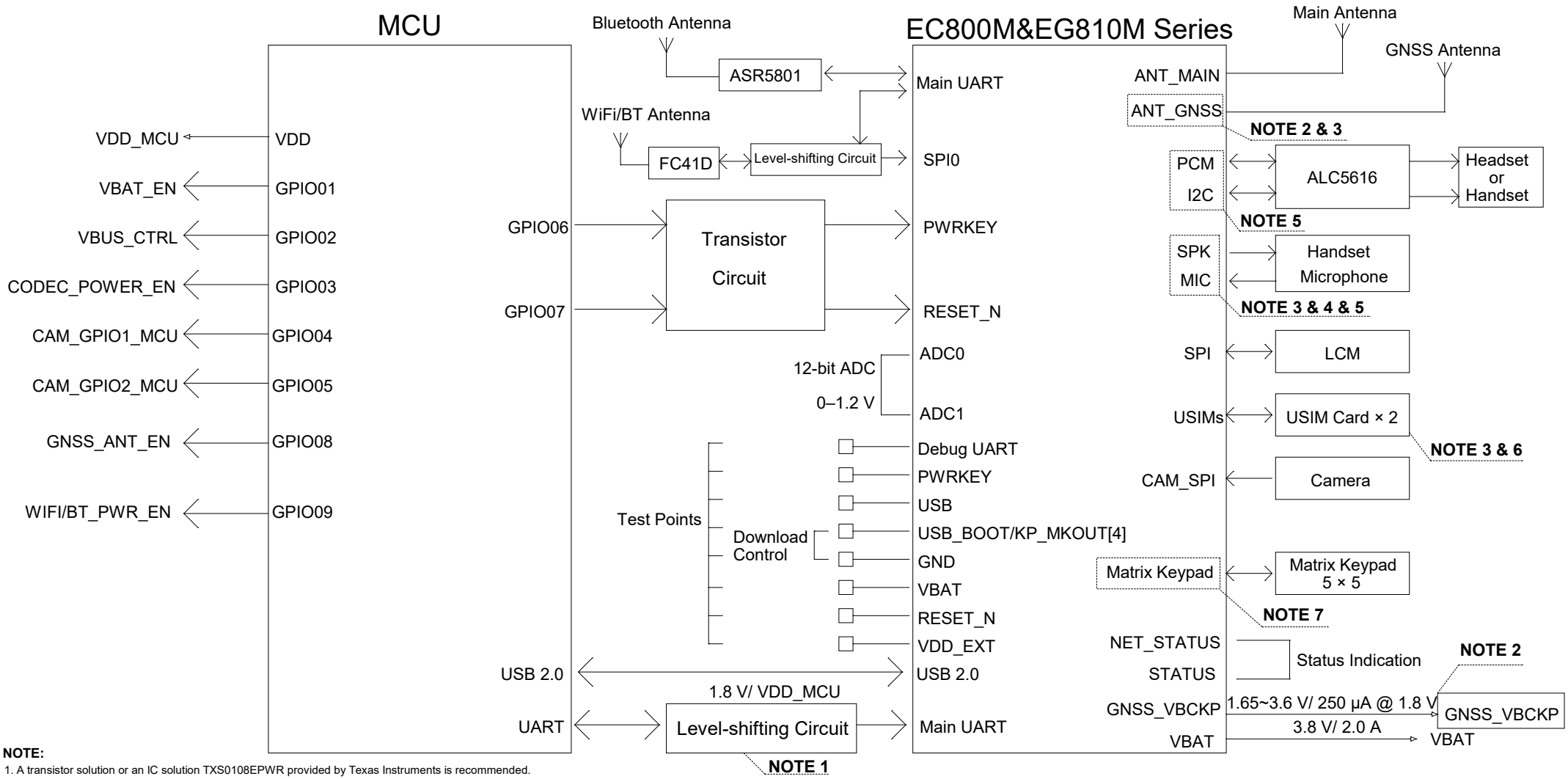
1.2. Schematics

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

NOTE

It is required to confirm the applicability and price from the supplier about the IC involved in the reference design.

Block Diagram



NOTE:

1. A transistor solution or an IC solution TXS0108EPWR provided by Texas Instruments is recommended.
2. For EC800M-CN and EG810M-CN, GNSS function is optional. EG810M-EU does not support GNSS function.
3. When using the analog audio input function of EC800M-CN, please note that:
   a) If the module with GNSS function is selected, an external microphone bias circuit is required. And MICBIAS must be provided with 1.8 V power supply by using a low-noise LDO. Only USIM1 interface is supported in this situation.
   b) If the module without GNSS function is selected, external microphone bias circuit is unnecessary. And dual USIM cards are supported in this situation.
4. When using the analog audio input function of EG810M-CN and EG810M-EU, an external microphone bias circuit is not required.
5. PCM, I2C and analog audio functions of the modules are optional.
6. For EC800M-CN and EG810M-EU, USIM2 interface is optional, and if the interface is required, please contact Quectel Technical Support. EG810M-CN only supports USIM1 function.
7. EG810M-EU only supports 3 × 3 Matrix Keypad.

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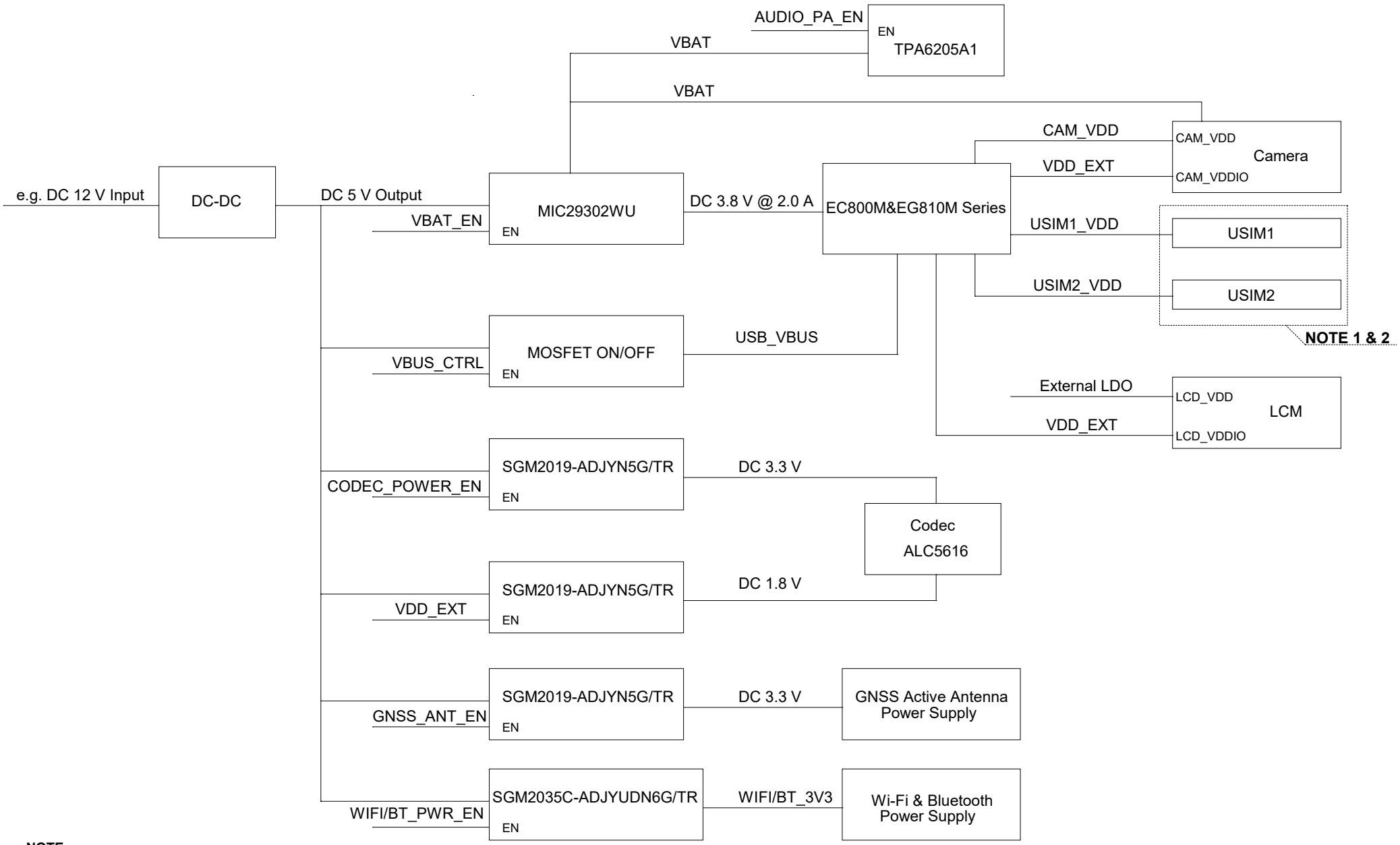
Power System Block Diagram



NOTE:

1. For EC800M-CN and EG810M-EU, USIM2 interface is optional, and if the interface is required, please contact Quectel Technical Support.
2. EG810M-CN only supports USIM1 function.

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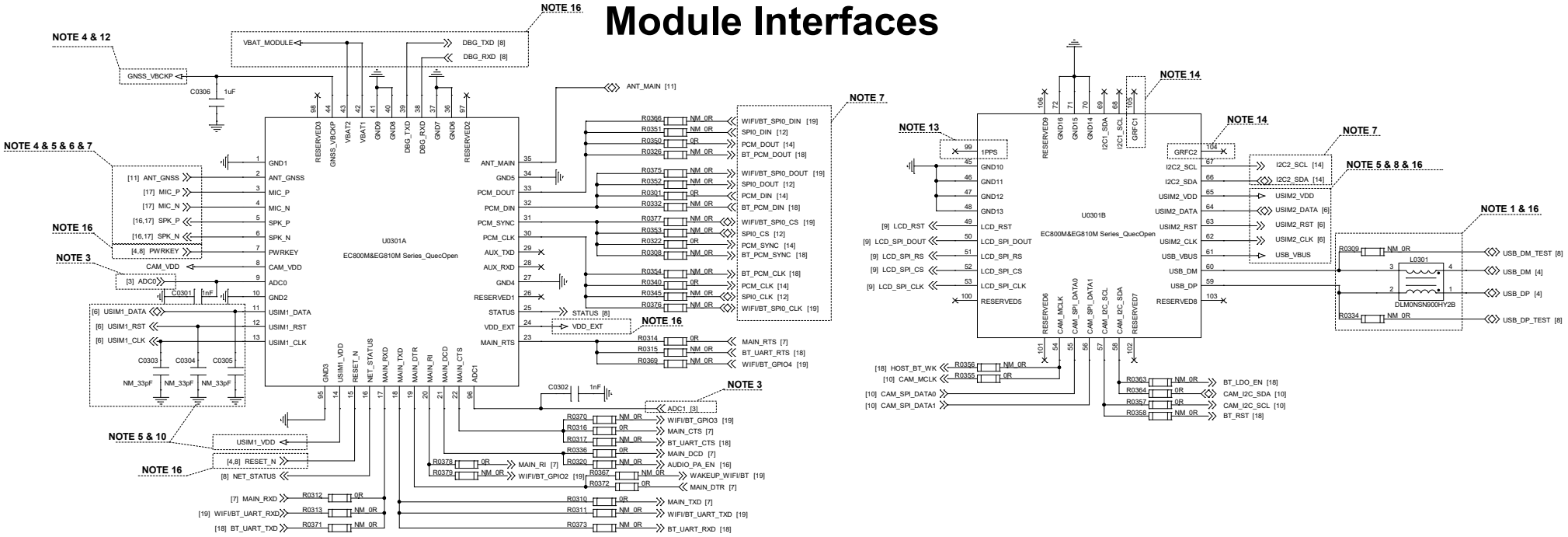
Module Interfaces



NOTE:

1. It is recommended to add a common mode choke L0301 in series between the module and your MCU to suppress EMI.
   Additionally, test points must be reserved over USB_DP and USB_DM for firmware upgrades, and it is recommended to minimize extra trace stubs.
   Place L0301 and two resistors, R0301 and R0302, close to the module to ensure USB signal integrity.
2. USB_BOOT/KP_MKOUT[4] cannot be pulled down to low level before the module starts up successfully.
3. The input voltage range of ADC0 and ADC1 is 0–1.2 V. A voltage divider circuit with two resistors must be used for ADC0 and ADC1 voltage inputs respectively,
   and the required resistance of the two resistors (R0304 and R0306) that connected to VDD_MCU is between 100 kΩ and 1 MΩ. The accuracy of the resistors directly affects ADC sampling error.
   It is recommended to use resistors with 1 % accuracy. For higher ADC accuracy, resistors with 0.5 % accuracy are recommended.
4. For EC800M-CN and EG810M-CN, GNSS function is optional. EG810M-EU does not support GNSS function.
5. When using the analog audio input function of EC800M-CN, please note that:
   a) If the module with GNSS function is selected, an external microphone bias circuit is required. And MICBIAS must be provided with 1.8 V power supply by using a low-noise LDO.
      Only USIM1 interface is supported in this situation.
   b) If the module without GNSS function is selected, external microphone bias circuit is unnecessary. And dual USIM cards are supported in this situation.
6. When using the analog audio input function of EG810M-CN and EG810M-EU, an external microphone bias circuit is not required.
7. PCM, I2C and analog audio functions of the modules are optional.
8. For EC800M-CN and EG810M-EU, USIM2 interface is optional, and if the interface is required, please contact Quectel Technical Support.
   EG810M-CN does not support USIM2 function, and pins 62–65 are RESERVED.
9. EG810M-EU only supports 3 × 3 Matrix Keypad, and pins 84–87 are RESERVED.
10. The 33 pF capacitors of USIM1 should be reserved, and be used according to the actual debugging situation.
11. Connect all GND pins to ground, and keep unused and RESERVED pins open.
12. For EC800M-CN and EG810M-CN, GNSS_VBCKP (pin 44) is optional. For EG810M-EU, pin 44 is RESERVED.
    GNSS_VBCKP requires that the voltage domain is 1.65–3.6 V, with a typical value of 1.8 V, and 250 μA @ 1.8 V external current should be provided.
    A 1 μF filter capacitor is needed to be placed close to the pin. The circuit of backup power supply input for GNSS part need to be designed by yourself.
    For more details, please contact Quectel Technical Support.
13. For EG810M-CN, 1PPS (pin 99) is optional. For EC800M-CN and EG810M-EU, pin 99 is RESERVED.
14. For EG810M-CN and EG810M-EU, pins 104 and 105 are GRFC interface. For EC800M-CN, pins 104 and 105 are RESERVED.
15. Ensure an uninterrupted reference ground plane below the module, with minimal distance between the ground plane and the module layer.
    Avoid routing other traces on the first layer adjacent to the module layer. At least four-layer board design is recommended.
16. Test points must be reserved for DBG_TXD/RXD, USB_DP/DM and USB_VBUS. It is recommended to reserve test points for VDD_EXT, USB_BOOT/KP_MKOUT[4], PWRKEY and VBAT.
    If RESET_N is unused, it is recommended to reserve a test point.

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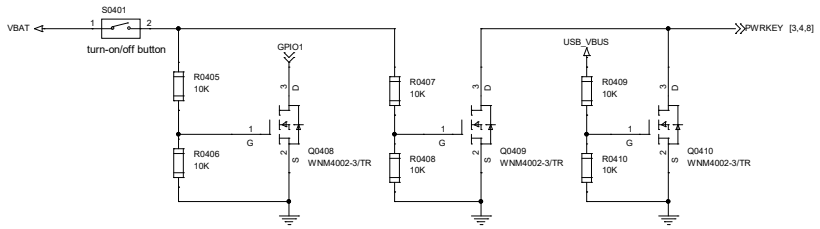
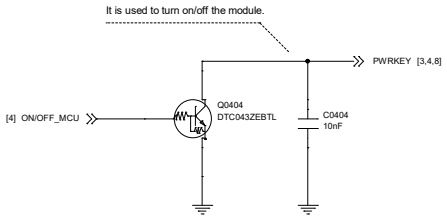
MCU Interfaces

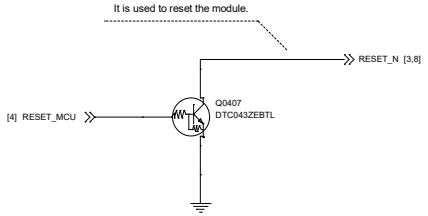
USB Insertion Enables Automatic Boot

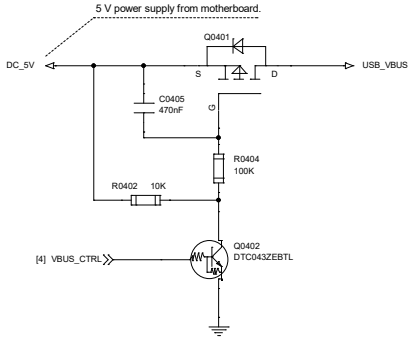


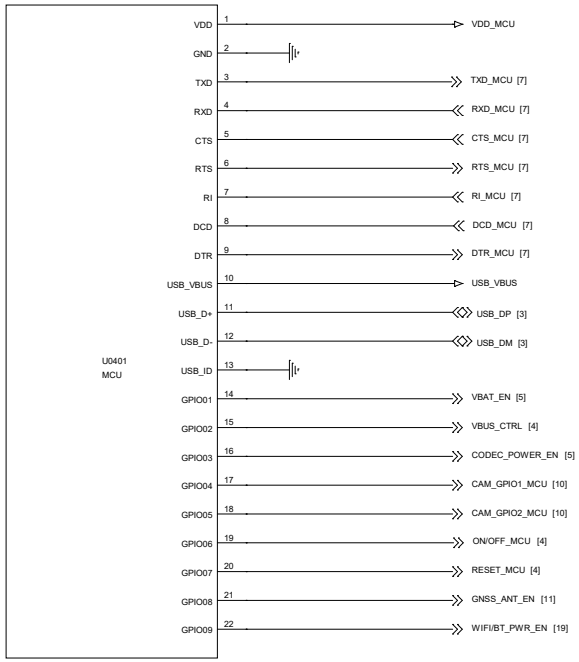
NOTE:

1. When USB is inserted, the module cannot be shut down nomally, and will boot automatically after the shut down.
2. When USB is inserted, the level states of GPIO1 and PWRKEY pins are used to determine whether the module is turned on by the turn-on/off button or USB insertion.
   GPIO1 utilizes the GPIO resource with a default pull-up (PU) state.









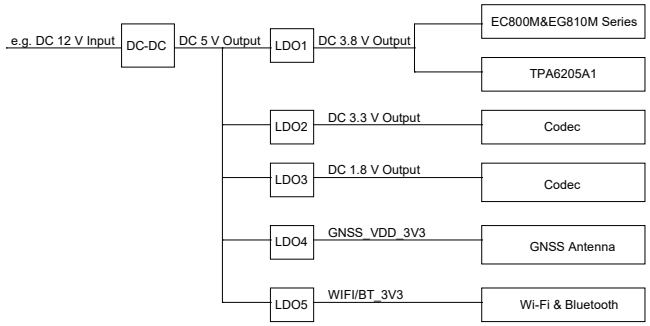
NOTE:

1. If the power domain of your MCU (U0401) is also 1.8 V, the level-shifting circuit is not necessary as it matches the 1.8 V power domain of the module's GPIO interfaces.
2. The USB interface of the module can only serve as a slave device 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 OTG function.
   For USB detection, the USB_VBUS pin of the module should be powered by an external power system. Use VBUS_CTRL to control the on/off state of the USB_VBUS power supply.
3. It is recommended to choose MCU GPIO pins with a default low level to control the module's PWRKEY and RESET_N pins. Ensure that the load capacitance on these pins does not exceed 10 nF.

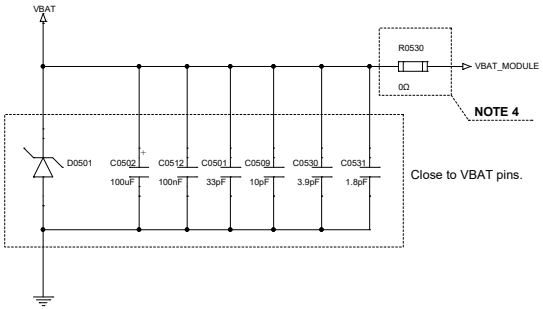
Power Supply Design

DC-DC Application

When the input voltage is above 7.0 V, use a DC-DC converter to convert the high input voltage to a 5.0 V output, and then use LDOs to convert it to 3.8 V, 3.3 V and 1.8 V to power the module, aduio PA, Codec, GNSS antenna and Wi-Fi & Bluetooth.



VBAT Design

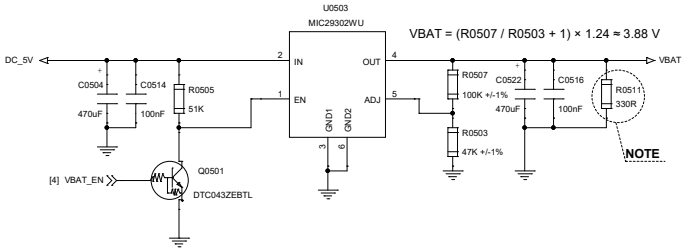


NOTE:

1. The power supply for the module should be capable of supplying a minimum current of 2.0 A.
2. The width of VBAT trace should be at least 2 mm.
3. The recommended operating voltage range for VBAT is 3.4 V to 4.3 V, with a typical value of 3.8 V.
4. It is recommended to reserve a 0 Ω resistor (minimum package size: R-0603) near the VBAT pins for future debugging purposes.

LDO Application

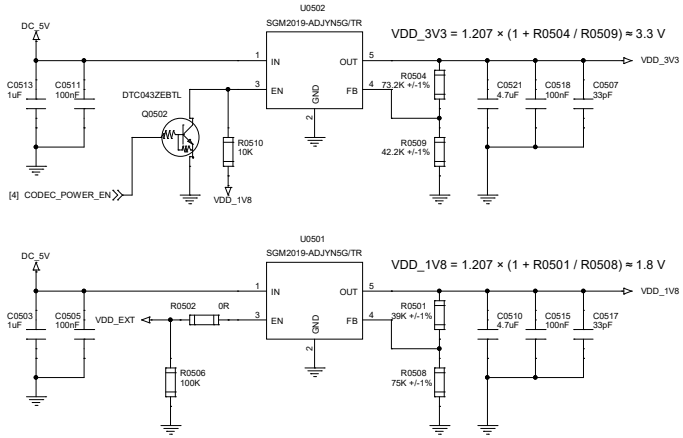
When the input voltage is below 7.0 V, use an LDO to convert the input voltage to 3.8 V.



NOTE:

The recommended load current should exceed 10 mA.

Power Supply for Codec



NOTE:

1. VDD_EXT and CODEC_POWER_EN are used to turn on/off VDD_1V8 and VDD_3V3 respectively.
2. To ensure proper functioning of the audio codec, adhere to the following power-up/down sequences:

   Power-up sequence: power on VDD_1V8 first, followed by VDD_3V3.

   Power-down sequence: power off VDD_3V3 first, followed by VDD_1V8.

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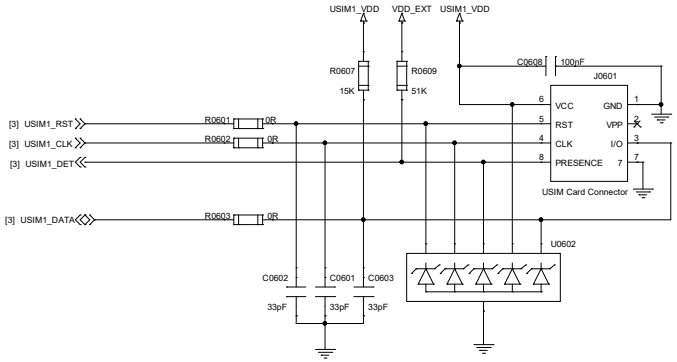
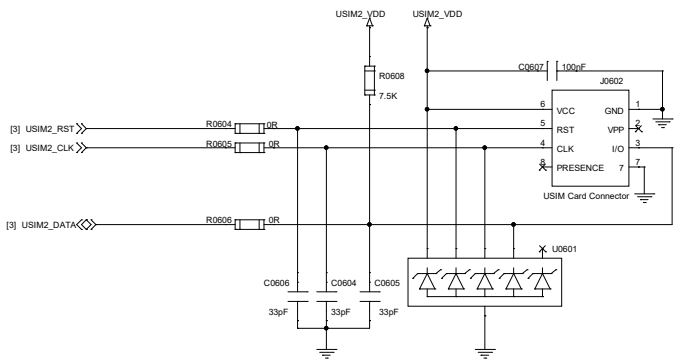
USIM Interface Design

USIM1



USIM2



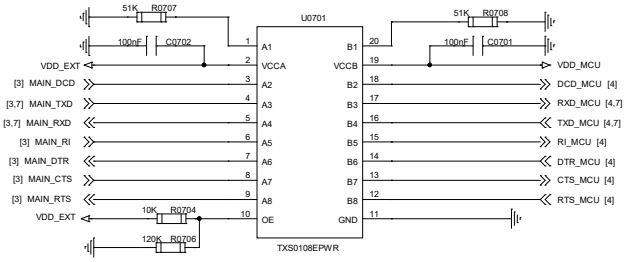
NOTE:

1. It is recommended to use U0601 and U0602 for effective ESD protection with a parasitic capacitance below 15 pF.
2. For USIM_DATA, it is recommended to add a 15 kΩ pull-up resistor R0607 and a 7.5 kΩ pull-up resistor R0608 near the (U)SIM card connector to improve the anti-jamming capability of the (U)SIM card.
3. R0601–R0606 are used for debugging, and C0601–C0606 used for filtering out RF interference should be placed close to the USIM card connector.
4. The capacitance of C0607 and C0608 should be less than 1 μF and they should be placed close to the USIM card connector.
5. When using the analog audio input function of EC800M-CN, please note that:
   a) If the module with GNSS function is selected, an external microphone bias circuit is required. And MICBIAS must be provided with 1.8 V power supply by using a low-noise LDO. Only USIM1 interface is supported in this situation.
   b) If the module without GNSS function is selected, external microphone bias circuit is unnecessary. And dual USIM cards are supported in this situation.
6. For EC800M-CN and EG810M-EU, USIM2 interface is optional, and if the interface is required, please contact Quectel Technical Support.
   EG810M-CN only supports USIM1 function.
   Only USIM1 supports hot-plug function.

UART Interface Design

UART Level-shifting Circuit - Transistor Solution

UART Level-shifting Circuit - IC Solution



NOTE:

1. There are two level-shifting solutions: transistor solution and IC solution, and it is recommended to select the latter one.
2. The power supply of TXS0108EPWR's VCCA should not exceed that of VCCB. For more information, see the datasheet of TXS0108EPWR.
3. The transistor solution is not suitable for applications with high baud rates exceeding 460 kbps. The capacitors C0703 and C0704 of 1 nF can improve the signal quality.
4. MAIN_RTS and MAIN_DTR's level-shifting circuits are similar to that of the MAIN_RXD interface.
   MAIN_CTS, MAIN_RI and MAIN_DCD's level-shifting circuits are similar to that of the MAIN_TXD interface.
5. To increase the stability of UART communication, it is recommended to add UART hardware flow control design.

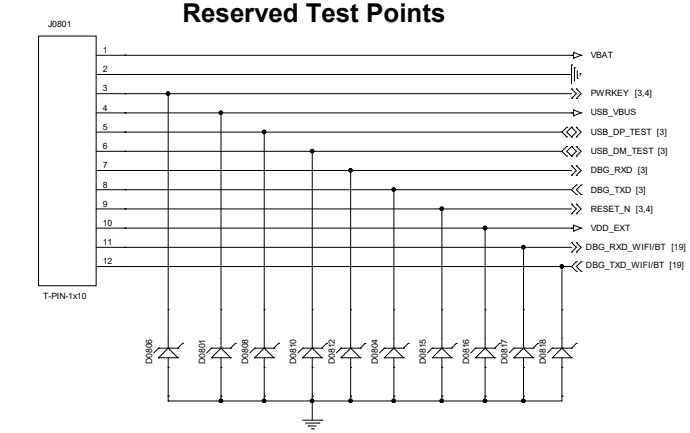
Other Designs

Indicators

NOTE:

1. For more details about STATUS and NET_STATUS, see the hardware design document of the module.
2. To minimize the module's power consumption during the sleep mode of your device, replace the power supply (VBAT) of the STATUS and NET_STATUS indicators with externally controllable sources and turn off the indicators when the module is in sleep mode.

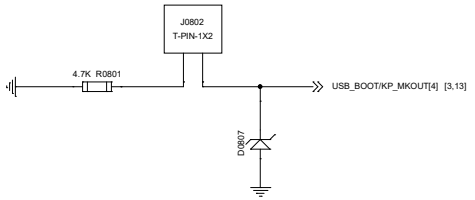
Reserved Test Points



NOTE:

1. Test points for both USB and debug UART interfaces are reserved for capturing logs.
2. Test points for USB interface can also be reserved for firmware upgrade.
3. The junction capacitance of the ESD protection componets on USB data traces should be less than 2 pF.
4. The debug UART interface supports a 1.8 V power domain. If your application operates at 3.3 V, use a voltage-level translator.

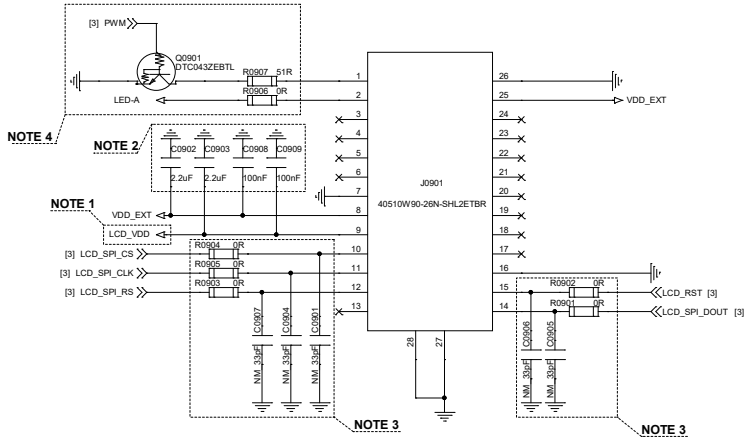
USB_BOOT Interface



NOTE:

1. Make sure to reserve the USB_BOOT interface design and it is recommended to reserve a test point for USB_BOOT/MKOUT[4].
2. Before turning on the module, pull USB_BOOT/KP_MKOUT[4] down to GND to activate the forced download mode. This mode enables firmware upgrades via the USB interface.
3. The 6.0 and above version of QFlash tool must be used for firmware upgrading.

LCM Interface Design



NOTE:

1. It is recommended to design LCM power supply by yourself.
2. To avoid abnormal LCD display caused by power fluctuation, it is recommended to mount filter capacitors.
3. Reserve 33 pF capacitors for the signal pins for debugging.
4. The LED-A backlight power supply should be designed by yourself. Select an appropriate resistor (R0907) based on the rated current of the digital transistor and the LED-A voltage value.

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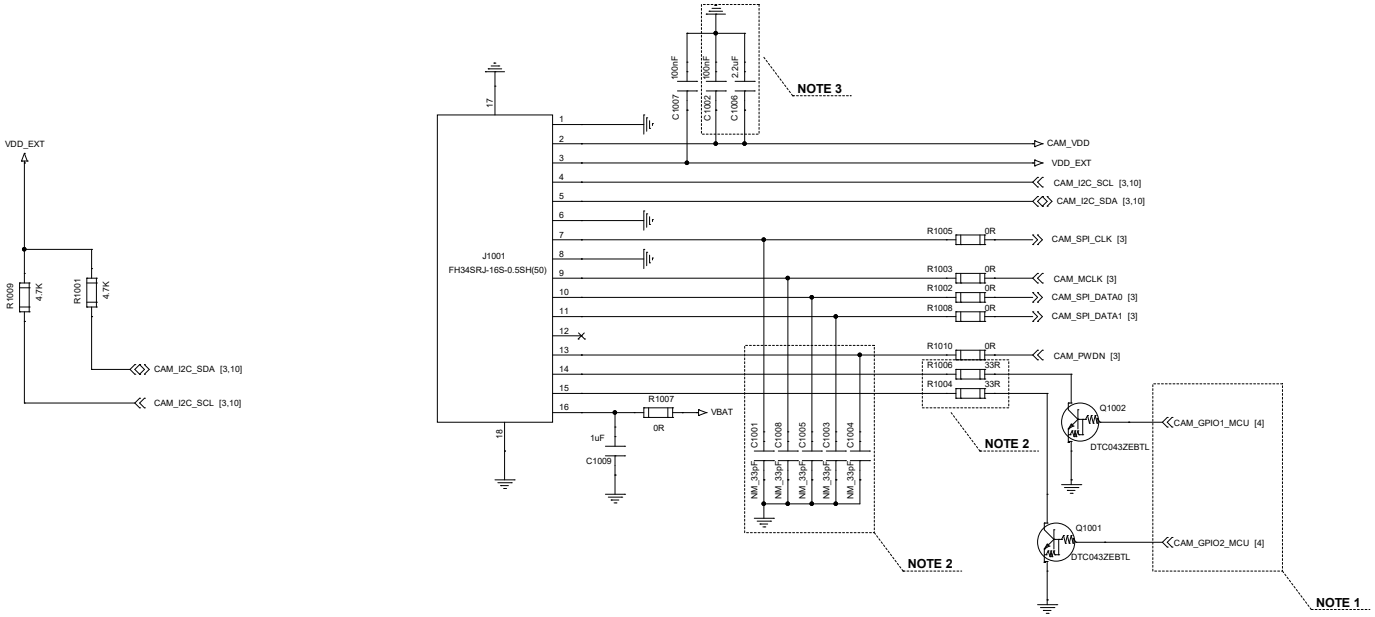
Camera Interface Design



NOTE:

1. To control the cathode of the camera's positioning light, use CAM_GPIO1_MCU with a triode switching circuit.
   Similarly, CAM_GPIO2_MCU controls the cathode of the camera's supplement light. It is recommended to choose GPIO pins that are in a pull-down state by default as these two control pins.
2. Reserve 33 pF capacitors for the signal pins and use them for debugging.
   The values of current limiting resistors for the positioning light and supplement light (R1004 and R1006) should be adjusted based on the desired brightness level.
3. Connect the capacitors (C1002 and C1006) of the CAM_VDD power supply directly to the GND layer.
   Failure to do so may result in power supply noise causing abnormalities such as white dots on the preview screen.

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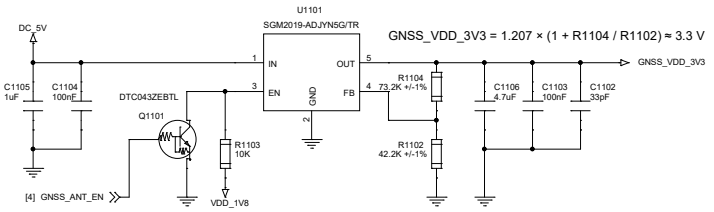
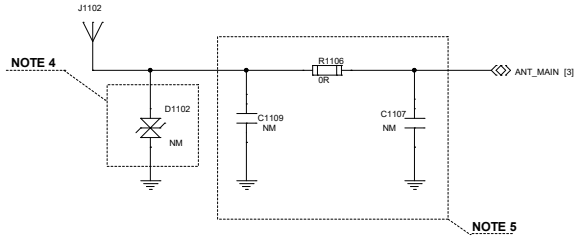
Antenna Interface Design

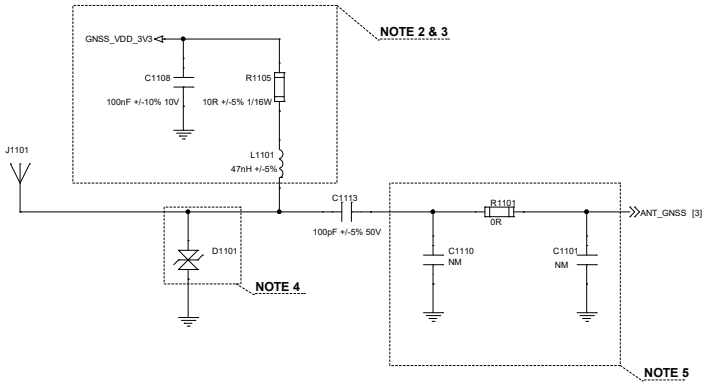
GNSS Active Antenna Power Supply



Main Antenna Design



GNSS Antenna Design



NOTE:

1. For EC800M-CN and EG810M-CN, GNSS function is optional. EG810M-EU does not support GNSS function.
   The above GNSS antenna design is specifically intended for modules with built-in GNSS functionality.
2. For active antennas, select an external LDO according to the active antenna types. In case of passive antennas, the VDD circuit is not necessary.
3. L1101, R1103, C1101 are recommended to be placed close to the RF traces during layout.
4. It is recommended to reserve an ESD protection component for the antenna interface and the junction capacitance should not exceed 0.05 pF.
5. Reserve a Π-type matching circuit at antenna interface.
6. The single-ended impedance of the RF antenna is 50 Ω, and length should be minimized.
7. The external active antenna power supply voltage range is 2.8 V to 4.3 V, with a typical value of 3.3 V.
   The power supply voltage can be designed according to the power supply requirements of the selected active antenna.

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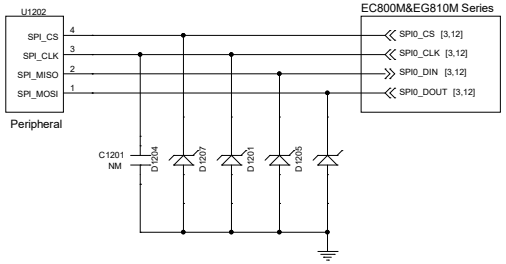
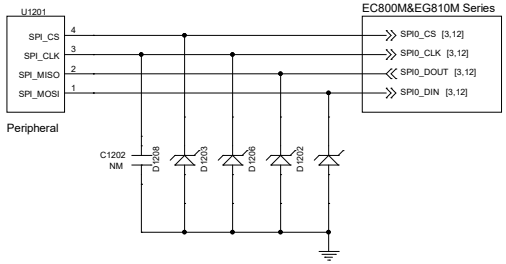
SPI Design

Module As Master



Module As Slave



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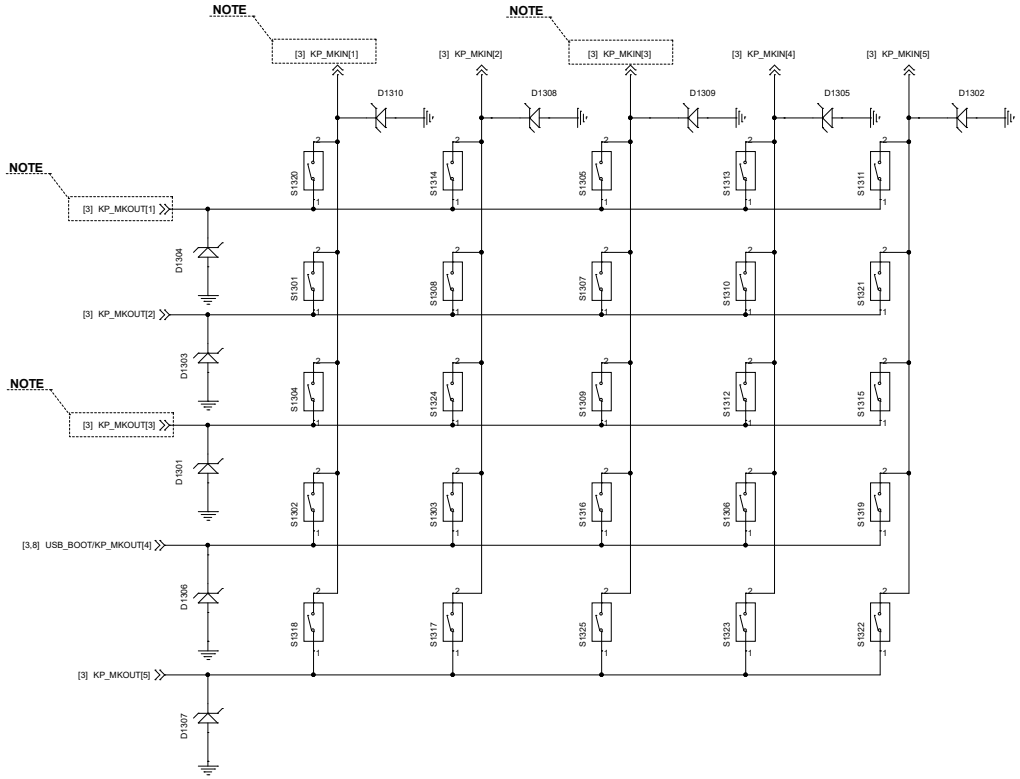
Matrix Keypad Design



NOTE:

EG810M-EU only supports 3 × 3 Matrix Keypad, pins 84–87 are RESERVED.

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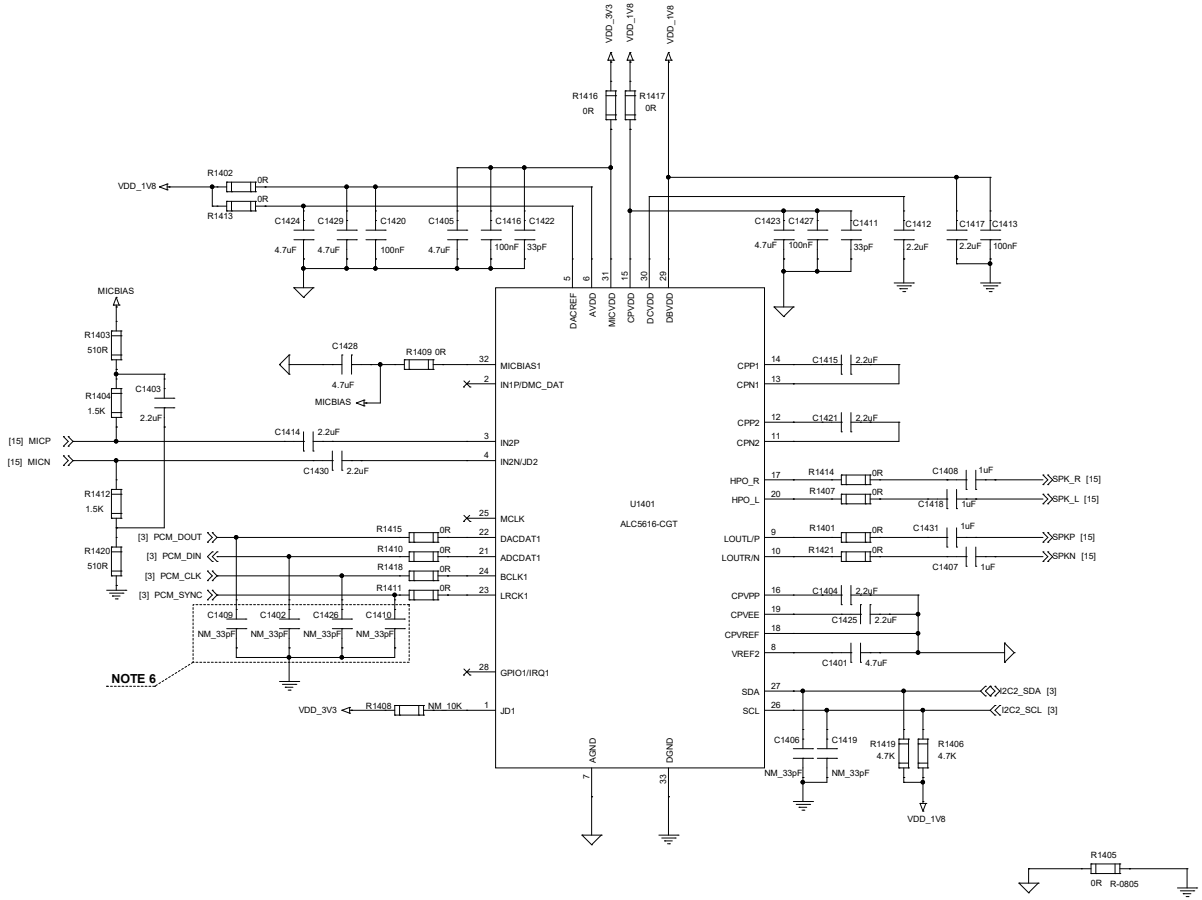
Audio Codec Design (ALC5616)



NOTE:

1. ALC5616 power-up sequence: DBVDD/I2C pull-up power/AVDD/DACREF/CPVDD → MICVDD → software initialization.
2. ALC5616 power-down sequence: disable Codec function by software → MICVDD → DBVDD/I2C pull-up power/AVDD/DACREF/CPVDD.
3. Ensure all power supplies for the codec are powered on before the module automatically initializes the codec via the I2C interface.
4. Differentiate between analog ground and digital ground. Connect analog ground and digital ground using a 0 Ω resistor (R-0805). Refer to "Audio Codec Interface Design" for more details.
5. For more details, see the datasheet of ALC5616.
6. Reserve 33 pF capacitors for the signal pins for debugging.

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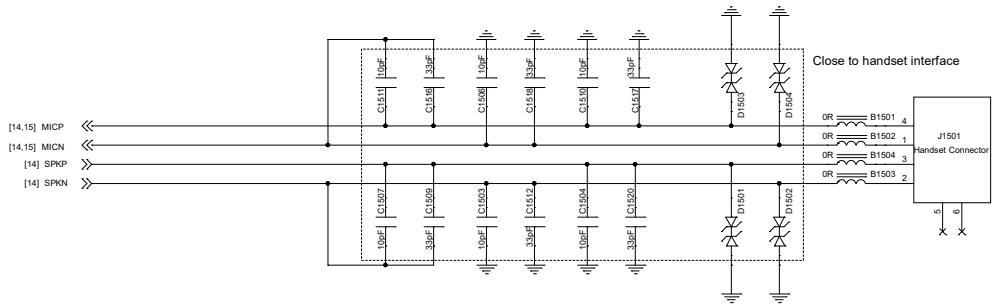
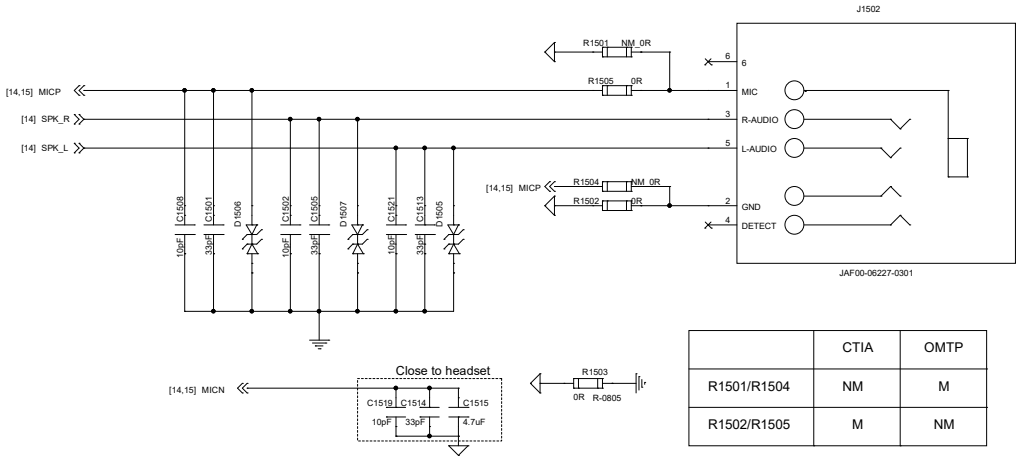
Audio Codec Interface Design

Handset Application



Headset Application

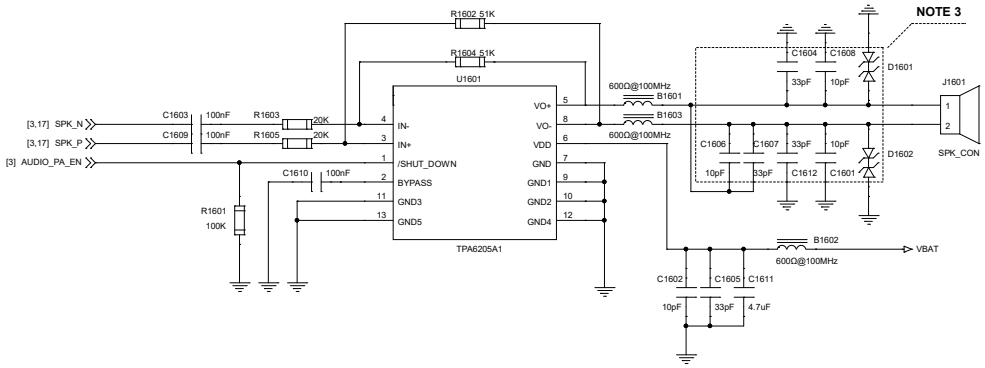


	CTIA	OMTP
R1501/R1504	NM	M
R1502/R1505	M	NM

NOTE:

1. The Codec analog output can drive handset and headset. For larger power loads such as loudspeaker, add an audio power amplifier in the design.
2. In handset applications, route the MIC and SPK signal traces as differential pairs.
3. In headset applications, route the MIC signal traces as a differential pair.
4. Surround all MIC and SPK signal traces with ground on the same layer and with ground planes above and below to minimize noise interference, such as clock and DC-DC signals.
5. Differentiate between analog ground and digital ground. Analog ground should have a direct via to digital GND through a 0 Ω resistor (R-0805).

Analog Audio Design (Audio Power Amplifier)



NOTE:

1. SPK_P and SPK_N channels are differential output channels intended for connecting to an external audio power amplifier.

   To eliminate Pop noise, it is recommended to utilize MAIN_DCD of the module as the control signal for the audio power amplifier's enable pin.

2. The power amplifier above is for reference only. Select the appropriate audio power amplifier according to actual needs.
3. When designing the layout, ensure that filter capacitors and ESD protection components are placed close to the loudspeaker to filter out interference and provide adequate protection.
4. The selection of ESD protection components should consider the output voltage range of the audio power amplifier.

   Ensure that the output voltage of the amplifier remains within the maximum reverse working voltage range of the selected ESD protection components under normal operating conditions.

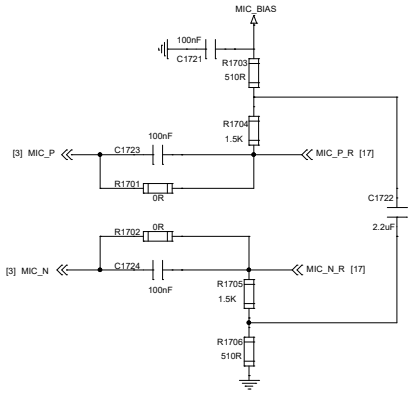
   This precaution helps prevent damage to the ESD protection components.

5. The analog audio function is optional. If this interface is not used, keep it open.

Analog Audio Design

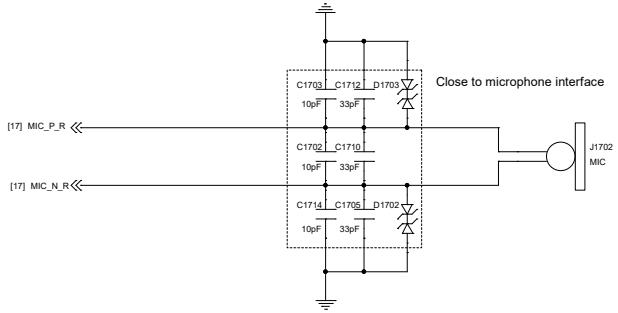
NOTE 1

Microphone Bias Circuit

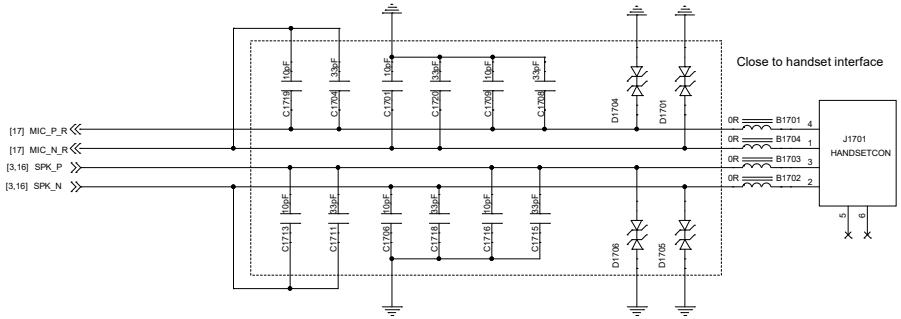


Case	C1721/C1722/C1723/C1724 R1703/R1704/R1705/R1706	R1701/R1702
With external microphone bias circuit	M	NM
Without external microphone bias circuit	NM	M

Microphone Application



Handset Application



NOTE:

1. When using the analog audio input function of EC800M-CN, please note that:
   a) If the module with GNSS function is selected, an external microphone bias circuit is required. And MICBIAS must be provided with 1.8 V power supply by using a low-noise LDO. Only USIM1 interface is supported in this situation.
   b) If the module without GNSS function is selected, external microphone bias circuit is unnecessary. And dual USIM cards are supported in this situation.
2. Both the MIC and SPK signal traces need to be routed as differential pairs.
3. Surround all MIC and SPK signal traces with ground on the same layer and with ground planes above and below to minimize noise interference.
4. In the audio design, you can choose either the analog audio or the codec.
5. It is recommended to use 10 pF and 33 pF capacitors to filter RF interference.
6. Analog audio function of module is optional.

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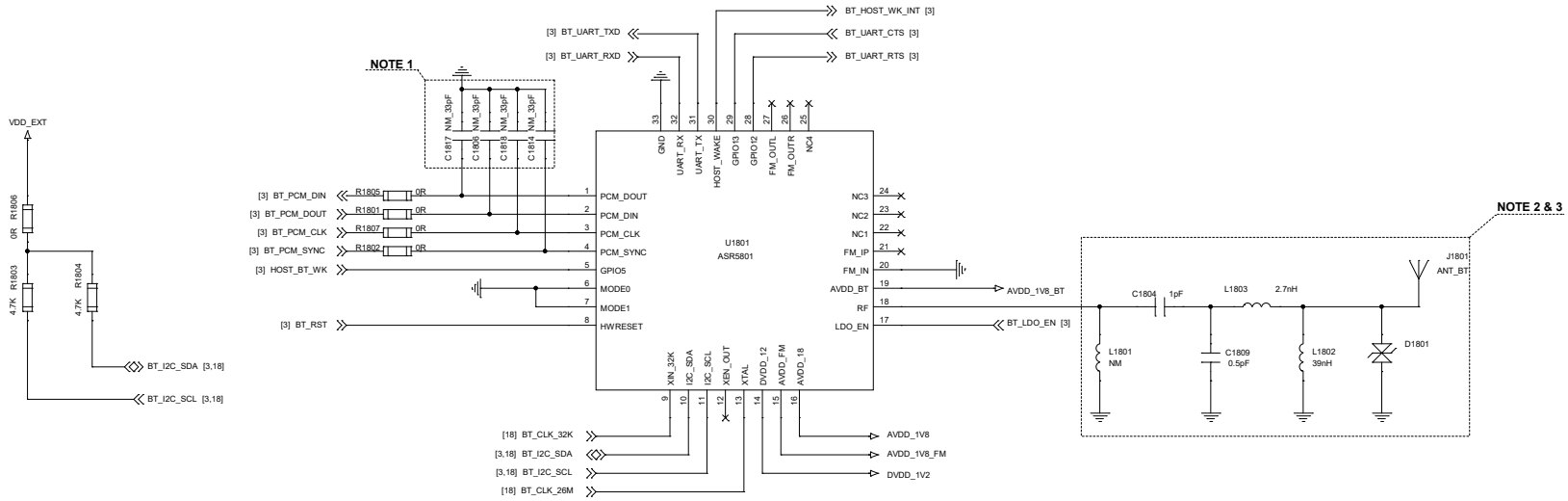
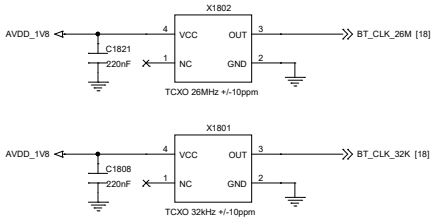
Bluetooth Interface Design



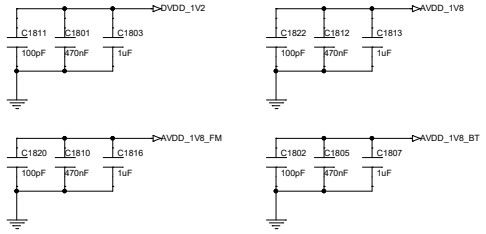
NOTE:

1. Reserve 33 pF capacitors for the signal pins for debugging.
2. It is recommended to reserve an ESD protection component for the antenna interface and the junction capacitance should not exceed 0.05 pF.
3. The single-ended impedance of the RF antenna is 50 Ω, and length should be minimized.



NOTE:

26 MHz and 32 kHz oscillators are recommended to be used and you need to design power supply circuits by yourself.



NOTE:

Design the 1.8 V ±0.1 V (at least 150 mA external current should be provided) power supply (AVDD_1V8) for the Bluetooth chip to provide the required voltage for its operation, and the remaining three power supply pins (DVDD_1V2, AVDD_1V8_FM and AVDD_1V8_BT) are internal power supply pins of the chip to be connected to external filter capacitors.

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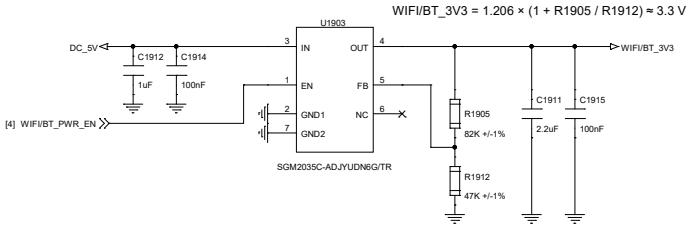
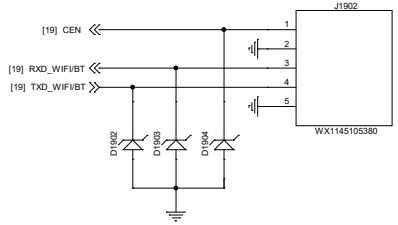
Wi-Fi & Bluetooth Interface Design

Power Supply for FC41D



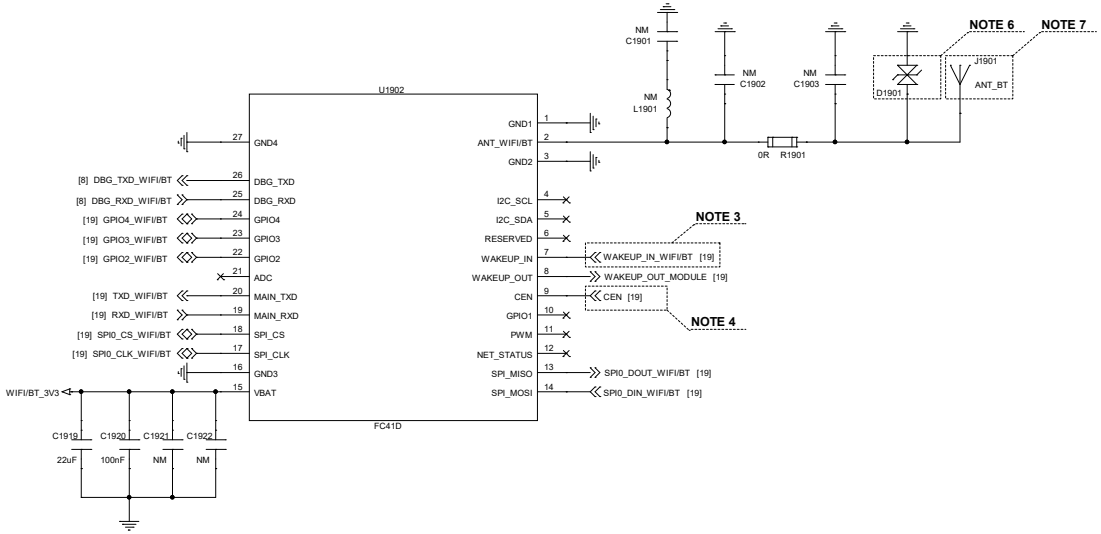
Download Interface Design

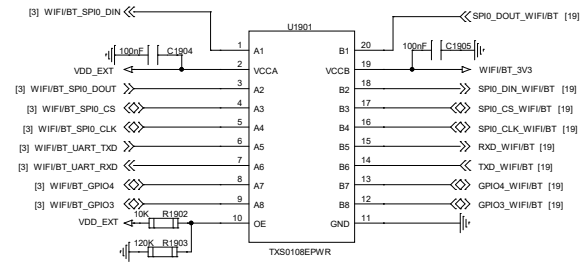


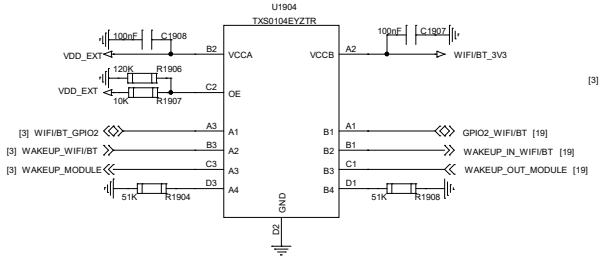
NOTE:

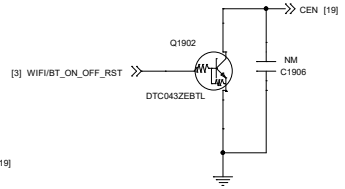
Firmware upgrade steps:

1. Click the "burn" button of the software download tool.
2. Connect the CEN to GND at STA mode for two seconds.
3. Release CEN.









NOTE:

1. WIFI/BT_3V3 trace is recommended to be wider than 0.3 mm. In principle, the longer the WIFI/BT_3V3 trace is, the wider it should be.
2. The main UART or SPI can be selected to transmit Wi-Fi and bluetooth data from the module to FC41D according to your actual design, but based on the software version, main UART will be selected by default.
3. You can use the rising edge of WAKEUP_IN (pin 7) to wake up the FC41D module.
4. Pull down CEN pin and then cut off WIFI/BT_3V3 to turn off the module to save power.
5. When using the PCB antenna, the module should be placed at the side of the motherboard and kept away from metal components, and the clearance of PCB antenna should be kept as large as possible.
6. It is recommended to reserve an ESD protection component for the antenna interface and the junction capacitance should not exceed 0.05 pF.
7. The single-ended impedance of the RF antenna is 50 Ω, and length should be minimized.

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